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NACZELNA ORGANIZACJA TECHNICZNA
FEDERACJA STOWARZYSZEŃ NAUKOWO-TECHNICZNYCH

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NOT-owskie wydawnictwo prasy technicznej rozrastało się, obejmując swymi tytułami nowe obszary nauki i techniki. A wydawane przez nie czasopisma odznaczały się wysokim poziomem fachowości. Gwarantowały to zespoły redakcyjne złożone z wybitnych naukowców i doświadczonych praktyków sztuki inżynierskiej.

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70 lat to wiek dostojny, wskazujący na duży dorobek, ale i potencjał na przyszłość. Zarząd Główny FSNT-NOT oraz 39 stowarzyszeń naukowo-technicznych, sfederowanych w Naczelnej Organizacji Technicznej życzą SIGMIE, by rozwijała się, odnosiła sukcesy i nie traciła zdolności dostosowywania swojej działalności do szybko zmieniających się i nie zawsze łatwych uwarunkowań zewnętrznych.

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Z wyrazami uznania i sympatii

E. Mańkiewicz-Cudny

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Dear readers!

The basic goal of publishing "Polish Technical Review" is to popularize Polish scientific research, technology and innovation outside of Poland. To reach the widest possible international audience, we publish the article in English. In addition to scientific articles, the magazine reminds distinguished figures, organizations and associations. The year 2019 is an abundant in jubilees, including The Association of Polish Surveyors has been operating and supporting its members for 100 years, find more about on page 31 of the magazine.

The Polish Scientific Concern ORLEN SA celebrating the 60th anniversary of its existence is certainly the Polish industrial, technological and economic pearl. We open this issue with a reminder of the history and successes of PKN ORLEN and with a vision of the refinery's development until 2050.

In Polish science, a lot of space is devoted to environmental engineering and agriculture, which is why these topics can also be found in the pages of the "Polish Technical Review". Failure and loss in the water supply network is a hot topic, especially in winter, when pipeline damage is more likely as a result of the temperature difference. Water and agriculture are strongly interrelated, and remote control of agricultural processes is more and more often everyday life, not the singing of the future, so it's worth learning about its use in Poland to learn as much as possible.

Good reading!

Magdalena Borek-Daruk
deputy editor-in-chief

JUBILEE OF 60 YEARS OF ACTIVITY OF POLISH PETROLEUM CONCERN ORLEN SA (PKN ORLEN)

JUBILEUSZ 60 LAT ISTNIENIA POLSKIEGO KONCERNU NAFTOWEGO ORLEN SA

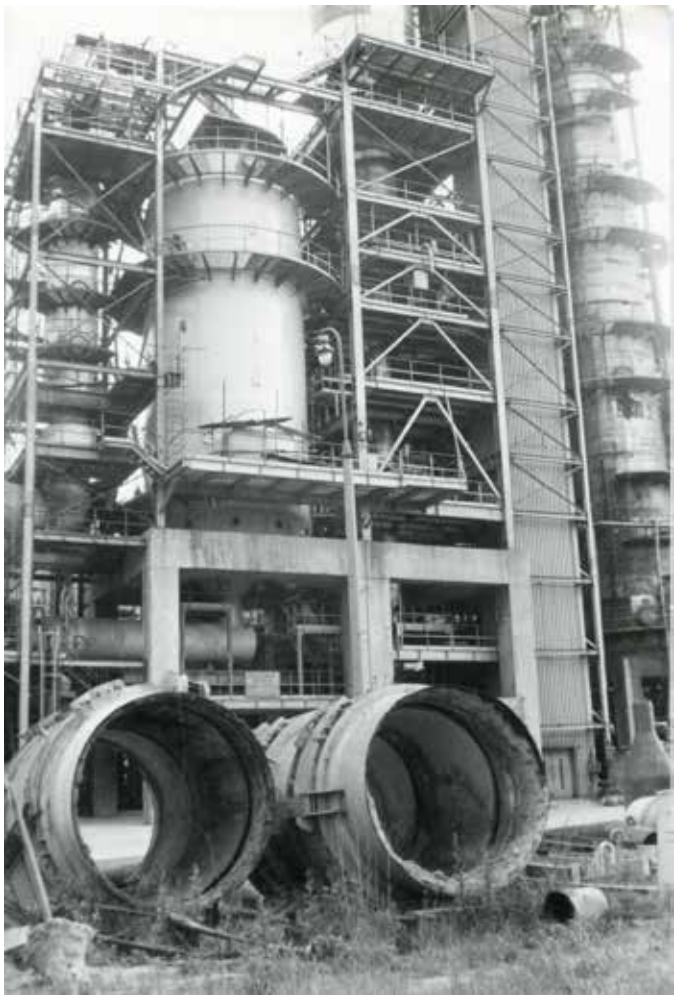
Płock oil refinery, as belonging now to the Polish Petroleum Concern, celebrates the 60th anniversary of its foundation. It is the excellent occasion to remind its abundant history and to emphasize its role as a leading producer of motor fuels and petrochemicals.

In order to understand the history of PKN Orlen, we have to come back to 1854 when Ignacy Łukasiewicz, the inventor of kerosene lamp, established the world's first oil field in Bóbrka near Krosno. Two years later, in Ułaszewicze near Jasło, he launched the first distilling plant of petrol on the territory of Poland.

The intensive development of petroleum industry was stopped as late as by the breakout of the World War II. In 1944, Polish Oil Monopoly was organized with the aim to secure the petrol infrastructure that remained after the war. The name of the mentioned organization was few times changed and in 1958, it was transformed into the Central Office of Petroleum Products (CPN). The mentioned name had been deeply rooted in the memory of the Poles for many years. At the peak of its development, the company had a network of more than 1400 stations. CPN had a white-orange logo designed by Ryszard Bojar; it was recognized as one of the most successful logos in the history of Polish design.

After the World War II, the demand on the fuel increased and the processing capacities of the existing refineries were insufficient. In 1959, there was commenced, therefore, the construction of the Mazovian Refinery and Petrochemical Plant in Płock. For the implementation of the mentioned undertaking, it was necessary to establish a new construction company – Petrobudowa (1960). The refinery was constructed until 1965

Fot. 1. Construction of the first installation of catalytic cracking (Photo: PKN Orlen SA)



Fot. 2. Visit of Edward Gierek in Płock Factory, the seventies of the 20th century (Photo: PKN Orlen SA)

and the whole investment cost was equal to ca. 12 billion PLN. The production of fuels was commenced in August 1964. Ten years later, in Płock, 50 million tonnes of petrol were processed; in 1987 – 100 million tonnes and in 1987 – 200 million tonnes.

The choice of the site of the refinery was not incidental. Płock occurred to be the attractive place due to, inter alia, shaping of the territory and a small distance from Warsaw. The advantages included also the presence of transport routes: by train, by land and by water (Vistula river). The discussed factory required big quantities of water; therefore, the access to the river was a significant criterion for the choice. The Płock refinery, similarly as CPN had also a characteristic logo, the "P" letter in blue and white colour. It was the image of retort, chemical vessel with the inscribed P letter, coming from "petro-chemistry" and according to some persons, deriving from the name of the town. Witold Surowiecki was the designer of the discussed mark.

On July 1, 1993, after economic transformation, the Mazovian Refinery and Petrochemical Plant was transformed into the State Treasury Company under the name Petrochemia Płock which was merged with CPN five years later. On September 7, 1999 Polish Petrol Concern was formally established. The new economic

Fot. 3. Panoramic image of the Płock Factory (Photo: PKN Orlen SA)

Fot.4. Reforming VI - Installation (Photo: PKN Orlen SA).

entity was expected to be associated with the modernity and fuel sector and, at the same time, to preserve a national nature. The name was meant to symbolize quality, strength, energy and power and to be associated with the petro-chemistry, ecology-promoting approach and Polish nature. Finally, at the end of 1999, the name "Orlen" was chosen from among more than thousand proposals; it was the combination of words "eagle" and "energy".

After the choice of the name, the time came for the choice of logo. As a result of the competition, the piece of work by Henryk Chyliński was recognized as the best one. It represented a stylized head of eagle which was supplemented with the world "Orlen". The colouring was based upon red, white, grey and silver colours. In 2009, the trade name Orlen was adopted and a new image of the brand was presented.

On May 3, 2019, the successive record was noted in Płock: the 600 million tonne-s of oil have been processed. The incomes of the Concern in 2018 amounted to more than 100 billion PLN. PKN Orlen is a strategic player on the European fuel market and after a fusion with Lotos Group, it will become one of the greatest fuel concerns in the world. It will bring a lot of profits for the both enterprises as well as for Polish economy. The mentioned fusion will allow joint programming and implementation of the activities outside the territory of Poland as well as it will improve the process of oil purchase and accelerate the development of the national petrochemical industry.

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VISION OF THE REFINERIES' DEVELOPMENT UP TO 2050

WIZJA ROZWOJU RAFINERII DO 2050 R.

***Summary**: The history of petroleum industry, including refining sector and the perspectives for its development until 2050 has been presented. The prognoses for consumption of petroleum as primary energy carrier and of transport fuel as well as dominating role of petrol products in the world economy have been illustrated. The attention was paid to the legal regulations, including those ones limiting emission and having an effect on the discussed industrial sector and the participation of a new generation of fuels in the total balance of fuels and consumption of new raw materials in their production. The report 'Fuels Europe' which is simultaneously a vision of the way of evolution of refinery branch and liquid fuels up to 2050 has been described.*

***Keywords**: petroleum industry, refinery, crude oil, transport fuel, law, biofuels, liquid fuels*

***Streszczenie**: Przedstawiono historię przemysłu naftowego, w tym rafineryjnego, oraz prognozę jego rozwoju do 2050 r. Zobrazowano prognozy dla zużycia ropy naftowej, jako nośnika energii pierwotnej oraz paliwa transportowego a także dominującą rolę produktów naftowych w światowej gospodarce. Zwrócono uwagę na regulacje prawne, w tym ograniczające emisję i mające wpływ na ten sektor przemysłu oraz udział nowej generacji biopaliw w ogólnym bilansie paliw i użycie nowych surowców do ich produkcji. Opisano raport Fuels Europe, który jest jednocześnie wizją ścieżki ewolucji branży rafineryjnej i paliw płynnych do 2050 r.*

***Słowa kluczowe**: przemysł naftowy, rafineria, ropa naftowa, paliwo transportowe, prawo, biopaliwa, paliwa płynne*

Introduction

Not all people understand the meaning of refinery industry and think that petroleum serves only for production of fuels, especially of those ones employed in transport 1-16). Our all surrounding, i.e. inter alia, plastics, composites, glass, medicines, furniture, construction and isolation materials and cloth materials, is directly or indirectly (also, more and more frequently, natural gas) produced from petroleum. In connection with this fact, replacement of the discussed raw material in the future will be difficult. According to different literature sources [6, 7, 11,14, 17-31], in 1837, the first commercial petrol plant, distilling petrol to paraffin was established. In 1847, the Scottish chemist, James Young noticed a natural leakage of petrol in coal mine Riddings Colliery in Alfreton, from which light, "thin" oil was distilled; it was suitable for greasing the machines. It should be stressed here that petrol owes its success to our countrymen and namely, Ignacy Łukasiewicz who was the first who carried out the process of its distillation and obtained paraffin oil. This last product was used, *inter alia*, in lighting. The first kerosene lamp was lighted up in March 1853 in pharmacy of Mikolasch in Lvov and later, in the Lvov hospital where on 31 August 1983, the first surgical operation was carried out at its light [6, 7, 11, 14, 17-31].

The first refinery, manufacturing petroleum products on the industrial scale was found in Cleveland, in the Unites States of America. It was launched in 1861. One of the first modern refineries, being simultaneously the largest one in the world, was constructed in the nineties of the 20th century and was situated near Michigan Lake in Whiting. Rockefeller's Standard Oil was its owner and the raw material originated from the oil fields of Lima. In 1891, refineries of Standard Oil produced 175 products from petroleum.

The increase of interest in petrol products required building of new refineries. The most of them was constructed in the Western Europe what resulted from the strongly sulphated oil from the Near East. In 1964, there were ca. 700 refineries. In the successive years, less refining plants were constructed but the already functioning ones were modernised and their processing capacities were increased. The greatest refineries belong to private giants such as ExxonMobil, Royal Dutch-Shell, British Petroleum, Conoco Philips, Total, Chevron Texaco, and the state enterprises such as Sinopec, Petro China, Petrobas, Pemex, NIOC and Lukoil, operating in the leading producer countries [6, 7, 11, 12, 17-31].

It is estimated that at the beginning of the 21st century, ca. 750 refineries with different processing capacities worked all over the world, from million tonnes/year to as much as 44 million tonnes/year, including *inter alia*, Baytown (Texas), Falcon (Venezuela), Omsk

Tab. 1. Goals of the world agreement on climate

No.	Goals
1	Long-term goal: maintaining the increase in the global temperature to well below 2°C, i.e. above the pre-industrial level
2	Striving to limit the global temperature increase to 1.5°C; this would significantly reduce the risks and impacts of climate change
3	The necessity to obtain globally as soon as possible the returnable point of maximum emission level, assuming that this will take longer for developing countries
4	Undertaking the rapid reduction in emissions in accordance with the best available scientific information

(Russia) and Ulsan (the South Korea). Due to the time period in which they were commissioned, their age as well as technological level is differentiated. Many of the discussed objects implement the so-called "shallow oil processing". They utilize the technological scheme, in which there is a basic system of installations, allowing production of fuels, i.e. DRW installation (in Polish: pipeline – column distillation) + reforming of gasoline + hydro-refining of distillates + bloc of sulphur plus recovery and, optionally, isomerisation *of n*-alkanes $C_5 - C_6$, contained in a light gasoline from DRW installation and, also, alkylation of isobutene with propylene or n-butylenes [6, 7, 32-34].

Nowadays, oil refineries are complex industrial objects, consisting of many production units, implementing many technological mutually linked processes, owing to which highly valuable petroleum products are produced.

At refineries, there are usually situated polymers-producing plants including polyethylene, polypropylene and polystyrene. By-products of refineries include also organic dissolvents such as petroleum ether, toluene and acetone.

Adaptation to climate changes – legal regulations

In December 2015, during the conference of the United Nations in matter of climate changes (United Nations Framework Convention on Climate Change), COP21 (21st Conference of the Parties), 195 countries adopted the first-in-the-history universal, legally bounding agreement in the field of climate. The problems, to which the agreement related, are presented in Tab. 1. In the agreement, the global action plan was defined; the mentioned plan is expected to save the world from the threat of far-advanced climate change owing to limitation of global warming to value being found considerably below 2°C.

The refineries affect undoubtedly the natural environment. The influence on the particular components of the environment may be different and is dependent on many factors. The participation of emission from refinery in contamination emissions coming from industrial activity and from power sector is presented in Tab.2. It should be stressed that the absolute values of emission of contaminations from oil refineries in the years 2007-2009 were decreased from few to several percent and in the case of SOx and

Tab. 2. Participation of contaminants 'emissions from oil refinery to the air in UE-27 (2007–2009)[35]

The main air contaminants	Total emission coming from industry thousand tons	Emission from energy generation thousand tons	Emission from refinery 2007, thousand tons	Participa-tion of refinery emissions in the industry %	Participation of refinery emissions in energy generation, %	Emission from refinery,2009, thousand tons
Greenhouse gases (GHG) (equivalent of CO_2)	4 638 000	2 201 000	158 880	3,4	7,2	146 745
Carbon oxide (II) (CO)	27921	4 634	58	0,2	1,3	55
Dust(PM_{10})	1 952	312	8	0,4	2,6	7
Dust ($PM_{2,5}$)	1 266	224	11	0,9	4,9	-
Nitrogen oxides (NOx)	10 939	3 991	193	1,8	4,8	162
Sulphur oxides (SOx)	7 442	6 024	574	7,7	9,5	426
Non-metallic volatile organic compounds (NMVOC)	8 951	265	180	2,0	67,9	138

non-methane volatile organic compounds (NMVOC) were the highest ones and were equal to 29.6% and 26.4%, respectively.

The European Union wants to be a leader in problems of environmental protection and therefore, it undertakes discussion concerning the climate changes more and more frequently. It will be difficult to reconcile the development and reduction of GHG (greenhouse gases) emission, and especially, of CO_2, what is illustrated in Fig.1. Hence, in the strategies, we meet variants of the so-called sustainable development, considering the environmental problems.

At this moment, in the opinion of the authors of the present article, we have to make a critical remark to the suggestion of decreasing CO_2 emission in the industry, including refinery sector as we know that the discussed emissions constitute below 5% of global industrial emissions. We should also remember that each extracted tonne of any fossil fuel (coal, crude oil or gas) in its final LC (life cycle) will be transformed into CO_2, sulphur oxides, nitrogen oxides and dust and the quantity of the discussed substances is dependent on the content of carbon, sulphur, solid particles, nitrogen in a given raw material and on the way of processing. We should also bear in mind that there is a theoretical, thermo-dynamical limit of improving the energy effectiveness behind which the further improvement results in negative consequences in other areas or components of environment.

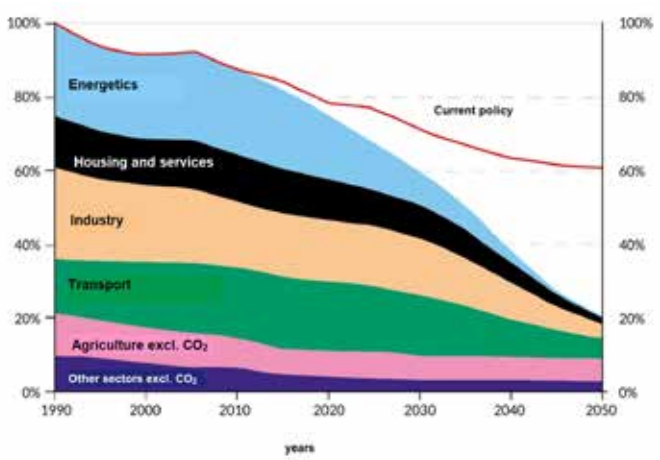
It is a degradation of natural environment that may be a significant reason for deterioration of the life quality. It becomes a barrier to placing capital in such territories and forces a change in economic processes, orienting them to the economy acting in favour of sustainable development. A model of such management assumes the appropriate and aware relations between the economic development and care of the environment and the quality of life. The political conception of sustainable development is an effect of the work of the World Commission on Environment and Development. The mentioned Commission has contributed to convening the Earth Summit in Rio de Janeiro in 1992 during which there were adopted the documents, defining the fundamental principles in social-economic policy, ordering consideration of environmental protection.

The sustainable development of economy and environment protection

Until now, the key long-term goal of the European Union has included the emission of greenhouse gases (GHG) up to 2050 by 80-95% (in relation to 1990). At present, the EU prefers the scenario of 1.5°C and 100% of GHG reduction until 2050.

On 28 November 2018, the European Commission presented its strategic, long-term vision of prosperous, modern, competitive and climate-neutral economy up to 2050. The strategy shows how Europe may outline the way to climatic neutrality when investing in real technological solutions, strengthening of citizens' position and adapting the action in key area, such as industrial policy, finances or research, with the simultaneous assurance of social fairness, serving the just transformation. After the invitation of the European Parliament and of the European Council, vision of the Commission concerning the future climatic neutrality includes almost all area of

Fig. 1. Reduction in CO_2 emission to obtain a low-emission economy up to 2050 (in relation to the emission level of 1990)[36]

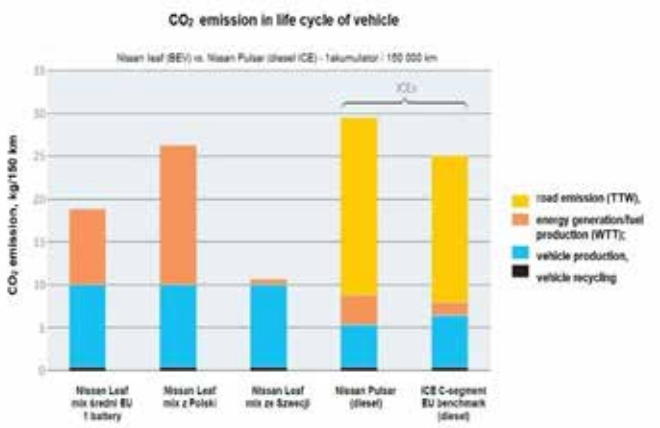


the EU policy and in consistent with the target of Paris Agreement to maintain increase of temperature all over the world considerably below 2°C and continue the efforts aimed at maintaining the temperature to 1.5°C.

Emission of GHG from transport, as it is followed from Tab.3, is increasing. In effect, the electro-mobility seems, for some people, to be the only one way for obtaining the reduction of GHG. Such thinking is a considerable challenge for the European refinery and car industry. The electric vehicles, however, not always and not everywhere decrease really the emission of GHG in transport. In Fig. 2, the emissions of CO_2 in life cycle of vehicles have been illustrated, with the attention paid to the effect of national "energetic mix" employed during the drive of two comparable vehicles of a segment of C class. The present development of technology does not allow transforming each transport mean into electrical one (e.g. aircraft).

In the EU, the emission from the produced transport fuels is responsible for 23.8% of the total emission of greenhouse gases in the Community, including the emission of CO_2 amounting to 27.9%.

Fig. 2. CO_2 emission in life cycle of vehicle[34]



Tab. 3. Emissions of greenhouse gases (GHG), EU-28, in 1990 and 2015[38])

Source of emission	1990, Gg	2015, Gg	Participation in 1990, %	Participation in 2015, %
Combustion of fuels and emissions from evaporation of fuels (excluding transport)	3 554 744	2 454 082	62,2	55,1
Transport (inlcuidng international aircraft)	851 082	1 048 070	14,9	23,6
Industrial processes and utilization of commodities	516 886	373 937	9,0	8,4
Agriculture	548 270	436 784	9,6	9,8
Waste management	240 948	139,313	4,2	3,1
Sum (without LULUCF (Land Use, Land Use Change and Forestry), including aircraft	5 711 969	4 450 151	100	100

Of course, the European Union undertakes many actions, oriented to the limitation of transport emissions, including first of all car transport (e.g. the rule to limit the emission of CO_2 by engines of newly produced vehicles to 120 g per vehicle kilometre up to 2015 and to 95 g in 2020; the recommendation of 10-% participation of energy from renewable sources in the energy consumed by transport in 2020).

Demand on energy and fuels

The world leaders try to construct a new approach to global energetic system but due to such differentiations as abundance of natural resources, geographical location, level of technological advancement, the reaching of universal agreement is not easy. From among few scenarios, including, inter alia, the most probable (available), most reliable (the lowest number of risks) and the sustainable one, the recent scenario seems to enable the possibility of inhibiting the climatic changes. According to elaborated document[39)], the world consumption of primary energy increased by 2.2% in 2017, as compared to 1.2% in 2016 and above the mean for 10 years being equal to 1.7%. As it is followed from different scenarios, the discussed demand will be increasing during the coming years (Fig. 3).

Petroleum is a dominating fuel all over the world and constitutes one third of the total consumed energy. A high increase of demand on oil has affected the increase of its volume and processing which increased in 2017 by 1.6 Mb/d, i.e. more than twice than the mean for 10 years; it caused the increase of utilization of processing capacities of refineries [39, 40)]. According to the developed materials40, the total consumption of energy produced from oil in the European Union was found on the level of 37% in 2017 what together with the energy from gas on the level of 24% remained the main source of energy in the European Union and gave 61% of its consumption. According to the report [38, 41, 42)], ca. 65 % of petroleum, being processed in the refineries in the European Union, is constituted by liquid transport fuels, the next 10% is a component of petrochemical raw materials and 25% are utilized in manufacture of other products.

The combustion of fuels is a source of energy in transport. The fuels are produced from oil. According to the elaboration [43)], the EU transport is based in 97% on oil-derived fuels. When looking look via the prism of the aims of the world policy in respect of sustainable development, we may say – as it results from numerous literature elaborations [11, 39, 40, 42, 44-47)] – that petroleum shall remain the main energetic-industrial raw material for production of liquid fuels, destined for driving of transport means but also for manufacture of other products indispensable for satisfying various needs, including the economic ones of the developing world. The refineries will play important and meaningful role in manufacture of modern fuels (hydrogen fuels in cracking process) and also, together with the modern infrastructure, they will constitute the stores of future-driving energy. The report [48)] points to transport consequences of the anticipated social-economic changes, connected with the demand on transport services what, in turn, is translated into the increase of demand on the fuels of this type.

Fig. 3. World consumption of primary energy, as calculated into equivalent of tons of oil[39)]

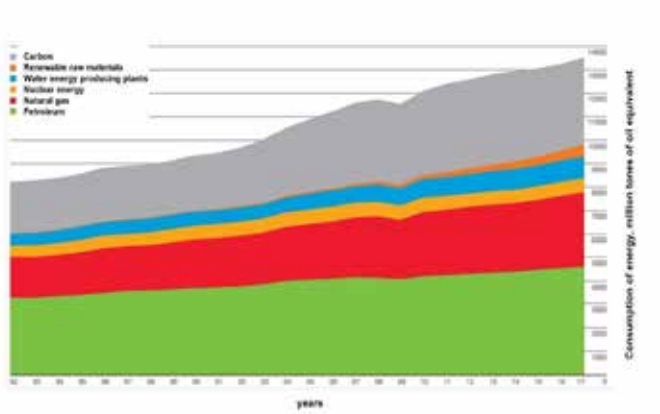
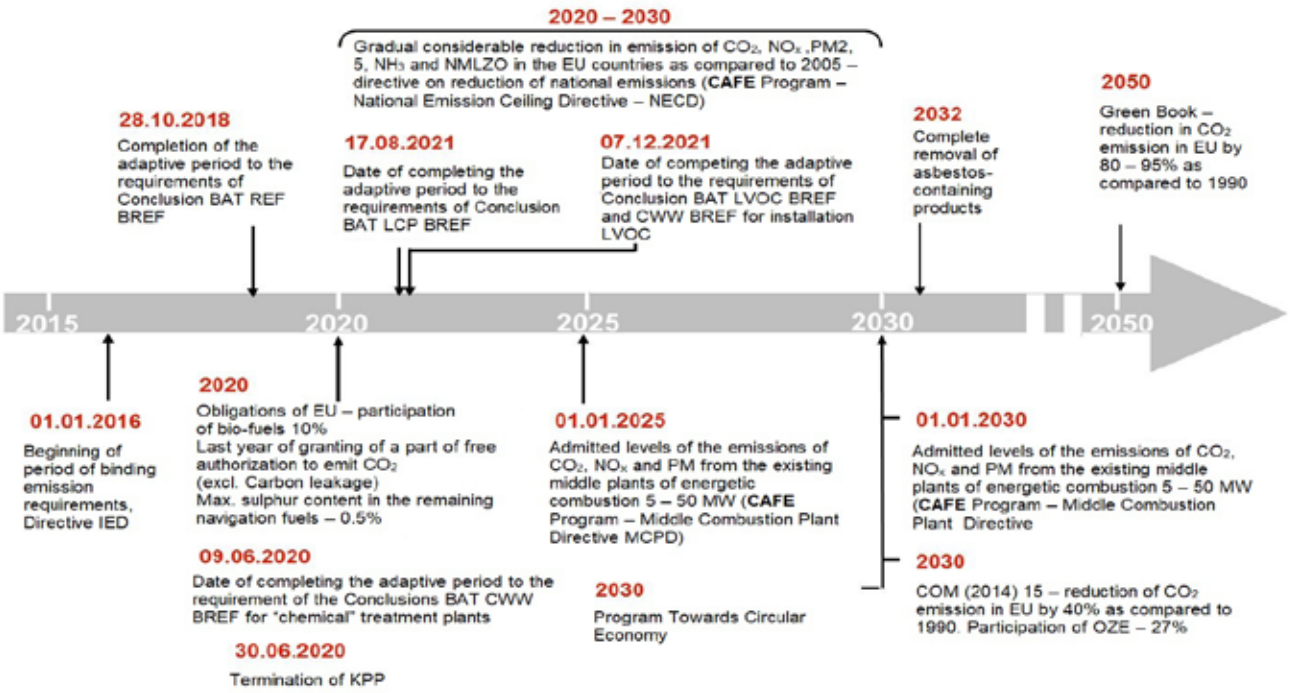


Fig. 4. Environmental legal regulations concerning refinery industry

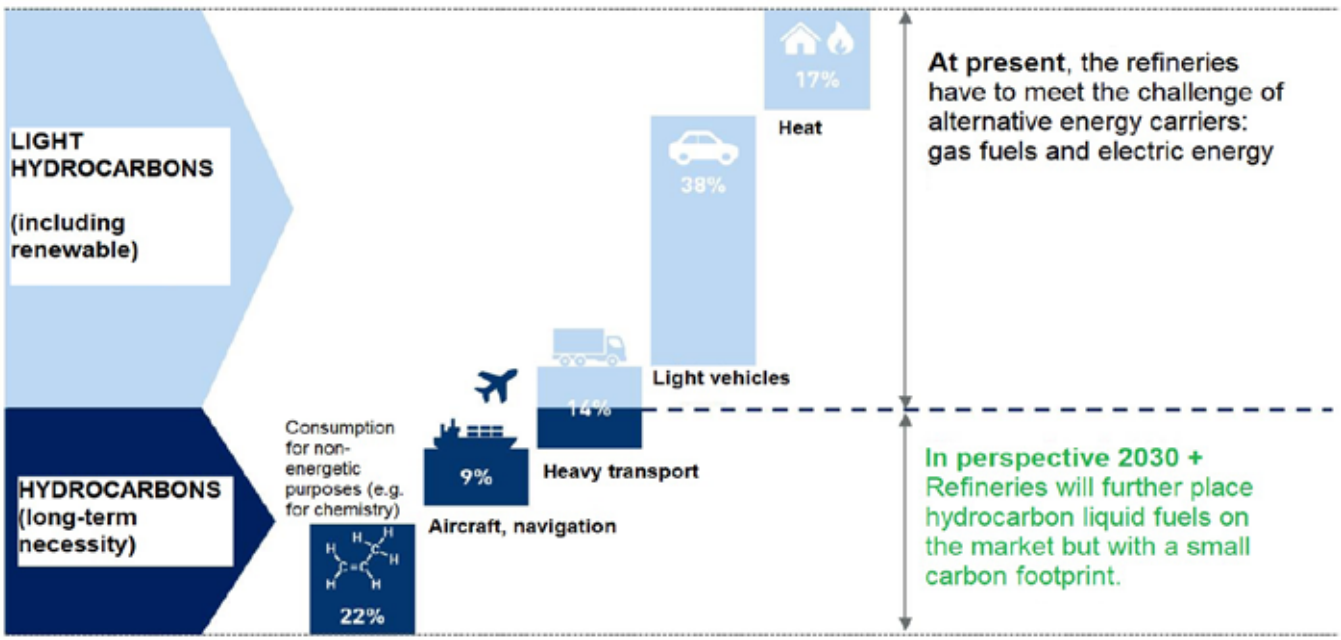


Refinery of the future

In long-time perspective, liquid hydrocarbons as well as the resulting fuels and products will be indispensable. According to the elaboration [35], only crude oil refining plants deliver 42% of the EU demand on energy and 95% of fuels, used by transport. In the European Union, Switzerland and Norway there are found more than 100 refineries which process about 700 million tonnes of crude oil annually in total. Also, 4 natural gas-processing plants are situated on the land. The particular plants are relatively uniformly distributed at the territory of Europe and majority of them are situated near sea coast. It is estimated[35] that the refinery sector in Europe employs directly 55 thousand persons and ca. 35 thousand people indirectly.

The changing legal regulations, especially in respect of environment protection will have a great meaning and influence on refinery industry, bearing the additional cost by it in respect of adaptation and introduction of preceding and developmental measures. Fig. 4 shows certain environmental regulations having a significant effect on the discussed sector. Fig. 5 contains the prognoses of the European Union in respect of petroleum utilization and the limited long-term role of light hydrocarbons, resulting from the policy of sustainable transport.

Fig. 5. Project of the EU concerning utilization of petroleum[42, 49]



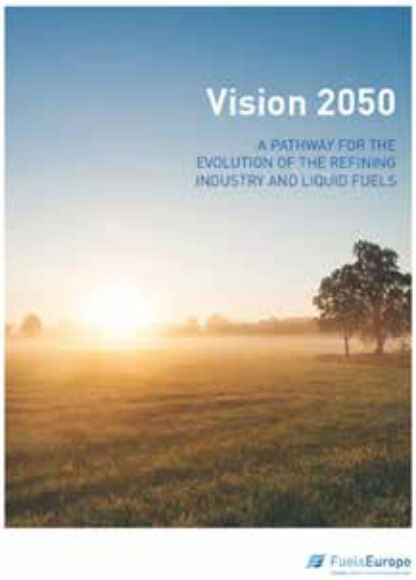
Tab. 4. Pathway of development of refinery industry and of liquid fuels up to 2050[42)]

No.	The main conclusions coming from EPRA report
1	Change of climate requires urgent and decided measures in all sectors
2	Hydrocarbon liquid fuels will remain an important part of the future mobility system even if the participation of alternative energy sources is increased; demand on refinery products will be increasing due to a global economic development and demography; there are limitations for application of electric drive in sea transport, aviation and heavy vehicles: for these types of transport, the key requirement is storage of maximum energy quantities in possibly smaller volume and mass – oil derivate fuels have a meaningful advantage in regard to e.g. batteries
3	Combustion engines will still play the important role for different transport sectors in the coming decades
4	Development and introduction of low-emission hydrocarbon liquid fuels offers a meaningful possibility to satisfy effectively the demand on oil-derivate fuels, and simultaneously, contribute to the solution of the threats, caused by climate change
5	Liquid fuels with a low level of hydrocarbons may decrease CO_2 emission in all segment of transport in a very short time, with the utilization of the existing float of vehicles and the existing infrastructure for production, distribution and storage of fuels (gas fuels, synthetic fuels, fuels with the participation of biodegradable components); the existing network of distribution of fuels for navigation, aircraft and road transport may easily become adapted to the future decrease of the emissions
6	A meaningful potential of decrease in CO_2 emission may come from the betterment of infrastructure and, operational improvements, resulting from construction of vehicles and age of fleet: quicker renovation of fleet, optimization of aerodynamics (especially in the case of heavy transport vehicles and semi-trailers), better energetic effectiveness of tyres, systems of braking energy recovery
7	Decarbonisation of transport may be and should be self-financing; a high competitiveness of the European refinery industry and the related branches (chemical and petrochemical) should be maintained
8	Technological neutrality in the work on decarbonisation of transport should be continued; in each location, different technical-economic methods may be applied

Tab. 5. Comparison of scenarios of development of passenger cars

EU Scenario	EPRA Scenario
Scenario of mass electromobility – refineries supply 10% of fuels	Scenario of low-carbon liquid fuels – refineries supply 70% of fuels
EU scenario is characterized by expensive infrastructure and a high risk	EPRA scenario is characterized by decisively lower costs
Investment on chargers and infra-structure of network up to 630-830 billion EURO up to 2050	Investment on chargers and infra-structure of network up to 326-390 billion EURO
There is a need of 15 Giga of batteries--producing plants (550 TWh)	There is required only 5 or 6 Giga of batteries-manufacturing plants
6-fold increase in the world lithium obtaining - only for coverage of the Europe's needs	The possibility to deliver fuel for the whole already existing fleet of light and heavy vehicles

Fig. 6. Report Vision 2050[42)]



The answer to the social expectations and the international climate policy is contained in plan (Fig. 6), developed by the European Petroleum Refiners Association (EPRA, allowing the maintenance of the work of refining industry, even with the full introduction of the Paris Agreement provisions and preservation of self-financing of refineries (preservation of competitiveness). The pathway for development of refinery industry and liquid fuels until 2050 is given in Tab. 4[42)].

From document Vision 2050 it is followed that the reduction of CO2 in transport will be based upon (i) improvement of effectiveness of fuels' production and their use in vehicles, (ii) change of raw materials, (iii) change of energy sources and (iv) utilization of technologies CCS/CCU (technologies of capture and storage of CO2/utilization of caught CO_2).

During the transformation period, new legal solutions are required, including application of LCA (life cycle analysis) and protection from the unfair non-Europe competition in respect of emission.

In EPRA publication[42)], two scenarios of development of passenger cars development were presented (Tab. 5) (Fig. 7),

Fig. 7. Scenarios of development of passenger cars[50]

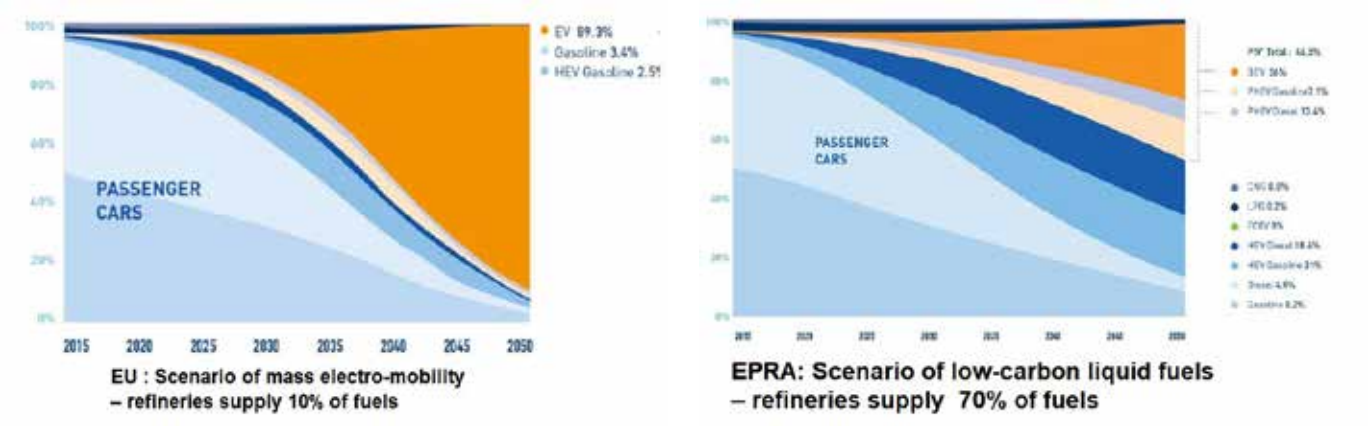
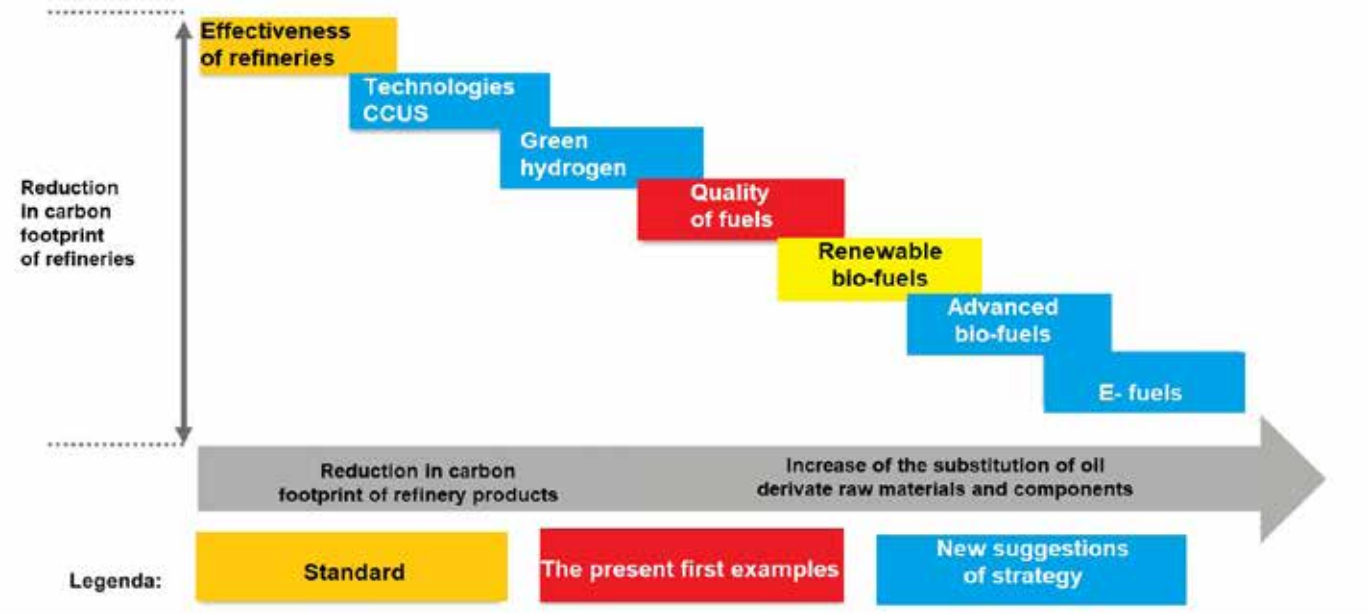


Fig. 8. Solutions towards reduction of carbon footprint in refineries[42]



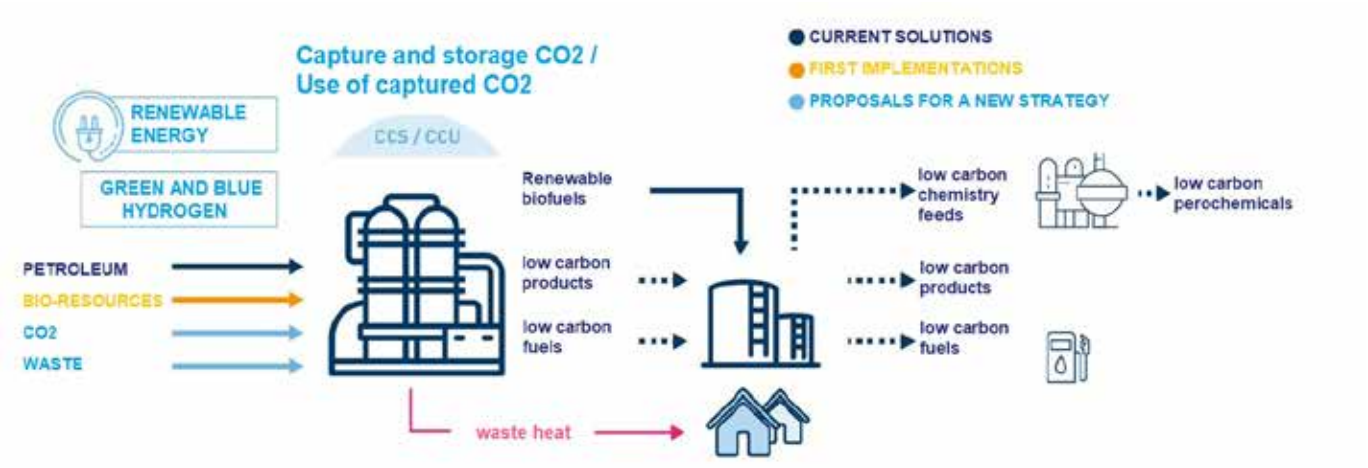
allowing obtaining ca. 90-% reduction of emission of CO_2 up to 2050 (ca. 3% annually). The solutions proposed by EPRA are based upon the better utilization of energy, OZE (Renewable Energy Resources) and change of the employed raw materials (Fig. 8). Many technologies may be utilized together in order to obtain a meaningful reduction of CO_2 emission intensity from liquid fuels. Vision 2050 indicates a refinery as a centre of industrial cluster, utilizing a wide range of raw materials.

Refineries will be transformed into energy hubs in industrial clusters. Fig. 9 shows the possible ways of future production of low-emission fuels with consideration of various types of waste in refinery processes and co-processing, the traditional one i.e. from crude oil to fuel and two future possibilities from organic waste and mineral waste to manufacturing processes of low-emission fuels e.g. industrial food waste, wood biomass, biomass different than wood (subscreen fraction, grasses, tree branches), plastics, used greases, used tyres, recovered solid fuels and solid municipal waste.

It is recognized that emissions connected with functioning of oil refinery may be reduced by many methods but most of them will be focused – in the future – on alternative raw materials for manufacture of petroleum products. The advanced bio-fuels are already developed on a high scale but more possibilities result from processing or co-processing the new types of waste materials. The refinery sector may contribute the expert knowledge to the development of alternative to the possibility of storage and combustion of plastic waste and the residues.

In the opinion of the authors, there is no fuel with a low content of hydrocarbons and with economic meaning at the present moment as compared to the traditional fuels. The national long-term targeted indicators, assuming the participation of bio-fuels in the total pot on the level of 10% consider the necessity of producing the bio-fuels of the next generations. They have to be especially advanced due to the growth of the population and the necessity of food assurance as the bio-fuels of the 1st generation are connected with the indirect land use change (ILUC).

Fig. 9. Transformation of refining plants[42, 50]



Further development of refinery technologies (in respect of new catalysts, more effective processes of fractions' separation and hydrocarbons' transformations, development of installations of reforming and isomerisation) will require the adaptation of the stream of the generated waste to the raw material which might be utilized in the refinery, guaranteeing simultaneously the quality of final product. It results from Fig. 10 that many refineries are integrated and are found in the radius of 100 km from the towns with the number of inhabitants higher than 50 thousand persons. It is anticipated that the mentioned configuration may be a future for ensuring the input to oil manufacturing plants. In Fig. 11, the conception of producing aviation fuel from the stream of municipal waste of urban infrastructure, situated near refinery, was presented.

The conception of the plant assumes that the waste is collected and then subjected to recycling. The appropriate waste is selected as suitable for aircraft fuel JET and is converted into synthetic aviation fuel of this type. The synthetic aircraft fuel JET is then blended as to be suitable for use in airplanes. Finally, the fuel is delivered to fuel terminal of the airport where the tanks of the airplanes are filled up.

Fig. 10. Situation of oil-refining plants and big urban areas in Europe[42]

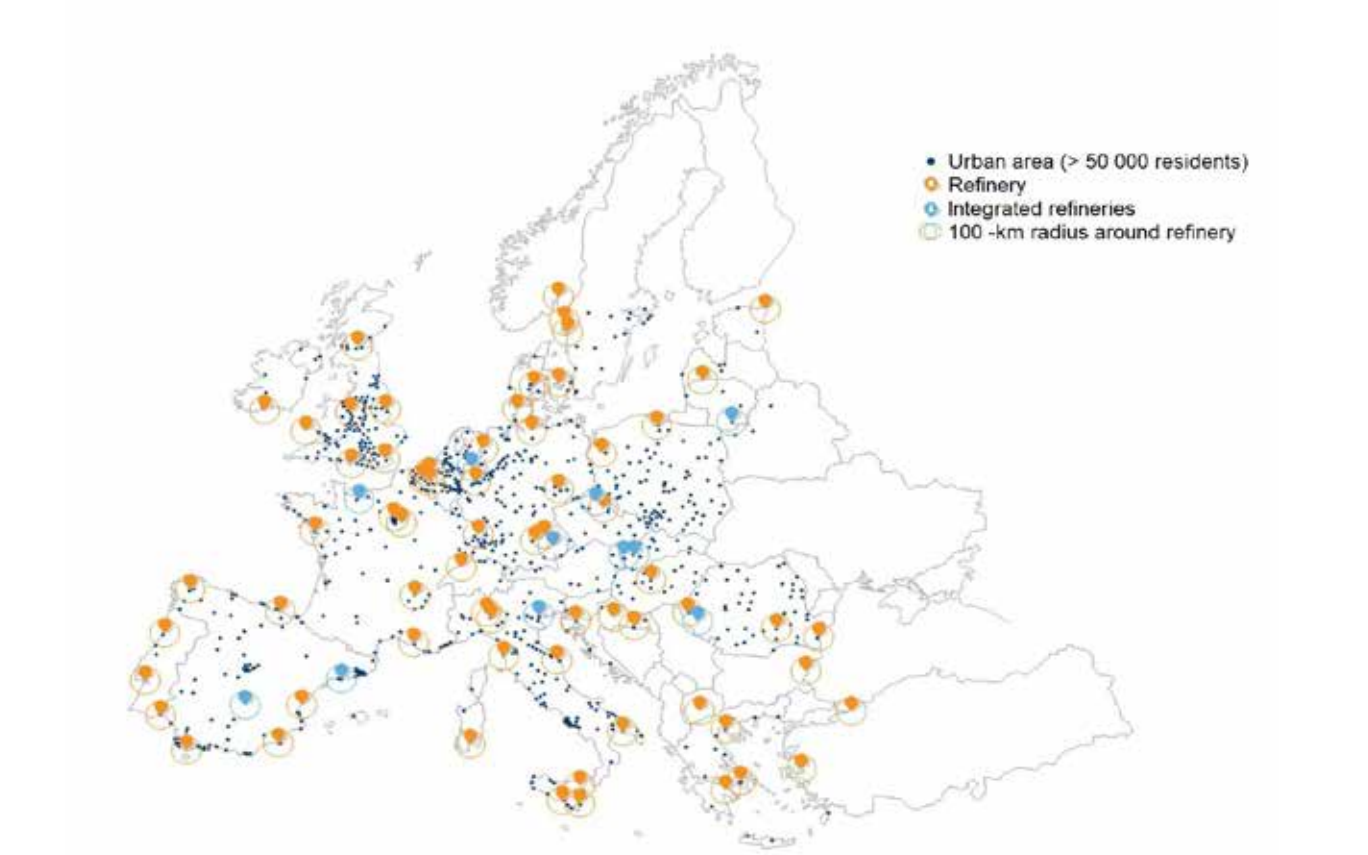


Fig. 11. Conception of utilization of municipal waste in aircraft fuels JET[42)]

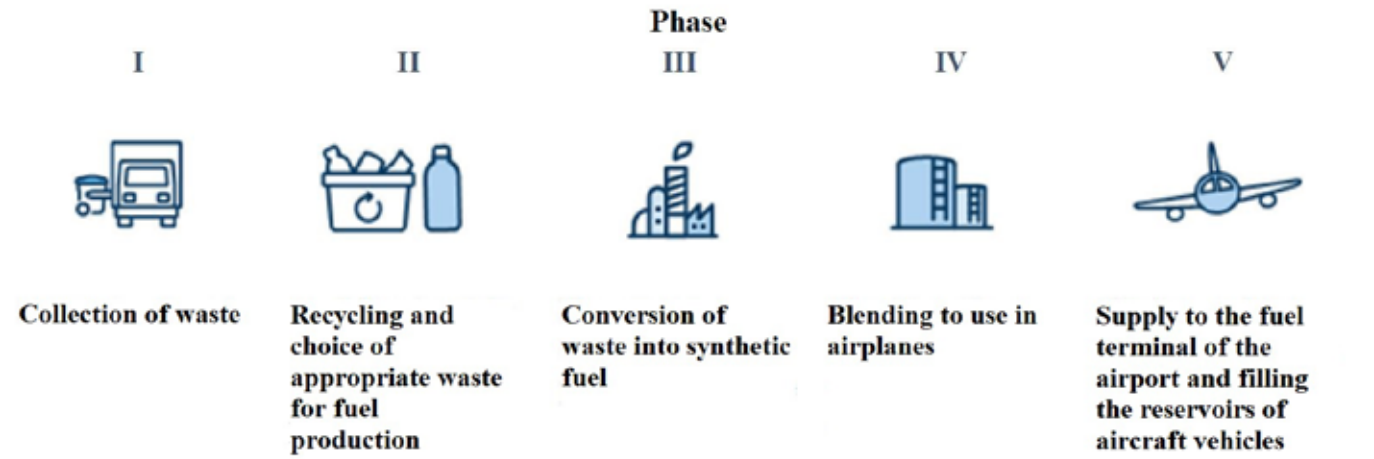
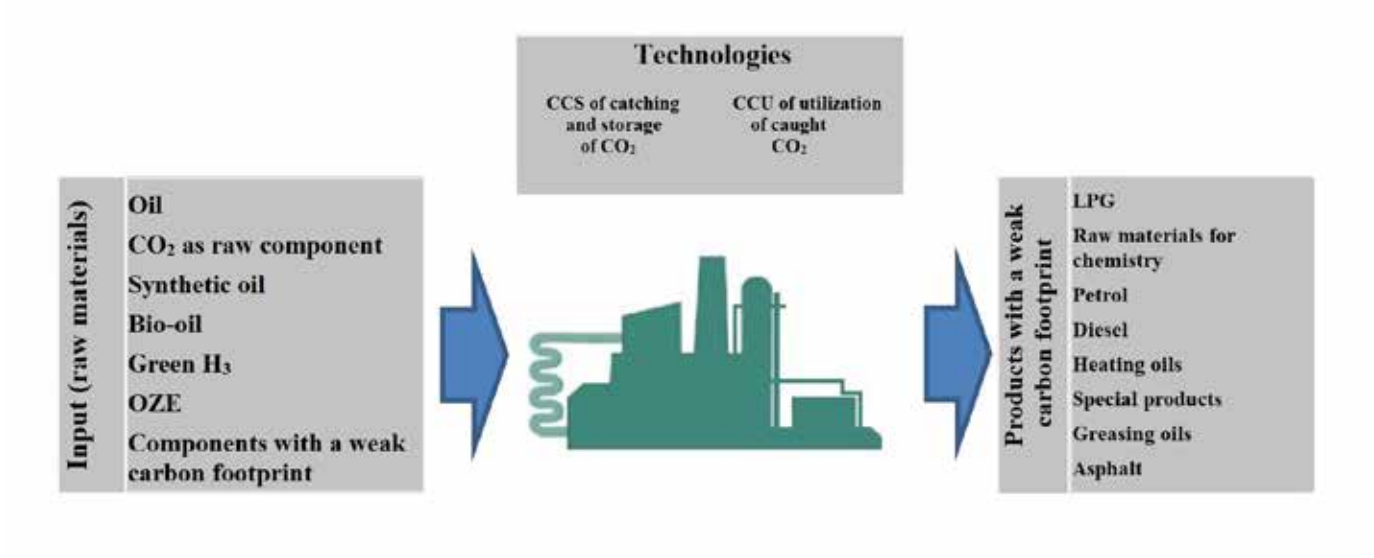


Fig. 12. Vision of refinery in 2050



Summing up

The products of crude oil processing will be responsible for 90% of the demand of the European sector of transport in 2030 and 89% in 2050. The forecast for the world demand on petroleum products is also optimistic for refineries. The refineries will be, therefore, necessary not only as the source of input to petrochemical production but also as storage places for energy. Fig. 12 contains a vision of refinery in 2050.

Polish Petroleum Concern ORLEN intends to utilize the existing refineries in Płock and Litvinov for implementation of the process of co-hydrogenation in the industrial scale. It consists in introduction of vegetal oils or used fats to refinery installations in parallel with petroleum fractions. Owing to it, the obtained drive oil contains the hydrogenated vegetable oil (HVO). The mentioned components will supplement esters being applied until now in the drive oil; they will be further used in a wide range up to the limit, provided by the standards of the fuel quality. The transition of hydrogenation process into the industrial scale was determined by the successful run of the technological test, implemented in September 2018 within the frames of CP-Bop Project, co-financed from the means of the sector programme Innochem.

When utilizing the experience with the co-hydrogenation of vegetal oils in the industrial scale and considering the way of implementing Directive RED II (Directive (UE) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources) on the ground of Polish regulations, ORLEN will undertake – in the perspective of 2020 – the decision on constructing the independent manufacturing installation of HVO. Additionally, there is analyzed the project concerning erection of installation for ethanol production from raw cellulose materials and also, other technologies allowing obtaining the advanced bio-components are found under the consideration.

The program for development of bio-fuels in PKN ORLEN will require preparation of refinery to receipt of a new component and organization of logistics of raw material supplies.

The Concern builds also systematically the knowledge on the market of renewable fuels and expects the increase of its role up to 2030. The interest of the Concern in bio-fuels refers especially to the utilization of waste raw materials for production of renewable fuels fits into a wider trend of closing a circulation of raw materials in the economy.

The planned research-developmental work includes the implementation of the pre-implementing tasks in respect of fuels with the increased participation of bio-component and also, the research activities, preparing PKN ORLEN to further technological and product changes.

Conclusions

The energetic scenarios are a big challenge for the oil refining industry. It is affected both by the variations of the raw materials' prices, pressure of the society to decrease the effect on the environment as well as refinery margins. The decrease of the consumer market is one of the main threats to refinery due to the prohibition of producing the fossil fuel-driven vehicles, mainly on the European market.

Due to the fact that during the recent years the petrochemical industry has been developing in a considerably quicker rate as compared to the market of transport fuels, the integration of refining and petrochemical processes is necessary for constructing the synergies capable of lowering the operating costs and increasing the value of derivate products, manufactured in the refineries.

The change in raw materials for refineries must be and will be accompanied by the change in technologies. It means the passage from conventional refining of heavy raw materials, using (usually) technology of coking (high temperature carbonization) to more innovative processes which will be concentrated on maximum utilization of raw materials.

LITERATURE

[1] E. Bortel, H. Konieczny, Zarys technologii chemicznej, PWN, Warszawa 1992.
[2] A.G.D. Emerson, Quantitative forecasting of problems in industrial water system, World Scientific Publishing 2003.
[3] W. Górski, Przetwory naftowe i płyny eksploatacyjne. Leksykon, Instytut Technologii Nafty, Kraków 2016.
[4] L. Gradoń, A. Selecki, Podstawowe procesy przemysłu chemicznego, WNT, Warszawa 1985.
[5] E. Grzywa, J. Molenda, Technologia podstawowych syntez chemicznych, t. 1, WNT, Warszawa 2008.
[6] http://abarrelfull.wikidot.com/.
[7] https://www.hydrocarbonprocessing.com.
[8] R.A. Meyers, Handbook of petroleum refining processes, McGraw-Hill Education – Europe, 2016.
[9] M. Mujtaba, Batch distillation. Design and operation, Series on Chemical Engineering, t. 3, Imperial College Pr., 2004.
[10] A.C. Palmer, Introduction to petroleum exploration and engineering, World Scientific, 2016.
[11] S. Pilat, Zarys technologii nafty, Drukarnia i litografia Piller -Neumann, Lwów 1939, reprint: Drukarnia Wydawnicza im. W.L. Anczyca, Kraków 2001.
[12] A. Puchowicz, Impresje naftowe. Z okazji przerobu 500 mln t ropy w Płocku, Płock 2012.
[13] A. Puchowicz, Paliwa, jaka alternatywa? Stowarzyszenie Płockich Naftowców i Oddział Stowarzyszenia Inżynierów i Techników Przemysłu Chemicznego w Płocku, Płock 2009.
[14] A. Puchowicz, Z naftą przez pokolenia, SITPChem o/Płock, Płock 2004.
[15] J.G. Speight, The chemistry and technology of petroleum, Marcel Dekker, New York 2009.
[16] J. Szarawara, J. Piotrowski, Podstawy teoretyczne technologii chemicznej, WNT, Warszawa 2010.
[17] Praca zbiorowa, Nafta polska, (red. A. Bochen), Polska Izba Paliw Płynnych, Bydgoszcz 2015.
[18] Praca zbiorowa, Historia polskiego przemysłu naftowego, (red. M. Boryń, A. Chodubsk i B. Duraj), Wyd. Adam Marszałek, Toruń 2014.
[19] J.E. Carruthers, L.H. Solomon, A.L. Waddams, Petroleum refining. History of oil. encyclopedia britannica, November 2018, https://www.britannica.com/technology/petroleum-refining.
[20] https://www.cire.pl, Międzynarodowy rynek ropy naftowej. Charakterystyka okresów kryzysowych.
[21] https://www.ektinteractive.com/history-of-oil, History of crude oil.
[22] https://www.history.com/topics/industrial-revolution/oil-industry, A history of petrol.
[23] A. Klocek, Płocka rafineria i petrochemia w latach 1959–2000, monografia, Wyd. P.P.-H. Drukarnia Sp. z o.o. w Sierpcu, Płock 2010.
[24] Organization of the Petroleum Exporting Countries (OPEC), World Oil Outlook, Worldwide Fuel Charter. . http://www.acea.be/uploads/publications/Worldwide_Fuel_Charter_5ed_2013.pdf, dostęp październik 2015 r.
[25] S. Ptak, J. Jakóbiec, Nafta-Gaz 2016, 72, nr 6, 451.
[26] K. Ruszaj, P. Gorlicki Przemysł naftowy – od powstania do współczesności. 2010 r., https://docplayer.pl/782744-Kinga-ruszaj-recenzja-prof-dr-hab-wlodzimierz-bonusiak-gorlicki-przemysl-naftowy-od-powstania-do-wspolczesnosci.html.
[27] M. Rutkowski, Technologia chemiczna ropy naftowej i gazu, Politechnika Wrocławska, Wrocław 1976.
[28] Praca zbiorowa, Ropa naftowa właściwości przetwarzanie, produkty, WNT, Warszawa 2006.
[29] Z. Tomczonek, Studia Ekon. 2013, nr 4 (64), 114.
[30] A. Wasilewski, Ropa naftowa w XX wieku, Instytut Nafty i Gazu, Kraków 2011.
[31] Praca zbiorowa, Historia polskiego przemysłu naftowego, (red. R. Wolwowicz), Wyd. Brzozów-Kraków, t. 1 1994 r., t. 2 1995 r.
[32] M. Michułka, Charakterystyka technologiczna rafinerii ropy i gazu w Unii Europejskiej, Ministerstwo Środowiska, Warszawa, wrzesień 2003.
[33] J. Molenda, Przem. Chem. 2002, 81, nr 10, 644.
[34] The Oil Companies' European Association for environment, health and safety in refining and distribution (CONCAWE).: Life-cycle analysis. A look into the key parameters affecting life-cycle CO2 emissions of passengers cars.
[35] P. Barthe, M. Chaugny, S. Roudier, L.D. Sancho, Best available techniques (BAT), Reference document for the refining of mineral oil and gas industrial, Emissions Directive 2010/75/EU, (Integrated Pollution Prevention and Control), European Commision, 2015.
[36] Komisja Europejska, Prezentacja. www.ec.europa.eu/commission/index_pl/.
[37] Suncor Energy Inc., Report on sustainability 2018 r. https://sustainability.suncor.com/.
[38] Eurostat, GHG statistics tables and figures update, 2017.
[39] BP p.l.c.: Statistical Review of World Energy, June 2018, https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html.

[40] Fuels Europe, Statistical Report 2018 r. https://www.fuelseurope.eu/publication/statistical-report-2018/.
[41] Eurostat, http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Consumption_of_oil_EU-28,_2015,_percentage.
[42] Fuels Europe, Vision 2050. A pathway for the evolution of the refining industry and liquid fuels, June 2018.
[43] E. Menes, Transport Samochodowy, Wyd. Instytut. Transportu Samochodowego, 2009, nr 1.
[44] Communication from The Commission to The European Parliament, The European Council, The Council, the European Economic and Social Committee, The Committee of The Regions and The European Investment Bank.: A Clean Planet for All, A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy. Brussels, 28.11.2018 COM(2018) 773 final, https://ec.europa.eu/clima/news/commission-calls-climate-neutral-europe-2050_en.
[45] European Commission, The EU Biodiversity Strategy to 2020, 2011, http://ec.europa.eu/environment/nature/info/pubs/docs/brochures/2020%20Biod%20brochure%20final%20lowres.pdf.
[46] Komisja Europejska, Komunikat Komisji do Parlamentu Europejskiego, Rady, Europejskiego Komitetu Ekonomiczno-Społecznego i Komitetu Regionów: Nasze ubezpieczenie na życie i nasz kapitał naturalny - unijna strategia ochrony różnorodności biologicznej na okres do 2020 r., Bruksela, 3 maja 2011 r., KOM(2011) 244 wersja ostateczna.
[47] Niskoemisyjna Polska 2050 – podróż do niskoemsyjnej przyszłości, raport, http://polskabezco2.pl/pl/aktualnosci/n42-prezentacja-raportu-2050-pl-podroz-do-niskoemisyjnej-przyszlosci.
[48] Fokus Groups, The Future of Transport, Report 20.02.2009, https://ec.europa.eu/transport/sites/transport/files/themes/strategies/studies/doc/future_of_transport/2009_the_future_of_transport.pdf.
[49] AG Prognos, Berlin 2019, https://www.prognos.com/presse/news/.
[50] Impact Analysis of Mass EV Adoption and Low Carbon Intensity Fuels Scenarios, Summary report RD18-001912-3, Wyd. Ricardo, August 2018.

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EVALUATION OF FAILURE FREQUENCY AND WATER LOSSES IN MUNICIPAL WATER SUPPLY NETWORK ON THE EXAMPLE OF Z CITY IN THE YEARS 2012-2017

OCENA AWARYJNOŚCI I STRAT WODY W SIECI WODOCIĄGOWEJ NA PRZYKŁADZIE MIASTA Z W LATACH 2012-2017

Summary: *In 2017, the analysed enterprise ZPWiK (Zabrzańskie Enterprise of Water Supply Network and Sewage System) operated the water supply network of 486.3 km length, constructed mainly (in 76.3%) from PE-DH (polyethylene of high density). The age of as much as 85% of the network is up to 20 years old. The most of failures in water supply network is caused by a corrosion of steel pipelines and the conducted constructional work. It is followed from the studies that the failure frequency is systematically decreasing: from 2.33 failures/km in 2012, to 1.76 failures /km in 2017. The majority of the occurring failures are removed during up to 8 hours but we may observe that since 2015, the number of more difficult failures, being removed during longer period than 13 hours, has been successively increased.*
In spite of a high failure frequency, the level of losses is relatively low and is decreased from 11.36% in 2012 to 8.75% in 2017, what in comparison to the data of IGWP (Economic Chamber "Polish Water Supply Network") is a very good result. The obtained good effects are connected with the renewal of the network materials, purchase and utilization of new equipment for finding out and recovery of the failures and constantly developed and analysed monitoring of work as well as the pressure reduction in the water supply network.

Keywords: *water supply network, material, failures, water losses, the methods for reduction of losses*

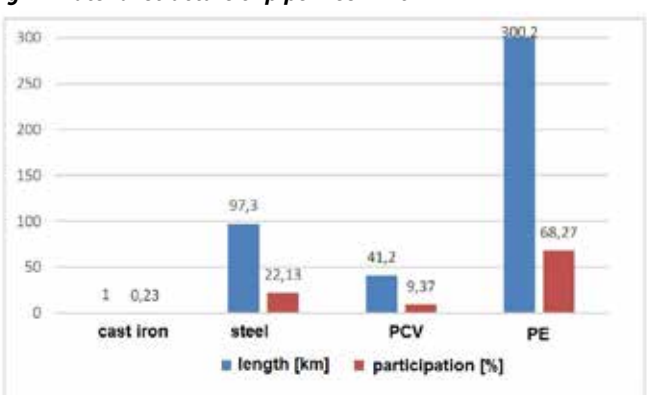
Streszczenie: *Analizowane przedsiębiorstwo ZPWiK eksploatowało w 2017 sieć wodociągową o długości 486,3 km wykonaną głownie bo w 76,3% z PEHD i aż 85% stanowią sieci o wieku do 20 lat. Większość awarii w sieci wodociągowej spowodowana jest korozją przewodów rur stalowych i pracami budowlanymi. Z badań wynika że awaryjność ulega systematycznemu obniżeniu z 2,33 w 2012 do 1,76 w 2017 awarii/km rok. Większość awarii jest usuwana w czasie do 8 godzin, ale można zaobserwować że od 2015 roku sukcesywnie rośnie liczba trudniejszych awarii usuwanych w czasie dłuższym niż 13 godzin.*
Mino dużej awaryjności poziom strat jest stosunkowo niski i ulega obniżeniu z 11,36% w 2012 do 8,75% w 2017, co w porównaniu z danymi IGWP jest wynikiem bardzo dobrym. Uzyskiwane dobre efekty mają związek z odnową materiałów sieci, z zakupem i wykorzystaniem nowego sprzętu do lokalizowania i usuwania awarii oraz ciągłym rozbudowywanym i analizowanym monitoringiem pracy jak również redukcji ciśnienia w sieci wodociągowej.

Słowa kluczowe: *sieci wodociągowe, materiał, awarie, straty wody, sposoby obniżenia strat*

Introduction

According to the data of the Main Statistical Office (GUS), at the end of 2017, the analysed enterprise supplied water to 174 thousand inhabitants of the community. Water delivered to the inhabitants comes from different sources which include the purchase of underground and surface water and own production of underground water. The diagrams (Fig.1 and 2) present the changes in the material structure of water supply network during the period of 2012 – 2017. We may observe a considerable decline in the participation of steel pipelines in the discussed structure (by ca. 7%) and successively growing participation of PE (polyethylene) pipelines (increase by 8%) what is consistent with the trends in the discussed sector. The participation of cast iron and PVC (polyvinyl chloride) are varying in a small range. The damages, occurring in the mentioned

Fig. 1. Material structure of pipelines in 2012



pipelines are mostly caused by ground work conducted on their vicinity. Their failure in relation to steel is small, the percentage in

the whole structure is also low; the changes occur on the occasion of conducting another work in the pipelines.

Fig. 2. Material structure of pipelines in 2017

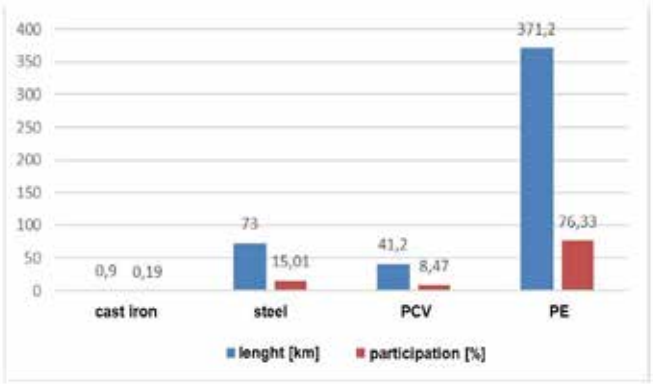


Fig. 3. Length of water supply network in the years 2012-2017

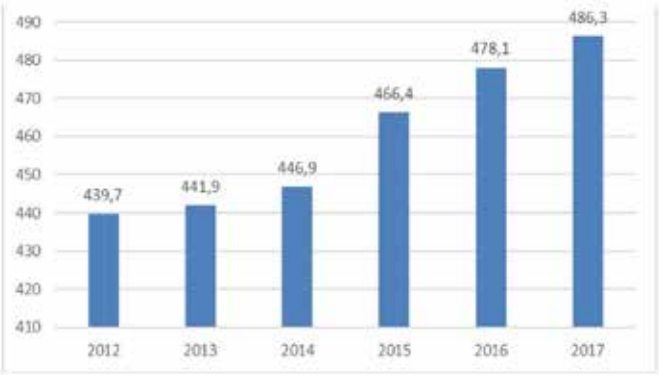
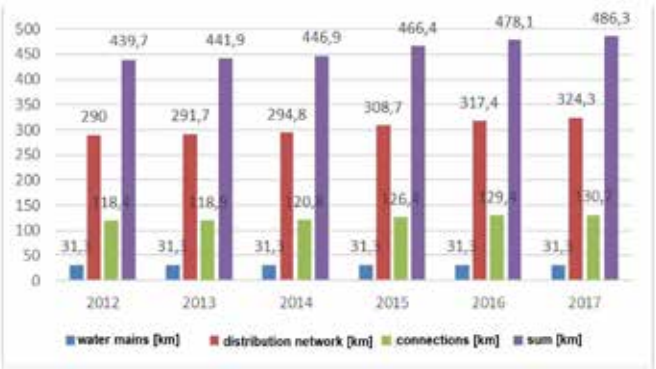


Fig. 4. The length of the water supply network with the division into the share of the water mains, distribution network and the connections in the years 2012-2017



ZPWiK modernizes its networks systematically; at the end of 2017, almost 85% of the water supply network, being under the administration of the company, consisted of the maximum 20-years old pipelines.

In the paper, the range of diameters for water supply connections from d=25 mm to d=80 mm was adopted. The range of diameters from 90 mm to 400 mm will be referred to distributing networks and above d=400 mm, we speak about the water main. As it has been shown in Fig.4, the length of distribution networks in the city is systematically increasing and consequently, the length of the connections. It is connected with the development of the city.

The sites of and the reasons for occurrence of failures in water supply pipeline network

Fot. 1. Point corrosion of water pipeline connection

Failures and leakages are the element, occurring in every system of water supply. It is not possible to anticipate the place and time of leakage; sometimes, we do not know about a failure until the moment when its occurrence causes the visible consequences on a surface, being often equivalent of substantial material losses [1]. Detection and removal of even small leakages brings, from one side, the benefits for the company owing to limitation of water losses in the distribution system and on the other side, the protection from serious failures. The aspect of environment protection and first of all, more reasonable management of water resources, decrease of chemicals use at water treatment and electric energy consumption, necessary for introduction of water into the network, are also important issues. The number of failures and their reasons are determined by many factors; the most important ones include: material defects, the conditions connected with the production technology, corrosion, ground-water conditions in the site of laying the pipelines, hydraulic parameters and, in particular, the range and frequency of the pressure changes in the network, careless performance of the ground work in the vicinity of water supply pipelines, and, finally, a negative effect of mining operations [1].

Fot. 2. Image of corrosion inside the steel pipeline

Fot. 3. Image of point corrosion

Fot. 4. Rupture in the area of tee joint in the distribution PVC network

Fot. 5. Damage of steel connection during performance of jacking

As it can be seen, the most of the failures in water supply networks are caused by corrosion of the pipelines (Fot. 1 – 3). The successive reason for failure occurrence is connected with geological conditions – what can be perfectly seen in Fot.4: how the movements of ground masses have caused the deformation of the pipe and, in consequence, damage of pipe socket at the tee. One of the more frequently occurring causes of failure includes damages, generated during the performance of ground work such as drilling, jacking etc. The damage of water supply connection, as illustrated in Fig.5, is a model example of such situation.

In the area of ZPWiK activity, the number of failures, being recorded in the analysed years, was found on the level of 2.86 failures/day in 2012 and up to 2.3 failures /day in 2017.

The assessment of the indicators of damage intensity in the water supply network

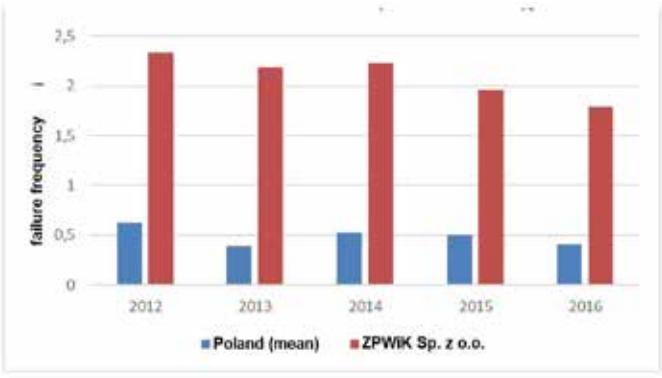
The unitary intensiveness of failures, determining the number of damages per unit of length of the pipeline (most often 1 km) and time unit (most often 1 year) is one of the major indicators of the evaluation of technical state of water supply pipeline network. Fot.5 shows the indicators of the intensiveness of failures. It may be observed that since 2015 until now, the discussed parameter has been decreasing in the networks as well as in connections.

Compared to the indicators given in literature, the analysed network may be classified as being in a very bad technical condition > 0.5 failures /km/year [2]. The index of failure frequency in water supply network of the discussed enterprise, with the connections or without, is high and it would indicate the necessity of undertaking the quick repair measures.

In the light of the data available for water pipeline systems at the territory of the whole country, ZPWiK is not "distinguished" in the respect of the current calculated data on the intensity of damages in the water supply network. The data on the failure frequency in the network contained in the Benchmarking 2016 Report, published by IGWP [3] are given in Fig.6.

Fig. 5. Indicators of failure for the whole city [failures/km/year]

Fig. 6. Index of failure frequency in the water supply network – the comparison. Source: IGWP.org.pl [3] plus own data

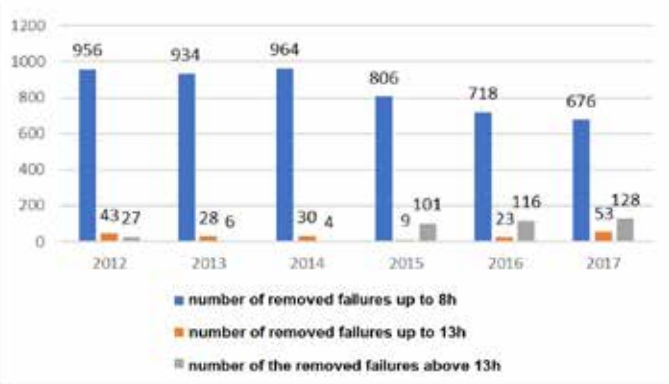


Time of failure removal

In the case of detection of leakage (visible or hidden), the appropriate measures are undertaken with the aim to remove the failure. The failures, occurring in the network of ZPWiK are classified as regard to the size of the leakage: small, medium or big; the place of occurrence: connection, network or the mains. The work on the improvement of the procedures is conducted at the Department of Wod-Kan Network; the park of machines and equipment is carried out and qualified staff is employed. We should also pay attention to the fact that the prevailing part of the brigade operates the equipment of a very good quality and of the recognized producers what affects considerably the limitation of the number of downtime and failure recovery speed. The diagram (Fig.7) illustrates the number of failures and time intervals in which they are removed. As it can be seen, the most of the failures 993 – 78%) are removed during one working shift (i.e. up to 8 hours). It is evident that the equipment and skills of the operating brigades are utilized in a very high degree; however, a certain space exists for improving the effectiveness.

It may be also seen (Fig. 7) that in the years 2015 – 2017, the increase in the number of failures, removed during more than 13 h since the moment of reporting, had place 911-15%). In the case of the discussed enterprise, it is connected with the fact that after the period of network infrastructure development, connected with the stage I and stage II of the project for improvement the water and sewage management, the period of more complicated repairs was commenced; it included such operations as replacement of tees, two-port networks and locks in the central part of the city, what is connected with a high complication of work in respect of logistics (development of plan of respective marking during the period of

Fig. 7. Time of failure removal



Fot. 7. The successive stage of gate tee replacement

Fot. 6. Gate tee, prepared to be replaced (over and next to the tee, the pipelines of rain sewage and, also, telecommunication cables in protection tubes are visible)

Fot. 8. The replaced gate tee (before recovery of the correct water flow, the worker visible in the photo, is checking the force of tightening the screws)

operations, appropriate reporting to the public administration authorities in connection with occupying the traffic lane) (Fot. 6-8).

Water balance and losses

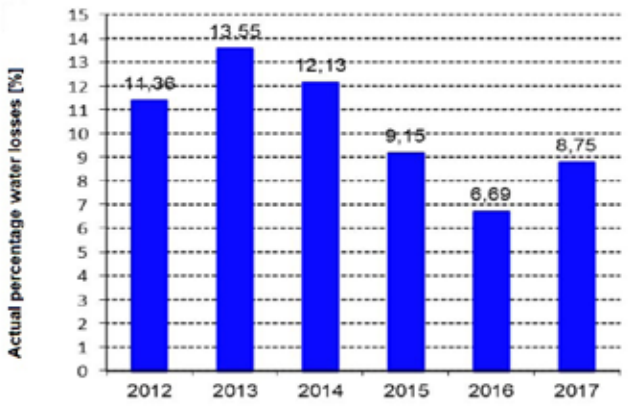
During the recent years, Polish water supply companies have paid a special attention to the volume of unsold water instead of dealing with the real losses. The uniform approach and methodology for determination of the discussed water loss components did not exist. According to IWA (International Water Association) that is what assures water balance. According to the balance, volume of water introduced to the distribution system is principally divided into authorized consumption and water losses. In turn, the authorized consumption consists of invoiced authorized consumption, i.e. such water volume that is sold by the company and of the non-invoiced authorized consumption, i.e. such water volume that the enterprises uses for the own needs. Water losses are classified into apparent losses, connected with the non-authorized consumption (e.g. theft), errors of measurement and readings out of measuring devices and the real losses, including the water losses from leakages – failures [4].

When implementing the water supply and sewage system management, the analyzed ZPWiK enterprise utilizes water, in particular, for the following purposes: living, operation, waste treatment, sewage drain clearing and cleaning, dehydration, venting, rinsing and disinfection of water pipeline network as well as providing the water intake points in the case of its lack, caused by water supply failures. The water volume used for the own company's needs is estimated. The main reason for such procedure is a lack of the possibility of performing all measurements of water consumption, in particular in the direct work in the networks, which – in the opinion of the company – constitute a prevailing part of the discussed consumption. The successive cause of such procedure includes the costs connected with the performed measurements.

From the above diagram, the interesting trend may be observed: year by year, volume of water introduced to the networks has been gradually decreasing and since 2013 until now, the volume of water sold has remained at the same level (it varies from 6.5 million m^3 to 6.24 million m^3).

It is connected, to a greater degree, with the improvement of the quality of water pipeline infrastructure, replacement of steel pipes by PEHD pipes and the speed of finding out and recovery of failures. It is also determined by ecological awareness of the users and saving of water. What is important, the level of losses is also decreasing: in 2012, they constituted 11% of the introduced water and in 2017 – only 8%. The difference of 3% in this case means 285 863 m^3 of water what gives saving of ca. net PLN 1.4 million (considering only water price).

Fig. 9. Comparison of percentage water losses for the whole city in the years 2012-2017



When analyzing the data of water losses at ZPWiK and comparing them with the data contained in Benchmarking 2016 Report, published by IGWP (which also contains the references to the mean data of 2014 and 2015) [3], it may be observed that despite the relatively high indicator of network failures, water losses are found on the level below the mean values, indicated in the IGWP report (Fig. 10).

The selected spectrum of the implemented tasks in the enterprise with the aim to limit the losses in the years 2012 – 2017

Fig. 8. Water introduction to ZPWiK pipeline network, water sales and losses [m^3]

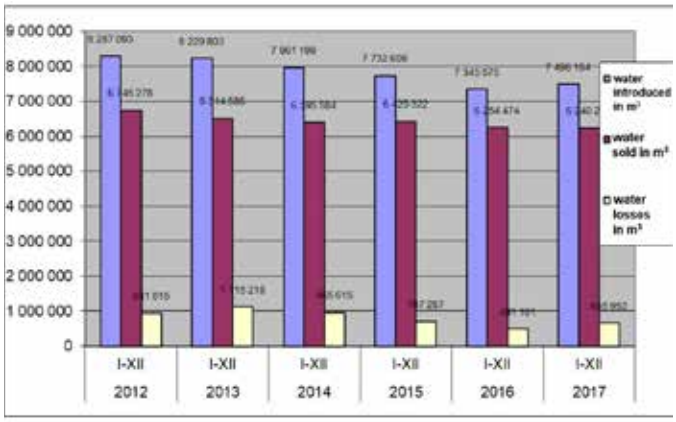
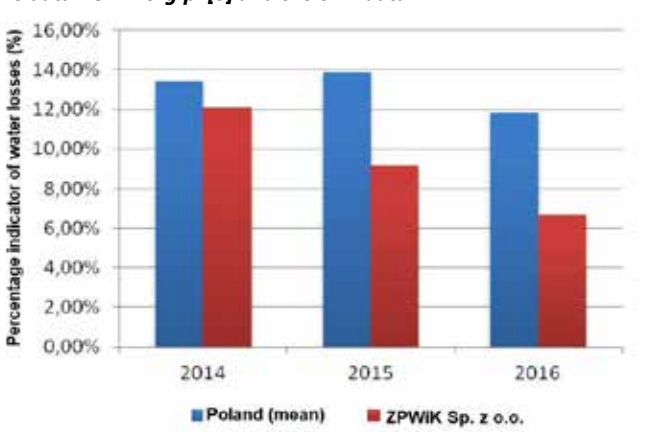


Fig. 10. The percentage indicator of water losses – comparison of the data: IGWP.org.pl [3] and the own data



During the discussed period, the project "Improvement of water-sewage management at the territory of city Z" was a very important undertaking, affecting the failure frequency in the water supply network. Within the frames of the project, the replacement of ca. 31 km of water pipelines had place; it makes 7% of the whole network. The equipment used in detection of the leakages is also subjected to the replacement. In 2015, the company bought a modern digital EUREKA correlator and MICRON 3 geophone. The mentioned equipment replaced their analogue version, utilized until now. In 2014, there was purchased the successive cable tracker type RD7100. The replacement of the equipment for detection and situation of leakages has greatly contributed to the limitation of the number of failures which in 2012 was equal to ca. 1000 cases and in 2017 – 857. The precision of location had the same effect although the 100-% accuracy of indicating the leakage sites is still far away.

To check the leakages and minimize their consequences, ZPWiK conducts the activities, based on three procedures:

- Control of night flows, with the application of monitoring and measuring of wells;
- Periodical control and testing of tightness of water supply pipeline network;
- "Waiting for failures", consisting in assembly of sensors, serving for recording of acoustic signals in the regions, most vulnerable to failure.

In the analyzed company, the telemetry system is successively developed. There are also considered the current market solutions which would enable integration of the telemetry system with the failure evidence system to make them more mobile. The successful fusion of the mentioned two systems would allow the supervising persons to spend less time at the office and more outside, having all available information at the current time. For example, when a supervisor of the water-sewage system goes to the region of failure, he has an access to tablet with the geo-location and is able to introduce the current data to the system: e.g. open armature, accordance of gate diameter, number of gates in junction, diameters of materials in the network, its situation in the region (differences in post-performance measurements), etc.

The leakages, occurring due to the damages of joints, pipelines and water supply fittings [1] are the main reasons for real water losses. The damages as well as water losses are caused by many different factors, affecting the water supply system; the degree of this impact is differentiated very much in the particular materials of the water supply network. The height of the pressure present in a given zone of the water supply system is one of the most important factors. The pressure and its changes in a 24-hour cycle affect the degree of failures as well as intensity of water outflow from the damaged elements of the network, irrespectively of the cause of the damage. The intensity of water outflow via opening with a specified diameter at pressure of 0.6 MPa is by ca. 70% higher than at the pressure of 0.2 MPa [5]. At the constant pressure, the intensity of water outflow is increasing proportionally to the increase of the surface area of the caused damage.

Since November 2005 until July 2005, the enterprise bought and launched system of constant monitoring of water flow and pressure in the selected supplying wells and purchased wells, situated in the operating water supply networks.

In 2006, the stocktaking of the major water supply mains and of the water pipeline supplying wells and of the purchased wells was carried out with the aim to introduce and utilize the launched system of permanent monitoring. In 2007, the stocktaking was completed and the map of the main water supply networks together with supplying sources was developed. Based upon the map, the zones of supply were determined and, at the same time, the alert flows (minimum night flows) under the system of constant monitoring were established. The mean water pressure in the particular zones was lowered. It happens that even now we may find the reducers dating back to 2005/2006, operating in the reduction chambers at the borders of the supply zones. In connection with their high wear, the successive stocktaking should be planned in the near future with the aim to determine the number of the devices to be replaced. It would allow minimizing the probability of occurrence of such events as for example, "hanging up" of reducer what results in maintaining too high pressure in the supply zone (failures in connections) or vice versa – closure of the reducer, what brings about to the decline of pressure on higher floors and deficits of water.

Summing up

Limitation of water losses should be one of the most important activities of the water supply companies as it enables lowering of costs of the sold water and, simultaneously, increase of the quantitative possibilities of water sale. It is estimates that when eliminating a loss of one cubic metre of water, we liquidate also the unnecessary consumption of electric energy on the level of 1 – 1.5 kWh. At present, the water losses at ZPWiK are estimated on the level of ca. 8% what corresponds to 655 000 m3 of water lost per year.

The high level of water losses in Poland is affected by multi-year negligence in respect of modernization, repairs and development of water supply systems, leading to their degradation and also, negligent performance of work during construction of the network during the period of centrally planned economy. At ZPWiK, the subject of water losses is treated as a priority, with a great stress put on their limitation to the economic level. Such activity may be supported by the investment in infrastructure, the successive replacement of the network (which – due to the financial aspects – does not run as quickly as we would wish and as it would be justified) as well as the investment in the equipment and people.

The main directions of the measures which should be introduced in ZWPiK for improvement of the operating conditions of water supply networks include as follows:

- Replacement of water supply networks (at present, in cooperation with WFOŚ (Voivodeship Fund of Environmental Protection), the segments of network characterized by a high failure number, e.g.

steel network are replaced). One of the streets became selected for the replacement due to the number of failures, occurring since the beginning of 2012 to September 2017 - 43 failures had place in the network only (Ø steel pipelines). During the period of 2008 until September 2018, 140 cases of leakage were reported – the length of the network in the considered site was equal to ca. 2.5 km;

- Full monitoring of water flow and pressure in the operated water supply networks (gradual condensation of the existing zones, separation of new zones in the newly constructed settlements of single family houses):
- Further regulation of water pressure in the operated water supply networks (replacement of old models of reducers for the new ones, adding the new points to the telemetry system as to react in a real time).

When referring to the calculated indicators of failure frequency – which as regards to the literature sources are high and predestine the network to be quickly replaced – we should add some words of explanation. High values of failure indicator result partly from the limitations of the program, applied in recording of the events in the network and the integrated glossary of the events. At present, the failure includes such events as e.g. insufficient gate, ineffective reducer, switching of the connection etc. For example, when considering only the events having in the name the word "leakage", the indicator of failures was equal to 0.95 failures /km/year in 2017 and for the wording "leakage from the network" is 0.56 failures/km/year; totally, for all failure events, the discussed index is equal to 1.76 failures/km/year. As it can be seen, ZPWiK experiences a constant and systematic decline of in water supply system. In the case of the mentioned above big differences, it is recommended to consider what failures should be included to the failure indicator.

Despite the high index of failure frequency as compared to the data in the Benchmarking IGWP Report in the years 2012 – 2106, the percentage indicator of water losses is found on the level lower than the mean for the country what is an evidence of good organization and investment activities of the analyzed ZPWiK, directed to the reduction of water losses.

Literature

[1] Piechurski F.G. Ocena sposobów zmniejszenia strat wody na przykładzie czterech wybranych przedsiębiorstw wodociągowych i kanalizacyjnych. Nowe technologie w sieciach i instalacjach wodociągowych i kanalizacyjnych. Prac zbiorowa pod redakcją K. Kusia i F. Piechurskiego; Politechnika Śląska Gliwice. 2010. s. 269-296

[2] Kwietniewski M. Kierunki badań systemów dystrybucji wody w Polsce. Gaz Woda i Technika Sanitarna (12) 2018 : 436-445

[3] Izba Gospodarcza Wodociągi Polski – www.igwp.org.pl – dane z opracowywania Benchmarking – Wyniki Przedsiębiorstw Wodociągowo-Kanalizacyjnych w Polsce za 2016 rok

[4] Piechurski F. Efekty monitoringu w wybranej sieci wodociągowej – studium przypadku. Gaz Woda i Technika Sanitarna (10) 2017 : 395-298

[5] Hotloś H.: Ilościowa ocena wpływu wybranych czynników na parametry i koszty eksploatacyjne sieci wodociągowych. Oficyna Wydawnicza Politechniki Wrocławskiej. Wrocław. 2007

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REMOTE SENSING IN FARM MACHINERY DESIGN - AS FUNDAMENTAL IMPROVEMENT OF DEVELOPMENT - OF PRECISION AGRICULTURE PHENOMENON

ROZWÓJ PROJEKTOWANIA MASZYN ROLNICZYCH W ASPEKCIE ZDALNEGO STEROWANIA PROCESAMI ROLNICZYMI MAJĄC NA UWADZE ROLNICTWO PRECYZYJNE

***Summary**: When using remote sensing we can achieve not only high and good quality yields but also lower pollution of natural environment and substantial reduction of production costs. Some satellite systems make possible obtaining information about soil structure and different types of crops with plants designated for feeding purposes as well. Besides that it can contribute to the development of precision agriculture by steering of farm machinery during field work, providing monitoring of biomass and crop yields, taking soil samples, dosing of mineral fertilizers and pesticides, field crops' level measurement, monitoring of animals and monitoring of farm machinery work.*

***Keywords**: remote sensing, agricultural engineering, ecology, cultivation, control, satellite systems, GPS, monitoring, fertilization, harvesting, progress*

***Streszczenie**: Dzięki zastosowaniu teledetekcji możemy osiągnąć nie tylko wysokie i dobre plony, ale także mniejsze zanieczyszczenie środowiska naturalnego i znaczne obniżenie kosztów produkcji. Niektóre systemy satelitarne umożliwiają uzyskanie informacji o strukturze gleby i różnych rodzajach upraw, a także roślinach przeznaczonych do celów żywieniowych. Poza tym może przyczynić się do rozwoju rolnictwa precyzyjnego poprzez sterowanie maszynami rolniczymi podczas prac polowych, monitorowanie biomasy i plonów, pobieranie próbek gleby, dozowanie nawozów mineralnych i pestycydów, pomiar wielkości upraw polowych, monitorowanie zwierząt, monitorowanie gospodarstwa oraz pracy maszyn.*

***Słowa kluczowe**: teledetekcja, technika rolnicza, ekologia, uprawa, kontrola, systemy satelitarne, GPS, monitorowanie, nawożenie, zbiory, postęp*

Introduction

The technological tools often include the global positioning system, geographical information system, yield monitor, variable rate technology and remote sensing. Literature review shows that there are quite a lot of problems to be solved by utilization of remote control. By use of remote control we may be utilize crop management owing to which the areas of crop within a given field may be managed with different levels of input depending upon the yield potential of the crop in that particular area of land. The benefits of such operations are as follows: cost of producing the crop in that area can be reduced and the risk of environmental pollution from agrochemicals applied at levels higher than those required by the crop can be reduced, as well.

The global positioning system GPS is a network of satellites developed in U.S.A. The GPS constellation of 24 satellites, orbiting the earth transmits precise satellite time and location information to ground receivers. The ground receiving units are able to receive this location information from several satellites at a time for use in calculating a triangulation fix thus determining the exact location of the receiver.

Formerly, agronomic practices and management recommendations have been developed for implementation on a field basis. This generally results in the uniform application of tillage, fertilizer, sowing and pest control treatments at a field scale. Farm fields, however, display considerable spatial variation in crop yield, at the field scale. Such uniform treatment of a field ignores the natural and induced variation in soil properties, and may result in areas being under- or over-treated, giving rise to economic and environmental problems.

The more substantial of these problems being: economically significant yield losses, excessive chemical costs, gaseous or percolator release of chemical components, unacceptable long-term retention of chemical components and a less than optimal crop growing environment.

A geographical information system GIS consists of a computer software data base system used to input, store, retrieve, analyze, and display.

It is important "differential" treatment of field variation as opposed to the "uniform" treatment underlying traditional management systems. The result is an improvement in the efficiency and environmental impact of crop production systems. Elaboration of precision digital maps concerning

fertilization (mineral fertilizer, liquid fertilizer, manure spreading), sowing, spraying, on the basis of field soil tests is very important for yield concerning different crops. Also, it is important to collect yield models from different farm machinery such as corn and fodder harvesters of different models and companies.

The goal of remote sensing is to gather and analyze information about the variability of soil and crop conditions in order to maximize the efficiency of crop inputs within small areas of the farm field. To meet this efficiency goal the variability within the field must be controllable. Efficiency in the use of crop inputs means that fewer crop inputs such as fertilizer and chemicals will be used and placed where needed The benefits from this efficiency will be both economical and environmental.

Environment protection development

Environmental costs are difficult to quantify in monetary terms. The reduction of soil and groundwater pollution from farming activities has

a desirable benefit to the farmer and to society. If maps of the spatial distribution of soil productivity potential (maps of expected yield) and maps of the spatial distribution of plant nutrients available from the soil are developed for a field, fertilizers and organic wastes can be applied in amounts per acre that are directly proportional to the soil's expected yield and adjusted for the soil's fertility at any location in the field. Such

a procedure would optimize the economic potential of a field, yet minimize the leaching of nutrients.

The above protocol depends on having a good map of the spatial variation of the expected yields for crop fields. Maps of past crop yields for a field could be used for this purpose. However, multiple years of spatial yield data would be needed to overcome variations caused by year to year differences in weather, especially rainfall, and there remain multiple factors which result in lack of year to year correlation.

A major advantage of this approach is that remote sensing can provide a current assessment of the overall plant health of the crop rather than relying on the past history of yields. Several different approaches exist for using remote sensing data for this purpose. Most of the commonly recognized techniques depend on measuring the greenness of the field.

For example, it is a relative technique and can be significantly affected by soil conditions. It have been pursued a different path in this research. It have been examined the thermodynamic efficiency of the crop.

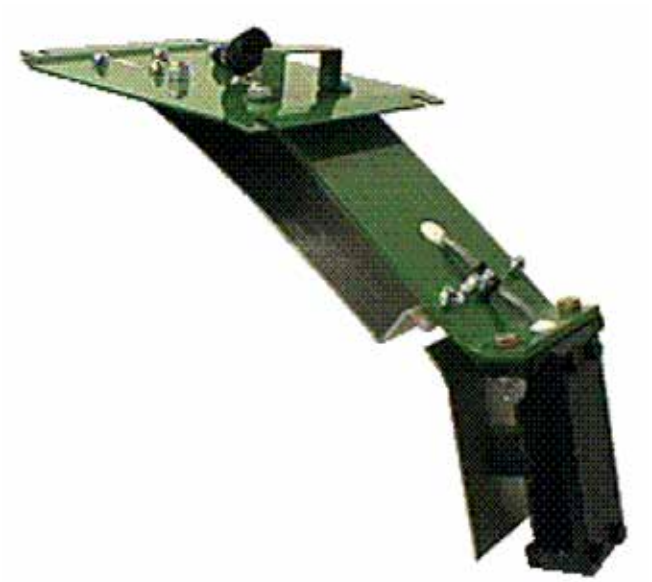
With remote sensing we can estimate many of the important properties of the soil. The organic carbon content can be estimated from albedo. Clay, iron and other mineral contents can also be estimated. While nutrients are important to plant growth, more critical to their vitality is plant available moisture. Water is essential for the transport of nutrients to and from the plant. This transport occurs laterally within the soil, and vertically within the plant.

Remote sensing in farm machinery systems

Remote sensing refers to the process of gathering information about an object, at a distance, without touching the object itself. The most common remote sensing method that comes to most people's minds is the photographic image of an object taken with a camera. Remote sensing has evolved into much more than looking at objects with our eyes - figures 1 and 2.

Fig. 1. Combine yield monitor
Source: John Deere Green star Precision Farming Equipment [2010]

Fig. 2. Combine grain tank flow sensor
Source: John Deere Green star Precision Farming Equipment [2010]



The term remote sensing is restricted to the methods that employ electromagnetic energy as the means of detecting and measuring target characteristics. Remote sensing is the information obtaining from a distance about objects or phenomena without being in physical contact with them. The science of remote sensing provides the instruments and theory to understand how the objects and phenomena can be detected.

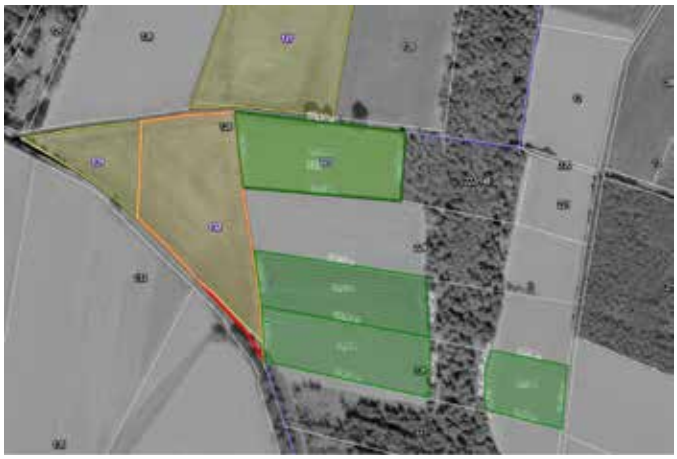
Variable rate technology ("VRT") consists of farm field equipment with the ability to precisely control the rate of application of crop inputs and tillage operations shown on figure 3.

A goal of many publicly funded research institutions is to promote technology transfer from government agencies to the private sector. Soil

Fig. 3. VRT Spreader
Source: [Amesremote, USA, 2009]

Fig. 5. Fertilizer spreader Case Co. equipped in remote control system
Source: Case Co. products [2011]

Fig. 4. Orthophotomaps can help in evaluation of crop development
Source: [Barwicki, 2011]



maps are also sometimes used to determine management zones. Soil maps are becoming a part of the Geographical Information

Systems (GIS) database. The grid sampling technique takes separate soil samples from uniform sized grids laid out over the field.

A problem with this type of sampling is the variability that can exist in soil types within each grid.

This variability makes it much more difficult to determine soil characteristics within the grid for crop input management purposes. To minimize this problem smaller grids are required what then requires many more soil samples to be collected for a larger number of grids. Soil samples can become a major cost of the socalled precision agriculture. An alternative to grid sampling is targeted or zone sampling.

The soil samples are located in homogeneous management zones instead of uniformly spaced grids. The zones are laid out using

a process similar to computer based unsupervised image classification. Images obtained from multispectral remote sensors are taken of the vegetated areas of the field.

One goal of remote sensing is to cut crop production inputs, which result in cost and environmental savings. Conventional farming methods apply herbicides to the entire field.

Site-specific variable-rate application puts the herbicide where the weeds are found. Aerial remote sensing has not yet proved to be very useful in monitoring and locating dispersed weed populations. Some difficulties encountered are that weeds often will be dispersed throughout a crop that is spectrally similar, and very large-scale high resolution images will be needed for detection and identification as shown on figure 4.

The United States and Russia are planning updates to their remote control systems, while the European Union and China are planning to launch their own systems. This will significantly improve the accuracy and robustness of satellite navigation but will require new receivers to be purchased, however, the timeframe of the upgrade is around 10 years so may not influence purchasing decisions in the short term.

The use of machine vision technology systems to detect and identify weeds places remote sensors directly on the sprayer equipment. Being close to the crop allows for very high spatial resolutions.

Machine vision systems have the ability to be used in the field with the real-time capabilities that are necessary to control sprayer equipment as above shown in Case fertilizer sprayer.

Management decision support systems

Remote sensing is just one component of a much larger integrated technology in farm machinery design. The increase in net profits from precision farming come from a combination of revenue increases from higher yields and decreased input use and their associated costs.

Global Navigation Satellite Systems (GNSS), are commonly used in agriculture for:

- crop and soil testing;
- crop yield and quality monitoring;
- remote and proximal soil and crop sensing;
- terrain modelling;
- variable-rate application of inputs;
- vehicle navigation systems - guidance and auto steering.

Many sensors and monitors already exist for in-situ and on-the-go measurement for a variety of crop, soil, landscape and environmental variables. Technological development continues to increase the range of

cropping attributes measured in real-time and at high spatial densities. Such sensors are commercially available for :

- yield and quality;
- crop reflectance for biomass, vigour and stress;
- soil apparent electrical conductivity, natural gamma radiation emission,
- reflectance and pH;
- elevation.

Discussion and conclusions

Remote sensing collect data on energy reflected from the surface of plants and soil. The physics used in remote sensing technology is very complicated. Farm operators will be dependent upon professional engineers and precision farming consultants to process the raw image data into useable information for making management decisions. There is an abundance of remote sensing technology available to measure variability in plants and soils. Also, there is a shortage of information about the causes of plant condition variability and the management solutions needed manage variability to improve crop production. The lack of knowledge needed to answer these variability questions is restricting the development of precision farming management decision support systems.

The concept of remote sensing has emerged over the past 15 years with the introduction of new electronic equipment which has allowed farmers to increase the efficiency of their operations and develop new farming practices. However, the investment in remote sensing equipment represents a significant financial outlay and as with all 'high-tech' equipment it can become superseded relatively quickly and therefore does not tend to hold its capital value. When deciding what equipment to purchase farmers need to understand the capabilities of currently available equipment as well as the likely evolution of the technology in order to 'future proof' their investment.

Most precision agriculture equipment is based around the Global Navigation Satellite System (GNSS). The United States and Russia are planning updates to their systems, while the European Union and China are planning to launch their own systems. This will significantly improve the accuracy and robustness of satellite navigation but will require new receivers to be purchased, however, the timeframe of the upgrade is around 10 years so may not influence purchasing decisions in the short term.

There is a major push from farmers and equipment manufacturers for standardisation between different remote sensing equipment and the associated data. It has led to the development of the ISOBUS 11783 standard which outlines both the hardware requirements in terms of plugs and wiring as well as the communication protocols so that equipment from different manufacturers can interact. Manufacturers are well down the path of meeting the standard with a lot of commercially available equipment already compliant. It is recommended that farmers should now look to purchase only ISOBUS compatible equipment to ensure maximum functionality into the future.

Electronic monitors and controllers have long been utilised with boom sprayers, from simple running totals to today's automatic boom section controllers. Research is being conducted into further advancing application control across the boom, driven by increasing boom widths and wider travel speeds. A lot of this work is centred on controlling the application rate and spray pattern of individual nozzles Another line of research is based around further advancing the concept of weed identification and automatic spot spraying. The systems are being developed that can identify and even differentiate plant species. This research is also closely tied to 'Micro Spray' research whereby several different systems are being developed to target and control weeds on a finer scale or individual basis. Given that an increasing proportion of cropping system is converting to minimum and no-till with the associate heavy reliance on bigger boom sprayers, it should be considered actively contributing to this major research effort.

Advances in digital technology and sensor systems over the past decade have resulted in a great deal of research and development of more intelligent agricultural vehicles capable of automation tasks with minimal operator input. The ultimate aim is to remove the human operator all together and have tasks completed autonomously. While most of the hardware and control systems are already a reality, issues of machine interaction with an essentially unpredictable environment still need to be addressed. It is generally accepted that autonomous operations will need to be conducted by a number of small machines which interact to complete a task rather that one large machine. This not only improves the safety aspects but also offers greater flexibility in terms of scalability. It should also be a part of this research effort as there are many operations in our farming systems which could greatly benefit from this technology.

Literature

[1] Barwicki J. 2011. Kontrola zasiewów polowych z przeznaczeniem na pasze z wykorzystaniem systemów satelitarnych, zdjęć lotniczych i teledetekcji. [Control of field crops using satelite systems, aerial photograps and teledetection] XVII Międzynarodowa Konferencja Naukowa, 20-22 września 2011.

[2] Barwicki J., Romaniuk W., 2011. Utilization of remote control systems for data collection from feed crops. Problemy Inżynierii Rolniczej (in press).

[3] Barwicki J. 2011, General aspects and international regulations concerning soil tillage conservation from the point of view of agricultural crop production and environment protection. Institute of Technology and Life Sciences, Falenty, pp. 7-21.

[4] Barwicki J., Gach S., Ivanovs S. 2011. Input analysis of maize harvesting and ensilaging technologies. Agronomy Research, Vol. 9, Biosystems Engineering Special Issue 1, pp 31-36, Saku, Estonia.

[5] Earl, Wheeler, Blackmore, (1997). Precision Farming - The Management of Variability, The Journal of the Institution of Agricultural Engineers, Landwards, vol. No.4 pp18-23, The journal of the Institution of Agricultural Engineers, July 16, 1997

[6] Gozdowski D., Samborski S., Sioma S. 2007. Rolnictwo precyzyjne. [Precision agriculture] SGGW, Warszawa.

[7] Ivanovs S., Barwicki J., Gach S. 2011. Evaluation of different technologies for preparing maize silage. Proceedings of 7-th International Research and Development Conference of Central and Eastern European Institutes of Agricultural Engineering (CEE AgEng), Minsk, 8-10 June 2011,

[8] The National Academy of Sciences of Belarus, pp.167-172.

[9] Kamiński E. et al 2011. Conservation tillage systems and environment protection in sustainable agriculture. Institute of Technology and Life Sciences, Falenty, pp. 86.

[10] Kamiński J. R., Kormszczikov A. 1996. New machines for work on slopes. Agriculture and Forest Engineering Review, no 6/96, pp. 18-19.

[11] Kamiński J.R. 2005. Perspektivy primenenija bortovych kompjuterov na selskochozjajstvennych traktorach. Materiały 4-tej naućno-praktićeskoj

konferencii „Ekołogija i selskochozjajstvennaja technika" S-Z NIIMER Sankt Peterburg, tom III, pp. 286-297.

[12] Kosolapov V.M., Perepravo N.I., 2011. Innovacjonnyie napravlienija razvitia semienovodstva kormovych kultur v Rossii. XVII International Scietific Conference, September 20-22 2011, Warsaw, Poland, pp.93-95.

[13] Kosolapova V.G., Bessagorova T.I., 2011. Chimiczeskije konsiervirovanije – nadieżnyj sposob sochranienija pitatielnych vieszczestv korma v nieustojczivych klimaticzeskich uslovijach. XVII International Scietific Conference, September 20-22 2011, Warsaw, Poland, pp. 85-86.

[14] Łaretkin N.A. 2011. Regionalnye aspekty razvitnja kormoproizvodstva. [Regionalne aspekty rozwoju produkcji pasz]. Mnogofunkcjonalnoe adaptivnoe kormoproizvodstvo.[Wielofunkcyjna adaptowana produkcja pasz]. Rossijskaja akademija selskochozjajstvennych nauk, Vserossijskij naućno-issledovatelskij institut kormov imeni V.R. Viljamsa. Moskva, pp. 425-435.

[15] Savinyh P., Buzikov S., (2011). Isliedovanije napravlijajuszczih lopatok vygruznovo deflektora mobilnovo podborszczika-izmielczitelia solomy iz balkov. XVII International Scietific Conference, September 20-22, 2011, Warsaw, Poland, pp. 256-260.

[16] Savinyh P., Kazakov V., (2011). Novyje technologii i masziny pluszczenija i konsiervirovanija zierna. XVII International Scietific Conference, September 20-22, 2011, Warsaw, Poland, pp. 200-205.

[17] Steward, B.L. and Tian, L.F., (1998). Real-Time Machine Vision Weed-Sensing Presented at the 1998 ASAE Annual International Meeting, July 12-16, 1998, Paper No. 983033. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659 USA.

[18] Sysuev V.A., Kovalev N.G., Kormśćikov A.D., Kurbanov R.F., Mjatin A.M., Tadipov I.T., Demśin S.Ł. 2007. Rekomendacii po ułućśeniju ługov i pastbiść v severo-vostoćnom regione evropejskoj ćasti Rossii. Ministerstvo Selskogo chozjajstva RF. Moskwa FGNY „Rosinformagrotach", pp. 116.

[19] Szeptycki A. 2006. Znaczenie techniki w systemie zrównoważonej produkcji rolnej [Importance of technology in sustainable agricultural production]. Journal of Research and Applications in Agricultural Engineering, vol. 51(2), 184.

[20] Szlachta J., Śniady R.A. 2008. Zadania inżynierii rolniczej w ekologicznym gospodarstwie rolnym [Tasks of agriculture technology for ecology farm]. Ogólnopolska Konferencja Naukowa "Ekologiczne aspekty mechanizacji rolnictwa". SGGW Warszawa, 25 czerwca 2008 r., s. 59-70.

[21] Waszkiewicz Cz. 2009. Rynek wybranych narzędzi i maszyn rolniczych do produkcji roślinnej w Polsce w latach 2001-2007 [Farm machinery market concerning plants production in Poland during 2001-2007] Problemy Inżynierii Rolniczej, nr 1(63), s. 51-56.

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A FEW IMPRESSIONS ABOUT GEODESY AND PROFESSIONAL ORGANIZATIONS OF SURVEYORS ON THE 100TH ANNIVERSARY OF THE ASSOCIATION OF POLISH SURVEYORS

KILKA IMPRESJI O GEODEZJI I ORGANIZACJACH ZAWODOWYCH GEODETÓW Z OKAZJI 100-LECIA STOWARZYSZENIA GEODETÓW POLSKICH

Summary: *The role and importance of a given field of human activity in the life of nations can be assessed from different perspectives, but in the end the most important thing is to determine to what extent the life of given society depends on this field and – as a consequence – to what extent its development paths affect the quality of life of the inhabitants. Individual parts of this activity always take a formal form, since the citizens of a given country must know and understand the rules of behavior as well as benefits and losses resulting from its application or omission. Poland built from basics during the release of captivity for many years had to establish and implement these rules on a living organism glued from three parts of the nation. Therefore, the achievements of the partitioning powers known to particular groups of inhabitants were used, but ultimately they had to set own path of development – a modern and safe path, giving all residents equal rights and setting similar tasks. In this light, the role of geodesy appears, as part of its broad definition, as a part of socio-economic life responsible for order in the description of space and for support for all activities that deal with care for this spatial order and its development.*

In the context highlighted above, Polish geodesy has such tasks as:

- *establishing the rules for the geometrical description of the elements of the economic space and attention to their correct application,*
- *geometric definition of the country's territorial division,*
- *description of the limits of ownership and the basic principles of belonging of the land to individual persons or institutions, as well as the form of its presentation and methods of sharing,*
- *determining the actual state of land use and overseeing its proper development,*
- *a geometric description of the location and shape of objects permanently associated with the area,*
- *location of designed objects in the area,*
- *assessment of the geometric state of objects related to the earth's surface and examination of changes in that state.*

Throughout the last century, the above tasks have been the concern of successive generations of surveyors. This care was institutionally implemented by appropriate offices representing administrative and self-government authorities, supported by the world of science and professional self-government associations of surveyors. Among these associations, the Association of Polish Surveyors played a special role as a continuator of the 100 years of activity of the surveyors' professional movement. This publication covers selected from the above-mentioned tasks, which, according to the author, constitute the achievements of geodesy as an area of socio-economic activity with a significant impact on the development of Poland in the period of 100 Years after regaining independence.

Key words: *history of surveying, basic map, cadastre, professional training, surveyors association*

Streszczenie: *Rolę i znaczenie danej dziedziny aktywności ludzkiej w życiu społeczeństwa można oceniać z różnych perspektyw, ale w ostateczności najważniejsze jest określenie na ile życie społeczeństwa zależy od tej dziedziny i – w konsekwencji – w jakim stopniu jej drogi rozwoju rzutują na jakość życia mieszkańców. Poszczególne działy tejże aktywności zawsze przyjmują postać sformalizowaną, gdyż obywatelom muszą być znane i zrozumiałe reguły postępowania oraz korzyści i straty wynikające z ich stosowania lub pominięcia. Polska budowana od podstaw w czasie wychodzenia z wieloletniej niewoli musiała te reguły ustanowić i wdrażać na żywym organizmie sklejonego z trzech części narodu. Korzystała zatem ze znanego poszczególnym grupom mieszkańców dorobku państw zaborczych, ale ostatecznie musiała wytyczyć własną drogę rozwoju – drogę nowoczesną i bezpieczną, dającą wszystkim mieszkańcom równe prawa i stawiającą podobne zadania. W tym świetle ukazuje się rola geodezji, w ramach jej szerokiej definicji, jako części życia społeczno-gospodarczego odpowiedzialnej za porządek w opisie przestrzeni i za wsparcie dla wszystkich aktywności, które zajmują się dbałością o tenże ład przestrzenny i jego rozwój.*

W tym kontekście, przed geodezją polską rysują się takie zadania jak:

- *ustalenie reguł opisu geometrycznego elementów przestrzeni gospodarczej i dbałość o ich poprawne stosowanie,*
- *geometryczna definicja podziału terytorialnego kraju,*
- *opis granic własności oraz podstawowych zasad przynależności gruntów do poszczególnych osób lub instytucji, a także forma jego prezentacji i sposoby udostępniania,*
- *ustalanie faktycznego stanu sposobów użytkowania gruntów i nadzór nad poprawnym jego rozwojem,*
- *geometryczny opis lokalizacji i kształtu obiektów trwale związanych z terenem,*
- *lokalizacja w terenie obiektów projektowanych,*
- *ocena stanu geometrycznego obiektów związanych z powierzchnią ziemi oraz badania zmian tegoż stanu.*

Przez cały okres minionego wieku powyższe zadania były przedmiotem troski kolejnych pokoleń geodetów. Troskę tę w sposób instytucjonalny realizowały odpowiednie urzędy reprezentujące władzę administracyjną i samorządową, wspierane przez świat nauki oraz związki samorządu zawodowego geodetów. Wśród tych związków szczególną rolę pełniło Stowarzyszenie Geodetów Polskich jako kontynuator sięgającego 100 lat działalności ruchu stowarzyszeniowego geodetów.

Niniejsza publikacja obejmuje wybrane z wymienionych wyżej zadań, które zdaniem autora stanowią o dorobku geodezji jako obszaru aktywności społeczno-gospodarczej o znaczącym wpływie na rozwój Polski w okresie 100 lat po odzyskaniu niepodległości.

Słowa kluczowe: *historia geodezji, mapa zasadnicza, kataster, kształcenie zawodowe, stowarzyszenie geodetów*

1. The role of geodesy in the life of the state

Together with the development of the life of the societies, the structure of the land management and its development becomes more and more complicated; as a consequence, a need arises to describe the mentioned structure in a precise way and to control its development on a regular basis. The specified tasks have been found in the competences of geodesy and cartography – the domain dealing traditionally with the collection, processing and making the spatial information on the Globe surface and the permanently attached objects available. To implement the discussed task in the efficient and correct way, geodesy has developed many activities, commencing from the description of the Globe's shape as a whole, and then, the methods of its management, the ways of its measuring and cartographical presentation, and finally, the methods for determination of the new objects in the site of their planned location. Each of the mentioned tasks requires the appropriate methodological approach, including the choice of the adequate measuring and computational techniques, implemented according the specified principles, with the consideration of the uncertainty management methods and service of more and more advanced collections of spatial data. The discussed methods have been developed since the most remote times, what was preserved in a form of primitive graphical artefacts (pictures made on the rocks) and in historical periods – prototypes of maps of a given territory (Mesopotamia) and traces of the division of land (state of ancient Egypt), the effects of constructional activity in ancient Greece and Roman Empire and, also, literature, illustrating the development of scientific activity, oriented to engineering and economic applications. The traces of the historical records illustrate the ideas, connected with the description of the Earth's shape, division of the agricultural land on the floodplains of the Nile river, building of irrigation systems, aqueducts, roads and constructions, becoming more and more developed in respect of size, shape and form. Together with the development of culture and organization of social life, including also its military aspects, the particular sectors of science and engineering activity were developing; they created commonly the activity, being called once surveying and specified to-day as geodesy and cartography. The presented spectrum of applications places the discussed domain of human activity among the main factors, having a direct impact on the development of the societies.

In effect of its development, the modern geodesy and cartography include the following groups of activities:

- Measuring techniques, developed with the aim to reach their automation, increase of precision and control of the quality of the measurement results;
- Computational techniques, including the calculus of coordinates, calculus of errors (uncertainty, reliability) and adjustment calculus,
- Cartographic techniques, and, in particular, large-scale cartography, adopting presently the numerical, database and ICT form.

The mentioned activities were developed in the 19th century in a form similar to the present one; nowadays, they are dynamically developing in effect of intensification of scientific and creative activity, technological development and abundant practical experience.

In the background of the discussed phenomena, the history of our Fatherland was running; it has been very complicated in the contemporary fates what was also reflected in the necessity of struggling with many problems, a lack of stabilised administrative, scientific and practical structures together with the expected abundance of their achievements, patterns of good practice and historically stabilised institutional base. In parallel, the awareness of surveyors in respect of their responsibility for the effects of land-measuring based elaborations, was increased; it was also referred to the need of joining the efforts towards integration of the professional environment in striving at the creation and improvement of the appropriate legal framework on the one hand, and supporting the betterment of professional qualifications and competences, on the other hand.

When entering the period of regaining the independence, Polish technical concept had to refer to the achievements of the past invaders and from the technological viewpoint, it was based upon the achievements of the developed countries with the stabilised, multi-annual economic development. In the present paper, the selected key aspects (in the opinion of the author) of development of Polish geodesy and cartography during the period of 100 years of the independence of our Fatherland and of our profession in the institutionally and professionally organized form such as the Association of Polish Surveyors were outlined. The important effect of the association activity, as a driving force of geodesy, on the social and economic life of Poland has been indicated.

2. Geodetic elaborations for the state and society

2.1. Geometric framework of the description of social-economic space

The basis for the implementation of the tasks, based upon the description of the space includes a definition, implementation and care of the technical state of the geometric frames, serving the mentioned purpose. The discussed frames are described as the national system of spatial references (Official Journal of Laws, No. 70, item 821); they include the following problems:

- Definition of the parameters of a solid, approximating the shape of the Earth and the implementation of these parameters in relation to the space of Poland;
- Definition of the principles of the description of vertical shaping of the Earth's surface and altitudinal location of the related objects;
- Definition and implementation of cartographic grids for all-geographic and medium and small-scale specified developments;
- Definition and implementation of the flat coordinates' systems for large-scale elaborations.

Practically, the discussed system is reflected in the set of the points of horizontal and altitudinal geodetic structure, defined in the specified projection of the Earth ellipsoid, adopted for a given country. Since the 19th century, the so-called geodetic reference system with its beginning situated at the geometric centre of the

Fig.1. Central point of the coordinates' system "Borowa Góra" in 1936 (Source: http://www.igik.edu.pl/pl/bg-rys)

selected rotary ellipsoid and local orientation in relation to the territory surface has been utilized for measuring purposes.

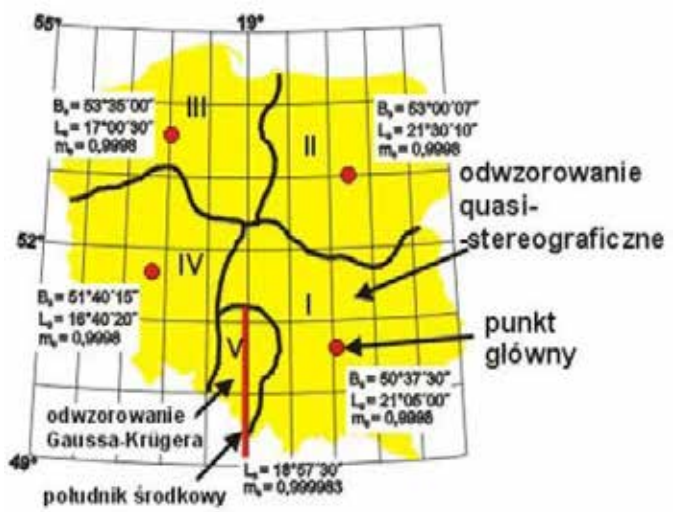
The period of the origins of the Second Republic of Poland was characterized by a considerable differentiation of definition and implementation of the reference ellipsoid models and coordinates' systems. After many years of the application of the models used by the invaders, the first Polish system "Borowa Góra" was defined with the aim to unify the existing models. It entered into force as late as in 1936. The Bessel ellipsoid with the driving point in the vicinity of Warsaw, with astronomic coordinates: Φ=52o28'32'', =21o02'12" and astronomic azimuth of direction Borowa Góra-Modlin: A=261o53'16'' was adopted a reference area [16]. The system "Borowa Góra" was utilized in creation of horizontal geodetic structures. For the structures used in civil purposes, the Gauss-Krüger projection in 5 two-degree belts was applied. Before the World War II, many local systems for the cities or industrial districts were additionally founded. Since the mentioned period, all maps, being issued during the peace as well as during the war time, contained a printing of the coordinates' grid in the "Borowa Góra" system [2].

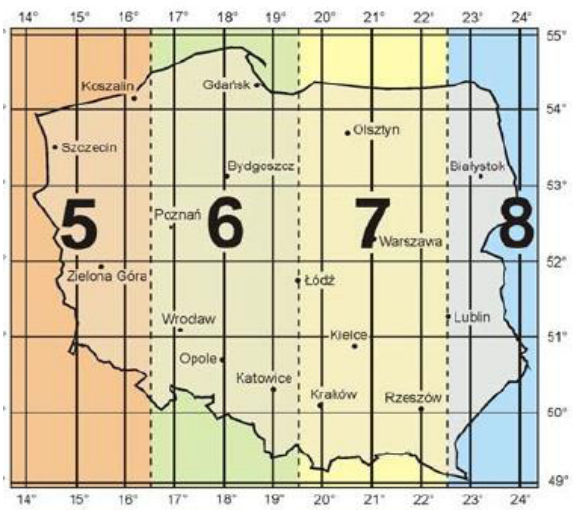
The post-war territorial changes of the country have caused the necessity of developing the map, covering a new territory of Poland. In the new situation, it was indispensable to use all Polish as well as German available geodetic-cartographic elaborations. They were adapted to the "Borowa Góra" system via transformation, with the simultaneous change of the quasi-stereographic project on Gauss-Krüger [3]. Since 1947, 3-degree mapping belts and scale factor for central meridian mo = 0.999935.

After the World War II, to unify the reference systems under the "Warsaw Pact", the system "Pułkowo 1942 was introduced in 1952 in Poland. It contained Krassowski ellipsoid and a driving point at the vicinity of the former Leningrad (presently: Sankt Petersburg). Based upon the mentioned system, three systems of flat coordinates were introduced: "1942" system (military and topographic civil maps), "1965" system (master map and derivates) and "GUGiK-80". The mentioned systems were applied until the end of the 20th century. In 6-degree projection up to 1959, the maps in scale 1:250000 and then, in the scale of 1:100000 were developed for the whole country; for the large-scale maps, the azimuth mapping "1965", with the division of the country into 4 separate mapping zones, with own system of coordinates and scale of 0.9998 in the centre of each of the mentioned systems was applied (Fig.2a). Due to a separate definition of four systems of the coordinates (and the fifth one in roller mapping), a considerable error resulted at the site of their contact what, in effect, made the transformation of coordinates to the uniform reference system very difficult.

Finally, three-degree Gauss-Krüger (roller transverse) projection of ellipsoid GRS80, with the consideration of scale factor 0.999923 in axial meridian and on the edges of mapping belts was adopted as the basis for flat coordinate systems. The x coordinates are counted from equator and y coordinates - from axial meridian, for which value of 500 000.00 m preceded by the number of belt is adopted; it is equal to value of axial meridian, being divided by 3.

Fig. 2. Post-war systems of coordinates, adopted for the needs of terrestrial measurements and large scale maps: a) "1965", b) "2000" (Source: https: //geoforum.pl/gis/odwzorowania)





For the needs of elaborating the large scale topographic maps, the same projection of ellipsoid GRS80 was adopted but in one belt covering the territory of the whole country, with the axial meridian 19o and scale 0.9993. The x coordinates are decreased by 5 300 000.00 m and y coordinates are not preceded by the number of belt.

The current obligatory state systems of coordinates in Poland are defined similarly as in many other countries. WGS84 is the system adopted as uniform for the whole Globe, mainly due to its application in navigation, including satellite navigation and that one in the military maps of the NATO. It is a geocentric system, based on ellipsoid GRS80. It describes the location, using geographic geodetic latitude and longitude and in gradian recording DDoMM'SS" or decimal DD.ddddo with suffix S, N, W, depending on the direction of angle measurement.

The grids of geodetic structures are physical representation of the specified systems of the coordinates. At the end of the 20th century, Polish reference grid was integrated with the European ETRF (eng. European Terrestrial Reference System), implementing the European Reference System ETRS89, modified at the breakdown of the centuries to the form ETRS2000 [https://geoforum.ol/geodezja/systemy-uklady]. The systems of altitude were also subjected to evolution of their definition. Being inherited after the invaders, the systems of normal altitudes (relating to gravitation) were referred to three points of measurement of the sea level – mareographs (sea-level recorders) in Amsterdam (German annexation), Trieste (Austrian annexation) and Kronshtadt (Russian). Due to the fact of remaining of Poland in the Russian influence zone after the World War II, there was adopted the common system specified as Kornstadt60 (dating back to 1960, after necessary measurement and integration with the pre-war systems). The discussed system was subjected to updating and modifications, reaching finally a form, defined as Kronszadt60. Poland inherited, from the German invader, many documents, connected with the construction of railway and urban infrastructure, the ordinates of which were measured in Amsterdam system. Due to this fact, to preserve the continuity and uniformity of the data, the railway sector preserved the mentioned altitude system. Similarly, numerous maps of the cities in the Western Poland still have the ordinates recorded in the old Amsterdam system.

In 2007, the system of normal altitudes EVRS, referring to the reference level NAP in Amsterdam (nederl. Normaal Amserdams Peil) was introduced in Poland as being uniform in the whole European Union. It constitutes mathematical and physical basis for the implementation of altitude systems which are, in Poland, marked with symbols PL-KRON86-NH and PL-EVRF2007-NH. The date of December, 31, 2019 was indicated as the term of changing the binding system of normal altitudes into PL-EVRF2007-NH [https://www.gugik.gov.pl/].

2.2. The records of the state of property and space management

Practical aspect of geodesy in the economy is visible, first of all, in connection with the turnover of the land and implementation of investment assumptions and, in particular:

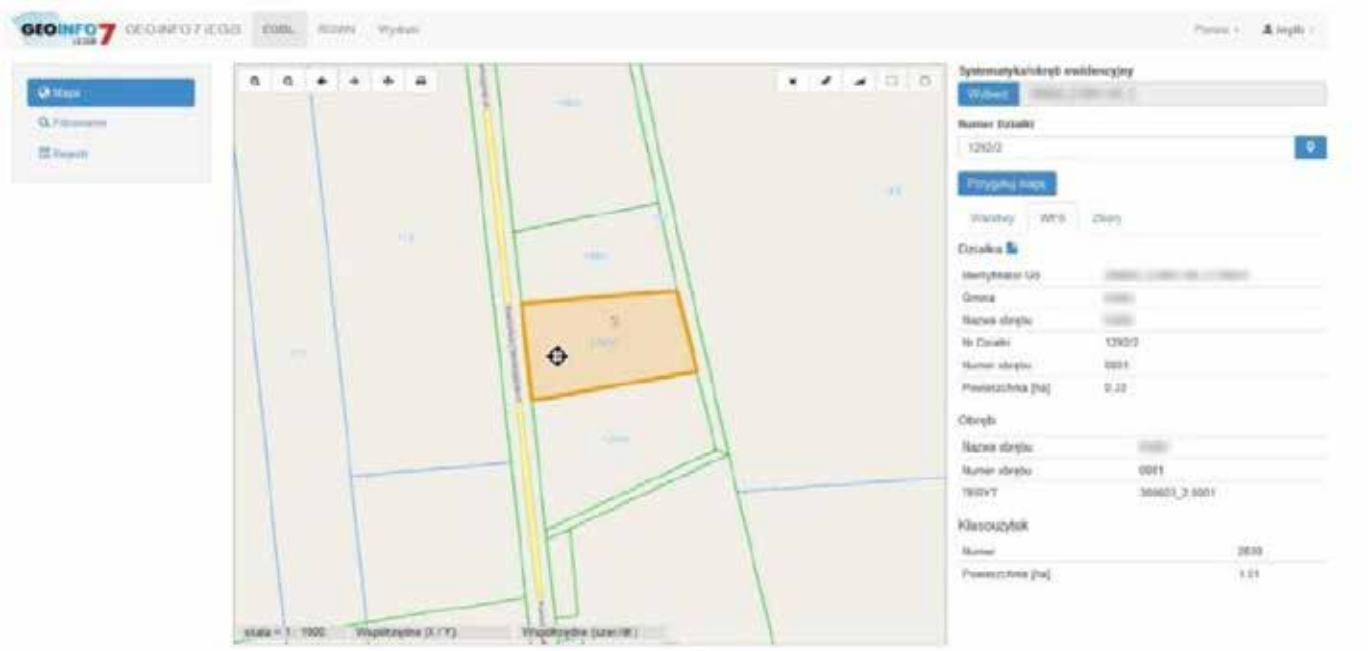
- The sale and purchase of land, and also the problems of property right succession;
- Individual investments oriented mainly to the improvement of life quality but also, intended for developmental purposes;
- Public investments, in particular – ensuring the appropriate conditions of transport, energy, gas and water supply and sewage disposal.

The basis for the implementation of the mentioned above goals provides the universal access to the existing spatial information resources, and individual one – to the resources being protected due to the personal data protection. The mentioned resources are collected for the needs of the inhabitants in the organizational units of the district authorities (in Polish: starostwo powiatowe), dedicated to geodesy. They include two categories of geodetic-cartographic data: registers of records of land, buildings and premises and a master map. The records of the land – EGiB – contain information on the land property, the methods of the territory utilization and on the buildings, with the eventual indication of the premises, possessing a separate owner. It is conducted in two blocs, being defined as a graphical part (cadastral map) and a descriptive part (collection of non-cartographic data). The master map collects the data, obtained on the grounds of the direct measurement and illustrating in detail the distribution of the objects permanently connected with the surface of the earth. Together with the development of computerization, the discussed resources are successively transformed from analogue form into numerical one, being accessible via ICT systems.

The recording of the land and buildings dates back to the Austrian and German cadastres which, gradually with the time, were subjected to evolution based upon the experience of other European countries. In Poland, the land cadastre was founded immediately after the first annexation on the territories, occupied by the Austrians and later on, in the first part of the 19th century – on the territories, occupied by the Germans [4]. On the territories of the Russian annexation in the years 1865 – 1900, the recording of the land in the area of Zamojski family estate (in Polish: Ordynacja) was locally established. It followed the geodetic principles of the Austrian cadastre. It is difficult to speak about any cadastre on the remaining territories of the former Russian annexation.

After the end of the World War I, Poland introduced the acts, based upon the rules of the former invaders in respect of the land tax and cadastre. The Act on the land classification for the needs of land tax (the so-called treasury act) was the basis for the organization of uniform land cadastre. Due to the outbreak of the Second World War, as early as in 1945, the Act on the state geodetic and cartographic service was published; in 1947, there was published the decree on the land and building cadastre which introduced the uniform land cadastre at the territory of the whole country, with the utilization of the so-far existing materials, including also cadastre documents coming from the former annexation. The final shape of the land cadastre in Poland was formulated in 1955 in the decree on the recording of land and buildings and in the executor regulations. The successive step towards the unification of the land cadastre occurred by means of the Act published in 1989: Geodetic and Cartographic Law (Official Journal of Laws, 1989, No. 30, item 163) and the published Regulation (1996) on the recording of land and buildings. In the successive issues, the mentioned regulation leads to computerization of the records and the improvement of functioning

Fig. 3. The example of map with the selected plot and record of the collected data in ICT system (Source: Podręcznik-użytkownika-aplikacji-GEO-INFO-o.EGiB_.pdf)



of the management systems. In February 28, 2019, as a result of numerous amendments of the Act – Geodetic and Cartographic Law and the executor regulations, the consolidated text with the newest version of the regulation of the records of the land and buildings was published (Official Journal of Laws 2019, item 393).

At present, at the end of 2019, the obligatory records of the land and buildings cover the data, describing as follows:

- The location, borders and area of the real estate and the occurring therein types of land and soil classes, and also, land and mortgage register designations, or the corresponding sets of documents;
- The location, destination, utility functions and general technical data of buildings;
- The location, function and utility area of the premises.

It contains also the subjective information on the owner or other natural or legal persons which manage the land or buildings or their parts and, also, on cadastral value of the property, or eventual enrolling of the said buildings to the register of historical relics. It also specifies whether or to what degree the distinguished area of land is covered with a natural environment protection.

The current records of land are run by the appropriate authorities in a form, being uniform for the whole country. It has a form of ICT system, ensuring the collection, updating, and making accessible the data covered with the tasks of EGiB (Records of Land and Buildings) system (Fig. 3).

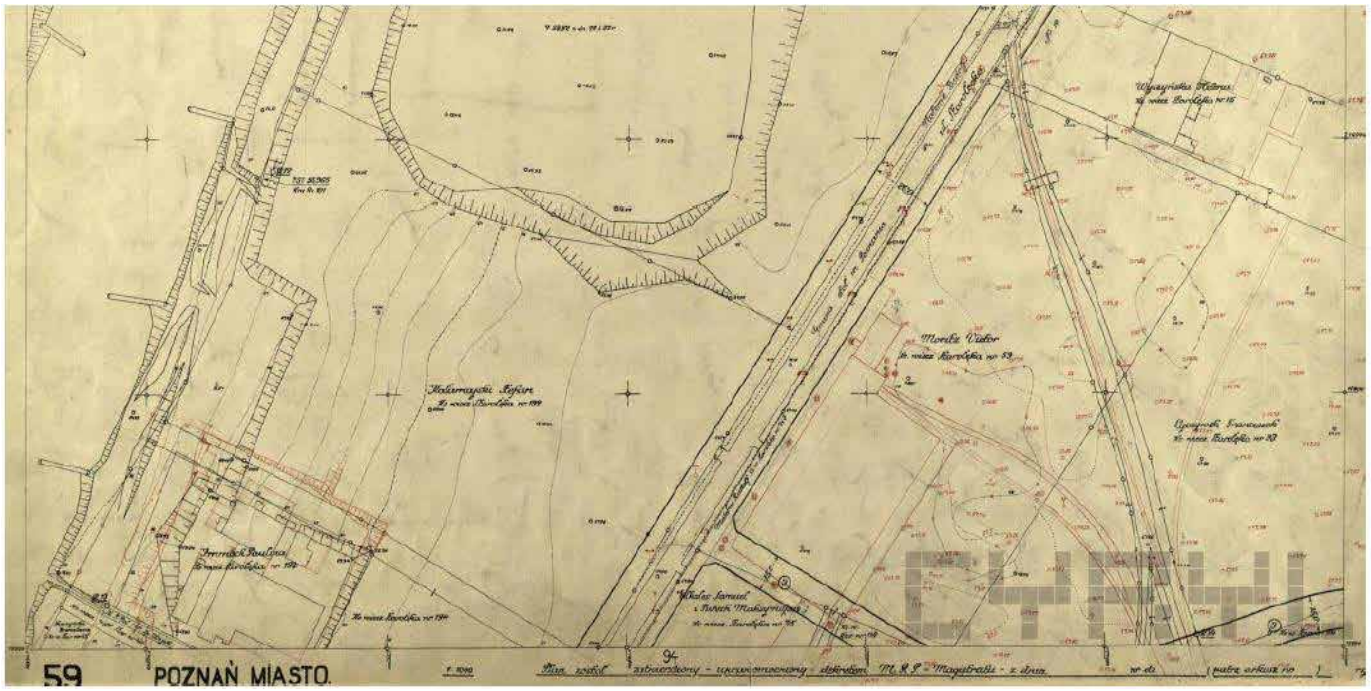
It is estimated that the records cover at least 30 million plots and the same number of buildings. Since a certain time, the attempts have been undertaken with the aim to transform the records into the cadastre of the real estate which would combine the information on the property and the records collected in the Real Estate Registers and tax records (the property tax).

The Integrated System of Information on Real Estates, ZSIN, is now being created on the national level. There will be created a central repository of the copies of district data collections of land and buildings' records. ZSIN will ensure the data exchange in a form of e-documents between EGiB and other public registers such as EKW (Land and Mortgage Registers), PRG (Register of Borders), TERYT, REGOn and KSEP. The task of ZSIN system will include also the mediation in sending notifications on the data changes, performed in the particular public registers, having the importance for other public registers (Source: https://gugik.gov.pl/projekty/zsin-faza-i/dane-egib,dost.1.07.2019) .

2.3. Master map

Before the World War II, the uniform large scale maps were not performed. Since the beginning of the 20th century, the cadastral maps were developed, mainly at the territory of Prussian (scales 1:4200 and 1:2100) and Austrian (scales 1:2880 and 1:1440) annexation. They contained the context similar to the present cadastral maps. More detailed maps were created unitarily in the cities. The examples include the scanned maps of the fragments of Poznań, dating back to the thirties of the 20th century, available at the website cyryl.poznan.pl. (Fig. 4). On the grounds of these maps, 50 copies were developed and successively updated and supplemented with the new data. The discussed plans – due to their destination – were performed with the unusual precision; the division into plots was marked and the names of their owners as well as the numbers of land and mortgage register, confirming the said property, the streets, parks, cemeteries, buildings of public service and many other objects were carefully drawn (cyryl.poznan.pl). In connection

Fig.4. The pre-war large-scale map of a fragment of Poznań, dating back to the years 1930-36 (Source: cyryl.poznan.pl/kolekcja/311/plany-dzielnic-poznania-1932-1950-archiwum-panstwowe-w-poznaniu)



with the planned big investments, similar maps were incidentally developed in Cracow (dawnemapykrakowa.pl) and in other cities.

The master map in a form similar to the contemporary one was kept in the 1970s based upon the regulations, contained in the technical instruction of GUGiK (The Head Office of Geodesy and Cartography) [5]. The map was performed in a paper version in four basic scales: 1:500, 1:1000, 1:2000 and 1:5000, being chosen according to the current and anticipated degree of the investment in a given territory (Instruction K1, 1979). In the intensively invested areas, with a big number of underground facilities, the scale 1:250 was employed. The selection of the size of the map sheet, based on the ISO A1 format, (practically 50 x 80 cm in a frame) resulted in the introduction of division into sections and of emblems, facilitating the location of the defined fragments of the territory (section).

Together with the development of reproduction techniques, the paper map was replaced by underlay made from transparent, matted film. To increase the readability and make the choice of the text of the map's copy easier, the details were divided into subject layers – situational (S), land records (E), territory infrastructure (U) and altitude (W). The primary map (P) on aluminium foil glued with the paper (the so-called boards) was the basis for the development of situational content. Additionally, the overlay of the structure was kept (O) and in certain district or urban Centres of Geodetic and Cartographic Documentation, there was a cover of the project arrangements (R). To avoid the repetition of the content, a part of a given object was outlined on one overlay and the remaining part was found on the other one. The register overlay contained only the labels of the plots or buildings; their contours were found on the situational lap. Similarly, the U overlay contained the pipelines together with the description and wells whereas the covers and manholes were outlines on S lap. For the reproduction purposes (cyanotype, later on, xerographic technique), depending on the need, the selected foils were overlapped.

The results of the elaboration of the direct field measurements were the main data source for creation of the master map. Due to this reason, the master map became a cartographic source elaboration, utilized later for performance of derivate maps. To preserve the map in the current status, the new text was charted on the existing section laps (foils), removing (by gilette) the objects which were subjected to demolition or transformation.

The map was performed in the continuous manner for the whole territory of the country, with the division into the areas, corresponding to the territorial competences of the geodetic and cartographic documentation centres – ODGiK (earlier "map storage places").

Together with the development of information technology, mainly of graphical software of personal computers, the map became to be developed in a numerical form, preserving the main principles of its creation; it was reflected in the successive version of Instruction K-1 and then, the regulations establishing the problems of the master map (Official Journal of Laws, 2015, item 2028). Finally, the map is created as a computer visualization of the content of few databases, corresponding – in respect of its content range – to the traditional overlaps of the map. The bases are kept by the district or urban ODGiK, mainly based on the direct field measurements, carried out by the surveyors within the frames of services for the society. Some contents of district bases are collected in the central resources. Due to computerization of geodetic and cartographic resources and of the units responsible for their keeping, making the cartographic data available and service of surveyors performing the updating of the resources are nowadays conducted in a form of computer

services (geo-portals); owing to this fact, the effectiveness of the service of the growing demand on geodetic-cartographic data has been improved. The quality of the performed elaboration has been also risen up.

3. The selected areas of the surveyors' activity

3.1. Geodetic and cartographic service

Since the beginnings of geodesy, its performers included royal or princely officials, later on, the state clerks, nominated to their post by the highest authorities of the state. During the period of annexation, the appropriate offices of Prussia, Austria and Russia carried out the mentioned activity. They published also the respective executor regulations and supervised their respecting by the performers of geodetic and cartographic work. In effect, after regaining the desired independence, the differentiated systems of measurements, measurement units and maps existed in different parts of the country; the performers of the measurement work had different titles which were obtained based upon different criteria. As late as in 1925, the resolved Act established a title of a sworn surveyor and determined the conditions to be met by a candidate to this title. The sworn surveyor's task was to implement the measurement work, reserved for the state service. He used also the official stamp. During the inter-war period, the unification of the measuring regulations had place; 5.5 million ha of land were integrated. However, one office, coordinating permanently the work of the surveyor did not exist. It should be noted that since 1919 until the 1930s, the self-governing environments of geodesists from different centres (mainly Lvov and Warsaw) undertook the initiatives that obliged the governing authorities to establish one such centre. In effect, the pre-war geodesy implemented its work in a certain degree of disorganization, what increased the costs and limited the range of the implemented work and later on, has brought the confusion, together with the unfavourable consequences until the contemporary times.

The first central office, coordinating the work of surveyors - the Head Office of the Country Measurements (GUPK) was established in 1945. GUPK undertook the tasks connected with the reconstruction of the country after the war destructions; it also commenced the creation of the uniform economic map of Poland. Gradually with the time, geodesy was found in three departments; principally, the matters of geodesy were taken by the Central Office of Geodesy and Cartography; however, the agricultural geodesy was subordinate to the Ministry of Agriculture, and the urban problems were located at the Ministry of Municipal Economy. The changes in the site of placing the geodesy and cartography in various governmental offices are continued. It refers also to the centre of geodesy management i.e. the Head Office of Geodesy and Cartography – GUGiK.

At present, Geodetic and Cartographic Service (Polish SGiK, Fig.5) consists of the organs of geodetic and cartographic supervision, i.e. the Chief Geodesist of the Country (GGK) and Voivodes, and of the geodetic and cartographic administration organs: marshals of the voivodeships and starosts (head of district). The Chief Geodesist of the Country is subjected to the minister specific of the administration, construction, planning or housing matters; GGK implements its tasks via GUGiK. The district or urban Centres of Geodetic and Cartographic Documentation Centres (PODGiK, MODGiK) play a function of direct performers of the services in respect of obtaining, processing and making the state geodetic and cartographic resources (PZGiK) available. They perform the following tasks of the head of the district:

- Keeping the district geodetic and cartographic resources, including the land and building register, soil science classification of agricultural land and geodetic records of the net of infrastructure of a given territory;
- Coordination of the position of the planned grids of the infrastructure of a given territory;
- Establishment of detailed structures;
- Running the common taxation of real estate and development and keeping the taxation maps and tables concerning a given property;
- Protection of geodetic, gravimetric and magnetic sings;
- Generation, running and making databases of land and building records available (cadastre of real property), geodetic records of the grid of a territory infrastructure, register of the prices and values of the real estates, detailed geodetic structures, topographic objects with the accuracy, ensuring the generation of standard cartographic elaborations in scale: 1:500 – 1:5000;
- Generation, running and making the standard cartographic elaborations available (i.e. master map and cadastre maps) on the ground of the data contained in the databases.

The units of geodetic administration in the structure of self-governing territorial organ, headed by the Voivodeship Geodesist in the Marshall Office, have a separate range of duties.

Fig.5. Structure of geodetic and cartographic service in Poland (own elaboration on the grounds of pl.wikipedia.org/wiki/Główny_Geodeta_Kraju)

3.2. Geodetic work for the society

Geodesists are employed in the field work in order to perform the maps for the design purposes and as-built object surveys as well as in all geodetic work connected with the formal legal operations on the land and service of the intended investments. Owing to such meticulous work, the national geodetic and cartographic resources

(PZGiK) are updated every day. The geodesists implement their work in accordance with the guidelines contained in the regulation on technical standards for performing the geodetic situational and altitudinal measurements (Official Journal of Laws 2011, No. 263, item 1572). Owing to this fact, the effects of the discussed work are immediately ready to supply the resources with the accurate and reliable data. When considering the problem from the historical viewpoint, since the period of regaining the independence until nationalization of geodetic work in the 1950s, similar activity was performed by the offices of the Sworn Surveyors (mainly in the respect of cadastre) and then, by the state and urban surveying enterprises. After introduction of the system changes in the 1990s, the mentioned tasks were undertaken mainly by the independent contractors and private geodetic companies.

Together with the development of measuring techniques, mainly GNSS (Global Navigation Satellite Systems), the methods of performing the measurements have been radically changed; it accelerated and improved the quality of geodetic and cartographic elaborations. The development occurred also in other measuring techniques, first of all, in photogrammetry and teledetection. The modern photogrammetry enables performance of spatial elaborations based upon the high-resolution digital photos made from the board of airplanes and drones, and also, from the ground stands, cars, trail or aquatic vehicles. Owing to the elaboration of the discussed image data, the models of a given territory's coverage as well as many of spatial objects, mainly of buildings, are created. They are supported by laser 3D developments as well as by large-scale satellite images. In effect, we obtain different teledetection elaborations, which become the subject of interest apart the official national resources. A wide spectrum of the said elaborations opens the door to many new initiatives which may positively affect the economic and social development of our Fatherland.

It seems that the attempts of Polish geodesy to exceed the borders of Poland, to appear in the world – what would become a source of export incomes – are still too weak. The effective attempt in this respect was undertaken in the years 1970 – 90 via the foreign trade company POLSERVICE and Geokart enterprise. The geodetic work was carried out in Iraq, Libya and Kuwait, and also, in Turkey, Tanzania and Greece and, to a smaller degree, in Czechoslovakia, German Democratic Republic and the Soviet Union (geoforum.pl/geodezja/historia). The mentioned work was continued in the 1990s by enterprises PPGK and WPG from Warsaw and OPGK from Cracow and Bydgoszcz and after bankruptcy of the state geodetic performance, by private companies. We should mention here Geoservex from Bydgoszcz, implementing its work in many countries, including India and Pakistan and the American continent.

Fig.6. Diagnostic measurements at the object in India (Source: http://www.geoservex-india.com)

3.3. Vocational education and science

The beginnings of the contemporary vocational geodetic education date back to the period of the First World War. As early as in the mentioned period, two-level structure of educating the surveyors was planned: higher education (engineering) and secondary (technical) education. Warsaw University of Technology (PW) was the first higher education school which introduced the Courses of Surveyors in 1916. Their task was to prepare professionally the performers of geodetic work for the needs of big tasks at the beginning of the Second Republic of Poland (the inter-war Poland). In November 1917, the Surveying School began its activity; later on 3-year national Surveying School (www.zs14.pl) was established. In 1919, the secondary Surveying Schools were opened in Lublin and Łomża; in 1922, similar school began their activity in Cracow, Kovel, Poznań and Vilnius. Earlier, in the school year 1917/1918, the surveying departments were created in building vocational schools (www.zsgd.poznan.pl).

Rich academic traditions in respect of teaching of the geodesy were developed since the pre-war period by the Lvov Polytechnic School, renamed into Technical University of Lvov in 1920. During the inter-war period, three faculties were joined into the Surveying Department [6] headed by the well-deserved professors – Lucjan Grabowski (1871-1941) or Kasper Weigl (1880-1941). In the autumn of 1921, the Faculty of Surveying was established at the Warsaw University of Technology; owing to the attempts of Professor Edward Warchałowski (1885-1953), it was later renamed into Geodetic Faculty in 1925. During the World War II, many meritorious professors and teachers died in the battles or due to the destructive activity of the invaders – Nazi Germany and communistic Russia. After the Second World War, the initiatives were undertaken with the aim to educate vocationally the geodesists; the secondary geodetic schools were established or reactivated. As early as in 1945, the Surveying Department was established at the National Building School in Jarosław (www.spg.rzeszów). The same situation occurred in some other cities. In Rzeszów, the post-secondary technical school, with direction: geodesy and cartography was brought to life. It was a precursor of Geodesy Technical School. In April 1945, the National Road Vocational Secondary School commenced its activity; it was included into the National Construction School in 1951. Finally, in 1960, the Geodetic-Road Secondary Vocational School (In Polish: Technikum) was established; at present, it is the Complex of Geodetic-Road Schools (www.zsgd.poznan.pl). The fates of vocational secondary technical schools in Bydgoszcz, Bialystok, Cracow, Łódź, Wroclaw and other cities were similar. Nowadays,

Fig.7. The main building of Warsaw University of Technology in 1975, the site of the Faculty of Geodesy and Cartography (Source: warszawa.fotopolska.eu/310159.foto.html)

the directions of geodetic education in numerous state and private upper-secondary schools and since the school year 2019/2020, in lyceums and secondary vocational school, have become more and more popular.

During the World War II, teaching at Warsaw University of Technology functioned on the principle of the underground education and in January 1946, it commenced a normal activity. It was the only one Faculty of geodesy after the war. In 1954, the Faculty was renamed into Faculty of Geodesy and Cartography (www.gik.edu.pl). At AGH University of Science and Technology, the independent Faculty of Mining Geodesy was established as late as in October 1951. In 1960, the geodetic studies were opened in Olsztyn. At the present moment, there are 20 units offering education in geodetic specialties; the traditional Geodetic Faculties at Warsaw University of Technology (Fig.7), AGH University of Science and Technology, University of Warmia and Mazury in Olsztyn and other later established directions of the studies at polytechnic schools (Gdańsk, Koszalin, Wrocław...etc) and Universities of Life Sciences (Cracow, Wrocław) enjoy an established reputation.

Polish geodesy has also its place in the international scientific environment. During the pre-war period, the professors involved in the organization of geodetic faculties at higher education schools, deriving mainly from Warsaw environment, were very active in the field of science. The first scientific papers and monographs were published as early as before 1920 by the future founder and the Dean of the Geodesy Faculty, and later on the Rector of Warsaw University of Technology – Prof. Edward Warchałowski. The geodesist and astronomer, Prof. Felicjan Kępiński (1885 – 1966) published numerous papers in the field of sky mechanics. The publication legacy of Prof. Kępiński in the inter-war period, amounts to more than 100 bibliographic items which brought him the recognition of the international astronomic environment. Despite of playing many important functions at the University of Technology and in the Chief Office of the Country Measurements, Professor Warchałowski participated actively in the domain of his profession and in the numerous international scientific conferences until the end of his life. The place of the mentioned Professors was later occupied by their successors and pupils. We should mention here the following names of the professors from Warsaw: Stefan Hausbrandt (1896-1971), Felicjan Piątkowski (1908-2004), Jan Różycki (1909-2005), Czesław Kamela (1910-1992), Tadeusz Lazzarini (1913-1986) or Zdzisław Adamczewski (1931-2018). The other national scientific centres may also be proud of their worthy representatives such as Michał Odlanicki-Poczobutt (1910-2004) from Cracow, Lubomir W. Baran (1935-2004) from Olsztyn or Roman Hlibowicki (1911 – 1999) from Wrocław. Many persons living abroad found also recognition in the field of science and higher education: in Canada - Prof. Teodor J. Błachut, a graduate of Lvov Polytechnic School, specialist in photogrammetry, the member of the National Council of Canada and Polish Academy of Sciences. Dr Jerzy M. Zarzycki, Engineer, graduate of Warsaw University of Technology followed his way. In Canada, the married pair of professors, Adam and Maria Chrzanowski, the post-war graduates of AGH University of science and technology enjoy a high appreciation; they are the recognized professors of the New Brunswick University. In respect of supporting the decision with the geo-information methods in the USA, Professors Jacek Malczewski and Piotr Jankowski, originating from Poznań, occupy a meaningful position. In Europe, Prof. Jerzy Gaździcki, the pioneer of geodetic information science in Poland and in the Netherlands has attained a significant position (Delft University). All the mentioned persons and places are the examples of abundant, recognized activity of Polish science.

At the present time, most of the scientific studies are implemented in Polish universities and scientific-research centres, mainly in IGiK, Cosmic Centre and recently, also in ASG system. Within the frames of the international organization of geodesists (FIG, Fédération Internationale des Géometres), specialists in photogrammetry (ISPRS, the International Society for Photogrammetry and Remote Sensing) and cartographers (ICA/ACI, International Cartographic Association), Polish authors have delivered many lectures and published the results of their studies during numerous conferences and symposia. It is not appropriate to mention any name as not to decrease the achievement of the remaining persons. The most of the discussed specialists were linked with the Association of Polish Surveyors and participated actively in its foundation, or represented the organization abroad. A group of successors follows their activity.

3.4. The Association activity

The support for the commercial activity for the particular sectors can be found in the professional organizations. In the case of geodesy, the Association of Polish Surveyors refers to the oldest roots of origin. Its beginnings reach to the first all-national Congress of the Surveyors in 1919, in consequence of which the seeds of the structure of the association movement were created in a form of the Circle of Engineers – Surveyors at the Association of Technicians in Warsaw. But first of all, the mentioned Congress was involved in the establishment of the organizational background of the Second Republic of Poland via drafting the memorial on establishment of the "Chief Surveying Office". Finally, in 1919, the self-governing organization of the surveyors participated actively in development of

the questionnaire on the organization of the state surveying system. The successive Congresses of the Surveyors' Delegates were held in Warsaw in 1921 (2nd Congress) and in 1923 (3rd Congress) and in the successive years. In effect, the new postulates were, inter alia, developed as regard organization of geodesy in Poland. The associations of the surveyors were founded not only in the Capital city of Warsaw but also in Poznań (Association of Cadastral Officials of the Western Territories of the Republic of Poland, since 1921), in Katowice (the Association of Mining Surveyor, since 1922) and in other cities, associating the higher and higher numbers of geodesists connected with the specificity of their specialization. In 1924, the first number of monthly "Surveyor Review" was published; for many years, it had been the only one periodical, dedicated totally to the geodesy problems. The "Geodetic Review" is now its continuation.

In 1926, Polish Unions of Surveyors made the accession to the International Federation of Surveyors (FIG). In Poland, the meetings of the Standing FIG Committee was organized three times: in 1932 in Warsaw, in 1959 in Cracow and in 1985 in Katowice. In May 1975, the meeting of the Commission 7 of FIG - "Cadastre and Agricultural Equipment" had place. The General Assembly of FIG was expected to be held in 1942; however, the World War II dramatically destroyed the plans. The War brought also about to the death of more than 1200 surveyors, many of them being involved in the association movement.

After the Second World War, the construction of a new society was commenced. As early as in 1945, the Union of the Surveyors of the Republic of Poland resumed its activity; after liquidation of the institution of the Sworn Surveyor, the mentioned above organization was transformed into the Scientific-Technical Association of Polish Surveyors, in abbreviation SGP. During its successive Congresses, SGP has updated its opinion in the matter of the national geodesy and, also, has initiated many activities connected with the profession of geodesist. In spite of the later removal of the definition "Scientific-Technical" from its name, the matters of science and development of geodesy and a new generation of geodesists remain still one of the main concerns and spheres of activity of the Association. Despite the formation of many competitive professional groups, the Association remains the main driving force of development and integration of geodesists; it is also the organizer of numerous scientific, organization and social meetings. The Celebration of the Jubilee of the 100th anniversary of SGP was a solemn form of summing up the mentioned above activity (Fig. 8). The ceremony was held in the historical building of Polish Federation of Engineering Associations NOT in Warsaw, on 25-26 January 2019.

4. Summing up and conclusions

A difficult history of our nation received a new, promising image after regaining the independence 100 years ago. The time of building the nationality and then, laborious undertaking of many challenges aimed at reaching a life standard similar to that one in other European countries is approaching slowly the desired target. There were the periods of ups and downs, sometimes very dramatic ones such as the Second World War, or the complicated situations such as dependence on Moscow and the imposed attempts to build the socialist economy and, finally, a difficult process of integration with the European Union with its sometimes unclear standards but with the enormous potential. The mentioned fates had a big impact on human life, obtaining and loosing of various forms of property, obtaining and loosing of the subjectivity by many social groups. Finally, it also affected the laborious gaining and sometimes, a

Fig. 8. Extraordinary Congress of SGP Delegates during the celebration of the Jubilee of the 100th anniversary of SGP, Warsaw, 25-26 January 2019

dramatic decline of the economic foundations. All these phenomena were accompanied by geodesy, being called "surveying" for a long time, and at present – geodesy and cartography.

We have undertaken the attempts to shape the profession of geodesist and the related structures, we have modified and updated the difficult problems of cadastre, we have outlined the geometric frames of the Globe surface description, we have founded and we are enthusiastically implementing the idea of the common, all-national large-scale economic map of Poland; we outline and perform a stocktaking of the new intended investments and we are involved everywhere where the issues of field measurements can help in the solution of the spatial problems. Introduction of the modern system of spatial references, integrated with the systems of the other European countries and implemented in a form of Active Geodetic Net (ASG), supporting the measurements with modern satellite techniques GNSS are the consequence of the discussed efforts. Cartography and spatial management, and first of all, cadastre, are based upon the carefully updated database systems owing to everyday involvement of many groups of geodesists. The national systems of photogrammetric and scanning (LiDAR) illustrations are created and the 3D developments of the building models are implemented. For the needs of the implementation of the mentioned tasks, the geodesists are equipped in better and better instruments and measuring and computational technologies.

For 100 years, the whole discussed process has been actively participated by the professional organizations of geodesists, which – under various names and recently as the Association of Polish Geodesists – have undertaken many initiatives; they included building of efficient organizational structures of the national geodesy as well as integration and professional organization of geodesists but first of all, the attempts to make geodesy and cartography useful for the society. Numerous vocational and associative relations with geodesists of other countries were initiated, many trainings, conferences and scientific symposia are organized, professional press is published and didactic publications are issued. The geodesists employed in higher education system implement and publish numerous scientific papers at the national as well as international level.

Is everything OK? No. The relations between the administration and practical performance are not satisfactory, the secondary education – after the period of liquidating the secondary vocational schools – is deprived of the teachers-specialists and has the deficits in equipment of laboratories; the greater technological deficits are however found in higher education schools. Science is underfinanced and at present, a discipline of geodesy and cartography has completely disappeared as an independent unit.

However, the period of 100 years of active participation of geodesy in the social life of Poland has strengthened the profession of geodesist as one of the main pillars of the social and national development. The Association of Polish Geodesists has been a meaningful binding element and a driving force of many undertaken initiatives.

Acknowledgments

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Literature

In the publication, the reference were made to the selected legal acts, indicated the text, and to the information available at the websites of GEIFORUM (geoforum.pl), GUGiK (gugik.gov.pl) and in Wikipedia (pl.wikipedia.org), and also, in the e-elaborations, issued on the occasion of the 100th anniversary of SGP, Warsaw, 2019. Besides it, the references were made to the following bibliographic items:

[1] Biernacki F., Słomczyński J., 1932: Odwzorowanie quasistereograficzne Wojskowego Instytutu Geograficznego, WIG, Warszawa

[2] IGiK, 2004: Nowe obowiązujące niebieskie i ziemskie systemy i układy odniesienia oraz ich wzajemne relacje, Seria monograficzna nr 10 pod redakcją J. Kryńskiego, IGiK, Warszawa

[3] Cisak M., Sas A., 2004: Transformacja współrzędnych punktów z układu „Borowa Góra" do układu „1942", Prace IGiK, Warszawa

[4] Mika M., 2010: Historia katastru polskiego. Infrastruktura i Ekologia Terenów Wiejskich, 6/2010, 75-85

[5] Izdebski W. 2005: Wykorzystanie zasobów PODGIK i technologii internetowej w tworzeniu lokalnych systemów informacji przestrzennej. I Ogólnopolska Konferencja Naukowo-Techniczna, Polańczyk 28-30 września 2005.

[6] Jerzy Krawczyk: Lwowska szkoła geodezyjna. Warszawa: Zespół Historii Geodezji PAN, SGP, 1991, s. 1-16.

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HISTORICAL OUTLINE OF THE CRACOW DEPARTMENT OF THE ASSOCIATION OF POLISH ELECTRICAL ENGINEERS (SEP)

RYS HISTORYCZNY ODDZIAŁU KRAKOWSKIEGO STOWARZYSZENIA ELEKTRYKÓW POLSKICH

Summary: *In this paper, the anniversary of 100 years of the history of the Cracow Department of SEP was summarized. The activity of Cracow electrical engineers in the period preceding the Foundation Congress held in June 1919 was recollected. The most important events from the history of the Department were discussed and the profiles of the persons whose activity had contributed to the present high position of the Cracow Department of SEP were mentioned.*

Keywords: *Electrotechnical section KTT, Circle and Department of Cracow SEP, Conventions in Cracow, major achievements of Cracow Department of SEP*

Streszczenie: *W artykule podsumowano 100 lat historii Oddziału Krakowskiego SEP. Przypomniano działalność elektryków krakowskich w okresie poprzedzającym Zjazd Założycielski odbyty w czerwcu 1919r. Omówiono najważniejsze wydarzenia z historii Oddziału oraz wspomniano sylwetki ludzi, których działalność przyczyniła się do aktualnej wysokiej pozycji O/Kr SEP.*

Słowa kluczowe: *Sekcja Elektrotechniczna KTT, Koło i Oddział Krakowski SEP, Zjazdy SEP w Krakowie, Ważniejsze osiągnięcia O/Kr SEP*

The beginnings of the activity of Cracow electrical engineers

Around 1904, the Cracow electricians joined the activity of Cracow Technical Society (KTT) connected, *inter alia*, with the construction of Urban Power Plant in Cracow. The most active electricians of the discussed period were: Stanisław BIELIŃSKI, Henryk DUBELTOWICZ, Kazimierz GAYCZAK and Leonard ZGLIŃSKI. As initiated by the above mentioned persons, the 2nd Congress of Polish Electrical Engineers was held in Cracow in 1912. The Congress undertook the initiative to create the nationwide Association of Polish Electrical Engineers. In April 1914, the Electrical Engineering Section of KTT was generated and its activity included the work on electrical engineering wording, organization of lectures and the matters concerning the licences of the electrical engineering industry. After the World War I, the activity of Cracow electrical engineers was focused on the establishment of the nationwide organization of electricians.

In June 7-9, 1919, during the National Congress of Electrical Engineers in Warsaw, there was established the Association of Polish Electrical Technicians, the name of which was changed – in 1928 –into the Association of Polish Electrical Engineers.

The founding Convention was attended by 14 Cracow electricians who delivered 5 lectures and submitted the programme of the regulations of Polish Electrical Engineering Delegation. The Cracow circle together with the Warsaw, Lvov, Łódź, Poznań and Sosnowiec circles joined the Association as the founding organs and the leader of the Cracow electricians, Stanisław BIELIŃSKI became the member of the Chief Board of SEP, consisting of 9 persons.

Fig. 1. Co-founder and first president of the SEP Circle and Krakow Branch Stanisław Bieliński

Activities of the Cracow Circle and Department of SEP during the interwar period

The Electric Engineering Section of the KTT existed formally until 16 June 1920 when the Cracow Circle of SEP was established. It consisted of 26 members. Stanisław BIELIŃSKI, director of Urban Power Plant was elected as the first President of the Circle, being transformed later into the Department (1928). The Cracow Circle of SEP carried on the scientific-technical activity via organization of lectures and discussion meetings. The social meetings were also organized. The Circle cooperated with the Bureau of Formal Logo of SEP. In the thirties, the institution of collective member was established in SEP. The Cracow Department acquired three collective members, i.e. Factory of Cables in Cracow, District Power Plant Siersza Wodna and Urban Power Plant in Cracow. The Cracow Department participated actively in life of the Association, organizing, inter alia, the 6th General Assembly of the SEP Members in 1934. During the mentioned Assembly, the exhibition of electrotechnical products was organized at AGH- University of Science and Technology.

In the thirties, the number of the members of the Department was systematically increasing; in February 1937, it associated 56 members.

The most merited activists of the Cracow Circle and Department of SEP during the first 20 years were the following persons: the Presidents - Stanisław BIELIŃSKI (1920-1932), Maryan PORĘBSKI (1932-1933), Henryk DUBELTOWICZ (1933-1935), Leonard ZGLIŃSKI (1935-1938), Tadeusz MOSKALEWSKI (1938-1939) and Jan SZMIDT (1939), and Zygmunt BEDNARSKI, Wacław CIEŚLEWSKI, Stanisław KIJAS, Jan PAWLIK, Izydor PILKIEWICZ and Stanisław RODAŃSKI.

During the period of Nazi occupation, the members of the Cracow Department of SEP made a significant contribution to the confident learning, protection of Polish industry and armed struggle with the invader.

The Cracow Department of SEP in the years 1945 – 1969

In March 1946, by the initiative of the pre-war members of the Board, the first post-war General Assembly of the Department Members was held; it elected the Board with Władysław PRZYBYŁOWSKI as the President of the Department. The department accounted for 93 members at the mentioned time and majority of them were the employees of the Power Station of Cracow District. In 1949, the number of the Department members increased up to 172, in 1959 – 706, and in 1969, it was equal to 1863.

During the first after-war decade, the major achievements of the Department included: work at organization of the Voivodeship Department of NOT in Cracow, establishment of factory circles, assistance at organization of Higher Engineering School for working persons, creation and active participation in activity of the Commission of Small Energy and aiding in establishing the site of broadcasting centre on Chorągwica Hill and TV studio at Krzemionki.

The appearance of SEP in work places had a significant meaning for the development of the Department. As early as in the years 1951-1952, 11 factory circles were organized within the department and their number increased up to 20 until the end of 1959. In the discussed period, the following successive Presidents of the Department gave the outstanding contribution to the development of Cracow Department: Władysław PRZYBYŁOWSKI (1946), Adam BALICKI (1946-1948), Jan DROBOT (1948-1949), Jan ORSKI (1954, 1960-1969), Roman ASLER (1951-1953), Karol CHWAŁA (1954-1959) and Stanisław DREWNIEWSKI, Wacław CIEŚLEWSKi, Wacław KIEŁBIK, Michał KIBIŃSKI, Zygmunt POPIELUCH and Władysław STYŚ.

In September 1956, the Department organized the 9th General Assembly of SEP Delegates held in Cracow during which a profound analysis of the work of the Association was carried out and the directions of its further activity were outlined.

At the end of the fifties, the Cracow Department of SEP, similarly as other Departments in Poland, was faced with the organizational crisis. At the end of 1959, the number of factory circles dropped to 20 and the number of the members was equal to 706. As a result of organizational efforts of the members of the Board in 1959, the Cracow Department gained first 7 collective members what constituted a reference to the tradition from the inter-war period. They included (the sequence of submitting): Power Plant Cracow-Outside Territory, Management of the Post Office and Telecommunication District, Cracow Factory of Cables, Enterprise of Electrical Work ELECTROMONTAŻ, Plant for Construction of Electrical Network ELBUD, Cracow Electronic Plant TELPOD and Power Plant SKAWINA.

At the breakdown of 1961, 5 sections commenced their work: Power, Telecommunication, Electrical Installations and Equipment,

Electric Traction and Nuclear Engineering; in 1964, the Sections of Industrial Power and Electronics were established. They organized meetings and lectures, and first of all, scientific- technical conferences. In the years 1963-1969 there were organized six conferences on electro-engineering problems (in Cracow) and two of them had the international range.

In 1963, the area team of experts was created at the Department; it was changed into Centre of Expertises of SEP in 1983; Roman ASLER had been the manager of the mentioned institution for 24 years.

Also, the activity was commenced in the students' environment. Since 1965, the Department has continuously conducted the competitions for the best diploma thesis in the field of electricity matters for the graduates of Faculty of Electrical Engineering, Automatics, Computer Science and Electronics of AGH. Later on, (since 1981), the mentioned competition included also the graduates of Faculty of Electrical and Computer Engineering of Cracow Technical University. Since 1966, there have been organized the annual competitions for the most active Circle of SEP.

At the end of 1969, the Cracow Department of SEP had 1863 individual members, 22 collective members and 56 factory circles.

In the sixties, a special contribution to the development of the Department was brought by: Roman ASLER, Edward CICHECKI, Karol CHWAŁA, Erazm CIOŁCZYK, Stanisław DEMBICKI, Stanisław DERDA, Stefan GRUSZCZYŃSKI, Apolinary KOWALEWSKI, Janusz KRZYSZTOFOWICZ, Zbigniew NARTOWSKI, Jan STROJNY and Henryk ZIEMNICKI.

Activities of the Department in the period of 1969 – 1998

In 1969 Jan STROJNY became the President of the Department and he played the mentioned function incessantly until 1984.

In the seventies, a considerable animation of the activities of the Department was recorded. A new style of cooperation with the factory circles was introduced – the meetings of the Board of the Department were organized at the territory of the factories. The activity of the branch sections was increased; until 1980, they organized 22 scientific-technical conferences and many symposia, lectures and technical trips.

In 1971, new Sections were organized at the Cracow Department: Radiotelephony and TV, and Automatics and Measurements; in 1977, the Section of Digital Machines and Systems was established. The outstanding achievements of the Department included organizational preparation of the 19th General Assembly of SEP Delegates (the mentioned event was held in October 1972 in Cracow) and of 4 sections of the Conference, accompanying the Assembly.

In the seventies, a systematic increase in the number of the Department members was recorded. At the end of 1980, the Cracow Department associated 3289 individual members, 56 collective members and 93 factory circles.

The economic and social-political crisis at the beginning of the eighties caused a significant regress of the Department's activity. The interest of the members in the work of the sections and circles declined. In the years 1980-1983, the number of individual members decreased by ca. 20%; some circles became liquidated. The most important task of the Board of the Department was to counteract the mentioned tendencies and gradually restore the belief of the SEP members in the purposefulness of social activity.

During the discussed period – the breakdown of the seventies – a high contribution to work was made by President Jan STROJNY and long-time technical secretary Antoni JUSZCZYŃSKI and Józef CURYŁO, Marek CZERNIEJEWSKI, Erazm CIOŁCZYK, Rudolf FENTON, Henryk KACZMARCZYK, Janusz KŁODOS, Zygmunt KONECKI, Jrzy KWAS, Zbigniew NARTOWSKI, Stanisław NOWAK, Stefan LUCIŃSKI, Stefan OSTAFIN, Longin RATAJEWICZ, Kazimierz SCHULERT, Władysław TENEROWICZ, Zygmunt WITEK and Edmund WOŹNIAK.

In December 1983, on the threshold of its 65 year anniversary, the Cracow Department had 2622 individual members, associated in 89 factory circles and 55 collective members.

Fig. 2. Participants of the occasional meeting of representatives of the Branches - SEP Co-founders in the club room of the NOT Technicians House in Krakow (29.11.1988)

Fig. 3. Participants of the Meeting on the occasion of the Electrician Day 1992 in front of the building of the Faculty of Electrical Engineering, Automatics and Electronics (10.06.1992)

Since 1984, a gradual animation of the activity of the Department had place. The crisis of the beginning of the eighties became practically broken down and even a small increase in the number of the individual members was recorded. At the end of 1988, the Department had 2937 individual members, associated in 84 circles and 54 collective members.

During the discussed period, long-time activists of the Department, Janusz KŁODOS played a function of the President. Most of 12 problem commissions and 9 scientific-technical sections were actively functioning. We may distinguish especially Section of Electrical Installations and Equipment which organized 2 all-country conferences and Section of Digital Machines and Systems which was the organizer of regional computer technology conferences.

In 1987, the solemn celebration of Day of Electrician, as organized annually in June, was inaugurated in the Department. The year 1988 passed to the history of the Department of SEP as the year of agreements. In the mentioned year, the following agreements were concluded: the Agreement with the Department of the Association of Hungarian Electric Engineers (MEE) on the exchange of experiences was concluded in Eger; the agreement between the Department, AGH and OIGE, as specifying the principles of obtaining the qualifying competences of SEP by the students and the agreement concluded with SITG on cooperation in the field of rescuing the Salt Mine in Wieliczka.

In the eighties, we might distinguish the following activists: Stanisław CHĘĆ, Erazm CIOŁCZYK, Janusz KŁODOS, Zygmunt KONECKI, Stefan LUCIŃSKI, Stanisław Ostafin, Stanislaw SITEK, Jan STRZAŁKA, Grzegorz SZCZEPANIEC, Zygmunt WITEK and Eugeniusz ZAWADZKI.

In 1989, on the occasion of the Jubilee of the 70th anniversary of the Department, conferences and technical meetings were organized; it worthy to mention also, inter alia, the ceremony of conferring the name of Prof. Roman Podoski to the Complex of Vocational Schools of MPK.

In 1989, to memorize the merits of the founder of SEP and the founder and the first President of the Cracow Department, the Board of the Department decided to establish the Stanisław Bieliński Medal. During the period up to 1998, more than 140 medals were awarded as the recognition for a special contribution to the development of the Department.

The years 1989-1994 were characterized by deterioration of the conditions of functioning, as being caused by the social-economic crisis and a considerable decline in the number of factory circles and the number of individual and supporting members, especially in the years 1990-1991.

The successive Boards of the Department, managed by Janusz KŁODOS, Stanisław KRECZMAR and again Janusz KŁODOS made the efforts aimed at maintaining the activity of the Department.

It is worthy to emphasize the organizational efforts connected with the celebration of the 70th anniversary of the Department (September 1989), ceremony of 75 years of the Department (October 1994) and General Meetings of Delegates of the Department (April 1990, February 1994 and March 1998). The important events in the life of the Department included organization of the 29th General Assembly of SEP Delegates which was held in on July 3-5, 1998 in the premises of the Congress Centre in Cracow and was linked with the organization of Exhibition and Promotional Seminar : "Innovations in Electrical Engineering".

In the nineties, the following persons were especially involved in the Association's activity: Erazm CIOŁCZYK, Józef CZEKAJ, Barbara FLORKOWSKA, Franciszek GRUSZKA, Henryk KACZMARCZYK, Janusz KŁODOS, Zygmunt KONECKI, Stanisław KRTECZMER, Piotr LECHOWICZ, Zdzisław LEPIARZ, Jerzy OPROCHA, Tadeusz STEFANIK, Jan STRZAŁKA, Henryk STYLO, Władysław TENEROWICZ, Józefa WOJCIESZAK-POPRAWA and Eugeniusz ZAWADZKI.

Fig. 4. A group of Branch delegates - participants of the XXVII General Congress of SEP Delegates in Kołobrzeg (June 10-11, 1994). From the left: Jan Strzałka, Tadeusz Malinowski (O / Piotrkowski), Henryk Kaczmarczyk, Wiesław Eysymontt (O / Warszawski), Erazm Ciołczyk, Eugeniusz Zawadzki, Zygmunt Konecki, Roman Asler, Piotr Molski, Kazimierz Bisztyga and Janusz Kłodos.

Fig. 5. Chairing the General Assembly of Branch Delegates in 1998. Behind the presidential table from the left: Cyprian Brudkowski (president of SEP), Danuta Prażmowska– Sobota, prof. Romuald Włodek and Janusz Lach.

The major achievements during the decade of 1999 – 2019

Up to 2002, the work of the Department was managed by Janusz KŁODOS; in the years 2002-2010 by Jan Strzałka, in the period of 2010-2014 – Władyslaw WAGA and again, since 2014 until now, Jan STRZAŁKA has played the function of the President. During the discussed period, the Department demonstrated a high activity. The most important achievements of the mentioned period include:

- The number of individual members is maintained on the fixed level of 1100-1200 persons;
- Stabilization of the number of SEP circles on the level of ca. 35-40;
- The stable number of supporting members (above 30);
- Organization of more than 35 scientific-technical conferences, including 26 meetings of the International Conference of Lightning Protection, attended by almost 200 participants from 30 countries;
- Organization of the celebration of the 80th anniversary of the Department's activity in June 1999, the 85th anniversary in June 2004, the 90th anniversary in June 2009 and the 95th anniversary in June 2014;
- Organization of 25-30 seminars and technical trips annually;
- Carrying out 3 000-7 000 examinations for legal authorization of performing a given job in respect of E (operation) and D (supervision) annually;
- Organization of 25-60 training courses and instructional education annually;
- Financial aid for the considerable number of the members who were found in a difficult random event situation;
- Successful participation of SEP circles in all-country Competitions;
- Organization of annual (since 23 years) Competition: "The best computer program";

Fig. 6. During the Solemn Meeting in the hall of the City of Krakow on the occasion of the 85th anniversary of the O / Kr SEP and the International Electricity Day, Vice President of Krakow Tadeusz Trzmiel (17.06.2004) speaks

Fig. 7. Participants of the XIV Council of Governors of SEP in Krakow for visiting the Salt Mine in Wieliczka (07/09/2013)

- A substantial activity of Students' Circles of SEP which resulted in organization of the 6th Polish Days of a Young Electrician at AGH in 2004, organization of Competitions of the Knowledge of Electricity for the pupils of secondary schools from the territory of Małopolska district (2007-2009) and organization of Cracow Days of Electrical Engineer by the Students' Circle of SEP no. 19 at AGH (2017-2019);
- Maintaining 30-years' foreign cooperation with MEE Eger and Miskolc (Hungary) and continuation of cooperation with Lvov Department of Association of Electrical Engineers of Ukraine;
- Maintaining many decades' cooperation with the Nowa Huta Department of SEP and commencing cooperation with the department of Coal Basin;
- Annual organization of very attractive foreign technical-touristic trips for the activists of the department;
- Annual organization of Competitions for Diploma Papers at AGH and PK (University of Technology) and successes of graduates of Cracow Technical Universities on the national level;
- Organization of the 9th Council of the Presidents of SEP (2004) and the 14th Council of the presidents of SEP in Cracow (2013);
- Organization of annual travel seminars of the members of Qualifying Commissions;
- Undertaking the organization of sport events in the field of game shooting and skiing, having a local and national range;
- Co-participation in organization and sponsoring of the Competitions TECHNICIAN OF THE YEAR and the Contest (Olympiad) of Technical Knowledge in the electrical-electronic field;
- Active participation in the work connected with the organization and development of activity of Małopolska District Chamber of Construction Engineers;
- Awarding 5 successive activists of the Department with the Distinction of Honorary member of SEP;
- Development and practical introduction of the Quality Management Scheme in the Department;
- Obtaining a legal personality by the Department in 2007;
- Development and publication of the first number of Biographical Dictionary of the Merited Cracow Electrical Engineers (within the frames of the preparation to 90 years of the activity of the Cracow Department of SEP) and the second number of the Dictionary (within the frames of the preparation to the celebration of 100 years of the activity).

During the recent twenty years, the following persons had the special merits in respect of the association activity: Marek CHRZANOWSKI, Józef CZEKAJSKI, Ryszard DAMIJAN, Barbara FLORKOWSKA, Franciszek GRUSZKA, Barbara JARZYMOWSKA, Henryk KACZMARCZYK, Janusz KŁODOS, Władysław ŁOZIAK, Jerzy OPROCHA, Zbigniew PORADA, Krzysztof EBRO – PROKESZ, Marek REJMER, Zygmunt SALWIŃSKI, Jan SOKOŁOWSKI, Jan STRZAŁKA, Grzegorz SZCZEPANIEC, Władysław TENEROWICZ, Władysław WAGA, Józefa WOJCIESZAK – POPRAWA, Tadeusz WPJSZNIS, Andrzej WYWIJAS and Maria ZASTAWNY.

It should be stressed that during the recent 20 years, a considerable activity was demonstrated by scientific-technical sections, including especially Section of Electrical Installations and Equipment (Chairman Piotr LECHOWICZ, Ryszard DAMIJAN, and Krzysztof WINCENCIK), Energy Section (Chairman Andrzej SIWEK and Zbigniew BISIKIEWICZ), Section of Electrical Traction (Chairman Waldemar ZAJĄC) and Electronics Section (Chairman Wiesław ZARASKA).

We should also note the active work of a considerable part of the SEP Circles and namely of: Circle of SEP No. 1 at EP Kraków S.A. (President Zbigniew BISIKIEWICZ), Circle of Seniors of SEP No. 7 (President Władysław BARACZ, Czesław KAPOŁKA and Ryszard GROCHOWSKI), SEP Circle No. 13 (President Ryszard STOLARCZYK and Janusz OLEKSA), SEP Circle No. 16 at AGH (President Władysław ŁOZIAK, Marian NOGA and Andrzej BIEŃ), Students' Circle of SEP No. 19 at AGH (President Mateusz BŁAŻUSIAK, Maciej BURNUS and Arkadiusz JURCZAKIEWICZ), Local Circle of SEP No. 26 in Niepołomice (President Tadeusz GORYCKI and Zdzisław JUREK), Circle of SEP No. 28 (President Bolesław DZIĘGIEL and Jacek BALANA), Circle of SEP No. 56 at MPWiK (Urban Enterprise of Water Pipelines and Sewage System) (President Zygmunt SALWIŃSKI and Piotr MAŁKA), Circle of SEP No. 60 at PGE (President Marian GINDEK, Cezary ŻYRKOWSKI and Przemysław GODZWON), Circle of SEP No. 65 at KEiE (President Tadeusz WOJSZNIS) and Cicrle of SEP No. 75 at PK (Cracow University of Technology) (President Marek REJMER and Wojciech MYSIŃSKI).

Major achievements of Cracow Department of SEP

The submitted description of more important achievements of Cracow Department of SEP throughout hundred years of its history is an undoubted evidence of incessant high level of its activity.

The position of Cracow Department of SEP in the Association is reflected in the fact of awarding 13 merited activists of the Department with the highest distinction of SEP – Honorary Member of this organization. The following persons were honoured:

- Władysław PRZYBYŁOWSKI, PhD., (the 24th General Assembly of Delegates, [WZD], Gdańsk, 1978),
- Prof. Zbigniew JASICKI (the 25th WZD, Warsaw, 1989),
- Roman ASLER, M.Sc., Eng., (the 26th WZD, Opole, 1990),
- Erazm CIOŁCZYK, MSc., Eng., (the 27th WZD, Kołobrzeg, 1994),
- Prof. Jan MANITIUS (the 27th WZD, Kołobrzeg, 1994),
- Prof. Kazimierz BISZTYGA (the 29th WZD, Cracow, 1998),
- Zygmunt KONECKI, Eng., (the 29th WZD, Cracow 1998),
- Stanisław KRECZMER, PhD., (the 30th WZD, Warsaw, 1999),
- Janusz KŁODOS, MSc., Eng., (the 31st WZD, Zielona Góra, 2002),
- Jan STROJNY, PhD,, Eng., (the 33rd WZD, Łódź, 2006),
- Dr Jan STRZAŁKA, Eng., (the 35th WZD, Katowice, 2010)
- Prof. dr. Zbigniew HANZELKA, Eng., (the 38th WZD, Poznań, 2018),
- Władysław WAGA, Eng., (the 39th NWZD [Extraordinary General Assembly of Delegates] , Warsaw, 2019.
- Besides it, Cracow Department of SEP applied for awarding Prof. Zdobysław FLISOWSKI from Warsaw University of Technology with the Distinction of the Honorary Member of SEP (the 36th WZD, Szczecin, 2014).
- The constant items of the programme of work of the Department include:
- Organization of annual cyclic scientific-technical conferences;
- Organization of the contests for competing between the factory circles (since 1966);
- Competitions for the best diploma paper for the students of the Faculty of Electrical Engineering, Automation, Computer Science and Biomedical Engineering of AGH (since 1965) and

Fig. 8. IV Symposium on the History of Electrical Engineering (November 15-16, 2018)

of the Faculty of Electrical and Computer Engineering of Cracow University of Technology (since 1991);
- Co-participation in organizing of the Contest (Olympiad) of Technical Knowledge (since 1975);
- Co-participation in organization of district contests of the Olympiad EUROELEKTRA (since 2016);
- Organization of the competitions for the best diploma paper of the graduates of vocational electrical-electronic schools (since 1981 to 2003);
- The competitions for the best computer program (since 1996);
- New Year's Meeting of Activists and the collective members, supporting SEP (for longer than 35 years);
- Occasional meting connected with the Day of Electrician (since 1987) and with the International Day of Electricity (since 2002);
- Maintenance and development of the activity of Expertise Centre of SEP;
- Publishing Technical Bulletin of Cracow Department of SEP (since 1996, 73 numbers were published);
- Co-participation in organizing and patronizing the ELEKTRO-ENERGY Fairs within the frames of the Agreement with Chemobudowa Kraków S.A. (1996-2004);
- Training activity and development of foreign cooperation of the Department with Department of MEE Eger and Miskolc (Hungary) and Lvov Department SIEU (Ukraine).
- The meaningful activities of the Cracow Department of SEP include:
- Distinguishing the teams of SEP in the Competitions of NOT Association for the outstanding achievements in the field of technology in the eighties and nineties of the 20th century,
- The success of Cracow Circles of SEP in the national contest for competition,
- The first place in the all-national Competition for the Most Active Department of SEP in 2017 in Group A,
- Success of Cracow people in all-national competitions for "The best diploma paper" and "The best computer program" ,
- Engagement in organization of sport events, covering the whole territory of Poland,
- Engagement of activists of the Department in the work of the Chief Board of SEP and its agencies and in the work of the Council FSNT NOT in Cracow and MOIIB (Małopolska District Chamber of Construction Engineers),
- Maintaining a positive financial result of the Department almost in every year.

The diversity of the acting forms of the Cracow SEP member is supported by the figures concerning the years 1989 – 2018 as given below. During the mentioned period, there were organized, inter alia: 105 scientific-technical conferences and symposia, 917 lectures, 337 branch meetings, 531 technical and touristic trips and 329 exhibitions and competitions.

The achievements of the Cracow Department of SEP over 100 years of its existence were possible owing to the engagement of a wide range of activists who received many state, regional and the association distinctions as recognition of their merits. It should be stressed that only in the period of 1998 – 2018, the members of the Cracow Department of SEP were honoured with 5 state awards, 59 HONORIS GRATIA Distinctions, 49 diplomas of the Merited Senior of SEP, 32 Medals of the name of Prof. J. Groszkowski, 86 Medals of the name of Prof. M. Pożaryski, 27 Medals of the name of Prof. S. Fryze, 21 Medals of the name of K. Szpotanski and 25 Medals of the name of A. Hoffmann, 12 Medals of the name of J. Obrąpalski and 5 Medals of the name of M. Doliwo-Dobrowolski. It we should also mention the contribution of the full-time employees of the Office of the Cracow Department of SEP and especially of Iwona Jurecka, Małgorzata Majerczak, Magdalena Czyhak and katarzyna Strzalka-Goluszka.

The discussed achievements of the Department were documented in the systematically conducted Chronicle of the Department and in Monographs or Informative-Historical Bulletins of Cracow Department of SEP, being published every 5 years.

Summing up

In the article, the most important facts and events which had place during 100 years of the history of the Cracow Department of SEP, one of the co-founders of SEP. The most important achievements were highlighted and the persons, who created the history of the Cracow Department of SEP throughout few generations, were mentioned.

Literature

[1]. A. Juszczyński, J. Majewski, J. Strzałka: 60 lat Oddziału Krakowskiego Stowarzyszenia Elektryków Polskich. Kraków, 1979r.
[2]. Z. Porada, J. Strzałka: Działalność Oddziału Krakowskiego Stowarzyszenia Elektryków Polskich. Mat. I Sympozjum Historii Elektryki. Gdańsk 2015.
[3]. J. Strzałka: Biuletyn Informacyjno-Historyczny Oddziału Krakowskiego Stowarzyszenia Elektryków Polskich, Kraków, czerwiec 2019.
[4]. J. Strzałka: 100-lecie Oddziału Krakowskiego SEP. Energetyka, czerwiec 2019

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THE JUBILEE OF THE XXV INTERNATIONAL SCIENTIFIC CONFERENCE OF INSITUTE OF TECHNOLOGY ADN LIFE SCIENCES

JUBILEUSZOWA XXV MIĘDZYNARODOWA KONFERENCJA NAUKOWA INSTYTUTU TECHNOLOGICZNO-PRZYRODNICZEGO

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On September 11-12, the 25th International Scientific Conference under the patronage of the Minister of Agriculture and Rural Development Jan Krzysztof Ardanowski on "Problems of intensification of animal production with regard to environmental protection, EU standards and production of alternative energy, including biogas" took place at the Institute of Technology and Life Sciences in Falenty and at the 4 Żywioły Hotel in Falenty.

During the conference, many topics were raised about sustainable development in animal and plant production, environmental protection and renewable energy. During session different issues were presented, but among others:

- domestic and foreign solutions in the field of animal and plant production technology,
- directions of work in the field of development and automation of animal husbandry technologies, taking into account their welfare and environmental protection,
- development opportunities for renewable energy sources according to the specific needs of agricultural production,
- methods of obtaining biogas from natural fertilizers and plant production,
- digestate management methods,

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- technological solutions and research results in the field of use of renewable energy sources in animal production and reduction of greenhouse gas and ammonia emissions,
- innovative solutions in the field of livestock, low-carbon and low-energy technologies.

About 90 participants from abroad (Russian Federation, Belarus and Latvia) and Poland participated in the 25th International Scientific Conference. The participants represented the following institutions and private companies:

- Koszalin University of Technology,
- University of Agribusiness in Łomża,
- West Pomeranian University of Technology in Szczecin,
- Warsaw University of Life Sciences - SGGW,
- University of Agriculture in Krakow,
- Poznań University of Life Sciences,
- National Research Institute of Animal Production in Krakow,
- West Pomeranian Chamber of Agriculture,
- University of Life Sciences in Lublin,
- Institute of Plant Protection PIB Field Experimental Station in Bialystok,
- Ministry of Agriculture and Rural Development,
- Agricultural Social Insurance Fund,
- Institute of Crop, Fertilization and Soil Science PIB Puławy,

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- Silesian University of Technology,
- State Academy of Sciences, Gdańsk,
- BELAGROMECH, Minsk, Belarus,
- FGBNC V.R. Viliams, Lobnia, Russia (Federal Scientific Center of Feed Production and Agroecology),
- RUNIP "IMSKH NAN Belarusi", Minsk, Belarus (Institute of Power Engineering),
- Latvian University of Agriculture, Jeglava, Latvia,
- GNU NIISH Agricultural Research Institute, Kirov, Russia,
- FGBNU FANC North-East NV Rudnicki, Kirov, Russia,
- State Engineering and Economics Institute in Knyaginino, Russia,
- RENK - Pomeranian Wholesale Agricultural and Food Center S.A.,
- TESTMER Warsaw S.A.,
- WOLF System,
- AgroNews.com Interactive Television,
- Online B2B Daily Now Environment.

61 papers were presented at the Conference, of which 26 in foreign languages (Russian and English). On the first day of Conference, the speeches were divided into plenary session on: innovative techniques and solutions in animal husbandry and plant production, and environmental protection (including ammonia reduction).

Then individual speeches were divided into thematic sections. The first was the section entitled "Basic problems in animal husbandry, renewable energy production and rural infrastructure." The second section covered the topics of "Basic problems in animal husbandry with regard to environmental protection", while the subject of the third section was entitled "Basic problems in renewable energy production with regard to environmental protection".

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On the second day a section entitled "Basic problems in animal and plant production including environmental protection and renewable energy".

During the meeting, participants exchanged scientific and research and implementation information with each other, and defined forms of further cooperation.

As part of the conference on September 12, an away session was organized for foreign guests to the University of Life Sciences in Lublin and the Institute of Technology and Life Sciences, Poznań Branch.

The organization of the 25th International Scientific Conference was possible thanks to the co-organizers:

- Fund of Agricultural Social Insurance,
- Department of Renewable Energy Sources Engineering at the West Pomeranian University of Technology in Szczecin,
- University of Agribusiness in Łomża.

The conference sponsors were:

- LUBELLA FOOD Sp. z o.o., Sp. k.
- WOLF SYSTEM Sp. z o.o.,
- TESTMER Warsaw S.A.,
- POL-FOODS Sp. z o.o.

Honorary patrons were: UPEBI - Union of Producers and Employers of the Biogas Industry and POLSUS - Polish Association of Pig Breeders and Producers.

The media patrons were:

- Polish Technical Review magazine
- Online B2B Journal 'Now Environment',
- Interactive TV AgroNews.com.

As a result of the submitted works of the Participants of the 25th International Scientific Conference, two monographs were issued:

1. Monograph "Improving technology in animal production and renewable energy, taking into account the requirements of sustainable development", pp. 359.
2. Monograph "Проблемы интенсификации животноводства с учетом охраны окружающей среды и производства альтернативных источников энергии, в том числе биогаза (Problems of intensification of animal production including environment protection and alternative energy production as well as biogas)", pp. 184.

The 25th jubilee International Scientific Conference was reported by AgroNews.com. The material is available on: https://www.youtube.com/watch?v=U0SpUEbFjPQ

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