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

ENERGETYKA WODNA

3/2019 (31)
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WHAT CHANGES DID THE AMENDMENT **TO THE RES ACT BRING?**

Page 24

TRENDS AND FORECASTING **OF WHOLESALE ENERGY PRICES**

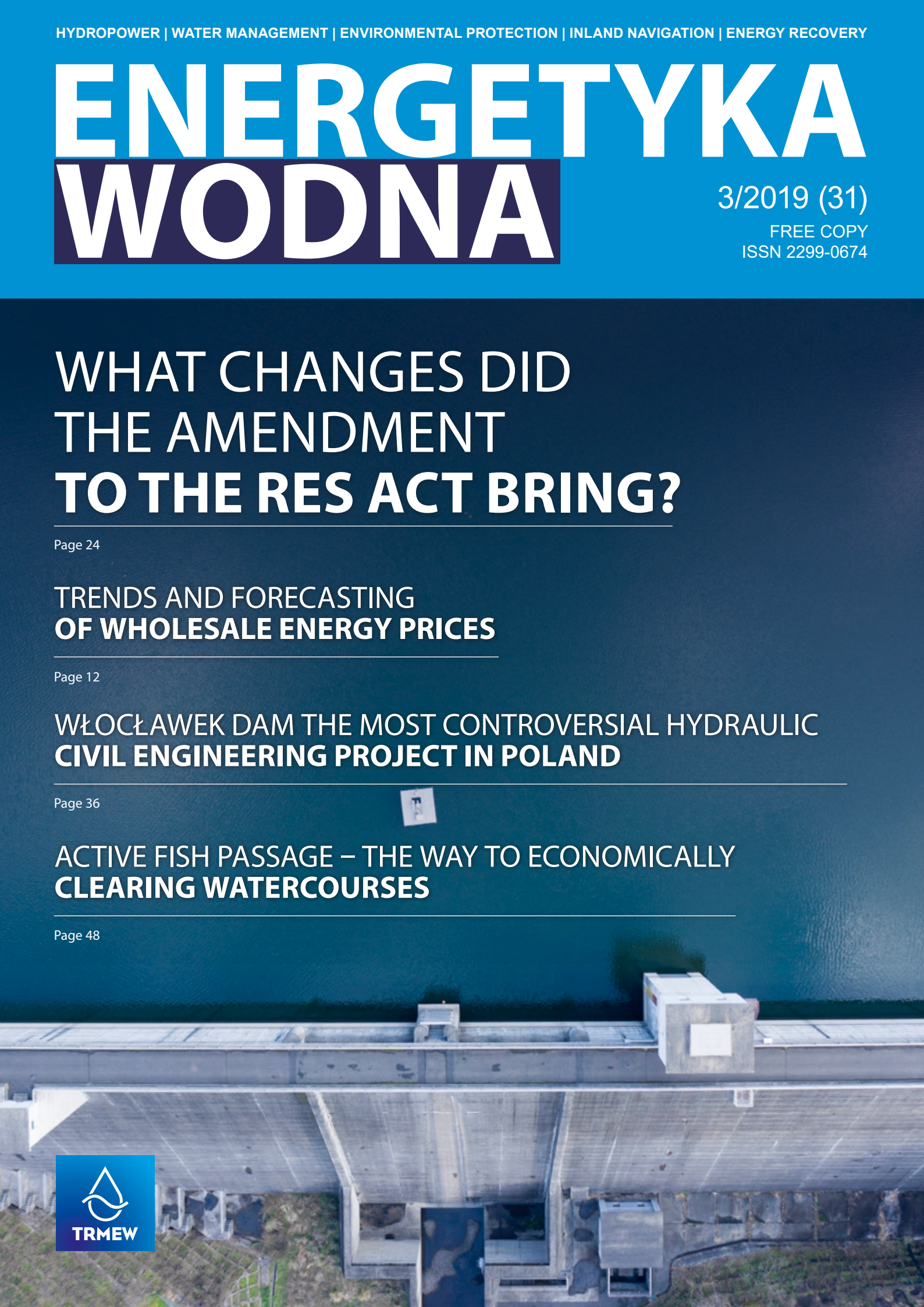
Page 12

WŁOCŁAWEK DAM THE MOST CONTROVERSIAL HYDRAULIC **CIVIL ENGINEERING PROJECT IN POLAND**

Page 36

ACTIVE FISH PASSAGE – THE WAY TO ECONOMICALLY **CLEARING WATERCOURSES**

Page 48



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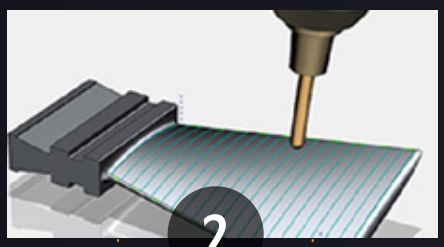

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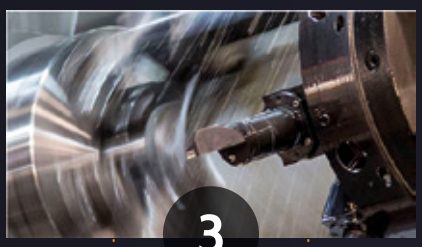

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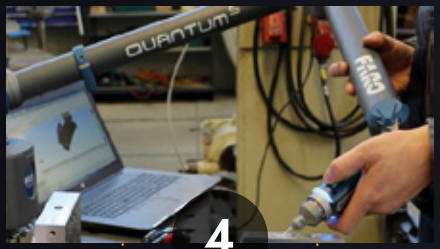

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FROM **EDITORIAL OFFICE**

Dear readers! I am pleased to announce that this year's autumn "Energetyka Wodna" is also an international edition. The positive reception of our debut issue at the HYDRO 2018 trade fair and conference in Gdańsk was a strong argument for us to continue publishing activity outside Poland. However, we went a step further compared to the previous edition. We have significantly increased the distribution range of the magazine and focused in particular on the Balkan market. The magazine will be available in electronic version for participants of events organized by REECO International: RENEXPO BiH 2019, RENEXPO North Macedonia 2019, RENEXPO Energy, Waste & Water 2020, as well as during the Hydropower Balkans 2019 conferences and fairs signed by Vostock Capital and Renexpo Interhydro, organized by the Salzburg Trade Fair Center. Furthermore, the international edition will also reach members and owners of hydropower plants affiliated within the European Federation of Renewable Energies. For dessert I will add that of course we will not miss HYDRO 2019 in Porto, where "Energetyka Wodna" will be available in paper version.

In this issue, we focus on two documents that will significantly shape Polish hydropower in the coming years. The first of these is another amendment to the Act on renewable energy sources, the provisions of which are intended to intensify efforts to reach 15% of the share of energy from renewable sources in final energy consumption by 2020. In the opinion of industry representatives, the adopted provisions will have a positive impact on the situation of Polish hydropower.

The second document is "The procedure for managing the property of the Treasury under control of Polish Waters". This document regulates in detail the principles of property management transferred to Polish Water, including making it available to interested entities in a non-tender procedure. It sets out the rules for the use by investors and owners of hydropower plants of water facilities and real estate necessary to conduct their business activities.

In this issue we also present the results of the analysis carried out by the Institute for Renewable Energy, which concerns trends and forecasts of wholesale electricity prices in Poland, as well as we introduce the issue of the location market, constituting an opportunity to adapt the domestic energy market to upcoming changes.

Bearing in mind the fiftieth anniversary, that will be celebrated next year, of the Włocławek Dam, which includes the largest flow-through hydro power plant in Poland, we publish an article by Professor Wojciech Majewski, which is a compendium of knowledge about the project, research, construction and operation of the barrage, as well as economic, social and natural aspects related to it. Enjoy!

Michał Kubecki
Editor in Chief

PARTNERS

HONORARY PATRONAGE

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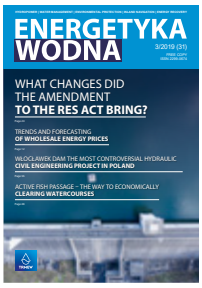

NEWS

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DRAFT GOVERNMENT ENERGY STRATEGIES **HAVE BEEN EVALUATED**

The European Commission evaluated draft government energy strategies for 2021-2030, which were prepared by Member States and the implementation of which is expected to achieve the objectives of EU climate and energy policy. Poland is among a dozen or so countries to which Brussels recommended raising the renewable energy target for 2030.

In accordance with the new EU energy strategy for 2021-2030, the implementation of its objectives in the field of reducing CO_2 emissions, renewable energy production or improving energy efficiency is to guarantee the implementation of the so-called national energy and climate plans for 2021-2030 (NECPs).

Source: iStock, ipopba

Member States submitted drafts of these plans to Brussels at the turn of 2018 and 2019, and by the end of the first half of this year the Commission was to submit their comments. The European Commission, after summarizing all draft national plans, estimates that although their implementation as proposed will allow the achievement of the target of reducing CO_2 emissions by 40% by 2030, it will not enable other objectives to be achieved. Brussels identified a clear gap in terms of the goal of improving energy efficiency. Analyzing the proposals included in the national plans, the EC evaluated that the achievement of the proposed objectives in total would allow for the reduction of energy consumption by 26-31 percent by 2030 at the EU level compared to the reduction target of 32.5 percent previously agreed by the European Union.

In turn, in the scope of RES targets proposed by Member States, the Commission decided that they would not allow for the achievement of the target of 32% of renewable energy in the EU energy consumption in electricity, heating and transport set for the end of the next decade, enabling a level of 30.4-31.9% to be reached. As emphasized by the European Commission, RES targets reported by Member States are insufficient to achieve the previously agreed level of 32% - despite the particularly ambitious contributions proposed by Denmark, Estonia, Spain, Lithuania and Portugal. At the same time, Brussels has distinguished model plans in the field of renewable energy developed by the Czech Republic, Italy and Ireland (with Ireland and the Czech Republic being recommended to raise the proposed RES target). In the commentary on the need to include mechanisms supporting renewable energy in national strategies, the European Commission mentions the need to provide appropriate instruments in the area of autoconsumption, energy cooperatives as well as market contracts for the sale of energy (PPA) and auctions.

As the Commission emphasizes, these areas are essential to supporting energy transformation, attracting private investment and achieving objectives in a cost-effective way. The EC also estimates that simplification of administrative procedures will be essential for the development of renewable energy in the next decade, including in the field of repowering, i.e. replacing old installations with new and more effective ones. Poland was among the fifteen countries to which Brussels recommended raising the national RES targets. In addition to Ireland and the Czech Republic, according to the Commission, Belgium, Bulgaria, Cyprus, Finland, France, Hungary, Latvia, Malta, Romania, Slovenia, Slovakia and the United Kingdom should increase their targets. In the Polish NECP, our government proposed to increase the share of renewable energy in domestic energy consumption in electricity, heating and transport to 21 percent by 2030 – compared to the 15% target that we should achieve in 2020. Referring to this proposal, the European Commission has recognized that we should increase our renewable energy target for 2030 to at least 25% in order to contribute to the implementation of the EU target.

Final versions of national energy and climate plans should be agreed upon by the end of this year. The EU renewable energy target for 2030 at the level of 32% will be binding only at the level of the entire European Union. Unlike the 2020 target arising from the first RES directive, it will not include compulsory national targets. The adopted principles of managing the energy union are, however, to ensure that individual countries will gradually increase the share of renewable energy in their energy mixes. In 2017, the share of renewable energy in energy consumption in the European Union was 17.5%, while in Poland it was 10.9% compared to the level of 15% required for 2020.

In the recommendations for national energy and climate plans, Brussels emphasizes that in terms of the new strategy for 2021-2030 the required level for the share of renewable energy in 2020, and not the actual level achieved by individual Member States, is to be the starting level.

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THE CONTRACT FOR THE DESIGN OF THE LUBIĄŻ **WATER BARRAGE ON THE ODER RIVER HAS BEEN SIGNED**

On August 12, the president of State Water Holding Polish Waters Przemysław Daca signed a contract for the design of a new Lubiąż water barrage on the Oder river in the region of the village of Gliniany in the Lower Silesian Voivodeship Office. The ceremony organized in the building of the Lower Silesian Voivodship Office in Wrocław was attended, among others, by Marek Gróbarczyk - Minister of Maritime Economy and Inland Navigation and Paweł Hreniak - Lower Silesian Voivode.

The scope of the investment will mainly include the construction of a new modular water barrage, which aims to protect against floods, stop erosion processes in the riverbed, improve water and soil-water relations, produce environmentally friendly electricity and improve navigation conditions of the waterway up to class Va. As a part of the facility, a minimum four-span weir, two-chamber navigation sluice, fish pass and hydropower plant are to be built, among others.

"The initial design procedure of the new water barrage in Lubiąż shows that tasks related to water management, navigation, flood protection as well as securing and preventing the effects of drought are exemplary in our region", said host of the meeting Paweł Hreniak, Lower Silesia Voivode. As a result of the tender procedure, a consortium was selected consisting of DHV Hydroprojekt Sp. z o.o. from Warsaw - as a leader - together with partners Energoprojekt Warszawa SA and Hydroprojekt Wrocław Sp. z o.o., which offered over PLN 13 million for carrying out works. "We are celebrating a very important day for water management in Poland. We have been systematically implementing our announcements and planned strategies for 4 years. The next stage is today's signing of the contract for the design of the Lubiąż water barrage on the Oder river together with obtaining the investment permit. Our activities are part of the programs for the development of inland roads and retention, renaturization and investment. We assume that the investment in Lubiąż will be carried out in accordance with the prospects of the EU budget in the next 7 years", said Marek Gróbarczyk, Minister of Maritime Economy and Inland Navigation.

"It is an honor that I can sign a contract for the preparation of investment documentation that will allow us to commence construction works on the Lubiąż water barrage. The more so because in the short history of the functioning of Polish Water we were able to complete the construction of the Malczyce barrage, where the activation of the local hydropower plant is in preparation. These are further breakthrough steps in investments in water management, which finally, after several decades of neglect, ensure the proper development of the Oder Waterway", emphasized Przemysław Daca. The main purpose of building the Lubiąż barrage is to stop the erosion processes in the Oder riverbed below the Malczyce barrage. Progressive bottom erosion causes a lowering of the water level in the river, directly below the barrage in Malczyce, reaching as far as Ścinawa and desiccation of the areas adjacent to the river. The designed Lubiąż barrage will also allow for the protection of the Malczyce barrage against flooding and loss of stability; restoration of the original groundwater levels; prevention of desiccation of adjacent areas (in particular, it will protect riparian forests); suppression of erosion processes in the riverbed below the barrage; production of electricity by a hydropower plant located at the barrage; restoration of shipping route parameters.

The contractor of the design is expected to complete the contract within 43 months of signing the contract. This means that the contractor should complete the design work by the end of the first quarter of 2023 at the latest. The construction cost is estimated at over PLN 400 million, and the end of construction is planned for 2027.

Social Communication and Water Education Team
at RZGW in Wrocław

PUBLIC CONSULTATION OF THE DRAFT PLAN TO PREVENT THE EFFECTS OF **DROUGHT ARE ONGOING**

Half-year public consultation of draft Plan to prevent the effects of drought (PPSS) are underway. The consultation are part of the Stop the Drought! project implemented by the State Water Holding Polish Waters. Such nationwide campaign in Poland is undertaken for the first time.

Consultation meetings will take place in 15 largest Polish cities and are runing from 15 August 2019 to 15 February 2020. The form of consultation is open and everyone can submit their comments and recommendations. Understanding and acceptance proposed measures is necessary to success of the whole project. – We care about every insight. Only after all comments have been collected, the drought effects counteracting plan design will become the first, such comprehensive document concerning the phenomenon of drought in Poland, and an important step towards real adaptation to climate change. Participants of the consultation will be presented with an in-depth analysis of the phenomenon, proposals for enhancing its monitoring, and we will also propose a wide catalogue of measures aiming at minimizing drought effects. PPSS is not only a document for the next few years. It will also determine the perspective for subsequent future studies - said Przemysław Daca, President of the Polish Waters during the inauguration of public consultations.

Stop the Drought! projectis an answer to an urgent need. There is only 1,000 cubic meters of water per one resident of our country per whole year. This is four times less than in other EU countries. Low water retention level is one of the reasons for this unfavourable state of affairs. Only approx. 6.5% of the so called annual river run-off is retained in Poland. This is definitely too low, and thus PPSS contains as many as 68 proposals for construction and reconstruction of water facilities used for retention enhancement and supporting drought effects counteracting. Public consultation in each city concerns different drought aspect. In Poznań main topic was agricultural drought, in Zielona Góra pond retention and in Wrocław minimalizing drought consequences in urban areas. According to Krzysztof Woś – deputy President of the Polish Waters for flood and drought protection, such wide range of topics should show, how serious, nationwide is a scale of drought events and also underline that drought is multi-aspect phenomenon. – When the public consultation will be finished, we will be sure that none of topics was ignored or treated briefly. It will guarantee the catalogue of key measures to counteract drought consequences – main part of PPSS – will be effective – deputy President Woś explained.

PPSS, along with water management plans and flood risk management plans will contribute to the enhancement of water management in Poland. After the public consultation, the draft of PPSS will be subject to the strategic environmental assessment, and the final element in 2020 will be its adaptation through the ordinance of the minister competent for water management. In this way, Poland will be among the 10 European countries, that have developed plans to counteract drought effects. Documents of this rank have been developed by, among others: United Kingdom, France, Spain, Portugal, Slovakia and Ukraine.

President of the Polish Waters is obliged to prepare the drought effects counteracting plan by the provisions of the Art. 240 (2) item 8 of the Act of 20 July 2017 – Water Law (Journal of Laws of 2018, item 2268).

The Stop the Drought! project is accompanied by a public campaign entitled 'Pamiętaj o wodzie!' (Remember about water!). More information at www.stopsuszy.pl and www.wody.gov.pl

State Water Holding Polish Waters

OVER PLN 37 MILION TO RESTORE ECOLOGICAL CONTINUITY **OF SECTIONS OF THE VISTULA, SOŁA AND SKAWA**

Many kilometres long the ecological corridors in the Vistula River basin (in the area of the Water Region of the Upper Western Vistula River) will be restored as part of an initiative of the Regional Water Management Authority in Cracow – State Water Holding Polish Water. It will be assisted by financial support from the European funds provided by the National Fund for Environmental Protection and Water Management. The project will also be co-financed by a dedicated grant from the State budget.

The allocation of the European Union funds was confirmed by the agreement signed on 22 August 2019 in Oświęcim by Mr. Marek Ryszka, Acting President of the Management Board of the National Fund for Environmental Protection and Water Management, and Mrs. Małgorzata Sikora, Director of the Regional Water Management Authority in Cracow – State Water Holding Polish Water. The ceremony was also attended by: Mr. Grzegorz Puda, Secretary of State at the Ministry of Investment and Economic Development, and Mr. Krzysztof Woś, Vice-President of Polish Waters for Flood and Drought Protection.

The cost of the project will be more than PLN 44.3 million, while the grant from EU resources allocated by the National Fund (as part of the Operational Programme Infrastructure and Environment 2014-2020) will be PLN 37.7 million. The additional grant from the State budget will be almost PLN 6.7 million. The project will be carried out in the Vistula River basin and in the lower sectors of the Soła and Skawa Rivers in Małopolskie Voivodship, in the Bielsko-Biała, Oświęcim, Wadowice and Chrzanów Counties. The aim of the project is to improve the ecological status of waters in sections of three rivers: the Vistula, the Soła and the Skawa, with a total length of 87.7 km. The works will restore the coherence of the Natura 2000 network and enable the reconstruction of historical ecological corridors linking the Vistula with the Soła and the Skawa. The beneficiary has proposed to open the passage through 9 hydro-engineering barriers situated in the section of the Vistula between the mouths of the Soła and the Skawa, in the part of the Skawa from the Świnna Poręba dam to its mouth and in the part of the Soła from the Czaniec dam to its mouth. The construction of fish ladders proposed in the project will enable free migration of aquatic living organisms, including different species of freshwater fish. The design documentation will be prepared in the nearest months, until the end of 2019. In turn, the construction works will be carried out from the beginning of 2020 to the end of 2022.

The project can be co-financed under measure 2.1 of priority axis II of the OPIE 2014-2010 Adaptation to climate change, including the safeguarding and enhancing of resilience to environmental emergencies, particularly natural disasters, and environmental monitoring. It is implemented by the National Fund in cooperation with the Ministry of the Environment.

Sławomir Kmiecik
NFEPWM spokesperson

MODERNIZATION OF THE DĘBE HYDROPOWER **PLANT IS UNDERWAY**

PGE Energia Odnawialna has signed a contract for the comprehensive modernization of the Dębe Hydropower Plant. The works are to last until the end of 2022, and after their completion, electricity production at the power plant should increase by 17 percent, to the level of approx. 120 GWh/year.

Modernization of the power plant will include the replacement of technological equipment, including all turbines, generators, flow system, regulation, excitation, as well as electrical and drainage installations together with equipment such as pumps, valves and gate valves.

The investment commenced in August will bring EW Dębe many benefits. Operation of electrical and mechanical equipment will be centralized and automated, and the energy efficiency of the power plant will improve. Potential environmental impact will also be eliminated by minimizing the use of petroleum-based lubricants in favor of biodegradable materials. Implementation of the investment will contribute to the failure-free operation of the power plant for at least another 40 years, ensuring full automation of turbine sets, the highest availability and reliability of work, improvement of service ergonomics and a radical reduction of fire risk. Dębe Hydropower Plant has been operating since 1963. It was built at the water barrage, covering a 230-meter dam on the Narew River.

The power plant building is part of the water-damming structure. Its underground part consists of two reinforced concrete blocks, and in each of them two hydropower sets with Kaplan turbines with a rotor diameter of 4.8 m, mounted with generators with a power of 6.25 MVA were installed. In the aboveground part there are: a machinery hall with technological rooms, control room, low voltage switchgear and assembly hall.

The power plant is connected to the National Power System by five 110 kV lines via two block transformers with a capacity of 16 MVA each, and its installed power is 20 MW achieved at a 5.7 m drop and the turbines installed discharge of water of 428 m³/s.

PGE EO press office

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TRMEW – **AN ORGANIZATION WITH TRADITIONS**

TRMEW - the Polish Association for Small Hydropower Development is a non-profit organization with more than 30 years of history, representing the Polish small hydropower sector in Poland and in the international arena.

TRMEW actively participate in creating legal and financial framework to stimulate development of small hydropower and support electricity producers in existing small hydropower plants. The organization brings together the owners and supporters of small hydropower plants. The history of the association goes back to the early 80s. It was formalized in 1988 when, on the initiative of the then President of the association, Marian Hoffman, it was officially registered. Over time the organization has undergone considerable development and currently has over 400 members who are both individuals and businesses

The Association operates on the international, national and regional scale. It also has an extensive network of contacts with national and European research centers, companies and institutions of the industry. TRMEW closely collaborates, among others, with the European Renewable Energies Federation (EREF) and the Polish Hydropower Association (TEW). Many years of activity of TRMEW have rendered it a well -known and recognizable brand in the Polish central and local government, as well as academic and economic environments.

The activity of our organization is focused on:

- representation of small hydropower sector in the political arena
- promotion and building of a positive image for the small hydropower industry
- integration of the SHP environment by organizing industry meetings, conferences and training
- education in the scope of small hydropower.

TRMEW has gained experience in international projects by participation in the RESTOR Hydro Project, co-funded by the IEE Programme of the EU which was carried out from 2012 to 2015. The project aimed at increasing renewable energy production from small and micro hydropower, by identifying and restoring suitable historical sites, mills and hydropower stations currently inoperative. In the project, TRMEW's main tasks and achievements were data completion for two databases: HYDI (energy, market and policy data on hydropower sector in Poland) and the RESTOR Hydro Map (8,000 SHP sites for Poland have been identified), analysing and adapting the idea of SHP cooperative on Polish legal grounds and starting the refurbishment procedures of selected pilot sites.

RESTOR Hydro was aimed at assessing the state of small hydropower and refurbishment potential in the EU-27 region, whereas starting from 2019 TRMEW is involved in implementing another international project - HYPOSO which aims at increasing the share of renewable energy, especially small and medium-sized hydropower in Africa and Latin America.

The HYPOSO objectives include the framework analyses with regard to small hydropower up to 30 MW for target countries with a high market potential hydro sector, i.e. Bolivia, Cameroon, Columbia, Ecuador and Uganda, mapping of more than 2,000 potential hydropower sites in the target countries, capacity building of local stakeholders, elaboration of business case studies of SHP projects and creation of a comprehensive web-based information hub for both, the European hydropower industry and stakeholders in the target countries.

Monika Grzybek
TRMEW Office

CONSTRUCTION OF A WATER BARRAGE ON THE PISA RIVER **IS GETTING CLOSE**

The Pisz Municipality transferred the right to dispose of the land on which the water barrage on the Pisa river is to be built to State Water Holding Polish Waters. Its creation is to contribute to the restoration of the Warsaw-Pisz water connection.

According to the plan, the Pisz barrage is to include: a navigation sluice, a weir with a fish pass and a 0.2 MW hydropower plant. The water retained by means of the barrage in Lake Roś is to supply the rivers of Pisa and Narew during the so-called low water periods, eliminating water levels that are too low for navigation. Thus, the investment is to contribute to the implementation of the Retention Development Program currently under development by the government. As early as in June, the municipality handed over the land to Polish Waters, for the construction of technical facilities - a hardware and repair base, which is to enable the waterway to be maintained in proper technical condition and to support the water barrage itself.

Przemysław Daca, President of Polish Waters, emphasized during the solemn transfer of land rights, that in the context of tourism this is one of the largest projects currently implemented by Polish Waters, because we are talking about a large navigable route from Warsaw to the Great Masurian Lakes. As part of restoring the waterway between Warsaw and Pisz, maintenance works have already been carried out at the port on the Narew in Ostrołęka. The rubble and silt from the bottom of the port basin and the port entrance were removed, wooden bumpers on the retaining walls of the port quay and two floating platforms (each 36 m long) were mounted, and the fence was replaced.

Paulina Wójtowicz
inzynieria.com

CALENDAR

14-16.10.2019 Porto, Portugal	**HYDRO 2019 – Concept to closure: Practical steps** *Organizer – The International Journal on Hydropower & Dams*	www.hydropower-dams.com
23-24.10.2019 Sarajevo, Bosnia and Herzegovina	**International trade fair and conference RENEXPO BiH** *Organizer – REECO SRB d.o.o.*	www.renexpo-bih.com
7-8.11.2019 Belgrad, Serbia	**Hydropower Balkans** *Organizer – Vostock Capital*	www.hydropowerbalkans.com
19-21.11.2019 Lublin, Poland	**12th Fair for Energetics** *Organizer – Targi Lublin*	www.energetics.targi.lublin.pl
22.11.2019 Warsaw, Poland	**Building Constructions 2019** *Organizer – Instytut PWN*	www.instytutpwn.pl
28-29.11.2019 Salzburg, Austria	**RENEXPO INTERHYDRO European hydropower trade fair and conference** *Organizer – Messezentrum Salzburg GmbH*	www.renexpo-hydro.eu
28-29.11.2019 Nowy Adamów, Poland	**VI HYDRO-FORUM TRMEW** *Organizer – Polish Association for Small Hydropower Development (TRMEW)*	www.trmew.pl
3-4.12.2019 Skopje, Macedonia	**International trade fair and conference RENEXPO North Macedonia** *Organizer – REECO International d.o.o.*	www.renexpo-nmk.com
26-27.02.2020 Kielce, Poland	**ENEX The biggest fair of renewable sources of energy in Poland** **21st Environmental Protection and Waste Management Expo EKOTECH** *Organizer – Targi Kielce*	www.targikielce.pl

FROM THE WORLD

5.06.2019 PUD SAYS REMOVING LOWER SNAKE DAMS IN THE US IS **'BAD FOR THE COUNTY AND THE REGION'**

The Board of Commissioners of the Grays Harbor Public Utility District (PUD) in Washington, US, has released a statement that throws support behind four hydroelectric dams on Eastern Washington's Lower Snake River that, in recent years, have been targeted for removal.

The board unanimously approved a resolution firmly stating that the "removal of elements of the Federal Columbia River Power System (FCRPS), including the Lower Snake River Dams would negatively impact the Grays Harbor Public Utility District's responsibility to provide reliable, efficient, clean and affordable power to its customers." "Removing the Lower Snake Dams is bad for the county and the region. Locally they mean efficient energy at an affordable cost and greater energy reliability for Grays Harbor PUD customers," said PUD Board President Russ Skolrood. "But to the region, especially Eastern Washington and the Columbia River Gorge, the impacts are even greater. They impact the lives of thousands of families through irrigation, flood control, navigable waterways and outdoor recreation." PUD Board Secretary Dave Timmons says that without the energy generated by the dams, the reliable flow of energy from the FCRPS would be threatened, which was also illustrated by a 2017 report from the Bonneville Power Administration.

"In January of 2017, when thousands of households across the Northwest needed power to stay warm, the output from wind generators varied from 3000 to 74 MW. Those are not numbers you can plan on to reliably power homes and businesses. At that same time, the Lower Snake Dams were generating nearly 1300 MW. To me that shows that one source can be counted on, the other can't," said Timmons.

International Water Power & Dam Construction

28.06.2019 HYDRO POWER'S VOLKSWAGEN **DATA CENTER IN NORWAY**

Volkswagen has opened a data center in Rjukan, Norway, that will be 100 percent powered by hydropower – resulting in a savings of more than 5800 tons of CO_2 per year compared to a conventionally operated data center.

The Volkswagen Group moved into the new climate neutral data center earlier this month. The facility was set up in just six months in collaboration with the Norwegian partner Green Mountain. "We support digitalization in all areas of the Volkswagen Group. With new technologies and digital forms of cooperation, there is a growing need for computing power in the company. As a result, we are constantly expanding our capacities," said Mario Müller, Head of IT Integration and Services at the Volkswagen Group. "For us, economic factors and sustainability in the company are important aspects. The new data center in Norway satisfies in both respects. The operation is cost-effective and completely climate neutral."

International Water Power & Dam Construction

29.07.2019 HYDROGEN PRODUCTION PLANNED **AT SWISS HYDRO PLANT**

Alpiq and H2 Energy have announced they have achieved a milestone for the development of hydrogen-powered mobility in Switzerland, with the country's first system for the commercial production of hydrogen expected to be operational at the Gösgen hydropower plant by the end of the year.

The 2 MW system is to be constructed on the left bank of the Aare canal by Hydrospider, which is owned in equal shares by Alpiq and H2 Energy. Alpiq and H2 Energy plan to use hydropower to produce hydrogen for some 50 fuel cell-powered electric lorries. In future, Hydrospider intends to produce climate-friendly hydrogen in Gösgen using electricity from 100 percent hydropower to power the first 50 of a total of 1,600 fuel cell lorries, which Hyundai Hydrogen Mobility, a joint venture between Hyundai Motors and H2 Energy, will bring onto Swiss roads by 2025.

International Water Power & Dam Construction

8.08.2019 TEESTA-V RATED AN EXAMPLE OF **INTERNATIONAL GOOD PRACTICE**

The Teesta-V hydropower station, in Sikkim, northern India, has been rated as an example of international good practice in hydropower sustainability, according to an independent report.

The 510 MW power station, owned and operated by NHPC Limited, was reviewed by a team of accredited assessors using the Hydropower Sustainability Assessment Protocol. Their report, which looked at the project's operation, has now been published and is available to view online.

According to the report, Teesta-V met or exceeded international good practice across all 20 performance criteria. It met proven best practice on its management of asset reliability and

efficiency, financial viability, project benefits, cultural heritage, public health, and erosion and sedimentation. Teesta-V is also the first hydropower project globally to publish results against new performance criteria covering its resilience to climate change and mitigation of carbon emissions, after the Hydropower Sustainability Assessment Protocol (HSAP) was expanded in scope in 2018. The report documents how NHPC, managed impacts on local communities and the environment, and how the project has provided "significant" benefits, including providing low-cost electricity and employment.

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FUNDS ANNOUNCED FOR **US DAM REPAIRS**

11.09.2019

Dams in West Virginia, US, classified as "high hazard potential" are receiving federal funding assistance it has been announced. Senator Shelley Moore Capito (R-W.Va.), chairman of the Senate Homeland Security Appropriations Subcommittee, and Joe Manchin (D-W.Va.), a member of the Senate Appropriations Committee, announced that funding totaling $277,019 has been awarded to the West Virginia Department of Environmental Protection to aid repair of these dams, courtesy of FEMA's Rehabilitation of High Hazard Potential Dam (HHPD) grant program.

"Throughout West Virginia and the entire United States, there are non-federal dams in dire need of maintenance and rehabilitation. Often the funds necessary to address this challenge are not available within cash-strapped state and local government budgets," Senator Capito said. "West Virginia dams have suffered from floods and other natural disasters in years past, so I'm pleased to see our state receive this much-needed federal assistance."

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NEW IHA LEADERSHIP **TEAM TAKES OVER**

20.09.2019

A new leadership team has taken the helm of the International Hydropower Association (IHA), with newly elected President Roger Gill joining Chief Executive Eddie Rich.

Rich, who took over from Richard Taylor on 9 September, presented to IHA's new Board the organisation's strategy for the next two years. This will see IHA focus on research and policy, sustainability and sharing knowledge on the role of hydropower in the clean energy transition. "With the demand for energy expected to double from 2015 to 2060, the world must look towards a sustainable, renewable mix of energy sources. IHA's role is to advance sustainable hydropower by building and sharing knowledge on its role in renewable energy systems, responsible freshwater management and climate change solutions," commented Rich.

International Water Power & Dam Construction

NEW MODEL COULD HELP FIND MOST PROMISING **DAM SITES IN THE AMAZON**

20.09.2019

A Cornell University-led team including ecologists, computer scientists and researchers from South American organizations has developed a computational model that uses artificial intelligence to find what is says is the most promising configurations of dam sites amid a staggering number of possible combinations, with a focus on the Amazon region.

The researchers found that achieving low-carbon hydropower requires planning that considers the entire Amazon basin – and favors dams at higher elevations. "If you develop these dams one at a time without planning strategically – which is how they're usually developed – there is a very low chance that you'll end up with an optimal solution," said Rafael Almeida, a postdoctoral research fellow with the Atkinson Center for a Sustainable Future and co-lead author of "Reducing Greenhouse Gas Emissions of Amazon Hydropower with Strategic Dam Planning," which published September 19 in Nature Communications. "Developing dams suboptimally can lead to really undesirable outcomes, with emission levels that are not compatible with future sustainable energy goals," Almeida said. The researchers said that when areas are flooded to build dams, decomposing plant matter produces methane, a more destructive greenhouse gas than carbon dioxide. Depending on location and other factors, the carbon emissions from dam construction can vary from lowest to highest by more than two orders of magnitude. Using the model, the researchers can identify the combination of dams that would produce the lowest amounts of greenhouse gases for a given energy output target.

The analysis found that dams built at high elevations tend to have lower greenhouse gas emissions per unit of power output than dams in the lowlands – partly because less land needs to be flooded in steeper environments.

There are currently around 150 hydropower dams and another 350 proposed for the Amazon basin, which encompasses parts of Brazil, Ecuador, Peru and Bolivia. This study is part of a larger effort to use computational tools to analyze the dams' impact, to help South American governments and organizations make informed decisions that balance the benefits and disadvantages.

International Water Power & Dam Construction

TRENDS AND FORECASTING OF WHOLESALE ENERGY PRICES

Electricity due to rising demand and high prices is becoming an increasingly important element of the economy. Despite attempts at direct regulation, fundamental reasons of the rising prices are possible to outline and with clearly stated assumptions are also possible to be forecast.

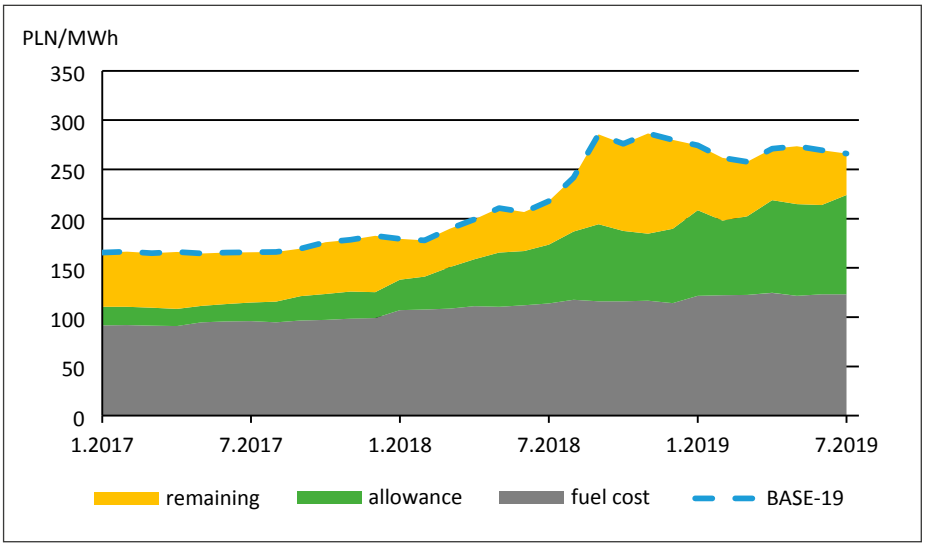
Contracts on commodity forward instrument market began their upwards trend in July 2017 (Fig. 1). In 2018 the speed of the increase picked up, especially in the second half of the year. Once raised prices stayed high during all of 2019 at 260-270 PLN/MWh. The key external factor influencing electricity prices in Poland is the price of CO_2 emission allowances – EUA. Narration of pointing at them as the sole reason, which antagonizes EU turning more and more towards energy sector decarbonisation, is difficult to undermine. However, deeper analysis leads to more nuanced conclusions. In simplification, the supply on the forward instrument market is tied to coal and lignite generation units.[1] For the last 3 years, coal prices have been driving the steady rise of electricity prices. Area labelled "remaining cost" (Fig. 1) includes a conglomerate: operational costs, investments and potential profits. In the first half of 2018 the sum of these costs visibly decreased – in that period generation companies possibly reported a loss. In the second half of 2018, when EUA prices still were rising, the situation flipped. An argument can be made, that generation sector used the opportunity and under the pretext of factually skyrocketing in 2018 EUA prices (leap from 15 to 25 EUR/t CO_2) inflated the wholesale price more than it was justified, reaching 270 PLN/MWh (leap of 80 PLN/MWh).

On December 19, 2018, the President of the Energy Regulatory Office ordered explanatory proceedings in this matter. On May 29, 2019, he made another announcement regarding the possibility of manipulating electricity prices on the wholesale market, arguing that the rising prices of allowances are not a sufficient reason for recent increases on the energy exchange. At the beginning of 2019, prices fell to the expected levels and since then they are more closely correlated with the prices of allowances, which follow the upward trend with slight fluctuations.

[1] Assumptions: emission level/rate 850 kg/CO_2, net efficiency 35%

[2] Market Stability Reserve

Fig. 1. Structure of BASE-19 index



Source: TGE, EEX, own figure

Changes in the organization of the emission allowance market (implementation of MSR [2]) mean greater interference in the free market nature of the ETS system - suppressing oversupply and rising prices.

THE NEED OF FORECAST

Determining the reasons for the increase in energy prices is necessary to start a substantive conversation on energy policy (an aspect so far ignored in energy debates) and assess the possibility of permanently reversing the worrying trend in Poland (in particular in the event of falling prices in other EU countries). The problem requires simulation studies related to the fundamental assumptions of the national energy policy. The analyzes conducted refer to them directly and are based on the results of cost modelling carried out in the comprehensive Institute for Renewable Energy (IEO) report "Medium-term forecast of production costs and electricity prices up to 2040 - Report and simulation results in Excel format". The analysis of the results obtained is supplemented with discussion and comparison with other forecasts.

FORECAST MODEL DESCRIPTION

Current phenomena in the energy environment and price trends are worrying, but at the same time difficult to translate into forecasts. Rather, they indicate the need to move away from statistical analyzes of historical results and extrapolating current trends towards a cost model based on technical, economic and political assumptions that make up long-term trends that are not affected by seasonality, and the impact of possible speculation on the market and prices remains automatically limited.

Considering the Polish power system with prospects of a significant scale of investment and diversification of production sources, a forecasting model that takes into account all the main types of technologies and their individual characteristics is necessary. The model developed by IEO is based on calculations of average annual costs for specific manufacturing technologies.

The cost calculations include:

- fixed costs:
  - operational,
  - investments,
- variable costs:
  - fuel costs,
  - CO_2 emission allowance costs,
  - other operational expenses.

The weighted average generation cost calculated on this basis (taking into account the relevant volume of generated energy) increased

by the profit margin is the average cost of electricity generation. In turn it forms the basis for the calculation of wholesale prices. Wholesale prices are calculated as the average cost of energy generation reduced by fees which are transferred directly to the final customer through other channels (bypassing the wholesale market).

Taxes taken into account:

- renewable energy fee,
- transitional fee,
- capacity market fee,
- cogeneration fee.

The estimates and forecasts of the fees were made on the basis of the assumptions of the parliamentary acts or the actual effects of their introduction (e.g. effects of the auctions). These assumptions have their limitations - they do not take into account speculation and market imperfections (strong monopolization of the energy market will lead to higher energy prices compared to the simulation results). Most of the necessary data for the simulation was directly taken from the National Energy and Climate Plan – including generation structure, fuel price forecasts, operational costs. The operation of the model has been fully adapted to the structure of NECP which was forced on all EU member states by the European Commission. In the energy price forecast, the Institute adopted the PEC (so-called Energy and Climate Plan) scenario as the baseline. Unlike the REF (reference) scenario, it is more consistent with EU policy and adapted to the requirements of the European Commission.

RESULTS

Simulations indicate that increases in energy prices are inevitable - first mainly due to the prices of allowances, and then by investment costs. With the existing assumptions of NEPC, the largest increases in energy production costs occurred partly in 2018, costs are still rising (even if they do not fully translate into prices, which will increase spectacularly in 2020). Due to the long-term effects of earlier decisions, even a possible change in energy policy will not significantly change the results of the cost forecast, at least until 2030. On the other hand, energy price forecasts, and especially their current fluctuations, required deeper analyzes.

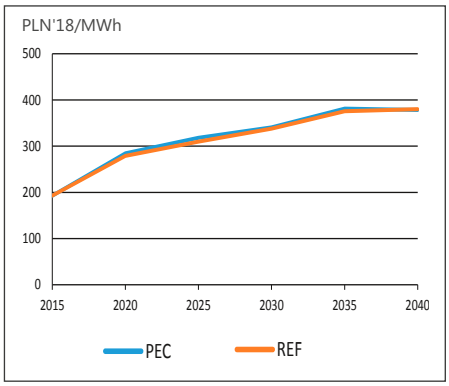
> *Simulations indicate that increases in energy prices are inevitable - first mainly due to the prices of allowances, and then by investment costs*

It is worth emphasizing that wholesale prices in 2020-2025 will be highly uncorrelated with production costs - the changing renewable energy and transitional fee, the introduction of capacity and cogeneration fees guarantee that part of the costs will be transferred from the generation sector to the retail tariffs. Despite the fact that the "Act of December 28, 2018 amending the Excise Duty Act and some other acts" partially reduces some components of the energy price for consumers (reduced excise duty and transitional fee), the final customer in the energy bill will feel the total burden of price increases for fundamental reasons, even though stock market indexes at energy exchange may show other trends.

MODEL VERIFICATION

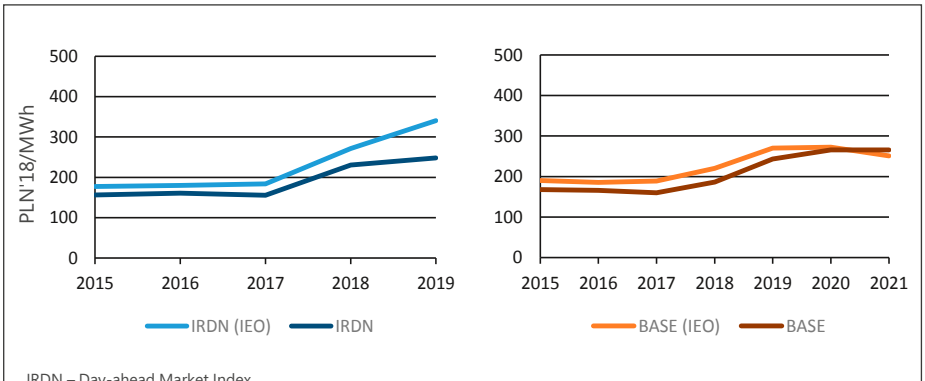
The NECP assumptions used by the IEO in the forecasting model allow reproduction of the value of stock market instruments (Figure 3). It is worth noting the limited objectivity of real stock indices in the form of futures contracts listed on the TGE (1-3 years). Energy prices with delivery after 2020 are determined on the basis of small volumes. Only contracts concluded in the future will be of key importance for average wholesale prices and subsequent energy market stock indices. Taking into account the above limitations and based on known historical data, ex-post verification of the IEO forecasting model was carried out. The trends and shape of changes according to the model are correct, and the results obtained are the basis for the correction and modification of assumptions to ensure the highest correctness of forecasts for the years ahead.

Fig. 2. IEO Forecast model results in two scenarios (fixed prices in PLN'18/MWh)



Source: Own figure

Fig. 3. Comparison (verification) model results and exchange indices (fixed prices in PLN'18/MWh)



IRDN – Day-ahead Market Index

Source: Own figure

SUMMARY

Assuming that further development of the energy sector will take place in accordance with the proposed energy policy and as part of the EU climate and energy policy, an increase in energy prices in Poland is inevitable and will be of a lasting nature. The electricity perspective presented in NECP is, in terms of costs, a progress compared to the energy policy created so far. Assumptions made for calculations based on the gradual evolution of energy policy and the energy mix are the result of current political prejudices (they may change). Model results, however, mean an absolute increase in energy prices - fuelled by rising costs of emission allowances and investment costs. Excluding speculation and aggressive monopolistic practices, wholesale energy prices will be temporarily stabilized by the introduction of additional fees imposed on the end users, but will remain at an alarmingly high level. Only after 2025 can a greater correlation of energy costs and wholesale prices be expected.

Michał Jędra
Grzegorz Wiśniewski
Institute for Renewable Energy Ltd.

HOW CAN THE LOCATIONAL MARKET REPAIR **THE POLISH ENERGY MARKET?**

The energy market in Poland is in crisis. The challenges of the Polish energy transition - high prices, old infrastructure and the dominant share of coal in the mix - should lead to an urgent, substantive debate on possible directions for reform. For the sake of the consumer, market competitiveness and security of supply. Can the locational market be a remedy for our problems?

The energy market in its present form was introduced in Poland by the Energy Law Act in 1997. It was assumed that it would perform the following functions:

- ensuring reasonable prices by increasing competition,
- ensuring a secure electricity supply,
- restoration of technical infrastructure,
- emissions reduction.

WHY DO WE NEED A REFORM OF THE ENERGY MARKET?

20 years ago, the energy market was suitable for a large energy sector based on big conventional units that produce electricity on a continuous basis. Changing technologies and new climate and energy efficiency targets have made the market no longer send the right price signals for the investments needed. It is now the case that large plants are able to satisfy the energy demand. Meanwhile, in Poland, the activity of prosumers and the share of RES in the mix will grow, as new technologies are becoming more common and cheaper. This in turn creates a number of challenges related to transmission and local balancing. The construction of the grid does not keep pace with the rapidly changing energy sector and the model of energy consumption. There are more and more variable resources. Therefore, the role of the operator is also changing rapidly. In the current situation, the operator is forced to manually remove transmission constraints, which naturally raises the costs of balancing the national energy system. Energy prices are rising and instead of looking for a systemic solution, we are treating our market with patches and paracetamol.

Large power plants were built in the 1960s and 1970s, usually in places where there was demand for electricity. Over the years the demand for electricity has been growing and the network load centres are also changing. This entails an increase in the costs of balancing the system. The average, flat price does not motivate market participants to make investment decisions necessary for the system - e.g. improving flexibility, building energy storage facilities, energy savings. The operator is forced to make expensive "manual" removal of network congestion, and the related expenses are charged equally to all market participants.

In Poland, we are convinced that these large, expensive generating units ensure safety. It is not taken into account that they can also fail and suddenly break down. Most often, the cause of electricity shortages in a specific place is grid problems - technical failures. Therefore, energy security in the new system should be redefined. It is not large units that will guarantee security of supply, but a system that is capable of quickly compensating for shortages and reducing oversupply - both through reduction and growth in demand, transmission and the ability to launch new generation quickly. The essence of such a system is the market, which adequately remunerates the desired services and technologies. It will be easier to implement such an approach at the local level - smaller (administratively designated) zones or network nodes. That is why we recommend the locational market.

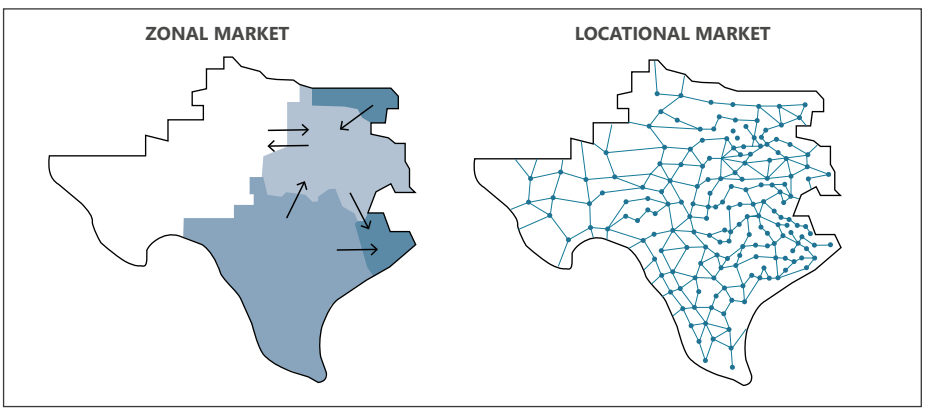
WHY THE LOCATIONAL MARKET?

The locational market effectively performs one of the most important functions of the electricity market - system balancing. In the latest report, the Locational market in Poland. Security of supply, costs and impact on the energy transition, we describe the American electricity market model based on locational marginal pricing (LMP).

The locational market is a wholesale market that takes into account the cost of production, supply (including congestion) of electricity to a specific location in the system. It is also often referred to as the nodal market. Its functioning is based on marginal cost, which distinguishes it from the zonal market. Locational markets have been successfully operating in Canada, Australia and many states in the USA. The best known are PJM (Pennsylvania, New Jersey and Maryland), ISO New England, MISO, CAISO, IESO Ontario, and naturally, the Texas ERCOT market. In Europe, the discussion about the evolution of the energy market is slowly starting, but it is not advanced. Poland has a chance to become a leader in this field in Europe.

In the current model of the zonal market, there is a single wholesale price. Transmission costs and congestion costs are shared between all market participants regardless of where the customer is located and what barriers need to be overcome to supply him with electricity. A locational market is, to put it simply, a market where the price is set at a specific location of the system, at a node - based not only on the cost of production, but also on the cost of supplying electricity to the customer.

Fig. 1. Overview of the structure of the zonal and locational markets based on the example of ERCOT in Texas.



Source: Own figure

The locational market best responds to the challenges faced by the power system, which will change from a centralized, operated by large units to a decentralized one. The grid of the future means dynamic development of the distributed generation, small generation units, advanced metering infrastructure and smart homes. It is also a market of an active consumer who can control his demand at a distance. Therefore, solutions are needed that follow the technology step by step, motivate investments instead of blocking them, optimise costs for the end user.

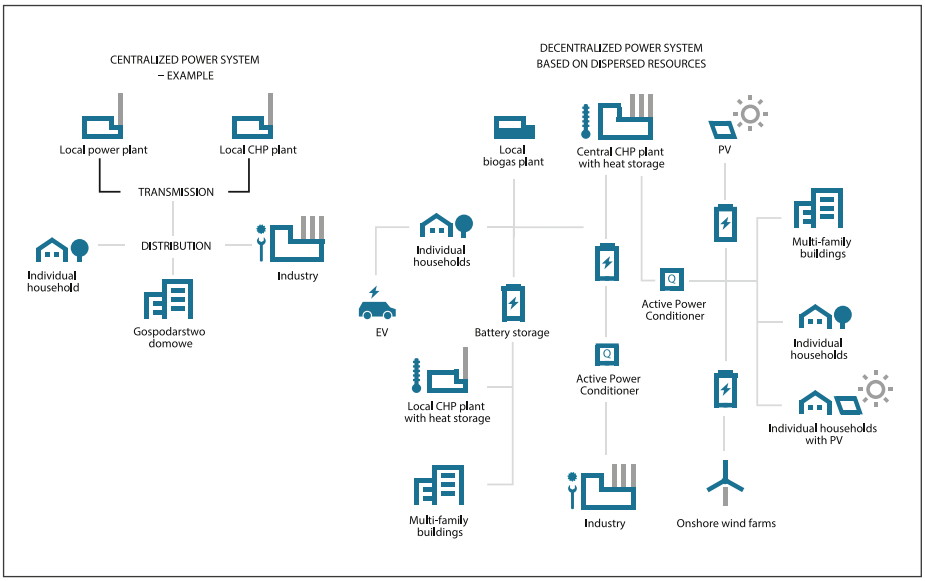
It is certain that the European energy system will largely be based on renewable sources - wind, sun, local biomass, hydropower - depending on the potential. The locational market can open up new opportunities for small hydropower plants. Instead of building networks leading from remote locations to places where there is demand for it, the locational market encourages the search for local energy sources and potential. The nodal market rewards entrepreneurship and increases competitiveness. The nature of the locational market encourages investment in generation sources, energy storage and networks where it is most needed. This means greater cost efficiency. When the inhabitants of a region do not see any benefits for themselves, it happens that they protest against investments. The certainty of lower electricity prices can motivate them to accept the changes. It would also be an important step in the energy transition, which should start at the local level. The locational market would change the role of the transmission system operator. Costly, intervention-based generation activation to maintain stability of supply would not mean shared costs for market participants.

THE LOCATIONAL MARKET AS SEEN BY EXPERTS

Michael Hogan, an American expert in Regulatory Assistance Project and co-author of the report, says: - It is becoming widely understood that 'flexibility' will be the scarce resource on the power system of the future; what is much less well understood is how much of that valuable flexibility will be driven by locational choices, both in short-term consumption and long-term investment. Without proper locational marginal price information, bad choices will continue to be made, needlessly driving up the cost of electricity to all Polish consumers, as we are already seeing next door Germany. Co-author of the analysis, Dr. Joanna Maćkowiak-Pandera, President of Forum Energii, emphasizes the importance of well planned market reform. - This is a subject that requires broad discussion and courageous decisions. The longer we rely on spontaneous and expensive measures taken by the system operator instead of the market itself, the longer the market will remain stagnant and investments in networks will not keep pace with demand. - adds Maćkowiak-Pandera. This solution can be seen as a philosophy of thinking about its local stakeholders and their specific needs and motivations. By increasing the competitiveness and liquidity of the market, we encourage the use of renewable and alternative sources, promote the most necessary investments and new technologies – she says.

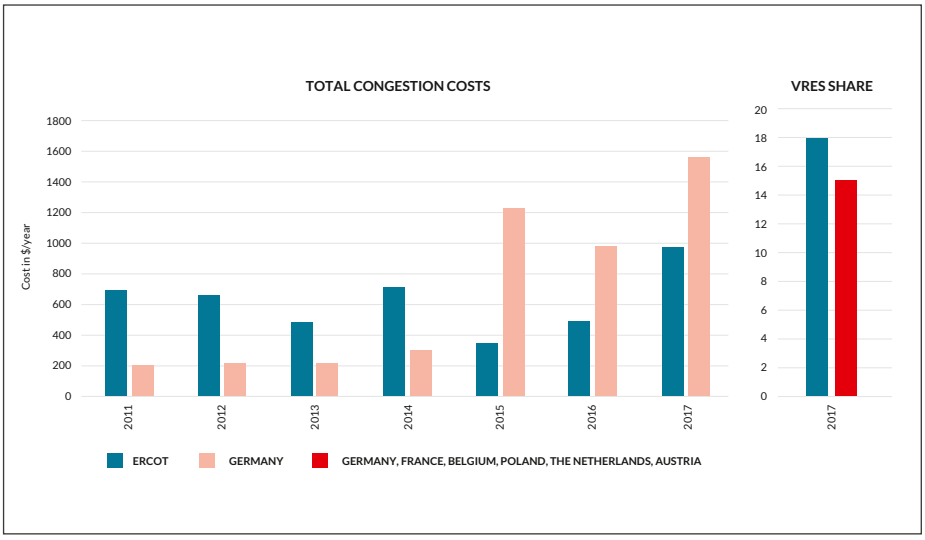
Klaudia Wojciechowska
Forum Energii

Fig. 2. Centralized and decentralized power system



Source: Own figure

Fig. 3. Total annual congestion costs on the ERCOT market and in Germany and the share of variable RES in the system.



Source: Annual market status reports ERCOT; BNetzA, DG Energy

Forum Energii

The article was written on the basis of the analysis "Locational market in Poland. Security of supply, costs and impact on the energy transition", Dr Joanna Maćkowiak-Pandera (Forum Energii), Michael Hogan (Regulatory Assistance Project), Forum Energii, July 2019.

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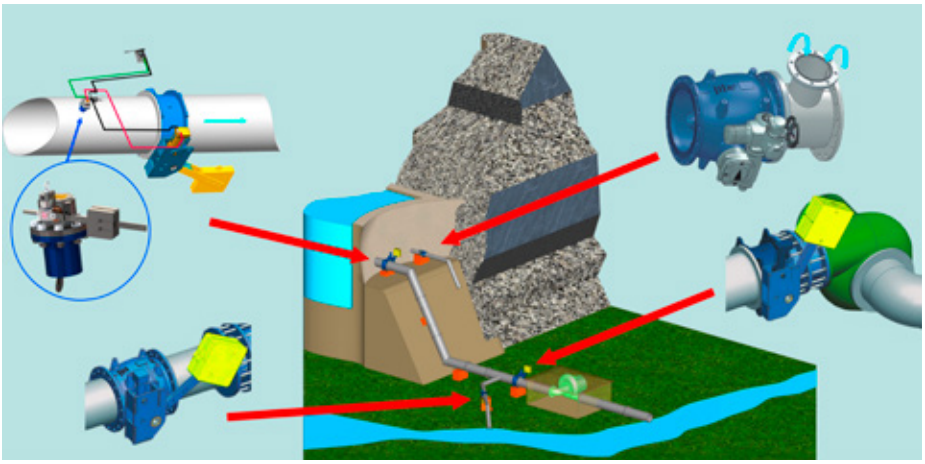
T.I.S. FITTINGS FOR **WATERPOWER APPLICATIONS**

T.I.S. Group, an integral part of which is T.I.S. Polska operating in Poland, is a supplier of fittings solutions for many applications. Its offer includes both general-purpose and specialized fittings, dedicated to specific areas of application, which include waterpower.

The presence of entities of T.I.S. Group on the market of waterpower and hydrotechnical facilities dates back to 1996. The current product offer for this market segment includes fittings for the following solutions:

- shutting off the water supply to the turbines;
- emergency closures in the event of excessive flow rates;
- flow control on turbine protection bypasses;
- by-pass flow control for filling and pressure equalization;
- bottom drains;
- water intakes (valves);
- renovation closures on pipelines;
- other, according to the customer's needs.

Fig. 1. Examples of applications of T.I.S. fittings in waterpower



BUTTERFLY VALVES

The type of shut-off fittings most often provided by T.I.S. intended for shutting off the water at the turbine supply are throttles, in the hydro-energy nomenclature called butterfly valves. For this T.I.S. Group offers double eccentric butterfly valves with ductile iron or steel bodies. The production program of double eccentric throttles, which are the basis for a completely equipped butterfly valve, in the case of ductile iron as the body material, includes the following diameter range: DN 200 ÷ 2400, and steel DN 200 ÷ 3000 (PN6, PN10). At the same time, throttles are offered for higher nominal pressures (PN16 ÷ 40). The solution recommended by T.I.S., which is gaining more and more recognition, especially in the case of larger nominal diameters, is a throttle body with an adjustable connection flange, i.e. a combination of a valve with an assembly insert into one integrated whole. An example of a throttle constructed in this way is shown in Photo 1. This is an interesting proposition not only from the point of view of costs, but also in technical terms, especially in cases of significant restrictions on the length of the building.

Photo 1. DN2200 PN6 double eccentric butterfly valve with integrated mounting insert

Butterfly valves (throttles) for shutting off the water supply to the turbine are usually supplied as fittings together with a hydraulic cylinder and counterweight. The cylinder has a dual function: a brake that provides control over the position of the disk when closing, and an actuator responsible for opening and maintaining the disk in the right position. The counterweight (weight on the arm) is the element providing the torque, suitable for triggering the automatic closing of the valve, without the need for external energy supply, which is crucial for reliable operation. The oil pressure for the actuator can come from the facility's oil system as well as from a local oil supply. A properly selected oil supply can be

Photo 2. The counterweight weights of DN 2200 PN6 butterfly valves of individually selected shapes

Fig. 2. Butterfly valve assembly with over speed sensor. 1. Butterfly valve (throttle) with a hydraulic cylinder and counterweight. 2. Over speed sensor. 3. Oil pump to open the valve.

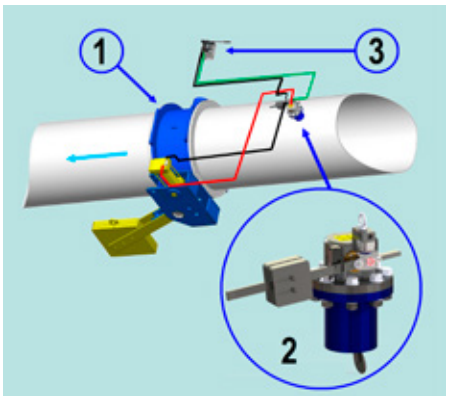
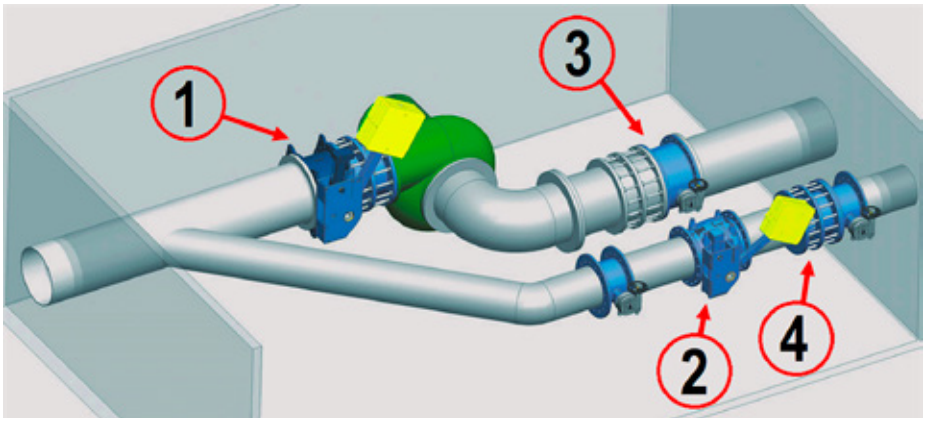


Fig. 3. An example of turbine pipeline and bleed bypass fixture with T.I.S. fittings. 1. Butterfly valve (throttle) with a hydraulic cylinder and counterweight. 2. Needle valve with hydraulic cylinder and counterweight. 3. Hut-off throttle (renovation closure). 4. Mounting insert.



included in the scope of supply together with a valve. The selection of the optimal version of the valve is carried out by the Technical Department of T.I.S. Polska, individually for a given project, based on complete data related to the water supply to the turbine, power supply to the actuator, taking into account all construction conditions, as well as various customer's wishes, including time range of disk position changes, position signaling, etc. Even the shape of the counterweight weights can be adjusted to the operating conditions, an example of which can be seen in Photo 2.

T.I.S. butterfly valves can also be used as shutting off fittings for other functions such as:

- safety shut-off in case of excessive flow rate;
- as renovation closures;
- pressure equalization by-pass;
- other, depending on the needs of the facility.

An example of a safety closure assembly in the event of excessive flow rate is shown in Fig. 2. The safety assembly consists of a complete butterfly valve (throttle) with a cylinder and counterweight, and a device responsible for detecting excessive flow rate, which is a fin speed sensor, also manufactured by T.I.S. The swing angle of the fin located near the pipeline axis depends on the flow rate.

Photo 3. An example of throttle installation activated by an over speed sensor

Exceeding the permissible speed causes the fin to be swung by the angle at which the sensor counterweight position changes and the limit switch that signals the hydraulics of the butterfly valve to close is activated. The closing of the butterfly valve controlled by the hydraulic cylinder begins. Re-opening the valve is only possible after the user's intervention. An example of the completed installation of such an assembly is shown in Photo 3.

NEEDLE VALVES

A separate, very interesting item in the T.I.S. fittings offer are needle valves (Italian: valvola a fuso) also used in the waterpower industry, also called plunger valves. It should be clarified here that, despite the multiple names used (which is the result of the absence of a fixed contractual nomenclature), it is the same, in terms of design and function as well as applications, type of fittings, and the above-mentioned terms are used so far simultaneously, depending on the nomenclature adopted by the manufacturer. In the following part of the article we will use the term "needle valve", derived from the direct translation of the Italian name valvola a fuso, used by T.I.S. Group. T.I.S. needle valve production program covers the range of diameters up to DN2000 for PN10 and PN16, or DN1000 for PN25, which places the manufacturer among the most significant in Europe.

Needle valves, due to their specific design, have a lot of operational advantages, thanks to which they find various applications, both in shutting off flow and regulation. Among many features characterizing this type of fittings, from the point of view of their usefulness in waterpower, above all we should mention the possibility of using them where the use of other fittings would mean working in cavitation conditions. This is determined by the characteristic structure of the valve body, due to which the medium flow rate at the valve outlet is higher than at its inlet, so the zone of possible cavitation is located just outside the valve body. This

Fig. 4. Operating principle of the aeration device

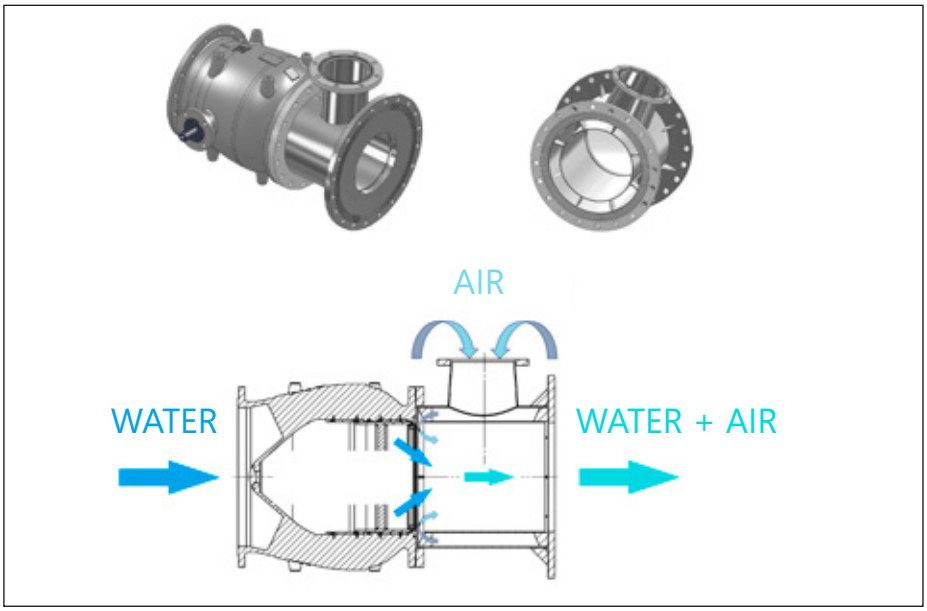
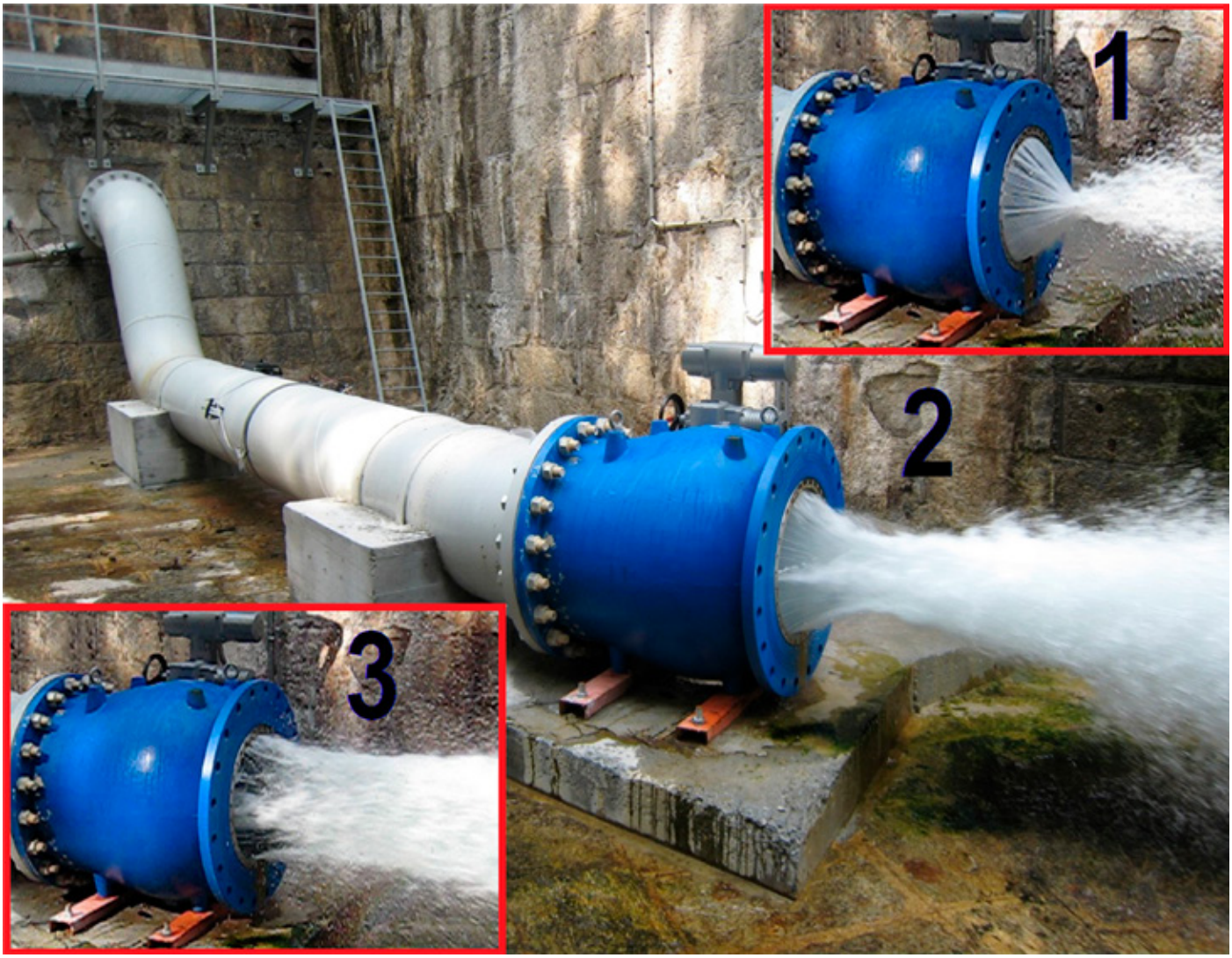


Photo 4. An example of the needle valve installation as a bottom drain fitting operating under conditions of free discharge. 1. Stream at a slight opening. 2. Stream at an intermediate opening. 3. Stream at a significant opening.



does not mean, however, that the section of the pipeline immediately after the valve is left under the influence of possible cavitation, because, in the event of such risk, the valve is equipped with appropriate anti-cavitation protection. Depending on the specific operating conditions and installation of the valve, it can be a properly selected gap ring, mounted directly on the valve piston, or an aeration device installed directly behind the valve. The use of a specific type of needle valve fixture results from an analysis of hydraulic conditions and is an integral part of the selection of the entire solution presented to the customer.

The aeration device, with an external shape resembling a flanged tee, causes the suction of atmospheric air and its inflow to the cavitation formation zone. The air supply reduces the pressure drop in the zone behind the valve, thanks to which it is possible to maintain the flow in cavitation-free conditions. An additional element of this simple device is the air supply pipe, the vertical section of which is also subject to selection to prevent water from flowing out under low flow conditions. The operating principle of the device is illustrated in Fig. 4.

The structure of the needle valve, in addition to cavitation prevention options unavailable for other types of fittings, has one more advantage, important from the point of view of water power applications: circular stream cross-section, with the stream narrowing in the zone immediately behind the valve, with a small opening of the valve assuming a conical shape. Due to this shape of the stream flowing out of the valve, a large dispersion of the kinetic energy of water particles is obtained. This property is extremely useful when using a needle valve, both as a fitting opening the flow in the turbine protection bypass, and on the bottom drain, because under the conditions of a large pressure difference (bleeding into the zone in which there is a pressure close to atmospheric pressure) it provides the possibility of very safe ejection, even at high inlet pressure and fast opening. The shape of the water stream flowing from the valve is illustrated in Photo 4, presenting an example of a valve installed on a bottom drain, operating in the conditions of slow discharge.

The most common applications of needle valves in waterpower include:

- flow control on bypasses taking water drainage for the time of closing or limiting the flow through the turbine;
- flow control in pressure equalization bypass;
- controlling the flow of water from bottom bleeds.

Generally, for needle valves mounted on bypasses taking water drainage for the time of closing or limiting the flow through the turbine, a drive in the form of a hydraulic cylinder and counterweight is provided, but it works in the opposite way than in the case of a butterfly valve, i.e. the counterweight falling ensures valve opening, while the hydraulic cylinder forces its closing.

Photo 5. An example of the implementation of a hydropower plant using T.I.S. fittings.
1. Double eccentric throttle with hydraulic cylinder and counterweight, together with mounting insert.
2. Needle valve with hydraulic cylinder and counterweight, together with an aeration device

OTHER TYPES OF FITTINGS

Additional items from the T.I.S. Group's offer include ball valves, used in waterpower, that have an analogous function as butterfly valves installed before the turbine spiral inlet, but for pressures above the PN25 limit. In the offer of T.I.S. Group there are also general-purpose fittings, useful for renovation closures or other auxiliary functions.

For needs such as renovation closures, the main offer of T.I.S. Group includes double eccentric dampers with worm gears, enabling manual operation or by means of an electric actuator, as well as a hydraulic 2-way operation. The offer in this area is supplemented with centric throttles, wedge gate valves and knife gate valves (including those of individually selected structure). Each of these types of fittings can be controlled manually or by an electric or hydraulic actuator. It is worth paying special attention to centric throttles and knife gate valves, due to the short length of the fitting, which can help solve the problem of limited space available on the pipeline. T.I.S. Group provides centric throttles and knife gate valves up to DN1600 inclusive, while wedge gate valves up to DN1000 inclusive.

Photo 6. DN600 PN25 needle valves with different types of slotted cylinders

Photo 7. Preparation for shipment of the DN1600 PN10 needle valve

TECHNICAL CONSULTING, CONTACT

Long-term presence of T.I.S. Group on the market related to waterpower and hydrotechnical construction would not be possible without providing competent consulting and technical support, from the design phase to implementation, in order to meet the expectations of the customer and the final user. T.I.S. Polska as a representative of T.I.S. Group in Poland and Eastern European markets, provides such support through the Technical Department at the company's headquarters.

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GROUP INSURANCE FOR HYDROPOWER PLANTS – RELIABILITY, TRUST AND ADDITIONAL BENEFITS

In July 2019, the eleventh edition of the group insurance program began, implemented as part of the proprietary program developed by Kancelaria Brokerska KO-RO (Brokerage Office) in cooperation with Polish Association for Small Hydropower Development (TRMEW). Currently, the recommended insurer is UNIQA TU S.A., which provides insurance protection for assets with a total value of over PLN 150 million.

Under the general agreement, the insurer offers the scope of insurance, individually selected by each member of the company being the insuring party, covering the following risks:

1. Property insurance against all risks – it provides protection for hydropower plant property (buildings, structures, equipment, machinery and equipment, current assets) against natural events such as fire, smoke and soot, explosion, flood, flooding, hurricane, heavy rain, snow and ice load effects, direct and indirect lightning, fall of trees and other random events. As part of insurance, you can increase protection by risks related to:
   - electrical damage, consisting of insulation damage, short circuit, failure or malfunction of the protection of generators, motors, transformers and electrical connecting, measuring and regulating devices,
   - damage to property as a result of devastation by third parties,
   - damage to the glass,
   - burglary and robbery.

The insuring party individually selects the scope of protection and estimates the replacement value of insured property.

2. Profit loss insurance - under this insurance, the Insurer will pay compensation (in practice, lost revenue) as a result of power plant breaks that were caused by events listed in property insurance against all risks.
3. Insurance of electronic equipment against all risks – it includes protection of stationary and portable electronic equipment (computers, control and measuring equipment, alarm systems) against fortuitous events, burglary, fall, improper operation and damage due to overvoltage.
4. Insurance of machinery and equipment against all risks - protection includes water turbines with a control and drive transmission system, generators, engines, measuring systems, electrical installations, as well as damming elements, e.g. coating weirs. The insurer is liable for damages caused by electricity, improper handling (errors), vandalism, foreign material getting in, parts loosening, tearing due to centrifugal force.
5. Insurance against loss of profit as a result of machinery failure - as part of this insurance, the insurer shall pay compensation (lost revenues) as a result of interruptions in power plant operation that were caused by events listed in the machinery and equipment insurance against all risks.
6. Third party liability insurance related to business operations, ownership of property and marketing of a product, i.e. electricity. The insurer is liable for damages caused to third parties by the Insured, for which they are liable in accordance with the Civil Code.

Conclusion of the insurance contract takes place at the request of the insuring party, in which they independently choose the scope of insurance and determine the sums insured corresponding to the replacement values of individual assets that may be damaged or completely destroyed as a result of events covered by insurance. As part of the cooperation, KO-RO Brokerage Office advises on the optimal risk selection and determination of the value of individual assets. In addition, KO-RO Brokerage Office actively participates in the claims settlement process of their clients.

The effectiveness of insurance programs is best demonstrated by the compensation paid. During all editions of the program, the owners of hydropower plants reported over 80 damage events in all insurance risks offered to Insurers. Insurers paid over PLN 4 million in damages. The highest compensation paid was related to the liquidation of the effects of the flood that took place in May 2014 at Small Hydropower Plant Świniarsko on the Dunajec. Repair of the coating weir in the SHP Osiecznica, lasting over 7 months, resulted in the payment of the largest compensation for loss of the plant's profit for the downtime period.

TRMEW group insurance has one more feature that is essential for all its participants - it is trust in proven and reliable solutions offered by the authors of the program. It is worth noting that for eleven years five insurers participated in the program, and the insured risks and detailed insurance solutions offered have not changed from the very beginning.

The trust I have been given by the clients of KO-RO Brokerage Office allows us to create new solutions dedicated to owners of hydropower plants, which in addition to property protection will bring additional income in the absence of a support system, which will expire at the end of September 2020 for over 50% of hydropower plants in Poland.

Radosław Koropis
Broker
KO-RO Brokerage Office

...we believe in the Power of Nature

WTW

Water Turbines Works

WTW Poland Sp. z o.o. is a leading Polish manufacturer of water turbines as well as mechanical and electrical equipment for hydro plants. Since we entered the Polish market in 1989, we have manufactured 186 Kaplan turbines not only for the local market, but also for Customers from Italy, Germany, Estonia, Ukraine and Belarus.

The domain of our company is flexible design, which enables us to select hydro turbines so as to reduce construction costs to minimum. We design and manufacture Kaplan turbines in many different versions, including but not limited to vertical shaft turbines, S- and Z-type turbines, horizontal turbines and numerous configurations of siphon turbines.

Our portfolio is complete with a full range of additional equipment dedicated to hydro plants, including but not limited to electrical power equipment, automation and remote supervision via the Internet, hydraulic power units, as well as warranty and post-warranty service.

WTW Poland in numbers :

- **29 years on market**
- **186 Kaplan turbines delivered**
- **12500 kW installed power**
- **25 high-qualified workers**
- **2000 square meters of production hall area**
- **Machining of rotor blades on 4-axis machining center (in our production hall)**

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5 YEARS OF **TRMEW OBRÓT S.A.**

TRMEW Obrót S.A. is currently one of the largest independent entities on the electricity market in Poland. The company cooperates with the biggest group of electricity producers in Poland, producing electricity from Renewable Energy Sources.

The company's activity focuses on many areas of the energy sector - from the wholesale of electricity, property rights or guarantees of origin, to the sale of electricity to end users and sale of comprehensive solutions for companies in the field of micro-installations connected with energy banks and the fleet of electric vehicles.

DYNAMIC DEVELOPMENT

TRMEW was founded in 2013 by the Polish Association for Small Hydropower Development - the largest non-profit organization in the renexable energy sector in Poland. In 2014, TRMEW Obrót sp. z o.o. obtained a license to trade in electricity by decision of the President of the Energy Regulatory Office. A year later, the company began purchasing electricity from renewable energy producers, offering them attractive terms of cooperation. Current shareholders took over TRMEW Obrót S.A. in April 2017. From that moment, the company's development gained a dizzying pace. Already in May 2017, the company began trading in electricity on Towarowa Giełda Energii S.A. Since September 2017, the company has been conducting commercial transactions on the inter-system exchange. A significant activity of TRMEW Obrót S.A. is its activity in the trading sector, which undoubtedly can be described as the most effective electricity wholesale department in Polish independent companies. Today, the company is a member of Towarowa Giełda Energii (TGE, Polish Power Exchange), Izba Rozliczeniowa Giełd Towarowych (IRGiT, Settling Chamber of Commodity Exchanges) and European Energy Exchange (EEX).

FROM HYDROPOWER TO ALL AVAILABLE RENEWABLE ENERGY SOURCES

Hydropower is a source that began the history of TRMEW Obrót S.A., however, today the company's offer and competence cover all renewable energy sources. The company buys it from individual, often small RES installations and sells green energy to end users. Due to the attention which, starting from hydropower, the company devoted to improving the skills of forecasting weather phenomena, renewable energy installations became understandable and predictable for it. Importantly, TRMEW Obrót S.A. forecasts volatility of conditions on electricity markets, based on data obtained from daily monitoring of these markets. This gives the company an advantage over the competition and allows it to expand its range of services related to energy management.

COMPREHENSIVE ENERGY SERVICE

Energy trading is currently one of many elements of the company's offer. TRMEW Obrót S.A. supports its customers, among others in defining their actual power demand, it helps them optimize energy consumption and apply for white certificates. Producers of renewable energy sources can also count on support from the company in sales and auctions. The company ensures that the energy producers cooperating with it are equipped with appropriate substantive facilities and implement innovative solutions. Energy producers are invited to workshops, specialist trainings, fairs, conferences.

TURNKEY COGENERATION

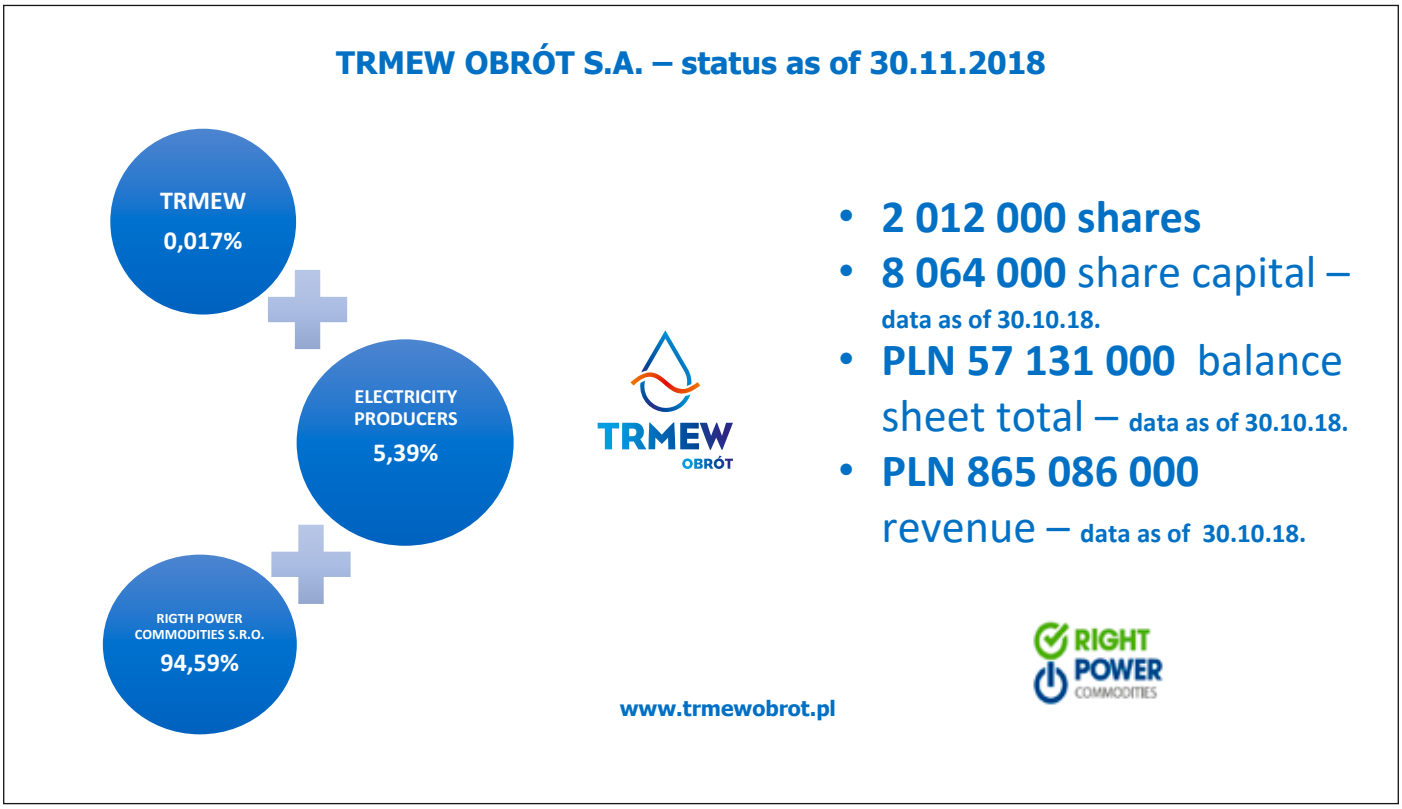
The company responds to changes in the energy market and effectively cares for energy security and energy optimization of the companies cooperating with it. It encour-

Brief history of TRMEW Obrót S.A.

Complete competences on the energy market

- In 2014, TRMEW Obrót sp. z o.o. obtained a license to trade in electricity by decision of the President of the Energy Regulatory Office
- In 2015 the company started purchasing electricity from RES producers, offering them attractive terms of cooperation
- In 2016 TRMEW Obrót sp. z o.o. signed General Distribution Agreements with the largest Distribution Grid Operators
- In 2017 TRMEW Obrót sp. z o.o. signed a Service Agreement for Energy Transmission with Polskie Sieci Elektroenergetyczne S.A.
- Since September 12, 2017 inter-system exchange with Germany, Czech and Slovakia has been taking place
- In 2018 Membership in Towarowa Giełda Energii
- In 2018 Independent service of PSE S.A. scheduling unit
- In 2018 Transformation of a limited liability company into a joint stock company

TRMEW Obrót S.A. - ownership structure in 2018

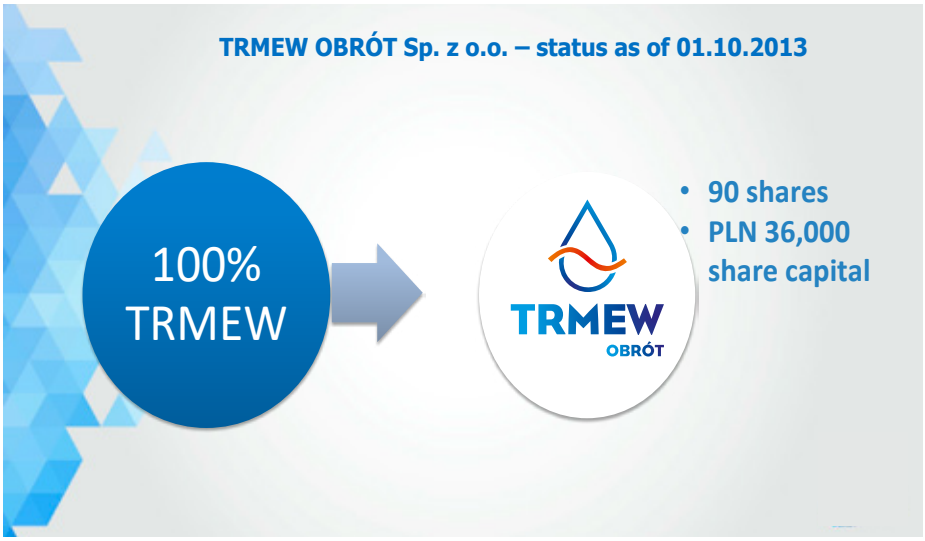


ages them to have their own sources of electricity, heat and cold. TRMEW Obrót S.A. offers the implementation of cogeneration "from A to Z", i.e. design, construction and commissioning. The company's customers may entrust it with, among others, management of a cogeneration source, financing investments in the ESCO formula, obtaining financing from aid funds, assistance in obtaining white certificates. The company also offers the purchase of any surplus electricity generated by the customer.

TRMEW OBRÓT S.A. SERVICES FOR RES PRODUCERS

The offer of TRMEW Obrót includes not only services addressed to customers interested in buying energy from renewable energy sources, but also services intended for entities joining the auction system to sell their electricity resources. In accordance with art. 73 of the Act of February 20, 2015 on renewable energy sources, it is necessary to collect the relevant documents, certifying the origin of substances used in the production of electricity, before joining the auction system. To maximally facilitate joining the system, TRMEW Obrót offers its customers services in the field of compliance, validity and completeness of documents required by the Act. At the same time, the company undertakes verification of the total value of investment aid, the determination of which is necessary to specify the maximum price offered in the auction (in accordance with Article 39 of the Act), as well as to calculate the productivity and estimate the production volume of a given RES installation, and these actions are necessary to verify the possibilities of joining the auction on the terms of art. 73 of the Act. Further stages of cooperation of TRMEW Obrót S.A. with energy producers also include support for the Internet Auction Platform and comprehensive service in the field of settlements with Zarządca Rozliczeń S.A. The company buys electricity from renewable energy sources and provides manufacturers with daily reports documenting electricity production, as well as billing reports based on measurement data obtained from DSOs, i.e. as part of the so-called next-day monitoring.

TRMEW Obrót Sp. z o.o. - ownership structure in 2013



TRMEW OBRÓT

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WHAT CHANGES DID THE AMENDMENT **TO THE RES ACT BRING?**

On August 29, 2019, the act[1] – long awaited by entrepreneurs - amending the act on renewable energy sources entered into force. The introduced provisions, in line with the grounds of the act, are intended to intensify activities aimed at achieving 15% share of energy from renewable sources in final energy consumption by 2020.

The most important changes introduced by the act include the extension of the definition of a prosumer, creation of a new concept for the operation of an energy cooperative, or extension of the term of connection agreements. The amendment will also make it possible to conduct further auctions for electricity from RES in 2019. The hydro-energy sector will also be affected to a significant extent.

Source: www.pixabay.com, qimono

AN ENTREPRENEUR CAN ALSO BE A PROSUMER

According to the definition in force until now, a prosumer was the final consumer who produced electricity in micro-installations for the purpose of its consumption for own needs, not related to the economic activity regulated by the Act of March 6, 2018 – Entrepreneurs' Law. The amendment to the definition of a prosumer (renewable energy prosumer) assumes, however, the extension of the catalog to include entrepreneurs, provided that their production of electricity in micro-installations is not the subject of the prevailing economic activity.

As a result, entrepreneurs who have not used electricity from their RES source for their own needs and introduced its surplus to the distribution grid will be entitled to take advantage of the so-called discount system. It is true that the discount system was already known to existing prosumers, but due to the expansion of the catalog of prosumers, this system has been modified and clarified. Pursuant to the provisions of the act, renewable energy prosumers, in exchange for putting energy into the grid, will acquire the right to receive electricity from the grid in a ratio of 1 to 0.8 for micro-installations with a total installed electrical capacity of less than 10 kW and a ratio of 1 to 0.7 for micro-installations with a total installed electrical capacity greater than 10 kW. Settlements will be carried out either with the seller chosen by the prosumer, and in the event that the seller selected by them does not agree to purchase electricity from micro-installations - from the so-called obligated seller, indicated by the President of the Energy Regulatory Office.

In terms of settlement principles, electricity can be "collected" within a maximum of 12 months in accordance with the settlement periods adopted in the contract. Unused energy in a given billing period is carried over to the next period, however not longer than for the next 12 months counted from the date of introduction of this energy into the grid. The obligation to settle the electricity in the above manner will last for the next 15 years, but not longer than until June 30, 2039.

An executive ordinance of the Minister of Energy will also be issued in connection with the act, which will allow to specify, from the technical perspective, the method of settling the entrepreneur as a prosumer. The legal basis for issuing this ordinance will, however, enter into force on February 15, 2020 and only after this date the ordinance will be expected to be issued.

A NEW SUPPORT SYSTEM FOR ENERGY COOPERATIVES

Another major change introduced by the amendment to the RES act affected energy cooperatives. Although these cooperatives have been in the Polish legal system since 2018, their potential is not being used to the same extent as in other European Union countries. However, their situation may be improved by a new support system provided for in the RES act.

The subject of activity of an energy cooperative may be the production of electricity, heat or biogas in renewable energy installations owned by the cooperative or its members. However, not every cooperative can have the status of an energy cooperative. In order to obtain the status of an energy cooperative, certain conditions must be met. One of them is the territorial limitation (the area of the rural or urban-rural municipality or the area of max. 3 such municipalities directly adjacent to each other), limitation in the number of members (less than 1,000 members) and subject limitation - if the subject of activity is electricity generation, the total installed capacity of all renewable energy installations (all members) makes it possible to cover min. 70% of own needs. It is worth adding that electricity introduced into the grid and generated in installations belonging to the cooperative itself and all its members will be taken into account.

The new support system dedicated to energy cooperatives assumes the possibility of using the discount system previously intended only for prosumers, with the difference that the ratio of energy introduced

[1] Act of July 19, 2019 amending the act on renewable energy sources and some other acts, Journal of Laws 2019 item 1524

[2] Ordinance of the Minister of Energy of May 15, 2019 on the reference price of electricity from renewable energy sources in 2019 and the periods for producers that won auctions in 2019 (Journal of Laws of 2019, item 1001).

into the grid and the energy that can be collected is slightly less favorable for an energy cooperative, amounting to 1 to 0.6. The surplus of energy (0.4) is intended to cover the seller's costs of settling the cooperative's balance and the costs of distribution service fees, from which electricity collected by an energy cooperative or its members is exempted. Electricity collected by an energy cooperative as part of settlement with the seller is not subject to distribution service fees. In addition, energy cooperatives have received many other privileges under the new rules. The most important, in addition to the exemption from distribution fees, is the exemption from the payment of the RES fee, cogeneration fee, and capacity fee; in addition there is no efficiency obligation (redemption of white certificates) in relation to such energy, and the energy consumed will not be subject to tax excise duty, provided that the total RES installation capacity does not exceed 1 MW.

CHANGES IN THE HYDROPOWER SECTOR

In addition to the above modifications in the so-called prosumer package, the amendment to the RES act also introduced major changes in the hydropower sector, beneficial for small hydropower plants. In this regard, the change of the definition of hydropower itself should be pointed out, which is the mechanical energy of water (excluding energy obtained from pumping work at pumped storage power plants or hydropower plants with a pump unit), rather than the energy of inland surface water decline as it has been so far.

However, the most important substantive change, from the point of view of hydropower, is the extension of the catalog of entities that can benefit from a dedicated support system of market price subsidies, the so-called feed-in-premium (FiP). In light of the provisions introduced, this type of aid will be available to producers generating electricity in a hydropower plant with a total capacity of 500 kW up to 2.5 MW. Until now, only power plants with a capacity up to 1 MW could benefit from the FiP system. Purchase of electricity produced in such an installation will be based on a fixed price of 90% of the reference price, specified in the ordinance issued by the Minister of Energy. Currently, fixed prices, based on the Ordinance of May 15, 2019[2], amount to 450 PLN/MWh for with a total capacity of 500 kW up to 1 MW,, and for installations with a total installed electrical capacity of more than 1 MW, using only hydropower to generate electricity, to 432 PLN/MWh (90% of the reference price). On the other hand, electricity producers using hydropower in installations with a capacity of up to 500 kW in the form of the so-called guaranteed tariff (FiT) or guaranteed supplement (FIP) can count on a higher amount of aid. For them, the fixed purchase price of generated energy is 95 percent of the reference price indicated in the ordinance. It is worth remembering, however, that in accordance with the provisions of the RES act, the fixed purchase price for electricity will still be reduced by the value of investment aid intended for the implementation of investments in a given RES installation. It should be noted here that the provisions regarding the extension of the catalog of entities that may use the FIP system and the provisions regarding the increase in the fixed price level to 95% of the reference price will become effective only after obtaining a positive decision of the European Commission in this respect. It is also worth adding that the provisions increasing the price level will also cover those installations that have submitted an appropriate declaration on their intention to use FIT/FIP before the amendment to the act enters into force.

AUCTION SYSTEM – ONLY FOR SMALL POWER PLANTS

The provisions of the amendment to the RES act also specified the volume and value of electricity that can be contracted under the auction system, thus materializing the basis for conducting the auction in 2019. Although the most resources and the largest volume of electricity that can be sold by auction were determined for the so-called baskets for onshore wind energy producers and for PV installations up to 1 MW, auctions are also planned for producers of electricity using hydropower. The auction basket dedicated to existing installations of up to 1 MW generating energy from hydropower, energy from bioliquids, geothermal energy, offshore wind a volume of 1,475,211 MWh and a value of PLN 811,366,050 were provided for. However, for new installations of up to 1 MW, a volume of 140,400 MWh, with a value of PLN 71,280,000 is provided for. Separate auctions will relate to large installations, above 1 MW, for which the volume of the above basket includes a volume of 594,000 MWh, worth PLN 285,120,000. Only owners of new installations with a certificate of admission to the auction may enter these last auctions.

Aiming to conduct the auction in 2019, the legislator introduced a number of changes improving the system's operation, such as the possibility of one update of the submitted bid, which won the auctions, or the change in the provisions regarding fines for failure to implement the investment, in the event of resignation from the participation in the auction system. The producer may be subject to a financial penalty if they sold electricity under the auction system below 85% of the amount specified in the bid (excluding cases of force majeure, breakdowns, etc.), but according to the amendment, this penalty may only be imposed in the case of commencing the sale of electricity under the auction. The above leads to the conclusion that failure to complete the investment at all will not involve a penalty for introducing electricity below the permissible level.

From the point of view of the hydropower industry, it is also important to introduce a transitional provision that allows for the application of exemptions from penalties for failure to produce a minimum of 85 percent of the offered amount of energy towards the auction participants from 2016 and 2017 in the event that the failure to produce results from factors lowering planned production specified in the act independent of the producer (e.g. drought, breakdown). Earlier, producers participating in auctions carried out in the first two years of operation of the auction system were deprived of this right.

Undoubtedly, the amendment to the RES act introduced a number of changes in support systems dedicated to both civic energy (prosumers, energy cooperatives), as well as dedicated to entities professionally involved in the production of electricity. The changes did not bypass the hydropower sector, allowing installations with a capacity of 1 MW to 2.5 MW, which until now could only participate in the auction system, to take advantage of the guaranteed FiP support system. Of course, such actions will not make all the investors' troubles and doubts disappear immediately, but hopefully they will eliminate legal uncertainty and stimulate investment activity in the small hydropower sector at least.

Ewelina Łuczak-Sosińska, lawyer
Patryk Matuszak, lawyer
Kancelaria Prawna Piszcz i Wspólnicy sp.k.

HOW POLISH WATERS **MANAGES STATE PROPERTY**

In order to specify regulations, on 4 March 2019, the President of State Water Holding Polish Waters released a regulation called "Procedures for managing state property held by Polish Waters". This regulates how Polish Waters manages such property and how it makes it available to interested parties without a tender procedure.

The Water Law Act of 20 July 2017 (Journal of Laws of 2018, item 2268), established the State Water Holding Polish Water on 1 January 2018. This took over the exercise of ownership rights to specific state property, such as real estate hitherto permanently managed by regional water management authorities.

Chapter 4, Section 6 of Water Law (Article 258 et seq) deals with how Polish Waters manages property, but the above Regulation specifies certain associated issues. The procedures do not constitute applicable law and have not been published officially, but they are available online from regional water management boards' websites.

Under the Water Law and the Regulation, Polish Waters represents the Treasury and exercises state ownership rights in relation to:

- waters:
  - inland flowing waters,
  - groundwater

(excluding inland waterways of special importance to transport such as the Upper and Lower Vistula, the Oder Waterway and other waterways of international importance);

- real estate:
  - constituting land covered by inland flowing waters,
  - land associated with water management (including buildings, structures and other installations and premises located on it),
  - other real estate used for tasks specified in the Act (e.g. land and structures used for the organisational needs of Polish Water, used as registered offices of organisational bodies),
- water installations:
  - located on land covered by inland flowing waters and on land with water installations situated away from the shoreline.

Polish Waters may grant a usufruct to, lease or rent such real estate and water installations depending on their type and the purpose for which the interested party has for them.

USUFRUCT

Under Article 261 of Water Law, a usufruct may be granted for land covered by surface flowing water, i.e. may be encumbered with the right to use and reap benefits from it. The Regulation states, though, that land covered by surface flowing water may not be leased. Real estate required to operate undertakings associated with hydropower engineering, water transport, transport, transmission, industrial, telecommunications infrastructure or services may be subject of usufruct..

APPLICATION FOR A USUFRUCT AGREEMENT

It is up to the party interested in using the land to apply for a usufruct agreement. The application should be submitted to the appropriate local Director of the Polish Waters Regional Water Management Authority "RZGW Director". A specimen application is to be found in an appendix to the Regulation and is available on regional management boards' websites. The applicant must specify the following:

- official land registry number of the waterbed land (plot number, area, zone, locality, district, county, province, map sheet),
- the intended use of the land (consistent with the specifications given in Article 261 of Water Law above, as a usufruct may be granted for such land only if the purpose has been clearly specified in the Act),
- statement on whether the applicant is running a business,
- a detailed description of how the land is to be used;

The following should be attached with the application:

- a survey or master map marking the area to be used,
- a recent extract from the land registry,
- a copy of the water permit or a certificate of effective filing of the application, if the type of the business conducted on the land requires it,
- current excerpt from the register (for parties operating a business, this will usually be the National Court Register),
- power of attorney or other document showing authority to act on behalf of the applicant (if the application is filed by a proxy).

These documents must be submitted either as originals, or as certified true copies, except that the original extract from the land registry must be provided and must not be dated more than six months before the application's submission date. The land area that the usufruct is being applied for, should, pursuant to the Regulation's guidelines, also include a protective zone required to operate facilities associated with the given business's activity, which would cause or may cause certain restrictions on other use of this land by other parties and by the owner of the water.

A properly drawn up application should be examined within at most 120 days, which runs from the date when the applicant submits a complete application. Depending on Polish Waters's decision, an agreement is then concluded, or the application is rejected. A usufruct agreement may be concluded in ordinary written form, unless the annual fee exceeds PLN 5,000. In such case, under Article 261 par. 3 of Water Law, the agreement must be drawn up as a notarial deed, or it will be invalid. The entity applying for the agreement must pay the costs of the notarial deed.

Polish Waters may require the applicant to provide financial security if the agreement obliges the user to make outlays in connection with the use of the property, or if the authority has identified a significant risk of having to enforce contractual obligations. However, there are no guidelines for classifying a given agreement as involving a risk of enforcement. The Authority has some discretion in this regard. In order to fulfil the obligation of providing financial security, the applicant may, among others, reserve funds in a bank account, submit

a declaration of voluntary submission to enforcement, or issue a promissory note. Neither the Water Law nor the Regulation specify how to arrive at a value for this security.

FEE AMOUNT

Polish Waters sets the annual fee for land usufructs. The annual fee is the product of the surface area of the land subject to the usufruct and the fee rate for the given type of real estate. The rates are given in the Council of Ministers' Regulation of 28 December 2017 on annual fee rates for the usufruct of waterbed land (Journal of Laws, item 2496). For example, the annual fee rates for the usufruct of 1 m² of land required for hydropower projects and intended for hydropower constructions is PLN 8.90, and in the case of land intended for water retention and release structures and other associated buildings and installations, the fee is PLN 2. The area subject to the usufruct should be rounded up for each "commenced metre". If the land's usufruct does not exceed one year, the annual fee is adjusted in proportion to the duration of operations. Therefore, applicants can easily calculate the annual fee payable to Polish Waters.

Water Law exempts only a narrow range of entities from the annual usufruct fee for land covered by flowing water. These include e.g. local authority organisations, or sports clubs, if providing universal and free access to the water.

DURATION OF USUFRUCT AGREEMENT

Polish Waters grants a usufruct to land covered by surface flowing water for a definite term of not more than five years. However, a usufruct may be granted for up to 20 years, if there is a particular public interest. As an example of a particular public interest the Regulation gives need to maintain the sustainability of an EU-funded project. Usufruct agreements may not be extended. Once an agreement's duration has expired, a new application must be submitted to Polish Waters. Withdrawal, expiry, or restriction of the water permit entitles each party to terminate the usufruct agreement.

The RZGW Director takes the decisions on land covered by surface flowing water, such as whether to grant a usufruct for the land. The authority must, though, maintain an electronic register of usufruct agreements. The register includes such data as: the date of the agreement, its duration, the usufructuary, the plot's territorial designation and the net annual revenue.

LEASE, TENANCY AND GRATUITOUS LOAN GRANTED WITHOUT TENDER

Other properties held by Polish Waters, such as: land with water installations away from the shore, land away from the shore, land that does not constitute land covered by flowing surface water - such as e.g. canals - as well as premises used for organisational purposes, are made available to interested parties under lease or tenancy. Water installations owned by the Treasury and held by Polish Waters may also be leased. The Act allows Polish Waters to conclude gratuitous loan agreements, but only if the loan is for social purposes, with no business purposes use.

The above real estate and water installations may only be made available without a tender in situations specified in Water

Law. An agreement may be concluded without a tender if, say, the property is being transferred:

- to an entity managing existing infrastructure built on real estate in compliance with construction law,
- in connection with the construction or operation of a water installation, if a water permit has been issued or a promise has been made to issue a water permit,
- a residential premises tenancy agreement is being entered into with a Polish Waters employee,
- a subsequent agreement is being concluded for the same real estate.

In other cases, an application to conclude an agreement with Polish Waters must be made in a tender procedure. The tender procedure for concluding lease, tenancy or gratuitous loan agreements with Polish Waters is described in the Council of Ministers Regulation of 3 August 2018 on how to conduct tenders for transferring treasury owned real estate (Journal of Laws No. 1580).

APPLICATION FOR A LEASE, TENANCY OR GRATUITOUS LOAN AGREEMENT

Just as for a usufruct, a party interested in using such real estate must start the procedure for concluding a lease, tenancy or gratuitous loan agreement. The application should be submitted to the appropriate RZGW Director. Like in a usufruct, an application for a lease or tenancy should include:

- details of the waterbed land (plot number, plot area, zone, locality, district, county, province, map sheet),
- the purpose for which the land is to be used,
- a statement on whether or not this is for business purposes
- a detailed description of how the land is to be used.

The following should be attached to an application for a lease or tenancy agreement:

- a survey, or master map with the designated area marked,
- a current extract from the land register,
- a copy of a water permit, or a certificate of filing an application, if required by the type of business to be operated on the land,
- a current extract from the pertinent register (for businesses, this will usually be the National Court Register),
- power of attorney, or other document showing authority to act on behalf of the applicant,
- if the land is for billboards, their dimensions and areas should be provided, together with a copy of the municipal/county authority's consent for the billboard's site.

Like in the usufruct application, the above documents must be submitted either as originals or as certified true copies, except that the original land registry extract must be submitted and may not be dated more than six months before the application's submission date.

Polish Waters may require the applicant to provide financial security in the form of: a statement in the form of a notarial deed on submission to enforcement, reserving appropriate funds in a bank account, a mortgage or a promissory note. The authority decides the amount of the security individually in each case - no binding guidelines exist for this. However, the applicant may choose the form of the security.

After the applicant has submitted a complete and properly filled in application, Polish Waters have 120 days to deal with the matter. Nonetheless, the time required to consider the application depends on the time that Polish Waters needs to obtain appropriate consents. The matter is considered resolved once an agreement has been concluded or the application rejected.

FEE AMOUNT

Polish Waters may set the annual rent for the lease or tenancy in three ways:

- the monetary equivalent of part of the lessee's business's annual revenue,
- the monetary equivalent of a multiple of the upper limit of the real estate tax rate in the given year for a business or for recreation or tourism activities,
- a multiple of the square metre rate for the subject land in the given category, as specified in the Regulation.

For example, the rental rate specified in the Regulation for a square metre of land located in the vicinity of land covered by water, or areas with artificial water reservoirs, canals, and land under surface standing water, and intended for hydropower plant construction projects, is PLN 13 per m², whereas for the same land, but intended

Water retention structures used for hydroelectric power plant requirements, have an annual rent of at least 7% of the annual revenue from the generated electric power.

for water retention and release structures and other constructions, the rate is PLN 3 per m². However, water retention structures used for hydropower plant requirements, have an annual rent of at least 7% of the annual revenue from the generated electric power. The annual rent for renting water retention structures is payable by 31 March of the year following the year of the lease. Just as for usufruct agreements, the rent is charged for full metres and rounding up each "commenced metre".

Neither Water Law nor the Regulation regulate, in any way, the amounts that the authority may set using the other two methods, i.e. in reference to revenue from activities and to property tax rates. It should be assumed that in the former case, the authorities have considerable freedom in setting the rent. Thus, unlike in the case of a usufruct to land, the applicant is not able to calculate what the rent will be, if the authority decides to use one of these two methods.

Pursuant to the Regulation, the fee for using real estate is subject to annual indexation using the average rate of growth in prices of consumer goods and services for the previous year, published by the President of the Central Statistical Office in Monitor Polski. However, indexation does not apply if the index falls below 100.

DURATION OF LEASE, TENANCY AND GRATUITOUS LOAN AGREEMENTS

Real estate and installations associated with water may be leased or gratuitously loaned for a specific term not exceeding three years. However, if there is a particular public interest, the agreement's duration may be the same as that of the water permit, or the time required to maintain the sustainability of an EU-funded project. For residential and commercial buildings and premises, the term of the lease or tenancy may not exceed ten years.

If the intention is to lease, rent or gratuitously loan the whole or part of a real estate for up to three years, the RZGW Director independently decides whether or not to conclude the agreement. However, if the

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agreement is to be concluded for more than three years, the RZGW Director must obtain the consent of the President of Polish Waters, the Minister of Maritime Economy and Inland Navigation to deal with the property. The President of Polish Waters must respond to the RZGW Director's request within 14 days, after which the request will be deemed accepted. Acceptance of the application entitles the RZGW Director to apply for permission to deal with Treasury property to the Minister of Maritime Economy and Inland Navigation. The following information should be included by Director with the application: the object to be dealt with (specifying the registration details identifying the real estate), the type transaction that will affect the real estate, an economic justification for the agreement, the impact of the agreement's conclusion on Polish Waters's fulfilment of its statutory tasks. The RZGW Director should include with the application, among others, a legally valid water permit or water notification, if the type of business to be operated on the land requires it, a map with the area of the real estate intended to be used marked and/or the location of water installations. Only the final decision on the application gives the Director an entitlement to conclude the agreement with the applicant.

Just as for a gratuitous loan agreement, the RZGW Director is obliged to maintain an electronic register of lease, tenancy and gratuitous loan agreements. The register contains information on, among others, the agreement conclusion date and duration, the parties to the agreement, the territorial designation of the plot and the net annual revenue. The Regulation will certainly facilitate Polish Waters in making available State Treasury property under their control to interested parties. However, the procedures that have been established are imprecise. For example, from the perspective of an entity applying for an agreement, the choice of method for calculating the lease rent by the authority is unclear. The Regulation specifies three methods in this regard. What is more, even if the applicant meets all of the formal requirements, the applicant cannot be sure of the authority's decision. In the end its, Polish Waters that will decide whether the agreement may be concluded, or whether to reject the application.

Nina Kuśnierkiewicz
Environmental Law Practice
Wardyński & Partners

Comment of TRMEW

In the opinion of the Polish Association for Small Hydropower Development (TRMEW) the document setting down precisely the procedures of managing the property of the State Treasury held by the State Water Holding Polish Waters is important since it specifies the rules of using water installations and immovable properties for the purposes of hydropower by investors and owners of hydropower plants. At the same time the small hydropower sector identifies some sources of concern in the rules adopted by the Polish Waters which, in the opinion of TRMEW, should be amended.

The first issue relates to the contracting period of agreements concerning lands covered with water use. At present, the provision allows to specify the period of use generally for 5 years, and only if justified by overriding reasons of general interest it can be 20 years. The cases of overriding reasons of general interest include such examples as the necessity of maintaining the EU co-funded projects sustainability, municipal and industrial infrastructure under the bed of the watercourse and transport infrastructure. In the opinion of TRMEW this catalogue needs to be extended with the hydropower infrastructure. In case of hydropower the use of lands covered with waters should always be allowed for the time of water-legal consent. Investments in hydropower require high capital expenditure and risk. 5 years contracting period in agreements concerning the use of lands covered with water prevents obtaining projects financing and increases uncertainty of investors. The current provision also rises doubts of interpretation in terms of what should and what should not be considered as other than specified in the provision examples of "cases justified by overriding reasons of general interest". A similar problem relates to the contracting period of agreements concerning lease, rental and lending of immovable properties.

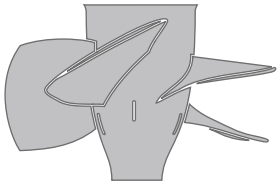
Another matter concerns the annual rate of rent for damming facilities used for hydropower purposes. The present provision specifies only the minimum rate which should be not less than 7% of income from the electricity generation in a hydropower plant. In the opinion of small hydropower sector this rate should be uniform and specified in advance (as is the case for leasing lands covered with running waters), or at least its maximum rate should be specified. Otherwise the rate can be arbitrarily determined by the Polish Waters. Analysis undertaken by TRMEW show that developing profitable small hydropower projects, at current level of costs and incomes will be possible if the annual rate of rent for weir does not exceed 6% of net income from electricity generation. This proposed by TRMEW maximum rate of rent for damming facilities results from the analysis of the financial condition of hydropower sector. According to the Act on Renewable Energy Sources, starting form 2020 the gradual closure of rights to use the support schemes by small hydropower plants will take place, which will undermine their financial condition. Therefore, it is important that the rate of rent for damming facilities is adjusted to the financial abilities of the powerplants owners.

Additionally, in order to allow the newly adopted provisions to use the hydropower potential of Polish rivers to a greater extent, TRMEW recommends to add another provision, according to which in case of bearing by the investor the costs of improving the technical condition of the damming facility the investor would be exempt from the charges for the lease until the time of return of these costs. This would allow to adjust the terms of each agreement to a specific site. It is worth mentioning that the damming facilities leased by Polish Waters are very often in a very bad technical condition (ruined, not performing their functions), and their reconstruction by private investors allows bringing the degraded State Treasury property to functionality.

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

SIEĆ BADAWCZA ŁUKASIEWICZ

Extensive handling of investments related to construction or modernization of small hydropower plants



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- Synchronous permanent magnet generator - KOMEL
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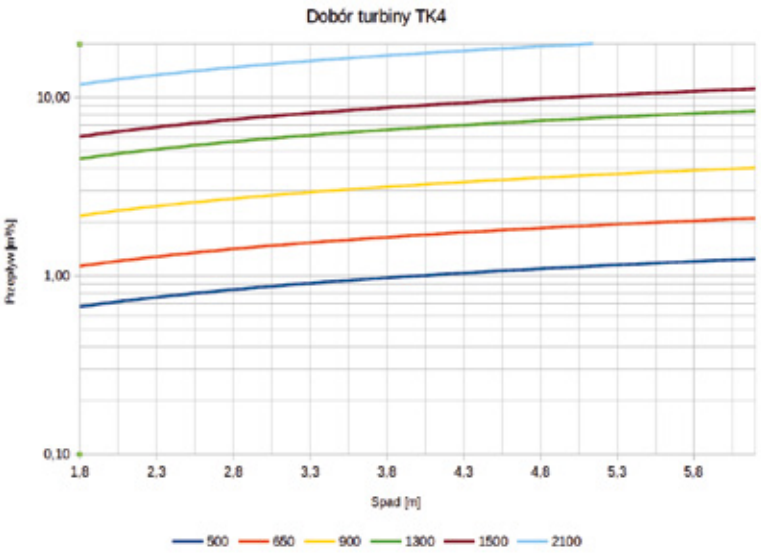
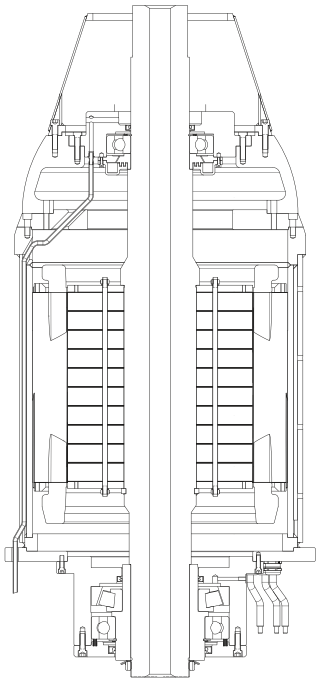
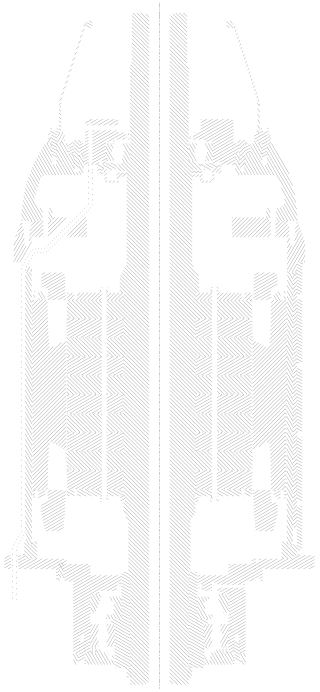
These components put together make a complete hydrogeneratorset operating at Wyspa Młyńska in Bydgoszcz







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Source: Zek

REVIVAL OF THE POTENTIAL OF HYDROPOWER INCREASES ECOLOGICAL VALUES

After about six months of construction, on July 20, 2016, near the Starnberg Lake, a hydropower plant of Dr. Joachim Siebenwirth was activated. This facility, designed as a small run-of-river power plant, uses the Ossberger turbine to generate electricity and can produce approximately 100,000 kWh of green electricity annually. Thanks to this facility, which was implemented both visually and technically in an exemplary manner, an additional benefit was obtained in the form of improving local ecological values.

In the idyllic hamlet of Martinsholzen, adjacent to the town of Berg, the use of hydroelectric power has a long tradition. This is evidenced by the over 200-year-old mill channel, where water energy was used to grind grain long before electricity was commonly introduced. Until the mid-70s of the last century a Francis turbine was used, and the power plant, working on an island system, supplied the hamlet's buildings with energy. Joachim Siebenwirth, a doctor who runs his office in nearby Wolfratshausen, did not want such existing potential to remain unused for longer: "Because, due to our location, we have our own sewage treatment plant and water pump, we cut firewood with a circular saw and run a boarding house for horses, we automatically use more energy than an average household." Resuming the use of hydroelectric power in Martinsholzen was therefore the next step.

THE POWER PLANT CONTRIBUTES TO THE IMPROVEMENT OF ECOLOGICAL VALUES

Neither in the municipality nor in the land and mortgage register could any entries be found about the possibly still valid water permit, which is why Dr. Siebenwirth had to apply for a new permin one. After approximately 15 months the competent authorities finally granted the permit for another 30 years. The permit was favored by the improvement of local ecological values, which was to result from the liquidation of a 1.4 m high water barrage. In place of the old weir, at the entrance to the mill channel, the plans provided for the construction of an inlet basin, which would significantly ease the flood-related situation. In addition, a natural pool pass with a flow of 70 l/sec was to be made, enabling fish to move up the watercourse.

SIX MONTHS OF CONSTRUCTION

The construction phase began at the beginning of the year with a thorough cleaning,

The Ossberger crossflow turbine handles sometimes very variable amounts of water in the Lüßbach river. From the first activation in July 2016 to the end of September 2016, more than 17,500 kWh of electricity were produced.


Source: Ossberger

A natural pool pass with a flow of 70 l/sec provides the optimal opportunity for aquatic organisms to move up the watercourse. The power plant operator, Dr. Siebenwirth, actively participated in the construction of the facility.

Technical data
flow rate: **360 l/s**
gross head: **7,2 m**
type of turbine: **crossflow**
rated speed: **337 U/min**
maximum capacity: **21,6 kW**
manufacturer: **Ossberger**
generator: **asynchronous**
terminal voltage: **400 V**
manufacturer: **ABB**
average annual production: **100 000 kWh**

The trash rack cleaner, turbine and all power plant electrotechnical equipment were supplied and installed by Ossberger in one package.

Source: Ossberger

of a part of the heavily silted mill channel with a length of 1.2 km. Practically speaking, it was not necessary to build an inlet structure on the existing upper water channel that drains water from the Lüßbach river. A 24-m long DN 600 steel pipeline is used to power the turbine. To ensure the smooth operation of the power plant, a trashrack cleaning machine with a hydraulic drive was installed directly in front of the engine building. The cleaning of the trashrack is fully automated. Dr. Siebenwirth, who is authorized to fish in the mill channel, is obviously very concerned about the best possible protection for aquatic organisms. For this reason, the investor has voluntarily decided to use a protective trash rack with 12 mm bar spacing, although the environmental protection office only recommends a grille with 16 mm mesh width.

DURABLE FLOW DEVICES

When choosing machines, the investor of the power plant focused on a cross-flow Ossberger. The company also supplied the entire steel structure and electrotechnical equipment for the power plant, and carried out their professional assembly. The trashrack and the penstock were purchased from a local company that manufactures metal structures. Due to its design features, the turbine copes well with the sometimes very variable amount of water in the Lüßbach river. Thanks to the multi-chamber design, this turbine ensures optimal performance over the entire flow range. Thanks to its structure, there are no cavitation problems that would have a negative impact on the turbine lifetime. In addition, the Ossberger turbine is undemanding in terms of operation. With the exception of monthly bearing lubrication, no additional operations are required to operate the device.

ENGINE BUILDING DESIGNED BY AN ARCHITECT

The machinery equipment is discreetly hidden in the power house, designed by a Munich architect, Andreas Eichlinger, MSc Eng. The design of this concrete building is modeled on natural crystal structures and was integrated directly into the existing hillside. At a flow of 360 l/sec, the turbine produces a maximum power of 21.6 kW. The runner speed is constant, and it is 337 rpm. As a current transformer, an "ABB" asynchronous belt transmission generator is used. An extremely smoothly running 3-phase generator provides electricity with a voltage of 400 V. The average annual electricity generation of this unit is about 100,000 kWh. The generated electricity is discharged to the public power grid through the ground cable. From the end of construction in July 2016 to the end of September of the same year, more than 17,500 kWh of green electricity were produced.

OSSBERGER GmbH + Co. KG

This article was originally published
in the journal ZEK HYDRO (October 2016)

Source: Port Praski Sp. z o. o.

HYDROTECHNICAL SIGNIFICANCE OF **THE PORT PRASKI**

The investment in the Port Praski is the only flood protection project in Poland implemented by a private investor. Therefore, we decided to talk about its aspects with a hydrotechnical expert – Dariusz Gronek, the CEO of Hydroinvest.

What is the purpose of this investment, what functions does it perform?

The purpose of the investment is to build flood protection of the Port Praski, consisting of a flood gate and a sluice with a pumping station along with the accompanying facilities and the necessary equipment on the entrance channel to the Port Praski in Warsaw as part of the investment called "Construction of flood protection in the scope of building a flood gate with a chamber and a navigation sluice head at the entrance to the Port Praski". The main function of the planned investment is securing the areas of the Port Praski and neighboring areas against flooding by closing the upper gates acting as a flood gate in the event of high-water levels in the Vistula. Speaking in non-technical language, the building, designed by Hydroinvest Sp. z o. o. - in the field executive project, and implemented by a consortium of three companies, where the leader is PORR SA, is a flood protection barrier for two districts of Warsaw, i.e. Praga Północ and Praga Południe.

What is the hydrotechnical significance of the sluice (why so significant)?

The sluice allows for the movement of vessels between the Port Praski, where the water level is to be kept constant, and the Vistula River, where water levels have high fluctuations. Its task will be to maintain a minimum water level in the Port Praski, regardless of the water level in the Vistula, i.e. preventing the drying of pools in the Port Praski, with low water levels in the Vistula, as well as adjusting the water level in the Port Praski, using a pumping station located in the northern part of the facility.

What is its technical significance in the context of the lack of water barrages?

Due to the failure to build water barrages on the Vistula River within Warsaw (postulated by water engineers since the 1950s), the sluice and the pumping station in the Port Praski partially restores navigation on this section, and at the same time allows for the reclamation of the Port Praski area, which at the end of the 19th century was a very important place of trade, transport and handling of goods. Unfortunately, it has been unused and neglected for decades. We are glad that we can contribute to the revitalization of this place.

Port Praski is a private investment, unique in the country, is it a good direction?

It is a very good direction, especially if it concerns medium and small size water infrastructure facilities. Strategic facilities for environmental protection, flood protection and water supply should be stimulated and managed by institutions responsible for this sector of the economy on a national scale. Facilities of local importance should be made available to private investors, especially when, in addition to commercial functions, they can be of significance to the general public, especially the local community. Investing in water management infrastructure is very capital intensive and such investments and investors are still rare.

As for the aesthetic values, it is located in the center of the capital, how does it affect the neighborhood?

The aesthetics of the Port Praski including the sluice and flood gate is extremely sophisticated and in combination with the recreational

function and public functions will constitute a decoration for our city - I am convinced of this and the facilities that have already been built only confirm this.

Does it matter for the conditions on the Vistula (flood protection)?

The construction of the sluice and flood gate should not release the institutions and persons responsible for water management in Warsaw from liability. The construction of water barrages conventionally called by water engineers the North water barrage and the South water barrage still remains valid. It is impossible to solve the problems of the development of the Vistula River, city flood protection, as well as drinking water supply (drinking water infiltration intakes) and cooling water supply for Warsaw Heat and Power Plants without building these facilities. All other solutions (such as the sluice at the Port Praski) should only be part of the necessary system that currently does not exist. The failure of the sewage disposal system to the "Czajka" treatment plant is an example of the importance of the Vistula River for Warsaw and the need to expand the hydrotechnical infrastructure of the areas downstream. Big problems in water management cannot be solved without technical development. I hope that Hydroinvest Sp. z o.o. will contribute to the development of hydrotechnical infrastructure serving Warsaw and the country with their work. EW

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We are grateful **Hydroinvest** company for sharing photos.

WŁOCŁAWEK DAM – THE MOST CONTROVERSIAL HYDRAULIC CIVIL ENGINEERING PROJECT IN POLAND

Włocławek Dam was commissioned in 1970 and till this moment operates as solitary project on the Lower Vistula bringing a lot of advantages, but also negative effects and hazards. During 50 years of its operation numerous expert opinions and reports concerning this project were prepared, which however, did not lead to any real solutions. Extreme proposals include construction of the next barrages on the Lower Vistula or dismounting of the project Włocławek and restoring natural state of the river.

The Włocławek Dam on the Lower Vistula is the most controversial hydraulic civil engineering project in Poland. It was commissioned in 1970, and its basic economic priorities were inland navigation and hydropower. Social and ecological priorities were not so important at that time. Włocławek Dam was the first project of the designed Lower Vistula Cascade (LVC) and till today it is running as a single barrage, creating the danger of damage. It raises severe controversies and various opinions of naturalists and hydraulic engineers on the existence and exploitation of the project. During past years there were numerous discussions, reports and expertizes prepared on the future of the project. They did not bring, however, any result, because critical arguments of the ecologists on the project existence suited the subsequent governments to do nothing.

Fig. 1. Włocławek Dam

Source: DHV Hydroporjekt Sp. z o. o. with registered office in Warsaw - author of the Włocławek Dam project

The specialists of water resources management consider the construction of the next dam downstream stabilizing the tail water of Włocławek as indispensable to secure its proper operation and safety. Ecologists consider that Włocławek project should be dismounted and the river channel restored to its natural state as before the construction of the project.

The aim of this paper is presentation of all aspects connected with the project: studies, construction and exploitation as well as economic and social advantages, which it creates. The changes of the hydraulic and thermal regime along the impounded river section and downstream of the dam are presented. The paper also shows the influence of the dam on the environment.

THE VISTULA AND ITS CATCHMENT BASIN

The Włocławek Dam was constructed on the Vistula, which was always an essential economic axis of the country. In many situations it played also important cultural and even military role. In XVII and in the beginning of XVIII century Vistula was the river used most intensely for navigation purposes in Europe. Annually more than a quarter million tons of raw materials and products were transported between Poland's interior and the harbor of Gdańsk. Vistula has its estuary in the Gulf of Gdańsk. River length is 1047 km. Its navigable reach is usually considered close to 941 km as counted from Przemsza tributary to the sea. The Vistula catchment area is 194 thousand km² of which 87% is within Polish boundaries and covers 54% of the country territory [Majewski 2013]. In 1895 an important hydraulic project Vistula Crosscut Canal linking the Vistula Main Branch the Baltic Sea in the Vistula Delta region was completed mainly for flood protection.

- After regaining by Poland independence in 1918, during interwar period, the first plans for Vistula development, mainly for navigation and hydropower purposes were proposed. After World War II in the first plan for management of water resources, prepared in the 60-ties by the Water Management Committe of the Polish Academy of Sciences, special significance of the Lower Vistula for national economy was indicated.
- In 1968-71 there was elaborated by Polish specialists in collaboration with UN Development Programme.
- Elaborated at the end of 70-ties Complex Project for Vistula Development and Utilisation of the Vistula strong populist significanse shortly called Vistula Project was connected closely with the economic development of the country, but also it

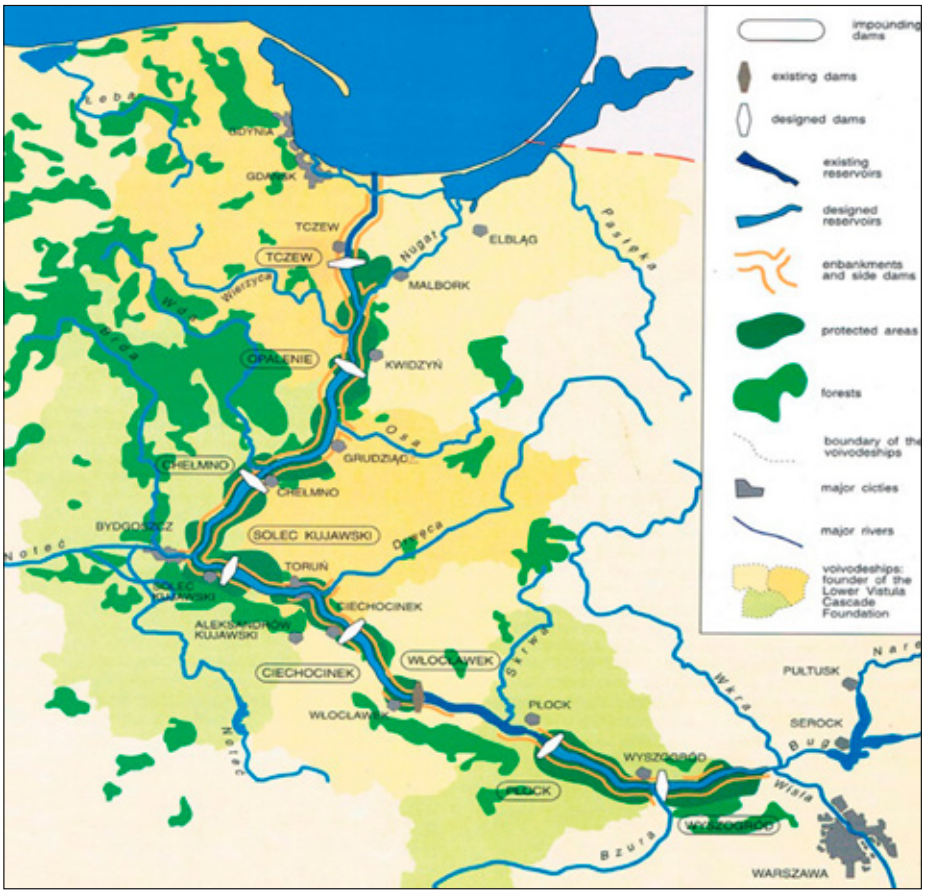
took into account natural, cultural and recreational problems.

- Hydrographically, Vistula is divided into three parts: Upper, Middle and Lower Vistula. All these parts show different nature, differ by discharge, character of the catchment, land cover and economic development [Majewski 2015].
- In economic utilization of Vistula a special importance had always the Lower Vistula and the large agricultural area at its mouth, called Żuławy Wiślane (Vistula Marshland). The Vistula and its catchment during many years has been significantly transformed by erection of numerous civil works and hydropower project in the Vistula river itself as well as at its tributaries [Majewski 2018]. This resulted in the change of discharge, thermal regime, sediment transport, and ecological state.

THE LOWER VISTULA CASCADE (LVC)

The Lower Vistula is the 391 km long river stretch which shows strong influence on the economy and the society. Along the Lower Vistula there are some significant cities and industrial centers - Tczew, Grudziądz, Bydgoszcz, Toruń, Włocławek, and Płock-located. Some important hydraulic nodes Gdańsk and Bydgoszcz, as well as the network of rivers and canals at Vistula Marshland are to be mentioned as well. Finally, tle Lower Vistula represents nearly 40% of the technical hydropower potential of Poland [Szymkiewicz 2017] and moreover it connects the center of Poland with the harbor of Gdansk [Kosiński, Zdulski 2013]. The possibility of hydropower and navigation use of this Vistula stretch has been emphasised in the subsequent concepts of Lower Vistula development.

Fig. 2. The first concept of the Lower Vistula Cascade



Source: Lower Vistula Cascade, 1993, PROECO, Warsaw

The first concept of the LVC included construction of 8 low head barrages with run-of-river reservoirs, hydropower plants, forming a compact cascade from Tczew to Wyszogród [Cascade 1993]. It was assumed that the installed power of all power plants will be 1 400 MW, and the annual production of electric energy that average hydrological year will amount to 4 200 GWh, which presented at that time a significant amount. Dammed waters of the reservoirs were located on the denudated terrains. In the 90-ties one returned to the concept of LVC [Hydroprojekt 2005], in a somewhat modified layout, with differently located dam and smaller installed power, which resulted in smaller production of electric energy, and another construction of the weirs. The last concept of the LVC was again modified to incorporate ten low head barrages [Szydłowski 2015] including the Warsaw North. State Water Holding Polish Waters (Regional Board in Gdańsk) undertook recently an action to resign of the last dam (Tczew) and to subsitute its impoundment by classical river regulation of Vistula downstream from Gniew cross-section [Kowalski 2018].

Table 1. The first concept of the Lower Vistula Cascade.

No	Name of the barrage	km	NWL (m a.s.l)	Head (m)	Power (MW)	Energy (GWh)
1	Wyszogród	586,0	72,00	8,00	170	
2	Płock	626,0	64,00	6,70	120	
3	Włocławek	674,8	57,30	11,30	160	
4	Ciechocinek	707,9	46,00	8,50	160	The whole cascade 4200
5	Solec Kuj.	757,8	37,50	7,50	140	
6	Chełmno	801,7	30,00	8,00	160	
7	Opalenie	864,0	22,00	10,00	200	
8	Tczew	904,6	12,00	12,00	200	

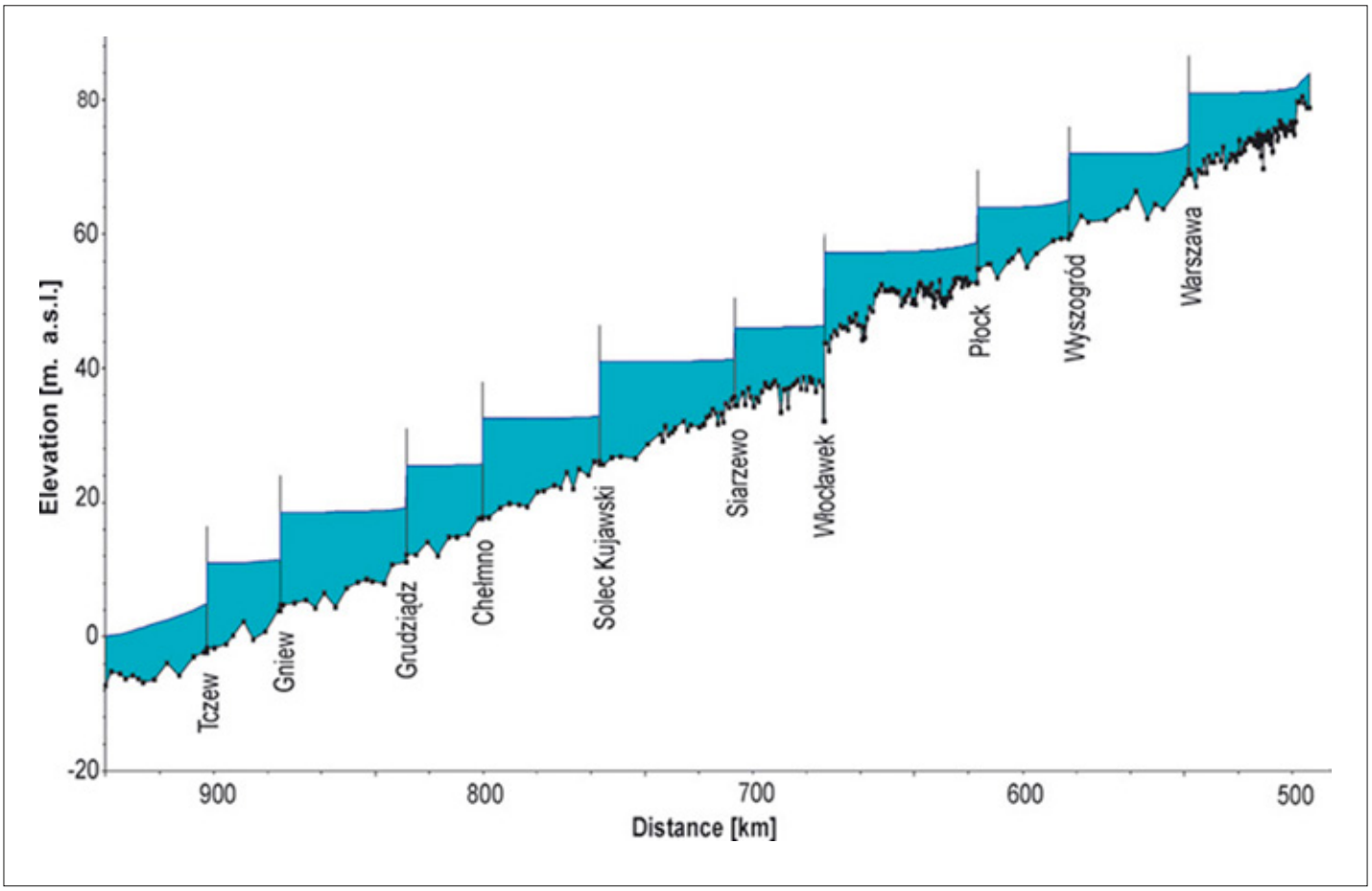
NWL – normal water level,
m a.s.l. – metres above sea level

Source: Lower Vistula Cascade, 1993, PROECO, Warsaw

WŁOCŁAWEK DAM

The idea to build the first barrage of the LVC in Włocławek (km 657) resulted from advantageous energy conditions and the idea of a Central Channel which would supply water to the suth western industrial part of Poland. The main aim of the construction of barrage was the production of electric energy and the development of inland navigation on the lower Vistula. Włocławek Dam was a pioneer undertaking in Poland. Design offices Hydroporjekt (presenty DHV Hydroprojekt) and Energopojekt prepared the technical documentation. Geodesic, geological, and geotech-

Fig.3. The longitudinal cross-section of LVC consisting of 10 barrages

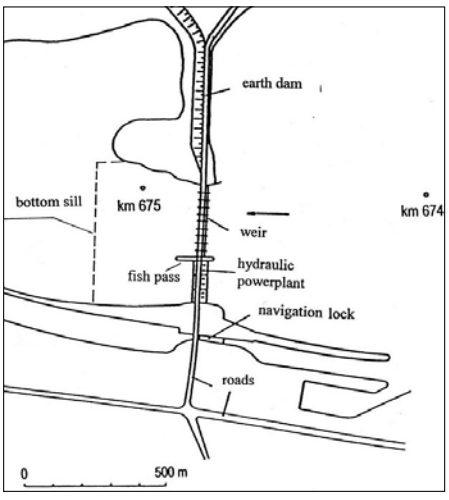


Source: Szydłowski i in. 2015, Hydropower potential of the Lower Vistula, Acta Energetica 1/22.

nical measurements were carried out by Polish enterprises, together with the analysis of hydrological and meteorological data. Hydraulic model studies were carried out in the hydraulics laboratory of the Institute of Hydro-Engineering of the Polish Academy of Sciences in Gdańsk.

The Włocławek Dam consists of frontal embankement part spillway gate portion for water and ice, hydropower plant (160 MW) consisting of 6 units (vertical Kaplan turbines produced in USSR) providing about 750 MWh electrical energy in an average hydrological year, navigation lock and fish pass. Installed discharge of the power plant is 2190 m³/s. The turbines can operate in head range 5.2 to 12.7 m [Majewski 2015]. The layout of the barrage is shown in Fig. 4. The Włocławek Dam formed run-of-river reservoir of the initial volume 400 hm³. The normal damming level was 57.30 m a.s.l. The tailwater level of the next barrage was assumed as 46 m a.s.l. This level guaranteed proper operation of the spillway gates, hydropower plant, navigation lock, as well as the stability of the whole project. The average discharge in the barrage cross-section was 890 m³/s. The discharge of 1% probability was estimated as 8700 m³/s. The minimum biological discharge was assumed as 350 m³/s.

Fig. 4. The layout of Włocławek Dam



Source: Majewski W., 2016, The monograph of the Lower Vistula, Institute of Meteorology and Water Management, Warsaw (in Polish)

The spillway weir consists of 10 bays, 20 m long each. The bays are closed by special steel gates. The chamber of the navigation lock has the dimensions 12 x 115 m, and the navigation lock has been designed for the transfer of 6 mill. tons per year. The upper gate of navigation lock is a lowered down segment, and the downstream gate was of the wicket type. Filling and emptying of the lock chamber is carried out by a special hydraulic system.

HYDRAULIC MODEL INVESTIGATIONS OF THE BARRAGE

This important and pioneer project required for design purposes detailed hydraulic model studies, which were conducted in hydraulics laboratory of the Institute of Hydro-Engineering of the Polsish Academy of Sciences in Gdansk. Studies included the following hydraulic models.

- Hydraulic model in the scale 1:200 included the inflow part to the weir and hydropower plant. The aim of this study was the determination of the layout of the currents upstream from the barrage during high discharges and various setup of the gates on the weir.
- On the model in horizontal scale 1:200 and vertical 1:100 flow conditions in the river cross-section decreased by the cofferdam. The weir and the power plant were constructed under the protection of a cofferdam.
- On the sectional model in the scale 1:50 flow conditions and ice flow passage for various gate openings were studied. The effectiveness of the stilling basin for energy dissipation was also investigated.

INDUSTRY CATALOG

- On the model in the scale 1:16 the filling and emptying system of the navigation lock was studied together with the measurements of forces acting on the navigating unit.
- On the model in the horizontal scale 1:80 and vertical 1:50 the process of the closing of the part of river channel 420 m long, which remained after dismounting of the cofferdam, was studied. Two variants of the river channel closing were studied.

CONSTRUCTION OF THE BARRAGE

The dam was constructed in the period 1962 – 70 by the Polish enterprises Hydrobudowa and Energobudowa. The first stage was erection of the navigation lock with avantports on the left bank of the Vistula. Next under the protection of cofferdam, weir and hydropower plant were developed. Subsequently the cofferdam was dismounted and river flow was directed to the weir, at this moment still without gates. An important stage of barrage construction was cutting off the remaining river part frontal embankment dam. This operation was carried out simultaneously from both banks, as it was recommended in hydraulic model experiments. The operation was carried out in autumn during low discharge in the river and was completed with success. The closed part of the river channel was transferred afterwards into the earth dam.

THE BENEFITS FROM THE CONSTRUCTION OF WŁOCŁAWEK DAM

The Włocławek Dam has no stable tailwater which results in numerous problems. Despite the drawbacks which are caused by the lack of next project downstream one tried to improve the situation at least partially. For this purpose an underwater sill downstream of the power plant and weir was erected (Fig. 4). This structure did not improve the stability of the frontal earth dam and the operation of the navigation lock. The whole Vistula upstream of Włocławek reservoir was severely polluted and a significant portion of the sediment settled in the reservoir forming hazardous toxic deposits. For this situation the reservoir was unjustly blaimed.

After the tailwater level fall, the original fishpass appeared incapable to function satisfactorily, which affected infavourably the migratory fish. It is, however, necessary to emphasize that the decreasing amount of migratory fish was not entirely connected with the barrage erection, but was also due to high pollution of Vistula.

The advantages of the erecting the Wloclawek Dam.

- Production of electric energy in the amount of 740 GWh in an average hydrological year. Production of such amount of electricity in a conventional thermal electric power plant would require burning every day about 800 tons of coal, which would cause considerable air pollution and large amount of ash.
- Creation of additional road crossing through Vistula in Włocławek.
- New possibilities for water abstraction for industrial, domestic, and agricultural purposes even in case of low discharges in the Vistula.
- New possibilities for recreation and water sports.
- Stabilization of water level in the reservoir and in consequence stabilization of ground water level around the whole reservoir.

Włocławek Dam was criticized, especially by naturalists and ecologists as the interference into water environment. The necessary solution, suggested by hydraulic engineers, is construction of the next barrage downstream of Włocławek, which will stabilize tailwater level. This would solve the detrimental consequences of the erosion downstream of the barrage and improve the operation of hydropower plant, stilling basin as well as the navigation lock. Such solution is firmly supported by local authorities and local society.

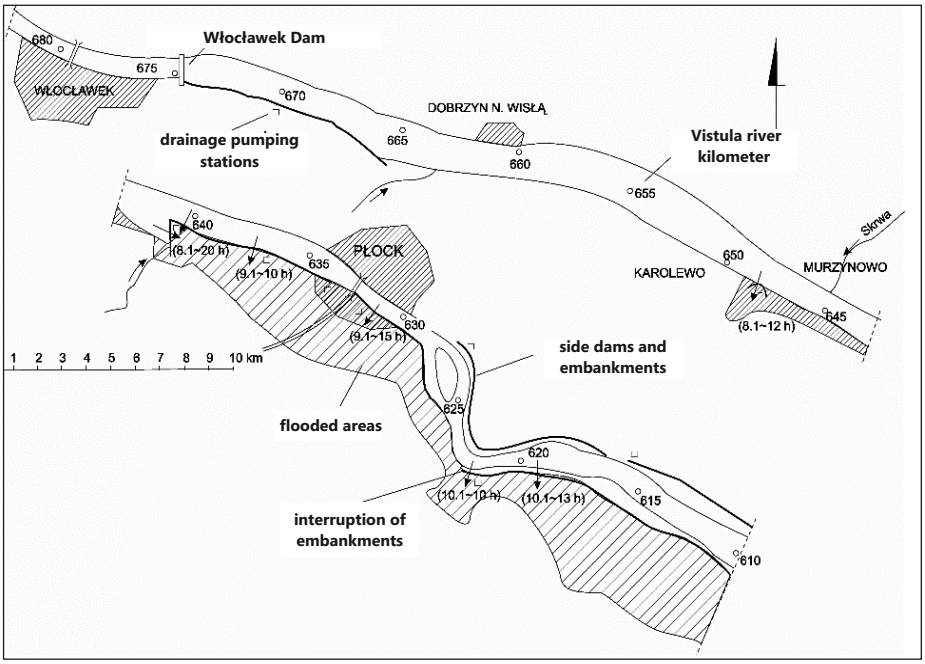
Ecologists propose the dismounting of the barrage and restoration of the Vistula to its previous natural state. However, even among ecologists not all support this opinion [Giziński 2000]. Construction of the next barrage as well as its dismounting are very expensive. Therefore the consecutive governments preferred to keep "status quo".

CONSEQUENCES OF WLOCLAWEK DAM ERECTION

Construction of the Wloclawek Dam and reservoir resulted in the change of thermal and ice regime on the reservoir as well as on the Vistula downstream from the barrage. Hydraulic regime was also changed due to increased flow depth and decreased flow velocity. The dam is run now in the run-of-river mode and maintains stable water level, which exerts good influence on ground water table around the reservoir.

As the result of the change of thermal regime of the dammed Vistula river section there was the decrease of the passage of ice floats and frazil ice during autumn period and quicker formation of stable ice cover on the reservoir, which remains longer in spring than on the free flowing river. Important problems form along the section of the river upstream, which is nearly in an natural state. Here during autumn and winter period large amounts of frazil ice are

Fig. 5. Flooded terrains along the upper part of Włocławek reservoir



Source: Majewski W., 2009, Flow in open channels including the influence of ice phenomena, Monograph of the Institute of Meteorology and Water Management, Warsaw (in Polish)

formed, which flow into the reservoir, where already stable ice cover has formed, thus resulting in important ice jams [Majewski 2009]. Bottom erosion in the downstream direction results in bottom irregularities [Majewski 2016], which move downstream forming large sand dunes.

The barrage and the reservoir did not bring increased water resources to the country, or in the catchment of the Vistula, because it did not increase the outflow to the sea. They, however, increased retention volume of Poland [Majewski 2016]. Formation of Włocławek reservoir has important influence on the decrease of flood and drought effects, which cause increased social, economic and even ecological losses. The large capacity of water in the reservoir allows for easier water withdrawals for agricultural, industrial and domestic purposes during drought periods. At present the government initiates a very important programme of increasing the retention volume in the new large and small reservoirs. It is planned to increase retention volume up to 10 or 15% of the average annual outflow, that is to 9.3 km³. The construction of the next barrage downstream from Włocławek is a very complex problem, because the whole valley of the Lower Vistula is within the NATURA 2000, area which in a considerable degree impedes construction of new hydraulic structures.

ICE PHENOMENA ON THE RESERVOIR AND ICE-JAM FLOOD IN 1982

Nearly the whole Lower Vistula is ice-jam prone. The formation of Włocławek reservoir changed hydraulic, thermal and ice regime of this Vistula river section [Majewski 2009]. Along the Lower Vistula several iceing periods could be observed since then. They were based on the formation of solid ice cover, subsequent break-up and next again freeze-up. Such situation connected with simultaneous appearance of unfavorable hydrological and meteorological conditions was one of the reasons of ice-jam floods in the upper part of the reservoir in 1982. In addition, wind blowing against the current, appeared a very important factor accelerating the flood, due to the stoppage of ice floats flow.

Comprehensive studies after winter ice-jam flood in 1982, which were based on the detailed measurements of ice cover, hydraulic conditions and back water profiles along the whole length of the reservoir, revealed complexity of operational conditions, which may appear on such reservoirs [Majewski 2009].

Fig. 6. Włocławek reservoir in the region of Płock (view in the upstream direction)

Source: Majewski W., 2009, Flow in open channels including the influence of ice phenomena, Monograph of the Institute of Meteorology and Water Management, Warsaw (in Polish)

In December 1981 in Poland low air temperatures with large amounts of snow appeared. At the end of December sudden air temperature rise occurred with rain, which resulted in rapid snow melting and increase of discharge in rivers. At the beginning of January 1982 ice break-up occurred on the Włocławek reservoir and on the Vistula stretch upstream and downstream from the barrage. Substantial drop of air temperature up to -20 °C, occurred together with a strong wind blowing from the west direction, that is against flow direction in this section of Vistula. This resulted in the stoppage of ice flow, which immediately froze forming thick ice cover, consisting of loose frazil ice, consolidated frazil ice, often mixed up with ice floats. The Vistula stretch upstream the reservoir had no solid ice cover at this time which under low air temperature and water temperature close to 0 °C resulted in immense amounts of frazil ice.

Frazil ice was flowing intensively to the reservoir and meeting solid ice cover moved under it forming hanging dams or even completely blocking the cross-sections. Such ice cover formed very high flow resistance and diminished active flow cross-section. Simultaneously rose the discharge, which reached in Płock cross-section on the 7 January the value 3 800 m³/s.

It is estimated, that the inflow of frazil ice to the reservoir was about 100 Mill. m³, which resulted in an increase of water level in Plock by 3 m. This caused breaching of side dams in 7 places and inundation of large terrains (Fig. 5). Inundated terrain amounted to 18 thousand ha. Flooded were 14 thousand farms. It was an evident influence of compound ice cover, which extended along the length of 30 km. After the passage of main flood culmination, the discharge systematically decreased, however, water level in Płock was still about 1.50 m higher than for analogous discharge with free water surface.

THE ACTION UNDERTAKEN AFTER THE FLOOD

After the flood all breached side dams were repaired, strengthened, and heightened. In the upper part of the reservoir the main river bed was cleared by removing all bushes, trees and dredging. All these obstacles could stop flowing ice floats and frazil ice. Floating ice booms were designed in the upper part of the reservoir, which could stop floats and ice pans [Polak 1987]. Floating ice booms also caused rapid formation of solid ice cover upstream from the reservoir and thus limited the development of frazil ice. All applied engineering activities fulfilled their task and after the 1982 flood such dangerous ice problems did not appear on the reservoir.

NAVIGATION ON THE LOWER VISTULA

In January 2017 Poland signed and ratified AGN Convention (European Agreement on Main Inland Waterways of International Importance). Polish territory is crossed be 3 navigation routes of international importance (Fig. 7).

As is shown in Fig. 7 for international navigation as well as national, special importance has the Lower Vistula stretch, due to the E70 and E40 navigation routes situated here. Development of this river section to the IV navigation class is only possible by erecting the barrages and impounding the river. Such river management solves also many problems of water resources management.

PROPOSAL OF THE NEXT BARRAGE DOWNSTREAM FROM WŁOCŁAWEK

After commissioning of Włocławek Dam the preparations to the development of subsequent barrages began. For the downstream barrage – the Ciechocinek Dam – technical design was completed and preparations to organize the construction site started. Unfortunately bad economic state of the country resulted in suspension of this project. Upstream of Włocławek the Wyszogród Dam was planned.

In 2005 consulting office Hydroprojekt Warsaw (presently DHV Hydroprojekt) completed the concept of another barrage downstream Włocławek – the Nieszawa Dam. This concept was accepted by the Regional Water Management Authority in Warsaw. This design differed substantially from the existing Włocławek Dam by the construction of the weir, as well as power plant and fish pass.

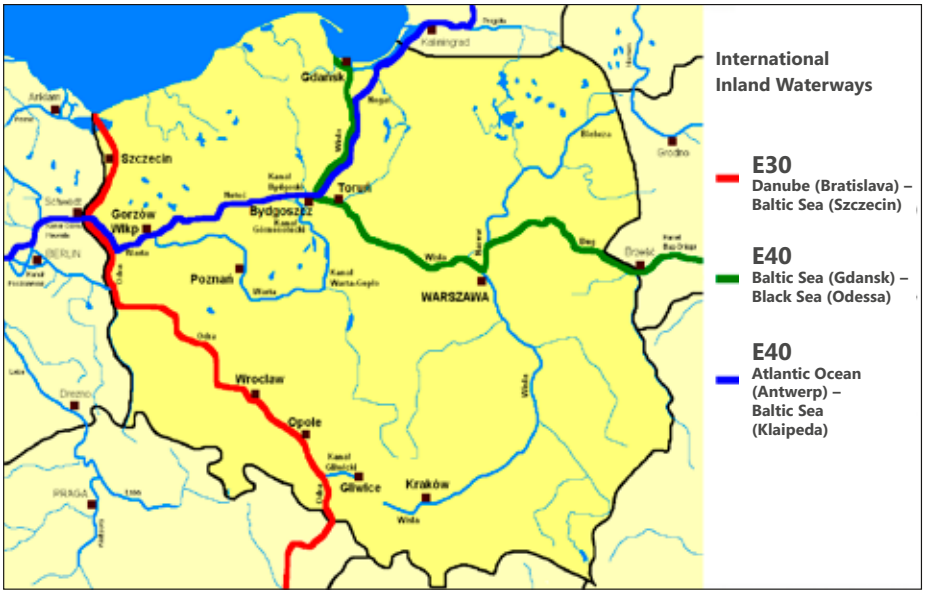
In 2013 a new concept of the barrage downstream Włoclawek – Siarzewo Dam – was proposed. It was completed by the consulting bureau ARUP on the order of ENERGA S.A. The advantages of erecting a barrage downstream of Włocławek include: improving safety of Włocławek Dam, improvement of navigation, recreation, new road passage through the Vistula, flood protection and decrease of the drought hazard. These actions should be co-financed by appropriate economic sectors and the state budget. This project is now evaluated from the ecological point of view. Regional Water Management Authority in Gdańsk is conducting further considerations on the water resources management of the Lower Vistula [Kowalski 2018].

Detailed economic analysis including the management of the Lower Vistula [Wojewódzka, Rolbiecki 2017] was carried out by the Gdańsk University indicating full profitability of this project. All matters connected with the development of Siarzewo barrage is now under the auspices of State Water Holding Polish Waters.

FINAL REMARKS

- In 1970 the Włocławek Dam was commissioned and put into operation as the first project of LVC. The barrage provides numerous advantages, but still operates as a single project, which shows its negative consequences.
- The whole cost of Włocławek barrage construction was returned within 7 years, only from the income of produced electric energy.
- Hydropower plant produces in an average hydrological year 740 GWh of renewable and ecological electric energy. Production of such amount of electric energy in a thermal power plant would require burning daily about 800 tons of coal with all associated consequences.
- Construction of the next barrage downstream from Włocławek was proposed several times [Szymkiewicz 2017], but unfortunately its realization was suspended because of economic crisis as well as protests of ecological organizations.
- At present State Water Holding Polish Waters undertook an initiative to erect the first barrage downstream Włocławek in Siarzewo. This project requires, however, numerous agreements and acceptance of ecological organizations.
- Discussions concerning new hydraulic projects should take into account economic, technical, social and ecological aspects. Achievement of this aim requires detailed analysis, but also real discussion of all partners involved in the project under consideration. This, however, is missing.

Fig. 7. Navigation routs AGN which pass through Poland



Source: Majewski W., 2015, Complex management of the Lower Vistula the opportunity for the region and Poland, Water Management 2/2015 (in Polish)

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MAVEL INSTALLED THREE UNITS AT PRAGUE´S HISTORIC ŠTVANICE HYDROELECTRIC POWER PLANT - OUTPUT INCREASE 25% -

M a v e l, a.s. („Mavel") during summer 2019 installed, tested and commissioned three generating units at the Štvanice Hydroelectric Power Plant (Štvanice HPP) on the Vltava River in central Prague, Czech Republic. The output of the new double regulated Kaplan "S" turbines Mavel **Model KS3400K4** exceeded guaranteed values by more than 25%. The original Štvanice HPP was completed in 1914 and decommissioned in 1972. Eventually, the state power utility completely renovated the plant. The original architecture and landscaping was preserved and the Štvanice HPP was back online in 1987. The renovated plant housed three Kaplan "S" turbines, each with a flow capacity of 55 cms, head of just under 4 meters, direct generator coupling and stated installed power of 1.9 MW. Over the past few years, the efficiency of the turbines declined while problems with the bearings increased. In August 2017, Mavel was awarded the contract to perform the refurbishment by Povodi Vltavy s.p., a Czech water management authority overseeing all activities related to the Vltava River. Mavel's engineering, procurement and construction (EPC) contract was for the complete rehabilitation of the power plant, including mechanical and hydraulic design, replacement of three horizontal turbines, refurbishment of generators, supply of a control system and all related civil work. The first phase of the contract was engineering with the goal of maximizing the potential of the site. Design engineering was constrained by the need to maintain the historic powerhouse and minimize changes to water currents so as not to interfere with the many tour boats in that area of the river. Using Computational Fluid Dynamics (CFD) modeling, Mavel engineers found that reversing the rotational direction of the turbine would maximize the energy potential and minimize losses in the inlet and draft tube. Hence, Mavel developed a new hydraulic design for the turbine customized for the specific hydraulic parameters and requirements of the Štvanice HPP. All three new units with four blades, 3400 mm runner diameter horizontal Kaplan turbines were installed with a counterclockwise rotational direction. The solution allowed fot the use of the existing generators, which were refurbished for higher outputs and also adopted for the directional change.

Mavel a.s. is a global leader in the supply of turbines (Kaplan, Francis, Pelton and Micro) for hydroelectric power plants from 30 kW to 30+ MW per unit. Over the past twenty plus years, the company has installed or signed contracts for over 500 turbines at more than 325 sites in 43 countries around the world. Czech company designs and manufactures its turbines and related equipment at its ISO certified facilities in the Czech Republic.

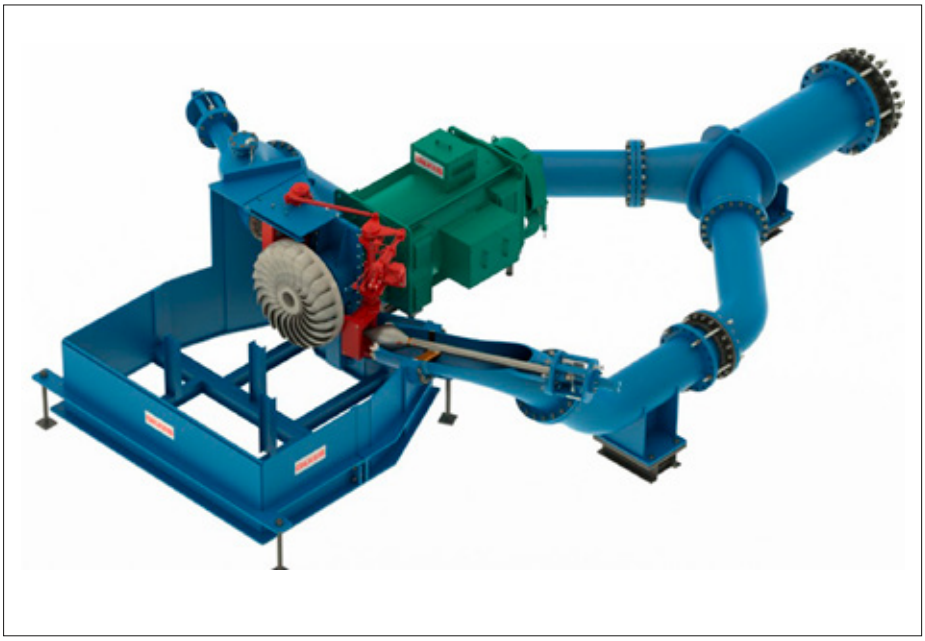
M a v e l, a.s., Jana Nohy 1237,CZ - 256 01 Benešov, Tel. 00420 317 728 483, info@mavel.com

100 YEARS OF **THE TURGO TURBINE**

100 years ago an engineering company based in the North West of England invented and successfully patented a new type of hydro turbine design – the Turgo Impulse Turbine. To this day the turbine remains popular on the world market due to its unique geometry offering advantages over rival turbine designs.

2019 is the year Gilbert Gilkes and Gordon Ltd, celebrate the centenary of its Turgo Impulse Turbine. The Turgo was designed by Gilkes in 1919 by the grandfather of Gilkes' current chairman. Almost immediately after returning from the war he conceived the idea of a side entry impulse turbine which would run, typically, at twice the speed of a Pelton turbine when operating on the same head. A patent was applied for in 1919 and granted to the young engineer, Eric Crewdson, for his new turbine design the "Turgo Impulse Turbine". The first ever 30kW Turgo was installed at Invergeldie Lodge near Crieff in Scotland in 1919. Eric Crewdson died in 1967 but his legacy to Gilkes lives on in the modern versions of the Turgo Impulse Turbine which continue to make a major contribution to hydropower around the world. There are currently over 1,000 Gilkes Turgo installations worldwide, ranging from 25 kW to 7.5 MW.

Fig. 1. Sectioned view of a twin jet Turgo Impulse Turbine typical arrangement

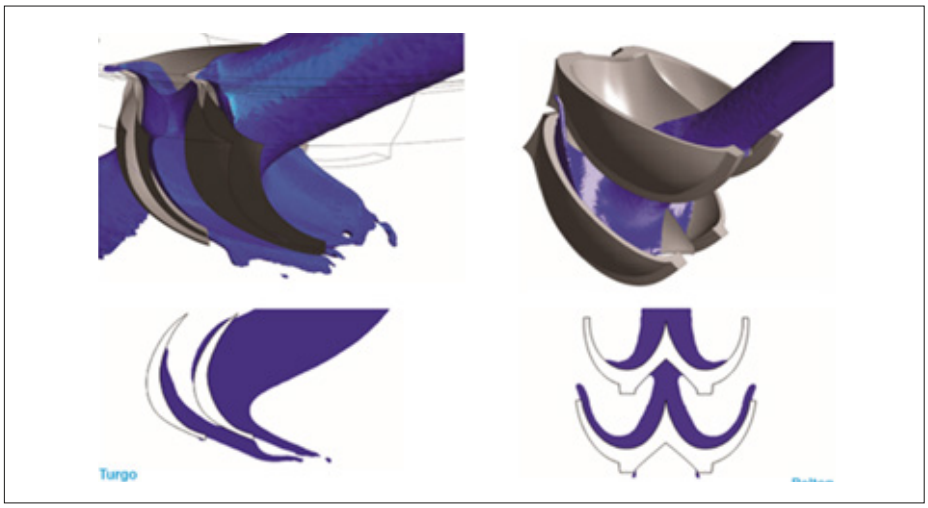


DESIGN PRINCIPLES

The Turgo Turbine is an impulse type hydro turbine. The operation consists of a water jet striking and rotating a Turbine runner to transmit torque to a generator through a rotating shaft. The Turgo is similar to the Pelton Turbine in its design, with the key difference being the angle at which the jet is positioned relative to the runner, and the runner design itself. The inclusion of the jet angle, combined with some innovative runner design allows the Turgo Turbine to process a larger jet diameter, and its specific speed means it typically runs faster than the equivalent Pelton turbine. It is these elements of the design which were the reason for the early success of the Turgo.

However, as well as passing a larger diameter jet than a Pelton Turbine, the Turgo is often preferred for its simplicity and robustness. The Turgo is renowned for its ability to process dirtier and more abrasive water, due to the nature of the runner design meaning that the way in which the water wears the runner blades is less detrimental to the hydraulic efficiency. It is these unique advantages which allowed for the Turgo turbine to grow in popularity since it was conceived in 1919.

Fig. 2. Turgo and Pelton Turbine runner to jet interaction



TURGO APPLICATIONS

To date Gilkes have supplied Turgo turbines to 65 countries. One of the largest single Turgo installations carried out by Gilkes in recent history was installed in Oregon, USA in 2015. The site previously housed two Francis machines commissioned in 1985 with a combined capacity of 3 MW. Due to the site's aggressive water supply and varying flow range, the annual maintenance costs were high and the turbines were rarely running at peak efficiency. The Turgo was an ideal replacement for the scheme due to its robust, simple design and its ability to run at lower flows with a relatively flat efficiency curve. Gilkes supplied one twin jet 2.64 MW Turgo Turbine to replace the 1 MW and 2 MW Francis machines. Despite the Turgo's lower rated output, it was able to produce 12.5% more annual energy in its first year and almost completely eliminate maintenance costs.

The largest Turgo scheme ever installed by Gilkes is located in Zimbabwe, Africa and was commissioned in 2017. The site consists of four 4.2 MW twin jet Turgo Turbine's with a combined flow capacity of 12000 l/s. The selection of these turbines for this site

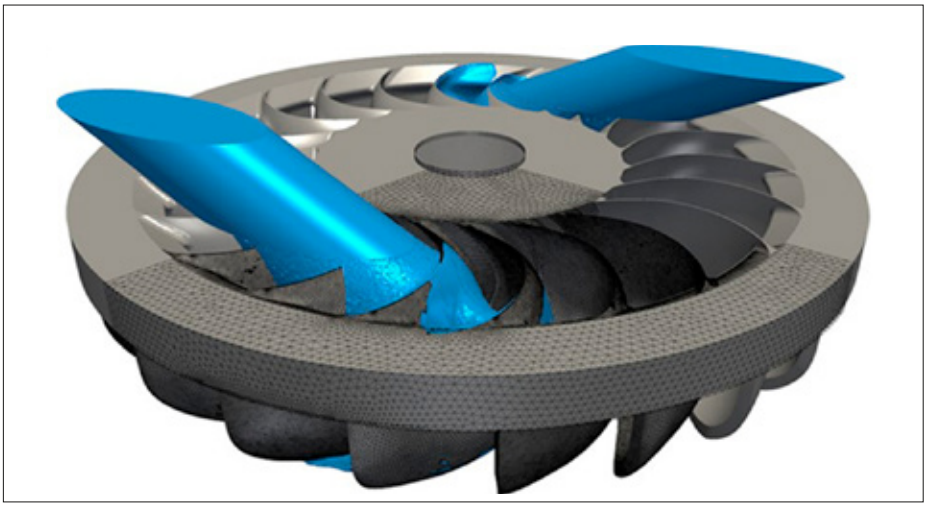
Photo. Four 4.2MW Turgo turbine installation in Zimbabwe, Africa

was a testament to Gilkes' understanding of their customer's key requirements. Due to the head and flow conditions available at site, the default selection based on peak efficiency would have been 2 vertical 6 jet Pelton machines. Although Gilkes had the capability to supply such machines, the geographic location of the site and powerhouse design meant that the maximum lifting capacity was limited to 25 tonnes. The Turgo's inherently faster running speed means a considerably smaller generator is required and along with its simplicity, robustness and ability to process more abrasive water, the Turgo was a perfect choice.

DESIGN DEVELOPMENT

In order to maintain the competitiveness of the Turgo Turbine Gilkes continually look to improve its product. Over the last 7 years improvement processes have been driven by significant investment in research and development capabilities with the aim of producing new designs with enhanced efficiency. The Turgo turbine was one of the first beneficiaries of Gilkes' strive to continually improve products through innovation. With the application of computational fluid dynamics (CFD) and finite element analysis (FEA), a study was carried out on the Turgo turbine with the aim of improving the hydraulic efficiency of the turbine runner. The results of the study were validated via prototype testing in of the Gilkes Turgo testing facility and the output of the project was a new design of Turgo runner with an increased peak hydraulic efficiency of around 2%. A further study was carried out into the efficiency of the Gilkes turbine injector. Via similar development methods used for the runner, the turbine injector efficiency was also increased. The output of this specific study was particularly rewarding as it enhanced both Gilkes' Pelton and Turgo design offerings. The new runner and injector designs are now supplied as standard on any new Turgo Turbine made by Gilkes.

Fig. 3. CFD Flow visualization of a twin Jet Turgo runner



FUTURE INNOVATION

The initial success of increasing the Turgo Turbine efficiency has laid solid foundations for future development work which Gilkes will complete in line with its innovation strategy. The Turgo Turbine remains one of Gilkes most popular Turbine designs and will continue to be developed in areas such as improved manufacturing methods and advanced material applications which will further improve the robustness of the Turgo design. In addition to new installations, the optimised Turgo components will contribute to future plant modernisation packages, which can be supplied to existing customers in order to improve machine life and ultimately increase annual energy for the customer. All of this means the Turgo can quietly look forward to its next 100 years.

Gilkes Hydro design, manufacture and commission hydro schemes worldwide.With over 160 years of experience Gilkes offer single source, water to wire solutions for a range of hydropower applications. From large utilities to small mini grids, our solutions are tailored to meet the needs of each individual project.

Austen Wheatman
Product manager, Hydro
Gilkes

We are grateful to **Gilkes** company for sharing photos.


Source: www.pixabay.com, RJA1988

HYDROPOWER GROWTH AND DEVELOPMENT **THROUGH THE DECADES**

Hydropower has come a long way since first emerging as a new and innovative form of power generation, with worldwide installed capacity now above 1,250 gigawatts.

In this article, Samuel Law and Nicholas Troja, research analysts from the International Hydropower Association (IHA), report on the sector's growth and development over the past century.

AN EMERGING TECHNOLOGY

The nineteenth century saw the first turbines developed to generate electricity from the power of water. By 1900 hundreds of small hydropower plants were in operation as the emerging technology spread across the world. The beginning of the twentieth century witnessed rapid innovations and changes in hydropower facility design, during which time hydropower development was dominated by growth in North America.

Policies enacted by U.S. President Franklin Roosevelt, including the New Deal in the 1930s, supported the construction of several multipurpose projects such as the Hoover and Grand Coulee dams with hydropower accounting for 40 per cent of the country's electricity generation by 1940.[1 2] From the 1940s to 1970s, spurred initially by World War II followed by strong post-war economic and population growth, state-owned utilities built significant hydropower developments throughout Western Europe, as well as the Soviet Union, North America and Japan.[3]

Low-cost hydropower was seen as one of the best ways to meet growing energy demand and was often tied to the development of energy-intensive industries such as aluminium smelters and steelworks.

Over the last decades of the twentieth century, Brazil and China became world leaders in hydropower. The Itaipu Dam, straddling Brazil and Paraguay, opened in 1984 with a capacity of 12,600 MW - it has since been enlarged and upgraded to 14,000 MW - and is today only eclipsed in size by the 22,500 MW Three Gorges Dam in China. Decadal capacity growth stagnated in the late 1980s before falling in the 1990s. This was due to increasing financial constraints and concerns expressed about the environmental and social impacts of hydropower development, which halted many projects around the world.[4] Lending and other forms of support from international financial institutions (IFIs), most notably the World Bank, dried up in the late 1990s, which particularly affected hydropower construction in the developing world.

INCREASED FOCUS ON SUSTAINABILITY

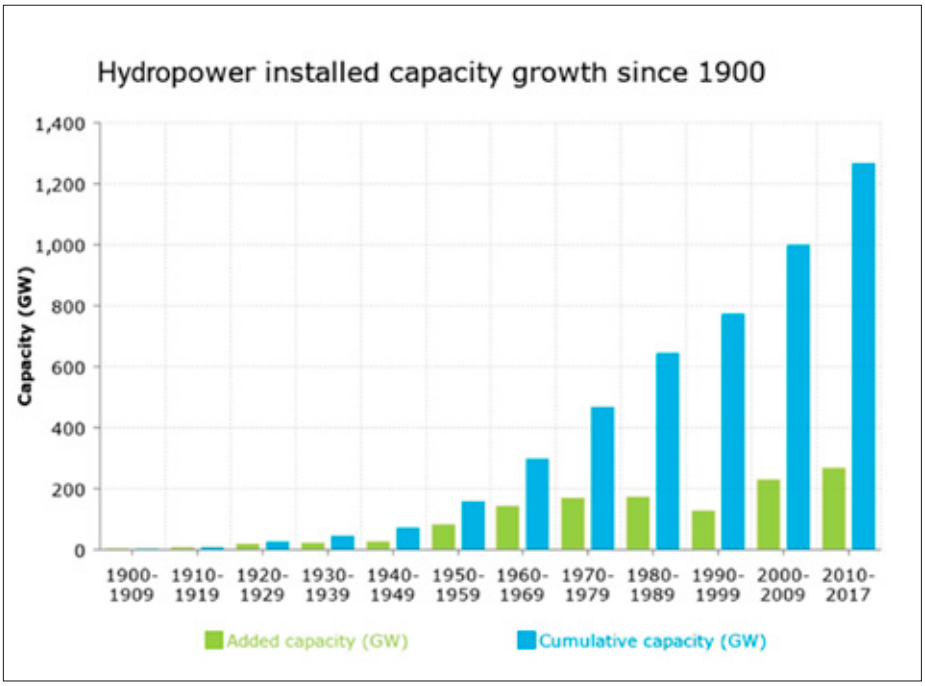
Towards the end of the century, during which global understanding increased on environmental and social impacts, there was a process of reassessing hydropower's value and role in national development. In 2000, a landmark report published by the World Commission on Dams (WCD) challenged existing practices and initiated a change in the planning and development of hydropower towards a focus on sustainability and affected communities.[5 6]

The International Hydropower Association (IHA), formed under the auspices of UNESCO in 1995, began work on the IHA Sustainability Guidelines in 2004, which took into account the WCD Strategic Priorities, as well as World Bank Safeguard Policies, International Finance Corporation Performance Standards, and the Equator Principles. These guidelines led to the development of the Hydropower Sustainability Assessment Protocol (HSAP), a multi-stakeholder tool for assessing projects at all phases of their lifecycle.[7] These developments led to a fundamental shift in how best to plan, develop and operate hydropower projects, and resulted in a growing appreciation of the technology's role in combatting climate change, reducing poverty and boosting prosperity.

RENEWED AND RAPID GROWTH IN INSTALLED CAPACITY.

Not long after the turn of the century, hydropower development gained

Hydropower installed capacity growth since 1900



Source: IHA

a renewed momentum, particularly across Asia and South America. Between 2000 and 2017, nearly 500 GW in hydropower installed capacity was added worldwide, representing an increase of 65 per cent, with growth since 2010 already outstripping that recorded in the first decade of the century. The significant rise in installed capacity and generation from hydropower has been driven by a variety of often interrelated factors, notably:

Demand for energy in emerging economies

Developing countries, including Brazil and China, needed an affordable, reliable and a sustainable source of electricity to support rapid economic growth.[8] Since 2000, China has more than quadrupled its installed capacity to 341 GW (2017), accounting for over half of the world's hydropower capacity growth.[9]

South-to-South investment and trade

The boom in South-to-South investment and trade (between developing countries) has become a critical source of hydropower financing and technology transfer. From 2004 to 2012, South-to-South trade in hydropower products and equipment increased from below 10 per cent of total global trade to nearly 50 per cent.[10] National development banks and private investors from emerging economies such as China, Brazil and Thailand have become major contributors to foreign direct investment (FDI), which in the past was largely provided by developed economies and multilateral development banks.

As part of the Chinese government's 'Going Out' strategy and its Belt and Road Initiative, Chinese companies and banks invested nearly USD 25 billion in projects overseas between 2000 and 2016 and in the process have become leaders in global hydropower development.[11 12]

Multilateral agreements and goals

The past decade has seen greater recognition of hydropower's role in achieving internationally agreed development outcomes, such as through the Sustainable Development Goals and climate goals including the Paris Agreement which have influenced national policy targets. Small hydropower projects (under 20 MW) in particular have benefited from the Clean Development Mechanism which was introduced under the Kyoto Protocol, the precursor to the Paris Agreement, to encourage clean and sustainable development.[13 14]

Support from the World Bank and IFIs

Lending from the World Bank for hydropower development increased from a few million dollars in 1999 to nearly USD 2 billion in 2014.[15] The World Bank also extended its role from a 'primary investor' to an important 'convenor' that provides assistance in technical knowledge and bringing other financiers to the table.[16 17] While the monetary value of the World Bank's lending is a small fraction of the total amount invested in the sector each year, the bank's recommitment to hydropower, along with other IFIs including the Asian Development Bank encouraged greater private sector investment and engagement.

FUTURE OF HYDROPOWER DEVELOPMENT

In 2018, IHA, in its annual Hydropower Status Report, reported worldwide hydropower installed capacity to have risen to 1,267 GW, with a record 4,185 TWh estimated to have been generated in 2017. Due to its multiple services and benefits, hydropower will remain the world's largest source of renewable electricity for years to come and with significant untapped hydropower potential; much of the sector's future growth is expected to come from Africa and Asia.

According to the International Energy Agency, in order to meet the main energy-related components of the Sustainable Development Goals, including the below two degrees Celsius commitment of the Paris Agreement, an estimated 800 GW of additional hydropower will need to be brought online over the next two decades.

Samuel Law
Nicholas Troja
International Hydropower Association

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ACTIVE FISH PASSAGE – THE WAY TO ECONOMICALLY CLEARING **WATERCOURSES**

Technology developed in Polish conditions reveals a new approach to clearing watercourses. For the first time in history, a fish ladder becomes a device that ensures the profitability of such an investment. The surplus electricity can become a source of generating positive cash flows. The article presents the principle of operation of the fish pass and the possibilities of its application.

The purpose of the fish passage is to allow the migration of aquatic fauna species along the river bed, both upstream and downstream. The fish passages are supposed to replace natural river rapids in places where water damming structures were built. In general, traditional fish ladders, regardless of the technology in use, "divide" the difference in water level before and after the damming structure into ten or so, or several dozen parts (depending on the size of the difference). This is achieved by building a sufficient number of interconnected pools with a different water level, elevated by appropriate height. The difference and flow rate between consecutive pools are selected in such a way that certain fish species are able to overcome them by swimming against the current. The idea of an active fish passage is to force the water in the pools to move up and down the river.

Source: Flying Fox Michał Lis for Instytut OZE Sp. z o.o.

PRINCIPLE OF OPERATION

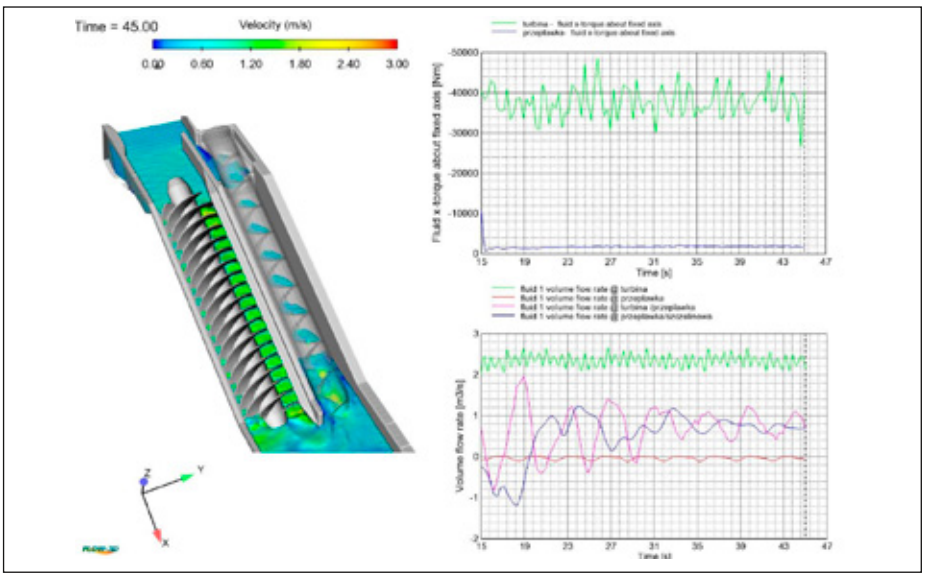
One could imagine a few technical solutions for forcing an adequate volume of pool water to move, but the most easily feasible and, at the same time, allowing for the use of energy of the descending path of the fish passage, is the use of Archimedes' screw as a working element. The screw allows water to be transported in both directions (originally, Archimedes' invention was a pump), pumping takes place without changing the water pressure in open high-capacity chambers with low linear velocity. All these parameters make it possible to safely "transport" fish in both directions of the river. In terms of technical design, the fish passage consists of two paths - the ascending path, pumping water up, and the descending path, bringing water down. The principle of operation of each path is based on the principle of operation of Archimedes' screw, but the elements differ in terms of their design. The ascending path consists of a large diameter pipe with an internally welded single blade of Archimedes' screw. The whole system has bearing connections in two places and is driven by a gear motor. Its end, from the tailwater side, is completely submerged in water, making it possible to take the water from the bottom position and transport it to the top position together with migratory organisms. The descending path consists of a shaft with externally wound Archimedes' screws blades, usually four, arranged in 90-degree increments. The whole system also has adequate bearings and cooperates with a trough with a size slightly larger than the outer diameter of the blades. In the case of a descending path, the rotor with blades is driven by water pressure.

ENERGY-POSITIVE FISH PASSAGE

The individual blades, in cooperation with the trough, form chambers in which the fish can be floated safely down the river. Speed

Simulation of flow through the fish passage

Source: Instytut OZE Sp. z o. o.



(that must not be too high) is fundamental for safety. The hydraulic system of the device does not ensure proper deceleration of the floating water speed, and it is necessary to slow down the rotor speed. Braking means converting the energy of the rotating shaft into another type of energy, e.g. thermal energy, by using a friction brake. Of course, a friction brake could be used, but then only the immediate surroundings could be heated, and yet the energy could be used in a more useful way. First of all, there is a descending path right next to this system, which requires energy to raise water from the bottom position. In theory, we are able to select devices in such a way that, when mechanically connected with each other, they could drive and brake each other, but it would be necessary to complete energy balances of both devices, taking into account the efficiency of mechanical systems that connect them. However, it could be very difficult to create such a mechanism in practice, due to the changing conditions in the river.

Thus, it seems much more practical to convert mechanical energy into another kind of energy and use it for propelling the ascending path. In this case, electricity is the optimal choice. The rotor in the descending path can be braked very effectively by means of an electric generator that produces electricity, which can supply power to the gear motor for the ascending path. It should be remembered that practically the entire amount of water flowing downstream in the river could be used for supplying power to the descending path of the fish passage, instead of passing through the damming structure unproductively. If you were to do an energy analysis of both paths at that time, it would turn out that the descending path produces several times more energy than the ascending path needs to work. This makes such a fish passage not only an active but also an energy positive system (it produces energy). The power grid is, first of all, an appropriate buffer

Active fish passage – the implementation in Starogard Gdański

Source: Instytut OZE Sp. z o. o.

that reduces problems with the variability of flow in the river (which would be the case if a mechanical connection was used) and allows you to manage the surplus energy produced.

ADVANTAGES OF THE ACTIVE FISH PASSAGE

The main advantage of an active fish passage in relation to a traditional fish ladder is a much smaller amount of space required for its installation. Due to the small differences in height between consecutive pools and a large volume of individual pools, traditional fish ladders are structures that require a lot of land. An active fish passage, which uses Archimedes' screw, would occupy several times or even more than ten times less land, depending on the difference in water levels. This is directly related to the magnitude of interference in the natural environment and the costs of the investment.

An additional advantage of the active fish passage over the traditional one is the difference in the way a fish crosses the ascending path. In the case of a traditional fish ladder, the fish have to overcome the current of water in the cracks on their own, which makes them exhausted. In the case of an active fish passage, the fish are lifted together with the water and they can overcome the level differences without any loss of strength.

APPLICABILITY

The basic limitation of using the described active fish passage is the amount of level difference. Due to the size and limitations related to the angle of inclination of the fish passage of this type that can be applied, the upper limit of applicability is about 5m of level difference. Of course, in specific cases, if the terrain conditions allow it, it is possible to use a cascade of fish ladders, which solves this problem. The range of applications is:

- use of eco-flow turbine at existing hydropower plants,
- in the construction of a new SHP, ensuring two-way fish migration,
- clearing the watercourse at other weirs.

TECHNICAL PARAMETERS

As to the size of the ascending path device, it is usually a pipe with a diameter from 1 to 1.5m and a length depending on the level difference, from a few meters to even more than 20m in length. In the case of the descending path, the diameter of the rotor is between 2 and 3.5m, depending on the amount of water to be brought down the river. Devices of this size have a quite considerable weight, ranging from a few to a dozen or so tons. As it comes to the ascending passage, the power of the devices may vary from a few to a dozen or so kilowatts; as far as the descending path is concerned, the power is from 20 to even about 200kW in the case of the largest devices.

Thanks to many years of experience, knowledge and involvement in research and development projects, we deliver a new product to the market in the form of an active fish passage. We are convinced that it will become an excellent alternative to traditional fish ladders and will increase the ecological capacity of river sections.

Instytut OZE sp. z o.o. implements a project co-financed by European Funds "Research and development to design an innovative active fish and aquatic fauna passage". The aim of the project is to increase the innovativeness of Instytut OZE by carrying out complex R&D work allowing for adding a new product to the Company's offer in the form of an active fish and aquatic fauna passage.
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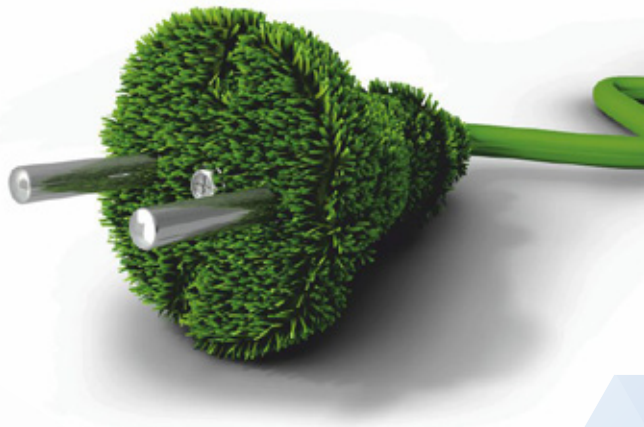
ENERGY

STRAIGHT FORM NATURE



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