HYDROPOWER | WATER MANAGEMENT | ENVIRONMENTAL PROTECTION | INLAND NAVIGATION | ENERGY RECOVERY

# ENERGETYKA WODNA

3/2018 (27)
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# FROM **EDITORIAL OFFICE**

Dear Readers! 2018 has been unusual in the Polish hydropower not only due to the amendment to the Polish Act on Renewable Energy Sources signed by the President of Poland in June, which introduced more favorable rules for our industry, constituting a catalyst for new investments. It also has been unusual thanks to this year edition of HYDRO fair and conference which thanks to the engagement of our editorial team are taking place in Poland for the first time.

It is an honor for our editorial office and the publisher of the magazine to host in Poland prominent participants and organizers of one of the most prestigious events in the hydropower in the world. The source of personal satisfaction is also the fact that by our modest efforts we have contributed to organizers' decision about selecting Poland as the country hosting HYDRO 2018. Especially in the times of crucial changes in the industry, connected to the new rules of support of RES and to the initiative of development of inland navigation, which we are witnessing.

For this occasion we have prepared for the first time a special bilingual edition of "Energetyka Wodna", the English language version of which is addressed, among others, to the participants of HYDRO 2018. We decided to include in it the Polish hydropower in a nutshell, beginning with current events in the industry and basic facts, through crucial changes in the Polish law, initiatives realized by the Ministry of Energy and the Ministry of Maritime Economy and Inland Navigation, currently conducted investments, and ending with the Polish hydrotechnological thought, Polish products and services addressed to the international group of clients.

Considering the fact that HYDRO is not only a business but also a chance to learn about local history, culture and art, we included articles presenting tourist attractions of Gdańsk, which is the host city of this year edition, and history of Poland on the occasion of 100th anniversary of regaining independence by our country. We hope that changed form of this special edition of "Energetyka Wodna" will appeal also to our regular readers and will allow them to take a look at our country from a bit different perspective.

On this occasion we would like to thank all the persons involved in the preparation of the English version of "Energetyka Wodna" for their invaluable support, especially our friends: Alison Bartle, Lukas Port from the editorial office of Hydropower & Dams as well as Ewa Malicka, the President of the Polish Association for Small Hydropower Development. Without your help, we would not have been able to achieve it!

We wish all the participants of HYDRO 2018, that stay in Gdańsk, in line with this year's motto "progress thanks to partnership", resulted in establishing numerous business contacts and implementation of inspiring projects!

P.S. If you want to learn more on Polish hydropower, you are welcome to contact our editorial office!

Michał Kubecki
Editor in Chief

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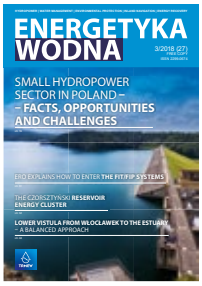


## NEWS



## PRACTICE



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Dam and hydroelectric power plant in Dobczyce on the Raba river, source: iStock, ewg3D

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# DEVELOPMENT OF THE INLAND WATERWAY **TRANSPORT FAVOURS CLEAN ENERGY PRODUCTION**

**Due to years of neglect in the field of the development of the inland waterways, no investments were carried out on the main shipping routes, no comprehensive investment actions were taken, no infrastructure was built that could restore appropriate navigation parameters, and that could simultaneously give opportunity of its multifunctional use, at least in the form of barrages with hydroelectric power stations.**

The Ministry of Maritime Economy and Inland Navigation (MGMiŻŚ) since its creation works on and improves the programme of the inland waterways development. At first, we have focused on the waterways E30 and E40, i.e. the Oder Waterway (Odrzańska Droga Wodna) and the waterway of Vistula (Wisła) river. The first effects of the intense work are the proposed locations for the new dams on the Oder. The dams, that in the case of barrages, will not exclude building hydroelectric power stations. The next step will be the hydro-technical analysis for individual objects. At the same time, the transport analysis is underway to show the potential flows of loads. The cost-benefit analysis which aims at showing the effectiveness of the planned investments is carried out, including the possibility of financing the part of the construction from the sale of hydro-generated electricity.

Simultaneously, the MGMiŻŚ has begun preparing the investments that are essential in the context of flood safety, water supply and ensure appropriate waterway transport parameters. That is why the tasks related to constructing the barrage on the Vistula and consecutive dams on the Oder have begun. The investment carried out in Siarzewo is crucial not only from the waterway development point of view, but also for suppressing the steppe-formation process in Kujawy and Pomerania. The planned barrage will consist of the following objects:

- The spillway part: a weir with 15 spans, with a low crest with operating dam, and a stilling basin;
- The hydroelectric power station with gates, equipped with 6 to 8 hydro turbines (capacity ca. 80 MW);
- The water transport lock with the spaces for vessels and ice-breakers;
- The barrage evading additional riverbed, two fish ladders, and the devices for smooth fish flow;
- Side earth dams.

The work will be carried out taking into consideration the needs and conditions, including environmental, social and economic conditions. The inland waterway transport, energy sector and tourism will benefit from it. In December 2017 the Ministers of Environment, Energy, and of Maritime Affairs and Inland Waterway Transport have signed the Agreement on the implementation of the construction of Siarzewo Barrage investment. This investment has been classified as a priority water project in the country, that should be implemented as a part of the State's public tasks, not later than by the end of 2025. the National Water Holding "State Waters" (PGW WP) has been designated as the investor of the barrage construction. The project is advanced and in December 2017, the Regional Director of Environmental Protection in Bydgoszcz issued a positive decision on the environmental conditions for its implementation. Work on the barrage financing formula is currently underway, which covers issues such as the analysis of project implementation options, also with use of private funds, in various configurations and ownership forms, and maintenance / exploitation forms. Other key projects are the constructions of the barrages on the Oder Waterway in Lubiąż and Ścinawa. the National Water Holding "State Waters" issued a call for tenders for these projects implementation. Consecutive barrages of the Oder cascade are to be multifunctional objects, including electricity production.

At the same time, the final work at Malczyce barrage takes place. It was opened for the free waterway transport in June, and the functional completion of the barrage construction, including hydroelectric power station, is planned for July 2019.

The plan to restore inland waterway transport in our country and the construction of new barrages on rivers, which is being implemented, is a great opportunity to increase the production of clean energy from hydroelectric power stations.

Marek Gróbarczyk
Minister of Marine Economy and Inland Navigation

# HYDRO-ENERGY AND **WATER RESOURCES MANAGEMENT**

**Hydro-energy is an essential part of water resources management, as well as economy of every country. At present all actions of water resources management should in a comprehensive way solve problems of hydro-energy.**

Water resources management is a very important sector in` the economy of every country, and covers wide range of problems connected with water. These are: water supply for people, industry and agriculture, flood protection, reducing of drought effects, inland navigation, limiting the pollution of surface and ground waters, and hydro-energy. In this broad spectrum of problems hydro-energy played an important role in the past as well as today.

In many regions of our globe water has become a basic factor for social and economic development. At present a very important problem is caused by sustainable development and possible changes in water resources and hydrologic cycle due to climate changes. The amount of water in hydrologic cycle is constant, however, due to increasing number of inhabitants the amount of water for one inhabitant is constantly decreasing. In addition, climate changes cause an increase in non-uniform precipitation distribution, and thus water resources both in space and time. One of the possibilities to solve this problem is to provide for appropriate volume of water in retention reservoirs, which allows rational water use and a more uniform outflow of water to the sea.

*One of the possibilities to solve the problem of non-uniform precipitation distribution, and thus water resources both in space and time, is to provide for appropriate volume of water in retention reservoirs.*

During the period of intense industrialization in XIX century the world required large amounts of electric energy and water. Taking into account the required amount of water at that time, and in fact in excess, this problem practically was not seen. Moreover, people did not pay attention to water pollution, which in some places became catastrophic. The problem, however, was electric energy. It appeared that it is possible to obtain important amounts of this energy from hydraulic power plants. Their operation required two basic factors i.e. water discharge and head. The flow of water was connected with rivers while head required damming. Electric power plants were dynamically developing on the European and American continent. This resulted in a wide development of water turbines and generators, as well as civil engineering technologies connected with the construction of dams. In connection with this activity important progress was observed in many realms of technology and economy.

*Sometimes it is difficult to convince ecologists to accept a particular hydraulic structure, despite the fact, that in the design all their requirements in the form of fish passages or flow rapids are fulfilled.*

The construction of various types of weirs, barrages, and dams required specific localizations on rivers. These localizations were conditioned by technical and economic factors, which could justify the construction of such objects. At present the choice of a particular localization depends also on social and ecological conditions, which very often decide about the realization of the construction in a particular place. In connection with such approach the amount of potential localizations decreased substantially.

Now very often hydraulic structures and hydraulic power plants, justified from technical and economic point of view are subject to ecologic protests. These protests are justified if we will take into account only energy production. The problem is completely different, if we will regard these hydraulic structures also for flood protection, water supply, navigation, or very popular, at present, for recreation. Most of these aims are contradictory. Reservoir for flood protection should have a special volume empty for an eventual advent of flood wave, while the energy sector would like to have a high water level in the reservoir, which results in high head. Recreation and social functions of the reservoir will desire a steady water level without fluctuations, which may be sometimes even more important than all other functions. If we consider proposals for new hydraulic structures it seems very rational that this decision should be taken by a broad team of water resources specialists, ecologists, economists, sociologists and representatives of local authorities. It is important to emphasize construction of these complicated hydraulic projects results very often in the economic development of the region and a decrease of unemployment. Sometimes it is difficult to convince ecologists to accept a particular hydraulic structure, despite the fact, that in the design all their requirements in the form of fish passages or flow rapids are fulfilled.

It is also important to present ecological benefits which are connected with the construction of a hydraulic power plant or its modernization. Electric energy from hydraulic power plants is renewable and does not pollute water and atmosphere. In order to produce an equivalent amount of electric energy in a thermal power plant, it is necessary to excavate certain amount of coal, transport it to the power plant and burn it, which results in the pollution of the atmosphere. Using inland waterways for transport of goods is also much more ecological and economic than road and rail transport.

The approach to final decisions on new hydraulic projects or their modernization requires discussions by all relevant specialists and must also take into account all rational postulates. Discussions should be accompanied by the willingness to compromise and final decisions should be accepted by the majority.

Wojciech Majewski
Institute of Meteorology and Water Management,
Warsaw National Research Institute

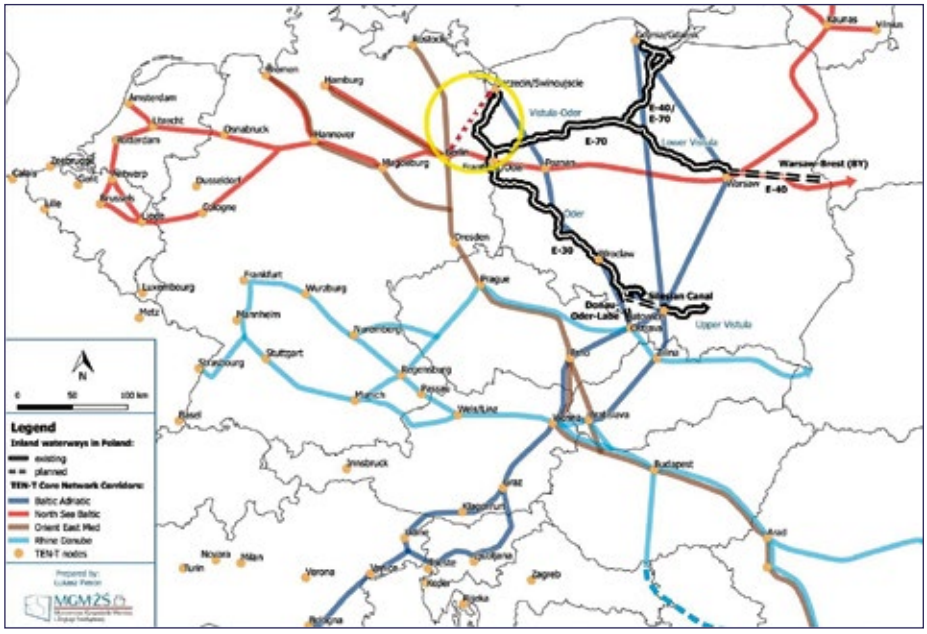
# EUROPEAN COMMISSION SUPPORTS PLANS **TO DEVELOP NAVIGATION ON THE ODRA RIVER WATERWAY**

**The Szczecin-Berlin inland waterway connection has become a part of the European transport corridor of the North Sea-Baltic Sea. This opens up the possibility of applying for funds from the Connecting Europe Facility for the modernisation of the Odra River Waterway in its final part. A tender for a cost-benefit analysis and a communication strategy was also launched. Both tasks will be financed by the EU Structural Reform Support Programme run by the European Commission.**

On 6th June 2018 the European Commission published a draft of a new regulation governing the operation of the "Connecting Europe Facility" (CEF). In Annex I to the Regulation, in the corridor of the TEN-T core network "North Sea-Baltic", the inland waterway connection Świnoujście/Szczecin-Berlin has been included.

The including of the section that integrates Polish inland waterways with the European transport network into the North Sea-Baltic transport corridor opens up the possibility of applying for CEF funding for the modernization of hydrotechnical infrastructure in the framework of the current financial perspective. Although the Odra section near Szczecin was part of the trans-European transport network TEN-T, it was not included into any of the so-called "core corridors". It was constituted a formal barrier to applying for funding for the development of the TEN-T network. The inclusion of a fragment of the Odra River Waterway in the North Sea-Baltic corridor is the result of a joint Polish-German proposal and fruitful dialogue with the European Commission. MGMiŻŚ (Ministry of Maritime Economy and Inland Navigation) hopes that this is the next step towards including the entire Odra River Waterway in the TEN-T corridors. The Ministry is preparing to update the TEN-T guidelines for the next financial perspective by drawing up a programme for the modernisation of the Odra River Waterway. The European Commission was involved in the conceptual work on the programme and within the framework of the Structural Reform Support Programme adopted for implementation the project "Support for the policy of development of inland waterways in the light of the new Water Law" prepared by the Ministry of Maritime Economy and Inland Navigation. In the first stage of the project, a cost-benefit analysis for the modernisation of the Odra River Waterway will be prepared.

Fig. Polish inland waterways and the TEN-T Core Network Corridors. A dotted line marked Szczecin-Berlin in the North Sea - Baltic Sea corridor.




*Source: Ministry of Marine Economy and Inland Navigation*

A communication strategy will also be developed. On its basis, actions promoting the development of inland waterway transport in Poland will be implemented. The European Commission is responsible for selecting the contractor for both tasks, and the contract was signed on August 8, 2018.

Work on the hydrotechnical concept for the modernisation of the Odra River Waterway and on the transport analysis is progressing according to the schedule. The latter task is to be completed in November 2018. Simultaneously with the programming of the Odra River Waterway development, navigation projects co-financed from the Operational Programme Infrastructure and Environment (POIiŚ) 2014-2020 are being implemented. During the last change of the programme, the Ministry of Maritime Economy and Inland Navigation managed to solve the problem that POIiŚ allowed the modernisation of existing hydrotechnical facilities on the Odra up to the 3rd class of navigability, while the already implemented projects include the modernisation of facilities (e.g. locks) of the 4th class. This situation complicated the process of implementation and accounting for the investment. The European Commission agreed with the arguments of the Ministry of the Environment and the inconsistencies have been removed at the level of regulations relating to specific projects.

Leaving at the level of the Operational Programme Infrastructure and Environment 2014-2020 the provision on the restoration of the 3rd class navigability of the Odra River Waterway as the expected objective of project implementation in the current financial perspective does not in any way affect the implementation of the objectives set out in the assumptions adopted by the government for the development plans for inland waterways in Poland for the years 2016-2020 with a perspective until 2030.

MGMiŻŚ
Ministry of Maritime Economy and Inland Navigation

Ministry of Marine Economy and Inland Navigation

# GOAL OF RES FOR 2030 AGREED. **AMBITIOUS?**

**Neither 27%, as was decided in 2014 by the heads of states of the European Union, nor 35% as the European Parliament and several EU countries wanted: recently, a goal for the contribution of green energy in the Union's energy mix by 2030 was agreed in Brussels at the level of 32%.**

The goal of 32% represents a compromise between the positions of the European Commission, the European Parliament and the European Council whose opinion was a result of the voices of all the ministers of energy in the European Union.

The level is in fact higher than that agreed in 2014 by the EU heads of states, who were postulating acceptance of a target of 27% (at the summit, Poland was represented by Prime Minister Ewa Kopacz). Initially, acceptance of a higher target hardly seemed realistic, and the level of 27% was supported by the European Commission and the European Council, both conservative in this matter. Last year, however, the Commission signaled its support for a more ambitious level, pointing out that realization of a higher level – in relation to 27% – would involve the same expense as that previously agreed, due to the clear decline in the costs of renewable energy production. The European Parliament, in turn, advocated a target of 35% – supported by the organizations representing the union's renewable energy sector, but also by a few leading energy companies in the EU.

Just before the final decision, the group of states advocating the 35% target increased. Sweden, Portugal, Luxembourg and Lithuania were joined by Spain and Italy. On the other hand, on 11th June 2018 the German delegation announced that would not support a target higher than 32% and the negotiations ended at this level. "Renewable energy is good for Europe, and Europe is good at renewable energy development. This agreement is a hard-earned victory in our actions to take advantage of the potential for energy transformation in Europe", the EU Commissioner for Climate and Energy, Miguel Arias Cañete, commented.
While we can positively assess the increase in the RES target with reference to the initial ideas of the EU decision makers, the uncertainty about the investments in renewable energy introduces the lack of individual, national goals. In exchange, the European Union is supposed to implement mechanisms which will ensure achievement of the targets at EU level. The first review of progress and possible revision of these mechanisms should take place at the latest in 2023. On 14 June before 4 am, in Brussels (despite the 32% target) also a complete prohibition of the use of palm oil for energy until 2030 was agreed. It was also decided that the use of first generation biofuels in transport will be frozen at the level reached by 2020. Also a target of a 3.5% conribution of biofuels of the second generation, that is those which do not use food raw materials, was agreed. At the same time, a goal of 14% of renewable energy for transport until 2030 was agreed. Also, protection of the rights for production, storage, auto-consumption and sale of energy by the EU's prosumers was agreed. The limit will be 25 kW.

So far, the European Union has to meet the target of a 20% share of renewables by 2020. In this case, the obligatory targets for each EU country, commonly 20%, were accepted. It is already known that many countries will have a problem meeting their own country's goals. This group includes Poland, where the target is 15%. Lack of progress in RES investments which has been noted in recent years, and also the relatively low share of green energy in the state's mix of energy consumption, has recently prompted officials at the Ministry of Energy to admit that we might not realize our goal. Previously, the Ministry was reassuring that we would not have any problems with reaching the level of 15%.
Not meeting the RES target for 2020 could mean that it will be necessary to supplement shortfalls in green energy by, among other things, so-called static transfers, that is by a purchase of "virtual" energy from RES from the countries which worked out a surplus within their targets. An example could be Lithuania. We would rather not buy the lacking energy from Germany, a country which actually leads in the production of green electricity, but after considering the contribution of RES to heat and transport, our Western neighbours might not reach their goal (18%).

According to data from Eurostat, in 2016, the share of green energy in the consumption of electric energy, thermal energy and in transport is in total, in the European Union, 17%. Our country, in the same year, reached a level of 13%. What is the level of achievement of national RES targets in other EU countries?

Photo: Commemorative photo of participants after the adoption of RES targets for 2030.


*Source: https://twitter.com/mac_europa*

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# 85 YEARS OF OPERATING **THE OTMUCHÓW RESERVOIR**

**85 years ago, on 17 June 1933, the Otmuchów dam and storage reservoir was commissioned on the Nysa Kłodzka River, along with a hydroelectric plant. The reservoir, called Staubecken Ottmachau at that time, had been built for five years.**

Lake Otmuchowskie is located in the western part of Otmuchów (Opole Voivodeship). At maximum storage level (18.6 m), it has an area of 20.6 km² and a capacity of 130.45 hm³. It closes the Nysa Kłodzka catchment with an area of 2352 km².

The construction of the reservoir was planned in 1913, but the First World War delayed the implementation of the scheme. The idea was revived in 1926 and made possible thanks to the modernization of the nearby railway line. Although the reservoir was created for electricity production, its main task was to provide flood protection to the Oder valley and supply the waterway with the required water volume for shipping, agriculture and industry, according to Tauron Ekoenergia, the company which owns the hydroelectric plant at the outflow of the reservoir. The distinguishing factor of this facility, compared with other hydroelectric plants in Poland, is the fact that the powerplant building is located on an upstream escarpment. This is a remarkable phenomenon as regards European water infrastructure.

Photo: The Otmuchów reservoir has the longest earth dam in Poland, the length of which is 6.5 km

*Source: TAURON Ekoenergia*

The powerplant building was constructed of steel and glass. The machine hall is almost 100 m long, 16.7 m wide and more than 11 m high. In 2013-2014, a thorough modernisation of the plant was carried out. As part of this project, two old hydro generating units were replaced by Kaplan vertical turbines each with a rated capacity 3487.5 kW, and synchronous generators.

Łukasz Madej
inżynieria.com

# CONSTRUCTION OF A RETENTION RESERVOIR **ON THE ZŁOTNICKI STREAM**

**Lake Strzeszyńskie, one of the most popular holiday spots for the residents of Poznań and the surrounding areas, is to be protected against possible pollution. This is to be achieved by the construction of a retention and filtration reservoir on the Złotnicki stream.**

Złotnicki stream is the only natural stream flowing into Lake Strzeszyńskie. It starts in the area of Suchy Las commune, where the construction of various buildings is progressing, and all rainwater is drained into Złotnicki stream and further on to Lake Strzeszyńskie.

The fundamental reason for the construction of a retention and filtration reservoir was a situation which arose in 2011. As a result of rainfall on an unprecedented scale, sewage escaped into Lake Strzeszyńskie. Since then, both the city of Poznań and Suchy Las commune have been doing their best to prevent a similar situation from happening in the future, according an announcement by Piotr Szczepanowski, Deputy Director of the Environmental Protection Department of the Poznań City Office. The retention reservoir will occupy an area of approximately 2 ha (comparable to three football fields) with a water surface area of about 1.7 ha, while the area of the biological filter is less than 0.3 ha. The average depth of the reservoir will be 130 cm, which will allow for the inflow of more than 11,000 m³ of water (equivalent to 18 sports swimming pools). The retention reservoir is intended to prevent potential degradation of the lake. Its role is to slow down the flow and seepage of the waters before they are directed to the lake. For this purpose, a soil and vegetable biological filter has been prepared. Thanks to this natural solution, the flowing water will be much cleaner than the present of inflow into the reservoir, says Piotr Szczepanowski.

The construction works began at the end of April, and lasted until September. The cost of this investment is PLN 3.5 million, of which almost PLN 3 million is EU funded. Lake Strzeszyńskie is a natural water reservoir and the cleanest of the large reservoirs of Poznań. It is located among forests on the north-western edge of the city (10 km from the centre). Its area totals 34.9 ha, while the maximum depth is 17.8 m.

Łukasz Madej
inżynieria.com


Source: ETP S.A.

# PLN 150 MILLION FROM NFEP&WM **FOR THE CONSTRUCTION OF THE BARRAGE ON THE ODER RIVER IN MALCZYCE**

**The National Fund for Environmental Protection and Water Management will grant PLN 150,930,000 of a reduced-interest loan for the completion of the barrage in Malczyce. The beneficiary and entity responsible for the implementation of this venture - of such importance for the region - is the National Water Holding "State Waters"(PGW WP).**

The investment will be implemented in Lower Silesia, the area covered by the activity of PGW WP - Regional Water Management Board in Wrocław, in Malczyce. The loan enables the priority programme of NFEP&WM named Environmental risk prevention and mitigation, Part 1) Climate change adaptation. Additionally, the initiative may be supported from special-purpose reserve funds. The estimated total cost of the investment is PLN 273,860,000. The agreement for the loan line of the project was signed up on 21 June 2018 at the seat of NFEP&WM by: Vice-president of the Management Board of NFEP&WM Anna Król and President of PGW Przemysław Daca.

The implementation of the project envisages a very wide range of works. The completion of the baffle of the existing Oder bed designed as a permanent weir of 300 m (including the overflow part, length: 130 m). Also the basis for the water plant of 9 MW (another step in the use of renewable energy sources in Poland) will require complex finishing works and commissioning. There are plans for finalizing the construction of the navigation lock, 190 m long, 12 m wide and 12 m high with an outer harbour (the depth of the upper outer harbour will be 3.5 m and of the lower outer harbour - from 2.5 to 9.10 m). The plan also includes reconstructing the destroyed access roads to the structure. The whole investment will be finalized by the end of December 2019 The construction of the barrage in Malczyce will bring numerous ecological and social advantages. First and foremost, it will contribute to flood safety in the region, as well as the protection of the local area against drying out. The completion of the venture will be an important step towards organizing a proper larger retention system. The structure will ensure optimum level of ground waters and stabilize the level of the river water. For a long time, there have been efforts taken to obtain and retain Navigability Class 4 on the Oder River. The construction of barrages is a prerequisite for it. The plant will be located by the barrage and, regardless of current works, there will be the possibility of connecting it to the national power system. It will strengthen the general power efficiency in Poland. Importantly, energy produced by the renewable source - in this case, dammed water - will reduce the emission of $CO_2$ into the atmosphere.

*– The basic function of the venture in Malczyce is to prevent intensive deep erosion on the Oder River below the water barrage in Brzeg Dolny. It is noteworthy that the lack of this form of river regulation has had a negative influence on the surrounding areas that were very dry* – explained President of the National Water Holding "State Waters" Przemysław Daca after signing up the agreement.

*– Furthermore, the investment will extend the waterway by additional several dozens of kilometres from the abovementioned water barrage in Brzeg Dolny and, eventually, it will enable obtaining the parameters of international waterway. The lock will have the following significant attribute: Navigability Class 5* – added the Head of PGW WP. President Przemysław Daca also underlined that the water barrage on the Oder River in Malczyce will be equipped with a hydro power plant producing "clean" energy - therefore, it will bring profit.

*– Another asset will be flood defence, namely the improvement of safety of people living in the neighbouring communes who have been interested in the finalization of the investment for years. As far as I remember, during the meetings in the Lower Silesia region, the following issue has always been raised: "When will the water barrage in Malczyce be completed?" Along the reservoir in Świnna Poręba, the structure is a "stain on the conscience" of the Polish water management system. I am even more happy that we are able to complete the investment and focus on other, long-term tasks set for "State Waters" by Minister Marek Gróbarczyk* – summarized President of PGW WP Przemysław Daca.

National Fund for Environmental Protection and Water Management

Sławomir Kmiecik
Spokesman
National Fund for Environmental
Protection and Water Management

# CONTRACT FOR THE PREPARATION OF A FEASIBILITY STUDY **FOR THE DEVELOPMENT OF THE VISTULA RIVER WATERWAY SIGNED**

**On 2 July in Gdańsk, a contract for a feasibility study of the Vistula River Waterway was signed. It was signed by representatives of the Port of Gdańsk Maritime Authority: president Łukasz Greinke and vice-president Marcin Osowski, as well as Artur Mazurek, representing the contractor selected by tender, the British company Halcrow Group Limited. Marek Gróbarczyk, Minister of Maritime Economy and Inland Navigation, also took part in the event.**

Minister Gróbarczyk emphasized that signing the agreement is the next stage on the way to reaching the Vistula river navigability: "The opening of Gdańsk and the whole Tri-City is the opening of a new direction - the connection of the Baltic Sea with the Black Sea. We can see how much needs to be done to activate the last rivers in Europe with such great potential" said the Minister. He also thanked the Port of Gdansk Authority S.A. for its commitment.


*Source: Ministry of Marine Economy and Inland Navigation*

He also added that the process of adaptation of rivers for navigation in Poland is carried out taking into account all environmental restrictions, as well as after consultation of the environmental risks involved. Feasibility study for comprehensive development of international waterways: E-40 for the Vistula river between Gdańsk and Warsaw, E-40 from Warsaw to the Poland-Belarus border (Brest) and E-70 between the Vistula and the Vistula Lagoon (Elbląg) will consist of three stages, including: carrying out necessary analyses and inventory of the existing condition, including location analysis, main stakeholders, legal environment, area and source of financing, inventory of the current infrastructure, analysis of needs and problems related to programme implementation. The planned duration of the contract is 18 months.

The new policy towards the inland navigation sector has resulted in the development of inland waterways and the reactivation of the idea of economic use of rivers while preserving their natural values being reflected in strategic plans and projects. In compliance with the provisions of the Water Law Act, the Ministry of Maritime Economy and Inland Navigation commenced work on the preparation of feasibility studies for the main waterways in Poland, including the Vistula River waterway - the entire Polish section of the international waterway E40. In terms of E-40, the Ministry cooperates with the Port of Gdańsk Authority S.A.

MGMiŻŚ
Ministry of Maritime Economy and Inland Navigation

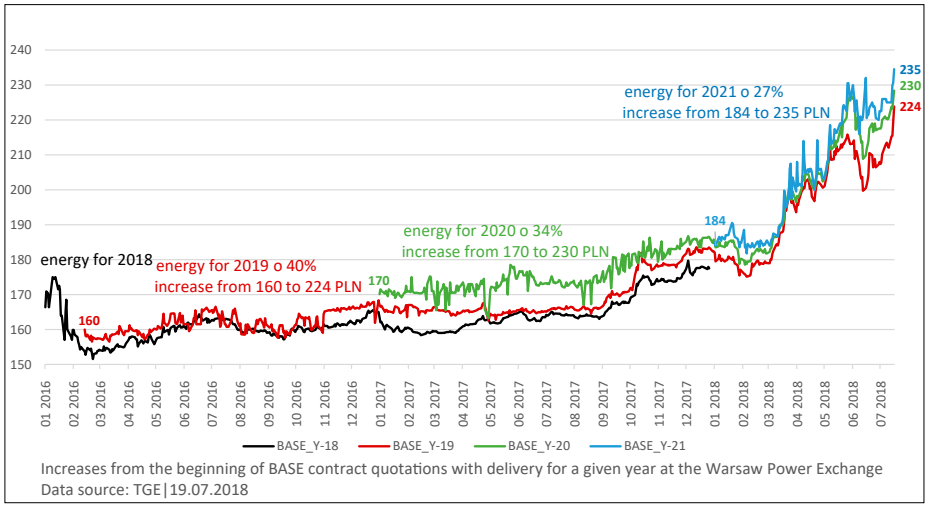
Ministry of Marine Economy and Inland Navigation

# PRICES OF ELECTRICITY IN POLAND **HIGHEST IN HISTORY**

**The price of electricity with delivery for the next year, was, on 19th July 2018, highest in history of the Polish Power Exchange. Current prices are even higher. Also the prices of gas are increasing fast. It seems that we will not avoid an increase of bills in the next year.**

On Thursday, 19 July, the price of electric energy ordered for the next year reached 224 PLN/MWh. Never in the history of the Polish Power Exchange, the price for next-year contracts was so high. For delivery of electricity for the two following years we will have to pay even more – respectively 230 and 235 PLN. These are also the highest rates that ever were paid for energy respectively for 2 and 3 years in advance.

Fig. 1 Increase of the prices of electric energy for 2019-2021




Increases from the beginning of BASE contract quotations with delivery for a given year at the Warsaw Power Exchange
Data source: TGE|19.07.2018

*Source: WysokieNapiecie.pl*

The situation is not better for the spot market where energy is contracted a day in advance. In June, the average price of these contracts reached almost 234 PLN. Such levels occurred a few years ago during very strong winters, but never before the price was so high for two months in a row, as in May and June. It seems that July will be similarly expensive. On Thursday, 19 July 2018, for Friday 20 July 2018 energy delivery the price was on average 230 PLN, and for energy used in peak hours it was even 260 PLN/MWh.

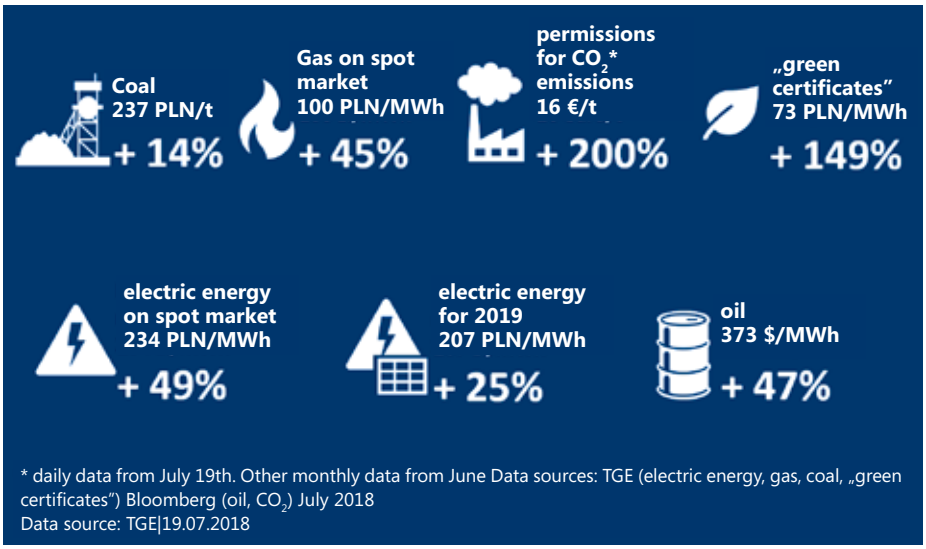
The prices are high in whole Europe. On the most expensive European market – in Great Britain – electricity with delivery on Friday evening was bought the day before for equivalente of 390 PLN/MWh. In France and Germany, for over 250 PLN/MWh. Also the next-year prices on these markets are going up. In Germany and Czech Republic, delivery of energy for the next year already cost over 190 PLN/MWh, and in France over 210 PLN/MWh. Increase of prices also affect the cheapest Scandinavia. In Norway, the next-year prices exceeded 165 PLN/MWh. One of the key reasons is dry weather and related low level of water reserve in the hydroelectric power plants. According to Reuters, this way, in Norway, almost 36 TWh of potential electricity production in relation to normal hydrological situation "have evaporated". That is three months of power usage of this country, which is the biggest electricity accumulator in Europe. Current drought, is paradoxically the reason for which... we will buy electricity with delivery at a higher price in three years in Poland.

According to the rules, prices of electric energy for the following years follow current situation on the market. So, if the prices of energy increase in summer due to heat and dry weather, the energy with delivery in two and three years is also sold at a higher price, even though it will have nothing in common with the current hydrological situation. And because European market of electric energy is closely interconnected, the drought in Norway makes price of electricity with delivery in Poland increase in 2021.

Apart from drought, prices of energy also go up because of the increase of prices of fuel. During last 12 months, oil has become significantly more expenisve (as much as 47% globally) and so has coal (as much as 14% on the Polish market). Also a double increase of prices of permissions for $CO_2$ emissions has a great significance. The increase of prices of "green certificates", supporting production of ecological energy – as much as one and a half times from July 2017 – will contribute slightly to the next-year bills, too.

Over the year, the spot market prices of electricity at the Warsaw exchange have increased a half, and deliveries for the next year one quarter. The situation on the gas is similar. The price of gas increased respectively 45% and 20%. This will be translated into next-year bills for households and will affect strongly energy-intensive industry.

Fig. 2 Increase of prices of fuel and energy over the last 12 months




* daily data from July 19th. Other monthly data from June Data sources: TGE (electric energy, gas, coal, „green certificates") Bloomberg (oil, $CO_2$) July 2018
Data source: TGE|19.07.2018

*Source: WysokieNapiecie.pl*

Bartłomiej Derski
WysokieNapięcie.pl

# FROM LIVE **OF TRMEW**

**After many months of intense works on the paragraphs in Act on RES, hundreds of hours spent on consultations and forcing suitable notations for our industry – today we finally can say "we've go it!" The Act on RES has been signed by the President of the Republic of Poland, and the system of FIT and FIP tariffs has become a fact!**

On 29 June this year, the President of the Republic of Poland signed the Amendment To The Act On Renewable Energy Sources (RES) and to some other acts from 7 June 2018. Right after the document came into force, the board of the Polish Association for Small Hydropower Development (TRMEW) decided to organize a training "How to access the FIT and FIP system?". Already in July two meetings took place – the first one in Grudziądz, the second one in Częstochowa. There was a great interest in both of them – what was not surprising to us at all, as the new system of support was long awaited by the owners of hydroelectric power plants. During the training, all the participants learned how the application, including application form, should be completed and how to migrate efficiently to the system of tariffs FIT/FIP. Today we are happy to have the new solution thanks to which small hydroenergetic industry will "catch a breath" at least for a moment and will be able to take advantage of fixed prices of selling energy, but we are constantly aware that the possibility of using the support system will end for most of the producers on 1 October 2020. It results, from the date of activation of the existing hydroelectric power plants and the length of the support which is settled for 15 years. Among Small Hydroelectric Power Plants of power not exceeding 1MW, 365 structures of combined installed power of 45.69 MW were activated before 2005 and among these of power exceeding 1 MW, but not more that 5 MW, 34 structures were activated before 2005 and their combined power is 84.785 MW. For these plants the support will come to an end in 2020.

Table: Potential SHPPs for modernization at the end of 2020

| Power of SHPP | Number (installations) | Capacity [MW] |
|---|---|---|
| Up to 1 MW | 365 | 45.69 |
| Over 1 MW – up to 5 MW | 34 | 84.79 |

*Source: TRMEW based on Energy Regulatory Office*

So, we are still working hard on the solutions which will allow the owners of these plants to continue and develop their businesses after 2020. Still, we are witnessing incorrect count of fees for water, what is a result of the amendment of the Water Act. This time the problem concerned the necessity of multiplying the rate for returnable offtake in SHPP by a differentiating coefficient (coefficient 2.8), indicated by managements of some catchments. Fortunately, after intervention of TRMEW and reporting the problem to the National Water Management, it was quickly explained that only individual fee rate for irreclaimable collection of technological water, not individual fee rate for a unit of produced electric energy, should be a subject of multiplication by a proper differentiating coefficient (related to the processes of water purification, and for surface water additionally related to particular part of the country).Therefore, we would like to point out that the owners of hydroelectric power plants who received or will receive a fee multiplied by any kind of coefficient should make a complaint, according to the instruction in letter received, as soon as possible. The complaint should be directed to the management of the catchment that calculated the fee.

It is a pleasure to share with you one more information – our association has received another subsidy from the Ministry of Entrepreneurship and Technology, as a part of the project realized in 2018 entitled "Support of participation of organizations of entrepreneurs in works of international groups and industry organizations", for a member fee in the European Renewable Energies Federation (EREF), the member of which we have been since 2017.

Finally I cordially invite you to the 5th HYDRO-FORUM 2018 organised by TRMEW on 30 November - 1 December 2018. As always, the issue of the current regulations on SHPP will not be missing and the leading subject of the conference will be the future of hydropower after 2020. Another traditional part of the meeting will include integration of the sector and nice activities in the Invest-Smardzewice resort by the Sulejowski reservoir.

Monika Grzybek
TRMEW Office

# ME HAS DETERMINED THE PARAMETERS FOR **AUCTIONING OF POWER**

**The decree which is being prepared by the Ministry of Energy constitutes the realization of a legal warrant included in the act of energy market, and determines the parameters of three closest main auctions and additional auctions. The decree came into force on 22 nd of August.**

The Ministry of Energy has published a draft of a decree concerning the parameters for the main auctions for the periods of 2021-2023, planned for December.

The proposed auction parameters include: values determining the demand in the auction, that is: the demand for power, the price to enter the market by a new production entity, the coefficient increasing this price, the parameter determining the amount of power below the demand for power, for which the price reaches the maximum value, and the parameter determining the amount of power above the demand for power, for which the price reaches its minimum value. For periods of supply in the period 2021-2023, the demand for power in the main auction will be respectively for 2021 – 22732 MW; for 2022 – 23003 MW, for 2023 – 23292 MW.

In addition, the decree indicates: the maximum price determined for the price-taker, determined based on capital and operational fixed costs; the maximum number of rounds of auction; individual levels of investment costs in relation to the achievable power net conditioning qualification of a unit of power market as a unit entitled to apply for a multi-annual power contract; minimal numbers of power obligations planned to be obtained as a result of additional auctions for particular quarters of a year of supplies which the main auction relates to. Correction coefficients of availability for particular groups of technologies are also indicated – including those for RES technologies. This coefficient is crucial for the parameter of available power offered in the auction, which includes the product of this coefficient and the net achievable power. The Ministry of Energy has proposed the following coefficients for the periods of supplies in 2021-2023: (1) 91.54% - for steam turbines, air turbines, fuel cells and Rankine's cycle; (2) 91.8% – for gas-steam power plants; (3) 93.21% - for gas powered plants working in simple cycle and for piston engines; (4) 10.94% - for wind turbines working on land; (5) 44.39% - for flow hydroelectric power plants; (6) 97.61% – for pumped storage plants and hydroelectric plants with possibility of storage; (7) 2.07% – for solar power-plants; (8) 96.11% – for electric energy storage in the form of accumulators, kinetic energy storage and super-capacitors; (9) 87.7% – for other types of technologies.

Also to be found, in the draft of the decree, are the maximum volumes of power obligations for the zones indicated in article 6 paragraph 6 of the act on power market. These zones are: (1) The zone of synchronous profile – including: (a) part of the transfer system of Germany constituting graphic area, as in Article 3 point 91 of the decree of the Commission (EU) 2017/1485, establishing the guidelines concerning work of transfer system of electric energy, directly connected with the system, (b) transfer system of the Czech Republic, (c) transfer system of Slovakia; (2) Lithuania; (3) Sweden. In this case, the value indicated for auction for years 2021, 2022, 2023 is in total 0 MW.

The Ministry of Energy indicates in regulatory impact assessment (RIA) to this decree, that the cost of support in the form of the power market should reach around 4 billion PLN annually. It is known that these costs will be transferred to the accounts of recipients of energy in the form of so-called power fee. Nevertheless, currently it is impossible to provide the price of closing the auction which will be set in the competitive process, and it is the price which will determine the costs of power market resulting from the main auction – the ministry underlines.

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## CALENDAR

| | | |
|---|---|---|
| **15th – 17th October**<br>Gdansk, Poland | **HYDRO 2018 – Progress through Partnerships**<br>*Organizator – The International Journal on Hydropower & Dams* | www.hydropower-dams.com |
| **23th – 25th October**<br>Poznan, Poland | **POL-ECO SYSTEM 2018 International Trade Fair of Environmental Protection**<br>*Organizator – Międzynarodowe Targi Poznańskie Sp. z o.o.* | www.polecosystem.pl |
| **24th – 25th October**<br>Sosnowiec, Poland | **10. Targi Urządzeń I Technologii Branży Wodociągowo-Kanalizacyjnej HydroSilesia 2018**<br>*Organizer – Expo Silesia Sp. z o.o.* | www.exposilesia.pl |
| **24th – 25th October**<br>Sarajevo, Bosnia and Herzegovina | **International trade fair and conference for. RENEXPO BIH**<br>*Organizer – REECO SRB d.o.o.* | www.renexpo-bih.com |
| **13th – 15th November**<br>Lublin | **11th Lublin Fair for Energetics**<br>*Organizer – Targi Lublin* | www.energetics.targi.lublin.pl |
| **29th – 30th November**<br>Salzburg, Austria | **RENEXPO Interhydro, European hydropower trade fair and conference**<br>*Organizer – REECO GmbH* | www.renexpo-hydro.eu |
| **30.11.2018**<br>Gdansk, Poland | **Building Constructions 2018**<br>*Organizer – Instytut PWN* | www.instytutpwn.pl |
| **30.11-1.12.2018**<br>Smardzewice, Poland | **V HYDRO-FORUM TRMEW**<br>*Organizer – Polish Association for Small Hydropower Development (TRMEW)* | www.trmew.pl |

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# FROM THE WORLD

## 25. 05.2018 IHA RELEASES 2018 HYDROPOWER STATUS REPORT

A record 4185TWh in electricity was generated from hydropower last year, according to the 2018 Hydropower Status Report, published yesterday by the International Hydropower Association (IHA). The worldwide installed capacity of commissioned hydropower plants rose to 1267 GW in 2017, according to the flagship report of the International Hydropower Association (IHA). Some 21.9 GW of capacity was added including 3.2 GW of pumped storage, bringing global pumped storage capacity to 153 GW.

The report shows that growth in hydropower in 2017 was fastest in East Asia and the Pacific, with 9.8 GW of capacity added, followed by South America (4.1 GW), South and Central Asia (3.3 GW), Europe (2.3 GW), Africa (1.9 GW) and North and Central America (0.5 GW). China consolidated its status as the world's largest producer of hydroelectric power, accounting for nearly half of global added installed capacity at 9.1 GW. It was followed by Brazil (3.4 GW), India (1.9 GW), Portugal (1.1 GW) and Angola (1.0 GW).

In addition, the report publishes findings from a study of the greenhouse gas footprint of 500 large hydropower reservoirs. The research used a new tool to assess net emissions and found hydropower's median emissions intensity to be just 18.5 $gCO_2$-eq/kWh.

International Water Power & Dam Construction

## 30.05.2018 WORLD BANK APPROVES FUNDS FOR ALBANIAN DAM SAFETY PROJECT

The World Bank's has approved €12 million in additional financing for a project that will safeguard hydroelectric dams on the Drin and Mat river cascades in Albania, and improve the operational efficiency of these dams and enhance the stability of the power supply in the regional market.

The Drin Cascade represents an important asset in the country. The three power plants in the Drin River cascade: Fierza, Komani and Vau i Dejes with total installed capacity 1350 MW, generate about 70% of total energy supply in Albania which, at recent regional market prices, represents an annual value of about US$200 million. In addition, they play an important role in the connectivity with the regional energy market. Safe and reliable operation of the hydropower plants on the Drin Cascade is not only a safety concern, but also a potential revenue management source for the Government in the future. The Project aims at improving the safety of dams and their performance and availability, extending their lifetime, and increasing their compliance with environmental safeguards best practices.

International Water Power & Dam Construction

## 14.06.2018 INDIAN GOVT APPROVES PROPOSAL FOR DAM SAFETY BILL

A proposal to introduce a dam safety bill that will help India adopt uniform dam safety procedures across all its states and union territories has been approved by the Union Cabinet, chaired by Prime Minister Shri Narendra Modi.

The Dam Safety Bill 2018 has been developed following extensive consultation with experts across India and internationally. It calls for the proper surveillance, inspection, operation and maintenance of all specified dams in the country, and provides for the set up of a National Committee on Dam Safety together with State Committees. A National Dam Safety Authority will also be established as a regulatory body with the goal to implement the policy, and provides guidelines and standards for dam safety in the country. It will also maintain a national level database of all dams in the country and records of major dam failures.

There are currently over 5000 large dams in India, with over 400 under construction, with thousands more medium and small dams. Dam safety is considered a concern in the country due to a lack of legal governance for the structures.

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## 21.06.2018 STUDY TO LOOK AT DOUBLING CAPACITY OF HYDRO TASMANIA'S TARRALEAH PROJECT

One of Tasmania's oldest hydro schemes could see its capacity more than doubled if a feasibility assessment proves favourable.

The Australian Renewable Energy Agency (ARENA) has provided $2.5 million, matched by Hydro Tasmania, for a feasibility assessment into upgrading or replacing the Tarraleah Power Station. The project would also improve other parts of the Tarraleah scheme. The proposal would more than double the scheme's capacity from 104 MW to 220 MW – contributing to the overall boost of 2,500 MW planned for Tasmania under Battery of the Nation.

Replacement would also transform the Tarraleah scheme into a state-of-the-art hydropower asset, perfectly suited for Australia's changing energy system. By converting the station to flexible operation, instead of just base load, it could flexibly boost output at times of high market demand. The Tarraleah scheme in the Central Highlands was commissioned in the 1930s and produces about 630 GWh of energy each year - about 6.5% of Hydro Tasmania's total production. Feasibility work into the preferred option (upgrade or replace) is expected to take about 18 months. The redevelopment could cost up to $500 million over three years, and support hundreds of engineering and construction jobs in the Derwent Valley and across Tasmania.

International Water Power & Dam Construction

## PUMPED STORAGE PROJECT PROPOSED **FOR LOCH NESS**

**22.06.2018**

A new 400MW pumped hydro scheme is being planned that would use the waters of the famous Loch Ness in Scotland. Plans for the Red John scheme are due to be released next week, but it has been revealed that the pumped storage project will see water pumped between Loch Ness and a newly created upper headpond which will use the natural topography between Loch Duntelchaig, Loch Ashie and Loch na Curra and Lochan an Eoin Ruadha, from where the development gets the Red John name. "Renewable energy capacity in Scotland has more than doubled since 2007, but due to its intermittent nature there is a need to store surplus energy from sources such as wind so it can be used when we need it most," said Mark Wilson, CEO of ILI "Pumped storage hydro is the largest and cleanest form of energy storage that currently exists – and a key enabler in helping Scotland meet its green energy ambitions. As well as dramatically improving our energy security, this transformational proposal is a fantastic opportunity for the community to benefit from the energy transition while helping turbo-charge Scotland's decarbonisation efforts." It is anticipated that the construction phase will create between 200-300 jobs and, once complete, Red John would be able to provide 2.4 GWh of storage capacity for the Grid over a six hour period.

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## CHINA AND UNIDO PARTNER FOR SMALL **HYDRO TECHNICAL GUIDELINES**

**25.06.2018**

New technical guidelines for standards of small hydropower development internationally are to be developed under a partnership between the Government of China and UNIDO.

The guidelines will address the current limitations of the regulations applied to the planning, design, installation, commissioning, operation and management of small-scale hydroelectric generating plants. They will be used to train manufacturers, engineers and decision-makers, especially in developing countries. "The project will help the development of efficient and sustainable SHPP which will, in turn, provide the power for productive activities and create employment opportunities," said UNIDO Director General Li Yong. "The technical guidelines will make it possible to develop small hydropower and, with training, technology transfer will become a reality," added Li.

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## NEW HYDRO PLANT **FOR NORWAY**

**3.07.2018**

Construction firm YIT and Norwegian power company Sunnfjord Energi AS are to build a new hydropower plant in the Sogn and Fjordane County in Western Norway. Under a €32 million contract, the firms will begin work on the Jølstra plant in July 2018, with completion scheduled for December 2020. The contract covers the construction of a power plant, including water intake, power station and approximately 7km of tunnel.

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## EIB FUNDS NEW DAMS **IN PORTUGAL**

**23.07.2018**

The European Investment Bank (EIB) has approved €650 million to Iberdrola for three new dams and hydropower plants, including pumped storage, on the Tâmega and Torno rivers in northern Portugal.

This major hydropower project will increase energy storage capacity in the EU, provide services to the Iberian grid operators and ultimately facilitate the increase of the renewable share of the Portuguese energy mix. This investment will reduce the dependence of the Iberian market on fossil energy as well as $CO_2$ emissions.

With a total investment of around €1.5 billion, Iberdrola´s new infrastructure will have a total capacity of 1158 MW and will start operating in 2023.The Alto Tâmega, Daivões and Gouvães dams are located in the Douro River Basin and are expected to provide an average of 1760 GWh per year to the Iberian market. Iberdrola´s project will require hiring up to 13,500 people, including direct and indirect jobs, during the entire construction phase and several hundred in operational phase.

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Source: iStock, Piotr Borkowski

# SMALL HYDROPOWER SECTOR IN POLAND – FACTS, OPPORTUNITIES AND CHALLENGES

**This issue of "Energetyka Wodna", being a special "HYDRO 2018 issue" and published in English as well as the regular Polish one, is intended to present some round-ups and overviews for a broader, international audience.**

A summary of the present status of the small hydropower sector in Poland should not be missed. Representing the Polish Association for Small Hydropower Development, the organization with a history spanning over 30 years, whose main objectives include development and promotion of small hydropower in Poland, I feel I have a duty to present such overview of this sector and I would like to do so in this article.

## DEFINITION

There is no official definition of small hydropower (SHP) plants in Poland. However, normally installations with a total capacity of no more than 5 MW are included in this category[1]. This categorisation is also partially reflected in the Act on Renewable Energy Sources (Act on RES), according to which hydropower plants with a capacity up to 5 MW are currently entitled to receive "green certificates". However, the Act on RES also includes other size-dependent regulations, such as the capacity limit of 20 MW for hydropower plants entitled to auctions for renewables, separate solutions (prices, baskets in auctions and feed-in premiums (FIP)) for installations with a capacity not exceeding 1 MW, as well as separate solutions (prices, feed-in tariffs (FIT) and some simplified rules) for hydro facilities defined as "small installation" with a capacity below 500 kW.However, considering that in many countries a small hydropower plant is defined as a plant with an installed capacity less than or equal to 10 MW, I will use this criterion in this article to make it more comprehensible for international readers.

## SHPP IN NUMBERS AND HYDROPOWER POTENTIAL OF RIVERS

In 2017, Poland had 766 hydropower plants, of which 756 were up to 10 MW[2]. The total installed capacity of hydropower plants in Poland was 988.38 MW of which 294.75 MW was the installed capacity of small hydropower plants. In 2016, electricity generation from all hydropower plants (renewable) was 2139.4 GWh, of which 908 GWh was produced in SHP plants[3]. In addition to the developed capacity, in 2017, 162 SHPP projects (up to 10 MW), with a total capacity of 55.97 MW and expected annual generation of 252 GWh, were pending approvals or under construction[4].

Furthermore, the technically feasible potential capacity, which could be developed over a longer perspective, is likely to be much higher. The total theoretical hydropower potential of Polish rivers has been estimated to be 23.6 TWh/year with a technical potential of 13.7 TWh/year[5]. Out of this, the technical hydropower potential for SHP plants is estimated to be approximately 5 TWh/year of which approximately 50 per cent (2.5 TWh MW) is economically feasible[6]. Taking into account the current annual generation at SHPP plants (908 GWh) that would indicate that less than 20 per cent of the country's technical SHPP potential

has been developed so far. Hydropower potential in Poland is characterized by uneven distribution throughout the country with 68 per cent of resources concentrated in the Vistula River basin, out of which half are allocated in the lower Vistula region. The Oder River basin contains 17.6 per cent of the hydropower potential, while 2.1 per cent is concentrated in the rivers of Przymorze as well as Warmia and Mazury regions, which are not connected with Vistula River Basin. Another 12.5 per cent of hydropower potential is concentrated in the remaining rivers in Poland. The rivers with the largest hydropower potential are the Vistula, Dunajec, San, Bug, Oder, Bóbr and Warta. Regions most favourable for hydropower development are southern parts of Poland (mountain area) as well as western and northern parts (due to existing hydro infrastructures)[5].

## REPOWERING OF HISTORIC SITES

It is estimated, that in the 1920s and 1930s, there were over 8,000 hydropower facilities in Poland (many types of mills and some hydroelectric power plants). In 1953, there were still 7,230 installations, but only 2,131 remained by 1980s and only 300 were in use at that time[7]. The possibility of repowering these historic sites is indicated as the potential for economically feasible and environmentally sustainable small and micro hydropower generation both by the Government and non-governmental organizations. In the Energy Policy Of Poland Until 2030 as well as in the Addendum To The National Action Plan For Energy From Renewable Sources utilization of existing state-owned damming structures for electricity generation is listed as one of the aims. To meet this objective, the National Water Management Authority took an inventory of the damming structures. The results showed that there are more than 14,000 dams and weirs (with minimum head of 0.7 m) of which only 4.5 per cent is used for electricity generation[8]. At the same time, similar objectives to develop micro-hydropower potential, by identifying and restoring suitable historic sites, were at the core of the European project RESTOR Hydro, co-funded by the Intelligent Energy Europe Programme of the European Union, with Poland as one of the project implementation countries. Within the project, the RESTOR Hydro Map was created indicating 50,000 SHPP sites in Europe with 8,000 located in Poland[9].

## ADMINISTRATIVE PROCEDURES

Obtaining administrative permits for the SHPP project in Poland consists of several steps. Firstly, the environmental impact of the development needs to be considered and the environmental decision needs to be obtained. Furthermore, the decision on building conditions is necessary and issued by the local administration unless, in rare cases, there is a spatial development plan covering the investment area. A 'water-legal' consent and 'water-legal' assessment needs to be gained from the water authority. The next important stage is to acquire the rights to manage the real estate which is the property of the State Treasury (i.e. lands covered with running water and most probably the weir) from the water authority which is responsible for maintenance and ownership supervision over the estate. The final stage of the procedure is to acquire a permit for construction through an application to the 'Poviat' or 'Voivodship' authority. Apart from the

decisions above, to start operating a power plant a decision on terms and conditions of grid connection and subsequently a grid connection agreement is required from the system operator. Finally, the concession to produce electricity from the renewable energy source from the Energy Regulatory Office will be needed for plants with an installed capacity exceeding 500 kW. Plants with a capacity between 50 and 500 kW must be entered in the register of electricity producers in small installations, also run by the Energy Regulatory Office, while micro producers (installations of up to 50 kW) need to notify the local system operator about their plan to start generation.

## POLICY

Although Poland refers to sustainable development in its constitution (Constitution of Poland, Article 5), the electricity sector is still largely based on carbon-intensive fossil fuels, and renewable energy sources development do not play a significant role for decision-makers.

The main energy policy objective in the field of renewable energy sources, and the country's binding target from the EU 2020 Climate and Energy Package, is to increase the share of renewable energy sources in total energy consumption to at least 15 per cent by 2020, and further increase it in the following years. By 2016, Poland had reached an 11.30 per cent share of energy from renewable sources (including electricity, transport, heating and cooling sectors) in gross final energy consumption[3]. The path indicating how Poland is intending to meet its 2020 targets is concluded in the National Renewable Energy Action Plan.

On 16 November 2017, the European Commission presented the Clean Energy for All Europeans proposals which, according to the Ministry of Energy, will imply the work on Energy Policy of Poland 2050. This long-awaited document should determine a long-term vision for energy sector in Poland. Until then the Energy Policy of Poland until 2030 adopted in 2009 is the main energy-specific long-term strategy in force.

Another strategic document which indicates the main directions of the country's development, including those of the energy sector, was adopted in 2016. In the Strategy for the Responsible Development increasing the use of hydropower potential and hydropower sector development was classified as one of the projects to be implemented. This objective should be achieved by means of „liquidation of administrative barriers constricting hydropower investments, development of hydropower equipment manufacturers industry as well as utilisation and refurbishment of existing, State-owned damming facilities for the purpose of hydropower generation".

## SUPPORT SCHEMES

Since 2005, support schemes for renewable energy have been based on green certificates. Renewable energy producers who could join this system by 1 July 2016 are supported in two ways: first, they are entitled to obtain tradable certificates of origin (green certificates); second, in the case of installations up to 500 kW there is an obligation for electricity to be purchased by the appointed energy entities, with a price announced quarterly by the Energy Regulatory Office and based on the average electricity sales price on the competitive market. Since mid-2012, the system has been destabilized mainly due to the oversupply of certificates, causing the value of green certificates to decrease from PLN 251.21 (€58.42)[10] per MWh in 2012 to PLN 36.47 (€8.48) in 2017 and electricity price within

the obligation of purchase to decrease from PLN 198.90 (€46.25) per MWh in 2012 to PLN 169.70 (€39.46) in 2016[11]. On 20 February 2015, the Act on RES was adopted in Poland, introducing a support scheme based on tendering (auctions). In the new scheme, reference (maximum) prices are defined for each technology and additionally within the technology separate reference prices are defined for installations with capacity not exceeding 1 MW and separate for those with capacity above 1 MW. Auctions are conducted separately for existing and new installations and there are separate auction baskets for installations with capacity up to 1 MW and separate for larger ones. The producers who win a tender have the right to receive the offered price for 15 years. The key solutions comprised in the act came into force on 1 July 2016.Several auctions were carried out according to the these rules in 2016 and 2017, including two auctions for installations with productivity above 3 504 MWh/MW/year and with $CO_2$ emission levels up to 100 kg/MWh, where 93 offers from SHPP producers won contracts and were able to migrate from the certificate system to the system of guaranteed prices within auction system.

The latest amendment to the RES Act dated 7 June 2018 is the most significant for the small hydropower sector. It brought changes in the auction system, including implementation of simple technological auction baskets, introduction of a mechanism which excludes bids with highest offers and softening thus far very strict sanctions for failing to generate the contracted volumes. But first of all, the latest amendment introduced FIT and FIP for small hydro and biogas installations. According to the RES Act, the guaranteed price for electricity fed into the grid by both existing and planned hydro installations which will join the FIT or FIP scheme in 2018 is PLN 495 (€115.12) per MWh for SHPP with a capacity lower than 500 kW and PLN 450 (€104.65) per MWh for those with a capacity of 500 kW - 1 MW.

## WATER LAW

Another important legal act which has an impact on the SHPP sector is the new Water Law, adopted on 20 July 2017. This act entirely reformed water administration and management by introducing catchment-based approach and the National Water Holding "State Waters". From an SHPP perspective, the most significant changes include introducing fees for water use in the hydropower sector (PLN 1.24 (€0.29) per each MWh of electricity generated in a hydropower plant) and rules of enabling investors' utilization of state-owned weirs through tenders, with certain exceptions. Other important regulations, such as requirements for residual flow, fish migration and restrictions in developing new hydropower projects which have to be consistent with the EU Water Framework Directive are contained in Water Basement Management Plans and Conditions of Water Use in Water Regions.

## THREATS

So far continuously changing legal conditions have made a challenge both for SHPP investors and operators. The reduction in prices of green certificates has been very perceptible for renewable energy producers, nevertheless, very few hydro producers have decided to make offers in tenders and switch from certificates to auction system, regarded as very risky, complicated and not appropriate for small producers.

At the same time, the small hydro sector is bearing an increase in the operational cost of SHPP due to the obligation to adapt facilities to more and more rigorous environmental requirements (building fish passes and fish barriers, increasing residual flow, etc) as well as the implementation of water pricing for hydropower in 2018. In addition, due to the financing model of the newly established "State Waters" the sector predicts a further increase in operational costs caused by the increase in fees for leasing damming structures and lands covered with water.

Last but not least, operators of existing SHPP plants are facing a threat of reduced profitability after the operational support period. According to the Act on RES, in 2020 small hydropower plants commissioned before 2005 (approximately 350 out of 740 installations) will be deprived of the support which could be claimed so far. Having very little profitability already, such a reduction of income could bankrupt many producers. The regulations on refurbishment, which could constitute a solution in such cases, are not clear enough, making the future of existing SHPP plants uncertain. So is the future of the whole sector in the longer term perspective, because all the regulations seem to disregard any development after 2020.

## CONCLUSIONS

More than 80 per cent of technical SHPP potential capacity in Poland remains unexploited as a result of historical circumstances and various administrative barriers, but also due to its specific nature. Both the governmental inventory and the RESTOR Hydro project outcomes prove the need for adaptation of existing weirs, and for making use of sites characterized by very low heads and small flows. According to the SHPP sector, this goal can only be achieved with stable financial conditions and effective regulations, giving investors access to SHPP sites (i.e. state owned weirs). There is a chance that the newly adopted FIT and FIP system will reverse the stagnation in launching new SHPP projects. Thus, the SHPP producers and investors await the Energy Regulatory Office's decisions enabling their installations to join the FIT and FIP system, and seek strategic documents and a legal framework, especially as regards SHPP refurbishment, which would include a time horizon beyond 2020. They also hope for effective management of State-owned weirs by newly established "State Waters" which will allow utilisation of existing weirs for hydropower purposes.

Ewa Malicka
President of the Polish Association
for Small Hydropower Development (TRMEW)

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# PROFESSIONAL DIVER – A SPECIALIST OF MANY SKILLS, **NECESSITY OR EXTRAVAGANCE**

**Dear Reader, you have probably been thinking repeatedly and asking yourself a question – what can divers do for hydroenergetics. I will try to answer this question clearly, but before that, I need to explain what is the difference between professional and amateur diving.**

In the Polish context, according to the Act on Underwater Works from 17 October 2003 (Journal of Laws No 199, Pos.1936, as amended), a person pursuing underwater works must have a professional license, while a company running such business must have at least one Certificate confirming implementation of the Safety and Health Management System PN-N-18001:2004 – pursuance of underwater works. Only a compilation of these two permissions allows a pursuance of underwater works and the job of a diver. Any other permissions in diving are amateur permissions and do not allow pursuing a job of a diver and underwater works. Moreover, according to the regulations of the aforementioned Act, a team taking part in the underwater works should consist of at least four people. Additionally, the team must include a person with a national license of Supervisor of Underwater Works, without whom any underwater work cannot be done.

## WHAT A PROFESSIONAL DIVER CAN DO?

Going back to the question – divers, during a long period of training, are prepared to pursue many jobs with use of technical equipment (hydraulic and pneumatic). They practice manual skills in works often done with zero visibility.

Their expertise, especially concerning hydroenergetics, include:

- review and underwater inspections,
- launching and sealing valves (stop logs) for the repair of turbine sets,
- exchange of trash racks,
- cutting and welding under water,
- concreting,
- conducting „thickness" measurements of pipelines and trash racks under water,
- cleaning "foreground" of inlet chambers from objects covering them (branches, rubble),
- removing alluvion with pumps and ejectros (a kind of a water or pneumatic pump using air or water power for transport of the output).

## REALITY OF WORK

Many factors influence the efficiency and safety of a diver during underwater works, e.g. his permissions and experience, depth, temperature, visibility, "closed" spaces, pollution, etc. We consciously omit here all the medical aspects, focusing only on technical issues. Therefore, it is indispensable to pursue the works in total isolation from the environment. For this, "dry" suits and diving helmets are used, which, despite full isolation, provide a connectivity with the surface and a possibility to breath with an air transported from the surface via ambilical. Unfortunately, there is a cost, the comfort of using such equipment comes with some limitations and load. The equipment put on by a diver weights several dozen of kilos, what is a big load on the surface, while underwater it definitely limits movements.

## COMMISSION FULL OF CHALLENGES

One of the most demanding underwater works among numerous commissions realized by the team of Orka Group Ltd., were the ones conducted in the Hydroelectric Power Plant Czchów. In order to carry them out properly, engagement of divers with big experience and preparation of a significant technical base were necessary. The work commissioned consisted in exchanging broken trash racks of turbine set 1 and 2, which most likely had been damaged due to oscillation and vibrations caused by water flow, as well as due to contact with large objects such as e.g. trunk snags.

As a part of this task we had to launch stop logs at the turbine set, and then seal them in order to secure the chamber of the turbine set against an uncontrolled inflow of rubble and other pollution. Otherwise, there would be a big risk of breaking the turbine. The operation consisted of two tasks – launching and sealing from "upper and down" water. Then, the rubble was removed, the foot of the trash racks was cleaned from slit, and the welds fixing the

Photo: Extraction of the damaged trash racks

Photo: Example of damage to the trash track

trash racks were cut off. The next step was bringing old trash racks to the surface. The operation described above make an impression of an easy and simple one. Unfortunately, in reality it looks completely different and neither best qualified people nor best equipment has an influence on it. Because of unexpected situations, members of the team carrying out the commission have to be flexible and have a non standard approach to solving encountered problems. All the complications which occur are described below in order to explain the degree of complexity of the operation conducted in the Hydroelectric Power Plant Czchów.

## PROBLEMS ENCOUNTERED

In spite of great cooperation with the team which gave the commission and engagement of the contractor, some difficulties occurred in the form of sealing valves in the hydroelectric power plant built in 1936-1949, caused by big material wear of the infrastructure. Despite exchanged bars, precisely cleaned threshold and installment of new sealing gums, leaks through the locks were still occurring. The leaks were stopped after two days of intense work.

The next stage was to remove the rubble and clean the foot of the trash racks from slit. However, after removing the covering layer, with countless amounts of foil, bottles and branches, we found large snags of trees stuck into lower parts of the trash racks. Removing them was another quite complicated task.

After cutting off the weld of the upper part of the trash racks with use of gas burner, another surprise appeared. During an attempt to remove the trash racks, they turned out to be blocked on crossbars welded into them and it was impossible to remove them. Unfortunately, the divers could not do much with the trash racks which had over eight meters height and weighted several tons. After a brain-storm we found a solution consisting in introducing a tackle (pulley) with repeated shift and in pulling away the trash racks from the wall of the dam. Thanks to such solution, the removal of the trash racks to the surface was possible. When one thing goes right, another problem pops up. In our case, the trash racks which were being pulled away brought another part of slit to the cleaned threshold, and a small water flow going to the turbine set 2 carried it into already cleaned places, what definitely extended the operation of installing new trash racks. We had to clean the threshold with use of a dipper (a kind of fire-hose nozzle) powered by water under pressure. It is worth mentioning here the importance of precision of making new trash racks. A precision on the level of one centimeter was needed for the new trash racks, in order to make them all come into the place of the previous ones and fit into the rails guiding the cleaner trolley.

Another problem was lowering down the new trash racks in the place of the old ones in a way they would not block themselves again during pulling down, what was made with use of a gantry. For technical reasons, the gantry was only coming to the edge of the dam, and not outside of it, what resulted in a non axial pulling down of the trash racks. For technical reasons, use of a lift was also impossible due to the lack of possibility of getting to the outreach of the operation. A non standard thinking and quick reaction of the cooperating teams led to a solution also of this problem.

Special sledge, made of pipes, was used, on which the grilles were lowered, and after leaning the grille against a foot (a special construction channel in the concrete of the dam), it was taken out to the surface, and the trash racks put "themselves" in the proper position. After welding its upper part, we could approach further works and another tasks connected to placing subsequent trash racks.

The most important conclusion from the described renovation is the difficulty of predicting all possibilities, especially in the case of older hydroelectric power plants, the infrastructure of which is heavily worn. For that reason, it is indispensable to have experienced divers in the team and proper technical base thanks to whom it is possible to solve unexpected problems.

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We are grateful to **Orka Group** company for sharing photos.

# REINFORCED RUBBER **WEIR GATES**

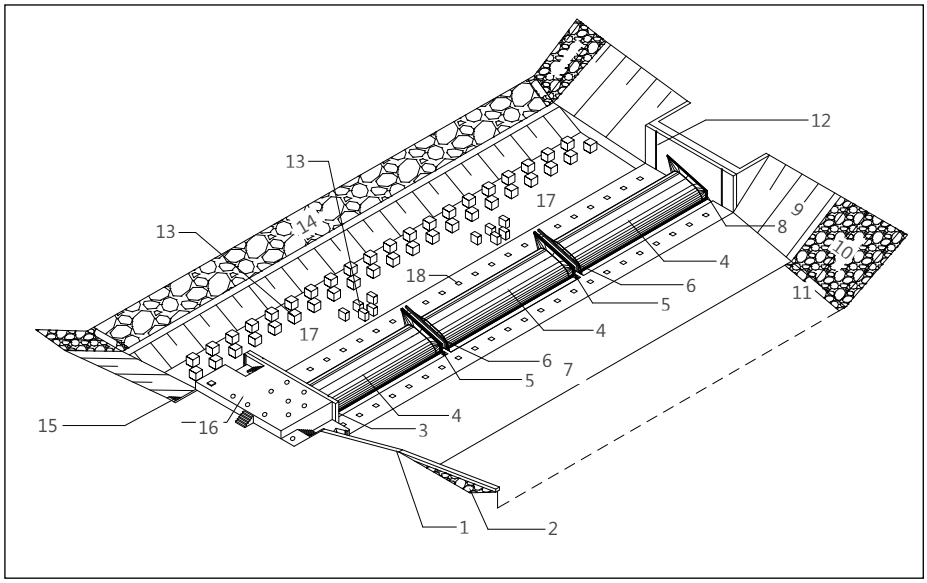
**Among many materials used so far in water civil engineering, the current technological progress is aimed at usage of materials based on synthetic resins, polyesters and elastomers. The sum of physical-mechanical properties of these materials ensures so far unexpected material endurance. Thanks to manufacture technology they are considered ecologically pure and come from recycling.**

AQUA-Tech specializes in the production of reinforced rubber weir gates. Since the beginning of the firm's activity, we have been introducing a number of innovative solutions for hydrotechnology.

## ELASTIC WEIR MEMBRANES

Our flagship product are elastomer inflatable weir gates used most often as an equipment of small hydroelectric power plants. Weir membrane is a polyester-polyamide composite joint with amorphic polymers (elastomers). This solution has a lot of advantages. The membrane diverts naturally river current from the bottom up to the head water level. Additionally, thanks to the resilience to freezing from the ice floe, this solution is very safe during winter exploitation. Thanks to the possibility to endure multiple reactive deformations – elastomer membranes are a very durable element of water dams in contrast to the steel materials (valves and steel flaps) used so far. Moreover, composite materials do not corrode in the water environment, and, thanks to this, they can be exploited numerous times without typical conservation with greases and lacquers, considered unfavorable for the natural environment. The way of filling weir shells with river water or air in a natural way is safe for water environment. Any breakdown of the system of weir shells does not lead to water pollution.The way of filling weir shells with river water or air in a natural way is safe for water environment. Any breakdown of the system of weir shells does not lead to water pollution.

Fig. Triple section weir gate




1 – weir wing, 2 – gabion mattress, 3 – fixed pillar left, 4 – inflatable gate, 5 – floating pillar right, 6 – floating pillar left, 7 – upstream apron, 8 – fixed pillar right, 9 – concrete slab, 10 – gabion mattress, 11 – gabion, 12 – renovation shutters guides, 13 – baffle blocks, 14 – stone overlay, 15 – access to the weir control, 16 – weir control shaft, 17 – downstream apron, 18 – slots for repair closures

## CONTROL OF THE FLAP WEIR

An innovative solution was the start of selling flap weirs controlled with an elastomer bladder. This solution is designed for low dammings, within head range up to 150 cm. These can be new installations or mounted on modernized permanent barriers. The first installation of this type was made for Oława HPP at the Oder river, where until 2014, the permanent barrier was modernized, on which a flap gate structure controlled by a hydraulically inflated weir bladder was placed. Similar solution was applied for the Nowogrodziec SHPP weir, but in this solution, the weir flap is lifted by a weir bladder inflated pneumatically. This type of installations can be used also as a retention reservoir gate in places located far from power sources.

Photo: Rubber weir in Kliczków SHPP launched in winter conditions

## AUTONOMOUS INSTALLATIONS

AQUA-Tech produces installations powered autonomously from renewable energy sources. Typical weir system is equipped with an elastomer weir bladder inflated hydraulically or pneumatically. Energy obtained from a renewable energy source powers the water pump or a compressor unit, thanks to which we receive a control of the weir membrane and keep the given level of damming of a river or reservoir of retention.

## CASCADE DAMMING

Another, new solution is the cascade damming system. It can be used in many inflated

Photo: From left: water inflated flap weir at Oława HPP, Oder river; pneumatic flap weir SHPP Nowogrodziec, Kwisa river

Photo: Cascade weir Leszno Dolne SHPP, Bóbr river

weirs with a potential of an additional damming in the low water periods. An exchange of weir bladder in existing weir installations is expensive. Looking for cheaper alternative solutions, AQUA-Tech worked out a new technology of cascade damming, which can be used as a supplementation of the already existing hydraulic bladders. A pneumatic weir gates installed on top of the water inflated bladder increasing thus the available damming height by some 50 cm.

Photo: Autonomous weir Krosnowice SHPP, Biała Lądecka river

Photo: Rubber weir Kliczków SHPP, Kwisa river

## MODULAR HYDROPOWER POWER PLANTS

Currently, together with Polish producers - WODEL and ELMARK companies - with support of the Instytut OZE and the KOMEL Institute, we are working on implementation of technology of a low-modular hydroelectric power plant of high energy effectiveness and minimal interference with the environment (island zero-emission micro power plants). The program is funded by the Polish Centre for Research and Development from the European Regional Development Fund. This solution, thanks to duplicated synchronous turbogenerator modules and weir modules, 3D controlled by a central unit uses optimally the energy of low-head rivers. Innovative modular technology of construction makes the structures cheap in erection and relatively effective.

In response to the market demand, AQUA-Tech company runs a number of innovative activities. Our knowledge, experience and will to develop is open for every Investor. We are happy to work on individual projects.

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We are grateful to **AQUA-Tech** company for sharing photos.

Source: www.zklaster.org

# ENERGY CLUSTERS ARE A NEW DIRECTION FOR **THE DEVELOPMENT OF DISTRIBUTED ENERGY**

**We are conducting activities aimed at the promotion and development of distributed energy at the Ministry of Energy in cooperation with other ministries and local government authorities. Such an approach results from the assumption that distributed energy will play an important role, in particular as an element of local energy security. This is confirmed by the observation of global economic trends, clearly aimed at the effective management of raw materials and local energy potential.**

Forecasts indicate that the development of distributed energy can be an important formula for supplementing energy supplies in less urbanized areas and rural areas. Technological changes are particularly important, they enable reducing the costs of energy production in renewable energy sources (RES) installations. When combined with the growing costs of $CO_2$ emission allowances and conventional fuels, investments in dispersed renewable energy sources (in particular in regions far from traditional generation sources) are becoming more and more profitable. The achievement of "grid parity" in a few years, i.e. a situation in which a renewable energy source enables electricity to be supplied at a cost lower than or equal to the cost of energy purchase in the power grid in relation to the most profitable wind and PV projects depends on further changes in commodity markets and on technological progress in the area of renewable energy sources. It will enable increasing the number of investments in the areas, which will also positively affect the development of energy clusters.

The role of dispersed energy has been strongly emphasized in the Strategy for Responsible Development (SOR), where it is one of the strategic projects. According to it, the main goal is "the development of electricity and heat production using renewable sources (RES) for the needs of the local community and creating regulatory conditions enabling the development of local energy-sustainable areas – energy clusters, energy cooperatives, etc." Importantly, the element of energy clusters, due to its cross-sectional nature, appears many times in the SOR in the context of the future development of the energy sector in Poland.

## ENERGY CLUSTERS PROJECT TAILORED TO LOCAL NEEDS

The concept of energy clusters emerged at the turn of 2015 and 2016, and formally the definition of an energy cluster was introduced into the Polish legal order by the Act of 22 June 2016 amending the act on renewable energy sources and some other acts (Journal of Laws, item 925). The definition of energy cluster has been formulated very broadly, so as not to limit or even encourage local communities to create individual solutions adapted to local needs. Thus, the energy cluster is a civil law agreement, i.e. a contract concluded by its participants. They can be natural persons, legal entities, scientific units, research institutes, as well as local government units. Its subject is the generation and balancing of demand, distribution, trade in energy (including from renewable sources) or individual elements selected by cluster members. The operation is part of a distribution network with a rated voltage of less than 110 kV. The area of the cluster's activity cannot exceed the boundaries of one poviat district or five municipalities. It is represented by a coordinator who can be any member of the energy cluster or a cooperative, association or foundation established for this purpose. It is therefore an agreement between locally operating entities involved in the production, consumption, storage and sale of: electricity, heat, cold and fuels.

The development of the idea of energy clusters leads to stable energy supplies and energy self-sufficiency at the level of the poviatdistrict, municipality or a single town. Their effectiveness depends on the rational and effective use of local potential: innovation and entrepreneurship in the area. Clusters increase local energy security in an environmentally friendly way, and the cooperation involved in their activities enables the use not only of local resources but also promotes the implementation of the latest technologies where they are useful and profitable. The innovative formula of this solution is mainly based on its flexibility,

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# Hydro Power VALVES

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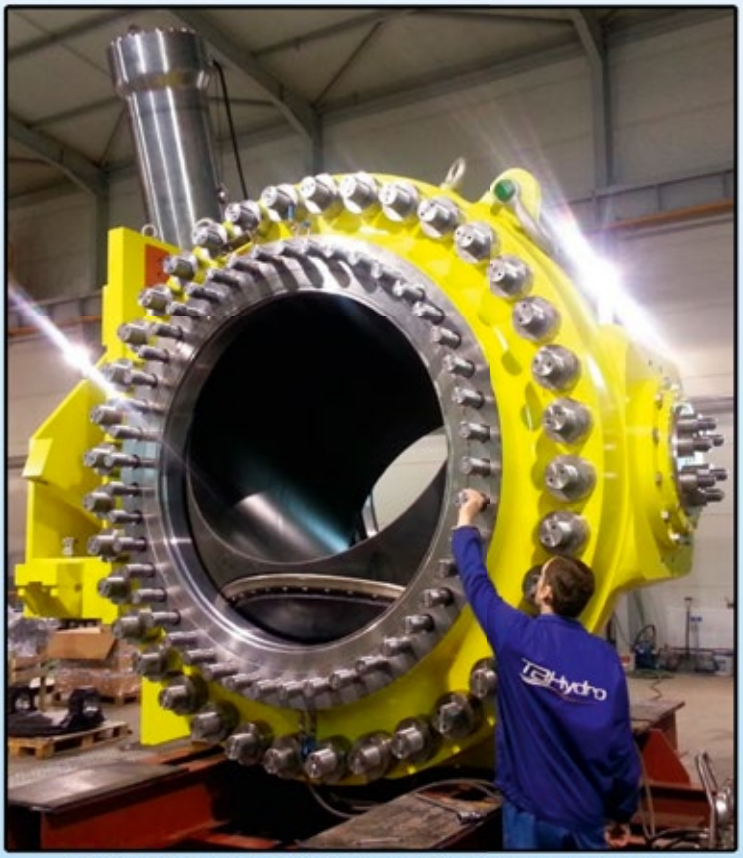
SPHERICAL TURBINE INLET VALVE TYPE SPV-2P-M DN1600

BUTTERFLY SHUTOFF VALVE TYPE BTV-B DN3250
BUTTERFLY SHUTOFF VALVE TYPE BTV DN1000



SPHERICAL TURBINE INLET VALVE TYPE SPV-2P-M DN1700

We are present all over the world

Lloyd's Register 9001:2015

thanks to which its participants can build an individualized business model and choose the right legal form of the activities.

### BEST INITIATIVES WITH THE PILOT ENERGY CLUSTER CERTIFICATE

The idea of introducing and developing the concept of energy clusters in Poland attracted considerable interest not only among the representative of the dispersed energy sector, but above all local communities. That is why we have conducted a competition thanks to which the best initiatives have been granted the Pilot Energy Cluster Certificate. It was a great opportunity to promote energy clusters, activate local communities and exchange experiences.

115 initiatives from all over Poland submitted projects to the first edition of the competition. After the formal and substantive evaluation of the submitted projects, the Ministry of Energy awarded 33 Certificates of the Pilot Energy Cluster in May this year. There are more and more initiatives, and interest is growing, another edition of the competition has been announced. This is an opportunity for those who have failed to obtain the Certificate in the first edition of the competition and new initiatives that have been recently created. We are planning the announcement of results and awarding the next Certificates of the Pilot Energy Cluster in October this year.

### ENERGY CLUSTERS, THE FUTURE OF ENERGY

The further development of energy clusters will depend on a favorable legal environment. That is why we are analyzing the existing activities of clusters and preparing solutions facilitating their functioning. We are also working on applications that will be the basis for the development of draft legal changes.

Energy clusters will become a tool for regional development policy used under Territorial Contracts in the future. They are mostly bottom-up initiatives that respond to local market needs. Proper integration of activities in this area of energy clusters at the regional level will enable broadening the scope of their impact. At the same time, they contribute to the implementation of national RES targets and will influence the country's energy policy. The energy clusters project is an opportunity to create new areas of activity for locally operating entrepreneurs and economic growth in the areas of their functioning. Effectiveness depends on the rational and effective use of the potential of locally available energy resources, renewable energy sources, innovation, entrepreneurship in the area of generation, transmission, distribution as well as energy receipt management. Reliability of energy supply, as results from the organization of clusters, will have a significant impact on the pace of economic and social development of less developed areas where there are difficulties with ensuring the continuity of energy supplies. Nevertheless, technical coordination between the generation, supply and use of electricity by entrepreneurs, in the public sector and households is also important.

MINISTRY OF ENERGY

Piotr Czopek
Agnieszka Przesmycka-Gołębiewska
Tomasz Chmiel
Ministry of Energy


# ON-SITE MACHINING FOR HYDROPOWER PLANT

**WWTECH offers innovative service services in the field of mobile machining on production facilities for the hydropower sector. The company focuses on mobile machining of main, including large-sized components of a hydro unit. These works are carried out directly on the site, without dismantling or with a considerably limited range. Our experience and specialist equipment places us on the leading position for this type of services in Poland.**

”

**The precision** of our measuring devices is **hundredths of a millimeter,** which is less than the thickness of a sheet of paper”

1

WWTECH ows fully equipped professional mobile machinery park, in practice allowing for all types of machining. Basic machines are mobile boring machines, flange lathes and milling machines, which are supported by drilling rigs, honing machines, beveling and over-lay welding machines.Such professional machines and equipment along with proper technolology guarantee opportunity to provide the highest quality service that results further, long-term and effective operation.

## The specifics of the company

The company WWTECH specializes in mobile machining - an unconventional approach to machining, where the traditional process of using stationary machines located in a remote service factory, which involves a wide range of disassembly, packaging, transport (often oversized), crane operations, etc. We perform machining on site. It takes place using devices designed for this purpose, which we assemble directly on the element requiring intervention. Our machine tools, due to their modular design, do not require special transport, but they are very easy to modify for a specific application. Short time of mobilization and fast reaching the place of failure, precision of execution and current control of progress as well as elimination of unnecessary costs are main advantages of mobile machining. The use of machine tools mounted directly on demanding fragments individualizes the entire machining process, which allows to perform different type of services and reduces to a minimum the risk oflong downtime or a lack of rewarding result. WWTECH ows fully equipped professional mobile machinery park, in practice allowing for all types of machining. Basic machines are mobile boring machines, flange lathes and milling machines, which are supported by drilling rigs, honing machines, beveling and over-lay welding machines.

Such professional machines and equipment along with proper technolology guarantee opportunity to provide the highest quality service that results further, long-term and effective operation.

## Experience

Each of the industries requires proper preparation and individual approach. This is extremely important in the most demanding branches - energy. Thanks to the proffesional approach, every the possibility of shape, position of individual elements and the structure being processed error is eliminated. "Usually, a part or machine must be dismantled and taken to a sta-

"Usually, a part or machine must be dismantled and taken to a stationary workshop or sent to the manufacturer. We make repairs on site, using our own ‘know-how’ and equipment created in our prototype shop. Often these are individual projects due to the task to which they will be dedicated.For example, such a machine was made from scratch for works at the Hydro Power Plant in Turkey .The aim was to perform surface tmechining for a slide bearing on the turbine shaft on the Tigers River. Once again, our company has proved that owning a design office and a team of experienced technologists and a tool shop equipped with the latest CNC machines guarantees perfect execution of complicated works. Our company completes many interesting Polish and foreign projects. Thanks to the quality of action and commitment, we share opinion of our innovativeness and being the industry leader in Poland and in Central and Eastern Europe. "

**Przemysław Wójcik**, founder and CEO of the WWTECH Company.


2

1. Machining of surface of the rotor shaft in Turkey

2. Machining of water turbine's bottom ring in Hydropower Plant in Poland

3. Coaxial machining for water turbine's guide vanes in Latvia

3

tionary workshop or sent to the manufacturer. We make repairs on site, using our own 'know-how' and equipment created in our prototype shop. Often these are individual projects due to the task to which they will be dedicated. For example, such a machine was made from scratch for works at the Hydro Power Plant in Turkey. The aim was to perform surface tmechining for a slide bearing on the turbine shaft on the Tigers River. Once again, our company has proved that owning a design office and a team of experienced technologists and a tool shop equipped with the latest CNC machines guarantees perfect execution of complicated works. Our company completes many interesting Polish and foreign projects. Thanks to the quality of action and commitment, we share opinion of our innovativeness and being the industry leader in Poland and in Central and Eastern Europe."

## Machine park

The hydro industry requires machining of large components and WWTECH is prepared for it. At the moment, we can machine the surface of 8 meter diameter. In the proces of production there is a machine that will perform a 12 meter diameter machining while maintaining tolerance and surface quality data. The entire machining process is accompanied by permanent metrological supervision, which supports and regulates the work of WWTECH staff. Professional, precise metrological devices for 3D measurements such as Laser Tracker and Measurement Arm, enable efficient implementation of projects with the highest accuracy regimes.

Experience, technical capabilities and good preparation allow our specialists to reach hard to get areas, all thanks to machines that can be divided into smaller modules, packaged, and then mounted on the processing site.

The WWTECH company constantly strives to improve the services provided. It is significant for the particularly demanding water power industry that we have obtained ISO 9001: 2015 Quality Certificate and we proceed to achieve ISO 45001: 2018 Safety Certificate. Since the company was founded in 2009, we can boast over a thousand successful repairs and measurements, which effects rapid development of the company. Plans for the future are to build and develope bigger machining center with employment of more engineers and operators. At the moment we are ready for further expansion of the domestic and foreign market.

### WWtech briefly

- Over 15 years of experience;
- Tools designing, backoffice, test station;
- The largest park of mobile machines in Poland; Stationary machining
- Stationary machining;
- Emergency tools & spares production;
- ISO 9001:2015;
- ISO45001 coming soon;
- Trading flexibility;
- Worldwide mobility;
- 3D Metrology

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The WWTECH Team

# HYDRO-POWER ENGINEERING - SERVICE

- Coaxial boring of steering paddles' mounting eg. for Deva sleeves
- Bearing holes legalisation
- Boring of large – scale water turbine elements
- Milling of large – scale water turbine surfaces
- Dowels correction machining
- Flange connection machining
- Valves machining
- Shaft coupling flange bolt hole boring and face machining

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# ERO EXPLAINS HOW TO ENTER **THE FIT/FIP SYSTEMS**

**The Amendment to the Act on Renewable Energy Sources, which came into force this in July, introduces new mechanisms of support for the producers of energy in smaller biogas power plants and hydroelectric plants. The Energy Regulatory Office explains here the procedures for producers wanting to enter the new system.**

The last amendment to the Act on Renewable Energy Sources, from 7 June this year, which came into force on 14 July, introduced FIT/FIP systems of support for RES installations up to 500 kW, in the form of fixed prices. Producers of energy from hydroelectric plants, agricultural biogas, waste biogas, biogas obtained from sewage treatment plants, and also biogas obtained in other ways, will be able to take advantage of this.

## BENEFICIARIES OF THE SUPPORT SYSTEM

A mechanism described in the Act as a feed-in-tariff (FIT) has been introduced for plants of less than 500 kW; for plants up to 1 MW there is a system described as feed-in-premium (FIP).

The new pricing mechanism may include schemes which are planned to go ahead, so far using the system of green certificates, implemented after 1 July 2016, which did not use an auction system, as well as schemes which won auctions as decided before the day the last amendment to the Act on Renewable Energy Sources came into force, that is, before 14 July. (After receiving a document of acceptance to the FIT/FIP system, the producer will lose the rights and obligations resulting from the auction system).

## APPLICABLE RULES

The fixed price for the purchase of energy in the FIT/FIP system will be 90% of the reference price for a given type of plant (these prices can be found in Article 8 of the Amendment to the Act on RES, of 7 June) and should be valorized annually, with an average annual index of the price for consumer goods and services together, from the previous calendar year. FIT or FIP tariffs should take effect for 15 years, but not beyond 2035.

Within the FIT system, the energy which is not used will be sold to an obliged vseller, while in the FIP system, the renewable energy producer will have to find a recipient himself and it will not be an obliged seller.

## PUBLIC AID

FIT and FIP mechanisms will have the same requirements for receiving public help as auction system. Producers wanting to take advantage of FIT or FIP must submit, together with a declaration about the intent of sale, the surplus of energy at a fixed price, an appropriate form providing information about the public help received.

As ERO emphasizes, submitting such a form, together with the declaration confirming the intent to enter the FIT or FIP system, is an initial requirement. If this is met, the next step will be verifying whether the producer can be included in either the FIT of FIP system.

The next requirement, resulting from public assistance, which may be in the form of the FIT and FIP systems, is to verify, with reference to the planned investment projects, the so-called encouragement effect. If an investor has already received investment assistance for his project, the fixed purchase price must be decreased accordingly (regulated by the art. 39A of the ACT on RES).

## INSTALLATION SCHEME

Having, by an installation of a renewable energy source, a separate set of devices serving to derive power exclusively from this installation into the grid, what should be confirmed by a proper scheme, is also a requirement of joining the new mechanism.

## SUBMISSION OF SUBSIDIES

The Energy Regulatory Office recommends submitting the FIT/FIP declaration together with necessary attachments and statements, via the On-Line Auction Platform, which, as ERO stresses, will significantly speed up the process of receiving the acceptance document, and this is also a step which is necessary to generate an individual account number so that it will be possible to pay the reservation fee.

The fee, of around 30 PLN per 1 kW, or a bank guarantee, will be returned within 60 days from the date of selling the energy within the FIT/FIP system for the first time, or up to 30 days from a decision about refusal of issuing the document of acceptance.

## START DATE IN THE NEW SYSTEM

The deadline for energy production within the FIT/FIP system for the first time is, for new schemes, 36 months from the day of issuing the document of acceptance. And for the schemes which began previously, or started after 1 July 2016 using green certificates – the start of the energy sale must occur not later than the first day of the month which is 3 months after the date of issuance of the document of acceptance.

For installations where an auction has been won, adjudged before the day of the last amendment to the Act on RES coming into force, the rights and obligations of this producer, resulting from the auction system, will expire before the end of the quarter following the quarter when the producer received the document. The start of production of energy in the new system will occur at the beginning of the second quarter, following the quarter when the document was received.

Obtaining the document to enable the sale of energy within the new system, but failing to begin producing the energy before the give deadline, means it will not be possible to re-enter this system for three years, and the producer also could be subject to a fine of 1000 PLN for each 6 months without fulfilling the obligation, starting from the day of the obligation coming into force.

When an obliged seller has to be a contractor, it is necessary to sign a contract with him within 1 month from obtaining the document, in the case of installations producing energy, or 6 months in the case of an investor who is going to start production.

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# THE CZORSZTYŃSKI RESERVOIR **ENERGY CLUSTER**

**The article focuses on the process of creating energy clusters in Poland, and on the role of the Czorsztyński reservoir energy cluster in this process. A short description of the planning of the Czorsztyński Reservoir and of its current update. The article also includes a few observations about the influence of current tariff regulations for the emobility field. Finally, conclusions are drawn from recent operating experience.**

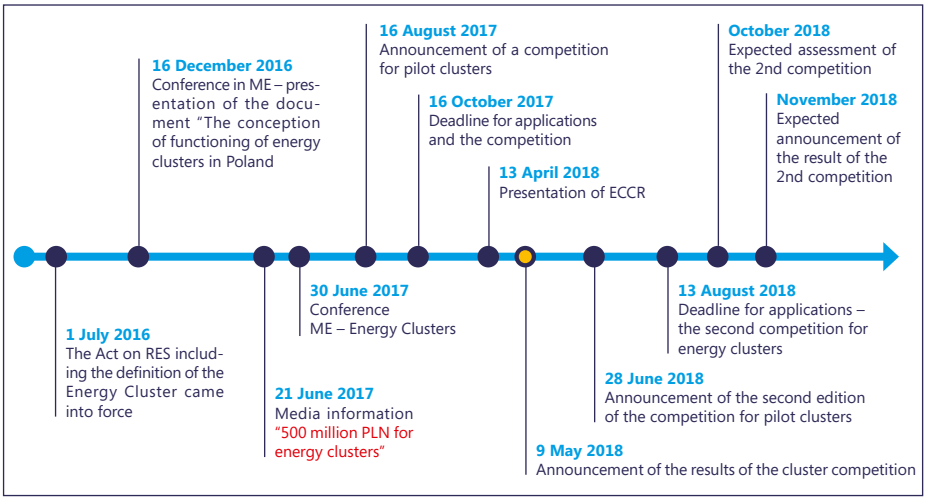
The Energy Cluster of the Czorsztyński Reservoir (known as ECCR) is located near the Czorsztyński Reservoir (Fig. 2). The ECCR covers the territory of three communes (Czorsztyn, Łapsze Niżne, and Nowy Targ).

The members of the cluster are the aforementioned communes as well as two business entities – Podhalańskie Municipal Enterprise [Podhalańskie Przedsiębiorstwo Komunalne Sp. z o.o. (PPK)] and Hydroelectric Power Plants Group Niedzica [Zespół Elektrowni Wodnych Niedzica S.A. (ZEW Niedzica)] – serving as the coordinator of the cluster. The selection process for the members of the cluster was actually natural – the initiator was ZEW Niedzica, which had been functioning for 20 years – administering production sources. Based on the up to date business and social relations the initiator offered to three local communes and to the entity PPK – having in the reception basin of the Czorsztyński Reservoir several dozen of receivers (pumping stations and sewage treatment plants), creating an energy cluster.

The main goals of the members of the cluster are as follows:

- improvement of local energy security and reliability of the power supply,
- reinforcing the local economy by optimization of the use of locally available energy resources, in the form of renewable energy sources and other pro-effective activities,
- improvement of the local natural environment, including air quality,
- integration of firms and institutions around the activities aimed at economic development of the region of the Czorsztyński Reservoir and realization of common interests of the Cluster members,
- raising ecologic awareness and implementation and consolidation of the standards of production of energy from RES, according to the idea of sustainable development and high energetic efficiency.

Fig. 1. The most important events related to the creation of energy clusters in Poland




## THE CZORSZTYŃSKI RESERVOIR

Czorsztyński Reservoir was created as a result of storage of water from the Dunajec and Białka rivers following the construction, between 1975 and 1997 of a dam in Niedzica. On 1 January 1998, the exploitation of the reservoir and two hydroelectric plants, as well as of the associated infrastructure them was started by a joint-stock company created for this purpose, called Group of Water Reservoirs Czorsztyn – Niedzica – Sromowce Wyżne [Zespół Zbiorników Wodnych Czorsztyn - Niedzica - Sromowce Wyżne] – current name Group of Hydroelectric Power Plants Niedzica [Zespół Elektrowni Wodnych Niedzica S.A.] (100% of the shares belong to the Treasury). The Czorsztyński Reservoir has a usable capacity of 136.78 mln m$^3$ which, as a result of storage at around 43±2 m and augmenting the reservoir with the waters of the Dunajec and Białka with an average SSQ of 25.46m$^3$/s, allows for annual production of between 61.8 and 133.2 GWh of renewable electricity. The generation over the last 10 years are presented in illustration 3. Administering such a large energy potential, already – in 1999 year, the Board of the joint-stock com-

Fig. 2. The area of the Energy Cluster of the Czorsztyński Reservoir - the blue color of three communities

pany assumed activities aiming at making ZEW Niedzica a local energy company. A 15 kV cable was laid in 2000 at the bottom of Czorsztyński Reservoir, which was the start of building a distribution network to supply local consumers, the number of whom was increasing from year to year. The majority of the consumers were located on the then undeveloped banks of the Czorsztyński and Sromowiecki Reservoirs. Localization of the 15 kV cable enabled the beginning of the distribution activity, which today has about 150 consumers and distributes about 10 GWh/year of electricity (the average instant power charged by the consumers is more than 1.1 MW).

## PREPARATION OF ECCR STRATEGY

The members of ECCR decided that because of the need for a customized strategy, a document would be prepared without the help of external entities. It was decided that a team for strategy preparation would be created, and that it would include six people from ZEW Niedzica and one person indicated by each of the other members of the cluster. In total there were 10 people, who came together to verify data about, among others, production and use of energy, investment needs, etc. Dozens of analyses were conducted and, as a result, preliminary selections were made and 27 of the most efficient projects were selected to be introduced to the strategy. It was quite big and efficiently conducted project; in total, 2000 working hours were devoted over about six months for the preparation of the strategy document. Selected projects can be divided into the following groups:

- Building new RES sources (10 projects – 8 MW of hydropower, and 4.5 MW solar PV),
- taking advantage of high temperature, energetic efficiency and anti-smog activities (10 projects, for example, In the season 2017/2018 air cleanliness measurements were done at 15 locations),
- emobility (4 projects, eg, a rental place for electric cars and bikes was set up next to a tourist walkway on the crest of the Niedzica dam),
- activities promoting energy clusters (3 projects, eg, Annual Open Day of the ECCR).

The strategy prepared in this way was submitted, together with a competition application for so called "1st competition for pilot energy clusters".

## THE RESULTS OF THE FIRST COMPETITION CERTIFYING PILOT ENERGY CLUSTERS

The results of the competition were announced, by the Ministry of Energy, on 9 May 2018. Later media information concerning the result of the competition was presented; this was posted, among other places on the portal www.cire.pl.

*„The competition for pilot clusters was announced by the Ministry of Energy in August last year. There were 115 applications submitted for the competition, over 70 of which went through the first stage of formal assessment and were qualified for the assessment of the content. The entities participating in the assessment of the content had the possibility to make a presentation, in the seat of the Ministry of Energy, of the conception of functioning and development of their cluster. The projects with the highest rate received the Certificate of Pilot Energy Cluster. 33 Certificates of Pilot Energy Cluster were awarded; the 10 best received a certificate with distinction. The name of the leader in the competition was awarded to the Energy Cluster of Czorsztyński Reservoir, which received the maximum points at the stage of the assessment of content.*[1]

It is worth mentioning that the team who worked on the ECCR strategy was very satisfied with the information that ECCR "received the maximum points at the stage of the assessment of content". No less effectively, it passed the stage of the formal assessment, that is, without a need to make any supplement to the application.

## SPECIFIC SIGNIFICANCE OF HYDROPOWER IN THE CONTEXT OF ENERGY CLUSTERS

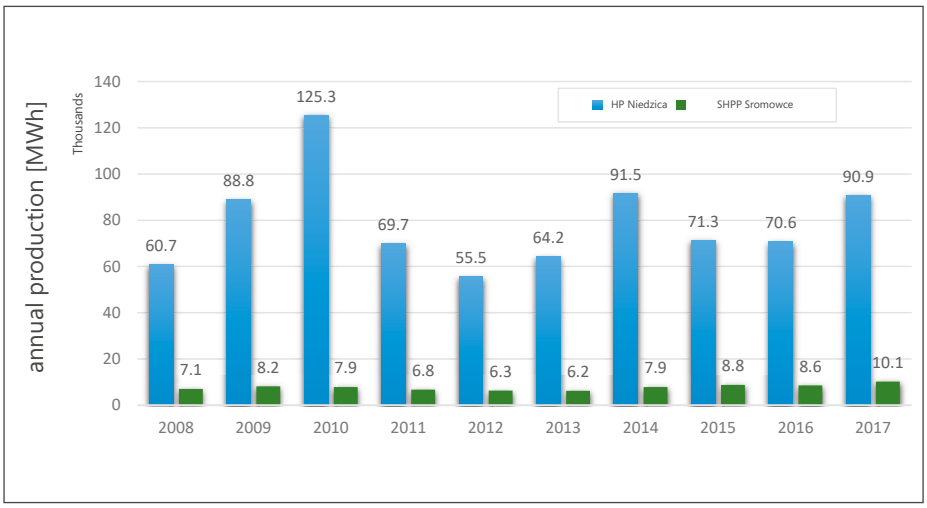
ECCR is mostly based on hydropower. This results from natural conditions and the fact that hydro-power engineering is perfect for stable power supply and balancing local areas; this actually originated 100 years ago, through numerous uses of water power fall in mills and sawmills. In many cases these were subsequently transformed into hydroelectric plants. During the work on the ECCR strategy, two sources of energy were compared SHPP of reachable power of 1.4 MW and a photovoltaic farm re-scaled in the analysis to the power identical with SHPP. As a result, the advantage was confirmed of the hydropower source over the solar PV one. However, we should not underestimate the positive values of the latter, such as covering the demand during peak hours. Most often the profile of the larger group of consumers includes a daily increase in demand, thus the best solution is combining the two types of sources in appropriately selected proportions, that is, stable and most often sequence hydro generation properly selected for the peak demand of the solar PV farm.

## PREVIOUS ACHIEVEMENTS OF THE ECCR.

ECCR is implementing actions described in its strategy as intensely as possible. So far, the following tasks have been completed:

- Measurements of air quality have been conducted. The results are presented in Illustration 4 (a chart covering one day of measurements). An increase in the level of air pollution during the afternoon lighting of furnaces by local inhabitants can be clearly seen,
- free parking for electric vehicles with a place for charging them has been provided,
- boiler houses heated with expensive heating oil (because of a lack of natural gas in a large part of the cluster area) have been replaced by a number of installa-

Fig. 3. Annual generation from the hydropower plants located in the cross-section of Niedzica and Sromowce




[1] Portal www.cire.pl – article from 10 May 2018, entitled "Which clusters won in the competition of the Ministry of Energy

tions based on air heat pumps powered 100% by local renewable sources have been installed,
- open days of the ECCR have been organized twice, with presentations, after which the participants could take part in a discussion,
- two electric bike rental places for tourists have been organized,
- a successful pilotage of heating up buildings with cheap electric energy during non peak hours (mostly nights and weekends hours accompanied by a surplus of cheap energy from RES) has been conducted,
- Several renewable energy projects are being prepared, for obtaining building permits.

## EMOBILITY

There are two charging points for electric cars functioning in the area of the cluster: on the parking next to EW Niedzica and near to the crest of the dam, which is a popular tourist walkway. ECCR is considering the future installation of a fast and ultra-fast charger, filling the gap for more than 100 km on the map of such chargers. Following analyses concerning the installation of the chargers, a problem of a very high proportions of fixed cost in the OPEX area (operational expenses) was identified, which could be a significant obstacle in the early stage of the development of emobility in Poland. The proportion of variable costs associated with the delivery of energy for charging a car exceeds 40% of the total energy costs only after exceeding 200 to 1500 charging cycles per year, depending on the charger's power. In

Fig. 4. Diurnal measurement of air purity with a visible morning and evening increase in PM10 and PM2.5 levels - caused by firing up furnaces in individual boiler rooms

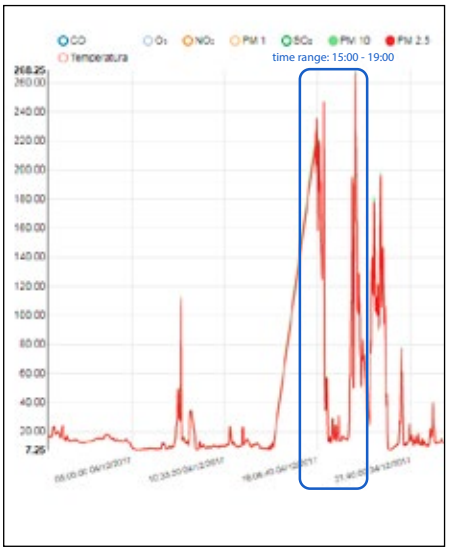
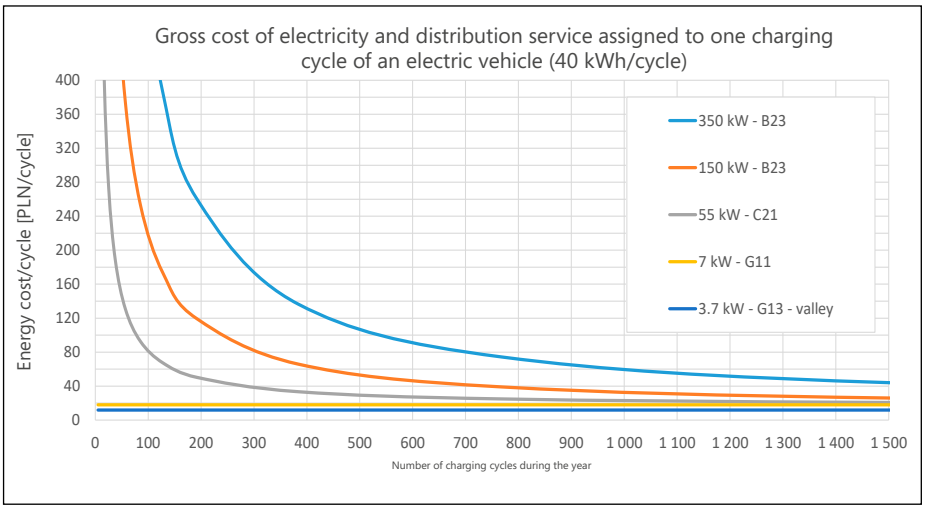



Fig. 5. The relation of the unit cost of energy supply to the charging of the electric vehicle and the number of loading cycles during the year




the opinion of the author, it will constitute a significant barrier to the development of the charging station; especially the big CAPEX (investment expenses) connected with the purchase of the charging station will increase the fixed costs of this kind of activity even more.

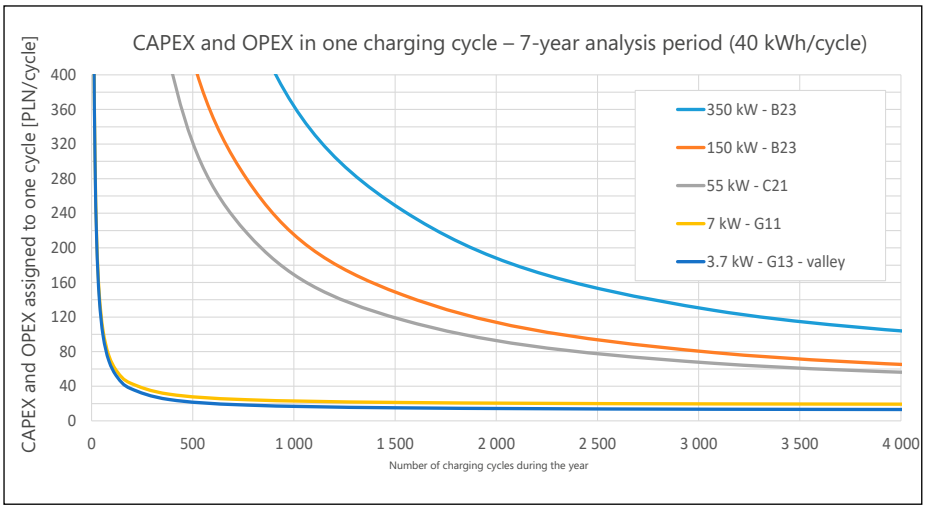
The best way to overcome this obstacle may be the creation of special tariff groups for charging stations for electric vehicles, that is, tariff groups characterized, in the first years of functioning of the emobility programme, by a very low proportion of fixed fees while settling with the recipient – possibly being compensated by increased variable fees. One of the possible solutions could be proportions between variable costs' participation and fixed costs' participation the same as for recipients from G group (individual customers). In the ZEW Niedzica tariff, recipients from G groups have around 92 per cent participation of variable costs in the total costs of the energy supply. In the simulations studied, the current tariffs of distribution companies have brought such proportions only with 380 to 3100 charging cycles per year respectively, for chargers of 55 kW and 350 kW. Such number of charges will probably be achievable only over a few years. Illustration 5 shows the relationship between the single cost of energy delivery for charging electric vehicles and the number of charging cycles during a year. It is easy to see that large and fast chargers will have three or even 14 times higher energy costs assigned to one cycle, at 1500 charging cycles per year and 200 charging cycles per year, respectively. As a result, the owners of electric vehicles will be limited to charging in their garages, using WallBox type chargers of about 7 kW, and regular network chargers connected to electrical outlets of 230 V (both able to be installed without additional fixed costs, within owned contracts for energy delivery to their houses). The relationship shown in Illustration 5 is even worse when investment outlays associated with the purchase of the charger are included, as can be seen in Illustration 6. In this case, the quotient of charging costs at an ultra-fast charger in comparison with a charger of the WallBox type or a regular network charger connected to the 230 V outlet gives a 12 times higher value for 1500 charging cycles and a 42 times higher value for 200 charging cycles per year, respectively.

The necessity of changes in the method of tariffing should start to be considered already from 2019, otherwise implementation and popularity of emobility in Poland will be significantly delayed.

## CONCLUSIONS AND PROPOSED DIRECTIONS OF ACTIVITES

Summarizing the article, which has merely touched on a fragment of the broad question of energy clusters, the author would like to propose some priorities regarding the current stage of developing energy clusters in Poland. To implement energy clusters in Poland rapidly we should:
- promote clusters which are successful –to attract the interest quickly of entities and individuals who are the potential starting points for new cluster initiatives,
- simplify as much as possible the tariff process for the case of dispersed energy production – for instance, in the distribution costs of the consumer in a given network – including that belonging to the cluster, are lower than at proper OSD (dis-

Fig. 6. Presentation of the CAPEX and OPEX relations assigned to the 1 cycle of charging the electric vehicle and the number of cycles of charging the electric vehicle during the year




tribution network operator), on whose area the cluster is located, apply maximally simplified tariffing process. In the case of ZEW Niedzica, the number of cells in the submitted tariff applications exceeds 20 000, with 10 000 of them being of greater significance, it seems to be too big formal load – conducting tariffing process at such level in particular,

- support the development of innovative solutions in dispersed energy production – for instance, minimization of the number of documents in hard copy format, development of Blockchain technology for application in clusters, electronic information platforms for exchanging experience between clusters and for contacts between members of individual clusters,
- support the possibility of simple communication and exchange of experience – one possibility would be to organize thematic discussion forums, or webinars, which would avoid the necessity to travel for several hundred kilometers.
- prepare, at central level, standards for dispersed energy production – that is, analyse possible large number of cluster initiatives, prepare handouts in the form of road maps for creating energy clusters, indicate the profits to be made from energy clusters and legally regulate in the future Act on Dispersed Energy Production only to the extent which is absolutely necessary,
- provide financial resources to support energy clusters – especially at the pilot stage; this would fulfill the announcement in the media "500 million PLN for energy clusters", which, a year ago 'electrified' the entire sector so much that there were not enough seats at the conference which took place on 30 June 2017.

The author would like to encourage readers to contact (marcin.skornog@niedzica.pl), to ask questions and exchange experiences; at the same time, he wishes success to all engaged in developing the idea of energy clusters in Poland.

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We are grateful to Marcin Skórnóg, **ZEW Niedzica** company for sharing photos.

# SHPP ZAGRODY – **AN IDEA FOR AN OLD MILL**

**Small Hydroelectric Power Plant "SHPP Zagrody" was put into operation in September this year. It is already the fortieth SHPP functioning in Świętokrzyskie Voivodeship and the fourth which uses the technology of hydrocomplex in the form of Archimedes' screw. For realization of the project responsible was the project company Instytut OZE Ltd. The power plant equipped in Archimedes' screw, provided by Enerko Energy Ltd., produces electric energy at the level of 150 MWh annually.**

Photo: Construction area during installation of Archimendes' screw, on the photo we see the old hydrotechnological system, supplemented with the newly built fish pass.

The small hydroelectric power plant has been build in the immediate conservation zone – of the complex of water mill in Markowizna, in Sitkówka-Nowiny commune. It is the best preserved mill in the commune, with working water system which had to be preserved as an example of a complete installation. Water mills are the monuments of technology of great significance due to the industrial traditions of the commune. Archimedes' screw uses the potential of historically industrious river Bobrza. Industrious because it used to supply a number of factories and mills. Only in the Sitkówka-Nowiny commune's area 3 water mills were located. Bobrza, being a right and the longest tributary of Czarna Nida, flows through the Nothern, North-Western and Western edge of Świętokrzyskie mountains. It is 48.9 km long, and the terrain of its catchment occupies 379 km$^2$. Localization of the new SHPP is in the lagging of Chęciny-Kielce Area of Protected Landscape.

## PROJECT WORKS

The process of preparation of the investment lasted over 2 years. Due to the attractiveness of nature of the localization and environmental conditioning, it was necessary to carry out the assessment of its influence on the environment and to design a fish pass. The environmental decision about water-legal permission and remaining agreements and permissions indispensable for obtaining the decision of permission for construction were made by the company Instytut OZE Ltd. Due to the fact that the investment was being realized in an immediate neighborhood of a monument of technology, the existing part of it had to be preserved. Installation of the Archimedes' screw was designed in parallel to the existing turbine cage where a water turbine used to work for the mill's needs. The elevation of the building of the new SHPP was covered with natural lime stone in order to maintain architectural consistency with the neighboring building of the historical mill. In addition, the owner of the object used the space between the channel of the Archimedes' screw and the residential building for construction of a recreation terrace. Finally, the entire object looks unusually attractive. It is a great example of an adaptation of a historic mill not only for the purposes of a new hydroelectric power plant but also of taking advantage from the charm of localization and of creative use of this potential. Instytut OZE has big experience in designing new hydroelectric installations in the areas of water mills, often devastated. The portfolio of the company includes already over a dozen of such revitalizations. The company works on complex design of small hydroelectric power plants including obtaining necessary administrative decisions based on the proxy granted by the investor.

## ARCHIMEDES' SCREW

SHPP Zagrody, equipped with asynchronic generator Cantoni Group, is able to generate 37 kW. The element which distinguishes this installation is the inverter system made by ABB, which enables work with variable rotation speed ensuring maximum use of the potential of flowing waters. The Archimedes' screw was made as a steel construction hanged on the edges in bearing made by FAG. The angle of the turbine axis in relation to the level is 22°. The screw itself consists of a steel tube and Archimedes spirals wrapped on it with a diameter of 2600 mm that are angularly offset from each other by 90°. The hydrocomplex was placed traditionally on a concrete steel gutter. Enerko Energy Ltd. also has in its offer Archimedes' screws built in self-supporting steel structure and Kaplan turbine in various systems of S, PIT, Z types and of vertical axis. Apart from providing water turbines, the company also offers services of complete construction of small hydroelectric power plants.

## AUTOMATICS OF SHPP

The control and automation system of the power plant is based on the programmable modular PLC of ABB production and the HMI panel enabling setting param-

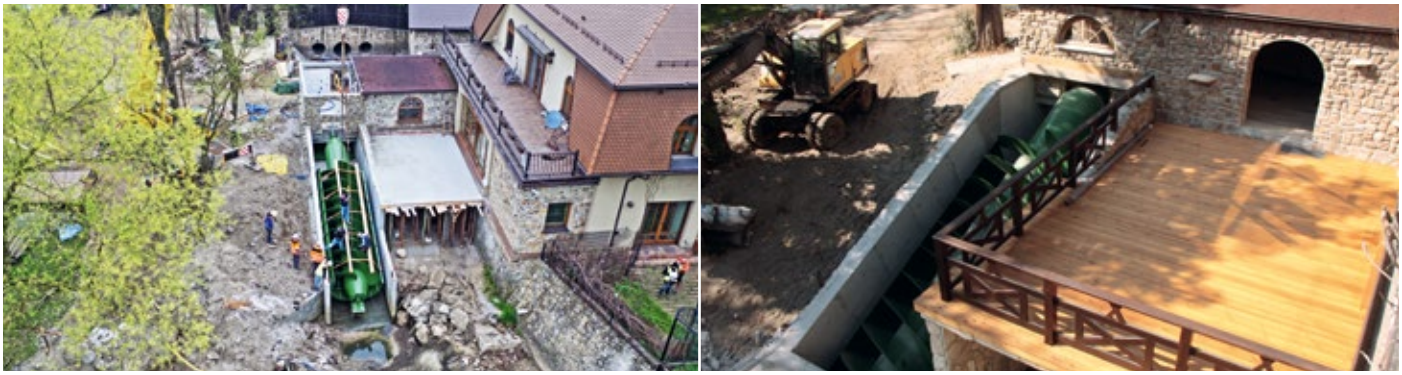
Table: Summary list of the main technical parameters of the hydro unit

| Type of turbine | Archimedes screw |
|---|---|
| flow rate | 2.0 m$^3$/s |
| head | 2.5 m |
| runner diameter | 2 600 mm |
| runner speed | 22.3 rpm |
| installed capacity of the generator | 37 kW |
| average annual production | 150 MWh |

*Source: Enerko Energy*

Photo: From the left – historical turbine case, revitalized water mill before transformation into SHPP

Photo: From the left. A challenge during installation of Archimedes' screw was its transport from the semi-trailer to the channel because of high trees located in the immediate neighborhood. Development of the old outlet channel into recreation terrace.



eters of work of the hydrocomplex and updated screening of current electric and mechanical parameters. The operating panel is equipped with the port of Ethernet standard and software enabling online view on selected computer connected to the Internet, according to the same rules of access that direct operation. The controller having modular construction allows a hassle-free extension of its functionality in additional modules. The controller is powered by constant voltage 24 VDC by buffer power supply equipped with gel batteries enabling work in case of power failure. In normal conditions it functions as an automation system power supply and battery charger. In case of power failure, it automatically switches off it and transfers power from the batteries. After return of power, it charges batteries. The controller is collecting up to date signals from a number of installed sensors as well as of gauges of network parameters. The most important monitored elements include:

- rotation speed,
- temperatures,
- water level before and behind the grille,
- logical positions of the equipment,
- water flow through the turbine,
- the level of dam opening,
- energy quality,
- energy production,
- level of hydraulic power.

The power plant uses an inverter system thanks to which a smooth change of rotation speed of the generator is possible, what, at particular hydrological parameters, enables obtaining higher efficiency of the hydrocomplex. The power plant has also been equipped with information system SCADA for communication, monitoring and archiving of exploitation parameters of the power plant, thanks to which there is a possibility of efficient constant remote control over proper work of this object. The solutions used here allow making work of the object's operator more efficient through the remote collection of measurement data from the power plant work and archiving them. In turn, the implemented software enables showing data in the tabular, numeric or graphic form, what increases correctness of functioning of such installation, enables optimization of work, what is followed by increased security and efficiency of the power plant.

## EXAMPLE OF A GOOD PRACTICE

This investment is another revitalization of an inactive hydrotechnological object thanks to engagement of private sector. It is a good example of development of formerly functioning water plants using locally available hydroenergetic potential. Existing infrastructure and comfortable terrain conditioning enable obtaining high profitability of projects in such localization. It is worth to recall the information about the hydroenergetic potential of Poland provided by the Polish Association for Small Hydropower Development. In the 1950s around 6.5 thousand hydroelectroc power plants were functioning in Poland. Today, their number does not exceed 770 and over 81 percent of technological potential (about 50% of economical potential) is not used in the territory of our country. According to current assessments, there is around 7.5 hydrotechnological objects in Poland which are not used for energetic purposes. Poland has conductive conditioning for the development of hydroenergetics, especially in the form of SHPP, although the pace of activating the new production powers is still too low.

However, considering the fact that the Act of RES supports, in particular way, the development of hydroenergetic installations in Poland, in the coming years we will surely observe a boom in the industry of small hydroelectric power plants.

Łukasz Kalina
Business Development Manager
Enerko Energy

We are grateful to **Flyingfox Michał Lis** and **Enerko Energy** for sharing photos.

# MŁYN WIELISŁAW – **AN UNUSUAL TECHNICAL MONUMENT**

**Millions of years ago, the landscape of the nearby Kaczawskie Foothills could be compared to hell - all because of hundreds of volcanoes, smoke, discarded ashes and darkness enveloping the entire region. Today, the remains of that period serve as a huge tourist attraction and are often still unknown to us despite their proximity. In the heart of the 'Land of Extinct Volcanoes', we can find a place that is an unusual technical monument from the early 19th century - the place is Wielisław Mill.**

More than 190 years ago, at the foot of Wielisławka Hill near the Wielisław Organs, a water mill was built, which was driven by a turbine supplied with water from the Kaczawa River. A few years ago, this building became a home for two people from Poznań, who decided to reactivate the small hydropower plant there and create a guesthouse and restaurant in its historic interior.

## THEY HAD A PROSPEROUS BUSINESS, BUT THEY NEEDED A CHANGE

For the owners of Wielisław Mill, the reason for investing in the hydropower plant in 2009 was the Government's incentive for investments in renewable energy. The search for the site for renovation began in the Drawsko Lake District. However, that location did not appeal to them. However, it was different in Lower Silesia, as there was a place with a soul that they came across...

## ALTHOUGH THEY LIVED IN A POWER PLANT, THEY INITIALLY DID NOT HAVE ELECTRICITY

The beginnings were not easy. The power of the Sędziszowa plant is estimated at 45 kW - the paradox was that the new tenants of the historic mill had to struggle with a the lack of electricity. Their new location required renovation and restoration of its former splendour.

It was possible to recommission the power plant relatively quickly. The machines were in quite good condition and required only a slight renovation. It was a profitable business for the owners, but not enough to become the only source of income - their main business still remained in Poznań.

In 2010, it was decided to somehow develop the mill area. This was more challenging, as the greatest obstacle was the lack of professionals who would undertake such a task. A neighbour, who turned out to be an amazing professional, helped the owners with work on the renovation of buildings and some ancient pieces of equipment. Another problem, which almost ruined the plans, concerned formalities and official procedures. For almost half a year, the owners had to wait for the decision of the monument conservation officer, who had to decide whether the mill was to be protected or just the opposite. Unfortunately, the huge number of legal procedures often deters people from investing in old houses and often decaying monuments. The initial plans of the owners of Wielisław Mill did not foresee the opening of a guesthouse - this concept emerged thanks to tourists interested in this unusual technical monument.

Soon, the power plant with its mill turned into an attractive agricultural facility. Amazing accommodation and a restaurant were created in the restored building. It is worth noting here that as enthusiasts of old devices, the owners had never wanted to change the character of the building - all the devices were skilfully incorporated into the living and dining space.

Photo: The original equipment of the mill integrated into the current design

Photo: A relic of Permian volcanism - "The Wielisławskie pipe organ"

Wielisław Mill was built in 1827. The mill buildings consisted of the main building as well as the granary, barn and several other farm buildings. The mill was supplied with water from the Kaczawa river through a water channel called Młynówka. Today, Młynówka supplies the small hydro plant located near the building.

## THE LAND OF EXTINCT VOLCANOES TEMPTS WITH ITS BEAUTY AND MYSTERY

According to the legend, the treasures of Wrocław are hidden inside Wielisławka Hill, which can only be accessed with numerous tunnels and adits. However, no entrance has been found so far. The Land of Extinct Volcanoes abounds in numerous places for recreation - From our habitat, you can quickly get to various interesting places not only in the Kaczawskie Mountains and Foothills, but also in the Karkonosze Mountains, the Jizera Mountains range or other locations in the Sudetes range - say the owners of Wielisław Mill. Exactly. Wielisław Mill can be an excellent starting point to explore various interesting places in the area, where everyone will find something for themselves.

For parents with children, a great idea may be the Sudecan Educational Farm in nearby Dobków, which is a modern interactive learning centre located in a 19th-century farm. There, both children and adults can learn more about the region's volcanic past in a very accessible way, through games as well as digital and moving models. Another place which is a real must-see for tourists visiting this region is Wielisławka Hill, built of Permian porphyry, on the slope of which porphyry excavation began in the mid-19th century. Quartz porphyry, the distinctive bar structure of which resembles an organ front, was uncovered during the works, hence the name Organy Wielisławskie (eng. Wielisław Organs). On the western slope of the mountain (about 100 meters from the Mill) is Wielisław Cave, which is a natural volcanic vent hole enlarged during mining works in the 16th century. The cave corridor is approximately 100 m long and up to 3 m wide. On the top of the mountain, we can find the ruins of Knight-Bandit Wielikosław's castle as well as the ruins of the former shelter and restaurant. The mountain top also constitutes a vantage point, from which there is a view of the surrounding mountains.

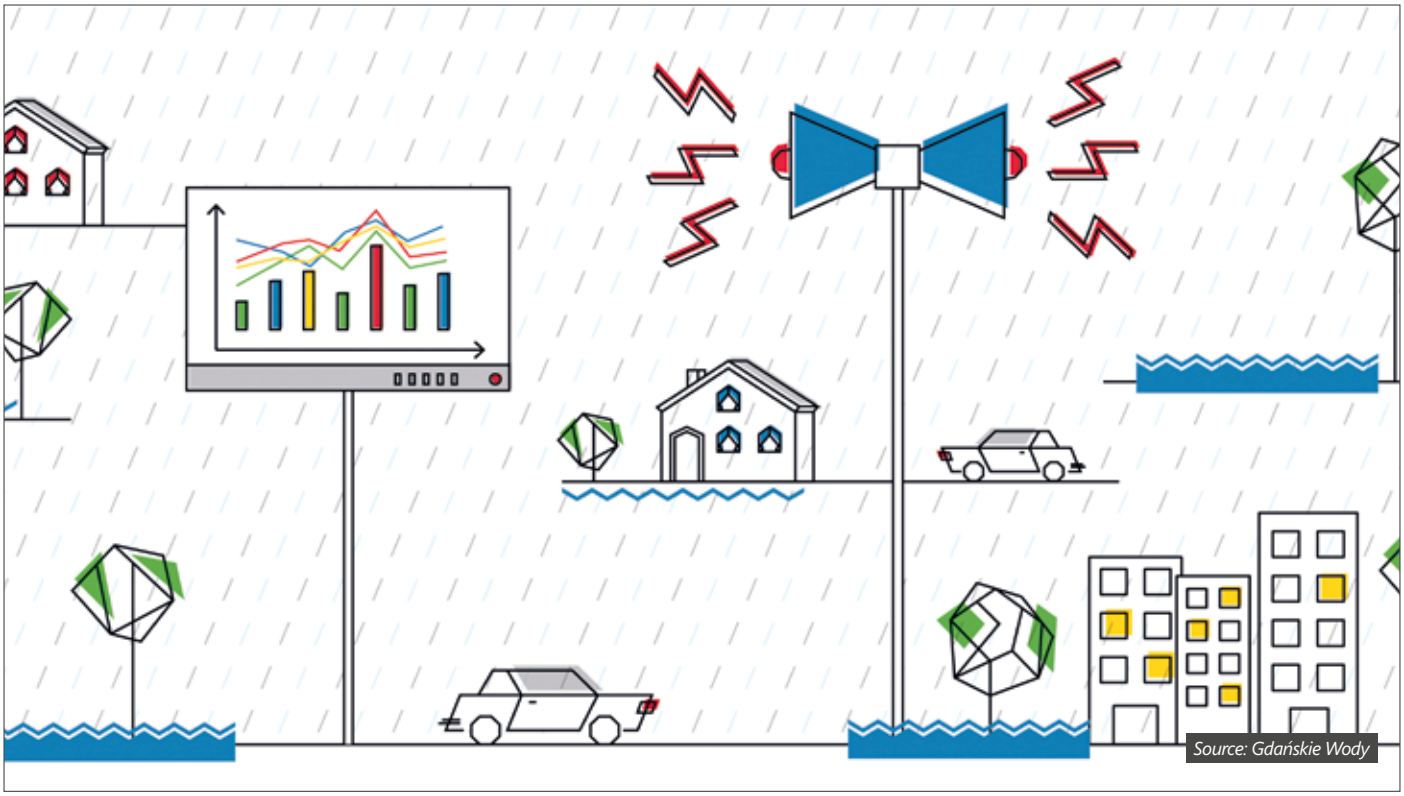
## ... THE OFFER OF WIELISŁAW MILL IS ALSO TEMPTING

Year after year, more and more tourists come to visit the mill, tempted both by beautiful surroundings of this unusual technical monument and what they find inside...Wielisław Mill offers comfortable rooms in the atmospheric interior of a historic water mill. A few years ago, a restaurant was opened in the building - Our dishes are created on the basis of regional products, which allows to preserve the traditional taste and the way of preparation - the hosts assure. The specialty of the restaurant is goose. The offer of the guesthouse also includes a small spa with a jacuzzi for five people, a sauna and lamps for light therapy and aromatherapy. On cloudy days, the guests can use, among other places, in a relaxation corner located on the top floor of the building. Here you can find comfortable armchairs, sofas, TV, a bookcase and board games. The enthusiasts of outdoor recreation can relax by the channel from which water used to power the mill, and today supply the small hydropower plant. The guests can enjoy an outdoor barbecue, as well as a playground equipped with a trampoline, swings and a slide. The hosts of the facility are not resting on their laurels - they are drawing up new ideas and successively putting them into practice, including the organisation of various events. Last summer the mill hosted, for the first time, gold rinsing workshops, a perfect solution for interesting and non-standard activities designed for individuals as well as couples or families...

Not without good reason Lower Silesia known as a real mine of tourist attractions and one of the most beautiful places on the map of Poland. It is worth appreciating the region in which we live, as well as discovering its secrets and beauty. Why not start with Wielisław Mill?

Wielisław Mill owners

We are grateful to **Wielisław Mill** for sharing photos.


Source: Gdańskie Wody

# CITY IN **THE RAIN**

**Educational initiative, realized in Gdańsk, shows how development of hydrological monitoring and of warning systems influences our flood safety.**

A modern, uniform and fully digital system of alarming, which includes a system of hydrological and atmospheric fall monitoring, and enables effective notification about flood danger for Gdańsk's inhabitants, has been created as a part of the European Union- subsidized project "Development of systems of information and warning about dangers, especially flood, for Gdańsk and Sopot".

## MODERN SYSTEMS OF MONITORING AND WARNING

- 19 new pluviometers (measuring stations for inspecting the amount of fall), as well as 55 new hydrological probes, which indicate the height of water level in practically all reservoirs and watercourses, have been installed in various regions of Gdańsk.
- 55 new alarm stations, with electronic sirens, radiophone, control block and antenna mast, have appeared. Additionally, 15 existing alarm stations have been developed to include radiophone and control block.

### Benefits of the City in Rain project:

- improvement of flood protection
- improving the quality and speed of informing residents about the threat
- current examination of the amount of rainfall as a factor generating hazard and water level on reservoirs and watercourses as a catchment reaction

## BIGGER FLOOD SAFETY

Developed network of monitoring (one of the biggest in Poland) allows proper management of flood situation and full knowledge about current danger: amount of fall, fulfillment of reservoirs, current water flow in watercourses and projected phenomena. At later stages, the data obtained will also be a base for a thorough analysis of the phenomena occurring in the catchment basins, allowing to create detailed scenarios of development of dangers.

The system of informing and warning allows to inform the inhabitants about a danger via voice announcements and ensures covering terrains which so far were outside of the voice information system.

## EDUCATIONAL ACTION IN THE RAIN

Geographical localization of Gdańsk and more and more often occurrence of weather anomalies caused by global climate changes increase the risk of flood. The most violent ones are those cased by heavy rains which occur during so called "cloudburst". They usually have an unexpected character and short, but violent course. Urban services have then very little time to successfully inform the inhabitants about the danger. For that reason, the development of the information system and the educational initiative "City in the Rain" which aims at preparing Gdańsk's inhabitants for proper and fast reaction in the situation of flood danger, have been pursued. Multimedia animations and an educational booklet inform about the ways in which people should behave. Special training, events and radio programs are organized. All for increasing the flood safety and learning to properly react in the situation of danger. More about the initiative at: www.miastowdeszczu.pl

Value of the project is 2 822 637.7 PLN. Subsidy from the European Regional Development Fund as a part of the Operational Programme of the Voivodeship of Pomerania 2014-2020 is 70%.

Agnieszka Kowalkiewicz
Gdańskie Wody

# KATALOG BRANŻOWY

# ENGINEERING AS **A WAY OF DEVELOPMENT**

**This is an opinion of Dariusz Gronek, the owner and the Chairman of the Board of HydroInvest Ltd. According to him, hydrotechnology should return, as soon as possible, to its deserved place in the country's economy. This mission has been realized by his company.**

**So far, in Your professional life, the main position has been occupied by Hydroprojekt, one of the leading project companies in the water management. For 30 years you have been realizing here your passions, gaining experience and also, for 16 years, managing the company, introducing new technologies. What, after finishing your work in Hydroprojekt, would you consider your biggest professional success?**

For these years, we have realized in Hydroprojekt many prestigious and innovative projects. I will list only a few of them, e.g. the dam and hydroelectric power plant Czorsztyn-Niedzica, the dam and water reservoir "Wióry" near Ostrowiec Świętokrzyski, canal Ulgi for the city of Opole built after the flood in 1997, which completely secured the city against further floods. Also, 1 100 meteorological stations were created as an element of systematic flood protection. However, we have not managed to realize a part of the plans, such as the next element of the Wisła program in the form of a dam and hydroelectric power plant Nieszawa-Ciechocinek. To illustrate the significance of this problem, I will add that on the stretch from Warsaw to Gdańsk, the same water "falling from the sky" could be used 7-8 times for energy production, though for energetics it is more urgent to solve the problems of water management.

**It is being said that Hydroprojekt was a kind of academy of hydrotechnology...**

This is true. From 1951, hundreds of brilliant professionals, engineers, for whom hydrotechnology was a passion of their lives, passed through the company. It is an honor for me that I could learn from them, work with them, and for 16 years manage them. A confirmation of the significance and strength of that team of engineers was receiving the title of the leader of Polish ecology, awarded by the National Fund for Environment Protection, three times. I will only remind that it was in Poland where in the interwar period, at the construction works of the hydroelectric power plant Rożnów, the first fish pass in Europe, and maybe even in the world, was designed and built, what has been forgotten by many ecologists. The fish pass is up to this day a masterpiece of engineering art in this scope.

**But we still have many opponents of the hydroenergetics, who consider it as a harmful and anti-ecologic industry.**

These people do not see that production of electric energy with the use of water is the cheapest, the cleanest and the safest one. Water for energetic purpose, for mill start, devices start, was used by our fathers and grandfathers. In the interwar period, we had a few thousands such objects, currently we have only about 700 of them.

**You are currently the owner and the Chairman of the Board of HydroInvest Ltd. It looks by the name that it is a continuation of hydrotechnology....**

It cannot be otherwise. We have a big experience in this area and proper qualifications. We are realizing or already have realized a few significant projects: small hydroelectric power plant Lipki on the Oder near Brzeg, a municipal waste landfill Jaroszów for Wrocław, we are preparing for an auction concerning construction of a sewage treatment plant, we are working on an opinion concerning the newest type of municipal waste incineration plant. Moreover, we are extending our offer to include projects in environment protection and related infrastructure, such as a sluice serving as a flood gate in Warsaw Praski Port. It will be a hydroelectric multifunctional device enabling sailing, flood protection for Praga part of Warsaw, and will become a tourist and leisure time attraction of Warsaw. I hope that the company will be developing and soon we will reach for a foreign client.

**Investments in the water management are more and more complex, and therefore the job of hydroengineers is more and more difficult....**


Source: HydroInvest

You are right. Many problems are posed by arrangement of proper relationships within: contractor - designer – implementer. A chance will be the new technological system BIM (Building Information Modeling) based on an on-line cooperation. This new technology speeds the stage of designing, lowers the costs of realization and exploitation. It is a novelty on the Polish market. My company is preparing to apply this system in practice through implementation of elements of this technology (3D modeling) into currently realized projects.

**I understand, that HydroInvest will offer services in the water management area and in the area of infrastructure concerning environment protection....**

Of course! Today the client wants to sign a contract with one business partner which includes designing, conducting investment process, that is receiving the contracted enterprise turnkey. We also want to play the role of an investor. We administer a young team of engineers and we will be perfecting it and extending.

**You entered the market in the right time, as the government announced a lot of investments in the water management and environment protection areas, such as ditch of Vistula Spit, an underwater pass connecting Świnoujście with the rest of the country. Moreover, we are obliged by the European Union climatic pact, prescribing environment, nature, protection....**

This is nothing new for me. I was applying the motto "we design in harmony with nature" as the Chairman of the Board of Hydroprojekt. Currently, I have been using it in my new company, although in a slightly modified form - "engineering as a way of development". Engineering means implementation of scientific achievements in everyday life, because as you know, we owe to engineers the progress in the surrounding world. The technological progress, implemented with respect to the nature, is a motto for our company. And as for the plans of current government, I am happy that the state restores the rank of water management and inland sailing. There are already symptoms of activities in this direction at the government level, among others, appointment of the undersecretaries of state working on this issues. However, we should set priorities, determining the significance of particular investments for the economy of the country, we should wisely plan strategy and tactics in design and implementation of a given enterprise. We should remember that the projects in the water management require continuity in realization, are very capital-intensive, and the effects come only after years. An example of an irregularity and tardiness is the dam Świnna-Poręba, realized for almost.... 30 years, that is 25 years too long. I think that there will be enough work for hydroengineers, as the majority of objects from the times of prosperity of hydroenergetics, that is 1970s and 1980s, are exploited and thus require modernization.

The amount of negligence, abandonment and current needs in the water economy of our country, but also in many other places in the world, is huge. Neither the dangers related to drought, nor the dangers related to flood, nor the sailing needs, will be solved by one-time actions or sociotechnical ones. Water do not watch television. They can be solved only by a consistent realization of coherently constructed plan distributed throughout decades and realized systematically according to the possibilities of the state and self-governments, regardless of current political fluctuations. The problems with water access, its quality, flood dangers, etc, despite huge progress in technologies and sciences such as information technology, medicine, still remain a symbol of the challenges in the 21st century.

**Thank you for the conversation and good luck in business.**

Interview by Irena Hamerska, Przegląd Przemysł i Gospodarka

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# LOWER VISTULA FROM WŁOCŁAWEK TO THE ESTUARY – **A BALANCED APPROACH**

**The article concerns the questions of analysis of management of a stretch of Vistula, covering a fragment of Lower Vistula from the barrage in Włocławek (km 774.85) to its estuary in Gdańsk Bay (km 941.3).**

Current riverbed of Vistula from Tążyna estuary to the Baltic Sea (over 200 km) is a result of regulatory installation with groynes, realized already from the first half of the 19th century. Its aim was creating a water route and making flow of flood waters and ice more efficient. Not without significance was making a crosscut in 1895, which turned out to be an effective solution protecting from flood, shortening the run of Vistula by 10 km. In the 20th century it was decided that these works did not bring expected results (they caused lowering of the riverbed by average 1.3 m) and, due to too wide regulatory route, expected navigation conditions were not obtained. After creation of independent Poland in 1918, regulation of the riverbed of Vistula was began on its entire length. Lack of funds and the second world war stopped the works on the cascade of Vistula. However, they were partially realized after the end of the war.

## ENVIRONMENTAL CONDITIONS

The area of Lower Vistula from Włocławek to the estuary to Gdańsk Bay is important also in the system of terrains environmentally protected. The bottom of the Vistula Valley, generally reshaped in the 19th century, is currently considered incorrectly as a seminatural area. Antropogenic (post-regulatory) flood plain constitutes an ecological corridor of international rank, and a refuge of wetland birds of European rank. 9 areas Nature 2000 (2 of birds, 7 of habitat), 7 areas of protected landscape and 5 nature reserves were established here. A natural regime of flows below the barrage Włocławek has been interrupted since 1970 with the work of the barrage, and because of that the bottom of the riverbed has lowered directly after the dam in almost 4 m and 25 km lower in average 1.6 m. The zone of erosion entered even the regulated stretch, reaching Toruń and further. Average annual flows are here: 921 $m^3/s$ (Włocławek) and 1042 $m^3/s$ (Tczew). Maximum flow was recorder in March 1924 and it was 8305 $m^3/s$ (Włocławek). In turn, in 1970-2010, 46 flood waves were recorded, with maximum flows 2420÷5972 $m^3/s$. The frequency of spates is dependent on the season, 2/3 of which occur in spring and summer. The main problem, connected to the ice jam floods, is throwing ice from the Włocławek Reservoir, which may occur only after streamlining Vistula with icebreakers. As a result of the existing, insufficient regulation of the river, ice jams occur which complicates or even makes the progress of icebreaking action impossible form the estuary upstream, which is additionally limited by insufficient

Photo: Physical models – research stations. On the left – Nowe, barrage with low slope, on the right – Siarzewo, barrage with high slope)

*Source: National Water Management Authority*

## HYDROTECHNICAL INFRASTRUCTURE

On the analyzed stretch of the river, there are 2870 groynes, 25 longitudinal dams, 27 stretched of embankment with 16 pump-rooms and 14 bridges. Due to the condition of the hydrotechnological installations it can be devided into 4 characteristic stretches:

I. km 674.85 (st. Włocławek) – km 718 (Silno): partially regulated with fragmentary hydrotechnological installation damaged in result of erosion magnified by the work of Hydroelectric Power Plant Włocławek;
II. km 718 – 905-910 (Tczew): regulated, with strongly meandering current and centrally situated sandbanks;
III. km 905-910 – km 936 (Przegalina): regulated;
IV. Przegalina (km 936): regulated, estuary with an alluvial fan.

Many years of underinvestment of water management and continuously planned installation of barrages in Lower Vistula led to partial degradation of the riverbed, by, among others, lack of actual renovation of the groynes. The groynes and other installations undergo damaging activity of flood waves and ice annually, the effect of which

Table: Lower Vistula is divided into 3 classes (depths):

| Class | Kilometer [km] | Depth [m] | |
|---|---|---|---|
| | | According to regulations | Actual |
| Ib | 684÷718 | 1.6 | < 1.0 |
| II | 718÷910 | 1.8 | 1-1.2 |
| III | 910÷941.3 | 1.8 | ok. 1.8 |

*Source: National Water Management Authority*

is a reverse transformation of the riverbed, (from regulated into divided into creeks by numerous islands, sandbanks and clumps). This results in decreasing the depth and additional accumulation of rubble in the main current, what worsens already limited navigation conditions, possibility of conducting icebreaking and ice passing actions; it also creates huge ice jam flood danger.

The conceptions of management of the stretch of Lower Vistula, elaborated last year, originated from economical utilization of the river, especially energetic utilization, possibility of navigation and creation of water reservoirs and from an assumption that barrages are indispensable for these purposes. These elaborations require reanalysis due to time which has past and due to new social-economical, economical and environmental conditioning. In result, the works were undertaken aimed especially at determining the minimum of indispensable activities.

All model studies described below are conducted for water flows of probability of surpassing p = 0,2%, 1% and 10% and average waters SNQ i SSQ, without considering the question of patency of the estuary of Vistula. Model studies carried out in 2009 by the Institute of Hydro-Engineering of Polish Academy of Sciences showed that an optimum and compromise solution is introduction of the ends of the wheels on the ordinate of the bottom from -3 m to -5 m, while the eastern wheel should be longer from the western one by approx. 300 m. In order for the wheel ends to reach the minimum depth, they should be extended by approximately 770 m (western) and 900 m (eastern). Such a range would effectively solve the problem of the estuary's patency for about 10 ÷ 15 years. These works were initiated in 2011-2015 by renovating both wheels and extending the eastern one by 200 m.

## PROTECTION AGAINST FLOOD WATERS – A CONCEPT

In 2014, on commission of the Regional Water Management Board in Gdańsk, "Conception of protection of the lower stretch of Vistula from Włocławek to its estuary to the Gdańsk Bay before flood waters" was carried out. This conception is an important elaboration for conducting further effective protection from flood waters, determining, de facto, the minimum framework of indispensable activities. The aim was to indicate the solutions which are supposed to provide a complex flood protection of the stretch of Vistula from Włocławek to its estuary to the Gdańsk Bay, in three aspects:

- protection of the barrage in Włocławek;
- winter flood protection – Vistula as a water road for icebreaking action;
- passing flood waters 1%.

In order to protect the barrage Włocławek, it is indispensable to restore damming in the lower position up to projected level, existing at the moment of putting it into operation – 46 m asl. On the eroded section below St. Włocławek, solutions based on regulatory structures (groynes) can not be implemented, therefore a solution here is a barrage. For the remaining stretch of the river other solutions are possible. These problems and the analyses became the base for determining variants of activities. 2 reference variants and 5 introductory variants were made.

Reference variants:

- variant zero – existing condition;
- variant of a breakdown of the barrage in Włocławek.

Introductory variants:

1. ensuring the depth for icebreakers' work – reconstruction of the system of groynes on Lower Vistula;
2. security of the barrage Włocławek and ensuring the depth for icebreakres' work on the stretch from planned barrage to the barrage Włocławek;
3. carrying out conservation works in the area of the riverbed of the big water of Lower Vistula for passing flood wave;
4. complex flood protection of Lower Vistula Valley to the estuary to the Baltic Sea;
5. ensuring the depth for icebreakers' work – construction of a number of low thresholds.

The analysis of the introductory variants resulted in 3 solutions as hybrid variants which can ensure complex flood protection (summer and winter protection) and security of the barrage Włocławek:

I. reconstruction of the groynes together with cutting in the riverbed of the big water and with construction of a barrage below Włocławek;
II. construction of low thresholds together with cutting in the riverbed of the big water;
III. dismantling of the barrage Włocławek and reconstruction of the groynes.

A numeric modeling was conducted for all analyzed variants and the most advantageous solutions for projecting flood danger was indicated. Hybrid variants were analyzed for meeting the requirements of the General Water Directive and of environmental, multivariant and economical-financial ones. In result, the recommended

variant is "reconstruction of the groynes together with cutting in the riverbed of the big water and with construction of a barrage below Włocławek", ensuring both ecological as well as flood security. The modeling indicated that in order to ensure the depth for icebreakers' work, first, a reconstruction of about 1100 groynes is indispensable for correction of the regulatory route. The depth of min. 1.85 (min. for icebreaking) will be ensured on the entire stretch. Localization of the groynes were selected in order to maintain the existing current of the river in actual course.

The aforementioned conception enabled introduction of construction of the barrage below Włocławek to the Plan of Flood Risk Management and to the actualization of the Plan of Water Management. In December 2017, an environmental decision was made for the mentioned barrage, for localization in Sierzawo.

## INSTALLATION WITH SPURS – MODELING

In the selected variant, in the task of construction of the northern groynes: „reconstruction of regulatory installations on Lower Vistula at km 718-933" (conception from 2016), modeling studies on a physical model as well as numerical model were carried out for checking and supplementing the solution, especially:

- physical model of 7 km of Vistula's stretch (km 854 – 861);
- numerical model (km 718 – 933) calibrated with the physical model;
- project of the route and regulatory installations with parameters of regulatory constructions.

The aim of the studies on physical model was:

- establishing regulatory installation for obtaining the depth ensuring icebreakers' work (min. 1.8 m) at flow SNQ;
- analysis of the influence of proposed installation for morphodynamics of the bottom and movement of the rubble;
- determining the ordinates of flood waters for proposed construction.

For the stretch from Silno (km 719.8) to Piekło (km 888.3), a route of the width of the regulatory riverbed 210÷235 m and average depths 2.02÷2.28 m was designed. Considering current condition of the riverbed of Lower Vistula, the new route was designed in order to run within the existing riverbed and to include the localization of the existing regulatory installations without necessity of their partial or complete liquidation. From Piekło the river narrows down what makes it impossible to form a regulatory riverbed of the required width without dismantling a significant number of the existing groynes. This stretch at the flow SNQ and min depth of 2.0 m ensures conditions for icebreakers. For that reason route design has been abandoned.

International water routes require the transit depth of 2.8 m, while the indicated parameters of the regulatory route concerned enabling conducting icebreaking actions, that is around 1.8 m. For obtaining the parameters of international class of water route, we should make a correction of the proposed solutions connected to the groynes, however, ensuring navigation with groynes alone does not guarantee maintaining a route of international parameters, at least because of deteriorating of the groynes by ice passing.

## ANALYSIS OF ADAPTATION TO THE CASCADE - MODELING AND CONCEPT

Conception from 2014 did not give answers concerning other aspects of utilization of the river, e.g. for hydroenergetic purposes, navigation, counteracting the effects of drought, intake and retention of water, and economical aspects. However, it indicated the minimum scope of actions for ensuring flood protection and security of the barrage in Włocławek.

The scenarios making order in the current situation are:

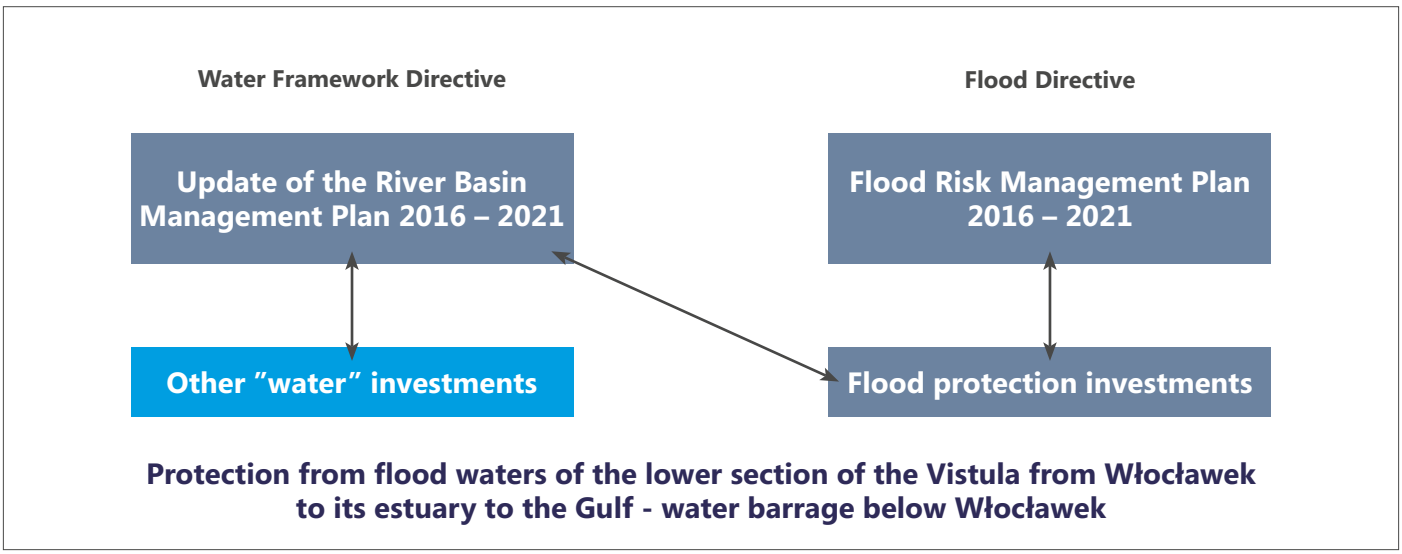
1) installation on the river in the form of regulatory constructions, limited only to the main riverbed;
2) cascade construction on the river by barrages;
3) combination of the two mentioned above.

These scenarios concern the stretch below the barrage which will be created in Sierzawa. The first scenario was recognized in effect of the two discussed elaborations. Because of that, in order to recognize other solutions, currently is being realized „The analysis of adaptation of Vistula river on the stretch from Włocławek to the estuary to the Gdańsk Bay for big and small cascade – modeling".

Its aim is:

1. elaboration of the conceptions ensuring:
   - IV navigation class at minimum;
   - flood protection;
   - ensuring winter flood protection;
   - ensuring security of the barrage Włocławek;
2. model studies:

Fig. Strategic programming related to the implementation of flood protection investments on the Vistula river




*Source: National Water Management Authority*

- physical models – of barrages of high slope – Siarzewo (damming 6÷10 m) and low slope – Nowe (damming 3÷4 m);
- numerical models respective to the physical models;
- numerical model of Lower Vistula – with proposed solutions;

3. assumptions for construction of barrages on Lower Vistula;
4. conception – recommended solutions.

In order to maintain consistency with the earlier works, also the stretch from Włocławek to the estuary was a subject of the analysis. The aim of model studies of barrages is not only the question of functioning of the barrage alone, but also of the phenomena of erosion below and above the barrage, and the possibilities of letting the rubble through the barrage, and minimization of negative influence. Modeling covers also determining NPP and Max PP for proposed variants. The existing conditions will be the base for assessment of justification of selection of the variants of protection through comparison of the values of flood risk – it is the zero variant included in the Plan of Flood Risk Management. Due to the fact the works are being currently conducted, it was impossible to present their results.

## SUMMARY – WHAT NEXT?

All the works described above, constitute a contribution to the Strategy of development of water courses that the government is currently working on. It will also constitute a contribution for works of the Port of Gdańsk to the task „Carrying out a study of practicability of complex management of water courses: E-40 for Vistula river on the stretch from Gdańsk to Warsaw, E-40 from Warsaw to the Polish-Belorussian border (Brześć) and E-70 on the section from Vistula to the Vistula Lagoon (Elbląg)". Contrary to the conception of management of Vistula elaborated last year, we tried to present indispensable scope of the works described above, which should be carried out as soon as possible. We also tried to make analyses already at this stage to make it possible to put the recommended solutions in the strategic documents of water management, what in the case of the barrage in Włocławek turned out effective.

dr eng. Piotr Kowalski
PGW WP Regional Water Management Board in Gdańsk

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# GDAŃSK – MORE THAN 1000 YEARS OF HISTORY **IN ONE CITY**

**Gdańsk is a unique city, with more than 1000 years of tradition. Its history is so rich that it could be divided between other cities of comparable size. Guests who come here in great numbers every year emphasize the special character of the city; it has an extraordinary atmosphere which underpins the city's originality.**

Gdańsk is the capital of an agglomeration with over one million residents. Together with Sopot and Gdynia, it forms the so-called 'Tricity'. Thanks to the location, near the Vistula River estuary, Gdańsk was one of the most important members of the Hanseatic League even back in the Middle Ages, and this also made it a very rich city from early times. Despite having been affected by many historical events, the city has always been rebuilt. It has risen like a phoenix from the ashes every time a natural disaster, war or fire occurred. World War II began right here in Gdańsk. It was in Gdańsk that the first brick from the Berlin Wall was "pulled out" and the "Solidarity" trade union triggered the collapse of the communist regimes in Central Europe. The numerous events over time have shaped the characters of the city's residents. Despite all the turmoil and migrations, the locals still value freedom, openness and the right to express their opinions. They have the courage to say "no" even in the most unfavourable circumstances.

## NOT ONLY FOR TOURISTS

Gdańsk is also a very popular tourist destination. Located on the Baltic coast, full of magnificent Gothic buildings, historic churches, interesting museums and charming streets, filled with amber, Gdansk invariably impresses and fascinates. Its symbol, god of the sea Neptune, looks from his pedestal at more than 2 million people who visit the capital of Pomerania every year.

Gdańsk's numerous attractions determine its popularity. One of the attractions is the European Solidarity Centre built in the place where during the communist era the biggest social initiative in Poland was started: "Solidarity". A huge exhibition presents the Poles' struggle against the oppressive communist regime. Only a few hundred meters away there is the Museum of the Second World War. The building looks like a gigantic piece of glass stuck in the ground, which contrasts with the neighbouring buildings. Inside one can see an exhibition which graphically depicts the history of the most horrible conflict in the history of humanity. Also, in Westerplatte, it is possible to see a place of heroic resistance of the Polish garrison against German invaders in September 1939, thus the place where World War II began.

Going further, one passes a modern lift bridge to Ołowianka island, where the majestic building of the Polish Baltic Philharmonic is situated. Next is the Main City with its shops, cafes, restaurants, beautiful tenements and charming streets. It is there that one can find all the wonderful and symbolic city landmarks: Neptune's Fountain, St. Mary's Church, Artus Court, Uphagen's House, Gdańsk Town Hall, and the magnificent city gates – one of them the Crane, which is also the largest and oldest preserved medieval dock crane. However, this is not all. Nearby there is a massive black cubic building, which is the Gdańsk Shakespeare Theatre, where the English playwright's works are staged. The Main City is the true heart of Gdańsk, thanks to its remarkable character and atmosphere. After becoming acquainted

*Source: Materials of the Municipal Office in Gdańsk*

with this part of the city, it is worth visiting the majestic Oliwa Cathedral, which is located in a beautiful park. Inside the cathedral one can admire the huge organ, the sound of which has been making an impression for 230 years!

## RICH CULTURE AND ENTERTAINMENT

Every year, one of the biggest open air events in Europe takes place: St. Domink's Fair, a fair with 758 years of tradition. In addition, we should not forget the International Tall Ships Gathering "Baltic Sail", the open air theater Festival - FETA, the Mozartiana Festival, a beautiful Christmas market and many more, smaller but equally interesting events. Music lovers are drawn to Gdansk by numerous concerts, including those by stars of international repute. Along with all of these attractions, Gdańsk is, above all, a city strongly connected with the sea, and in the summer several wide sandy beaches can be enjoyed. During your stay we highly recommend to take a stroll on the Brzeźno pier, or a cruise on one of the White Fleet ships.

## THE PRESENT EQUALS DEVELOPMENT

Besides all the tourist appeal of Gdańsk, something new is the emergence, on an unprecedented scale, of modern shopping and technology centres. Also, some of the world's largest corporations have businesses branches and offices in the city.

Gdańsk Lech Wałęsa Airport is constantly and dynamically growing, offering more and more direct flights to the most important European cities (including Munich, Hamburg, Dortmund, Cologne, Frankfurt, London, Helsinki, Paris, Copenhagen, Oslo, Antalya and Thessaloniki) while the road and rail networks provide a safe and fast connection to southern Poland and western Europe. What is important, especially for tourists, is that there are already 50 hotels in Gdańsk. Including also the guest houses and hostels, there are 19,000 sleep options to choose from! Contemporary Gdańsk is a modern European metropolis with the economy based on knowledge, rapidly growing cultural, scientific, entertainment and sport centres, popular tourist attractions and the world's capital of amber.

## THE CAPITAL OF THE AGGLOMERATION

The Tricity altogether has more than 750,000 inhabitants. The other two cities have a lot to offer too. Sopot is known as the entertainment centre of Tricity. There are numerous pubs, restaurants and clubs, often open 24 hours a day. The famous promenade, "Monciak", is located in Sopot. The city is also called the summer capital of Poland, thanks to the longest wooden pier in Europe (511 meters) and the promenade. In Gdynia there is the Oceanarium, with hundreds of sea creatures and amazing ships – Dar Pomorza (Gift of Pomerania) and the original participant of World War II fights - ORP Błyskawica destroyer. The Emigration Museum is another place worth visiting: the exhibits demonstrate the challenges of displaced people throughout history. It's not only Tricity, but the whole Pomeranian Region that is attractive for tourists. Even the residents are often not familiar with all the places of interest. After all, the world's largest castle (as far as surface area is concerned), the Teutonic fortress in Malbork, is situated only about 50 km from Gdańsk. The Kashubian region offers traditional cuisine and warm hospitality, among its countless picturesque hills, clean lakes and old dense forests.

The pearl in this magnificent crown of Pomerania is Gdańsk: a city where everyone will find something special to encourage them to return.

See for yourselves!

Gdańska Organizacja Turystyczna

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niepodległa

POLSKA
STULECIE ODZYSKANIA
NIEPODLEGŁOŚCI

# THE 100TH ANNIVERSARY OF POLAND REGAINING **ITS INDEPENDENCE**

**Poland. A country located in the very heart of Europe with a thousand years of history. Today it welcomes you with historical treasures, beautiful landscapes and a business-friendly environment, but there was a time when looking for Poland on the map of Europe was a vain attempt. In the year 2018, we celebrate the Centenary of Regaining Polish Independence. How did this come to be?**

At the end of the 18th century, Poland disappeared from the map of Europe. During three partitioning actions (in 1772, 1793 and 1795) three neighboring countries (Prussia, Austria and Russia) took advantage of the unstable internal political and social situation and divided the Polish lands between themselves. Poles had to wait 123 years for freedom to return. In 1914, the First World War broke out and with it a great political turmoil began. Eventually, it provided the foundation for a new European order and for the idea of self-determination, which was taken up by Poland and other Central European nations. Poland regained its sovereignty on November 11, 1918.

## A NEW COUNTRY

The fact that the Second Polish Republic appeared on the maps of Europe did not bring an end to the maladies that had always lingered, but the state had to be rebuilt from scratch. To understand the scale of this challenge, one must realize that until 1918 Polish lands were under three different legal systems, different languages were spoken, different school systems were in place and different currencies were used as legal tender. All these elements had to be merged and the law had to be unified. Even worse, the fronts of the First World War had engulfed Polish lands, wreaking havoc.

> *The right to use the official logo of the celebration of the century of regaining independence by Poland can be obtained by completing the form on the website www.niepodlegla.gov.pl/logo/.*

First, it was necessary to establish various kinds of state institutions, prepare political and economic plans, and create social security for citizens. This was overshadowed by border conflicts, economic crises and two powerful totalitarianisms that emerged just outside Poland's borders. Nevertheless, the Poles were proud of their freedom and worked hard to rebuild the country.

Photo 1: Construction of a water dam on Soła river in Porąbka, 1928

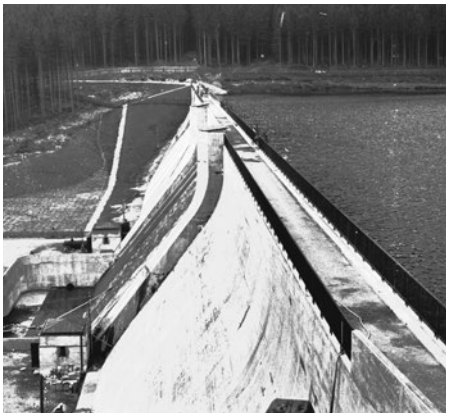
While the country was being formed anew, the experience and solutions used in other countries were inspirational to the rebuilding effort. Trends from the West were quick to reach Poland, both in everyday life and fashion. In interwar Europe, huge social changes took place in reaction to the effects of World War I. Women became financially independent from men and gained voting rights. Interestingly, Polish women gained the right to vote and take part in the elections very early, on November 28, 1918 – earlier than in most European countries.
Not only society changed. Modern infrastructure was built, technological innovations were introduced, and new branches of the economy developed, effectively aided by Poles returning to the country from abroad.
In order to celebrate the 100th anniversary of regaining independence, and especially to honor the Poles who contributed to it, the Polish government – stressing that regaining independence and rebuilding the state was a long-term, multi-stage process – passed the Multi-annual Program "Niepodległa" for the years 2017–2022. The program combines various initiatives and events celebrating the centenary of Poland's independence, including cultural, sports and educational events, but also relating to the industrial and economic successes of the reborn state.

> *Events are entered to the calendar of the celebrations of the century of regaining independence by Poland by the events' organizers via the form on the website: www.niepodlegla.gov.pl/dodaj-wydarzenie/*

## NARUTOWICZ – THE DAM BUILDER

One of the most distinguished but also most tragic figures, which are remembered during independence celebrations is Gabriel Narutowicz. Before the first Polish president came into politics, he became known as an outstanding hydro-technical engineer and electrician – a pioneer of Switzerland's electrification and a builder of hydroelectric plants. During his stay there, he never forgot about his homeland, helping his countrymen at home and abroad whenever he could. After

Photo 2: The President Ignacy Mościcki Dam (earth-filled embankment dam) on the Wapienica river and the Barbara stream in Wapienica, near Bielsko-Biała



returning to the reborn Poland, as the Minister of Public Works he became involved in the reconstruction of the destroyed country, supervising among others the construction of the Porąbka water dam (photo 1), which was finally commissioned in 1937. In the late 1970s, a pumped-storage hydroelectricity plant was established here which – as one of originators – Gabriel Narutowicz had designed half a century before.

The Porąbka Dam is not the only "souvenir" left after the first Polish president. Niedzica Dam, also known as the Czorsztyńska Dam, is a monument of sorts to Gabriel Narutowicz. The idea of building a dam in this place

Photo 5: Leisure time at Lake Czchowskie. View of the dam

Photo 3,4: Construction of a dam on the Dunajec River in Rożnów, 1937 and 1939

was born at the beginning of the 20th century. The first president of Poland was one of the consultants on the project, which eventually led to the construction of a hydroelectric power plant on the Dunajec river. The power plant in Niedzica is named after him in his honor. The decision to build a dam was only made in 1934 after the catastrophic flood that struck Podhale, but the work was interrupted by the Second World War. The idea was revived in the 1970s. The finished object was commissioned on July 9, 1997, when the flood-wave of the largest contemporary flood in Poland, known locally as the "Millennium Flood", passed through the dam.

## CELEBRATION OF THE JUBILEE

The first President of independent Poland was the main "star" of the international historical conference "Spotkania na Żmudzi - Gabriel and Stanisław Narutowicz, Polish and Lithuanian roads to independence 1918-2018", which took place on 20 to 22 September 2018 at the Plungė Manor (Pałac Ogińskich) in Plungė, Lithuania. The conference was accompanied by the International Michał Ogiński Festival. The co-organizer of the event was Fundacja Pomoc Polakom na Wschodzie (The Aid to Poles in the East Foundation), and funds for the festival were donated by the Senate of the Republic of Poland.

Jan Kowalski
Director
The Office of the "Niepodległa" Program

The photographs are part of the **National Digital Archives** (Narodowe Archiwum Cyfrowe) collection

## The Dams of the Second Polish Republic

Recalling the achievements of Polish water resource management in the interwar period, it is worth mentioning other infrastructure projects that were a huge challenge for a country struggling with post-war damage and the consequences of the partitions. Built between 1929–1931, one such project is the President Ignacy Mościcki Dam on the Wapienica river and the Barbara stream in Wapienica (photo 2). At present, its "Jezioro Wielka Łąka" (Great Meadow Lake) reservoir is within the Bielsko-Biała city limits, which by law is a sanitary protection zone. The dam and the hydropower plant in Rożnów were also a great challenge for the young state (photos 3 and 4). Construction began in 1935 and was completed in 1941. The power plant was part of the Central Industrial District (Polish: Centralny Okręg Przemysłowy), which, along with the Port of Gdynia, is the greatest economic achievement of the Second Polish Republic. The dam in Rożnów forced the construction of a surge tank (reservoir) in Czchów. The reservoir, now called Jezioro Czchowskie (Lake Czchowskie), became a popular recreational area (photo 5).

# ELECTRICAL BARRIERS – TAILOR-MADE FISH PROTECTION

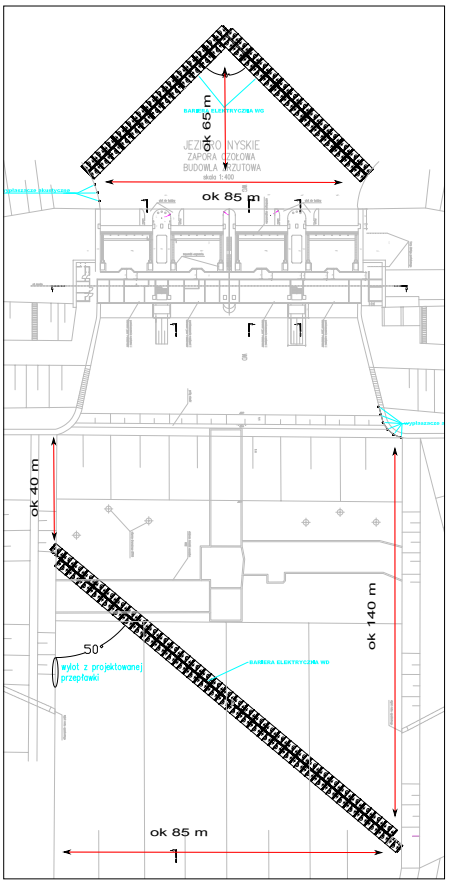
**For many years, the most innovative solutions aimed at preventing fish from swimming into for instance turbines of hydroelectric power stations or water suction pumps have been installed and tested in the West. Recently, such solutions have also appeared in Poland.**

In 2015, RZGW in Wrocław opened a tender for the construction of fish pass at the end of Nyskie Lake leading to the river. The investment included application of solutions dedicated to fish protection and facilitating migration of both freshwater and diadromous fishes. Electrical barriers were selected. The task of the first barrier installed in the high-level reservoir (HLR) was to prevent fish from getting into the turbine of the hydroelectric power station which is part of the drop structure, while the task of the other, installed in the low-level reservoir (LLR) was to block fish migrating against the current towards the dam, simultaneously channelling them towards the pass entrance. What was the requirement and at the same time the goal determined by the investor was average efficiency of blocking fish at a level of 70% with respect to all species and preventing them from passing into the area between the barrier and the drop structure. At the same time, the applied solution was supposed to enable fish which may overcome the protective barrier, to get out of the space between the barrier and the drop structure. The investor assumed that the electrical barriers that block fish will be periodically deactivated and acoustic deterrent devices, whose task was to be guide any fish out of the area between the barrier and the dam. The effectiveness rate of each such single guiding fish away may amount to at least 35%. The figure below shows the initial concept of distribution of the electrical barriers with respect to the damming structure. After thorough analysis of the environmental conditions present at the site and taking into account all the requirements set by the investor, and after approval, the following solutions were implemented based on electrical barriers:

Fig. 1 View of the damming structure of Nyskie Lake during modernisation

*Source: Own figure*

Fig. 2 Concept of application of the electrical barrier in the high-level reservoir and the low-level reservoir at the damming structure in Nysa.




*Source: detailed design by MELBUD-SWECO*

### High-Level Reservoir

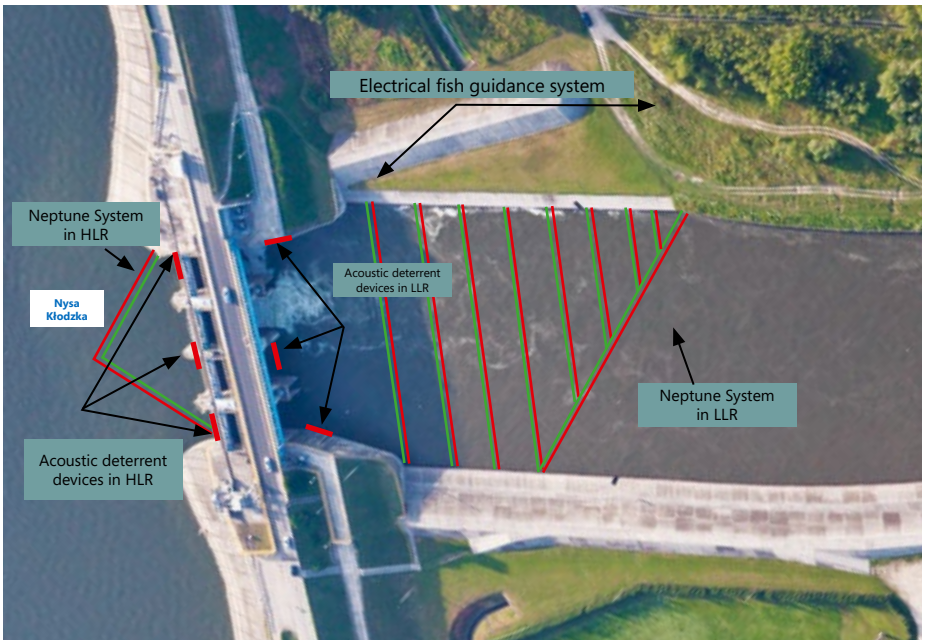
Two-row barrier in the form of 60-meter-long sides of a triangle. The arrangement makes it easier for fish that are going downstream towards the dam to change the direction by an angle of 50°-90° than in the case of a barrier parallel to the drop structure. The distance between the rows of positive and negative electrodes was selected so as to obtain sufficient space enabling free withdrawal of fish from the area between the electrodes. The length of the electrodes in the place of installation of the barrier was between 6 m and 9 m. The electrodes were fixed pivotally to steel chains laid on the bottom of the basin. The pivotal fixing of electrodes secures them against mechanical damage caused by large solid obstacles flowing downstream and limits deposition of small solid contaminants such as grass, leaves, etc. Each electrode was equipped with buoys to keep it vertical. In order to enable fish to get out of the space between the electrical barrier and the drop structure, 30% of which were estimated to pass the barrier, an acoustic guidance system was used, comprising 3 acoustic wave generators. The guidance system is turned on repeatedly in accordance to the set schedule or manually on operator's demand. As the barrier and the guidance system in the HLR are synchronised, when the guidance system is turned on, the barrier goes into the stand-by mode. The electrical barrier is then reactivated after the end of the driving away process.

### Low-Level Reservoir

An electrical barrier of 110 m was installed at an angle of 40°–45°with respect to the axis of the outlet canal. Due to the varied and rocky bottom, the length of electrodes ranged from 1.5 m to 3.5 m. Just like in the case of HLR, electrodes were fixed pivotally to steel chains laid on the bottom of the canal. Each electrode was equipped with a buoy to maintain a vertical position. One of the requirements of the Investor was to apply a guidance system with an efficiency of at least 35% for one-off fish guidance. As can be seen on Figure 2, the distance between

the place of fixing of the barrier and the dam is between 40 m and 140 m. The application of only an acoustic system in these conditions would not ensure the required efficiency of 35%, as the tests showed that the acoustic guidance systems reach the said efficiency only at a distance of a few to over a dozen meters from the sound source. Therefore, in order to achieve the requested efficiency of fish guidance away from such a large area, beside the acoustic fish guidance system located within the outlet niche area, an innovative, multisequential electrical guidance system was applied. The acoustic system was composed of three synchronised acoustic wave generators was located symmetrically within the outlet canal of the drop structure. The sequential electrical guidance System comprises 8 independent sections of positive and negative electrodes fixed perpendicularly to the axis of the outlet canal, see Figure 3.

Fig. 3 Distribution of electrical barriers and the acoustic and electrical guidance systems in the high-level and low--level reservoirs at the damming structure of Nyskie Lake.

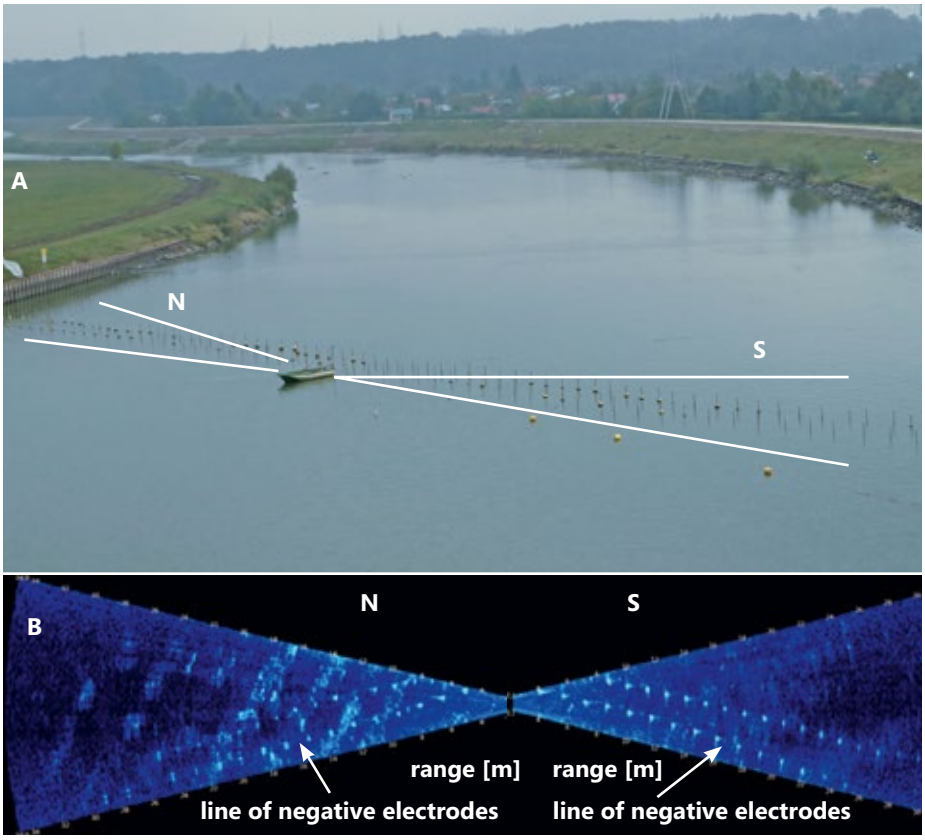



*Source: Own figure*

## VERIFICATION METHOD

What was the crowning of all the works related to installation of specific systems was demonstration that the efficiency requirement had been reached. The only reasonable and practicable way, within the available budget, to verify the efficiency of the operation of the systems was to apply the acoustic method. The methodology of performance assessment of the systems was developed by the National Marine Fisheries Research Institute from Gdynia, which is an institution that has the appropriate knowledge and experience in that area. Post-implementation studies were also carried out by that same Institute. Efficiency assessment of the electrical barrier and the guidance system in the areas adjacent to the dam on the Nysa Kłodzka River was based on observation of the numbers and behaviour of fish with the use of multibeam sonar ARIS 1800. The sonar was equipped with an automatic rotational system Rotator that enabled control of the position of the sonar (acoustic beam), both in the horizontal and the vertical planes. The study covered a band with a width of a few dozen meters above the dam of the hydroelectric power plant on Nyskie Lake and a section of the Nysa Kłodzka River of ca. 150 m below the drop of water from the weir.

Fig. 4 A – Location of the boat with the sonar with respect to the electrical barrier. B – Image of the sonar reading.

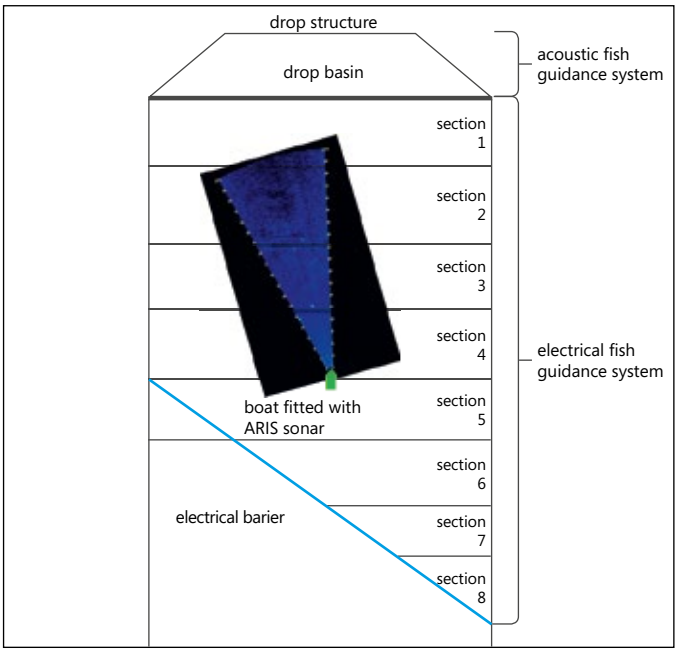



*Source: the National Marine Fisheries Research Institute in Gdynia*

**Measurements of the effectiveness of electrical barrier in the LLR.**
Measurements of efficiency of the NEPTUN electrical barrier on the river (below the dam) were carried out on 4-10 October 2016. Due to the varied depth of the river on the section below the barrier, from ca. 2 m at the northern section to ca. 4 m at the southern bank, the sonar was fixed to a boat anchored at the middle section of the barrier, at a distance of ca. 1 m from the line of negative electrodes above the barrier. The measurements were carried out at intervals of 30 minutes, with the acoustic band directed alternatingly to the northern and the southern banks.

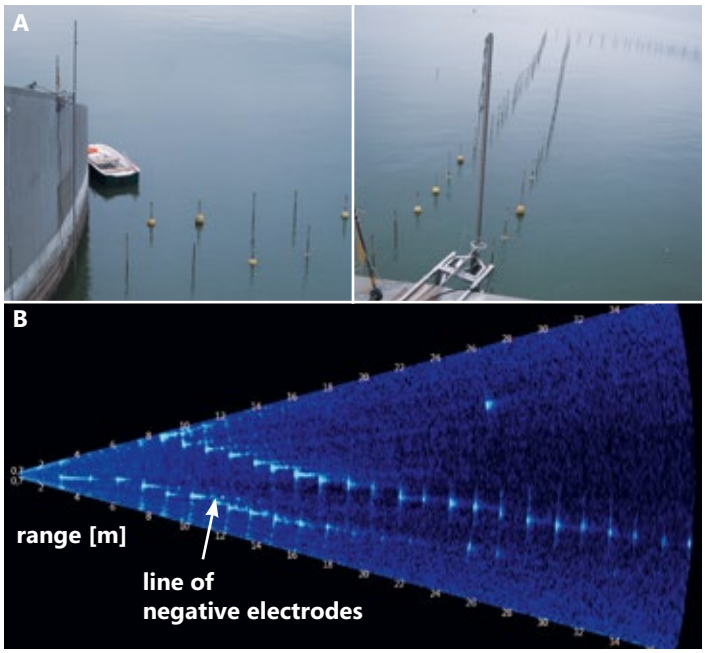
**Measurements of effectiveness of the electrical fish guidance systems in the LLR.**
Measurements of effectiveness of the electrical fish guidance system in the river below the dam was carried out on 11-13 October 2016 during 3 measurement sessions. The sonar was fixed to a boat anchored in the middle section of the river at a distance of ca. 90 m from the drop structure, with the band directed towards it. Such placement of the sonar resulted in the fact that it was located in

Fig. 5 The location of the boat with the acoustic sonar with respect to the acoustic and electrical guidance systems at LLR.




*Source: the National Marine Fisheries Research Institute in Gdynia*

Fig. 6 A – Location of the boat with the sonar with respect to the electrical barrier fixed in the HLR. B – Image of the sonar reading.




*Source: the National Marine Fisheries Research Institute in Gdynia*

the 4th section of the operation of the guidance system (ca. 1 meter from the line of negative electrodes constituting the beginning of the 5th section) and covered sections no. 4, 3, and 2. A schematic of the location of the ARIS sonar and the arrangement of the acoustic beam with respect to the zones of operation of the guidance system are presented below. A schedule of operation of the fish guidance system on subsequent measurement days is presented in the table below. Measurements with the ARIS sonar began on 11 October 2016 at 09:30 and were conducted continuously until 16:00 on 13 October 2016, yet data recorded during 1h of observations before turning on the guidance system (reference measurements), during the full cycle of operation of the guidance system, and 1h of observations after turning off the system (final measurement) were used in the analysis of the effectiveness of the fish guidance system – a total of five hours of recording during three consecutive measurement days.

### Measurements of effectiveness of the electrical barrier in the HLR.

Measurements of effectiveness of the electrical barrier on Nyskie Lake (above the dam) were carried out on 14-20 October 2016. The Sonar in the high-level reservoir was fixed to the side concrete wall of the weir by means of especially prepared metal structure, at a distance of ca. 1m from the line of negative electrodes below the barrier. Effective migration of fish towards the weir was perceptible until the 4th meter of the sonar's coverage. Measurements started on 14 October 2016 at 13:00 and were carried out continuously with the barrier alternatingly working and not working (in a cycle of 24 hours) – 3 days of observations in total at the turned off barrier and 3 days of observations at the turned on barrier.

Table 1. Schedule of operation fish guidance system

| date | beginning | end |
|---|---|---|
| 11.10.2016 | 11.42 | 14.39 |
| 12.10.2016 | 11.41 | 14.37 |
| 13.10.2016 | 11.56 | 14.53 |

*Source: the National Marine Fisheries Research Institute in Gdynia*

### Data analysis

Acoustic data were analysed with the use of the Sonar 5-Pro software (Lindem Data Acquisition, Oslo, Norway, ver. 6.0.3). The recorded signal was first filtered in order to remove background noise ('backgound filter') and amplification of signal from moving objects – fish ('foreground filter').

### Verification of barrier effectiveness

The method adopted to determine the effectiveness of the barrier consisted in calculation of the percentage ratio of the average number of fish that crossed the line of negative electrodes towards the drop structure while the barrier was working to the average number of fish that crossed that line towards the drop structure while the barrier was not working. For that reason, when measuring effectiveness of both barriers, the numbers of only those fish that crossed the negative electrode towards the drop structure were analysed with the barrier both working and not working, whereas the analysis did not take into account fish that entered the area form the direction of the drop structure and still being within the reach of the acoustic beam turned back crossing the line of negative electrodes towards the structure. The collected data were analysed by means of statistical tests to verify the hypothesis concerning the existence of statistically significant differences between the numbers of fish between subsequent pairs of measurements / observations with the barrier on and off.

### Verification of the effectiveness of the fish guidance system

The effectiveness of the fish guidance system was established on the basis of the changes in the numbers of fish observed in the fragment of section no. 3 visible in the sonar coverage. The coverage provided the optimum possibility to trace the numbers of fish thanks to spanning the full width of the section. The 2nd section was removed from the analysis as, due to high volumes of water dropped which took place on 12 and 13 October (25m$^3$/s), the recorded signal was distorted by noise, especially above the 30th meter of the coverage, and could mask the presence of small fish, and thus falsify the results. In the case of fish guidance effectiveness measurements, the fish observed in the third section were counted at one-minute intervals. The schedule of operation of specific sections of the guidance system and the reference measurement is presented in the table below.

Table 2. Schedule of operation of the electrical fish guidance system at LLR during the study.

| Measurement date | | 11.10.2016 | 12.10.2016 | 13.10.2016 |
|---|---|---|---|---|
| Reference measurement | | 10:42 – 11:41 | 10:41 – 11:40 | 10:56 – 11:55 |
| Acoustics | | 11:42 – 11:58 | 11:41 – 11:56 | 11:56 – 12:10 |
| Section | I | 11:59 – 12:18 | 11:57 – 12:16 | 12:11 – 12:32 |
| | II | 12:19 – 12:38 | 12:17 – 12:36 | 12:33 – 12:52 |
| | III | 12:39 – 12:58 | 12:37 – 12:56 | 12:53 – 13:12 |
| | IV | 12:59 – 13:18 | 12:57 – 13:16 | 13:13 – 13:32 |
| | V | 13:19 – 13:38 | 13:17 – 13:36 | 13:33 – 13:52 |
| | VI | 13:39 – 13:58 | 13:37 – 13:56 | 13:53 – 14:12 |
| | VII | 13:59 – 14:18 | 13:57 – 14:16 | 14:13 – 14:32 |
| | VIII | 14:19 – 14:38 | 14:17 – 14:36 | 14:33 – 14:52 |

*Source: the National Marine Fisheries Research Institute in Gdynia*

The effectiveness of the fish guidance system was determined on the basis of the obtained percentage share of the average number of fish which were observed in the area covered by the sonar (fragment of the section 3 area) during the last hour of the system's operation with respect to the average number of fish that was recorded before the guidance system was turned on (reference measurement).

## RESULTS OF MEASUREMENT OF EFFECTIVENESS OF ELECTRICAL BARRIERS.

### The electrical barrier in the HLR

The total effectiveness of the electrical barrier on Nyskie Lake was 79.7% (there was observed a total of 1105 fish that crossed the line of negative electrodes towards the weir / drop structure when the barrier was not working, and 224 fish that crossed the line of negative electrodes towards the weir / drop structure when the barrier was working). In particular pairs of observations (barrier not working/working), effectiveness was: 80.3%, 75.8% and 75.7%.

### The electrical barrier in the LLR.

The total effectiveness of the barrier on the river was very high – 99.4% (in total, 8902 fish were observed that crossed the line of negative electrodes towards the weir / drop structure when the barrier was not working and 54 fish that crossed the line of negative electrodes when the barrier was working). In particular pairs of observations (barrier not working/working), effectiveness was: 99.0%, 99.7% and 99.2%.

### Effectiveness of the electrical fish guidance system in the LLR

The operation of the guidance system, consisting in sequential turning off of subsequent sections of the system, starting from the acoustic section (located the closest to the drop structure), and then the next sections of the electrical guidance system should be reflected in the number of fish observed in the third section. To illustrate this, the total number of fish in the third section was determined during the operation of subsequent elements of the guidance system in accordance with the schedule presented above. Since different sections had different working times, to ensure comparability of results, the number of observed fish was calculated per minute of operation of a given section. The average numbers of fish observed during the one-hour-long initial reference measurement and the final measurement were expressed likewise. The effectiveness of the fish guidance system, determined through comparison of the number of fish recorded during the three one-hour-long periods before the start of operation of the system with the total number of fish from the last three hours of operation of the system (for the three measurement sessions in total) was 61.8%.

## SUMMARY

Based on the results and the analyses presented above, it can be concluded that the systems offered by PROCOM SYSTEM S.A., such as electrical barriers, as well as guidance systems proposed and installed within implementation of the investment "Construction of a fish pass at the outlet of Nyskie Lake to the river," are highly effective and should be used in order to protect fish from getting into the turbines of hydroelectric power plants, pumping stations for process water in the industry, mains pumping stations etc. High effectiveness in terms of blocking and guiding moving fish highly endorse the offered systems for applications on fish migration routes, in particular diadromous fishes. The obtained results are the effect of many years of research and development works and implementation of many projects in Poland and abroad, with the involvement of experts and specialists in ichthyology, and also the accumulated experience and performed observations of fish behaviour both in the temperate and the tropical zones. Also, which is very important for the high effectiveness of the offered systems, customers are approached individually and assisted at the stage of preparation of the concept.

Just like in the case described in the article, the system is designed in a customised manner for each site, taking into account the hydrotechnical, physical and chemical parameters of the aquatic environment, the fish species composition and the expectations of the Ordering Party.

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Piotr Augustyn
PROCOM SYSTEM S.A.

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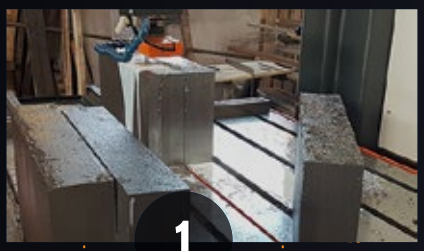


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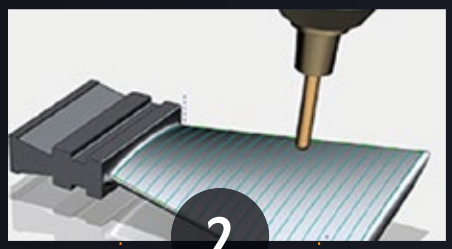


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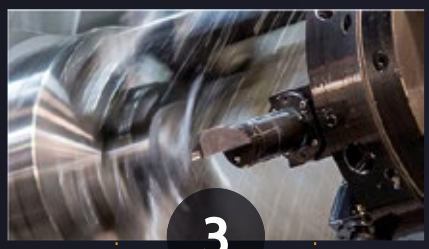


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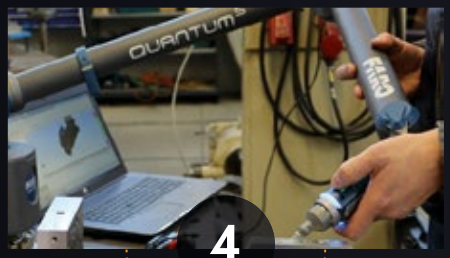
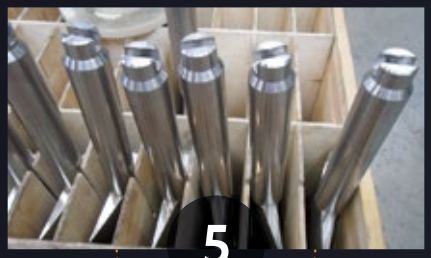



## Finished product

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