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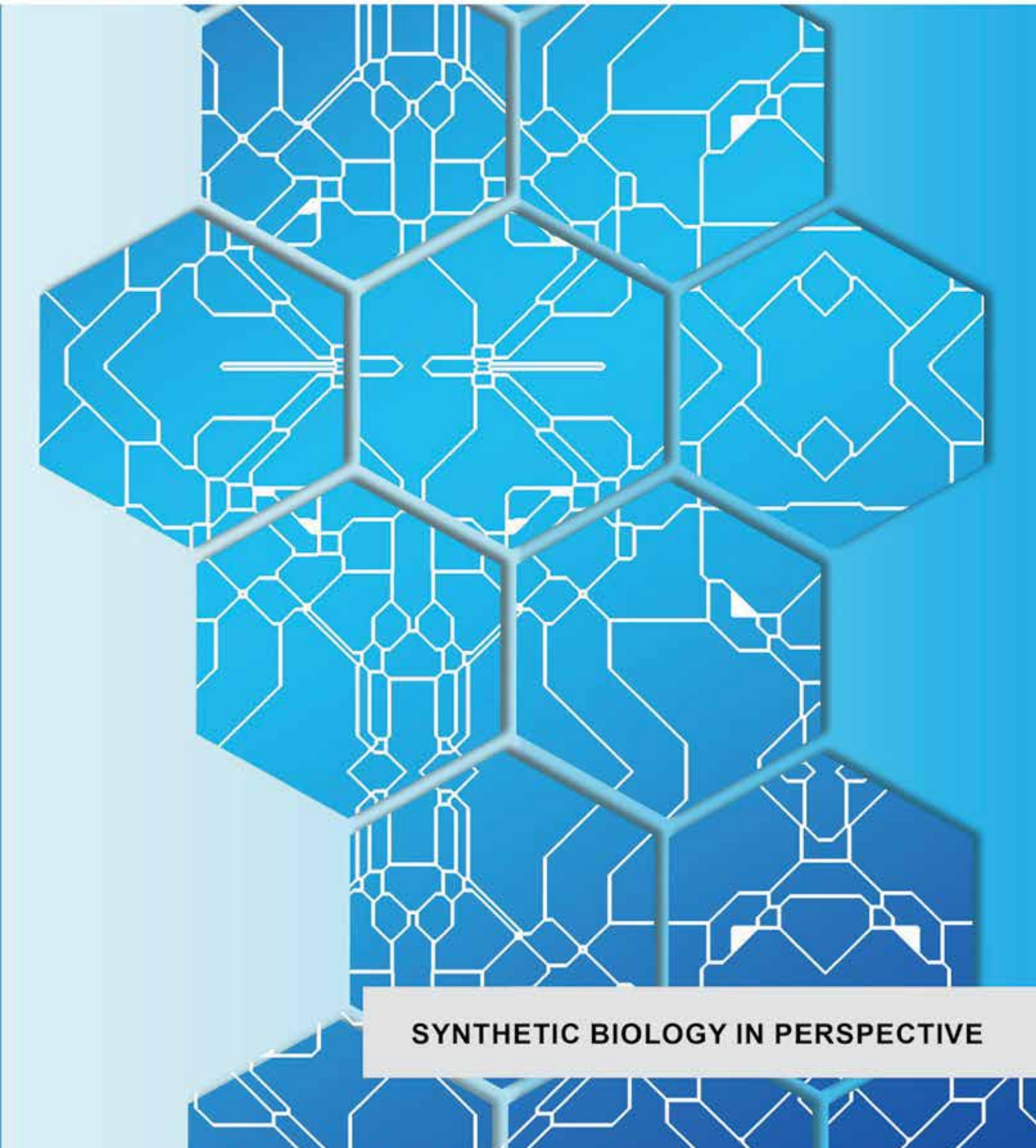

SYNTHETIC BIOLOGY IN PERSPECTIVE

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phone: +48 22 818 09 18, +48 22 818 98 32
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e-mail: sekretariat@sigma-not.pl

EDITOR'S ADDRESS/ADRES REDAKCJI:

Ratuszowa Street 11, VII p., 00-950 Warsaw, p.o. box 1004
phone: +48 22 818 09 18, +48 22 818 98 32
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On the occasion of the upcoming Christmas we would like to wish you that this special time would pass in good health, joy and a warm family atmosphere.

We wish you all the best in your private and professional life, as well as many successes in the upcoming New Year 2020.

Editorial Staff

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SCIENCE AND INDSTRY IN A COUNTRY OF CHAGES

Grzegorz GRYNKIEWICZ

Professor in Pharmaceutical Research Institute
Łukasiewicz R&D Network, Pharmaceutical Research Institute,
Rydygiera 8, 01-793 Warszawa,
e-mail: g.grynkiewicz@ifarm.eu

ORCID: 0000-0003-2439-2443

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SYNTHETIC BIOLOGY IN PERSPECTIVE

BIOLOGIA SYNTETYCZNA

Summary: *Towards the end of the XXth century, genetics expanded its scope not only in the field of structure and mechanisms of heredity, owing to progress in nucleic acid research including efficient sequencing and reassembly methods, but in acquiring precise tools which enable construction of new forms of life. Synthetic biology marks a radical change in practices of genetic manipulation from random mutations followed by selection, to design of specific DNA transformations attainable by application of genetic engineering methods. Mastering enzymatic gene splicing procedures and chemical synthesis of polynucleotides allowed perceiving macromolecules of life as "parts" or "bricks" amenable to specification, cataloguing and also fit for applications commensurable with the rules of engineering. The purpose of synthetic biology is to apply defined macromolecular constructs (abstracted from living matter or synthetic) as modules for construction of devices, sensors or switches, which can ultimately be integrated into self-sustained systems. Target applications of synthetic biology products ranges from biotechnological manufacturing of energy, fuels, chemicals, food and pharmaceuticals, through marker sensors and diagnostic devices, to various classes of therapeutics like antibodies, vaccines, probiotic microbes or modified immune cells. Thus, synthetic biology becomes an integral part of the prospective switch from present industrial reality to circular bioeconomy, which is the greatest challenge facing humanity.*

Keywords: *bioeconomy, bioengineering, biotechnology, xenobiology, biotransformations, biological constructs and devices, genetically modified organisms*

Streszczenie: *Na przełomie stuleci genetyka zyskała, w wyniku dogłębnych badań nad kwasami nukleinowymi, nowe specyficzne narzędzia modyfikacji materiału genetycznego, nieporównywalnie skuteczniejsze od wykorzystywanych uprzednio przypadkowych mutacji z następczą selekcją. W wyniku rozwoju różnych form biotechnologii, korzystających z narzędzi inżynierii genetycznej wyłoniła się (najpierw w formie postulatywnej) biologia syntetyczna, zakładając wykorzystanie funkcjonalnych biomakromolekuł jako elementów zamiennych (cegiełek lub podzespołów) do projektowania i konstrukcji większych modułów, systemów a wreszcie organizmów, spełniających z góry zadane założenia metaboliczne. Zadaniem biologii syntetycznej jest zapewnienie dostępności (docelowo w skali procesów przemysłowych) układów biologicznych zdolnych do korzystnego przetwarzania energii (szczególnie solarnej), transformacji składników biomasy w niskoemisyjne paliwa, półprodukty chemiczne, biopolimery oraz składniki żywności i leków. Inne zastosowania biologii syntetycznej koncentrują się w obszarze ochrony zdrowia; projektowane obecnie konstrukty będą spełniać role markerów i sensorów dla diagnostyki, probiotyków dla profilaktyki oraz przeciwciał, szczepionek a nawet celowo reprogramowanych komórek (np. układu immunologicznego) dla terapii lub medycyny rekonstrukcyjnej.*

Słowa kluczowe: *bioekonomia, bioinżynieria, biotechnologia, ksenobiologia, biotransformacje, konstrukty biologiczne, organizmy genetycznie modyfikowane*

Introduction

There is a general tendency to perceive the anthropocene period of the earth history in a dual and controversial perspective: as a rise of triumphant technical civilization able to support and sustain (at least thus far) large and dynamically growing populations, versus grim catastrophic perspective of inevitable global planetary damage caused by basically the same anthropogenic factors which stem from global industrialization.

It seems natural to look in time of predictable crisis towards Science as an ultimate guiding light, for general strategy as well as for particular technical solutions. Alas, many intellectualists share an opinion that scientific knowledge tends to be mismanaged by political forces, adding to already defined technical risk factors of industrial civilization [1-3]. Also, paradoxically, there are not clear cut and unanimous answers to simple questions about causative human factors in phenomena like global warming, though other visible environmental damages are easily attributable to industrial wastes, which cause legitimate public concerns deserving to be treated with the utmost caution [4-6]. The industrial double-edge sword seems to have drawn much attention recently, with experts suggesting that currently existing branches of manufacture can be made much safer, environment and human-friendly, basically by some gradual introduction of suitable laws and regulations [7-8]. However, it is reasonable to point out that history of civilization abounds in quantum leaps, which evoke new cycles based on exploitation of radical scientific and technological innovations.

In the life sciences domain we are currently experiencing, apart from incredible burst of information related technologies, remarkably dynamic translation of material manufacturing processes from synthetic organic chemistry to a novel realm of

Fig. 1. Green Chemistry pricipals.
Source: www.buddhajeans.com/encyclopedia

synthetic biology (SynBio), which emerged from more traditional disciplines as biochemistry, genetics, and classical biotechnology, with notable help of genetic engineering [9-11]. Based on already developed methodologies, it can be predicted that large sectors of production focused on such materials as fuels, polymers, chemical intermediates, pharmaceuticals, cosmetics, food additives and even nutrients, will transit from category of chemical processes to the most advanced new forms of biotechnology.

New bioeconomy, which is already present in the EU programs and regulations will rely to a large extent, on implementing SynBio principles for newly designed biological systems specialized in realizing complex biogenetical and metabolic sequences for mass production of organic materials [12-14]. It should be remembered that such transition from chemical to biological technologies, which in principle should help preservation of natural resources and slowing down environmental degradation, became feasible owing to fundamental discoveries made by generations of the 20th century scientists [15], among which some towering figures from Polish academic circles deserve particular attention as SynBio co-founders.

The era of omnipotent chemistry

Modern chemistry, armored by atomic and molecular theories, and supplemented with potent analytical tools, as well as plethora of methods (chemical reactions) for bond making and bond breaking, is less than two centuries old. Within that time, it has managed (with considerable help of equipment designed based on physical phenomena) to provide basic methodologies for identification, quantification, and structural analysis of compounds and composite materials found in surrounding environment. Moreover, driven by an ancient idea of metal transmutation, it strived from the beginning, to create new substances, based on mineral as well as organic natural resources.

From the time of serendipitous transformation of inorganic ammonium isocyanate salt into typically organic urea molecule, discovered by F. Wöhler in 1828 (by which date some hundreds of pure compounds of natural origin, like organic acids and their salts, alkaloids and their salts, glycosides and their components, etc., were already known) the collection of individual low molecular weight entities has grown to ca. 10^8 compounds, supplemented by rather difficult to assess number of new polymeric materials. Thus, chemistry demonstrated unprecedented ability to create previously nonexistent forms of matter, as well as facility to obtain by assembling from simpler elements, even the most complicated structures made by living organisms [16-18].

The total synthesis of complex organic molecules of natural origin, such as alkaloids, isoprenoids and acetogenins became initially a hallmark of academic excellence, but were soon followed by industrial achievements such as technical syntheses of biogenic amines, vitamins, hormones, antibiotics and their synthetic pharmaceutical mimetics and congeners [18-19]. The key role of discoveries in the field of catalysis (evolving from metal complexes, to biocatalysis and organocatalysis, along to newly created principles of Green Chemistry) has been underlined as evidence of catalytic chemical processes efficiency, crucial for economical and environmental reasons [20].

Mastering organic synthesis, involving many thousands of reactions and complex networks of competing pathways seemed particularly well suited for engagement of informatic tools to support choice of synthetic schemes for experimental validation. Fundamental concept of rethrosynthetic analysis, designed by R. Woodward and E.J. Corey [21-22] proved invaluable as a tool

Fot. 1. E. J. Corey (left) and Robert B. Woodward (right) at a conference in Uppsala, Sweden
Source: researchgate.net

for generations of synthetic chemists, but remained surprisingly recalcitrant to integration with current functional chemoinformatics. Basic methodological crisis in the field has been only recently overcome by valiant effort of Bartosz A. Grzybowski, who founded ingenious, powerful system of computer aided multistep chemical syntheses, called Chematica [23].

This breakthrough development is particularly valuable for planning multistep syntheses of pharmaceutical active substances, which involve decision making based not only on synthetic literature references but also on intellectual property status of target compounds as well as their intermediates [24]. Based on these successes in creating molecules of life, as well as newly designed materials to perform specific functions, chemistry has claimed central place among life sciences and material sciences. Moreover, structural representations commonly used in traditional chemistry became adapted as lingua franca for all molecular structure and molecular dynamics descriptions [25].

Accordingly, the extensive span of chemical disciplines participation in the leading breakthrough technologies striving for new materials, processes and devices to be applied for example for energy production, conversion and storage, is a matter of continuous experts debate [26-27]. Following the famous R. Feynman's advice concerning need for miniaturization, chemistry has already stepped down towards nanotechnology, microfluidics, microreactors, nanoswitches, microdevices etc. At this end the convergence of traditionally divided "two cultures" of chemistry and biology [28] becomes inevitable as they both in principle concern the molecular architecture perceived in a functional perspective.

Emergence of systems biology, chemical biology, and functional derivative – synthetic biology

In short, synthetic biology constitutes application of engineering principles to biology. Since it is a relatively new field of research, which spans over more established disciplines like genetics, biotechnology and molecular biology, it is easier to present its goals and methodology through recall of some milestones in evolution of modern life sciences.

The most significant advancement of biology leads from Mendel's observation of heredity principles, through formulation of theory of evolution, to modern genetics described in terms of nucleic acids biosynthesis and replication. Although a book entitled "La biologie synthetique", which coined up the wording appeared in Paris as early as 1912 [29], it was some decades before the matter of heredity got recognized as a defined chemical substance - DNA, and elucidation of its structure led to formulation heterocyclic base complementarity and pairing hypothesis.

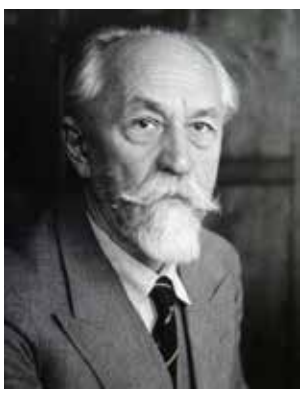
As a result, the study of nucleic acid formed the foundation of molecular biology and modern genetics, soon followed by birth of the recombinant DNA technology known as genetic engineering, which aims at manipulating transcription and translation processes with tools developed by biochemistry [9, 11, 30]. Practices of the surrounding living matter alteration are as old as humanity, known in form of selective breeding of plants and animals, but also in form of food and beverages making such as bread, beer, vinegar and wine, processes presently classified as microbial biotransformations. On a long way from tribal tradition to modern time molecular description of various aspects of life, countless discoveries were made out of which a handful extracted from the vibrant pool of the XX century Wien-Kraków-Lwów academic school, pioneering life sciences and philosophy studies in many fields, will be recalled.

Scientists like the founder of sociology of experimental research Ludwik Fleck, physiologists: Marceli Nencki and Leon Marchlewski, biochemists: Jakub Parnas and Kazimierz Funk, and microbiologist

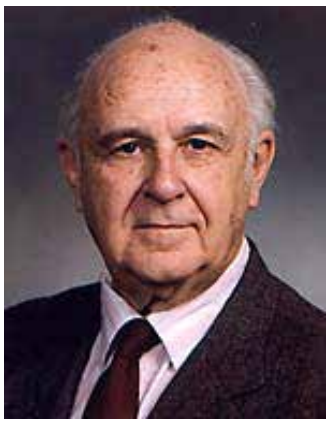
Fot. 2. Ludwik Fleck
Source: www.researchgate.net

Fot. 3. Leon Marchlewski
Source: www.en.wikipedia.org

Fot. 4. Marceli Nencki
Source: www.prenumeruj.forumakademickie.pl



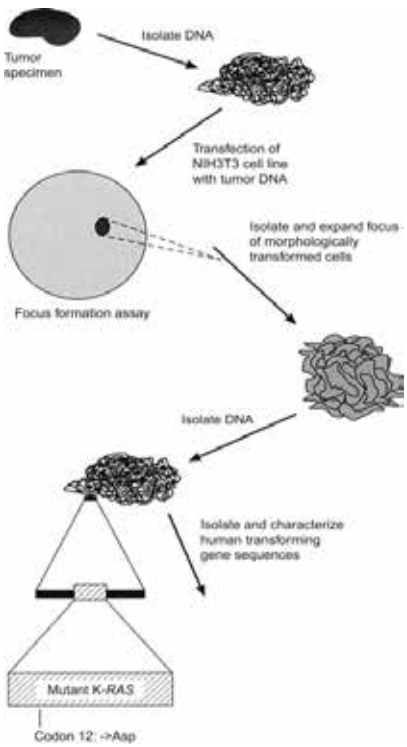
Fot. 5. Waclaw Szybalski
Source: www.news.wisc.edu



Rudolf Weigl inspired some generations of gifted disciples such as Ernest Sym (pioneer of enzymatic biotechnology), Hilary Koprowski (inventor of the polio vaccine) and Wacław Szybalski (geneticist, researcher of bacteriophage lambda and DNA transfection), who made profound contribution to establishing molecular foundations of biology. Ludwik Hirszfeld, prized for his discoveries concerning ABO blood group system deserves special mention, as a scientist of the mainstream research towards molecular markers of heredity.

In 1974, Wacław Szybalski posed the question: "What next?" to scientists involved in practicing genetic engineering, and suggested development of methods leading to design and assembly of new biological systems executing predetermined tasks, which he called synthetic biology (SynBio), as the answer [31-33].

Fig. 2. DNA Transfection.
Source: www.ScienceDirect.com



Apparently, the time was ripe for such idea to catch on, with some basic tools of molecular biology already in place to advance genetic engineering applications. Soon, dynamic accumulation of biological knowledge in form of consecutive "omics" – genomics, proteomics, metabolomics, glycomics, lipidomics, etc., led to the idea of systems biology, attempting to describe life as a network of biochemical processes of metabolic and regulatory nature [34-35].

After almost two centuries of reductionism, biology became ready for a conceptually new era of reconstructive activities along bottom up assembly lines, based on newly available subcellular or macromolecular constructs. SynBio embraces both: molecular modifications of existing biological parts at sub-systemic level, and creating radically novel constructs, designed to perform desired tasks, thus entering somewhat dreaded field of "synthetic life". One of the simplest examples of SynBio in action is the genetic code expansion, by including non-protein aminoacids for manufacture of artificial polypeptides [15]. Design and de novo construction of biological devices such as molecular switches, regulatory circuits, logical gates, oscillators, signal inducers and transformers, molecular motors, sensors, etc., (sometime included into nanotechnology field [36]) illustrate scope for new applications [37-38].

Research towards microorganisms with synthetic genomes, and in particular search for constructs equipped with only minimal self-supportive genetic assembly, has been already advanced to the stage of synthetic yeast chromosome completion, and creation of Synthia, the first synthetic bacteria [39]. Institutionalized academic SynBio is doing well – the first department dedicated to the field – in the US Lawrence Berkeley National Laboratory commenced in 2003; since that time several global conferences have been organized (MIT, Cambridge, MA, 2004; UCB Berkeley, CA 2006; Zurich, CH, 2007; Hong Kong, China, 2008; Stanford Univ., CA, 2011), and new research groups mushroomed around the globe, following initiatives like iGEM competition (in which Warsaw University team participates regularly; [40]), addressed to young undergraduate enthusiasts of the modern biology and biotechnology. Certain security concerns on possible dual use of SynBio, even if reasonable, are not likely to stop its conceptual and methodological progress heading towards new scientific advancements [41-42].

However, the synthetic biology label is associated in public perception mainly with genetically modified organisms (GMO), which evoke a great deal of contempt among social activist. Meanwhile, EU definition of genetically modified as organisms whose "genetic material has been changed in a way that does not occur under natural conditions through cross-breeding or natural recombination" has to accommodate such novel concepts as: genetically engineering machines, genomically designed organisms, genomically edited organisms, genomically recoded organisms, and chemically modified organisms, to keep pace with expanding field of SynBio [42].

Commercial development and applicability of these new advancements require legal market authorizations, which rely entirely on a state of local legislation. Unfortunately in the EU market region situation is complicated by restrictive GMO regulations, which are largely based on outdated state of knowledge. During the last two decades variety of new breeding techniques (NBT; particularly

in the field of plant biology and agriculture) emerged, for which legal status in view of current EU GMO legislature has not been clearly defined. These are genome editing techniques, based on oligonucleotide directed mutagenesis (ODM), and site directed nucleases (SDM), among which clustered regularly interspaced short palindromic repeats – the CRISPR/Cas9 system, has gained great popularity as the most useful tool for inducing precise mutations [43]. Lasting debate on the legal status of these new useful plant breeding procedures negatively affects competitive abilities of the European agricultural enterprises, as recently pointed out by T. Twardowski [44-45].

Synthetic biology as maturing operational system for advancement of bioeconomy

The previous century industrial advancements, such as introduction of new man made materials for construction, transportation, energy, communication, agriculture, medicine, pharmaceuticals, etc., generated by modern chemical industry, were welcomed by general public until recently, when the environmental impact of mass industrialization became a subject of general debate. Chemical industry invested much effort in modernization its processes, and academic movement of "green chemistry" proved very helpful in educating new generations of environmentally conscious citizens and customers. It seems evident, however, that fulfillment of "no emission" and "zero waste" postulates is beyond technical capacity of current manufacturing technologies, which are chiefly based on exhaustible oil and coal resources.

Bioeconomy, operated as a closed circuit, becomes an urgent need as at least a partial replacement for environmentally damaging industries. This need is global and already well pronounced in development strategies for Europe [45-46]. Thus far bioeconomy governance concerns primarily biomass conversion into the following array of products, arranged according to increasing mass unit value: energy and heat; fuels; bulk and platform chemicals; biopolymers; food and feed; pharmaceuticals, nutraceuticals and cosmetics.

Traditional biotechnologies, like fermentation, have already paved the way to perception of synthetic chemical reaction sequences as prospective biotransformations, which can be carried out catalytically, without turn to excessive process conditions. Enzymatic catalysis has extended its scope from engineering more stable and organic solvent tolerant natural proteins for industrial use, to the entirely new field of chemically modified biocatalysts obtained by "chemical evolution" [47], which found immediate application in pharmaceutical industry. Cell-free biotransformations are intensely exploited for syntheses of drug active substances and/or their key intermediates [48].

Basically, both principal lines of SynBio concentration on actions: a) from parts through modules, to devices and systems, and b) on natural biological information flow from transcription to translation exploration for new functionalities of products, are of great interest and value to sustainable biotechnology, which is presently focused on biorefinery technologies, securing when combined with new agro business well over 2 trillion Euro in annual turnover. Many other multibillion businesses arouse from traditional biotechnologies, which started as selected microorganism strain fermentation designed to manufacture a single overexpressed metabolite but constantly evolved striving for higher product titers by application of more efficient, eventually genetically modified organisms.

Current impact of biotransformations, carried out with constantly increasing SynBio protocols ratio, on industrial manufacturing of organic materials earlier available from chemical synthetic processes, like fuels, polymers, chemical intermediates and drug components already becomes critical. Modern biotechnologies cover global demand for aminoacids, organic acids (including hydroxyacids needed for biodegradable polymers), vitamins, hormones, antibiotics, enzymes, nucleosides and nucleotides, alcohols and polyols.

Apart from already mentioned medicinal products SynBio is instrumental in manufacturing secondary metabolites often used as pharmaceutical intermediates, phytochemicals for food, nutraceutical or cosmetic applications, and therapeutic proteins such as enzymes, antibodies and vaccines. Outside of molecular therapeutics category, biological devices are increasingly applied in diagnostics, while cellular therapies are still of rather limited utility.

In November 2015, more than 700 experts from around 80 countries which met in the first Global Bioeconomy Summit in Berlin, recognized that a sustainable bioeconomy should make defined contributions to achieving the United Nations Sustainable Development Goals (SDG ; United Nations. 17 goals to Transform Our World. https://www.un.org/sustainabledevelopment/).

The final document of the summit particularly stressed on the SDGs related to food security and nutrition (Goal 2), healthy lives (Goal 3), water and sanitation (Goal 6), affordable and clean energy (Goal 7), sustainable consumption and production (Goal 12), climate change (Goal 13), oceans, seas and marine resources (Goal 14), terrestrial ecosystems, and biodiversity preservation (Goal 15), but it is also very relevant for sustainable economic growth (Goals 8 and 9) and sustainable cities (Goal 11).

A few years later it can be concluded that role of SynBio in the SDG attainment ought to be significant. Artificial photosynthesis needs to be mastered, along with new bioprocesses for clean energy and clean fuels. Current advances in research on organisms biogenetically engineered for exactly these purposes prove that such goals are in principle realistic, if not readily attainable. During the last decade a number of process technologies employing multi-enzymatic reaction systems were implemented for industrial scale manufacturing of drug intermediates [48] with notable example of artemisinin – a model secondary plant metabolite derived antimalarial drug, for which the key intermediate – artemisinic acid, could be obtained by bioengineered bacteria (E. coli) or yeasts [49].

In fuel and energy sectors some projects have been advanced, which already demonstrated some capability for biocatalytic water into atom splitting – a highly endoenergetic process, which requires temperatures in excess of 1000^{0}C to get completed in a chemical laboratory. Hydrogen regarded as a clean fuel, is currently obtained mainly from natural gas, constituting an important industrial commodity with ca. 100 billion USD value market.

Research on alternative methods for hydrogen manufacturing has brought up some "green" solutions, including water splitting

Fig. 3. United Nations - 17 goals to Transform Our World. Source: www.un.org/sustainabledevelopment

in: photocatalytic, photo-electrochemical, photobiological, and microbial electrolysis cell exploiting ways. In one of prospective new processes, based on enzymatic generation of NADPH molecules from glucose 6-phosphate, generation rate of 310 milimole of H2 from 1L volume reactor per hour was achieved [50], when the biomimetic electron transport was facilitated by additional organic mediator and supplementary oxidoreductase. Admittedly, photoreactive devices for water splitting, which are constructed based on inorganic nanocomposites may offer some immediate advantages but all efforts towards sustainable bioeconomy deserve attention and systemic support [51] .

Concluding remarks

Currently over 85% energy needs worldwide is covered by fossil fuels (oil, coal and natural gas), which constitute a finite resource, illustrating dramatic need for new bioeconomy based on renewal biomass, solar energy etc. Research on systems biology points to vast resources of biosphere which can be responsibly exploited for development of novel technologies built on bioengineering principles.

SynBio fits well in this perspective as a multipurpose toolbox capable of delivering materials, molecular devices, functional subcellular modules, marker sensors, switches and indicators as "parts" for design of more complex systems with manufacturing, signaling, diagnostic and therapeutic functions. Interesting and useful synergy is expected from combining such high-tech platforms as SynBio, metabolomics, nanotechnology and microfluidics, on the way to manufacturing of novel functional materials efficiently, in closed technological circuits.

Among many successful applications of SynBio, metabolic pathways engineering procedures stand out, with shining examples of optimized, validated and implemented processes for energy, chemical intermediates, biopolymers and pharmaceutical active substances (including biologicals) manufacturing [52]. More complex therapeutic systems, like DNA and RNA constructs, probiotic microorganisms and modified human cells are on their way towards clinical applications [53-55]. Recent global gathering of experts (Global Bioeconomy Summit, 18-20 April 2018, Berlin) states in its report: "A key driver of bioeconomy innovation is the rapid development in the life sciences, in combination with digitization, and the convergence of key technologies in applications.

Promising innovations have for example been developed from genomics, applying big data analysis, and artificial intelligence as well as bio-, neuro- and nanotechnology. Such high-tech applications provide a huge potential in the various areas of bioeconomy and for sustainable development." It seems obvious that in order to achieve target circular bioeconomy, coordinated effort is needed, with focus on international cooperation and special stress on propagation of technical information through media and social channels. Unavoidable widespread application of genetic and metabolic engineering on the way towards bioeconomy, calls for extensive continuous education of all population segments, in order to avoid generating spontaneous contesting of GMO in general, based entirely on prejudice and ignorance.

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Witold Jan WARDAL*, Jan PAWLAK

Department of Rural Technical Infrastructure Systems
Institute of Technology and Life Sciences in Falenty, Warsaw Branch
ul. Rakowiecka 32; 02-532 Warsaw
tel. 22 243 54 43; www.itp.edu.pl
*email: w.wardal@itp.edu.pl

Witold Jan Wardal **ORCID: 0000-0002-4652-2299**
ResearcherID: B-8139-2019

AN ATTEMPT TO ESTIMATE CO_2 EMISSIONS CAUSED BY ENERGY CONSUMPTION IN POLISH AGRICULTURE

PRÓBA OSZACOWANIA EMISJI CO_2 WYNIKAJĄCEJ Z ZUŻYCIA ENERGII W POLSKIM ROLNICTWIE

Summary: *Based on Central Statistical Office (GUS) data and emissive indicators according to the National Center for Balancing and Managing Emissions (KOBiZE), emission of carbon dioxide, caused by direct energy consumption in Polish agriculture in 2015, has been estimated. The value of this emission totaled 12 535,0 Tg (thous. metric tons). It was 86,9 Gg per 100 ha of utilized agricultural area (UAA) and 877,2 Gg per 100 farms. Solid fuels had the largest share (46%) in CO_2 emission, including steam coal – 27,7%, and wood and peat – 16.7%. The share of liquid fuels amounted to 41%, including diesel oil 39% in CO_2 emission. The share of other energy carriers amounted to a total 13% in CO_2 emission. Electricity caused 10% of the total CO_2 emission resulting from consumption of energy carriers in agriculture, gaseous fuels – in total 2% (of that liquid petroleum gas 1,3%), and heat – 1%. Emission of CO2 resulting from the diesel oil consumption in agriculture amounted to 4 906,6 Tg (34,1 Gg·100 ha^{-1} UAA and 343,4 Gg per 100 farms). The consumption of the diesel oil in agriculture of particular voivodeships in 2015 has been estimated as proportional to the share of these voivodeships in national resources of selected categories of the agricultural land. This consumption amounted from 39 thou metric tons in Silesian Voivodeship to 205 thou metric tons in Mazovia voivodeship in 2015. Based on diesel oil consumption regional distribution, the CO_2 emission resulting from its use has been calculated for particular voivodeships. Yearly CO_2 emission per unit of UAA amounted from 30,9 Gg·100 ha^{-1} UAA in Warmia- and Mazury Voivodeship to 35,2 Gg·100 ha^{-1} UAA in Silesian voivodeship, with the country average 34,1 Gg·100 ha^{-1} UAA. Yearly CO_2 emission per 100 farms amounted from 124,1 Gg per 100 farm in Małopolskie Voivodeship to 958,5 Gg per 100 farm in West Pomeranian Voivodeship, with the country average 343,4 Gg per 100 farm.*

Keywords: *emission GHG, carbon dioxide, energy carriers, agriculture*

Streszczenie: *Na podstawie danych GUS i wskaźników emisyjnych według Narodowego Centrum Bilansowania i Zarządzania Emisjami (KOBiZE) oszacowano emisję dwutlenku węgla spowodowaną bezpośrednim zużyciem energii w polskim rolnictwie w 2015 r. Wartość tej emisji wyniosła 12 535,0 Tg (tys. Ton metrycznych). Było to 86,9 Gg na 100 ha użytków rolnych (UAA) i 877,2 Gg na 100 gospodarstw. Paliwa stałe miały największy udział (46%) w emisji CO_2, w tym węgiel energetyczny - 27,7%, a drewno i torf - 16,7%. Udział paliw ciekłych wyniósł 41%, w tym olej napędowy 39% w emisji CO2. Udział innych nośników energii wyniósł łącznie 13% w emisji CO_2. Energia elektryczna spowodowała 10% całkowitej emisji CO_2 wynikającej ze zużycia nośników energii w rolnictwie, paliw gazowych - ogółem 2% (z tego ciekłego gazu naftowego 1,3%), a ciepła - 1%. Emisja CO_2 wynikająca ze zużycia oleju napędowego w rolnictwie wyniosła 4 906,6 Tg (34,1 Gg · 100 ha^{-1} UAA i 343,4 Gg na 100 gospodarstw). Zużycie oleju napędowego w rolnictwie poszczególnych województw w 2015 r. Oszacowano jako proporcjonalne do udziału tych województw w zasobach krajowych wybranych kategorii gruntów rolnych. Zużycie to wyniosło od 39 tys. Ton w województwie śląskim do 205 tys. Ton w województwie mazowieckim w 2015 r. Na podstawie regionalnego rozkładu zużycia oleju napędowego wyliczono emisję CO_2 wynikającą z jego zużycia dla poszczególnych województw. Roczna emisja CO_2 na jednostkę UAA wyniosła od 30,9 Gg · 100 ha^{-1} UAA w województwie warmińsko-mazurskim do 35,2 Gg · 100 ha^{-1} UAA w województwie śląskim, przy średniej krajowej 34,1 Gg · 100 ha^{-1} UAA. Roczna emisja CO_2 na 100 gospodarstw wyniosła od 124,1 Gg na 100 gospodarstw w województwie małopolskim do 958,5 Gg na 100 gospodarstw w województwie zachodniopomorskim, przy średniej krajowej 343,4 Gg na 100 gospodarstw.*

Słowa kluczowe: *semisja gazów cieplarnianych, dwutlenek węgla, nośniki energii, rolnictwo*

Introduction

On average, around 10% of total greenhouse gas (GHG) emitted to the Earth's atmosphere in the EU comes from agriculture in the European Union. [Eurostat 2015]. Smaller values of this share (7%) are given: for Great Britain – by FRANKS & HADINGHAM [2012], and for the USA - PARTON et al. [2011]. The differences probably result from the uneven degree of industrialization of individual countries and the share of agriculture in the production of national income, with which the share of greenhouse gas emissions is positively correlated.

Despite a small share of total greenhouse gas emissions, measured in carbon dioxide equivalent, agriculture, however, emits as much as 53% of global greenhouse gas emissions other than CO_2 [BEACH et al. 2015]. Nitrogen fertilizers are the largest source of greenhouse gas emissions in plant production [NALLEY et al. 2011]. Soils, including grassland, have the largest share in the structure of greenhouse gas emissions (45%). The share of animal production, from which most methane comes, is 25%, exploitation of agricultural mechanization measures – 13%, manure handling, storage and application to fields – 11%, and other sources - 6%. In the greenhouse gas reduction programs, agriculture is in the non-ETS area (not covered by the emissions trading scheme). The

national inventory includes the following gases and greenhouse gas groups: carbon dioxide (CO2), methane (CH_4), nitrous oxide (N_2O), HFC gas group (fluorocarbons), PFC gas group (perfluorocarbons), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). The first three of these gases are dominant.

According to The National Centre for Emissions Management (Polish abbreviation: KOBiZE) data, [2014] in the structure of greenhouse gases emitted in Polish agriculture in 2014, carbon dioxide had the largest share (59,8%). The share of methane in this structure was 36,8%, and nitrous oxide 3,4%. Agriculture only generated 0,3% of carbon dioxide emissions (excluding the use of agricultural mechanization measures, which is not reported in the agriculture sector), but 33,7% of methane and as much as 78,9% of nitrous oxide.

Carbon dioxide is emitted as a result of the oxidation of an organic substance, among others during the breathing of animals and plants, as well as as a result of processes taking place in soil. Agricultural land use, changes in land use and forestry, on the other hand, cause the absorption of carbon dioxide from the earth's atmosphere, mainly due to photosynthesis in the plant world. However, for methane and nitrous oxide, these effects cause a small increase in emissions.

One of the sources of this emission is energy consumption for production purposes in agriculture [Camargo et al. 2013]. They are also used as the basis for estimating macro-scale energy costs [Pawlak 2016a] and greenhouse gas emissions [Aday et al. 2016, Pawlak 2017]. A lot of attention was paid to the issues of energy consumption in rural areas and the impact of energy management on the natural environment in the work of foreign and Polish scientific institutions, including the Institute of Technology and Life Sciences (ITP). Many works were also devoted to assessing the possibilities and purposefulness of increasing production and consumption of energy from renewable resources [Grzybek, Pawlak 2015a, b,c; Konieczna et al. 2019; Wardal et al. 2019; Niedziółka & Szpryngiel 2014; Pawlak 2004; Roszkowski 2013a, b; Terlikowski 2012; Wójcicki 2007, 2009, 2012;2015, 2015a,b] and the impact of renewable energy use on the natural environment and rural development [Hryniewicz, Grzybek 2013; Namyślak 2012; Pawlak 2013; Xiaohua et al. 2015; Wójcicki & Rudeńska 2014].

The level of CO_2 emissions in regional terms is proportional to the consumption of diesel oil in agriculture in individual voivodships. This consumption depends on many factors. They are influenced by, among others:

- share of mechanical draft sources in the production technology used,
- production directions on farms,
- yield level of cultivated plants,
- amount of work to be done using tractors and internal combustion engines,
- working conditions, including: soil type and condition, terrain, surface and shape of fields, distances in internal and external transport, and road condition,
- technical condition of tractors as well as machines and tools cooperating with them,
- quality of selection of agricultural equipment for working conditions and power of the tractor used for the parameters of machines and tools cooperating with it,
- qualifications of personnel servicing equipment and work organization.

It is practically impossible to include most of these factors in the estimates of diesel oil consumption and, consequently, in carbon dioxide emissions from this source. More simplified methods are needed. One of them consists in estimating diesel oil consumption on the scale of voivodships based on the area of cultivated plants as well as their yields and specific consumption of this fuel per hectare of each cultivated plant, taking into account the level of yield. It was used to estimate diesel oil consumption in Poland [PAWLAK 2012a] and in the Małopolskie Voivodeship [Pawlak 2012b]. At that time, data on the sown area of individual plants according to the results of the 2010 general census was used as the basis for calculations.

Objective of the work

The basis for developing solutions enabling the reduction of greenhouse gas emissions in agriculture is recognition of the current state. The purpose of this work was to estimate CO_2 emissions caused by energy consumption in agriculture on the basis of data from the Central Statistical Office of Poland – (Polish abbr. GUS) [2016a], referring to the state of 2015 and emission indicators according to the National Center for Emission Balancing and Management (KOBiZE) [2016a] and the regional differentiation of these emissions into example of diesel fuel. An additional objective is to present a method for estimating diesel oil consumption and related CO_2 emissions in a voivodship system.

The main terms and abbreviations have been used in accordance with the nomenclature recommended in the EU [Eurostat 2019], as follows:
AA – agricultural area, describes the area already used for farming, or that could be brought back into cultivation using the resources normally available on an agricultural holding.
UAA – utilized agricultural area, is the total area taken up by arable land, permanent grassland, permanent crops and kitchen gardens used by the holding, regardless of the type of tenure or of whether it is used as a part of common land.
ARA – arable land is land worked (ploughed or tilled) regularly, generally under a system of crop rotation.
PECR – permanent crops are ligneous crops, meaning trees or shrubs, not grown in rotation, but occupying the soil and yielding harvests for several (usually more than five) consecutive years. Permanent crops mainly consist of fruit and berry trees, bushes etc.
J0000 (or PEGR) – permanent grassland (pasture and meadow) is land used permanently (for several consecutive years, normally

5 years or more) to grow herbaceous fodder, forage or energy purpose crops, through cultivation (sown) or naturally (self-seeded), and which is not included in the crop rotation on the holding. The grassland can be used for grazing, mown for silage and hay or used for renewable energy production.

Source materials and methodological assumptions

The main sources of data on the consumption of the most important energy carriers in agriculture in 2015 was the publication of the Central Statistical Office (GUS) [2016a]. Based on these data and the carbon dioxide emission factors resulting from the consumption of individual ones (Table 1), adopted on the basis of the work of KOBiZE [2016a, b], CO_2 emissions were estimated.

The value of the indicator for heat energy delivered to consumers via the network was calculated on the basis of KOBiZE [2016b] data on domestic electricity and heat production and associated CO_2 emissions.

Table 1. Carbon dioxide emission factors as a result of consumption of selected energy carriers [KOBiZE 2016a, b].
Source: own study based on Central Statistical Office data [2016a].

Specification	CO_2 emission factor [Mg·TJ^{-1}]
Black coal	94.05
Brown coal	111.21
Brown coal briquettes	97.50
Coke (fuel)	107.00
Firewood	112.00
Other solid biomass	98.00
High-methane natural gas	56.10
Nitrogen-rich natural gas	56.10
Liquefied gas	63.10
Biogas	54.60
Motor gasoline	69.30
Aviation gasoline	70.00
Diesel fuel	74.10
Light fuel oil	74.10
Other fuel oils	77.40
Electricity	229.28
Heat from the network	110.59

The values of CO_2 emissions due to the consumption of individual energy carriers in agriculture were calculated using the formula:

$$Zen_{CO_2} = \frac{En \cdot Wen_{CO_2}}{1000} \quad (1)$$

where:

Zen_{CO_2} – CO_2 emissions due to the consumption of the nth energy carrier in agriculture [Gg];
En – energy consumed in agriculture in the form of its nth carrier in 2015 [TJ];
Wen_{CO_2} – CO2 emission factor for the nth energy carrier [Mg·TJ^{-1}].

The CO_2 emission values obtained in this way as a result of the consumption of energy carriers in agriculture were calculated per unit of utilized agricultural area:

$$Zenjs_{CO_2} = \frac{10000 \cdot Zen_{CO_2}}{S_{UAA}} \quad (2)$$

where:

$Zenjs_{CO_2}$ – CO_2 emissions due to the consumption of the n-th energy carrier in agriculture per 100 ha of utilized agricultural area [kg·100 ha^{-1}];
$SUAA$ – utilized agricultural area [thous. ha];

and per 100 farms:

$$Zenjg_{CO_2} = \frac{10000 \cdot Zen_{CO_2}}{N_g} \quad (3)$$

where:

$Zenjg_{CO_2}$ – consumption of the n-th energy carrier in agriculture per 100 farms [kg];
N_g – the number of farms [thous.].

The criterion for dividing the value of domestic diesel oil consumption in the period covered by the analysis into individual voivodships was the structure of the share of each of them in the total area of sown, permanent crops and meadows. The permanent crops group includes orchards and perennial plantations, including plantations of fruit trees and shrubs, tree nurseries and fruit shrubs, tree nurseries and decorative shrubs, forest tree nurseries for commercial purposes, other permanent crops, including wicker, trees and fruit shrubs growing outside plantations, as well as permanent crops under cover [GUS 2016b]. Data on the domestic consumption of diesel oil in agriculture were obtained from the relevant Central Statistical Office (PL: GUS) publications [2016a], and on the area of the aforementioned categories of agricultural land - from GUS agricultural statistical yearbooks [2016b].

When determining the share of individual voivodships in diesel oil consumption, categories of agricultural land were deliberately selected that were characterized by higher than average unit fuel consumption per unit area. The area of fallow land, home gardens and permanent pastures, where the consumption of diesel fuel is low or non-existent, was omitted. However, permanent meadows were included, because due to the large share of permanent grasslands in some voivodships, their omission could cause distortions of results, especially since pastures were not included. However, as a reference basis in the comparative analysis of unit consumption of diesel in the regional system, all types of arable land were included.

Indicators of the share of individual voivodships (provinces) in the domestic consumption of diesel oil were calculated using the formula

$$Uw_r = \frac{100 \cdot (Zw_r + Tw_r + Gw_r)}{Zk_r + Tk_r + Gk_r} \quad (4)$$

where:

Uwr – share od w[th] – voivodeship in the domestic consumption of diesel oil in r-[th] year [%],

Zwr – sown area in the wth province and r-[th] year [ha],

Twr – area of permanent crops (PECR) in the wth voivodship and r-[th] year [ha],

Gwr – area of permanent grassland in the w-[th] voivodship and r-[th] year [ha],

Zkr – domestic area of crops in the r-[th] year [ha],

Tkr – domestic area of permanent crops in the r-[th] year [ha],

Gkr – domestic area of permanent meadows (grassland) in the r-[th] year [ha].

Data on the area of included arable land categories and designated values of voivodships' share ratios in their resources are given in Table 2.

By multiplying the value of the Uwr indicator calculated in this way by domestic diesel consumption, we obtain diesel consumption in a given province:

$$DFw_r = \frac{ONk_r \cdot Uw_r}{100} \quad (5)$$

where:

DFwr – diesel fuel consumption in the w-[th] voivodship (province) in the r-[th] year [thous. tonnes],

DFkr – domestic consumption of diesel fuel in r-[th] year [thous. tonnes]

By dividing the diesel fuel consumption in individual voivodships by the number of ha of utilized agricultural area in good culture, we obtain the consumption of this fuel per unit of the utilized agricultural area in a given year:

$$JDFw_r = \frac{1000000 \cdot DFw_r}{UAAw_r} \quad (6)$$

where:

JDFwr – specific consumption of diesel fuel in the w-[th] voivodship and r-[th] year [kg·ha-[1] UAA],

UAAwr – utilized agricultural area in the w-[th] voivodship and r-[th] year [ha].

Table 2. Share of voivodships in the resources of selected types of arable land in 2015
Source: own study based on Central Statistical Office data [2016a].

Voivodships (V.)	Sown area [ha]	Area of permanent crops [ha]	Area of permanent meadows [ha]	Total [ha]	Share of voivodships [%]
Lower Silesia Voivodship	760 329	7 009	111 512	878 850	6.4
Kuyavian-Pomeranian V.	945 994	7 322	83 332	1 036 648	7.5
Lubelskie V.	1 103 653	83 485	209 891	1 397 029	10.1
Lubuskie V.	277 543	4 807	87 352	369 702	2.7
Łódzkie V.	765 270	39 412	137 040	941 722	6.8
Małopolskie V.	312 964	10 770	174 488	498 222	3.6
Masovian V.	1 259 848	119 210	438 907	1 817 965	13.2
Opolskie V.	449 675	1 840	37 430	488 945	3.5
Subcarpathia V.	320 216	10 902	186 004	517 122	3.8
Podlaskie V.	655 567	7 260	323 002	985 829	7.1
Pomeranian V.	598 626	12 079	112 287	722 992	5.2
Silesian V.	263 955	3 036	71 753	338 744	2.5
Świętokrzyskie V.	327 055	36 998	96 005	460 058	3.3
Warmia-and Mazury V.	608 740	8 956	237 371	855 067	6.2
Wielkopolskie V.	1 463 453	19 148	222 146	1 704 747	12.4
West Pomeranian V.	640 067	18 747	129 606	788 420	5.7
Poland (total)	**10 752 955**	**390 979**	**2 658 126**	**13 802 060**	**100.0**

Table 3. Consumption of energy carriers in Polish agriculture in 2015
Source: own study based on Central Statistical Office data [2016a].

Energy carriers	Consumption [TJ]
Black coal	36 400
Black coal	1 142
Brown coal briquettes	613
Coke (fuel)	252
Firewood and peat	19 000
Solid biomass	116
Total solid fuels	57 523
High-methane content natural gas	931
Nitrogen-rich natural gas	213
Liquefied gas	2 622
Biogas	385
Total gaseous fuels	4 151
Motor gasoline	42
Aviation gasoline	7
Diesel fuel	66 216
Light fuel oil	3 010
Mazut	420
Total liquid fuels	69 695
Electricity	5 425
Heat from the network	890
Total	**137 684**

Results: energy consumption in agriculture in 2015

Direct consumption of energy carriers in Polish agriculture in 2015 totaled 137 684 TJ (Table 3). After calculation per 100 ha of utilized agricultural area (UAA), it was 954,5 GJ · 100 ha^{-1}, and per 100 farms – 9 635 GJ.

Liquid fuels had the largest share in direct energy consumption (50%) (Fig. 1), including diesel fuel - 48%. The share of solid fuels amounted to 42%, including black coal 26,4%, wood and peat 13,8%, and other solid biofuels – only 0,1%. The share of other energy carriers was small and totaled 8%. Electricity accounted for 4% of the total consumption of energy carriers in agriculture, gas fuels - a total of 3% (including liquid gas 1,9%, biogas 0,3%), and heat - 1%.

The share of energy carriers from renewable resources amounted to a total of 14.2%, assuming that in the group of fuels defined by the Central Statistical Office as peat and wood, the share of peat as fuel used in agriculture is minimal.

Results: carbon dioxide emissions as a result of direct energy consumption in agriculture in 2015

The estimated value of CO_2 emissions as a result of direct energy consumption in Polish agriculture amounted to a total of 12 535,0 Tg in 2015 (Table 4). After calculation per 100 ha of utilized agricultural area (UAA), it amounted to 86,9 Gg · 100 ha^{-1}, and 887,2 Gg per 100 farms.

Solid fuels had the largest share in CO_2 emissions as a result of direct energy consumption (46%) (Fig. 2), including black coal - 27,7%, and wood and peat - 16,7%. The share of CO_2 emissions from liquid fuels was 41%, including diesel fuel 39%. The share of other energy carriers in CO_2 emissions totaled 13%. Electricity generated 10% of total CO_2 emissions as a result of consumption of energy carriers in agriculture, gaseous fuels - 2% in total (including liquid gas 1,3%), and district heating - 1%.

Due to the dominant share of solid and liquid fuels, the reduction of CO_2 emissions associated with the direct consumption of energy carriers in Polish agriculture should be seen in improving the efficiency of these fuels. This can be achieved by implementing energy-saving agricultural production technologies and environmentally friendly energy consumers.

Fig. 1. The structure of the calorific value of energy carrier groups consumed in agriculture in 2015.
Source: own study based on Central Statistical Office data [2016a].

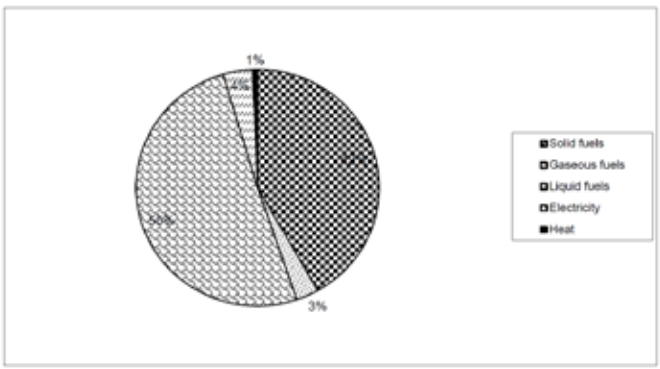

Fig. 2. The share of groups of energy carriers used in agriculture in 2015 in CO_2 emissions.
Source: own study based on Central Statistical Office data [2016a].

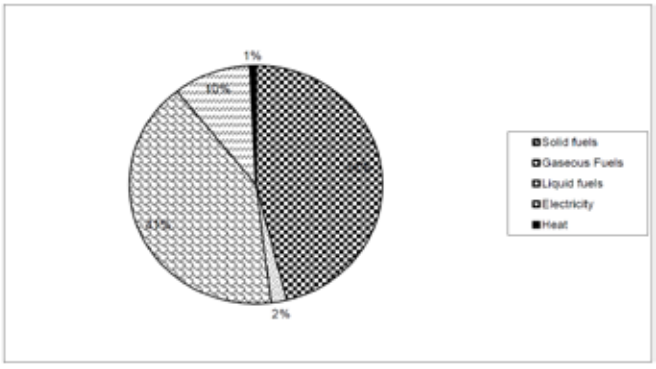

Table 4. CO_2 emission as a result of the consumption of energy carriers in agriculture in 2015 [own study based on data from the Central Statistical Office of Poland 2016 and KOBIZE 2016 a, b].
Source: own study based on Central Statistical Office data [2016a].

Specification	Annual CO_2 emissions		
	Gg	[kg] per	
		100 ha UAA	100 farms
Black coal	3 423.4	23.7	239.6
Brown coal	127.0	0.9	8.9
Brown coal briquettes	59.8	0.4	4.2
Coke (fuel)	27.0	0.2	1.9
Firewood and peat	2 128.0	14.8	148.9
Solid biomass	11.4	0.1	0.8
Total solid fuels	5 776.5	40.0	404.2
High-methane content natural gas	52.2	0.4	3.7
Nitrogen-rich natural gas	11.9	0.1	0.8
Liquefied gas LPG	165.4	1.1	11.6
Biogas	21.0	0.1	1.5
Total gaseous fuels	250.6	1.7	17.5
Motor gasoline	2.9	0.0	0.2
Aviation gasoline	0.5	0.0	0.0
Diesel fuel	4 906.6	34.0	343.4
Light fuel oil	223.0	1.5	15.6
Mazut	32.5	0.2	2.3
Total liquid fuels	5 165.6	35.8	361.5
Electricity	1 243.8	8.6	87.0
Heat from the network	98.4	0.7	6.9
Total	**12535.0**	**86.9**	**877.2**

Results: consumption of diesel fuel in a regional system

Such large regional differences in the level of fuel consumption were a consequence of unequal arable land area in individual voivodships. In 2015, agricultural land in good culture was over five times larger in the Mazovia voivodship than in the Silesia voivodship.

Diesel fuel consumption in the Lesser Poland voivodship in 2010, estimated on the basis of data on the sown area of individual plants according to the results of the 2010 general agricultural census and on unit consumption of diesel oil based on [PAWLAK 2012b] amounted to 67 Tg (by 8% more than value calculated for this voivodship and 2010 using the method adopted in this paper). Considering the fact of continuous technical progress, the obtained results should be treated as approximate.

Less varied than the absolute values of diesel oil consumption in individual voivodships were the values of the unit fuel consumption per hectare of arable land in good culture (Table 5). This consumption in 2015 ranged from 97,7 kg · ha^{-1} UR in the Warmian-Masurian Voivodeship to 111,3 kg · ha^{-1} UAA in the Silesia Voivodeship. Higher than the domestic average value of diesel consumption index per unit of UAA in good culture was recorded in the following voivodships: Lower Silesia Voivodship, Kuyavian-Pomeranian V., Lubelskie V., Lubuskie V., Łódzkie V., Opolskie V., Pomeranian, Silesian and Wielkopolskie V. These voivodships had a smaller share of permanent pasture in the arable land structure than the national average. On the other hand, voivodships characterized by a greater than the national average share of permanent pasture in the structure of agricultural land: Małopolskie, Mazovian, Subcarpathia, Podlaskie, Świętokrzyskie, Warmia- and Mazury and West Pomeranian Voivodeship had diesel oil consumption per unit of agricultural land area lower than the average in Polish agriculture .

The significant variation in the level of unit CO_2 emissions from diesel oil per 100 farms was also affected by the average UAA in individual voivodships. It ranged from 392,5 kg per farm

Table 5. Diesel oil consumption in Polish agriculture by voivodship
Source: own study based on Central Statistical Office data [2016a].

Voivodships (V.)	Diesel fuel consumption		
	[Tg (thous. tonnes)]	[kg] per	
		ha UAA	farm
Lower Silesia Voivodship	99	109.6	1 662.6
Kuyavian-Pomeranian V.	116	109.5	1 781.5
Lubelskie V.	157	109.6	881.4
Lubuskie V.	42	108.7	1 975.9
Łódzkie V.	105	108.7	818.3
Małopolskie V.	56	105.9	392.0
Masovian V.	205	107.4	966.3
Opolskie V.	54	109.4	2 018.5
Subcarpathia V.	59	106.1	444.2
Podlaskie V.	110	104.7	1 390.9
Pomeranian V.	81	108.2	2 027.2
Silesian V.	39	111.3	661.2
Świętokrzyskie V.	51	107.4	565.2
Warmia-and Mazury V.	96	97.7	2 289.6
Wielkopolskie V.	192	110.9	1 563.7
West Pomeranian V.	88	106.6	3 028.0
Poland (total)	**1 550**	**107.7**	**1 084.7**

in the Małopolskie Voivodeship to 3028,0 kg per farm in the West Pomeranian Voivodeship.

Results: regional differences in CO_2 emissions resulting from fuel oil consumption in agriculture

CO_2 emissions per 100 ha of UAA ranged from 30,9 Gg · 100 ha^{-1} UAA in the Warmia- and Mazury Voivodeship to 35,2 kg · 100 ha^{-1} in the Silesia Voivodeship, and per 100 farms - from 124,1 Gg in the Lesser Poland voivodship to 958,5 Gg per 100 farm in the West Pomeranian Voivodship (Table 6). Higher than the domestic average value of the carbon dioxide emission index from diesel fuel per unit of UAA in good culture was recorded in the following voivodships: Lower Silesia Voivodship, Kuyavian-Pomeranian V, Lubelskie V., Lubuskie V., Łódzkie V., Opolskie V., Pomeranian, Silesian and Wielkopolskie V. These voivodships had a smaller share of permanent pasture in the arable land structure than the national average. On the other hand, voivodships characterized by a greater than the domestic average share of permanent pasture in the structure of agricultural land: Małopolskie, Mazovian, Subcarpathia, Podlaskie, Świetokrzyskie, Warmia- and Mazury and West Pomeranian Voivodeship had diesel oil consumption per unit of agricultural land area lower than the average in Polish agriculture. The significant variation in the level of unit CO_2 emissions from diesel oil per 100 farms was also affected by the average UAA in individual voivodships. Higher than the domestic average value of the unit CO_2 emission rate from diesel fuel per 100 farms was recorded in the following voivodships: Lower Silesia Voivodship, Kuyavian-Pomeranian V., Lubuskie, Opolskie V., Podlaskie, Pomeranian, Warmia- and Mazury V., Wielkopolskie V. and West Pomeranian V., and smaller in Voivodships: Lubelskie, Łódzkie, Małopolskie, Masovian, Subcarpathia, Silesian and Świętokrzyskie V. Regional differences in CO_2 emissions as a result of diesel consumption in agriculture have also been shown by foreign studies [ADAY et al. 2016].

Final conclusions

As a result of direct energy consumption in Polish agriculture, a total of 12 535,0 Tg CO_2 was emitted into the atmosphere in 2015. Solid fuels had the largest share in CO_2 emissions as a result of direct energy consumption in Polish agriculture (46%), including hard coal - 27,7% as well as wood and peat - 16,7%. The share of liquid fuels amounted to 41%, including diesel oil 39%, and other energy

Table 6. The CO_2 emissions as a result of the consumption of diesel oil in the Polish agriculture in individual regions
Source: own study based on Central Statistical Office data [2016a].

Voivodships (V.)	Carbon dioxide emission per year		
	[Gg]	[Gg]	
		100 ha UAA	100 farms
Lower Silesia Voivodship	313 389.6	34.7	526.3
Kuyavian-Pomeranian V.	367 204.0	34.7	563.9
Lublin V.	496 991.7	34.7	279.0
Lubusz V.	132 953.2	34.4	625.5
Lodz V.	332 383.0	34.4	259.0
Lesser Poland V.	177 270.9	33.5	124.1
Masovian V.	648 938.2	34.0	305.9
Opole V.	170 939.8	34.6	639.0
Subcarpathia V.	186 767.6	33.6	140.6
Podlasie V.	348 210.7	33.1	440.3
Pomeranian V.	256 409.7	34.2	641.7
Silesian V.	123 456.5	35.2	209.3
Swietokrzyskie V.	161 443.2	34.0	178.9
Warmia-Masurian V.	303 893.0	30.9	724.8
Greater Poland V.	607 786.0	35.1	495.0
West Pomeranian V.	278 568.6	33.7	958.5
Poland (total)	**4 906 605.7**	**34.1**	**343.4**

carriers in CO_2 emissions - 13% in total. Due to the dominant share of solid fuels and diesel oil in CO_2 emissions as a result of direct energy consumption in Polish agriculture, the possibility of reducing this gas emissions should be sought primarily in the more efficient use of these energy carriers due to the implementation of energy-saving agricultural production technologies and the use of environmentally friendly energy receivers. Lack of official statistical data on diesel oil consumption in the provincial system makes it necessary to make appropriate estimates. This involves the use of methods differing in the degree of precision and labor intensity. Due to the progressive outdated indicators of unit consumption of diesel oil in individual agricultural production processes in Poland, determined on the basis of technological cards developed in the 1980s, a simplified method of estimating the consumption of this fuel in the regional system was used in this paper. This method consists in dividing the value of domestic consumption into voivodships in proportion to the share of these voivodships in the resources of three categories of agricultural land.

Comparison of the results of the application of the proposed method with the method previously used on the example of the Małopolskie Voivodship [PAWLAK 2012b] taking into account the structure of crops in the voivodship and the indicators of unit consumption of diesel oil appropriate for these crops showed that the difference between the results obtained is about 8%. Considering the fact that as a result of the progressive improvement of agricultural mechanization measures, the current values of the specific fuel consumption indicators are lower than those adopted in the work from which the results constituting the basis of this comparison come from, it can be assumed that the actual difference is less than 8%.

The above facts justify the use of the presented method to estimate the approximate regional distribution of diesel oil consumption in Polish agriculture. CO_2 emissions per 100 ha of UAA ranged from 30,9 Gg · 100 ha^{-1} UAA in the Warmia- and Mazury Voivodeship to 35,2 kg · 100 ha^{-1} UAA in the Silesian Voivodeship (domestic average 34,1 kg · 100 ha^{-1} UAA), and calculated per 100 farms - from 124,1 Gg in the Małopolskie Voivodeship to 958,5 Gg per 100 farm in the West Pomeranian Voivodeship (domestic average 343,4 Gg per 100 farms.

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Jan BARWICKI[1)], Sławomir NIECKO[2)]

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[1)] Institute of Technology and Life Sciences, Warsaw Branch, Department of Rural Technical Infrastructure Systems
Corresponding author: Jan Barwicki; e-mail: jbarwicki@.gmail.com

ORCID: 0000-0002-5437-5284

[2)] Pomeranian Wholesale Agriculture and Food Center RËNK S.A., University of Agribusiness in Łomża

THE ROLE OF WHOLESALE MARKETS IN RURAL DEVELOPMENT

ROLA RYNKÓW HURTOWYCH W ROZWOJU OBSZARÓW WIEJSKICH

***Summary**: In the Republic of Poland, agricultural sector is of a greater socio-economic importance than in Western European countries. There are still regions in which agriculture plays the role of one of the main branches of the economy, affecting the level of their development and standard of living of the inhabitants. In the Republic of Poland, the rural area, according to the terminology used by the Central Statistical Office (CSO), is the territory outside the administrative boundaries of cities.*

According to this criterion, rural areas occupy the area of 291 400 km^2 in the Republic of Poland, which is 93% of total country territory. Wholesale markets are an important element of the institutional infrastructure in rural development. The paper presents the importance of regional and local wholesale markets and their importance in rural development.

***Keywords**: rural areas, agri-food market, fruit and vegetable market, flower market, wholesale market*

***Streszczenie**: W Rzeczpospolitej Polskiej sektor rolny ma większe znaczenie społeczno-gospodarcze niż w państwach Europy Zachodniej. Wciąż istnieją regiony, w których rolnictwo pełni rolę jednej z głównych gałęzi gospodarki, wpływającej na poziom ich rozwoju i standard życia mieszkańców. W Rzeczpospolitej Polskiej obszar wiejski, zgodnie z terminologią stosowaną przez Główny Urząd Statystyczny (GUS), to terytorium pozostające poza granicami administracyjnymi miast.*

Zgodnie z tym kryterium, obszary wiejskie zajmują w Rzeczpospolitej Polskiej powierzchnię 291,4 tys. km^2, co stanowi 93% obszaru kraju. Ważnym elementem instytucjonalnej infrastruktury w rozwoju obszarów wiejskich są rynki hurtowe. W pracy przedstawiono znaczenie regionalnych i lokalnych rynków hurtowych i ich znaczenie w rozwoju obszarów wiejskich.

***Słowa kluczowe**: obszary wiejskie, giełda rolno-spożywcza, rynek owocowo-warzywny, rynek kwiatów, rynek hurtowy*

Introduction

TThe main problem in research that concerns rural areas is to define the term 'rural area'. In colloquial terms, intuitively, everyone understands them, but from a scientific point of view there is no universal definition. Various disciplines deal with rural issues. Rural areas in Poland constitute 93.1%, which is inhabited by 39.2% of the total population. There are strong links between rural areas and local urban centers. High economic activity of rural areas (production of fruit, vegetables, flowers) neighboring cities contributed to the development of wholesale markets [Adamowicz 2005].

The need to launch wholesale markets in the Republic of Poland was also caused by the effect of the transformation of the food economy, which resulted in the elimination from the market of structures dealing with the current organization and marketing of agri-food products. The activity of wholesale markets was commenced in the Republic of Poland in 1992, when the Greater Poland Agricultural and Horticultural Market S.A. was opened in Poznan. As a result of the implementation of government programs for the construction and development of wholesale markets, new wholesale markets were created. The object of trade in wholesale markets includes primarily fruit, vegetables and flowers, processed general food products, including dairy products, meat and its products. It is estimated that 80-90% of fresh agri-horticultural products are traded through wholesale markets, marketplaces and intermediaries, while only 10% go through chain stores.

The technical and technological progress taking place in agriculture enables the increase of production, and thus deepens (or tightens) the links between farms and the wholesale market. The wholesale market is the second level of trade in goods and

appears as an intermediate link in the process of trade in goods. It is here that homogeneous goods are purchased from all possible farms for further sale. Markets are equipped with places for presenting goods or samples, and prices are based on local supply and demand. Domestic and foreign customers buy on wholesale markets [Jabłońska 2014; Duczkowska-Małysz, Duczkowska-Piasecka 1999].

Wholesale market owners or shareholders can be various organizations, i.e. manufacturers, traders, producer groups, local government units, the Agency for Restructuring and Modernization of Agriculture (ARMA), the National Center for Agricultural Support (NCAS), food banks and insurance companies. There are wholesale markets in Poland: trans-regional, regional, local and border. The wholesale market as a link in the distribution channel is a place of direct transactions between a large number of sellers (mostly farmers from rural areas) and buyers.

The purpose of this study is to show an extremely important element of the agribusiness network in the form of wholesale markets, because the success of their activities is determined by the efficiency of information links created with producers of agri-food raw materials and their recipients. In addition, it is very important to achieve progress in the quality of service to consumer needs by more effectively meeting the individual expectations of end users, this role of wholesale markets in achieving this goal cannot be overestimated.

Concept and features of the wholesale market

In Polish and world economic literature there is no uniform definition of the term "wholesale market". Most often, wholesale markets are defined as organized meeting places for market participants taking place at a specific time, where supply and demand are concentrated and purchase and sale transactions are concluded.

One of the basic functions of wholesale markets, which also distinguishes them from commodity exchanges, is meeting the needs reported by retail trade companies for agri-food products and flowers. That is why their role is particularly important in the case of large and large urban agglomerations, in which a significant number of retail outlets are concentrated [Baker 2005].

The main features of the agri-food wholesale market are as follows:

- large scale of commercial transactions of agri-food products;
- offering a physically present product (as opposed to exchanges);
- direct negotiations between sellers and buyers (in separate places or directly from the farmer's car or from processor);
- appropriate technical, technological and service infrastructure (wholesale trade halls, warehouses, cold stores, unloading facilities, storage rooms, banks, customs offices, quality control institutions).

Wholesale market participants are producers (individual producers, producer organizations and groups, cooperatives in particular from rural areas), traders, representatives of distributors as well as consumers and retailers. Legal and organizational forms of wholesale markets are: joint-stock companies, limited liability companies, public enterprises, merchant associations, cooperative associations. The subject of trade on agri-food wholesale markets in Poland (and also on most wholesale markets in the world) are primarily fruit and vegetables, flowers, but also meat and its products, fish and their products, dairy products and other food industry products.

Wholesale markets in the EU countries operate on general principles in accordance with the law in force in individual countries. There are no separate Community legal acts regulating their activities. Wholesale markets are non-profit organizations in a significant proportion of the EU member states. This means that the use of the wholesale market (fees for renting sales space) should cover the costs associated with their conduct; in particular, where the appointing authority is self-government bodies or government institutions. In Poland, wholesale markets operate mainly based on National Trade Company (joint-stock companies, limited liability companies, other business entities) [Mierwiński 2010].

Functions and tasks of wholesale markets

The main task of the functioning of wholesale markets is to facilitate access to the market for small and medium-sized enterprises, including primarily producers of agricultural and food products operating in rural areas. Wholesale markets are primarily created to better meet the demand of retail trade units for agricultural, food and flower products. Hence, their location is mainly for large and large urban agglomerations, in which a large number of retail outlets are concentrated. The development of large-scale retail stores and wholesale networks did not limit or narrow down the basic functions of wholesale markets. However, it forced the group of recipients mainly by outdoor consumption outlets (restaurants and catering in the broad sense).

The basic functions of the agri-food wholesale market are in particular [Niecko 2018, wholesale markets to expand and improve the services offered, as well as expanding the Adamicki 1999]:

- concentration of supply and demand primarily for small market participants;
- reducing the number of intermediaries in trade;
- ensuring a higher quality of trade in agricultural, food and flower products by equipping them with appropriate technical, technological and service infrastructure;
- improving the quality of products offered on wholesale markets through their preparation for sale (packaging, completing) and quality control of the offered products (sanitary and phytosanitary inspection);
- participation in the dissemination of information on price levels;
- reducing price fluctuations due to the expansion of the storage system;

- improving financial and commercial security of transactions carried out on wholesale markets;
- facilitating the adjustment of the supply of agricultural and food products to the volume and structure of consumer demand.

The functioning of wholesale markets allows primarily:

- increasing the impact of customer expectations on the volume and structure of production in the region of the market and the assessment of the volume and structure of demand;
- balancing demand and supply and shaping prices of food, mainly agricultural products;
- accelerating price objectification due to concentration of supply and demand;
- increasing market transparency by improving the functioning of market information;
- implementation of applicable trade rules and rules.

Wholesale markets in europe and in the world

The development of wholesale markets for agricultural products is closely related to the development of cities and the increase in urban population. In most countries it was started in the second half of the 19th century. These markets experienced particularly intensive development after the First and Second World War. In most countries, food wholesale turnover fell, also due to falling prices, during the Great Depression. In the US, wholesale food turnover decreased in 1938 compared to 1929 by 27%. In subsequent years, however, the food wholesale markets were rebuilt. In the USA, this turnover in 1953 was more than four times higher than in 1938.

In Western European countries, wholesale markets began to lose their significance in the early 1970s with the development of commercial networks and modern forms of sales. The importance of wholesale in individual countries and in Europe varies, with as much as 80% of total turnover in four countries: Germany, Great Britain, France and Italy [Gburczyk 2005].

It should be emphasized that in the wholesale trade of these countries there are clear transformations, consisting mainly in modernizing and expanding the forms of the conducted activities. In particular, the following phenomena can be observed:

1) reducing the role of wholesale in relation to the internal exchange of food products for their export;
2) the growing importance of wholesale trade in the internal exchange of fresh unprocessed products, such as fruit, vegetables, meat and fish;
3) introducing new forms of sales, including mail order based on publishing catalogs presenting the products offered, telephone and electronic sales via the Internet;
4) diversifying logistics functions;
5) vertical backward and pre-emptive integration related to extending the scope of implemented tasks to include manufacturing activities and retail sales.

In Central and Eastern Europe, the construction of wholesale markets began only in the early 1990s. During this period, the distribution system for food products related to the centrally planned economy ceased to operate in most of the transforming countries. Wholesale markets seemed to be the best solution for this group of the countries. This was argued by the low level of organization of agricultural producers with the poor organization of food distribution. The development of wholesale markets in this region of Europe was supported by international financial institutions: the World Bank, the European Bank for Reconstruction and Development as well as Germany and Switzerland (as donors supporting the development of agriculture in Eastern Europe as part of bilateral relations with individual countries from this region). Thanks to these financial institutions as well as institutional donors in Poland, Bulgaria, Romania, Croatia and Hungary, many new wholesale and regional wholesale and supra-regional markets have been created. However, their development did not reach the level observed in Western Europe in the early 1960s. In most of these countries, these are single markets organized and functioning in a similar way as Western European. Most of them were created in Poland, and many of them achieve comparable turnover to large Western European markets. The fact that wholesale markets in Central European countries began to be organized at a time when international trade concerns joined their network expansion significantly limited their development opportunities. The bank's credit strategies and insufficient support for the development of wholesale markets by municipal authorities or government administration bodies were also important [Tajner 2003].

Department and government programs for construction and development of wholesale markets

As a result of political changes in 1989, significant structural changes took place in the Polish economy. It has been marketed, including the elimination of many structures dealing in trade in agricultural products. It was necessary to build new distribution channels for products manufactured in rural areas, similar to those operating in the European Union, which will eliminate adverse phenomena on the market.

The first modern wholesale market in Poland was Greater Poland Agricultural and Horticultural Guild SA in Poznań. Created with the involvement of aid from Switzerland, it began operating in 1992. The need to organize and build modern agri-food market infrastructure in Poland after a change in the economic system (as well as a favorable example of the operation of the Poznań market) decided about the involvement of government administration in the creation and development of modern distribution channels.

The organization of wholesale markets was initiated by the Wholesale Markets and Commodity Market Organizations Program until 2000, approved on July 17, 1996 by the Minister of Agriculture. The continuation of activities undertaken as a part

of the departmental program was the Government Program for the Construction and Development of Wholesale Markets and the Warsaw Commodity Exchange - stage 1 of 1999 and the Government Program for the Construction and Development of Wholesale Markets - stage II of 2001. A number of actions have been undertaken in the government programs to eliminate any irregularities and reasons hindering the construction and functioning of wholesale markets created in accordance with the departmental program. Wholesale markets were to operate in accordance with the provisions of the Commercial Code and other provisions of national law.

The 1996 department program envisaged the creation of several dozen wholesale markets, including:

- (excluding Poznań) of a supra-regional nature: in Warsaw, Gdańsk, Wrocław, Katowice, Kraków, Lublin, Szczecin;
- markets with regional reach in Białystok, Bydgoszcz, Łódź, Radom, Rzeszów and Zielona Góra;
- local markets operating in border regions, which were to be created in order to increase and facilitate trade with neighboring countries.

Markets of this type were intended to be created in Biała Podlaska, Terespol, Elbląg, Przemyśl, Medyka, Suwałki, Wałbrzych and Zgorzelec. It was also planned to build many local markets to support the functioning of regional and trans-regional markets. Appropriately equipped, they were to be created in cities with over 100,000 inhabitants. residents.? Already in 1996-1997, about 20 local markets were to be created.

The main shareholders and organizers of wholesale markets (created as joint-stock companies) were to be agricultural producers and producer groups and organizations, agricultural cooperatives, companies, trade associations, wholesalers, as well as local government organizations, banks and insurance companies and government agencies. The Agency for Restructuring and Modernization of Agriculture was designated to dispose of the treasury resources intended for the organization of markets, and the agency's capital support consisted in buying back shares of companies. The Agricultural Property Agency of the Treasury carried out in-kind contributions in the form of land intended for the construction of markets. FAPA (Foundation for Agricultural Assistance Programs) and PHARE (Poland and Hungary: Assistance for Restructuring their Economies) as well as FAO (United Nations Food and Agriculture Organization) and World Bank funds were also involved in building wholesale markets. The own and assistance funds were to be supplemented with preferential investment loans repaid from revenues obtained from the sale of lease space and rent. Co-financing the construction of local markets in the form of loans and interest subsidies from ARMA was to take place when the capital advantage in joint-stock companies is obtained by producers and their groups operating in particular in rural areas.

Under the departmental program, significantly fewer wholesale markets were created than expected. At the end of 1998, there were about 30 companies with very diverse capital, some of which were in a very unfavorable financial position. First of all, the plan to build a network of local markets failed. Less than expected trans-regional exchanges were created. Only the centers in Wrocław, Lublin, Gdańsk and Warsaw were created from scratch.

The main reasons for the much smaller development of wholesale markets and the financial disadvantage of many of them in Poland in relation to their intentions were primarily:

- heavily overvalued estimates of the volume of expected turnover on wholesale markets;
- not estimating the financial outlays necessary to build wholesale markets, in particular those incurred for creating associated infrastructure;
- failure by local government and administrative authorities to close existing makeshift municipal marketplaces;
- no progress in the organization of the primary market (organized producer groups), which was in some way a reason for the low participation of producers in creating markets.

In August 2000, 22 companies involved in the construction of wholesale centers conducted operating activities in Poland, and 4 prepared the investment process; 6 companies suspended their operations or were put into liquidation. A significant number of operating companies continued to generate losses. The main problems determining the poor financial condition of many wholesale squares were limited to a small extent, primarily competition from local marketplaces as well as incorrectly estimated investment needs and regional turnover.

Agricultural and food markets today

There are 28 agri-food markets in Poland, 12 of which were created as part of the departmental government program or with the financial involvement of state treasury funds (used through ARMA), and these are:

- Warszawski Rolno-Spożywczy Rynek Hurtowy SA in Bronisze;
- Pomorskie Hurtowe Centrum Rolno-Spożywcze SA Rënk in Gdańsk;
- Lubelski Rynek Hurtowy SA Elizówka in Lublin;
- Dolnośląskie Centrum Hurtu Rolno-Spożywczego SA in Wrocław;
- Podlaskie Centrum Rolno-Towarowe SA in Białymstok;
- Rolno-Spożywczy Rynek Hurtowy Giełda Elbląska in Elbląg;
- Rolno-Przemysłowy Rynek Hurtowy Giełda Hurtowa SA in Legnica;
- Rolno-Spożywczy Rynek Hurtowy SA in Radom;
- Podkarpackie Centrum Hurtu Agrohurt SA in Rzeszow;
- Małopolski Rynek Hurtowy SA in Tarnow;
- Wałbrzyski Rynek Hurtowy SA in Wałbrzych;
- Zielonogórski Rynek Rolno-Towarowy SA in Zielona Gora.

In addition, 15 agri-food wholesale markets in the form of:

- joint-stock companies;
- limited liability companies;
- general partnership;
- business activities carried out by natural persons.

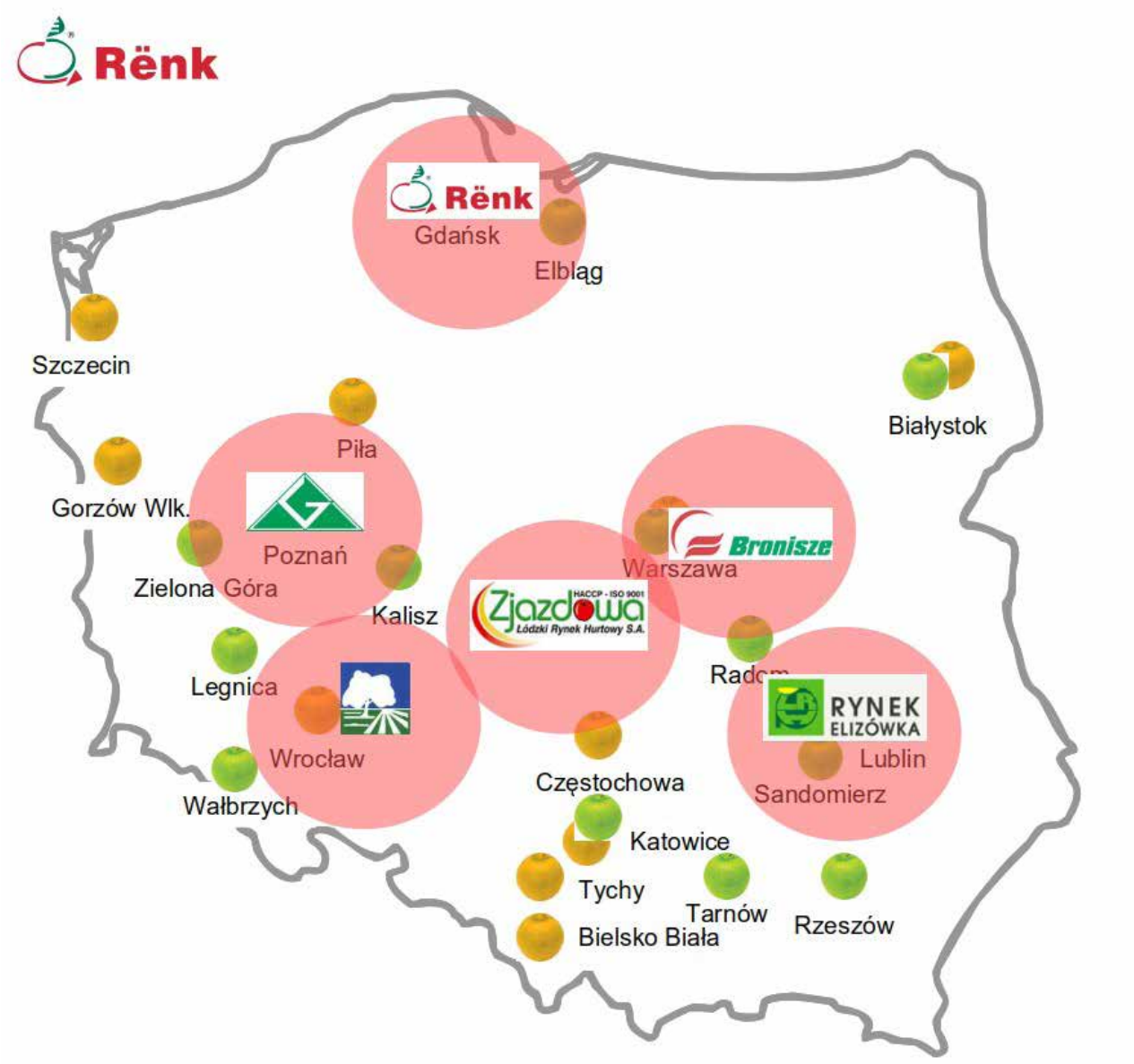
One market was created with the use of financial assistance from abroad - 10 million francs was donated by the government of the Swiss Confederation for the construction of Wielkopolska Gildia Rolno-Ogrodnicza SA in Poznań.The network of agri-food markets in Poland is shown in Figure 1.

Wholesale markets have a total area of about 360 ha. The area intended for trade in agricultural and food products is about 70 ha, including in halls - over 20 ha, and under shelters - 10 ha. Annually, around 6 million customers supply the wholesale markets. The range of products offered by individual wholesale markets is similar, although the sales structure is different.

On all wholesale markets there is a technical infrastructure necessary for conducting commercial activities. Most have refrigerators, freezers, warehouses (which helps stabilize the supply of agricultural and food products) and the infrastructure needed to maintain cleanliness and waste management. A small number of markets have supporting infrastructure in the form of banks or ATMs. Deficiencies in technical infrastructure, primarily supporting trade and enabling the improvement of the commercial quality of offered products are caused by insufficient financial resources of wholesale markets. This applies especially to trans-regional markets built from scratch (the need to repay investment loans).

However, wholesale markets achieve positive financial results, and some of them, in addition to renting sales space, conduct commercial activities on their own to improve the financial condition. Representation of agri-food wholesale market interests to central and local government administration bodies, as well

Fig. 1. Agri-food market network in Poland [PHCRS SA Rënk]



as activities aimed at strengthening the position of wholesale markets in the supply chain are handled by the Polish Wholesale Markets Association (SPRH). It includes markets created as part of government programs, as well as those created with the involvement of local and private capital. The exchange of experience in the functioning of wholesale markets is also carried out within the framework of the World Union of Wholesale Markets. Polish wholesale markets also belong to this association.

Economic and financial situation of wholesale markets supervised by the Minister of Agriculture and Rural Development

Pursuant to the Regulation of the Council of Ministers of 3 January 2017 on the list of the companies in which rights from treasury shares are exercised by persons other than the president and members of the Council of Ministers, government proxies or state legal persons (Journal of Laws of 2017, item 10, as amended), the minister of agriculture and rural development exercises rights from shares in 21 companies with the participation of the state treasury, of which 14 companies are wholesale markets.

The economic and financial situation of agri-food wholesale markets supervised by the Ministry of Agriculture and Rural Development is stable. Based on the results of the analyses, conducted after the second quarter of 2017, out of 14 companies, 13 achieved positive financial results, while one recorded a negative result, however, it is worth adding that the specifics of the above of companies means that they record the highest value of sales revenues only in the fourth quarter of the financial year.

The companies supervised by the Ministry of Agriculture and Rural Development implement investments involving the construction of modern commercial facilities that are to increase the market value of real estate, and thus increase the value of companies, generate higher revenues and improve the quality of commercial, logistics and technical infrastructure of a given wholesale market. The condition of success in a competitive environment is the introduction of changes, improvements and innovations in the services offered.

Polish Parliament on November 24 2017 adopted the Act on trade restrictions on Sundays and public holidays and on some other days. Since March 2018, the ban on Sunday trading has been in force, though only partially so far. In 2018 we will be able to shop in shopping centers and supermarkets only on two Sundays a month. The Act includes the postulates of wholesale markets, agricultural chambers and the Ministry of Agriculture so that wholesale markets and entities conducting activity on them could work on Sundays. In Art. 6, exclusions from this Act were included.

The ban does not apply:

- point 28 - on the agri-food wholesale markets operated by commercial law companies, the main activity of which is the rental and management of real estate for the wholesale of agri-food products;
- point 29 - at commercial outlets run by entities purchasing goods on the agri-food wholesale markets referred to in point 28, in the scope of activities related to the purchase and entrusting an employee or an employee with these activities.

The new regulations on trade restrictions on Sunday will not hamper the work of wholesale markets, on the contrary - they are an opportunity for their development. The tradition of agri-food wholesale markets active on Sunday results from the need to supply fresh agricultural products from very early Monday and post-holiday hours, as wholesale supplies retail, restaurants, hotels (which is of great importance in tourist traffic). Over 35% of trade turnover in the agri-food wholesale market takes place on Sunday, 35% on Thursday, and 30% on other days of the week.

Importance of wholesale markets in the sale of agricultural products

The modern wholesale market has ceased to be exclusively a place of sale of agri-food products. In Western European countries, various additional services have been offered as part of wholesale markets for several decades. The transactions concluded there are only one of the elements of the market, which must offer buyers a much greater added value, for example in the form of comprehensive support addressed to suppliers and buyers. For food producers, we offer: consulting, training, ensuring comfortable sales conditions, signing long-term contracts ensuring sales for manufactured crops or education in creating producer marketing groups. On the other hand, for entities purchasing products offered on the wholesale market, they are offered: the opportunity to purchase in comfortable conditions (e.g. air-conditioned rooms, modern sanitary, gastronomic, automotive), access to modern office equipment and IT network, the possibility of purchasing sorted, clean and labeled in detail products, lack of anonymity, packed in a way that meets the expectations of various groups of buyers. In addition, the seller and buyer conclude commercial transactions regardless of weather conditions.

Another extremely intangible product that should be offered by wholesale markets for both parties is the information set. Information resources must be up-to-date, complete and available in time and in a form that best suits their users. These conditions can only be met if a computerized market information system (SIR) is created in the wholesale market, enabling the acquisition and appropriate processing of necessary information resources. The above system also allows for quick access to specific data and editing according to the indicated criterion. Information should be available to all entities participating in the wholesale market by creating an internal Internet network and via external Internet connections. In the case of using the Internet, the interested entity should receive an access password enabling access to information resources collected in the wholesale market database, which would also protect the system from interference from representatives of competing companies. At the same time, one should not forget about traditional information media, such as the regularly published industry newsletter - an important element of the process of communicating with the market's marketing environment, especially with its regular collaborators.

Changes in customer preferences and the resulting growing pressure on quality and ensuring safety in food trading, force the wholesale markets to create the necessary organizational and infrastructural conditions to achieve and maintain product quality and improve trading conditions. All these activities serve to integrate participants in the food chain "from farm to the table" in order to maintain food traceability, i.e. to trace the product path (identification of origin) - from production to the finished product on the shelf in store - because of the need to believe that food sold on the wholesale market is safe. Wholesale market activities in the sphere of quality assurance focus on organizing training for agricultural producers and other market participants in order to obtain Euro and Globalgap certificates and implement strict requirements related to obtaining HACCP and ISO certificates in the food sectors.

Wholesale markets do not own agri-food products sold in their area, which is why their quality control capabilities are defined primarily by the Food Health Safety System. They undertake many activities aimed at maintaining the efficiency of this system through training in order to make market operators aware of the need to ensure the appropriate quality of products and the need to supervise, monitor and document all elements important for food health safety. Wholesale markets carry out internal audits of the system, commission external audits and cooperate with the commercial quality inspection of agri-food products and voivodship plant protection and seed inspectorates, possessing legal tools regulating and admitting primary production to trading. Taking over the functions of an initiator, organizer and coordinator of activities for the quality by the markets means that the costs of obtaining certificates and their maintenance are lower for operators [Oleszko 2006].

Analysis of the functioning of PHCRS Rënk in rural development

The Pomeranian Wholesale Center was founded pursuant to the founding act in 1995 as part of the implementation of the government's Wholesale Markets and Stock Exchanges Program in Gdańsk. Under this program, the construction of modern agri-food market infrastructure in the form of wholesale markets and commodity exchanges was foreseen, whose main organizers and participants would be agricultural producers or producer groups and their associations as well as wholesalers, with significant support of local governments. Significant capital entry into companies was expected from banking and insurance institutions. The company's operational activity began in 1999, after the completion of necessary investments and commissioning of facilities.

The company's mission presented in the strategy expresses the role that the company wants to fulfill for the environment in which it operates, especially in such matters as: the subject of the activity, market position, size of the target market and quality. The mission of PHCRS SA includes in particular:

- specialization in warehouse and commercial space lease services for the agri-food market, and shape the nationwide wholesale standard in quality and technical level;
- development and improvement of currently offered methods and ranges of customer service as well as promotion of the benefits of mutual cooperation and specialization;
- maintaining a good brand of a facility specializing in servicing regional agri-food trade, supports trade - domestic and foreign - with products offered by tenants and promotes exemplary ways of storing agricultural produce and healthy eating;
- the company's activities should be focused on flexibility to meet the expectations of the market and individual tenants;
- conscious participation of employees and shareholders in creating the company's value and achieving its success.

The main goal of PHCRS SA is to satisfy the interests of owners, employees and customers by continuing the stable and long-term development of the organization, providing tenants with stable and predictable operating conditions and development opportunities.

Analysis of the indirect and direct environment of the company

Centrum Rënk can be described as an exchange with high standards of services and importance beyond the Tri-City region. The Rënk Agricultural Stock Exchange was established in 1995, although it began operating in 1999. Its surroundings and geographical location are very important in defining and maintaining a strong market position. The location of the market next to the Tri-City ring road gives the possibility of free access to clients from both the metropolis and neighboring provinces. The company has a trans-regional character and is the largest in northern Poland - it covers an area of 24.73 ha.

The location of the market has been designed in such a way that it constitutes a food base for the Tri-City and the entire metropolitan area - from Wejherowo to Tczew. Successive road investments completed in recent years (A1 motorway, southern beltway) create further perspectives for the future, as the time to travel to the market from further areas is shortened.

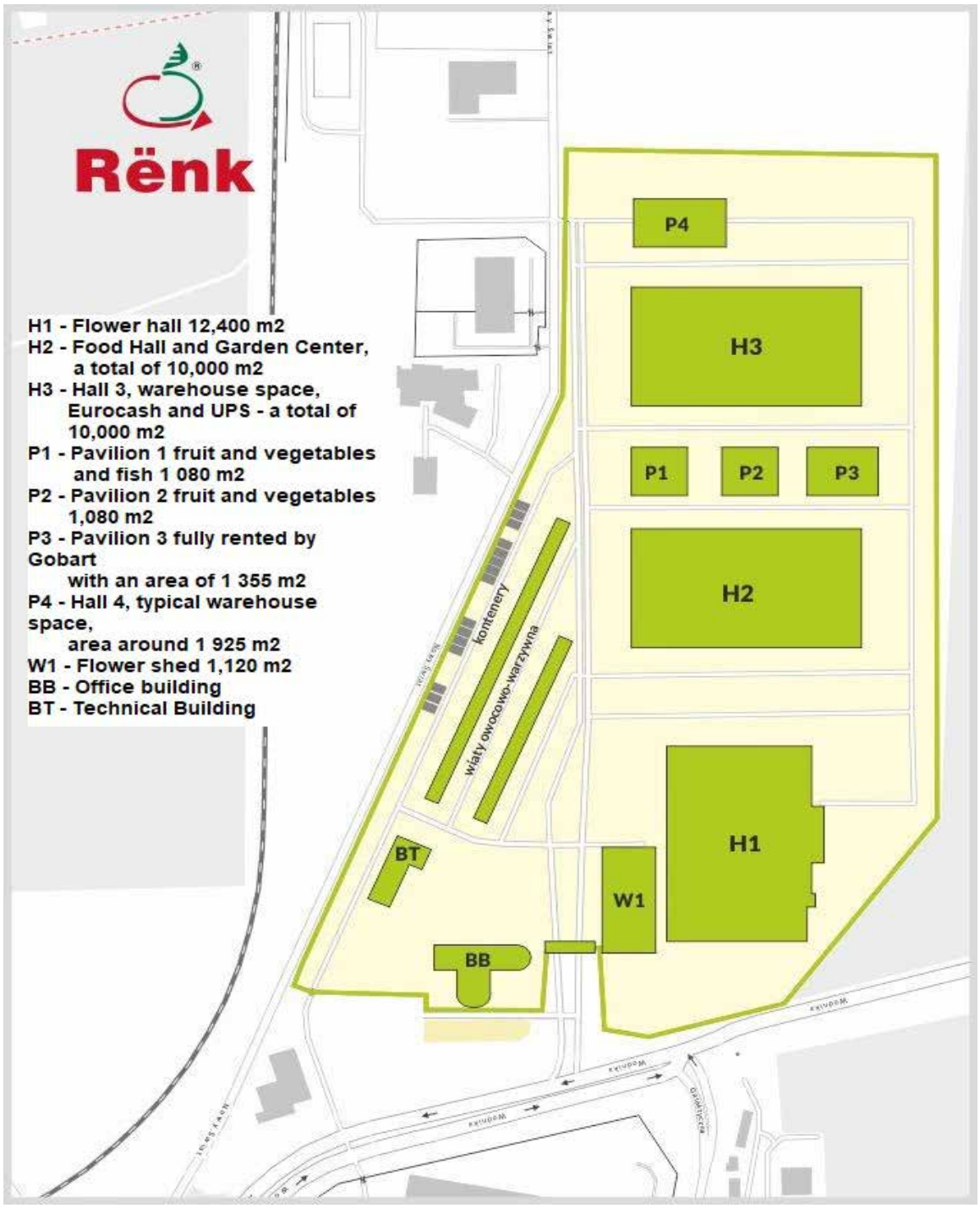
The Pomeranian Wholesale Market is not only a place where the distribution of articles from the agro-horticultural industry takes place, it also plays an important role in the organization of the horticultural environment. It includes fairs and exhibitions on gardening topics, which are also very popular among retail customers.

The main regional competitors include two trade exchanges - the Wholesale Market in Gdynia and the Commodity Exchange Transbud in Gdańsk. The Gdynia Stock Exchange - also known as the Chwaszczyńska Stock Exchange - operates at 7 Rdestowa Street, close to the Tri-City ring road.

In addition to the market in Gdynia Pomerania, there is also one more stock exchange called the stock exchange at Miałki Szlak, which was established in 1991. at the Transbud transport company base. Despite the fact that after launching the real wholesale market, PHCRS, there were no administrative decisions to close these marketplaces, many entities gradually moved their operations to Rënku.

Rënk has been repeatedly awarded for professional organization and the highest quality standards and has become an example of great management. As previously mentioned, the modern center of Rënk has not been fully used since its inception. Merchants traded at ordinary markets instead of air-conditioned halls. High standards of space for trade and storage of goods at the same time high prices of space for rent, entrances and parking lots did not prompt traders to change location. The situation improved significantly when rental costs were reduced and a lower entry fee was introduced. Currently, over 99% of the stock market space is used, and interest in vacant space and renting by subsequent entities is very high.

Fig. 2. Plan of facilities located on the wholesale market [PHCRS Rënk]



Development strategy for the rënk enterprise

The company jointly provides lease services to nearly 210 tenants and rents space in three halls, four commercial pavilions, an office building, a shed and roofed commercial stands. Trading conditions allow you to operate throughout the year. The boxes are equipped with water access and secured with electronic blinds. It was ensured that the conditions for trade and purchase of goods by customers were carried out in safe and hygienic conditions. The halls have toilets, showers and social rooms.

The center mainly sells flowers, decorative and gardening items, fruit and vegetables, general food items, meat and fish. Tenants who operate in Rënek rent an average of 99% of the space designated for rent. Figure 2 presents a plan of facilities located on the wholesale market at ul. Wodnika 50 in Gdansk.

Company development plans

Due to the nearly 100% utilization (rental) of commercial space, the company's development possibilities are limited. Further development is mainly planned through the construction of new facilities.

After the exchange of land with the commune of the city of Gdańsk in 2015, the company has definitely better development opportunities, as the area obtained in this way has a regular shape (similar to a rectangle), which will enable orderly development of commercial facilities in the future. The company has provided a development plan through the construction of new facilities, which assumes the implementation of future development using the area occupied by the protective shaft.

The company operates on an area of over 23.1 ha (of which the developed area is 17.3 ha), while the covered facilities occupy just over 4.2 ha. Considering the need to maintain full freedom of movement and maneuvering of large motor vehicles and taking into account existing green areas, the company may implement, according to the land use plan, further development of land by over 30 thousand. sqm. commercial space. Such development, however, depends on the needs of future tenants and the implementation of possible new directions of activity.

The company has economic development potential and areas for new facilities. The company's infrastructure development program should include the construction of a place to complete the delivery of products shipped for export. The proximity of Kaliningrad, established cooperation with Lithuanian food producers, and increasingly better contacts with representatives of Belarus may be of great importance in developing mutual exchange of food and industrial products between our countries. Such activity could expend the sale of many goods currently offered by operators only to domestic customers. Opening a wholesaler in Rënk offering food or industrial products (unknown in Poland) would increase interest in purchasing among existing customers and attract new buyers.

Summary

Wholesale markets have been and will be needed, in particular for producers in rural areas, but changes in the way they operate are necessary. Investments are not everything, however, the need for greater consolidation of joint projects and promotion of the brand under which sellers could operate and better promote Polish products. The location of wholesale markets within large urban agglomerations is associated with high consumer demand reported by retail outlets located there. Wholesale markets integrate clients on a large scale both in terms of the number of entities and the volume of sales realized. District stores, bars, catering outlets do not have a large storage area, and therefore are forced to supply fresh products on a daily basis. If wholesale markets were far from the agglomeration, people who needed fresh food every day would have nowhere to buy or would do it very rarely.

The biggest advantage of agri-food wholesale markets is the rich, year-round offer of vegetables and fruits. In the offer addressed to the owners of grocery stores, catering companies or bars and restaurants, wholesale markets also include agricultural products from around the world, but the basic group is the most popular domestic food produced in rural areas.

For the sake of rural development, we should all care about support for local enterprises, because they prove the condition of our economy. Agri-food wholesale markets operating primarily on the principle of distribution of goods between small and medium-sized agricultural producers and small and medium-sized shops, restaurants and catering companies seem to be one of the most important areas for this phenomenon. Daily supplying the company on a locally located wholesale market, not only with agricultural and fruit products, but also with complementary purchases, provides real support for producers from rural areas. The goods purchased there, due to their high quality and popularity among consumers, can significantly contribute to increasing turnover and sales in every company using them. Buying in a store supplied in the markets of local producers, we have the opportunity not only to benefit from the quality of fresh high-quality products, but to take an active part in the chain of building strength of the local food market focused on rural areas.

On the basis of the presented considerations, several important conclusions can be drawn regarding the Pomeranian Wholesale Agricultural and Food Center Rënk. First of all, the phenomenon of disappear the boundaries between wholesale and retail sales will be more and more clearly visible, while at the same time the possibilities of meeting the changing needs of increasingly demanding buyers and competing with market rivals will be significantly expanded. This applies in particular to reaching producers and buyers operating on competitive markets. Secondly, the sales function will become one of the many functions fulfilled by wholesale markets. Regional producers from rural areas will increasingly cooperate with distributors located in Rënk, especially with larger wholesalers. This will allow the development of increasingly fashionable online

sales. Thirdly, Polish wholesale markets - in response to actions taken by foreign hyper- and supermarket chains - can fulfill the role of activating the development of their environment. The most important issue will be building a Polish brand and increasing the quality of products. In addition, an intangible product in the form of a set of information that should be offered by each party, i.e. supply and demand, is extremely important for both parties represented on the market.

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Bożena GAJDZIK[1)], Klaudia PIASKOWSKA[2)]

[1)] Dr hab. Bożena Gajdzik, PhD.,
Professor the Silesian University of Technology
Faculty of Materials Science,
ul. Krasińskiego 8, 40-019 Katowice,
e-mail: bozena.gajdzik@polsl.pl

ORCID: 0000-0002-0408-1691

[2)] Eng. Klaudia Piaskowska, MSc.,
graduate of the Silesian University of Technology,
Faculty of Material Engineering (Katowice, September 2019)
e-mail Piaskowskaklaudia@gmail.com,

AUDIT OF THE CONTINUITY OF IT IMPROVEMENT IN MANUFACTURING ENTERPRISE – CASE STUDY

AUDYT CIĄGŁOŚCI DOSKONALENIA SYSTEMU INFORMATYCZNEGO W PRZEDSIĘBIORSTWIE PRODUKCYJNYM - CASE STUDY

Summary: *The text of the present publication contains the problems of the range of auditing the computerised IT system of the enterprise management in the frames of the process and cross approach. The audit of the computer IT system, employed in the manufacturing enterprise is used for the improvement of the system that is functioning in the specified conditions. The IT computer systems in the enterprises integrate a given enterprise via linking of the particular operations which cross (horizontally or vertically) its organizational structure. In the situation of the permanent changes in the enterprise, the employed IT computer systems for service of the processes must also undergo changes. In the publication, the range of auditing the IT computer system with the aim to improve it, have been presented. The paper is focused on identification of narrow links of the system and the statement of the problems, occurring in the manufacturing plant. The work is a form of case study, developed on the grounds of the situation occurring in the enterprise. The currently employed IT computer systems in the company are as follows: ERP class system, the system for documentation management, the system for management of the requirements for the railway sector (IBM Rational DOORS), the system for management of the projects, the system for designing and scheduling the production, the system for tracing the circulation of the documents, the package of Business Intelligence class for data analysis and reporting and the solutions based upon the Excel sheet.*

Key words: *IT computer system, audit of IT computer systems, improvement oif IT systems in enterprise*

Streszczenie: *Na treść publikacji składa się problematyka zakresu audytowania komputerowego systemu informatycznego zarządzania przedsiębiorstwem w ramach podejścia procesowego i crossowego. Audyt komputerowego systemu informatycznego stosowanego w przedsiębiorstwie produkcyjnym jest stosowany dla ulepszania systemu, który funkcjonuje w konkretnych warunkach. Systemy informatyczno-komputerowe w przedsiębiorstwach scalają to przedsiębiorstwo przez łączenie poszczególnych czynności, które swym przebiegiem przecinają (poziomo lub pionowo) jego strukturę organizacyjną. W warunkach ciągłych zmian w przedsiębiorstwie, używane komputerowe systemy informatyczne do obsługi procesów muszą również podlegać zmianie. W publikacji przedstawiono zakres adytowania komputerowego systemu informatycznego w celu jego doskonalenia. W pracy skupiono się na identyfikacji wąskich ogniw stystemu i zestawienie problemów występujących w przedsiębiorstwie produkcyjnym. Praca jest formą case study powstałą na podstawie sytuacji występującej w przedsiębiorstwie. Aktualnie stosowane w przedsiębiorstwie systemy informatyczno-komputerowe to: system klasy ERP, system do zarządzania dokumentacją, system zarządzania wymaganiami dla sektora kolejowego (IBM Rational DOORS), system do zarządzania projektami, system do planowania i harmonogramowania produkcji, system do śledzenia obiegu dokumentów, pakiet klasy Business Intelligence do analizy danych i raportowania oraz rozwiązania oparte o arkusz Excel.*

Słowa kluczowe: *komputerowy system informatyczny, audyt systemów komputerowo-informatycznych, doskonalenie systemów infromatycznych w przedsiębiorstwie*

Introduction

In management of the enterprise, the emphasis is placed on the integration of the elements of the process with the support of IT systems. The process approach as employed in management of IT systems integrates the parameters of evaluation of its functioning such as functionality and usability and the costs of operation and improvement of the system and also, the time period of its use and the developmental possibilities of the system. The development of IT technology enabled the control of the processes using computer IT systems in the enterprises in a form of package of different IT computer solutions (Kisielnicki and Sroka, 2001). In functioning of IT computer systems in the enterprises, the functional (usability) gaps may, however appear; they are determined by different factors (including, inter alia, a lack of compatibility between the IT computer systems, employed inside the company). Many modern IT systems have the self-learning and/or self-improving options. However, in the process of improving the systems, the matter consists also in identification of their limitations (narrows links, barriers) with the participation of their direct users. The users of IT computer systems should identify the problems and participate in their solving by the internal team of the specialists for IT problems or with the participation of external companies (suppliers of IT computer systems). The introduction of the appropriate betterment operations is preceded by the performance of audit of the IT computer system

in the enterprise. The betterment of the IT system means the continuous adaptation of standard solutions of the enterprise systems to the new expectations of the system users what allows better performance of their IT role. In audit of the discussed IT system, it is important to identify two basic objects i.e.:

- User of the system – individual object that is created by the authorised worker of the company,
- Functions of the system – description of the operations which the worker using IT system may perform and obtain the data range to which he has an access.

The audit of IT system is employed (most frequently) in order to determine the degree of its compatibility with the binding or IT standard. This publication is limited to the presentation of audit of the users of the system in aspect of their expectations as regards the changes in the IT system in the range of its continuous improvement. Due to the range of the analysis, the said audit was defined as audit of the continuity of improving the IT computer system of the enterprise.

Abbreviated literature study on the audits of IT systems

„Audit of IT system is a process of collecting and evaluating the evidence in order to determine whether a given IT system and the related resources protect the property in a correct way, maintain the integrity of the data and supply the appropriate and reliable information, reach the aim of organization in effective manner utilize the resources sparingly and employ the mechanisms of internal control as to supply the reasonable assurance that the operating and control aims are reached and there is a protection against undesirable events or they are detected at time and their consequences corrected at time" (Liderman and Patkowski, 2003). Audit of IT system, employed in a given enterprise allows performing a review of the company's resources, indicating the gaps in the system and potential threats, and preparing the action plan in the case of critical situation. Owing to audit it is possible to plan better the expenses for the purchase of equipment and software. Audit of the continuity of improving the IT system the aim of which is to indicate the possibilities of the company for further development is a very measurable example. Audits of IT systems are implemented by the external companies of internal IT teams. It is preferable to implement audit – review with the co-participation of the direct users of particular IT computer system modules before the implementation of the audit procedure, performed by the external company. Audit of IT – computer system of the enterprise includes, inter alia, audit of infrastructure, audit of licence, audit of binding service procedures and audit of agreements on Maintenance and Support (M&S). Its aim is to collect information on IT systems, their co-acting and verification of business justification and justness of the possessed service for maintenance if IT infrastructure. The complex audit of IT – computer system is commenced from the establishment of the range and timetable of the study to be conducted what has a big influence on the time of implementation and effect of the whole task. The recommendations of remedial action within the frames of the examined IT area, as contained in a final report, are the result of audit. Audit may be implemented according to the checklists based upon the selected standard, penetration tests and black box tests (checking the safety) (Liderman, 2012; Nowak and Scheffs, 2010; Galach, 2005) and other research forms: review, survey, observation, testing of the way of documents' obtaining, a review of the implemented procedures and other forms of collecting the evidence materials. When adopting PDCA model, the enterprises strive at the continuous improvement of IT systems. A dynamic development of IT technologies has significantly affected the competitiveness and effectiveness of the enterprises. Without the appropriate support of the IT systems, the contemporary enterprise is not able to function properly (Molski and Łacheta, 2007). Therefore, the enterprises implement, more and more frequently, internal audits in order to determine the "gaps" and problems of the users of the system, employed in a given enterprise. Audit may be classic, formal or substantial (Zalewski et al.). IT audit implemented by direct users of the system (employees of the particular departments of the enterprise) is treated as the classic model of audit; its aim is to understand the processes with the support of IT and to determine the problems connected with the application of the system by the direct users. Specialist consultations (aid of external companies) are not required on the stage of such audit. The discussed audit means individual approach of the particular users of the system to the problems connected with the use and service of IT system. When implementing the audit, we should apply the best practices, e.g. COBIT, used during construction and management of IT systems.

Case study: auditing of IT system in the enterprise

The example referred to the enterprise, equipped with a few packages, forming the IT system the enterprise has, inter alia, ERP class system, system for documentation management, the system for management of the requirements for railway sector (IBM Rational DOORS), the system for management of the projects, the system for planning and scheduling of production, the system for tracing of the documents' circulation, the package of Business Intelligence class for the data analysis and reporting, and the solutions based on the Excel sheet. The particular packages were introduced from 1999, obtaining the developed net of IT system in the enterprise in 2018. The following facts were considered as milestones of the while investment cycle: introduction of PDM interface, Business Object and bar code system. After 2018, the enterprise began to consider the application of a new IT system of SAP type. However, before a final decision on the purchase of the new system, the measures were undertaken in connection with the modification of the existing BAAN system. The mentioned measures were defined as audit of continuous improvement of the IT system. The map of the enterprise's processes in evaluation of functionality and usability of the employed IT computer system is created by two areas: the implementation of the engineering tasks and the implementation of the purchase. The configuration of the components of the map of the processes is given in Tab.1.

Tabela 1. The configuration of the components of the map of the processes

Task	Entrance	Exit
Implementation of engineering tasks	Calculation sheet of the project, range of the project, application-constructional documentation, date of the supply of the product, external receipt of material, service invoice, declaration of conformity (quality certificate), protocol, invoice specification (shipment evidence), data concerning assortment item.	Confirmation of purchase recommendation, internal order, shifting to the project from storage room or another project, invoice, liabilities, data for the need of the order, INTRASTAT (statistical system for the needs of trade of goods), data for the needs of GUS (the Main Statistical Office), data for the needs of Maximo (management of physical resources), data of assortment item, eBOM.
Implementation of purchase	Recommendation from the purchase (MRP, SIC), the „manually" reported needs – bar code systems, base of suppliers, data of assortment item, pricelists, control parameters (to storehouse) constructional documentation, data of assortment item, prognoses, supplier's offer, data concerning deliveries, data on the supplier (audits), claim protocol, external receipt of the product, invoice from the supplier, information on discrepancy.	Transfer of order to the supplier, timetable of deliveries, frame order, evaluation sent to the supplier, change of the status, confirmed by the supplier (Base of Suppliers), list of suppliers for audit, claim document to the supplier, changes in the order of the purchase, the order of purchase.

The range of auditing of IT computer system

In the analysed enterprise, the work on the improvement of IT system package (the applied IT solutions for the support of the enterprise management) was commenced from the recognition of the expectations of the IT computer system users and determination of the elements which disturb the functioning of the existing system. The aim of the implemented project, called the improvement of IT computer system in the enterprise was to determine the most important aspects of the functionality of the system: complexity and usability of the system, scheduling of the projects, *User-friendly*. The main area of the studies included the determination of barriers (limitations) of the particular components of UT computer system by their direct users. To this end, the following sheet of evaluation was developed (tab.2) where 1 – is the lowest score evaluation and 5 – is the highest score evaluation.

In evaluation of IT computer system, the deepened interview and observation were also employed. The questions directed to the users of the system were divided into several subject areas, depending on the implemented tasks and their functions in the enterprise.

The users of the audited IT computer system

Audit was carried out among the employees of the analysed enterprise: production manager, employees of manufacturing sector, logistics, workers of service, IT specialists, workers of administration department, workers of book-keeping and finances, the employees of planning and strategy, and the persons employed in sales and marketing sector. The employees, being situated higher in the organizational structure of the enterprise answered individually the questions (questionnaire of the interview) and the

Tab. 2. The sheet of the evaluation of functional parameters of IT computer system

	Parametry/kryteria oceny	1	2	3	4	5
1	Speed of operating (in respect of the tasks, to be performed by the employee)					
2	Quality of operating (subjective feeling of user)					
3	Rate of data processing for the needs of the enterprise (including reporting)					
4	Flexibility and easiness of developing the system, using Maintenance function					
5	Safety – guarantee of safety					
6	Possibility of obtaining the documents from different sources during the implementation of the tasks					
7	Integration with other systems and applications available in the enterprise					
8	Easy in operation (simple instructions)					
9	Stability (resistance to failures and protection from the network attacks)					
10	Functionality and readability of interface					

employees of the lower level of the organization answered the repeatable questions (a focused interview). The set of the common questions (identical) concerned functional and usable parameters of the studies IT computer system.

Identified limitations (barriers) of the employed IT system

During the procedure of auditing the IT system, its key limitations were identified. Parameter of functionality of the used IT system in the range of the possibilities of individual users to obtain the data from different sources within the different used IT systems was the greatest limitation. It means that the package of IT systems, employed in the enterprise, does not have a developed module which could enable and facilitate a quick obtaining of the data concerning particular operations (tasks) from one system in combination with other IT systems employed. The variety of IT packages, creating one IT system of the enterprise results also in slowing down the work of the system. In the opinion of IT specialists, the limitation of the speed of the system's functioning is a significant limitation in the process, oriented to compatibility of different IT systems, supporting the functioning of the enterprise. It results from the fact that the systems possess a small number of licences in relation to the number of the potential users. The more persons using the system at the same time, the longer is the time of data processing. The scores, obtained for the particular persons (audit participants) are given in Tab.3. The following symbols were used: Criteria of evaluation: K1 – readability of interface, K2 – stability (resistance to failures and protection from the network attack), K3 – easy in maintenance, K4 – integration with other systems and applications, K5 – the possibility of obtaining the documents from different sources, K6 – system safety, K7 – flexibility and easiness of development, K8 – speed of data processing, K9 – quality of functioning, K10 – speed of functioning. The employees: p1 – the employees of manufacturing line, P2 – the employees of logistics department, P3 – the employees of administration department, P4 – the employees of planning and strategy department, P5 – IT specialists, P6 – the employees of sales and marketing department, P7 – section of bookkeeping and finances.

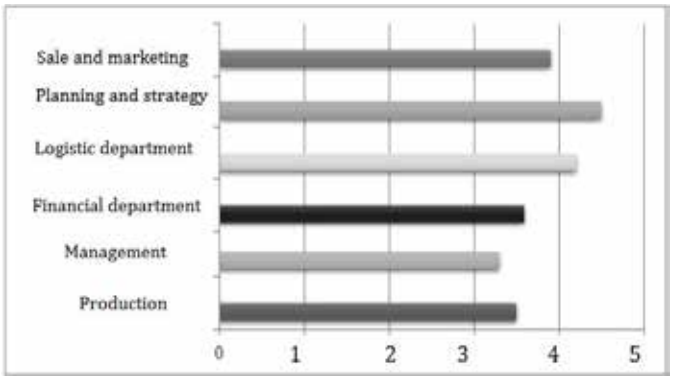
During the interview, a detailed list of the limitations in the field of functionality of the particular IT systems used in the enterprise was established. The examples of answers are as follows (Piaskowska, 2019):

a) Frequent failures of the system, slowing down of the work of the system at the end of the month (deadline for many implemented tasks in the enterprise), sporadically – the problems with the equipment and network,
b) Difficulties in compiling the system for the needs of the implementation of the new functions (changes in the system performed in the test environment – time 1 month),
c) Supplementation of the system requires a consent of the enterprise management (user introduces the notification by e-mail or by phone to the base for notifications and IT specialists create a session in the test environment),
d) Updating of the system is implemented by the particular suppliers of the software (all updates are checked in the test environment and later on, are uploaded to the manufacturing environment), the user of the system (the company) has a bought package: maintenance; however, when he wants to develop the system by the additional services, the external company makes the additional pricing of the range of the rendered services which have not been considered in the basic agreement between the user of the system (the enterprise) and the supplier of the system. The external company establishes also the time of implementing the order, improving the functioning of the system. The cost of removal of the defects and development of the system and the time of the implementation of the order may be considered as the barriers to the development of the

Tab. 3. Evaluation of the parameters of functionality of IT computer system
Source: own elaboration on the grounds of the direct studies (Piaskowska, 2019).

P/K	P1	P2	P3	P4	P5	P6	P7
K1	3,5	3,3	4,7	3,2	3,7	3,9	3,3
K2	3,4	3,2	4,3	3,2	3,6	3,7	2,8
K3	3,3	3,2	3,3	3,0	3,4	2,7	3,1
K4	3,2	3,0	3,0	3,3	3,3	2,9	3,0
K5	3,1	3,0	2,0	2,7	3,1	3,1	3,1
K6	3,4	3,4	3,7	3,2	3,4	3,3	2,9
K7	3,5	3,4	3,3	3,3	3,5	3,0	3,3
K8	2,9	2,9	3,3	3,0	3,3	3,6	2,9
K9	3,2	3,2	3,7	3,3	3,5	3,1	3,1
K10	3,2	3,5	2,7	3,1	2,8	3,7	2,8

Fig. 1. The results of the scores for cooperation
Source: Piaskowska, 2019.



enterprise in IT area in relation to certain used systems (ageing of IT systems affects the increase of the costs of their updating).

The positive evaluations concerned, first of all, the function of visualisation of the run of the processes in IT system. The example of the answer is as follows:

e) The system allowed making the visualization of the process in order to indicate the"bottlenecks" in the implemented manufacturing process. In the used system, the employee/user has the possibility of checking the time of implementation of the particular operations and, additionally, the discussed system allows arranging the operations, duration of the manufacturing time and the date at which the products may be manufactures, referring to a real time.

The range of the evaluation covered also assistance/IT service, implemented by the external team of IT specialists. The results of the evaluation of cooperation of the employees/direct users and OIT department in the enterprise is given in Fig.1. To measure the degree of cooperation, the scale 1 – 5 was employed. Number 5 means the highest evaluation score.

Based upon the results given in Fig.1 it was established that the planning and strategy department and the persons dealing with the logistics rate the highest cooperation with IT specialists and the lowest scores were given by the administration department and by the persons directly employed on the manufacturing lines. In the case of the administration employees, the justification for lower scores included the necessity to modify frequently the system in order to adapt the obtained information to the new guidelines of data protection (RODO). On the other hand, the employees of manufacturing lines expected greater competences in utilization of the system functions and development of the equipment for visualization of the manufacturing parameters, with the utilization of the newest techniques of transmitting the information.

Plan of the changes in the audited IT computer system

The proposals for the changes in the utilized IT system concerned the particular identified problems. The example of the sheet of the areas with the proposed changes is given in Table 4.

The following directions of the changes were outlined:

- Continuous improving of the system, and in particular, the current improvement of the elements concerning the quicker data processing and obtaining of the documents for the implementation of the processes (tasks) in the enterprise;
- Improvement of the system for communication between the employees of IT specialists and the external company,

Tab. 4. The example of the proposed changes in the utilized IT system
Source: own development on the grounds of direct studies

The employee/post in the enterprise	Identified problem	Solution of the problem
Head Manager	Lack of the possibility of generating the cross-section report in the system	Purchase of Business Objects – BO system, enabling the implementation of cross-section reporting on the level of Top Management
The employees of the logistics department	Lack of the possibility of developing the modifications of the system in the own range (as regards the problems, situated in the logistic proceees, implemented in the enterprise) Lack of the possibioity of comapring the logistic costs	Purchase of necessary modules (applications) of the system
The employees of the manufacturing line	Problems with the system errors	Notification of the system errors to the IT department of the enterprise (team of IUT specialists)
	Lack of the module of production scheduling	Purchase of the module for scheduling of production
IT specialists /IT department employees	Too small number of licences in relation to the number of users what causes the prolongation of the time of data processing in the system	Purchase of additional licences
	The limited possibility of obtaining the documents from different sources, using the system	Integration of the system with the documentation circulation systems
Other employees	Labour consumption during the introduction of the data (the system is supplied with the data introduced to the system by the employees – the situation refers to several work posts)	Automation of the process of the data introduction

responsible for the development of the particular modules of the system;

- Adaptation of the enterprise to the passage into the new It system due to the limited developmental potential of certain packages of IT solutions, employed in the enterprise (in the future, it is possible to consider the change of the present system by another, more functional one which would have more possibilities and facilitate the more effective management of the processes in the company).

The results of the audit were submitted to the managerial staff. The following strategies to be undertaken in the company in respect of IT computer systems were outlined as follows:

1. The adaptation of the selected IT systems to the new developmental areas of the enterprise. The strategic plan will be implemented up to the end of 2020.
2. The analysis of the market in respect of implementation offer for the new IT system (the following measures were undertaken: analysis and evaluation of the market offers of the suppliers of IT systems). At present, there is implemented the stage of the shipment of the offer inquiry to the key sellers of IT systems, in which the company is interested.
3. The organizational-preparatory procedure to implement the new IT system in the enterprise (the time of the project duration: since January 2020 until June 2020)
4. Introduction of the new IT system – the project named: Pilotage of the new OT system, implemented by the external company (period of the termination of the project: up to December 2020).
5. Closure of the utilized system (time of commencing the project: January 2020).
6. Full utilization of the new IT system (time of commencing the project: January 2020).

Summing up

The performed audit of the existing IT solutions in the analysed enterprise allowed establishing the directions of modification of the employed solutions and undertaking the decision on the purchase of the new (more developed) system in the future (the measures will be undertaken in parallel with the activity in respect of improving the existing system as to preserve the continuity of information transfer and support of IT system in the implemented processes. The aim of the audit was to identify the limitations of the employed IT system in the enterprise in order to obtain the arguments "pro" and "contra" as regards its replacement by another system. The planned activities of the replacement of IT system into the new one must be implemented fluently as to prevent the complications during the replacement of the existing system by the new one. The conducted audit of the continuous improving of IT system was, therefore, a tool for improvement of the system in order to maintain the correctness of the company's functioning during the transitory period before the passage to the new IT system.

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Ryszard RUS

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Chairman of the Chief Commission of History and Tradition
President of the Department of the Association of Polish Surveyors in Gdańsk
e-mail:ryszardrus@gmail.com

"TO BE USEFUL FOR THE NATION" STANISŁAW WAWRZYNIEC STASZIC

"BYĆ NARODOWI UŻYTECZNYM" STANISŁAW WAWRZYNIEC STASZIC

Summary: *Stanisław Staszic was born on December 6, 1755 in Piła. He died on January 20, 1826 in Warsaw. He was an activist and political writer, naturalist, philosopher and ideologist of the Polish Enlightenment. Staszic was one of the most outstanding representatives of the thoughts of Polish enlightenment, he exerted a multilateral influence on the intellectual life of the country, especially after 1800. As a political journalist, he made his debut with Notes on the Life of Jan Zamoyski (1787) and Cautions for Poland (1790), criticizing the flaws of the Polish political system he saw the main reason for her weakness, and postulating extension of burgher rights; the brochure On Polish Statistics (published in 1807) contained guidelines regarding the organization of the state in the spirit of Enlightenment rationalism and was an expression of support for French orientation. His study in geology of the Carpathians and other mountains and plains of Poland (1815), which together with the geological map of Poland and neighboring countries (one of the first maps of this kind in the world) constituted the first attempt at a synthetic approach to Polish geology, as well as description of the Tatra Mountains, which he visited in 1805. He presented his views on the evolution of social and political relations in an intricate historiosophical poem Human Family (1819–20, confiscated by censorship). As a philosopher, he preached a monistic concept of the world, based on the principle of development arising from the law of nature. After the fall of Emperor Napoleon I, he was a supporter of a close relationship between the Polish lands and Russia, convinced of the coming of the era of the Slavs united under her aegis (Pan-Slavism).*

Keywords: *thought of Polish enlightenment, Polish state, political journalist, philosopher, monistic concept of the world, law of nature,*

Streszczenie: *Stanisław Staszic urodził się 6 grudnia 1755 r. w Pile. Zmarł 20 stycznia 1826 r. w Warszawie. Był działaczem i pisarzem politycznym, przyrodnikiem, filozofem i ideologiem polskiego oświecenia. Staszic był jednym z najwybitniejszych reprezentantów myśli polskiego oświecenia, wywarł wielostronny wpływ na życie umysłowe kraju, szczególnie po 1800 r. Jako publicysta polityczny zadebiutował Uwagami nad życiem Jana Zamoyskiego (1787) i Przestrogami dla Polski (1790), krytykując wady ustroju Rzeczypospolitej, w których widział główną przyczynę jej słabości, i postulując m.in. rozszerzenie praw mieszczaństwa; broszura O statystyce Polski (wydana 1807) zawierała wskazówki odnoszące się do organizacji państwa w duchu oświeceniowego racjonalizmu i była wyrazem poparcia dla profrancuskiej orientacji. Duże znaczenie miało jego studium z zakresu geologii O ziemiorodztwie Karpatów i innych gór i równin Polski (1815), które wraz z mapą geologiczną Polski i krajów ościennych (jedna z pierwszych map tego rodzaju na świecie) stanowiły pierwszą próbę syntetycznego ujęcia geologii Polski, a także opisu Tatr, które zwiedził 1805. Swe poglądy na ewolucję stosunków społecznych i politycznych przedstawił w zawiłym poemacie historiozoficznym Ród ludzki (1819–20, skonfiskowany przez cenzurę). Jako filozof głosił monistyczną koncepcję świata, opartą na zasadzie rozwoju wynikającego z prawa natury. Po upadku cesarza Napoleona I był zwolennikiem ścisłego związku ziem polskich z Rosją, w przekonaniu o nadejściu ery Słowian zjednoczonych pod jej egidą (panslawizm).*

Słowa kluczowe: *myśl polskiego oświecenia, państwo polskie, publicysta polityczny, filozof, monistyczna koncepcja świata, prawo natury, panslawizm*

Intruduction

The Honourable Readers are entitled to receive information on the genesis of the motto of the First (I) General Congress of Polish Surveyors that was held on January 1 (Saturday) – 6 (Monday) (nota bene, it was the Epiphany) of 1919.....

At the beginning, let me mention some facts which are universally known; inter alia, the main stages of Poland's partition:

- Partition I – 1772 (Russia, Prussia, Austria)
- Partition II – 1793 (Russia, Prussia)
- Partition III – 1795 (Russia, Prussia, Austria).

After Poland's partition III, the area of Prussian partition occupied more than a half of the territory of the Kingdom of Prussia whereas the Poles constituted almost a half of its population. In 1807, Poland obtained a substitute of independence in a form of the created Duchy of Warsaw; in 1815 it became transformed into dependent Kingdom of Poland, formally connected by the personal treaty with Russia. By this, Russia occupied 82% of the territory of Poland within the boundaries of 1772, Austria – 11% and Prussia 7%. In 1916, Austria-Hungary and Germany generated the subordinate Regency Kingdom of Poland. After overthrown of tsarism, the Provisional Russian Government of Prince Lvov recognized – in the Manifest of 17 March/30 March 1917 – a full right of Polish nation to decide on its future according to the own will, and the fact that being faithful to the agreements with its allies, being faithful to the common plans of the struggle against the German world, eager to the fight, would help in establishing the independent Polish state, consisting of all territories where the Poles are in majority, as a guarantee of

Fot. 1. Stanisław Staszic
Source: www.ampoleagle.com

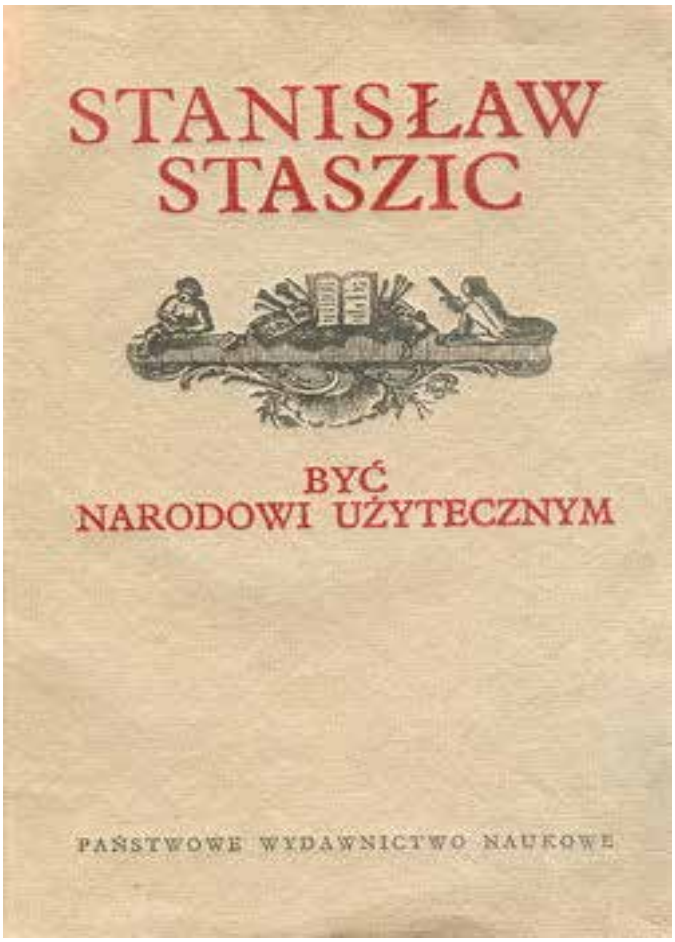
lasting peace in the emerging future Europe. On 29, August 1918, the Council of the Peoples' Commissars, when implementing the provisions of the Brest Peace, annulated the partition treaties by a special decree (however, the return of the seized territories or other properties as a result of the partitions, did not occur). On October 7, 1918, the Regency Council announced the independence of Poland and on November 11, 1918, it conveyed the chief military command to Józef Piłsudski. On November 14, 1918, the Regency Council was dissolved. After 1918, the new states were formed at the territory of the most of Polish pre-partition land: the revived Republic of Poland II, Lithuania and Free City Gdańsk; the scrapes of the territory of the land were found within the borders of Latvia and Estonia and a part of the territories remained within the borders of Germany and the Soviet Russia.

Historical calendar

- The Wielkopolskie Uprising 1806
- Free City of (Danzig) Gdańsk (1807-1813)
- The Duchy of Warsaw (1807-1815)
- The Kingdom of Poland (Congress) (1815-1831)
- Great Duchy of Poznań (1815-1849)
- Free City of Cracow (1815-1846)
- The Cracow Uprising (1846)
- Galicia (1772-1918)
- The November Uprising (1830-1831)
- The Springtime of Nations, the Revolutions of 1848 in Poland (1848)
- The Wielkopolskie Uprising of 1848
- The January Uprising (1863-1864)
- The Baikal Insurrection (1866)
- Revolution of 1905 in the Kingdom of Poland
- The Kingdom of Poland 1916-1918

In the partition conditions, the Society of Friends of Sciences (TPN) was formed. It has also other names such as the Warsaw Society of Friends of Sciences (1800-1832), since 1808 – the Royal Society of Friends of Sciences or the Royal Warsaw Society of Friends of Sciences – the Society, associating the researchers of

Fot. 3. Stanisław Staszic "To be useful to the nation" cover page, PWN Publishing House, 1976
Source: www.antykwariat.waw.pl

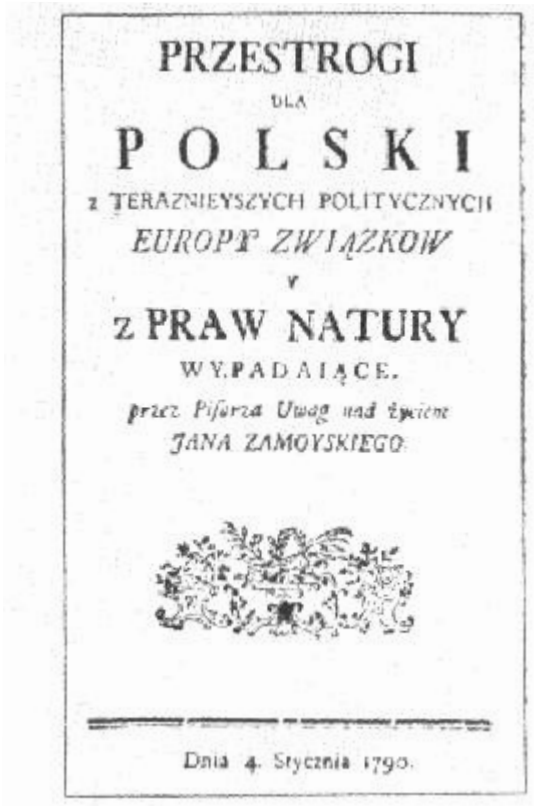


different specialities and meeting since November 1800 until April 1832 in Warsaw. The Society brought together scholars, writers, official individualities and the so-called friends of sciences. It was the third (after the Society of Writers in Polszcza, 1765-1770 and Society for Elementary Books, 1775-1792) permanently meeting Polish scientific academy which contributed to the establishment of the Royal Warsaw University, the precursor the University of Warsaw. This latter was the fourth university founded at the territory of Poland.

The mentioned above Society was founded in 1800, on the initiative of Stanisław Sołtyk. Initially it counted 30 members, including the initiator, who were considered as intellectual elite. They included, inter alia: Tadeusz Czacki, Prince Adam Czartoryski, astronomer Marcin Poczobutt-Odlanicki, Ignacy Potocki, Stanisław Kostka Potocki, Jan Śniadecki, Professor of Cracow Academy Walenty Sobolewski and priest Stanisław Staszic.on November 16, 1800, in the house of Jan Albetrandi situated in Warsaw, Kanonie 85, the solemn inauguration of the Society of Friends of Sciences had place. The first public meeting was held on 23 November 1800 in the Piarists' Order building. Albertrandi delivered the inauguration speech. The discussed association was established legally (confirmed by the rescript of the Prussian King, dated 1 July 1802), it had, however, to formulate its tasks carefully. The Society took care of the preservation of Polish language, literature and national traditions. It also brought together the representatives of artistic world and the reviving Polish Masonic lodges (being later closed by tsarism authorities). Apart from the scientific activity, the Society was involved in gathering of museum collections, organization of anniversaries and popularization of knowledge. The Presidents of the Society of Friends of Sciences were, successively: Jan Chrzciciel Albertrandi (1800 -1808), Stanisław Staszic (1808 -1825) and Julian Ursyn Niemcewicz (1826 -1831). The function of secretaries was played by the following persons: Franciszek Ksawery Dmochowski (1800 --1802), Józef Kalasanty Szaniawski (1802 -1804), Ludwik Osiński (1804-1814), Edward Czarnecki 91814-1824) and Łukasz Gołębiowski (1824 -1831). The more known members of the Society were: Jan Paweł Woronicz, Samuel Linde, Onufry Kopczyński, Jerzy Samuel Bandtkie and Stanisław Kostka Potocki. Gotfryd Ernest Groddeck – professor of the Greek and Roman literature at the Vilnius University, the teacher of Adam Mickiewicz (nominated to the member of the Society in 1831), Zan, Czeczot and Lelewel. The honourable circle included also, inter alia: Johann Wolfgang von Goethe, Nikolai Karamzin, François-René de Chateaubriand, Alexander von Humboldt, Georges Cuvier, W. Anastasiewicz, G.R. Dzierżawin and J. Dobrovski. The Society was dissolved by the Russian authorities in July 1832, as the repression after the November Uprising.

Stanisław Wawrzyniec Staszic [born on November, 6, 1755 in Piła, died on January 20, 1826 in Warsaw]. He was born in bourgeois family (his father Wawrzyniec and grandfather were mayors of Piła; mother, Katarzyna from the Mędlicki family, was the daughter of the

Fot. 3. Stanisław Staszic, Cautions for Poland - title page
Source: Illustration Archive of WN PWN SA © PWN Scientific Publishing House



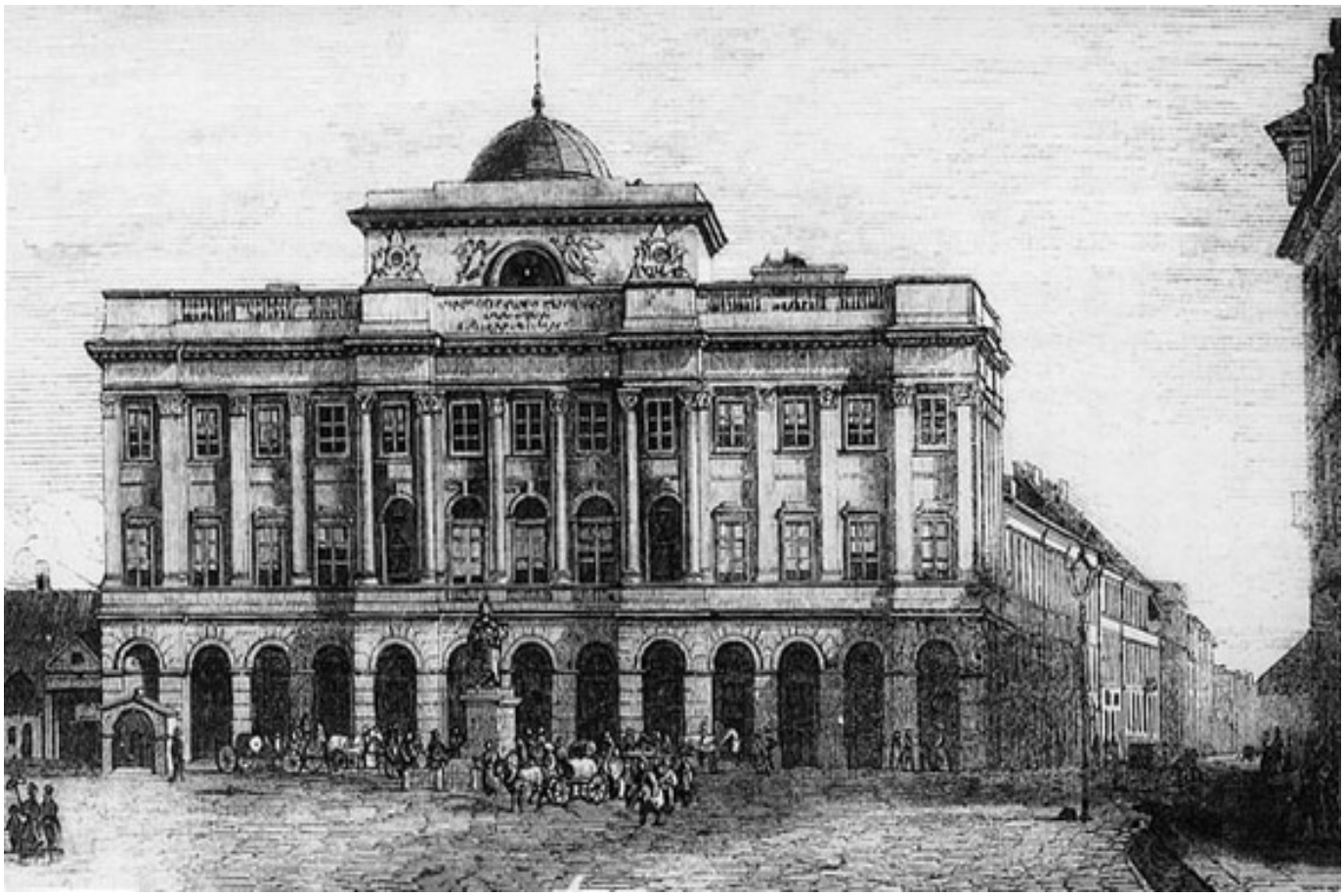
mayor). After graduation of school (priest seminar) in Poznan, he took the holy orders (1778/1779) and in 1779, he became a priest. He was the Polish enlightenment activist, pioneer of cooperative movement, political writer and publicist, philosopher and translator, member of a mason lodge, geographer and geologist and catholic priest [nota bene, for almost 20 recent years of his life, Staszic did not perform the pastoral service and did not wear a cassock]. He was the member of the Chamber of Public Education of the Duchy of Warsaw since 1807), the minster of the state of the Duchy of Warsaw since 1809 and the counsellor of the state of the Duchy of Warsaw since 1810.

Staszic was one of the main reformers and scholars of the Polish enlightenment epoch. He acted in favour of the improvement of the situation of peasants. In 1812, in Jarosławiec manor (Uchanie, province of Hrubieszów) he founded the Hrubieszów Agricultural Society and by this, he became the precursor of the cooperative movement in Poland. He was a follower of profound systemic reforms in the Commonwealth of Poland I; during the period of the Polish Great Seym meetings, he supported the changes, conducted by the Parliament. Since 1808 he had been the President of the Society of Friends of Sciences. In the years 1807-1812, Staszic was the member of the Educational Chamber, since 1815 – of the Commission for Religion and Public Enlightenment; he was the member of the Council of the State of the Kingdom of Poland. He was the co-organizer of the university school in Warsaw and Academic-Mining School in Kielce. He played a function of the deputy minister of education of the Kingdom of Poland in the years 1818-1824 and the minister of the state of the Kingdom of Poland since 1824.

Diligence, capabilities and unselfish readiness to public service caused that he became one of the most influential Poles in the discussed period of time. The motto "TO BE USEFUL FOR THE NATION" was his life motto. In the epoch of decline of the Commonwealth of Poland he supported the movement of the state's reform by writing the anonymous letters. After revival of the Polish stat, he developed the comprehensive organizational activity in the field of education, science and economy. He had the merits worthy to be mentioned. He always tried to help people. After his death, it was revealed that he was "not only the helm for his generation but also the torch for the generations to come".

Staszic played the important role in development of the industry, acting as geologist and researcher of the nature. In 1825, he published information on the Izerskie Mountains and the Karkonosze. In the years 1816-1824, he was a director general of the Department of Industry and Craftsmanship of the Congress Poland. He elaborated a plan for development of the Staropolski Industrial District. He restarted output of hard coal from the bed in Reden

Fot. 4. Medical and Surgical Academy, operating 1859–62 in the Staszic Palace in Warsaw
Source: Illustration Archive of WN PWN SA © PWN Scientific Publishing House



at the territory of the present Dąbrowa Górnicza.on his initiative, many industrial objects were erected, e.g. the first (in the Kingdom of Poland) metallurgical plants of zinc (4 metallurgical plants with a common name "Konstanty" – 1816-1822) and ferrous metallurgical works. He was the protector and promoter of the inventor Abraham Stern... (Yes, it is the man who constructed arithmometer, a sort of mechanical calculator). He was buried at the cemetery of the Niepokalane Poczęcie NMP Church in Bielany, the District of Warsaw. His funeral was attended by 14 thousand persons. According to the last will of Staszic, a part of his property – 800 000 zlotys was divided as the founding capitals for the earning house for the poor people and the baby Jesus hospital (200 000 for each of them). The remaining money was destined for Mikołaj Kopernik monument, Institute of the Deaf and for the Marcinkanki hospital. His grave had been the place of meetings of the Warsaw youth and the members of patriotic movements for 4 years.

The selected memorized events concerning life of Stanisław Staszic

- During his funeral, the music of Józef Elsner (teacher of Chopin) was played; his achievement contains a piece dedicated to Staszic: Cantata with Polish verse, ascribed to Minister Staszic, for 5 voices, with 5-voice canon for the use of Musical School – without accompaniment
- A story about Staszic "Judge Not!" by English writer, Charles Dickens (1851)
- Marian Brandys dedicated him a chapter of his book "General Arbuz" (Warsaw, 1988)
- Staszic became a patron of ca. 200 schools and few universities, including AGH University of Science and Technology since 1969. Several dozens of them are associated in the all-national Society of the Staszic Schools, founded in 1987.
- Monuments of Staszic are found in Ciechocinek (1961), Częstochowa (1974), Dąbrowa Górnicza (1962), Hrubieszów (1922), Jarosławiec (1926), Kielce (1906), Cracow (1901), Łódź (1984), Oblęgorek (1901), Piła (two – 1960, 1991), Poznań (1967) and Warsaw (1976).
- The salt mine in Wieliczka memorized Staszic, giving his name to the Chamber, being found on the route destined for visiting.
- The pond in the Tatry mountains, the mountain in Spitsbergen (Svalbard, Norway), the chamber of cave in Ukraine were called by the name of Staszic; the name of several fossils and minerals and the name of one single-celled organism from Dinoflagellata family were also generated from his name
- The image of Staszic was found on the note of 50 000 PLN, being in the turnover in the period of 1989-1993
- ...and the titular motto of the First (I) Congress of Polish Surveyors

P. S. No. 1

Staszic in anecdote: in 1816, on the initiative of Staszic, the Society of Friends of Sciences in Warsaw began to develop a new metric system of measurement and weight for the Kingdom of Poland. The developed project was then the subject of debate at the Council of the State where Staszic took a care of it – he was in the deputation, nominated to evaluate it; then, he submitted the provisions of the Council during the plenary sessions and opted for approval of the project (May 1818). Not all the participants liked the new law. It was criticised by, inter alia, Dominik Krysiński (1785-1853), economist, professor of the University of Warsaw. After many

Fot. 5. The tomb of Stanisław Staszic, located within the Vysehs Seminary (former Camaldolese church), located at the north wall of the church, Warsaw, Bielany, ul. Dewajtis 3 Source: www.uci.agh.edu.pl/

years, he talked with one of the state chancellors, asking how such "unreasonable and harmful "project could be resolved univocally. The answer was as follows: "Why are you surprised? Staszic, being carried away by a passionate inspiration, like Joas in "Atalia" told us so much about these metres, decimetres, miriametres, grams, litres and kilolitres during the sessions and he said that many my colleagues and me did not have any idea about all this; as we had to hear, all the time, the repeated words: metres, millimetres etc, and we were near to dreaming, we thought that Staszic – who was at the same time the member of the ministry of public education – introduced a new organization of schools in which he constantly repeated metres and teachers... we all were silent and he talked and talked. Nobody wanted to enter the dangerous discussion (as it was supported by a strong voice and breast) and the project passed univocally".

P. S. No. 2

Establishment of the Polish Academy of Sciences was connected with the decisions which were undertaken during the First Congress of Polish Science in 1951 and was linked with the liquidation of the Polish Academy of Abilities and of the Scientific Society of Warsaw (it was founded in 1907 and was the continuation of the activity of Warsaw Society of Friends of Sciences).

P. S. No. 3

The Royal University of Warsaw – Polish public university, founded on November 19, 1916 in Warsaw by the Commission for Religion Matters and Public Enlightenment, the first University of Warsaw. It was dissolved in 1831 within the frames of Russian repressions after the November Uprising. Establishment of the Warsaw University has its genesis in activity of educational institutions of the Duchy of Warsaw, inspired by the reform of Polish education, conducted by the Commission of the National Education, and being interrupted by the partitions of Poland. On January, 26, 1807, the authority of the Duchy – the Governing Commission created the Chamber of Public Education – the supreme organ of public administration specific of the matters of science, education and upbringing. It functioned in the years 1807-1812; until the decline of the Duchy of Warsaw; it was managed by Stanisław Kostka Potocki, in cooperation with Stanisław Staszic, Samuel Bogumił Linde, Onufry Kopczyński and other representatives of Polish intellectualists associated in different educational and scientific organizations such as e.g. Warsaw Society of Friends of Sciences.

P. S. No. 4

The Surveyor Review no 2 of 1926, page 8, Feliks Kucharzewski – lecture on the occasion of 100th anniversary of the death of Staszic: "He was also familiarized with the surveying matters what was well demonstrated in many of his treatises. We allow ourselves to cite a fragment of one of papers where Staszic treats the problem of geodetic education in the following way:

"Those ones possessing higher mathematics will enter the rooms where the architecture, geodesy and civil engineering with the practical application will be submitted. In winter semester, they will learn the above science...., and in summer semester ... they will be employed in measurement in the fields".

When understanding the question of education in such a way, Staszic organizes the surveying department at the Faculty of Fine Arts of the University of Warsaw..".

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STANISŁAW STASZIC COMPETITION FOR THE BEST INNOVATIVE PRODUCTS "LAUREL OF INNOVATION 2019"

KONKURS IM. STANISŁAWA STASZICA NA NAJLEPSZE PRODUKTY INNOWACYJNE „LAUR INNOWACYJNOŚCI 2019"

December 10th, 2019 a ceremonial Gala for announcing the results of the 9th edition of the Competition named after Stanisław Staszic for the best innovative products LAUREL OF INNOVATION 2019.

The goal of the Competition organized by the Federation of Scientific and Technical Associations NOT is to promote modern products, technologies and services, and the idea behind this undertaking is to believe that the key to the development of the Polish economy is to promote innovative products and their creators, and to help implement innovative solutions that are to contribute to the economic development and competitiveness of the Polish economy.

Guests of the ceremony were, among others:

- Mr. Wiesław KOŁODZIEJSKI- President of the Mazowieckie Credit Guarantee Fund, representative of the Marshal's Office of the Mazowieckie Voivodeship
- Ms Karolina DORYWALSKA - Director of the Communication and Marketing Department of the Polish Agency for Enterprise Development
- Mr. Radosław PLESKOT - from the Department of Promotion and Support of Innovativeness of the Polish Patent Office
- Mr. Ryszard PREGIEL - President of the Polish Chamber of Commerce for High Technologies
- Mr. Leszek RAFALSKI- Chairman of the Main Council of Research Institutes and General Director of the Road and Bridge Research Institute
- Mr. Jerzy Barglik - President of the Academy of Engineering in Poland, Chairman of the National Monitoring Committee for European Engineer
- Mr. Stanisław Ziółkiewicz - Director of the Research Network Łukasiewicz - Institute of Plastic Working

- Mr. Jerzy KRAJEWSKI - Vice President of the Congregation of Industry and Commerce of the Polish Chamber of Commerce, director of the European Business Institute, editor-in-chief of the portal "European Company"
- Ms Ewa MAŃKIEWICZ - CUDNY - President of FSNT-NOT
- Mr. Tadeusz PAWŁOWSKI - Chairman of the Chapter of the Laurel of Innovation 2019 Competition, Vice President of FSNT-NOT
- Mr. Kamil WÓJCIK- Vice President FSNT-NOT, President of the Association for the Support of Polish Technology, member of the Chapter

- Mr. Adam BARYŁKA- Vice President FSNT-NOT, President of the Board of the Polish Association of Experts and Court Experts, President of the Warsaw Branch of SIMP, member of the Chapter
- Mr. Jacek KUBIELSKI - Secretary General of FSNT-NOT in years 2012-2016, member of the Chapter
- Mr. Dariusz RACZKOWSKI - President of the Warsaw Branch of the SIMP in 2010-2018, member of the Chapter
- Mr. Jerzy ROŻEK - President of the Warsaw Technical House NOT, Partner of the Competition
- Mr. Ryszard MARCIŃCZAK President of the Warsaw Branch of SEP, member of the Competition Chapter
- Mr. Adam BUGAJCZUK - Vice President of the Management Board of KGHM Polska Miedź S.A. Development
- and Mr. Jarosław TWARDOWSKI - General Director for Development at KGHM Polska Miedź S.A.- representatives of the Patron of this year's Competition

Statuettes and Awards The jury awarded this time to 17 companies and institutes in 11 categories:

1. Construction and public facilities, safety and firefighting:
The award was granted to:
TGM Enterprise & Investments Sp. z o.o.
for the project - Fire tower with the function of drying room and training room

2. Ecology and energy efficiency:
Silver Laurel of Innovation was awarded to:
The Central Mining Institute
for the project - Dust Air portable dust meter

The Golden Laurel of Innovation was awarded to:
Central Institute for Labor Protection - National Research Institute (CIOP-PIB)
for the project - Prototype of the acoustic barrier for suppression of narrowband frequency components using the diffuser system (Sonic Crystals)

3. Power engineering, electrical engineering:
The Bronze Laurel of Innovation was awarded to:
Zakład Energoelektroniki TWERD Sp. z o.o.
for the project - Electric ship propulsion with a capacity of 1.4 MW

4. Mining and metallurgy:
Silver Laurel of Innovation was awarded to:
KGHM Polska Miedź S.A.
for the project - Evacuation Chamber

The Golden Laurel of Innovation was awarded to:
KGHM Polska Miedź S.A.
Branch-mining plant "Polkowice-Sieroszowice"
for the project - System of using heat from the chilled water of an air conditioning system in place of heat from the burning of heating oil

5. Information technology, software:
The award was given to:
KGHM Polska Miedź S.A.
Hydrotechnical Department
for the project - Using the 3DSensor sensor to build an innovative system for monitoring the technical condition of the reinforced concrete structure of the overflow tower located in the OUOW Żelazny Most reservoir

6. Mechanics,machines and devices:
Silver Laurel of Innovation for:
Łukasiewicz Research Network - Institute of Precision Mechanics
for the project: A miniaturized device for non-destructive testing eddy current method using measurement Amplitude-Frequency - M2 Wirotest

The Golden Laurel of Innovation The jury awarded:
Łukasiewicz Research Network - the Plastic Processing Institute
for the project: Special MWS-200 Wyoblarka for shaping axially asymmetrical products

7. Medical technology, pharmaceutical industry, chemistry:
The Golden Laurel of Innovation was awarded to:
Central Institute for Labor Protection
- National Research Institute (CIOP-PIB)
for the project - Filtering half-mask to protect the respiratory system of workers professionally exposed to anti-cancer cytostatic drugs

8. Food industry, gastronomy, agriculture, gardening, woodworking:

The award was granted to:

Łukasiewicz Research Network - the Wood Technology Institute

for the project - The use of rare earth metal nanoxides to protect the surface of wooden products against UV / VIS

Silver Laurel of Innovation received:

Łukasiewicz Research Network - Wood Technology Institute

for the project - Innovative measures and ways to protect wood against the harmful effects of fungi and algae

9. Military technique:

In this category two distinctions were awarded to:

Military Institute of Armament Technology

for the project - Pistol 9x19 mm PW Inka

and

PCO S.A.

for the project - GOC-1 and GOD-1 sighting and sighting devices for fire control systems in tower systems

The Bronze Laurel of Innovation was awarded to:

PIT-RADWAR S.A.

for the project - Development of the short range interrogator IKZ-50P identification system "own-foreign" of IFF Mark XIIA standard

The Golden Laurel of Innovation was awarded to:

Military University of Technology

for the project - WRE-1- portable broadband radio spectrum analyzer with artificial intelligence module for spectrum prediction

10. Logistics, transport, communication;

Golden Laurel of Innovation for:

SZCZĘŚNIAK Pojazdy special sp. z o.o.

for the project - Heavy special road rescue car on Renault K520 8x4 chassis

11. Services and other socio-economic solutions and innovations;

Silver Laurel of Innovationl was awarded to:

Fireworks Europe Innovation Sp. z o.o.

for the project - ECOLOGICAL FIREWORKS OF THE GAOO SPECTRUM BRAND

Congratulations to all the winners

Edited by: Editorial Board of PTR based on materials made available by the FSNT-NOT General Board Office

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- If the problem is extensive break it into articles for separate publications.
- Articles should be of a clear and logical structure: the material should be divided into parts with titles reflecting its content. The conclusions should be clearly stated at the end of the paper.
- The article should be adequately supplemented with illustrations, photographs, tables etc. however, their number should be limited to absolute necessity.
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