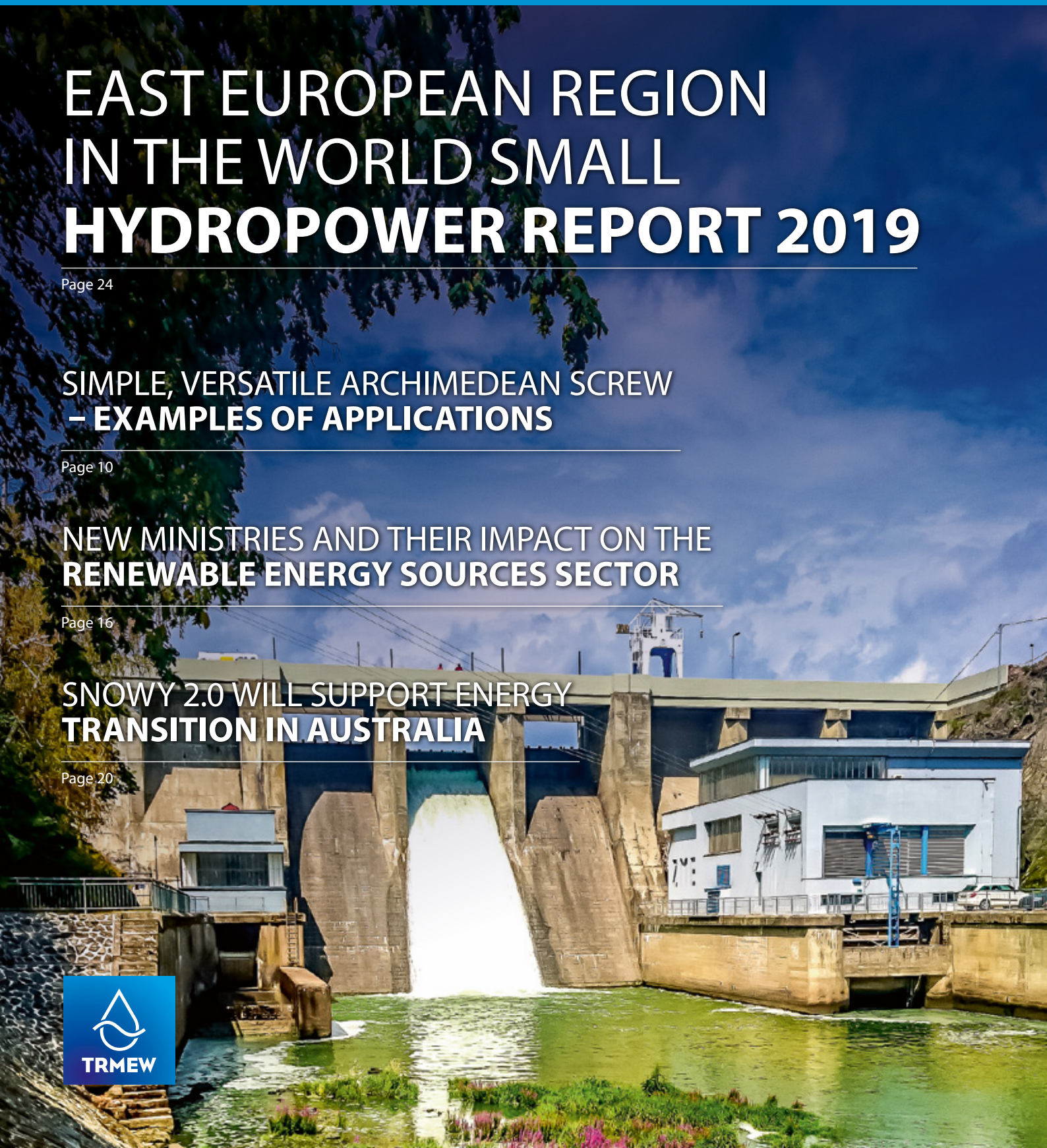
HYDROPOWER | WATER MANAGEMENT | ENVIRONMENTAL PROTECTION | INLAND NAVIGATION | ENERGY RECOVERY

ENERGETYKA WODNA

1/2020 (33)
FREE COPY
ISSN 2299-0674



EAST EUROPEAN REGION IN THE WORLD SMALL **HYDROPOWER REPORT 2019**

Page 24

SIMPLE, VERSATILE ARCHIMEDEAN SCREW **– EXAMPLES OF APPLICATIONS**

Page 10

NEW MINISTRIES AND THEIR IMPACT ON THE **RENEWABLE ENERGY SOURCES SECTOR**

Page 16

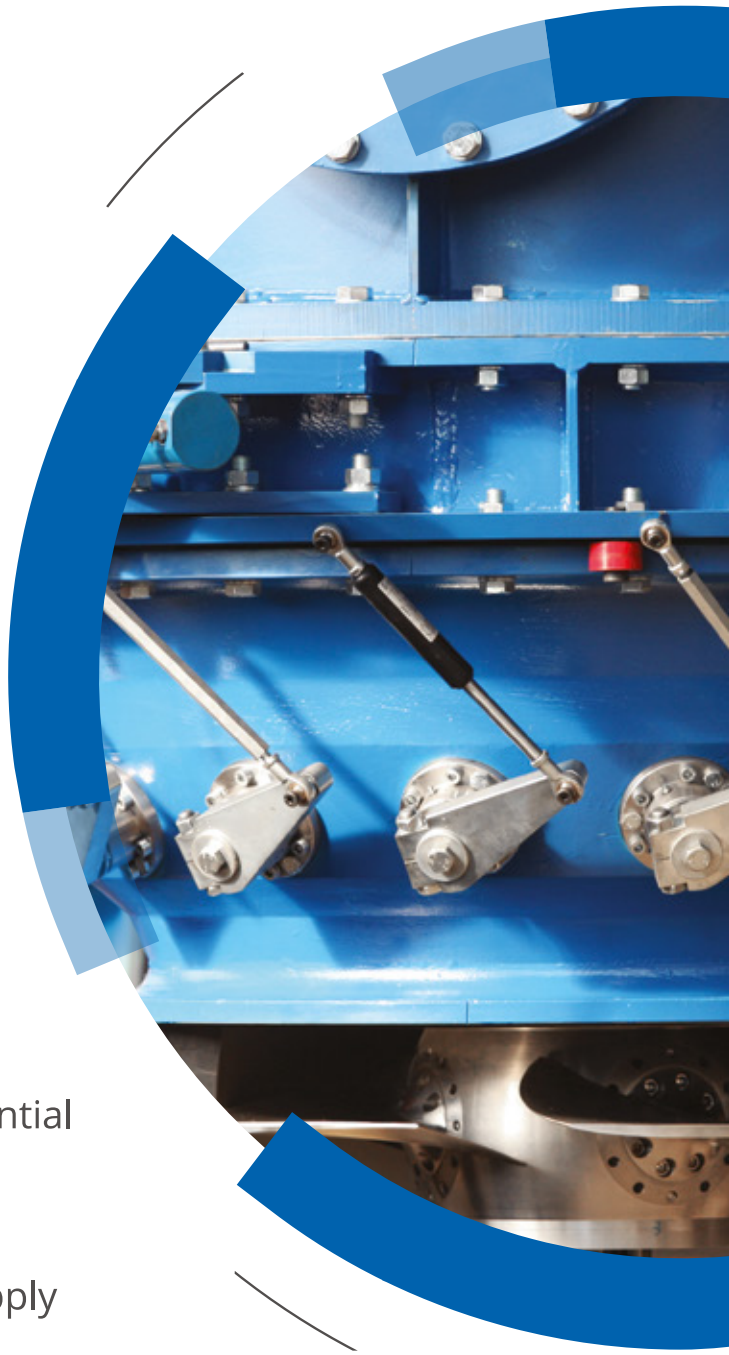
SNOWY 2.0 WILL SUPPORT ENERGY **TRANSITION IN AUSTRALIA**

Page 20

TRMEW

All for hydropower

We offer comprehensive, multi-stage consulting, including turnkey solutions of hydro power plants. Our company has its own R&D center and modern machine park.



Technology

- Kaplan turbine
- Archimedes screw
- Active screw fish pass

Offer

- Assessment of the hydropower potential
- Technical and investment consulting
- Multi-branch design
- Turn-key turbine and equipment supply
- Commisioning and training courses
- Operation suport, after sales service

ENERKO ENERGY SP. Z O. O.
Skrajna 41A
25-650 Kielce, Poland

tel.:+48 41 301 00 27
fax: +48 41 341 61 03
www.enerko.pl

Łukasz Kalina
e-mail: lukasz.kalina@enerko.pl
tel.: +48 512 008 805

FROM **EDITORIAL OFFICE**

What does hydropower have in common with the coronavirus pandemic? I decided to begin this letter from editors with this question as it is impossible to ignore the events happening lately, even in the magazine dedicated to issues so distant from microbiology. It is impossible to ignore it as hydropower, as an element of electro energetic systems throughout the world, provides the energy constituting the basis of social and economic development.

One of the effects of the coronavirus pandemic is the stoppage in many sectors of the world's economy, which directly translates into reduced energy consumption. At the turn of March and April, we witnessed huge decrease in the demand for electricity in Europe. It affected these countries where coronavirus was spreading in the most violent way. Italy observed the decrease by 31%, Spain by 21% and United Kingdom by 16%. In Poland, in turn, demand for electricity was 7% lower than usual. Lower demand results in the reduction of wholesale prices of electricity, thus removing energy sources with the highest variable costs from the market, changing the structure of its production. Coronavirus pandemic has also questioned so called Green Deal, the schedule of activities aimed at reaching climate neutrality by the European Union in the year 2050. At the beginning of April Frans Timmermans, Vice President of the European Commission, made a statement that the European Union is not going to change its plan of increasing its target of CO_2 emission reduction to 50-55% in 2030. However, it can be supposed with a large dose of certainty that members of the European community will first have to face the economic crisis coming right after the coronavirus and they will not be keen on directing 260 billion euros per year to reach climate targets. We need to be aware of the fact that the implementation of Green Deal will most probably get delayed.

Nobody has any doubts that it has already become much different and will be like this when the pandemic is over and the changes will affect the energy sector, too. What are they going to be? As the witnesses of this history, we will have to asses it ourselves.
In these difficult times our editors had to face the task of preparing this year's first issue of the magazine. I will frankly admit it that due to numerous difficulties, mostly of organizational and financial character, it has been a significant challenge for us. Unfortunately, it was impossible to avoid the delay and resigning from some elements of the magazine, such as for example the calendar of sector-related events. We were trying to do our best in order for this issue to maintain our regular standard and thus I am very satisfied to invite you to read it. In the current issue we are continuing the publication of articles based on last year's lectures from Polish Hydropower Conference HYDROFORUM, we quote the most important conclusions from the November edition of RENEXPO Interhydro in Salzburg and present new ministries connected with the sector of renewable energy sources. For those interested in foreign undertakings, we have prepared the article devoted to the Australian Snowy 2.0 project as well as the Swiss Muttsee Dam. History lovers, in turn, will become interested by the series of articles about the construction and modernization of the water dam in Wapienica. Finally, I would like to recommend articles presenting this year's edition of the World Water Day as well as the new drought monitoring and forecasting service – esusza.pl.

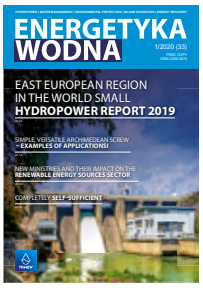
Dear Readers, enjoy current issue of our magazine. I would like to thank all our authors, advertisers and fans. Thanks to your support we managed to release it. At the same time, I would like to ask all fans of "Energetyka Wodna" to support our magazine financially by purchasing subscription or advertising space (prices start from the paltry price of PLN 250 net for the entry in trade catalogue) in order for us to win the battle with coronavirus with fewer injuries.

Michał Kubecki
Editor in Chief

ENERGETYKA WODNA

INTERNATIONAL QUARTERLY
NO 1/2020 (33) – international circulation 8000 copies

www.energetykawodna.info



NEWS

PRACTICE

LAW

PROJECTS

KNOWLEDGE

ECOLOGY

EDITORIAL OFFICE:
Michał Kubecki – Editor in Chief
Michał Lis – Managing Editor
Aleksandra Wołowiec – Editor
e-mail: redakcja@energetykawodna.info
mobile: +48 518 304 194

SUBSCRIPTION AND ADVERTISING:
Monika Grzybek
biuro@energetykawodna.info

DTP:
Gustaw Nowak
grafika@energetykawodna.info

PRINTING HOUSE:
Agencja Wydawnicza „ARGI"
ul. Żegiestowska 11
50-542 Wrocław

TRANSLATION:
mTłumaczenia.pl

EDITORIAL COUNCIL:
Wojciech Majewski
Janusz Steller
Bogusław Puchowski
Ewa Malicka
Radosław Koropis
Robert Szlęzak
Andrzej Grześ

PHOTO ON COVER:
The Brno Knincky Hydropower Station
Source: PleskyRoman, iStock

PUBLISHER:
Polish Association for Small Hydropower Development (TRMEW)
ul. Królowej Jadwigi 1
86-300 Grudziądz
phone: +48 (56) 46 49 644
fax +48 (56) 46 49 643
e-mail: biuro@trmew.pl
www.trmew.pl

Orders for institutional subscription adopts Kolporter Sp. z o.o. Sp.k. Information available at the hotline number 0 801 40 40 44 or on the website www.dp.kolporter.com.pl

PGE EO HYDROPOWER PLANT WITH **THE NEW MONITORING SYSTEM**

At the Dębe Hydropower Plant, belonging to PGE Energia Odnawialna, part of PGE Capital Group, one of the most modern security monitoring systems in Poland dedicated for hydrotechnical facilities has been installed.

The aim of the Automatic System for Technical Control of Dams (ASTKZ) consists in ongoing monitoring of technical condition of the hydropower plant together with the adjacent abutment through the analysis among others of weather conditions, water level and temperature as well as dam deformations, filtration processes taking place within hydrotechnical structure, its base and abutments. Monitoring and measurement equipment, constructed basing on a computer network, has been placed within the building of the power plant, in its base as well as within the area adjacent to it. What is more, an innovative solution has been applied, making it possible to evaluate the security of the facility (stability) through the implementation of a dedicated IT system, enabling mathematical calculation analysis, based on Finite Elementary Model (FEM). With the use of this method it is possible among others to evaluate structural strength, simulate deformation, stress, dislocations. What is important, thanks to applying modern engineering software Z_SOIL, it has become possible to solve in an efficient and reliable way even the most complex geotechnical issues to which traditional methods fail to provide appropriate solutions. The hydropower plant is currently undergoing modernization. The scope of works includes the replacement of technological equipment, including all turbines, generators, the flow, adjustment and induction system together with electrical and drainage installation and such elements as pumps, valves and bolts. Completion of the project, which is scheduled for the year 2022, will ensure complete automation of turbine sets, highest availability and reliability, enhanced service ergonomics as well as environmental threats reduced to minimum.

Maciej Gelberg
Head Communication Specialist
PGE Energia Odnawialna S.A.

HYDROPOWER PRESSURE ON EUROPEAN RIVERS: **THE STORY IN NUMBERS**

The first ever Europe-wide inventory of hydropower plants shows rivers to be saturated with hydropower dams and thousands more on the cards. This is despite EU rules which should limit new hydropower plants.

Commissioned by WWF, RiverWatch, GEOTA and EuroNatur, the study provides damning evidence of governments' failure to protect rivers and biodiversity, demonstrating a blatant disregard for EU water and nature protection laws. 28% of all planned hydropower plants are in protected areas, the vast majority in national parks and Natura 2000 sites. The study also evidences an alarming rise in small hydropower, which wreaks environmental havoc whilst producing very little energy. With more than a third of European freshwater fish species currently threatened with extinction – of which hydropower dams are a key driver – European rivers and their biodiversity cannot cope with the pressure of more hydropower.

Key findings:

- Europe is already saturated with 21,387 hydropower plants
- Despite this, 8,785 additional plants which are planned or under construction
- 28% of all planned hydropower is in protected areas (33% in the EU)
- 91% of the plants recorded by the study are small plants, which produce negligible amounts of energy (less than 10MW)

WWF

GREEN ENERGY AT **GREENWAY CHARGING STATIONS**

From 1st of February, 2020, electric drivers using GreenWay charging stations, will charge their batteries with ecological, green energy. Thanks to the agreement with Tauron Sales, in all GreenWay chargers (both existing and newly connected) powered directly from the grid, certified energy will be generated from renewable sources, primarily from small hydropower plants.

The change of the energy type used to power electric vehicles will be done gradually. Existing chargers connected directly to the grid managed by Tauron will be the first to switch to green energy, then the process will successively apply to the rest of the stations connected to the grid managed by other distribution system operators, where GreenWay will be changing its energy supplier. As a result, all stations directly connected to the DSO network will be 100% powered with green energy. The process will also apply to all new stations that are being built and will be connected directly to the network of distribution system operators.

Source: GreenWay Polska Sp. z o.o.

Green energy is already used in the Slovak part of the GreenWay network - there, all charging stations connected directly to the grid supply the electric vehicles with clean energy. This also applies to all newly constructed chargers. – The cleaner the energy that supplies the electromobility sector, the greater the ecological benefits of using electric vehicles – says Rafał Czyżewski, CEO of GreenWay Polska. – Sometimes the type of energy used to power EV's is used as the foundation of their criticism. However, as the energy mix changes into clean energy, this argument loses its relevance. Therefore, we are gradually striving for a situation in which, wherever it is technically possible, all our stations connected directly to the grid will have contracts with sellers offering "green" energy.

100% green energy provided by Tauron is available as part of the ECO Premium product. GreenWay chargers powered by green energy will be labeled accordingly, and the company's electromobile customers will also find information about the ecological source of energy offered by individual chargers in the mobile app.

Samanta Piernicka
PR and Marketing Manager
GreenWay Polska Sp. z o.o.

HYPOSO – AN INTERNATIONAL **PROJECT ON SHP**

In September 2019 a research project funded under the H2020 programme has started with the aim to support the European hydropower industry while at the same time fostering a sustainable development in selected target countries in Africa and Latin America. There are two Polish partners involved in this initiative: IMP PAN and TRMEW.

HYPOSO is an acronym for „Hydropower solutions for developing and emerging countries" and the overall objective of the project is to support the market uptake of EU hydropower technologies in Africa and Latin America by bringing together relevant actors from the European hydropower sector with stakeholders in the target countries with the aim to develop and improve small hydropower standard in the target countries. This should lead to a win-win situation enabling more technology export for European companies and stimulation of the energy transition in developing and emerging regions. The selected target countries are Bolivia, Cameroon, Colombia, Ecuador and Uganda.

HYPOSO OBJECTIVES

It is expected that the realisation of the HYPOSO objectives will lead to promotion of the European hydropower industry (equipment producers, investors and project developers) in target regions to boost their exports of products and services. It should also pave the way for better investment conditions (legal, political, financial, social) in export markets in target regions for European hydropower stakeholders and increase the share of renewable energy in target regions, especially small and medium-sized hydropower by helping relevant governments, authorities and local stakeholders to create better framework conditions for renewables (e.g. faster permits and shorter planning periods, energy cooperatives and communities, easier and faster funding, etc.).

Participants in the Kick-off meeting, Munich, October 21-23, 2019

Source: Joseph Kenfack

THE CONSORTIUM

Based on the above objectives, the project has received funding from the European Union's Horizon 2020 research and innovation programme. Thanks to that, 13 project partners from 11 countries can collaborate in the HYPOSO project, including 5 partners from the target countries and 8 ones from Europe. The coordinator of the project is a German company WIP-Renewable Energies and there are two Polish partners in the project, i.e. The Szewalski Institute of Fluid-Flow Machinery of the Polish Academy of Sciences and TRMEW sp. z o.o. – a company related to the Polish Association for Small Hydropower Development.

BACKGROUND

The European hydropower industry is well renowned, able to build tailor-made hydropower facilities all around the globe and has vast experience in the sector. The European know-how can foster the transition into a more sustainable energy system in parts of the world that still need support to develop the sector. While the European hydropower potential does not allow huge developments, the international market development potential is still big. The numbers describing European hydropower industry are impressive. In 2015, the European hydropower equipment manufacturing competence accounted for estimated two-thirds of the world market. In addition, many leading universities and research centres specialised in hydropower are located in Europe. Directly and indirectly, the EU-28 hydropower sector provides more than 100,000 jobs, directly including 50,000 jobs in generation and almost 7,000 in equipment manufacturing and the actual gross value creation resulting from European hydropower generation companies and equipment manufacturers adds up to 38 billion €.

TOOLS AND ACTIVITIES

The above mentioned objectives will be reached through a combination of tools and activities including framework analyses with regard to small hydropower up to 30 MW for the target countries, mapping of more than 2,000 potential hydropower sites in the target countries, capacity building of local hydropower professionals in cooperation with local experts and political stakeholders and elaboration of 15 dedicated business case studies of SHP projects (three in each of the five target countries) with a focus on local financing, leading to at least 5 signed MoUs between stakeholders from target countries and the European hydropower sector. For bringing together potential business partners with the European hydropower industry, a study tour will be organized, in which selected African and Latin American stakeholders, especially project developers, investors and multipliers will visit various European manufacturers, research institutes and reference hydropower plants to acquire information on the latest European hydropower technologies.

FIRST STEPS

On 21 and 22 October 2019, the HYPOSO consortium met for the first time in person at the Kick Off Meeting in Munich. During the two days, the project partners got to know each other and presented the work packages and tasks that will be worked on by them in the project.

After the KOM the work accelerated and the first deliverables of the project have been submitted, for example the Comprehensive list of European small hydropower stakeholders, the Contact list of hydropower stakeholders and multipliers in five target countries or the project website (www.hyposo.eu). Due to the restrictions related with the COVID-19 (the corona virus), the sequential meeting - the First HYPOSO Progress Meeting, initially scheduled from 25 to 27 March 2020 in Vilnius, Lithuania had to be cancelled and instead the online meetings were organized which again motivated the partners for taking further steps.

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

Janusz Steller
The Szewalski Institute of Fluid-Flow Machinery of the
Polish Academy of Sciences
President of the Polish Hydropower Association

Towarzystwo Elektrowni Wodnych
iha affiliate member

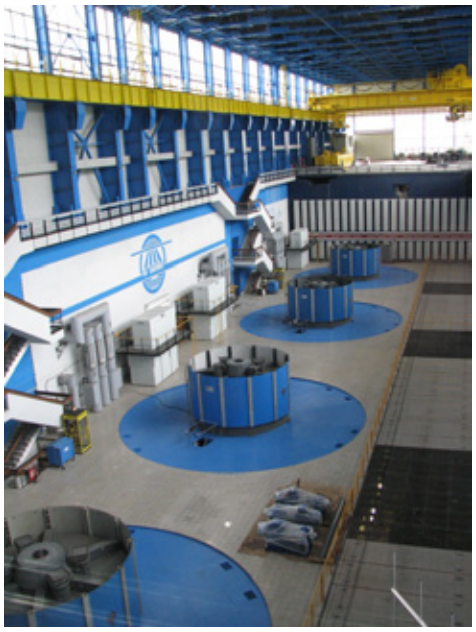
TRMEW

IMP PAN GDANSK

Polish Hydropower Conference
HYDROFORUM 2020

HYDRO FORUM

Gdansk, October 15-16th, 2020



The programme includes

- Hydropower status, prospects and development trends
- Hydropower and its infrastructure in the national economy and the social & natural environment
- Non-technical constraints for hydropower development
- Panel debate in the series: "Hydropower in search of its opportunities"
- Experience in design, erection and operation of hydropower plants and their equipment
- New technical concepts and R&D activities
- Technical visit to the Żarnowiec Hydroelectric Power Plant

Organisers

Polish Hydropower Association
mail address:
ul. Piaskowa 18, 84-240 Reda, Poland
phone: +48 58 678 79 51, e-mail: ***biuro@tew.pl***

Polish Association for Small Hydropower Development
ul. Królowej Jadwigi 1, 86-300 Grudziądz, Poland
phone: +48 56 464 96 44 , e-mail: ***biuro@trmew.pl***

Szewalski Institute of Fluid-Flow Machinery of the Polish Academy of Sciences
ul.Fiszera 14, 80-231 Gdańsk, Poland
phone: +48 58 5225 139, e-mail: ***steller@imp.gda.pl***

Partners

PGE Energia Odnawialna SA,
ul.Ogrodowa 59A, 00-876 Warszawa, Poland, ***https://pgeeo.pl/en***

Foundation of Energy Saving in Gdansk,
ul.Fiszera 14, 00-231 Gdansk, Poland, ***https://fpegda.pl/en/***

Join the conference and use the opportunity to sponsor the event!
Prospective authors are invited to propose their conference contributions.

Further information soon available from our websites:
www.tew.pl, www.trmew.pl, www.imp.gda.pl

Editorial collaboration and medial patronage

WYDAWNICTWO IMP PAN

ActaEnergetica
KWARTALNIK NAUKOWY ENERGETYKÓW

zek

CIRE.PL

ENERGETYKA WODNA

FROM THE WORLD

18.12.2019 SEFA AWARDS FUNDS FOR INNOVATIVE **SOLAR-HYDRO HYBRID PROJECT**

A 9MW solar-hydro hybrid project in development in Burundi is to benefit from a $990,000 grant awarded by the African Development Bank-managed Sustainable Energy Fund for Africa (SEFA).

The project consists of two plants, each featuring a solar and a hydro component as well as a local distribution network and interconnection to the national power grid. The innovative hybrid design is anticipated to regularize the power output during dry and wet season and mitigate power shortfalls caused by climate change. Upon completion, the project will also electrify about 20,000 households in surrounding communities through a local distribution network. By enhancing access to electricity, the project will also generate socio-economic benefits especially for women and small and medium-sized enterprises (SME).

International Water Power & Dam Construction

19.12.2019 TINA RIVER PROJECT CONSTRUCTION **SET TO START NEXT YEAR**

A landmark financing agreement has been completed for the 15MW Tina River hydropower project in the Solomon Islands, allowing construction to start in 2020.

The Government of Solomon Islands and the International Finance Corporation (IFC), a member of the World Bank Group, announced the completion of financing for the project. The over US$200 million package, through loans and grants from six institutions, marks the first large-scale infrastructure project for Solomon Islands to be developed as a public-private partnership (PPP). The Tina River project will curb Solomon Islands' reliance on imported diesel by almost 70%, lowering power prices for homes and businesses across the country, where the price of electricity is among the highest in the world and heavily exposed to global fuel price fluctuations and shocks. The project will also pave the way for the country to reduce its greenhouse gas emissions by two and half times its 2025 target.

International Water Power & Dam Construction

3.01.2020 SMALL HYDROPOWER **TECHNICAL GUIDELINES PUBLISHED**

The United Nation Industrial Development Organization (UNIDO) has published Technical Guidelines for the Development of Small Hydropower Plants to meet demand from member states. The guidelines address the current limitations of regulations for the development of small hydropower plants by applying expertise and best practices from across the globe.

The intention is for countries to utilize these guidelines to support their current policy, technology and ecosystems. Countries that have limited institutional and technical capacities will be able to enhance their knowledge in developing small hydropower plants, thereby attracting more investment, while at the same time encouraging favorable policies and therefore subsequently assisting in economic development at a national level, said UNIDO. The guidelines will help share technical know-how and best practices between countries that have limited technical capacities.

The publication has five volumes and 26 parts, which can be taken as the principles and basis for the planning, designing, construction and management of plants up to 30MW.

International Water Power & Dam Construction

7.02.2020 LUKOIL COMPLETES UPGRADE WORK AT **BELORECHENSKAYA, RUSSIA**

Lukoil has competed a major modernization of the Belorechenskaya hydropower station in Russia's Krasnodar Region, raising the project's capacity by over 30%. The reconstruction, which began back in 2017, included replacement of two generating units. The work increased the installed capacity of each unit from 16MW to 24MW, raising the total capacity of the power plant up to 48MW. The upgrade also extended the operational life of the plant for 40 years, increased reliability and improved environmental safety, said Lukoil, through the use of advanced technologies, like brushless excitation of the hydrogenerator and electric drive of the turbine wicket. The company also introduced integrated upgrade solutions at almost all auxiliary systems of the station.

The Belorechenskaya hydropower plant dates back to 1954. The station operates on the principle of diversion, using the elevation difference between the Belaya and the Pshish rivers.

International Water Power & Dam Construction

RESEARCHERS SUGGEST MAJOR DAMS COULD PROTECT AGAINST **PROJECTED SEA RISES, WITH SUBSTANTIAL CONSEQUENCES**

14.02.2020

New research has suggested that two large dams could be a solution to protect more than 25 million Europeans against the consequences of an expected sea level rise of several metres over the next few centuries, while also stating that the design of such extreme dams is mainly a warning which 'reveals the immensity of the problem hanging over our heads.'

Dr Sjoerd Groeskamp, oceanographer at the Royal Netherlands Institute for Sea Research, and Joakim Kjellson at GEOMAR in Kiel, Germany, published research this month in The Bulletin of the American Meterological Society that suggests building a 475km long dam between the north of Scotland and the west of Norway and another one of 160km between the west point of France and the southwest of England could act as a defence against climate change. The research calculates that the costs to build the dams could be between €250-500 billion, which amounts to 0.1% of the gross national product, annualy over 20 years, of all the countries that would be protected by such a dam.

Ultimately, the description of this extreme dam is more of a warning than a solution, Groeskamp stated. 'The costs and the consequences of such a dam are huge indeed. However, we have calculated that the cost of doing nothing against sea level rise will ultimately be many times higher. This dam makes it almost tangible what the consequences of the sea level rise will be; a sea level rise of 10m by the year 2500 according to the bleakest scenarios. This dam is therefore mainly a call to do something about climate change now. If we do nothing, then this extreme dam might just be the only solution."

International Water Power & Dam Construction

TEST SHOWS ICE HARBOUR TURBINE ACHIEVES HIGH FISH **PASSAGE SURVIVAL RATES**

3.03.2020

Preliminary testing on a new turbine installed by Voith at the Ice Harbor Dam on the Snake River in Washington state, US, shows the new design has achieved a survival rate of 98.25% for Chinook salmon passing through the turbine - a significant improvement over similarly sized conventional Kaplan turbine installations which typically see survival rates in the low 90 percent range, says Voith.

One of the primary goals of the new Unit 2 turbine design was to improve the fish passage survival rate, and this was accomplished while simultaneously increasing the turbine's hydraulic performance and extending the life cycle of the unit. Voith says the turbine achieved a 4% boost in hydraulic efficiency. The testing was conducted in late 2019 with the Voith-manufactured turbine that had been installed earlier that summer. To perform the test, the Pacific Northwest National Laboratory (PNNL) released "sensor fish" devices within the turbine intakes to collect pressure and acceleration data during operation.

Analysis of the preliminary results of these tests showed a high rate of direct survival for migrating juvenile salmonids as they passed through Unit 2, satisfying a key goal of the modernization project.

International Water Power & Dam Construction

STUDY SAYS SEASONAL PUMPED STORAGE COULD SOLVE RENEWABLE **ENERGY STORAGE CHALLENGE**

3.03.2020

Seasonal pumped hydropower storage (SPHS) could be an affordable and sustainable solution to store energy and water on an annual scale, according to new IIASA research published in the journal Nature Communications. Compared with other mature storage solutions, such as natural gas, the study shows that there is considerable potential for SPHS to provide highly competitive energy storage costs.

The new study is the first to provide a global, high-resolution analysis of the potential and costs for SPHS technology. In their analysis, researchers assessed the theoretical global potential for storing energy and water seasonally with SPHS, focusing on the locations with the highest potential and lowest cost. They also analyzed different scenarios where the storage of energy and water with SPHS could be a viable alternative. The study included topographical, river network and hydrology data, infrastructure cost estimation, and project design optimization, to identify technically feasible candidate sites. The study shows that water storage costs with SPHS plants vary from 0.007 to 0.2 US$/m3, long-term energy storage costs vary from 1.8 to 50 US$/MWh and short-term energy storage costs vary from 370 to 600 US$/KW of installed power generation capacity, considering dam, tunnel, turbine, generator, excavation and land costs. The estimated world energy storage potential below a cost of 50 $/MWh is 17.3 PWh, which is approximately 79% of the world electricity consumption in 2017.

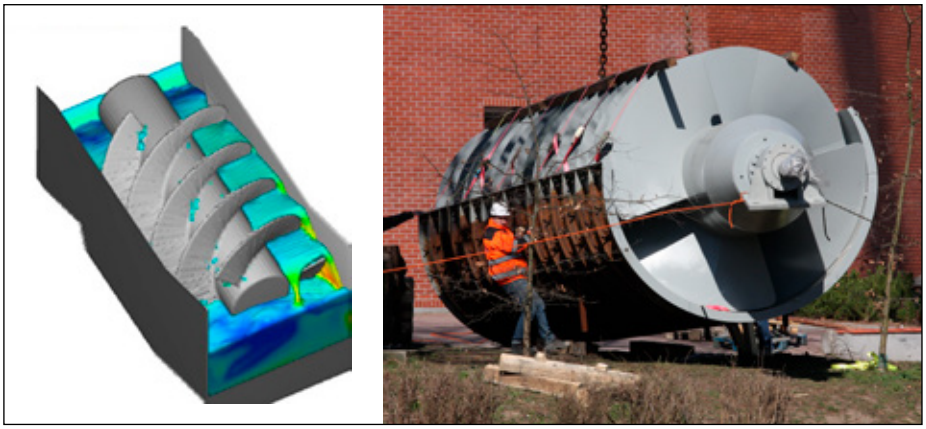
International Water Power & Dam Construction

SIMPLE, VERSATILE ARCHIMEDEAN SCREW – EXAMPLES OF APPLICATIONS

It might seem that the Archimedean screw is a device of very simple structure, and can be designed and made without a lot of knowledge and experience in this field. Nothing could be further from the truth. This is, unfortunately, shown by certain implementations in the domestic and foreign market, struggling with the issues of low power efficiency, failure frequency, premature bearing damage, or even motor shaft break-off.

Many years of research works in the scope of design and optimization of the Archimedean screw parameters allowed Energo Energy to market professional and proven solutions. Thanks to a modern technology of designing mechanical systems and structures, as well as simulations in the scope of fluid dynamics (CFD – Computational Fluid Dynamics), and first of all thanks to the experienced staff, the solutions proposed are characterized by low failure rate and high efficiency.

Fig. 1. From the left: an Archimedean screw model in the FLOW-3D software, preparations for installation.



The tests and simulations included and entire package of technical and technological solutions, which are significant from the perspective of safety and proper operation of the system.

The Archimedean screw technology finds applications in various branches of the economy. It was first used in farming, where these devices were part of the irrigation systems. Currently, they are most commonly applied in small water power engineering, and are used to generate energy.

Turbine-generator units with Archimedean screws are distinguished by the following parameters and properties:

- head/difference of levels and their variability
- flow rate,
- runner and coil diameter
- upper and lower runner priming
- lead and number of coils
- archimedean screw foundation angle and rotational speed,
- solutions in the scope of bearings in the upper and lower node,
- power transmission system with very high torques,
- automation and control of the entire system, including frequency converters for automatic change of the rotational speed.

Many years of research and development carried out at Enerko Energy Sp. z o.o. guarantee that the offered Archimedean screw solutions are characterized by high quality and efficiency.

ARCHIMEDEAN SCREW – SINGLE-RUNNER SCREW PUMP

The Archimedean screw pumps are lifting devices, perfect for transporting sewage, e.g. in waste treatment plants. The Archimedean screw can simply and reliably transfer high volumes at low rotational speeds. The open structure with large spaces between the runner threads ensures constant operation even in very difficult condition, where solid fractions and impurities are present. This technology is widely used in pumping systems in waste treatment plants around the world. A dozen or so such applications are present in our country as well. One of them is the Water Treatment Plant „Ruptawa" – the main treatment plant of the Jastrzebie-Zdroj conurbation. The pumping station, equipped with three identical Archimedean screws, with wormwheel length of 12.4 m and rotational speed of 47.5 rpm, can transport, in total, 1,200 l/s to the height of 5.8 m. Currently, the pumping station is being modernized, in order to automate the process, increase the energy efficiency of the entire system, and to ensure continued failure-free operation in the years to come. The supplier of the new device, a Polish designer and manufacturer Enerko Energy Sp. z o.o., provided a complete solution, additionally equipped with an inverter for automatic rotation control and reverse rotation lock. The runner system, upper and lower bearing solutions and electric equipment were designed individually for a long period of failure-free operation in very difficult conditions of feeding content to the waste treatment plant.

SMALL WATER POWER ENGINEERING

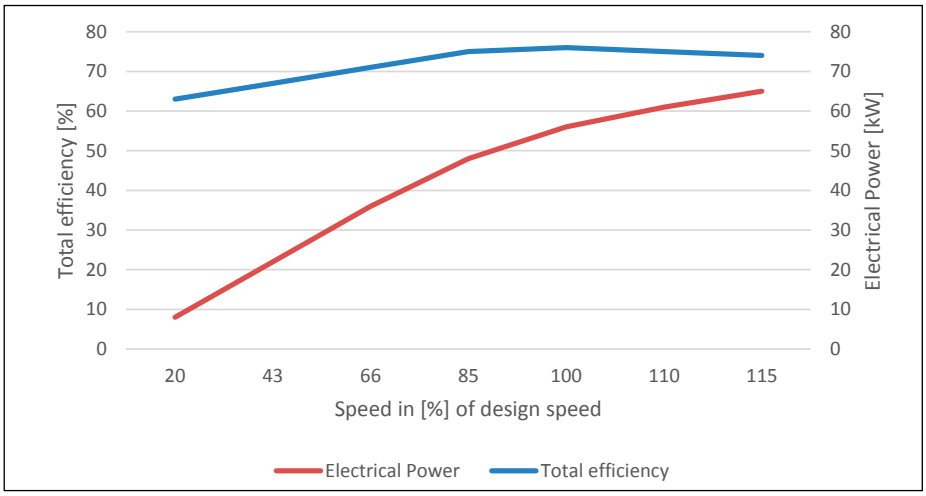
In the 1990s, the idea of the Archimedean screw as a gravitational water engine was developed – just like an overshot water wheel. This is the most efficient device among all the gravitational water engines. Low rotational speed and large spaces between the threads of the runner pose no harm for the fish moving inside. This technology is classified as „fish-friendly" and can be used in locations with very high natural values and in protected areas.

In our country, there are hundreds of places the parameters of which (head and flow) make it possible to use the water power potential and generate green energy, with relatively low investment expenditure.

Application of the Archimedean screw in small water power engineering is currently

becoming increasingly popular. One of the advantages of this low-head technology over traditional solutions, e.g. using the Kaplan turbine, is that the earthworks and hydrotechnical works are limited to the minimum. A small water-power plant equipped with an Archimedean screw is highly efficient, while using a frequency inverter to change the rotational speed additionally expands the operating range with a good efficiency and increases the electricity output. One of the examples of such a solution is a small water-power plant, located at a small river of Bobrza, in the Checiny-Kielce Protected Landscape Area and the buffer zone of the Checiny-Kielce Landscape Park. The Archimedean screw, 2,600 mm in diameter, operates in a very broad range of rotational speeds, between 20 and 115 per cent of the rated speed of the device. This range of adjustment enables efficient use of the river flows, while keeping the water elevation at a constant level. The inverter system slightly increases the cost of the entire system, but ensures production of electricity at a very high efficiency level, in a wide range of flows, as well as very smooth operation, which minimizes its environmental impact. The following chart shows the operational characteristics of a water-power plant fitted with an Archimedean screw working together with a frequency inverter.

Fig. 2. Performance curves of an Archimedean screw with inverter



ACTIVE FISH PASS

Using its long-standing experience in the industry, the company continuously makes efforts to ensure the solutions it offers are appealing to the investors, adapted to the actual needs of the sector, but also environmentally friendly. After years of observing barriers which curb the development of the water-power engineering industry, using its interdisciplinary design team, the company decided to develop an innovative product – an active fish pass. The device was created following multi-stage industrial studies as well as research and development works. The active fish pass is a mechanical device which changes the approach to clearing water courses, not only near the existing water-power plants. The fish pass consists of a system of two Archimedean screws – two tracks. The ascending track transports the water and the fish upriver, while the descending track – downriver, simultaneously generating power, part of which is used to drive the ascending track, while the rest can be transmitted to the power grid in the form of electricity. In reality, the descending track generates several times the power needed to supply the ascending track. This technology, developed in the Polish conditions, reveals a new approach to clearing water courses. For the first time in history, a fish pass becomes a profitable investment. The excess electricity can be used to generate a positive money flow. In Poland, the first installation of this kind was built on the Wierzyca River. The active fish pass can generate surplus electricity of 9,000 MWh per year. According to the national legislation, the active fish pass is a water-power installation eligible for support as part of the feed-in tariff scheme FIT for a period of fifteen years. The active fish pass can be used to utilize an environmental flow or to clear a water course next to an existing water-power plant; it can also operate independently as a small water-power plant. Currently, other projects of this sort are being developed in Poland and abroad.

Fig. 3. From the left: an active fish pass model in the FLOW-3D software, example of an active installation.

An Archimedean screw is a simple construction which, if properly designed, ensures failure-free operation for a very long period of time. This device can be used in many areas of the human activity, from waste pumping stations, feeders, water-power plants, fish passes, to agriculture or recreation. According to the current trends, Archimedean screws are now the most popular in small water-power plants, where, due to technical parameters or environmental requirements, they are the only possible and environmentally-neutral solution. The active fish pass technology is a comprehensive solution for the issues of biological passability of water courses, while simultaneously generating eco-friendly electrical power.

Łukasz Kalina
Business Development Director
Energo Energy Sp. z o. o.

Photos and graphics come from the archives of **Enerko Energy Sp. z o. o.** company.

The article was prepared on the basis of a paper presented during the 9th edition of the Polish Hydropower Conference HYDROFORUM

REDUCING MAINTENANCE WITH WATER LUBRICATED **TURBINE GUIDE BEARINGS**

Water lubricated turbine guide bearings can provide an effective solution for reducing maintenance costs and downtime associated with keeping older turbines running reliably. Significant operating and economic benefits can be realized by replacing a poorly functioning or damaged oil lubricated turbine guide bearing with a water lubricated design, as part of a refurbishment or overhaul project.

Future maintenance will be simplified since the water lubricated bearing allows the shaft seal assembly and the turbine guide bearing to be arranged much more efficiently. The seal assembly can be easily accessed, the oil sump and lubrication system will be replaced with a simpler water supply system, and the bearing itself can be quickly inspected or replaced, in case of damage, by renewing only the non-metallic bearing insert in a few hours. Moreover, there will be no danger of leaking oil into the river, eliminating pollution risk at its source. The first case study presented is a Francis turbine owned by a large Spanish utility, originally built in 1958 and upgraded with a water lubricated turbine guide bearing in 2015, currently fully operational. The second case study comes from a large utility in Italy where in 2016, a similar upgrade was made to a water lubricated turbine guide bearing on a Kaplan turbine originally built in 1956, also now fully operational.

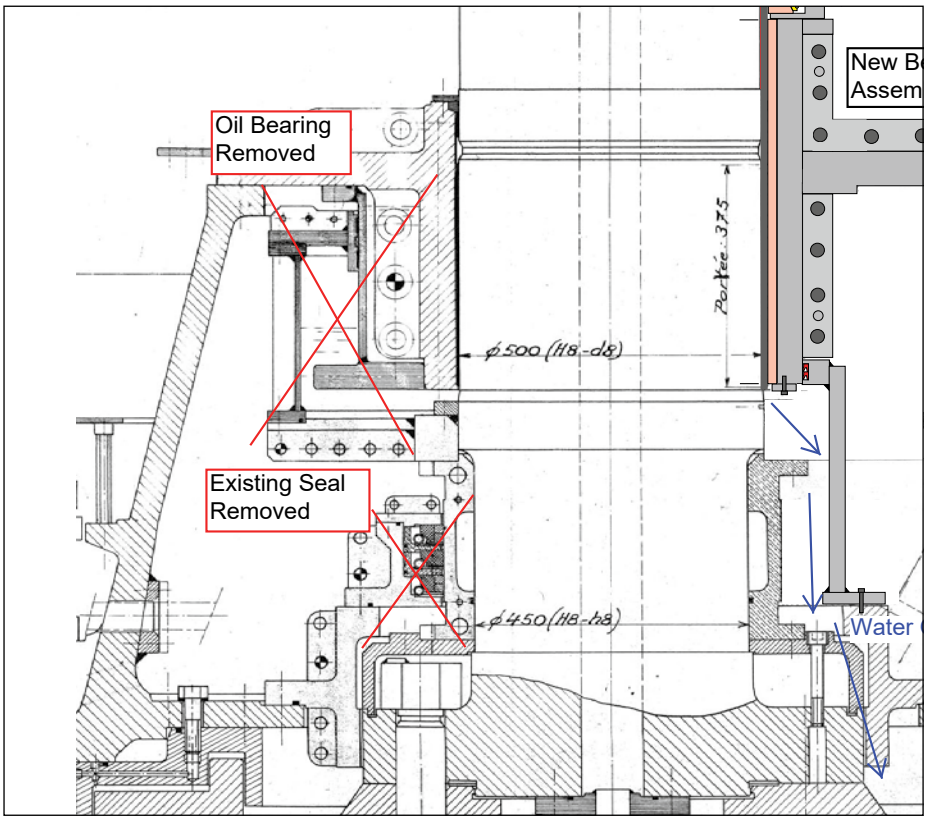
C.H. DE PRADA

The C.H. de Prada power station is owned by a large Spanish utility, and was originally built in 1958 with two 36 MW vertical Francis turbines supplied by Neyrpic, operating at 600 rpm and 308 m head. The original turbine guide bearing was an oil lubricated Babbitt design, with a conventional radial shaft seal using carbon graphite segments located below the oil lubricated bearing.

IMPLEMENTED SOLUTION – DESIGN DETAILS

In order to select the most suitable design, investigation at the site was undertaken in 2015. After reviewing the site data, it was decided to proceed with the general concept presented in Figure 1. Working together with a local Spanish workshop, the final assembly design was developed and a detailed bearing and shaft seal drawing set was prepared. The Thordon SXL elastomer bearing was installed inside of a newly fabricated steel housing made of AISI304 stainless steel. A bonded fit design was used with careful preparation of the housing and use of an epoxy adhesive.

Fig. 1. Conversion Concept - CH de Prada



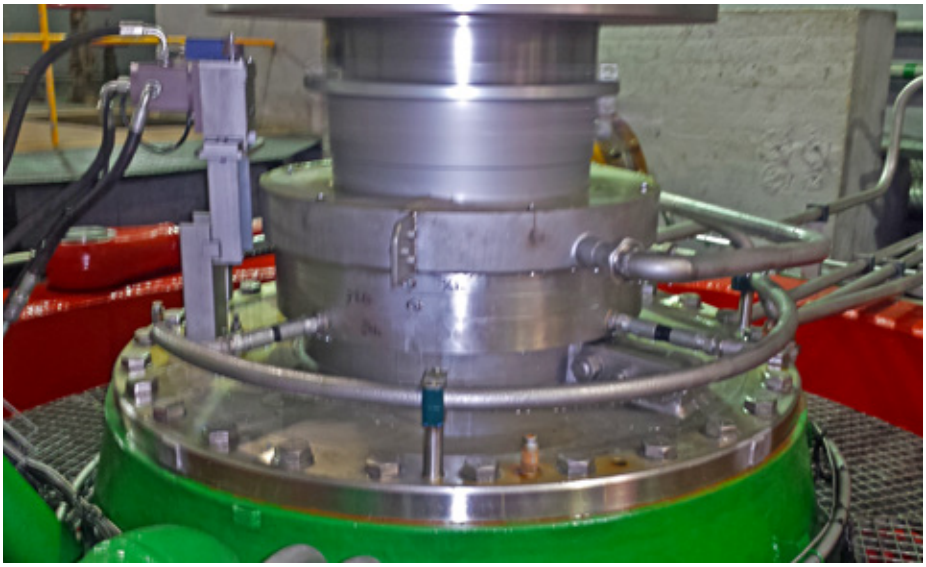
In order to protect the existing turbine shaft against corrosion after eliminating the oil from the system, shaft metallization was done in several areas along the shaft. A high hardness HVOF coating was applied in the active seal area on the shaft to eliminate risk of wearing of the shaft from seal contact, with a slightly softer 420 grade stainless steel metallization applied in the bearing area. The shaft was removed from the unit and taken to a workshop for this work to be carried out.

Water for bearing cooling & lubrication was supplied above the bearing and below the shaft seal at a flow rate of 150 – 180 L/min, with a minimum pressure of 2 bar in order to ensure positive water flow direction through the bearing at all times. The water system utilized a self-cleaning cyclone type prefilter, followed by a double inline filter of 60 micron. A pressure regulating valve was incorporated to reduce and control water supply pressure, and a flow control valve was included to allow the correct flow rate to be achieved. The control system was configured to confirm correct water flow & pressure as a pre-condition to allow unit start-up.

FINAL RESULT & CURRENT STATUS

After completing the fabrication of all components, the bearing and shaft seal

Fig. 2. Completed Assembly



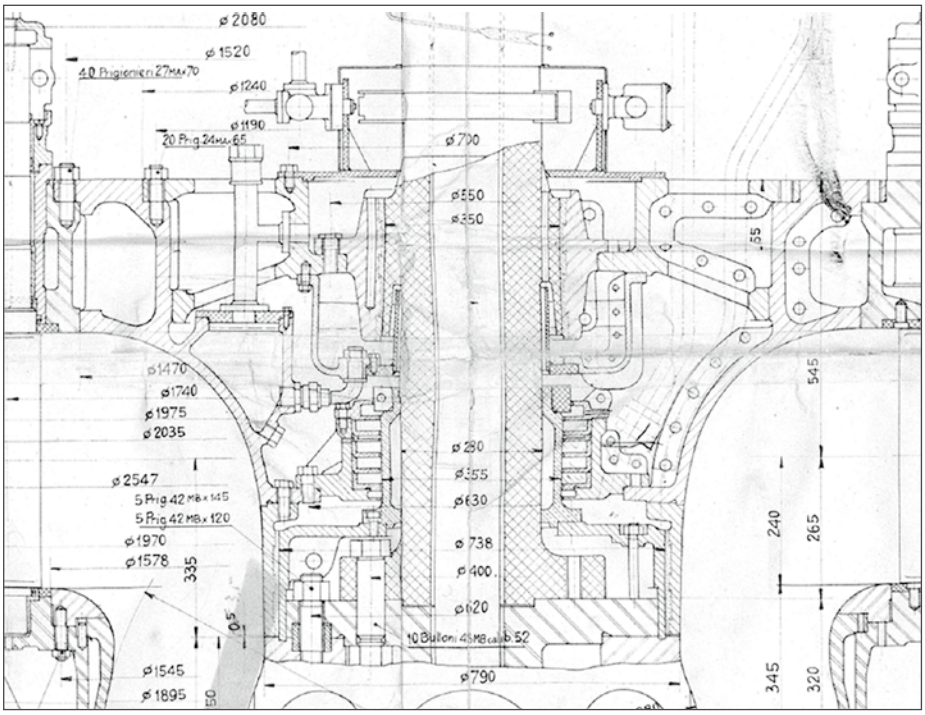
were installed successfully at the site in November of 2015.

In December 2015, the unit was re-started with the new water lubricated turbine bearing. It continues to run well today. In May 2016, Thordon worked again with the same customer and the local workshop to perform a similar conversion on the second unit at the same power station, so that now both turbines are working with an environmentally friendly water lubricated bearing solution with easy maintenance accessibility and zero risk of bearing related oil leakage.

CENTRALE DI FABBRICHE

The Centrale di Fabbriche power station is owned by a large utility in Italy, and was originally built in 1955 with one 15 MW vertical Kaplan turbine supplied by RIVA, operating at 430 rpm and 30 m head. The original turbine guide bearing was an oil lubricated Babbitt design, with a conventional radial shaft seal using multiple rings of carbon graphite segments located below the oil bearing. In 2014, discussions were focused on finding a way to improve access to the shaft seal. In the original design, any problems encountered with the shaft seal were very difficult and time consuming to resolve since it would require a complete disassembly of the oil lubricated turbine guide bearing. Water lubricated bearings could resolve the problem, so several design concepts were developed for review. The most suitable concept was similar to the previous case study, with complete elimination of the existing oil bearing and shaft seal, being replaced by a new water lubricated bearing and shaft seal mounted above the bearing assembly.

Fig. 3. Original Bearing & Shaft Seal – Centrale di Fabbriche



IMPLEMENTED SOLUTION – DESIGN DETAILS

Although the general concept was similar to the previous case study, there were a few notable differences in this case. Rather than securing the elastomer bearing material by bonding, in this project the bearing was installed using a tapered keyset design to create an interference fit between the bearing and the steel housing to allow for easy servicing of the water lubricated bearing inserts, reducing downtime associated with any bearing problems that may be encountered in the future.

The filtered water system configuration was also slightly different, with water entering the assembly below the bearing and moving upwards through the bearing to the shaft seal. Some minor leakage was expected through the runner gap and also through the shaft seal, but this configuration created a semi-closed loop system that reduced the total consumption of clean water while still maintaining the minimum required flow rate required through the bearing space to cool and lubricate the bearing. The shaft was protected using a split and bolted stainless steel shaft sleeve that could be removed if needed, rather than the permanent metallization approach that was utilized in the first case study. The disadvantage of using a bolted sleeve was that it increased the diameter over the shaft and therefore the bearing and housing must be correspondingly larger in diameter.

FINAL RESULT & CURRENT STATUS

After completing the fabrication of all components in late 2015, the new water lubricated bearing and shaft seal were installed successfully in March 2016. Initial trials went well with a planned stop for inspection several weeks after the initial start-up. The unit was stopped to inspect the bearing and shaft seal. It was initially observed that the water leakage from the shaft seal was high, but after investigation it was discovered that there was a problem with the orientation of the seal segments and after correcting this the leakage stabilized at an acceptable rate of <10 L/min.

Fig. 4. Installed Bearing & Seal

CONCLUSION

Water lubricated bearings have been used successfully in practice around the world since the earliest installations of hydro turbines utilizing wooden blocks or staves to support the turbine shafts, then evolving toward rubber, and eventually utilizing advanced synthetic elastomer materials. The water lubricated bearing technology is suitable for Francis or Kaplan turbines in vertical or horizontal configurations, provided the different design considerations are understood. As illustrated by the two case study projects, it is clear that conversion of turbine guide bearings from oil to water lubrication is a technically and economically feasible solution. Thordon Bearings has long been at the forefront of providing premium bearing and seal systems for water lubricated applications. With these recent conversions in Italy and Spain, Thordon has continued to demonstrate that a water lubricated design can eliminate risk of turbine oil leakage, as well as solve ongoing maintenance and repair problems associated with older equipment.

Greg Auger
Hydro Business Unit Manager
Thordon Bearings Inc.

Guojun Ren
Chief Research Engineer
Thordon Bearings Inc.

Photos and graphics come from the archives of **Thordon Bearings Inc.** company.

References

1. Kovalev, N. N.; Hydroturbines, Design and Construction, Israel Program for Scientific Translations Jerusalem, 1965, Translated from Russian by M. Segal,Mech. Eng.
2. Orndorff, Roy L. JR, Water-Lubricated Rubber Bearings, History and New Development, Naval Engineers Journal, November 1985, pp 39 – 52
3. Foulk, John M.; Water Lubricated Rubber Bearings: A brief overview of history, application guidelines and recent advancements, Presentation on Gulf Section of the Society of Naval Architects and Marine Engineers, April 18, 1986
4. T. L. Daugherty, N. T. Sides, DavidW. Taylor, Frictional Characteristics of Water-Lubricated Compliant-Surface Stave Bearings, ASLE Transactions, Volume 24, 3. pp 293 - 301
5. Abramovitz, Stanley, Water-Lubricated Fluid Film Bearings Can be Trouble Free, Pump and Systems Magazine September 1997, pp 1 – 4
6. Bharat Bhushan, Frank Dashnaw, Material Study for Advanced Stern-Tube Bearings and Face Seals, Tribology Transactions, 24:3, pp 398 —409
7. Ren, Guojun (Gary), Auger, Greg; Water Film Stiffness and Damping Analysis of Water Lubricated Bearings with Multiple Axial Grooves for Hydro Turbines, International Conference Hydro 2016, on 10 to 12 October, 2016, Montreux, Switzerland
8. D L Cabrera, N H Woolley, D R Allanson, and Y D Tridimas, Film pressure distribution in water-lubricated rubber journal bearings, Proc. IMechE Vol. 219 Part J: J. Engineering Tribology, pp 125 – 132
9. Nan Wang, Qingfeng Meng, Pengpeng Wang, Tao Geng, Xiaoyang Yuan, Experimental Research on Film Pressure Distribution of Water-Lubricated Rubber Bearing with Multiaxial Grooves, Journal of Fluids Engineering, Transactions of ASME, August 2013, Vol. 135
10. B. M. Ginzburg, D. G. Tochil'nikov, V. E. Bakhareva, A. V. Anisimov, and O. F. Kireenko, Polymeric Materials for Water-Lubricated Plain Bearings, ISSN 1070-4272. Russian Journal of Applied Chemistry, 2006, Vol. 79, No. 5, pp 695-706
11. Ren, Guojun (Gary), Ogle, Ken; Hydro-Turbine Main Shaft Axial Seals of Elastic Polymer– Principle and Practice, International Waterpower Conference, Spokane, Washington, U.S.A., July 2009

HYDRO FORUM

The article was prepared on the basis of a paper presented during the 9th edition of the Polish Hydropower Conference HYDROFORUM

WEB-BASED ATLAS OF MICRO-HYDRO INVENTORY **IN URBAN WATER NETWORKS**

Since the second half of 2018 an international consortium involving representatives of Spain, Lithuania and Poland is in engaged in a European Commission Life NEXUS project. The aim of the project is to promote recovery of energy lost in the municipal and industrial water cycles.

The use of hydropower associated with impoundment of natural rivers is a well-established and matured technology, the hydropower resources are well assessed and this kind of power generation is widespread worldwide. It is the conventional or pure hydropower that exploits the potential energy of stream flows and is considered as a renewable energy source. In a similar way can be assessed the potential energy present in flow of urban water networks, be it water supply, sewage collection and treatment or excess pressure from industrial installations. In contrast to the former, there might be raised the question of the renewable energy status.

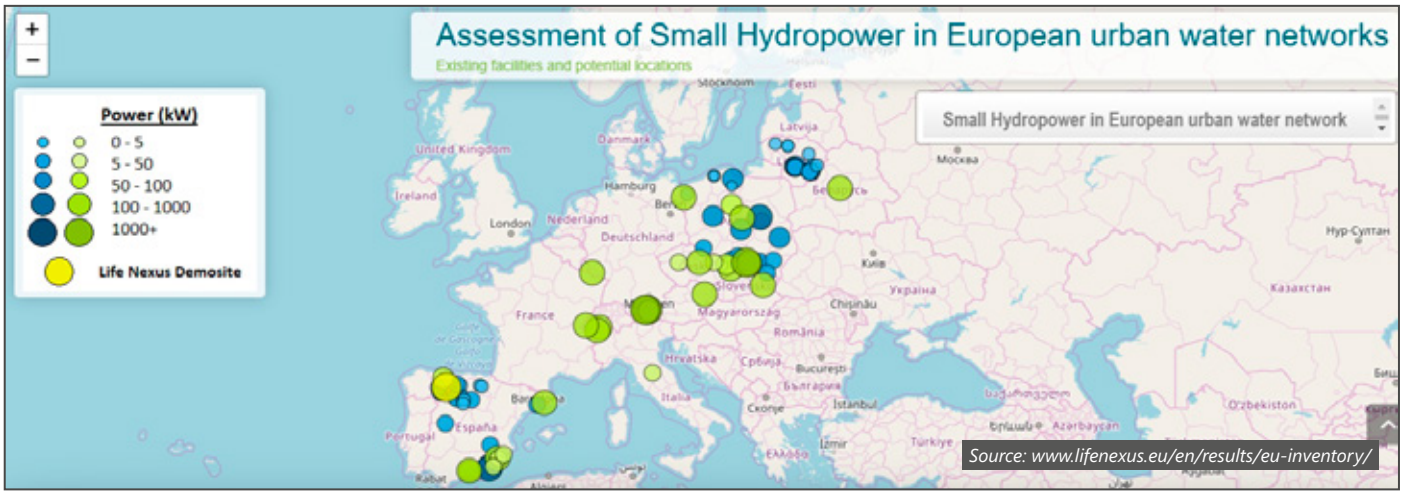
DORMANT POTENTIAL

Urban water management is clearly known to be very energy intensive. Therefore, the harnessing of the potential energy residing in gravity fed networks or excessive pressure installations (e. g. pressure reducing valves -PRV or break pressure tanks - BPT) is of great importance. One of the first aims is to evaluate the resources of this "sleeping" potential. This assessment does not require any sophisticated method, in the past they were considered in a number of studies [1-4]. Commonly it is known, that conventional hydroturbine technologies are not always competitive on the market and to offset this drawback low cost generators - pump as turbine (PaT) are suggested [5-7].

PRELIMINARY RESULTS

This paper presents the partial results of the ongoing EU LIFE NEXUS project performed by the consortium consisting of Spain, Poland and Lithuania [8]. The project aims to explore the potential for micro-hydropower energy recovery along urban water cycle in selected European cities. The one outcome of this action has been the creation of a Geo-database and geographical representation with new potential energy recovery locations and existing hydropower installations operating in selected European

Fig.1. Visualisation of micro-hydro potential locations in urban water networks



countries [9]. The information contained in this database is georeferenced, mapped in layers according to their location and is accessible through a web platform (Fig.1). This mapping would be important because it is publicly available enabling any party to see where the sites with potential lie and therefore make it easier for them to identify and launch a project development.

LITHUANIA

Due to the country's topographic conditions – a purely lowland country, only sewage (wastewater) networks with free gravitational flow can be attractive for the harvesting water energy. Drinking water distribution systems are artificially pressurised and cannot be used for energy recovery. The urban water networks of the two largest country's cities - the capital Vilnius and Kaunas were studied in depth along with a dozen smaller towns. So far, some 17 potential sites with their main characteristics were identified upstream or downstream waste water treatment plants (WWTP). All of the power capacities are below 100 kW (2 of them below 10 kW). No existing hydropower plants operating in water and waste water infrastructure identified so far in the country.

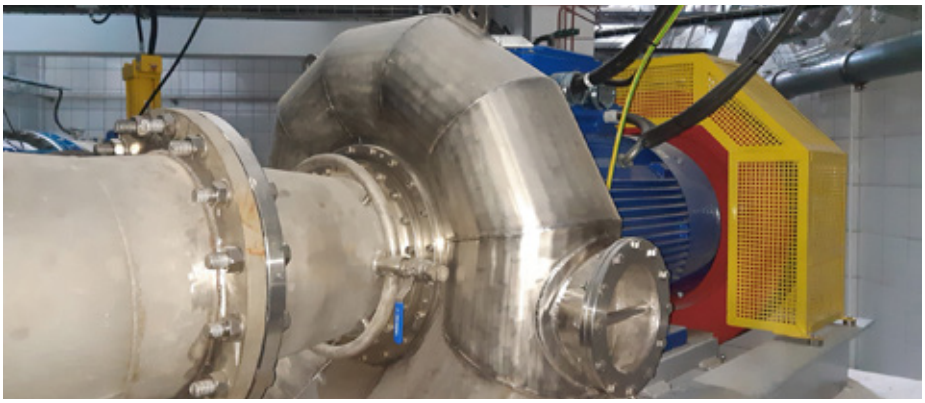
POLAND

20 potential sites were identified; most of them could be located in the sewage networks and WWTPs with free gravitational flows. Most of the power capacities are below 100 kW (4 of them bellow 5 kW). However, there are 2 potential sites very promising with 201 and 525 kW located in WWTPs (upstream or downstream) and a storage reservoir respectively. Regarding the existing facilities, 4 hydraulic energy recovery installations are currently under operation in the urban water network in Poland.

SPAIN.

4 potential sites have been identified in Spain and all of them are located at the entrance of the water distribution networks. Three of sites are PRV devices, while the other is a BPT. Approximate power capacities are in the interval 36 – 74 kW. A number of 9 hydraulic energy recovery installations are operating in the country, including the LIFE NEXUS demonstration site in Leon, involving a PaT machine. 8 of the facilities are micro-hydropower installations (power capacity in the range of 11-84 kW), with 7 PaT machines and 1 cross-flow turbine. Regarding the location in the urban water cycle, most of them are at the entrance to the drinking water distribution network, entrance pipeline to the drinking water treatment plant (DWTP) and in the outlet pipeline of the DWTP. Finally, there is the energy recovery device (Pelton turbine) in a desalination plant with a power capacity of 514 kW.

Fig.2. Francis turbine installed at the inlet to the water treatment station in Pomorzany near Szczecin.



Source: Maciej Kaniecki, ZRE Gdańsk S.A.

Raquel M. López Fernández, Víctor Iván Serna González
Energy Division, Technology Centre CARTIF,
Valladolid, Spain

Petras Punys, Algirdas Radzevičius
Faculty of Water & Land Management of Vytautas
Magnus University, Kaunas, Lithuania

Janusz Steller, Julita Jagielska
Centre for Hydrodynamics of the Institute of Fluid-Flow
Machinery of the Polish Academy of Sciences,
Gdansk, Poland

References

1. ESHA, Mhylab et al.: Energy recovery in existing infrastructures with small hydropower plants. Multipurpose Schemes – Overview and Examples. FP6, SHAPES, 2010.
2. Choulot, A., Denis, V., Punys. P.: Integration of Small Hydro Turbines into Existing Water Infrastructures. Hydropower – Practice and Application. Rijeka. InTech, 2012. pp. 239-276.
3. Bousquet, C., Samora, I., Manso, P., Rossi, L., Heller, P., Schleiss, A.J.: Assessment of hydropower potential in wastewater systems and application to Switzerland. Renewable Energy 113, 2017, pp. 64-73.
4. Gallagher, J., Harris, I.M., Packwood, A.J., McNabola, A., Williams, A.P.: A strategic assessment of micro-hydropower in the UK and Irish water industry: Identifying technical and economic constraints. Renewable Energy 81, 2015, pp. 808-815.
5. Williams A: Pumps as Turbines – A User´s Guide. ITDG Publishing, London, 2nd ed., 2003.
6. Steller, J., Adamkowski, A., Stankiewicz, Z., Lojek, A., Rduch, J. & Zarzycki, M.: Pumps as Turbines for Hydraulic Energy Recovery and Small Hydropower Purposes in Poland. Proceedings of the International Conference HIDROENERGIA, p. 10, Bled, Slovenia, June 12-13, 2008.
7. De Marchis, M., Milici, B., Volpe, R., Messineo, A.: Energy Saving in Water Distribution Network through Pump as Turbine Generators: Economic and Environmental Analysis. Energies 9, 2016, p.877.
8. LIFE NEXUS project.: European inventory of micro-hydroenergy recovery potential in water industry. 2019. https://www.lifenexus.eu/en/results/eu-inventory/
9. LIFE NEXUS project.: Geo-database of potential energy recovery locations in European urban water network. Deliverable D04. LIFE17 ENV/ES/000252. 2019.

NEW MINISTRIES AND THEIR IMPACT ON THE **RENEWABLE ENERGY SOURCES SECTOR**

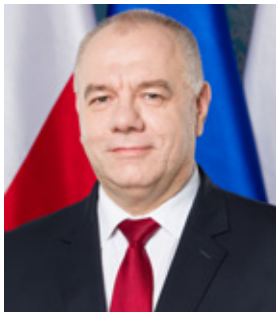
The autumn parliamentary elections have traditionally contributed to ministerial changes, both at personnel and organizational levels. The most important changes from the renewable energy sources (RES) perspective include the liquidation of the Ministry of Energy and the Ministry of the Environment, which have so far focused on key issues related to renewable energy sources. Currently, both liquidated ministries have been replaced by the Ministry of State Assets and the Ministry of Climate, respectively.

On February 29, 2020, an amendment to the Act on government administration departments will enter into force. This amendment introduces key administrative departments from the point of view of the subject - state assets and climate. The Ministry of State Assets was created as a result of a decree of November 19, 2019 of the Council of Ministers amending the decree establishing the Ministry of Energy. As a result of this regulation, the name of the Ministry of Energy was changed to the Ministry of State Assets.

MINISTER OF STATE ASSETS - EXPECTED SCOPE OF DUTIES

Therefore, the decree of the Prime Minister of November 18, 2019 on the detailed scope of activities of the Minister of State Assets seems to be even more important. In accordance with the above, Minister of State Assets manages the departments of public administration such as energy and management of mineral deposits. It should be presumed that in connection with the amendment to the Act on government administration departments, the Minister of State Assets will deal with matters falling within the department of state assets, i.e. matters relating to the management of state property, including the exercise of property and personal rights of the State Treasury, as well as protection interests of the Treasury - with the exception of matters which are assigned to other departments under separate provisions. In addition, the minister competent for state assets may initiate a state policy regarding the use of state property to ensure its rational and effective use, increase its value and implement the state's economic policy. As of the day of writing this article, there were no formal grounds for transferring this branch of administration to the Minister of State Assets.

From left: Jacek Sasin - Minister of State Assets, Michał Kurtyka - Minister of Climate, Ireneusz Zyska - Government Proxy for Renewable Energy Sources



Source: Ministry of State Assets, Ministry of Climate

ENERGY DEPARTMENT INSTEAD OF THE MINISTRY OF ENERGY

The energy department, in accordance with amended the act on government administration departments, covers matters of energy, energy resources and fuels. In particular, matters belong to the minister competent for energy department are:

1. the country's energy policy and participation in shaping the European Union's energy policy;
2. energy markets, energy raw materials and fuels, development and use of nuclear energy for socio-economic needs
3. the country's energy security, including security of energy supply, energy raw materials and fuels;
4. energy infrastructure, including the functioning of energy systems, with the consideration of principles of rational economy and the country's energy security needs;
5. initiating, coordinating and supervising international cooperation in the field of energy, energy raw materials and fuels, and participating in the work of the bodies of the European Union.

On the website of the Ministry of State Assets, in the "what we do" tab, in relation to renewable energy, you can find the following information: "The Ministry of Energy makes efforts to ensure that the renewable energy support system is beneficial from the point of view of the needs of the state, citizens and support various technologies. We want to support such forms of energy production that ensure stable supplies. We have prepared an act supporting Poles who want to produce energy for their needs. Its clear definition of the concept of prosumer granted citizens interested in renewable energy activities far-reaching protection resulting from the provisions on competition and consumer protection. The prosumer has been equipped with mechanisms to assert his rights. The system has been simplified and standardized.

We have also created the possibility of producing and using energy for citizens, schools, hospitals and public utilities. In this way, we want to develop civic energy. We are also developing energy clusters. Combining various renewable energy technologies, clusters ensure stable energy supplies. They also guarantee energy self-sufficiency at the poviat, commune or town level."[1]

NATIONAL PLAN FOR ENERGY AND CLIMATE

In addition, Miniter of State Assets has developed and forwarded to the European Commission the National plan for energy and climate for 2021-2030 assuming, among others:

[1] Source: www.gov.pl/web/aktywa-panstwowe/energetyka-odnawialna-i-rozproszona

a) 7% reduction in greenhouse gas emissions in non-ETS sectors compared to 2005 levels,
b) 21-23% share of renewable energy sources in final gross energy consumption (the 23% target will be achievable if additional EU funds are allocated to Poland, including those intended for a fair transformation), taking into account:
   - 14% share of renewable energy sources in transport,
   - annual increase in the share of renewable energy in heating and cooling by 1.1 percentage point percent. on average,
c) increase in energy efficiency by 23% compared to PRIMES2007 forecasts,
d) reduction to 56-60% of coal in electricity production.

Jacek Sasin, not yet associated with the energy sector, has become the Minister of State Assets. In addition, the Ministry's management includes Artur Soboń, Janusz Kowalski, Adam Gawęda, Maciej Małecki, Tomasz Szczegielniak, Zbigniew Gryglas and Tomasz Trautsolt.

THE SCOPE OF ACTIVITIES OF THE MINISTRY OF CLIMATE

The Ministry of Climate is a ministry created to serve the Minister of Climate after changing the name of the Ministry of the Environment, made on the basis of the decree of the Council of Ministers of November 19, 2019 amending the regulation establishing the Ministry of the Environment. Pursuant to the decree of the Prime Minister on the detailed scope of activities of the Minister of Climate of November 18, 2019, this minister is competent to deal with the department of government administration which is environment. The environment department covers matters, among others: protection and shaping of the environment and the rational use of its resources, management of natural resources and control of compliance with the requirements of environmental protection and testing of the state of the environment. According to the information posted on the Ministry's website, "The activities of the Ministry of Climate cover a very wide range of matters, including primarily the protection and rational use of environmental resources - air, animated nature or mineral resources. The environment is also associated with tasks in the field of sustainable development and climate policy, including adaptation to climate change as well as forestry and hunting."[2]

"CLIMATE" SECTION

The amendment to the act on government administration departments also established the "climate" section. In accordance with the amendment, the climate department covers climate issues and sustainable development, including for example:

1. implementation of the European Union climate policy, including the management of funds for the purposes of eco-

[2] Source: www.gov.pl/web/klimat/zalozenia

logical and climate transformation, in particular the management of auctions of greenhouse gas emission allowances and the management of the funds obtained as a result thereof, considering the country's energy security, including the security of energy supplies, energy resources and fuels,
2. supporting, including promotion, eco-innovation and technology, considering the objectives of climate and energy transformation,
3. management and coordination of programs in the field of dissemination, development and promotion of the use of low and zero carbon technologies, in particular in the field of renewable energy sources and transport,
4. development and use of renewable energy sources.

As in the case of the Minister of State Assets, at the time of writing this article, the Minister of Climate does not yet have the tasks of the government administration department entitled climate. However, it should be suspected that shortly after the entry into force of the amendment to the act on government administration departments, relevant ordinances of the Prime Minister on the detailed scope of activities of relevant ministers.

MINISTER OF CLIMATE

Michał Kurtyka became the Minister of Climate, among others from January 2016 he was the secretary of state at the Ministry of Energy, where he was directly responsible for technological development and introducing innovations to the energy sector, implementation of climate and energy policy in the fuel and gas sector, conducting international relations with states and international organizations. He was also responsible for overseeing the state's participation in the largest Polish energy companies in the oil and gas sector, such as Orlen, Lotos and PGNiG. He was the originator of the "Electromobility Development Plan" and then piloted the creation of the Act on electromobility and alternative fuels, thanks to which these forms of transport will be able to develop dynamically.[3]

GOVERNMENT PROXY FOR RES

Therefore, apart from the Minister, the Ministry of Climate does not have strong links with the issue of renewable energy sources, while on 20 January 2020 a decree of the Council of Ministers was issued on the appointment of a government proxy for renewable energy sources, who is the secretary of state at the Ministry of Climate (hereinafter: "Proxy"). Substantive, organizational, legal, technical and office-office services are provided by the Ministry of Climate to the Proxy, just like expenses related to the Proxy's activities are covered from the state budget from the part managed by the Minister of Climate.

The tasks of the Proxy include:
1. coordination of activities aimed at:
   a) development of the use of renewable energy sources, in particular offshore wind energy, agricultural biogas in renewable energy sources installations, bioliquids, biocomponents, liquid fuels and liquid biofuels consumed in transport and alternative fuels,
   b) development of electromobility and energy storage,
   c) improving energy efficiency;
2. developing proposals for actions leading to the achievement of objectives in the field of the share of energy and fuels from renewable energy sources consumed, in the electricity, heat or cold and transport sectors, as well as the use of geothermal resources;
3. identifying and analyzing existing barriers limiting the development of the use of renewable energy sources and presenting proposals for their abolition;
4. developing mechanisms and development directions for the use of specific types of renewable energy sources, including for the needs of low-emission transport and electromobility, implementing the objectives and plans set out in the state's energy policy;
5. analyzing development directions and taking action in the area of using high-temperature reactors
6. initiating and supporting activities aimed at popularizing the use of renewable energy sources, distributed energy, prosumer energy, energy clusters and energy cooperatives;
7. issuing, in consultation with the Minister of Climate, recommendations to government administration bodies and forwarding conclusions and opinions to institutions and entities involved in the implementation of projects and undertakings using renewable energy sources;
8. giving opinions on draft government documents, including draft legal acts that are important for shaping the state's policy in the field of renewable energy sources, prepared by government administration bodies.

In addition, the Proxy may, in consultation with the Minister of Climate, submit to the Council of Ministers for consideration draft of legal acts and other government documents arising from the scope of his tasks. Ireneusz Zyska, legal advisor, founder and chairman of the Parliamentary Mining and Energy Team, which became the nationwide platform of substantive discussion and shaping opinions on the transformation of Polish mining and energy, energy security, use of natural resources, fossil fuels and renewable energy sources, development of electromobility and the use of modern technologies in the process of changes and shaping the Polish power system, including nuclear and distributed energy became the government Proxy for renewable energy.[4]

A WORD OF SUMMARY

To sum up, apart from the appointment of the government Proxy for renewable energy sources, which may indicate increased interest and the special role that renewable energy sources can play in the work of the Sejm of the 9th term, structural changes in the areas of renewable energy ministries make me believe that climate issues, including green energy, will be taken seriously. Michał Kurtyka's appointment for the position of Minister of Climate can be nice, he made himself known as a person seeking optimal solutions for the issues he deals with, the issues of alternative energy sources are also not unknown to him. Therefore, it seems that the changes made do not announce a revolution, although they should be the right step towards strengthening the position of renewable energy sources in the Polish energy sector.

dr Rafał Trzeciakowski
lawyer
Grabowski i Wspólnicy Kancelaria Radców Prawnych sp. k.

[3] Source: www.gov.pl/web/klimat/minister-michal-kurtyka

[4] Source: www.gov.pl/web/klimat/ireneusz-zyska

INDUSTRY CATALOG

SNOWY 2.0 WILL SUPPORT ENERGY **TRANSITION IN AUSTRALIA**

The Fifth Continent has the potential to cover 100 percent of its energy needs from renewable energy sources. Australia intends to achieve the first 50 percent by 2024. How? With support of the pumped storage technology from Voith.

The facts are on the table. In 2018, Australia recognized that something had to be done to make sure the lights wouldn't suddenly go out all over the country. The problem: on account of the great distances across a continent of just under eight million square kilometers, different energy systems, increasing consumption and retiring coal-fired power plants, there was an impending energy crisis on the horizon. At that time, the share of renewable energies from wind, solar, biomass and hydropower stood at only 17 percent of Australian power generation, according to statistics from the Australian Department of the Environment and Energy. Hydropower made up the largest share of this "green electricity" - at 33.0 percent. Half of this amount was generated by the largest group of hydropower plants in the country - the Snowy Mountains Hydroelectric Scheme. The lion's share of Australia's power supplies today is coal-based. The rising contribution of intermittent renewables increases risk of an unstable power grid. It is increasingly difficult to maintain a balance between energy generation and consumption. Pumped storage technology is the solution. After all, it is currently the only long-term, technically proven and economically viable form of energy storage.

The Snowy 2.0 project links the two existing dams in the Snowy Mountains system – Tantangara and Talbingo (the photo shows the Talbingo Reservoir) – to each other by means of subterranean tunnels and a subterranean power plant.

CLIMATE CHANGE CHANGES EVERYTHING

In line with the disconcerting analyses, a change in the mindset among the general public and decision makers also occurred, acknowledging that climate change is threatening life on Planet Earth. The thinly populated continent with around 25.3 million inhabitants (as of April 2019, Australian Bureau of Statistics) is the sixth largest country in the world after Russia, Canada, China, the United States and Brazil. But most of all, this country is one of the most affluent in the world. In 2017, Australia ranked third in the United Nations Development Index, specifically due to its huge mineral deposits. On account of the high amount of fossil fuels extracted, the country is virtually independent of imports of such natural resources. There are no nuclear power plants for electricity generation. The snag: the massive share of fossil fuels leads to huge emissions of greenhouse gases and contributes to global warming. In 1997, Australia was the second to last industrial nation to sign the Kyoto Protocol that came into effect in 2005, the precursor to the Paris Agreement. The declared goal is now to cease wasting the country's own resources, and to use them with more care or find substitutes.

The Paris Agreement is an agreement between the 197 signatory countries to the United Nations Framework Convention on Climate Change (UNFCCC) with the objective of climate protection. The Convention was signed on December 12, 2015

THE RIGHT PLACE AT THE RIGHT TIME

Voith has had operations in Australia and New Zealand for decades. There are more than 80 employees working in Sydney, Brisbane, Perth and Melbourne. Voith opened a branch office in Sydney at the beginning of 2018, with the goal of expanding its local presence in the region. The objective of this new subsidiary is to serve local producers and customers quickly and flexibly, with high- quality products and customized services. Having a representative office in the country helps us understand the geographical conditions, to get a deep insight into the hydropower market and its (legal) peculiarities, and to fulfill the clients' specific needs.

A SUPERLATIVE

The Future Generation Joint Venture and Voith signed an agreement with Snowy Hydro Ltd. to build the Snowy 2.0 scheme in April 2019. The plant will be operated by Snowy Hydro Ltd. Equipped with electrical and mechanical power plant components, Snowy 2.0 is going to be one of the ten largest pumped storage power plants in the world. The gigantic project: the two existing dams in the Snowy Mountains systems with the Tantangara and Talbingo lakes are to be connected to each other by subterranean tunnels and a subterranean power plant with reversible hydraulic units. It should be kept in mind that they are 27 kilometers apart and at different altitudes! The entire power plant is almost one kilometer vertically below the mountain peak. The contract covers the delivery of six Francis type pump-turbines with a total capacity of 2000 MW (turbine mode). The scope of delivery further includes six motor-generators, the auxiliary systems and the entire power plant automation system. The imponderables that could be experienced, however great the effort put into planning, striving for perfection and the most exacting calculations, will be a major challenge. Voith has already successfully managed complex

projects of this kind. But in its specific constellation Snowy 2.0 is unique.

STABILITY AND RELIABILITY

In the meantime, Australia has more than 120 operational hydropower plants with an installed output of just under 8,800 megawatts. The country's hydropower resources are mainly concentrated in the states of Tasmania, New South Wales (NSW) and Victoria. The Snowy Mountains hydropower scheme that covers both NSW and Victoria is Australia's largest hydropower facility. It consists of 16 large dams and nine power plants with a total output of 4,100 megawatts. As investments in renewable energy sources, such as wind and solar power, are constantly on the rise, the demand for pumped storage must increase as a necessary balance to these sources. After all, wind and sunshine are to a certain degree unpredictable. There is at the heart of the innovative pumped storage technology a special asynchronous motor-generator. Its rotational speed is not tied to the line frequency and can be varied. This enables the system to react more quickly and flexibly to active and reactive power demands from the electricity grid. Furthermore, it offers additional stability in the event of a drop in voltage.

THIS IS JUST THE BEGINNING

The Australian government is promoting the expansion of pumped storage throughout the country. For instance, Hydro Tasmania has developed – in cooperation with the Australian Renewable Energy Agency – a concept for the new role that Tasmania is to play on the Australian electricity market. Ideas under review include the expansion of existing hydropower plants and the construction of an additional new pumped storage power plant to make the state the "Battery of the Nation". The country has, however, at least 22,000 lo cations suitable for new pumped storage power plants. This means that Australia has the potential to become a model country for nationwide use of renewable energy sources. With its experience and its hydropower components, Voith is making an important contribution to this development.

FOR THEY KNOW WHAT THEY DO

Voith has been offering everything needed for efficient and pioneering use of hydropower. The portfolio covers all components for large and small-scale hydropower plants as well as pumped storage power plants – from generators, turbines, pumps and automation systems to replacement parts, maintenance and training services, as well as digital solutions for the entire life cycle of the facilities. As long ago as 1937, Voith developed the first single-stage pump-turbine that acted both as a turbine for energy generation and – in reverse – as a pump. Today, almost 200 Voith pump-turbines have been installed worldwide with a total output of more than 25,000 megawatts. At our own locations in Asia, Europe, and in North and South America, we manufacture all components for hydropower ourselves. Furthermore, we are conducting research into tomorrow's means of generating electricity.

STAMINA AND DETERMINATION

The Snowy 2.0 project is the second-largest contract ever received by Voith and a nice example of how perseverance pays off. The tender process took almost two years, a test of patience that will bring benefits for all concerned. Especially for the climate.

Voith Group

The article was originally published in the journal **"Down-to-earth" 2019 / E.**


Source: Axpo

WINTER POWER FROM **A DAM**

Thanks to the sunshine in the Glarus Alps, the photovoltaic plant on the Muttsee dam will deliver a great deal of power, especially during the winter months. Project Manager Christian Heierli explains why this winter power is so important, and why it is not yet clear whether this pioneer facility will be profitable.

Christian, why does it make sense to install a solar plant on the Muttsee dam?
Because the dam is exceptionally well-suited for such an undertaking. We already have existing, developed infrastructure and will not need to build on any new areas. The dam has a southern exposure and gets optimal sunlight. The plant will generate a major portion of its production during the winter months – double the volume of a comparable facility located in Central Switzerland. The plant is situated at an altitude of 2500 metres. At this height, there is less fog and higher production thanks to reflecting snow effects, as well as increased efficiency owing to low temperatures.

Why is it important to produce power during the winter months?
Switzerland consumes more power than it produces during the winter. This situation will intensify in the upcoming years when large-scale power plants are taken off grid here and abroad. There are various scenarios to resolve power shortages during the winter. If available, we can turn to imports, we can increase our seasonal storage, or we can build power plants that are not dependent on weather conditions. An important approach from Axpo's perspective is the development of alpine photovoltaics. We want to prove that this is possible with this plant.

The plant on the Muttsee dam will deliver a large portion of its production during the winter – but in comparison to the large-scale power plants that will be shut down will this really make a difference?
Solar plants in Switzerland are comparatively small depending on their locations. However, the nationwide proportion of solar power has strong development potential. It's true: The plant on the Muttsee dam alone will not make a significant contribution. More such plants need to be built in non-protected areas where the required infrastructure is already in place. We want to prove that this is possible with the project.

What exactly will be mounted on the dam?
The projects foresees a plant with an installed capacity of 2 megawatts and an annual production of 2.7 gigawatt-hours, corresponding to the power consumption of about 600 average four-person households. We will install about 6,000 solar modules on a surface of 10,000 square metres. The plant will be installed a good meter away from the dam surface so that the wall remains accessible for maintenance and service.

Construction of the Muttsee dam was completed some time ago. Why has Axpo waited so long with the plans for the solar plant?
The Limmern pumped storage plant that is part of the Muttsee dam will be in test operation until the end of 2019. As a result, the dam will be intensively monitored up until the end of the year. This is why we waited with the solar plant project.

How complicated is it to install a photovoltaic plant on a dam?
Logistically it's quite complex. The dam is not accessible by road. Although there are tunnels from the pumped storage plant to the dam, they are used for maintenance and are unsuitable for transporting construction material. The material is delivered to Tierfehd and then transported to the dam area by helicopter. The time window for the work is very narrow – the plant has to be built during the alpine summer. That's a period of only three months – that's about as long as construction takes.

And the large volumes of snow aren't a problem for plant operation?
Of course, we have to consider snow volumes. The solar plant will be mounted to the dam at a 56-degree angle – steep enough for the snow to slide off. Because of the high snow volumes during the winter, we decided not to install modules on the lowest section of the dam. As a matter of fact, the snow is also helpful. Thanks to the reflection effects it has a positive impact on solar power production.

Will the plant be profitable?
At the moment we cannot say so definitively. We can say it won't be easy. Current subsidies are modest, amounting to less than 15 per cent of the investment costs. Switzerland's subsidy programme is designed for own consumption by home-owners. In Central Switzerland this is quite attractive: Home-owners can replace more costly power from suppliers with inexpensive solar power from their roofs. The costs for the installations can be recovered in 15 to 20 years. However, we have to go to the market with our solar power – and that is more difficult. Currently, we are in negotiations with different potential customers for long-term power purchase agreements. In Portugal, Axpo was able to realise a large-scale solar plant without state subsidies with such an agreement.

Does that mean Axpo will build the plant even if it isn't profitable?
We will be able to determine that once more precise figures are available. It is a pilot project which does not yet exist in such form. What we can say: Axpo wants to build this plant. We assume that the problem of winter electricity will also become a political issue and that Alpine PV will therefore become more important. We want to be one step ahead here.

What would be necessary on a political scale to make the construction of these types of plants more attractive?
We could envision tendering processes like those taking place in France. The Federal Council's efforts are going in that direction at the moment. Switzerland is lagging behind in the expansion of renewables. Last year it was one of the weakest countries in Europe in this respect. And Switzerland does not have enough energy during the winter. We have to decide how we want to handle that. An import strategy is problematic. It makes us dependent and we don't know if there will be sufficient capacities available in the long term. As a result, the winter power problem must be addressed on a political level.

Project lead Christian Heierli on the Muttsee dam

The article was prepared on the basis of a paper presented during the 9th edition of the Polish Hydropower Conference HYDROFORUM

EAST EUROPEAN REGION IN THE WORLD
SMALL HYDROPOWER REPORT 2019

The third edition of the World Small Hydropower Development Report (WSHPDR 2019) is already available from the UNIDO website. The official launch has been scheduled within the framework of the Vienna Energy Forum 2020. The WSHPDR is a unique compendium of knowledge on the global small hydropower status published since 2013 in 3 year intervals by the United Nations Industrial Development Organization (UNIDO, Vienna, Austria) under collaboration with the In-ternational Centre on Small Hydro Power (ICSHP, Hangzhou, China). Two authors of this paper have contributed to the WSHPDR 2019 as authors of regional and national reports whereas the third one was a member of the Editorial Team acting as a UNIDO coordinator.

The WSHPDR 2019 [1] was prepared by an editorial team headed by Professor Liu Heng, senior technical adviser at the UNIDO Department of Energy, Vienna. The document counts 1048 pages and consists of an executive summary (global overview) and 4 continental volumes (Africa, Americas, Asia & Oceania, and Europe) comprising a series of 166 national reports, preceded by 20 regional reports. The local small hydropower status is presented in the rich context of various con-straints such as physiographic conditions, national policy towards the RES sector as well as general situation in the national and/or regional economy, electrical power industry and hydropower sector as a whole. The additional part of the WSHPDR 2019 is the Case Study volume showing various aspects of small hydropower sector in various regions. The enormous analytical work was conducted by over 200 volunteer experts.

The "European volume" is divided into 4 sections, reflecting small hydro situation in the Eastern, Northern, Southern and Western Europe regions, respectively. The division follows the official UN geoscheme [2]. Each section is preceded by a regional introduction comprising summarisation and an overview of some data presented in the country reports. In case of the Eastern Europe, a significant obstacle for any comparative analyses was incorporating into the region the whole Russian Federation and not only its European part. Two authors of this paper were engaged in various way in preparing the East European section for both latest WSHPDR editions. A critical survey of country reports was conducted

SHP Rościno

Source. Robert Zimerski, ENERGA Wytwarzanie S.A.

when preparing the regional introduction. This included comparing the submitted data with those following from other publicly available sources, e.g. [3÷5], and consulting some local experts. The publicly available independent sources were used in particular to derive the statistical data on hydropower sector in the European part of Russian Federation, which enabled to express an independent opinion on the region meant rather as a part of European and not Euroasian continent.

Use has been made also of the proceedings of the latest Polish Hydropower Conferences and the East European Hydropower Forum debates held since 2017 during annual RENEXPO Interhydro events in Salzburg, Austria. The survey has been supplemented by an analytical component prepared using results of the regional hydropower sector overview as prepared for the HYDRO 2018 Conference [6]. Unfortunately, the survey has appeared too extensive as for the WSHPDR 2019 regional introduction needs. Furthermore, some statistical data as established in result of conducted comparative studies and numerous cross-checks have shown differences in respect to those presented in the national reports. Showing the East European data with and without the Asian portion of the Russian Federation has appeared completely incompatible with the UNIDO concept. Under these circumstances, the document was replaced by an abridged text as prepared under collaboration with Ms Oksana Lopatina, member of the ICSHP editorial team. The current East European regional introduction is fully compatible with national reports and follows the templates applied in case of other regions. At the same time, the analytical part had to be minimised. Therefore, the authors of this paper considered it reasonable to publish the results of the study standing in the background in the "Energetyka Wodna" quarterly. Both the head of the WSHPDR 2019 Editorial Team and the "Energetyka Wodna" Editor have welcomed such a proposal.

INTRODUCTION TO THE REGION

The region covers 10 countries representing ca 57% of the European territory (Fig.1) and over one third of European population. At the same time – providing less

Fig. 1. Eastern Europe (EE 10) according to the UN geoscheme [2]

than 15% of the European GDP [7]. All the countries share common history as former Eastern Block members or Soviet republics, which shows still some impact on their political and economic status. However, while Bulgaria, Czech Republic, Hungary, Poland, Romania and Slovakia are members of the European Union, integrated with its structures and legislation system, the situation of the former Soviet republics - Russian Federation (RF), Belarus, Moldova and Ukraine - remains highly differentiated and complex. So far, the electric power systems of Belarus, Moldova and most of Ukraine are operated in parallel with the Unified Power System (UPS) of Russia. Apart from Russian Federation the climate may be described as mild with features of a transitional one in Poland and a continental one in Belarus and Ukraine. Mediterranean like climate prevails at large portions of the Black Sea coast. Moderate precipitation of ca. 600 mm/a is typical for the region although it may exceed substantially 1,000 mm/a in mountain ranges and fall below 400 mm/a in some areas of the Central and East European Plain.

Due to various physiographic conditions the hydropower potential density is highly differentiated. The best conditions are encountered in Romania and Bulgaria. Significant untapped technical potential exists still in Ukraine. With over 50.5 GW installed capacity, including 18.3 GW in its European part Russian Federation uses merely 11.2 and 28.8 per cent of its vast technical potential, respectively. The last assessment excludes the pumped storage in the European part of Russia, but includes almost 2.3 GW hydropower capacities connected to isolated grids in the Eastern Siberia and Far East.

The climate of the European part of Russia varies from the sub-Mediterranean one at the Black Sea coast, through continental one at dry steppes of the Caspian region and most of the East European Plain to the subarctic one in the Far North. A feature distinguishing Russian and Ukrainian hydropower sector from that of most other countries in the region are large hydroelectric schemes erected at grand rivers of Eastern Europe and Siberia, heavily prevailing over SHP installations. Due to vast storage capacities of water reservoirs the pressure on development of classic pumped storage segment was not so strong here as in other countries of the region for a number of years. This is no more the case in Ukraine which proceeds with its pumped storage projects despite prolonged economic and political crisis [8].

The European part of Russian Federation represents almost 40% of the territory of Europe and 70% of the Eastern Europe as defined according to the UN geoscheme. Due to its vast potential, Russia shows also a decisive impact on the regional electrical power and hydropower statistics as discussed in this section. At the same time the European part of Russian Federation represents merely 23% of the whole Russian territory and only 14% of its technically available hydropower potential.

Due to the above reason, the East European statistics is shown below with the European part of Russia data included (EE10) in addition to those of the whole Russia (EE10+). This approach has appeared feasible due to access to the data of all the UPS Russia Operator daughter companies acting in the European part of Russian Federation. In case of the Ural Power System Operator, the total electricity capacity and generation data have been taken solely from the Bashkiria (Ufa), Orenburg and Perm dispatching centres [5]. With exception of the hydropower sector the European part contribution of individual technologies has been assumed proportional to that of the whole electrical power sector. Data from the whole Ural district have been included for the purpose of the European Russia SHP status considerations (see Russia country report). The capacity and generation data of the Zagorsk PSPP (1200 MW and ca. 1.8 TWh, respectively) have been subtracted from those of the UPS Russia reports. The contribution from the isolated grids has been added basing on the available data from the Far North Eastern regions, including those of the most significant large HPPs.

ELECTRICITY SECTOR OVERVIEW

The electrical power network is dominated by the thermal power plants with nuclear sector contributing as much as 30% to the grid. The main nuclear power contributors are Russia and Ukraine. Nuclear sector is the main source of electricity in Bulgaria, Hungary and Slovakia whereas natural gas plants provide so far 95.5% of electricity generated in Belarus. Fossil fuels (coal and lignite) remain the main energy carriers in Poland contributing still by over 85% to the national electricity mix.

As it can be calculated from Table 1, hydropower contributes by 8.6% to the regional electricity mix. This fraction grows to 13.2% in case the whole Russian Federation ter-

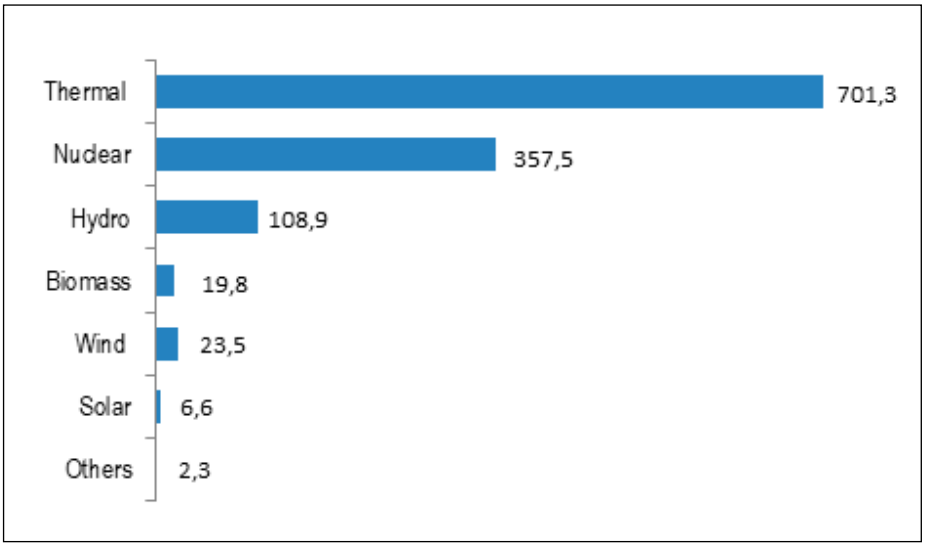
Table 1. Installed power and electricity generation in the East European region in 2018 [1, 3÷6]

Country	Population	Whole power sector		Renewable hydropower		
		Installed power	Generation	Installed power	Generation	
					2018	normalised
	million	GW	TWh	MW	GWh	GWh
Belarus	9.50	9.9	37.9	95	324	292
Bulgaria	7.10	12.5	46.9	2 515	5 146	4 339
Czech Republic	10.61	22.3	88.0	1 618	1 629	2 240
Hungary	9.80	9.2	31.8	57	222	234
Republic of Moldova	3.47	3.0	5.1	64	271	350
Poland	38.42	45.9	165.9	989	1 970	2 311
Romania	19.64	24.6	64.38	6 609	16 805	16 663
Russian Fed. (Europe)	110.00	147.1	631.5	18 355	69 966	65 931
Slovakia	5.44	7.7	27.1	1 819	3 590	4 446
Ukraine	42.42	50.0	159.4	48 19	12 238	11 366
Total with RF (Europe)	**256.40**	**332.2**	**1 258.0**	**36 940**	**112 161**	**108 172**
Russian Fed. (whole)	144.30	248.8	1 109.2	50 500	195 782	186 900
Total with whole RF	**290.70**	**433.9**	**1 735.7**	**69 085**	**237 977**	**229 141**

ritory is taken under consideration. The double-digit hydropower contribution is also a characteristic feature of the electricity mix in Romania (25.9%), Russian Federation (16.8 %), Slovakia (16.4%). At the same time Slovakia, Czech Republic and Ukraine are the countries having already harnessed over 50% of their technical potential - 64.8, 56.9 and 56.8%, respectively. With 46.8% of its potential developed, Romania is on the best road to join the club. The lowest hydropower contribution (below 2%) to the national electrical grid can be stated in Hun-gary (0.7%), Belarus (0.8%) and Poland (1.4%). At the same time Belarus, having tripled its capacities since the previous WSHPDR edition has increased its use of the technical potential up to almost 12%. Rapid increase of hydropower capacities is sometimes considered one of measures adopted in order to diversify Belarus energy market, heavily dependent on the natural gas supplies from Russia. While Belarus is expected to preserve its ties with Russian Federation, Ukraine has already broken the political-economic relationships with her traditional partner and makes significant efforts to join the West European structures. Despite the conflict in the East of the country, with severe impact on the national power sector, Ukraine remains still a significant local exporter of electricity. Ukrainian authorities declare also their commitment to continue developing the hydropower sector - mainly in order to increase the power system flexibility, security and independence. Unclear situation exists also in Moldova - a country torn by internal ethnic and political conflicts. Moldova is in 80% dependent on electricity imports. On the other hand the country has harnessed less than 12% of its technically available hydropower potential and shows slow dynamics in developing the renewable energy sector.

Over the recent decade the region has been showing a moderate growth of 160 MW/a or 0.44%/a of renewable hydropower installed capacities which is rather typical for Europe as a whole. The main contributors have been Russian Federation (60 MW/a), Romania (50 MW/a) and Bulgaria (36 MW/a). The regional growth rate value rises to 500 MW/a or 0.80%/a if the all-Russia data are included instead of those of the European Russia alone. This is due to completing some major projects in the Central and Eastern Siberia, including

Fig. 2. Contribution of various electricity generation technologies and energy carriers to the East European (EE10) electricity mix (TWh/annum), status 2016 [1, 4, 5]



Boguchanskaya HPP (3 GW), commissioning of new units in the ongoing Far East projects and systematic upgrading of the available assets.

Low installed capacity growth rate and high fluctuations in the annual rainfall are the reasons for using the normalised electricity generation instead of the annual generation records in the EU strategic documents. Following the EU 2009/28/EC RES Directive, the normalised electrical energy gen-eration in year N is defined as

$$E_{norm} = \frac{P_N}{15} \sum_{i=N-14}^{N} \frac{E_i}{P_i}$$

where Ei and Pi stand for the annual generation and capacity in year i. The Enorm values for individual countries are shown in the last column and summarised in the last two lines of Table 1. In case of Russian Federation only the 2008-2018 averaging period has been used. While economic constraints may be considered the main factors hampering faster sector growth in Russia, Ukraine and Moldova, environmental policy of the EU and local green movements stand usually behind the slow-down of hydropower growth among its East European members after joining the EU. Green movements take often part in local political campaigns as independent subjects or allow to be used by the main actors of the political arena. Different position of the abovementioned movements and different level of competence among authorities are key factors affecting differentiated interpretation of some European directives and other EU strategic documents. The consequence is diverse approach to the hydropower sector in different EU countries.

Some recently observed positive trends result from the ever better understanding of the climate change consequences and the mitigation and/or adaptation measures required. In practice this implies also better understanding of the need to develop the water and energy storage capacities in order to enhance water balance and increase national grid flexibility - so needed for accommodating the ever higher amount of intermittent renewables. The other opportunity - especially in such countries as Poland, Czech Republic, Slovakia and Romania - is restoration and development of inland navigation routes which requires erecting new multipurpose water barrages.

With rising presence of intermittent electricity sources an important method of increasing stability and safety of national grids within the region is cross-border collaboration between system operators. As mentioned, EU transmission system operators (TSOs) are members of the European Network of TSOs for Electricity (ENTSO-E) [9]. The Network was established and given legal mandates in 2009 by the EU's Third Package for the Internal Energy Market which is a set of two European directives and three regulations. The TSOs of EU members covered by this section and the Power System of Western Ukraine operate within the Continental European synchronous area (previously: UCTE) whereas the United Power System of Russian Federation (UPS) is synchronised with the rest of Ukrainian power grid as well as the power systems of Belarus, Moldova and the ENTSO-E Baltic synchronous area. The ENTSO-E competence and activity goes

TRMEW
OBRÓT

RESPECT ENERGY

100% OF OUR ENERGY IS GREEN!

We have a license for electricity trading and a license for gas trading.
We are a market maker in the Polish Power Exchange (TGE).
We cooperate with the largest group of energy producers who use renewable sources.

WE RESPECT ENERGY:

We RESPECT Poland's renewables energy market.
We RESPECT your business and time.
We RESPECT your need for a trusted partner.
We RESPECT nature.
We RESPECT YOU.

Respect energy with us!

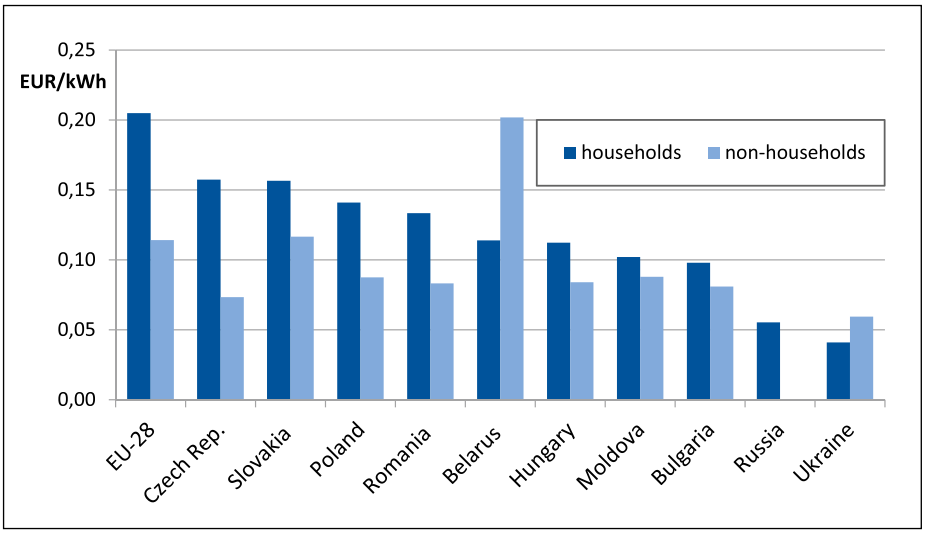
E: contact@respect.energy
W: www.respect.energy
A: TRMEW Obrót S.A. Ludwika Rydygiera 8,
01-793 Warsaw, Poland

RESPECT ENERGY

far beyond developing and updating the network codes. The Pan-European and regional ENTSO-E initiatives are included in the biennially updated Ten Year Network Development Plan (TYNDP) which forms a basis for the Regional Investment Plans and Annual Work Programmes. The TSOs of EU member states within the East European region are active in 3 ENTSO-E regional groups (Baltic Sea, Continental Central East and Continental South East one). An interesting regional initiative of Polish and some Scandinavian TSOs was the so called DC loop flow mechanism for energy transition between synchronous areas. The range of developed regional tools on operational security includes the ENTSO-E Awareness System (EAS) and the set of Regional Security Coordination Initiatives (RSCIs). On the market side, regional TSOs have cooperated to create a common auction office for allocating cross-border transmission capacity. Development of the European Electricity Market is a joint effort of national TSOs and energy regulators co-ordinated by ENTSO-E and the Agency for the Cooperation of Energy Regulators (ACER) [10] in close collaboration with various EU and national institutions. One of key contributors to achievement of the internal energy market is ENTSO-E's Central Information Transparency Platform, which is in constant improvement since its launch in January 2015. The European Electricity Market project is fairly advanced. In the end of 2017 the Electricity Market Coupling Mechanism was already implemented in 5 countries of the region (Czech Republic, Hungary, Poland, Romania and Slovakia).

The retail electricity market is generally governed by the energy regulation offices, usually responsible for both electricity and natural gas branches, sometimes incorporated in larger structures, covering also water management. The structure of tariffs is quite differentiated, but the average prices paid by the household and non-household consumers for electricity - including grid services and taxes - are shown after EUROSTAT and national reports in Fig.3. Generally, the prices for household consumers are lower than the EU-28 average. The lowest prices are to be found in Russia and Ukraine which should however be perceived in the context of the national currency depreciation. In all EU member states the household consumers pay more for electricity than the non-household ones. The true price difference may be even higher than that shown in Fig.3., as most commercial consumers are liable for VAT refunding. Lower prices for residential consumers in Belarus, Ukraine and (probably) Russia result from the socially oriented state policy. The wholesale market has been deregulated in all EU countries and over a major portion of Russian Federation. According to the European Commission DG Energy, in the second quarter of 2018 the average prices among the East European member states varied between 34 €/MWh in Bulgaria and 49 €/MWh in Poland.

Fig. 3. Retail market electricity prices [1,4]



New market mechanisms are planned or have been already implemented in order to improve the safety and flexibility of national electrical grids. These include in particular the electrical power market already in operation in Russia and Bulgaria and just initiated in Poland. Introducing the energy storage market is another option discussed and opening new prospects for the hydropower sector.

RENEWABLE ENERGY POLICY

All countries in the region have implemented their acts of law aimed at promotion of renewable energy sources (RES). However, while diversification of energy sources and the need to increase the energy safety are claimed the main goal in Belarus, Moldova and Ukraine, the need to mitigate the climate change is stressed in EU documents and especially in the 2009/28/EC RES Promotion Directive and the Winter Package [11]. Annex I of the RES Directive imposes target shares of energy from renewable sources in the gross final consumption of energy to be achieved by individual member states till 2020. The member states have been obliged to prepare their national action plans and to report annually on the progress to relevant EU institutions. As it can be seen from Figs 4 and 5 the majority of the member states within the East European region have reached their targets already in the period between 2012 and 2014. Shortly afterwards or already within this period they shrunk their support mechanisms so that the RES share trajectory flattened horizontally. Poland and Slovakia have not achieved their targets till today and there is little chance they will be able to reach them till 2020. In fact, both countries have increased their distance from the targets since 2015. The falling trend has been reverted only in 2018.

Abrupt deceleration of the RES sector growth rate after reaching the target - or even lowering its share in the national energy mix before the target has been reached - puts in question the true commitment of some countries to the long term EU policy on greenhouse gas emissions. Especially, as observation of the regional hydropower sector shows direct relationship between the sector growth and the policy measures implemented at the national level (see: next section and the WSHPDR 2019 country reports).

Unfortunately, public statements of some high ranking politicians within the region show that the whole EU climate policy and especially the national targets are often considered an unjust burden imposed by the officials from Brussels rather than a moral obligation for a joint effort aimed at securing the environmental safety for future generations. Regretfully, this line of thinking has been expressed also in some

Fig.4. Share of RES sector in the consumed energy mix among the East European EU member states [4]

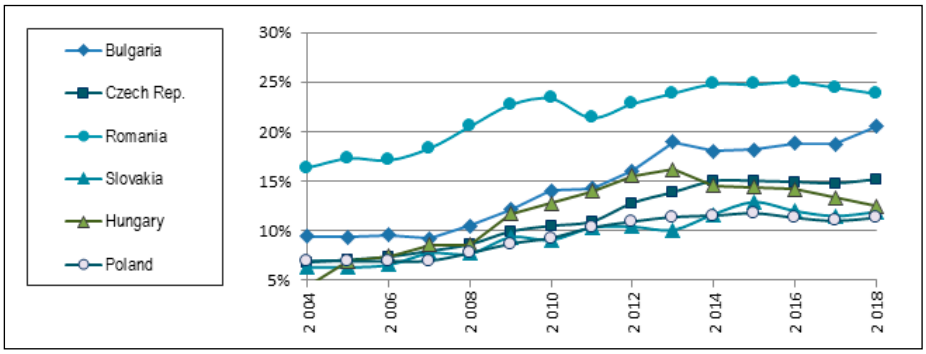
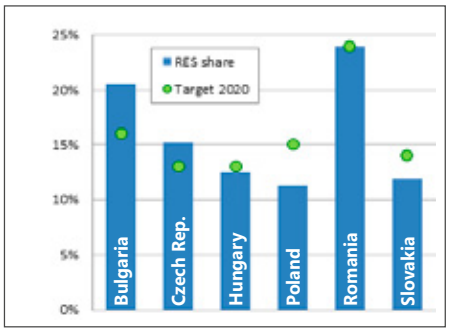


Fig.5. Share of RES sector in the consumed energy mix among the East European EU member states [4]



strategic documents issued by national institutions responsible for the energy sector and reflected in prolonged negotiations on the Green Deal in the end of 2019. Local environmentalists - so effective previously in blocking the hydropower sector - appear unable now to counteract efficiently this kind of policy.

Another feature characteristic for some national renewable energy policies to be observed over the major portion of the passing decade was hampering or even "manual" blocking development of selected technologies while promoting the other ones. Sometimes using environmental arguments, sometimes without explaining any rational reason. The approach may always change with the turn of political power, but the resulting instability is destructive not only for the electricity producers, but also for the whole technological environment. The long-term opinion of high risk among potential investors and financial institutions is also an obvious consequence. There is a general feeling that the individual renewable energy technologies are perceived by national authorities rather as individual actors competing for their role at a stage than a group playing jointly a concert at a nationwide energy scene. Unfortunately, it is hardly possible to convince the key decision makers that hydropower – if properly designed and developed - enables accommodating large amounts of intermittent renewables and harmonising their operation with that of other electricity providers. While it is difficult to explain the reason (short-term political horizon? insuficient competence?), the fact is that the electrochemical storage is often the only and not just an additional energy storage technology taken under consideration during public debates, in strategic programmes and state funded research & development programmes. Despite disproportionately low capacities as compared with hydropower storage and heavy ecological load at the end of the installation lifetime.

An East European country really committed to develop its pumped storage capacities is surely Ukraine. Although the progress has been substantially slowed down in the mid of the decade, the country has defined extremely ambitious development goals in the 2026 perspective. Only in recent time the unofficial signals on possible come back to pumped storage development plans are reported in Poland. The general situation of the hydropower sector remains quite difficult among the East European EU member states. As reported already in the previous WSHPDR edition, implementation of the Water Framework Directive (WFD) and the habitat directives 92/43/EEC and 2009/147/EC has strengthened substantially position of hydropower opponents, some of them requiring stopping any further damming of rivers. For a number of years already some European rivers have been completely exempted from damming, in some other ones major portions of river valleys are considered Natura 2000 areas as established basing on the habitat directives. Erection of hydropower installations very difficult or even impossible. Examples of imposed limitations include Slovakia where erection of several large hydro power plants was still under consideration in the beginning of the decade and Hungary where only 5 to 6 per cent of available potential is planned to be developed.

Nevertheless, some positive signs are coming from the influential circles with direct impact on the Water Framework Directive. While there is little chance for revision of the document, hydropower -

and especially small hydropower - is no more at the "fire line" of European water management experts. According to the European Renewable Energy Federation (EREF) Small Hydropower Chapter, positive opinion on environmental impact of small hydro installations is ever more frequent among the hydrologists. Hydropower is also strongly supported by the Euroelectric Union of the European Electrical Industry. It is difficult to state when - if at all - this positive mood will transpose on the hydropower sector situation in the East European countries. However, as summarised during the recent meetings of European hydropower associations held in Salzburg (Austria), the most severe problems seem to emerge out of national interpretation of the WFD. The very similar conclusion addresses problems linked with implementation of habitat directives and Natura 2000 areas. Probably, the most stable policy is to be observed currently in Russian Federation and Belarus. The modest hydro potential is developed now more or less systematically by economically viable medium size hydropower installations. No financial state support for small hydro is reported from the country. No such support is reported from Moldova either, which prevents development of the smallest projects in this country as well.

The reason for state assistance in developing small hydro in Russia comes most probably from acknowledging various benefits coming from renewables dispersed at the vast territory of the country with a number of remote areas. However, as only a small portion of the available potential has been developed so far, one may expect investors – mainly large companies - to prioritise the most economically viable projects, generally between 5 and 25 MW. As discussed in the next section, auction sys-tem is applied in order to support investment in small hydro (< 25 MW). High pay-back rate (14%) allows for short pay-back period. However, no support is envisaged afterwards. Due to this reason, one can hardly expect developing the smallest installations. The exceptions may include remote areas and highly localised electricity demand.

SMALL HYDROPOWER

Till 2017 the EUROSTAT office published SHARES database with small hydro generation data as divided into two installed capacity categories: up to 1 MW and in the range between 1 MW and 10 MW. This approach allowed often disregarding national legislations which use different capacity limits in the small hydro definition. Most countries within the region use the 10 MW threshold. 5 MW limit is used in Hungary and Poland and 1 MW – in Bulgaria. Much higher limit – 30 or 25 MW - has been preserved till today in Russia, but detailed regional data comprised in the WSHPDR country report allow avoiding problems with comparative analysis. Small hydro has been the hydropower branch best accepted and even supported among the EU member states having joined the Union after year 2000. The main reason is relatively low environmental impact - especially after implementing restrictive regulations on biological continuity and introducing new, highly specialised technologies - e.g. bidirectional Archimedes screws, VLHT units, electrical and acoustic fish barriers at water intakes etc. Using the existing dams and weirs for development of small hydropower schemes has been considered the best option for a longer time now.

Due to reasons valid for the whole hydropower sector, the small hydro potential in the countries under consideration is highly differentiated. Highly differentiated is also its development (Table 2). Following the WSHPDR 2019 country reports, Romania and Bulgaria are countries having already used a significant portion of their potential while merely 0.08 per cent of it has been tapped so far in the European Russia. Significant resources exist still in Poland, Slovakia and Ukraine. Relatively low use of their potential (below 20%) show Belarus and Moldova. Unfortunately, all these data should be approached with due care. There are several reasons for concern.

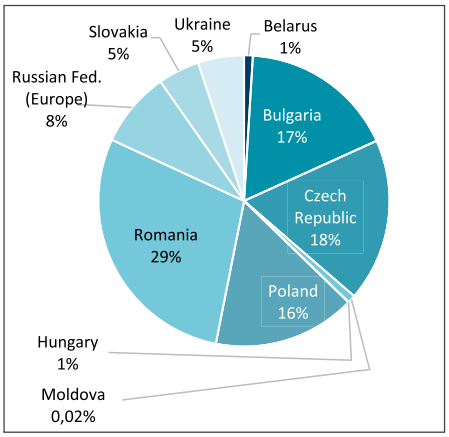
Firstly, the distinction between the technical, economic and environmentally accepted potential is often missing. While presenting the last value may be of the highest practical significance for potential investors, one should also bear in mind that it is also most vulnerable to fluctuations in national energy and environmental policies. It is well known that in some European countries the environmental potential may represent less than 10% of the technical one. The second reason is expressing hydropower potential and its development in terms of installed capacity instead of annual electricity generation. As a significant portion of the small hydro sector is represented by old storage installations with capacity of several MW and annual generation/capacity ratio well below 3000 h, one comes at different potential development assessments depending on the ratio value applied. Another problem is lack of relevant data from Russian Federation which uses an alternative capacity limit

Table 2. Small hydropower up to 10 MW in Eastern Europe (status 2017), [1,12÷15]

Country	Potential	Planned capacity*	Installed capacity	Annual generation	Normalised generation
	MW	MW	MW	GWh	GWh
Belarus	250	15.7	18	N/A.	N/A
Bulgaria	581	N/A	486	1 081	1 081
Czech Republic	465	7.0	337	1 053	1 118
Hungary	55	9.0	16.5	61,6	63,5
Republic of Moldova	3	1.2	0.4	N/A	N/A
Poland	1500	56.0	295	1 055	976
Romania	730	N/A	613 [12]	1 122 [13]	1 078 [4]
Russian Fed. (Europe) **	190 000	42	156	N/A	N/A
Slovakia	241	160.0	86 [14]	282	302 [15]
Ukraine	375	N/A	95	251	N/A
Total without RF.	3 051	N/A	1781	4 905	N/A
Total with RF (Europe)	**N/A**	**228.9**	**1937**	**N/A**	**N/A**
Russian Fed. (whole)**	825 845	42.0	170	N/A	N/A
Total with Rus. Fed. (whole)	N/A	N/A	1951	N/A	N/A

* Installations under construction or preparation
** Installations with capacity up to 30 MW. European part potential assumed proportional to the RF territory area.

Fig. 6. Share of regional SHPs by country [1]



in the small hydro definition (Table 2). One may only expect that applying the 10 MW limit would shrink the relevant potential several times. Another shrinkage may be expected after disre-garding the territories in the East of the main Ural mountain ridge when assessing the European Russia resources. In the end of the day the potential development factor may appear closer to 1%. Still showing vast reserves in the untapped potential and affecting decisively the regional statistics.

The regional leaders in small hydro are Romania, Bulgaria, Czech Republic, and Poland (Fig.4). Using the 10 MW SHP limit instead of that of 30 MW, as applied in the previous report, shifts the Europe-an Russia to the 5th position. Following the country report, taking the whole Russian Federation territory into consideration would not change this ranking as only two SHPs (<10 MW) have been identified in the East of Ural mountain range. A significant problem when conducting the comparative analysis of small hydro in Eastern Europe are inconsistent data coming from various sources. Although all the EU member states submit rele-vant data to the EUROSTAT statistical office, at least some of them raise severe doubts. This concerns in particular Romania and Bulgaria showing the annual generation/capacity ratios below 2000 h or even below 1000 h throughout a major portion of the recording period (2004-2016). The dis-crepancies concern also the installed power. The data provided by national associations are often higher (even by 50%) than those following from the EUROSTAT statistics.

Discrepancies have been observed also in case of Slovakia. The data of the Slovak Statistical Office show an abrupt fall in installed capacity from 99 MW in 2011 to 71 MW in 2012 followed by a steady growth up to 77 MW in 2016. A similar fall - but shifted by 3 years - can be noticed in the biennial reports of the Ministry of Economy. It is worthwhile to notice that the 99 MW value coincides with that stated by one of authors by adding hydropower plant capacities one by one for the purposes of HYDI database in the beginning of this decade. Discrepancies in the generated electricity values are even higher as the value of 282 GWh is shown in the Slovak country report and the Hydropower & Dams atlas [3] whereas only 147 and 151 GWh follow from the Slovak Statistical Office [14] and EUROSTAT documents [4], respectively.

In most countries within the region, small hydro has been responsible for the whole hydropower sector growth having taken place since the previous WSHPDR edition. However, high uncertainty in the available data is a major obstacle in assessing the prevailing trend. After applying the same reference values in the WSHPDR 2016 and 2019 editions (Bulgaria and Russian Federation) the capacity growth rate attains the value close to 0,8%/a. Using the same reference values for all the EE10 countries yields the growth rate estimation above 1.2%/a – the level several times higher than the average for the whole regional hydropower sector.

Current situation of the small hydro sector remains differentiated - depending on the available potential, economic conditions and the balance of political power between the parties of national environmental disputes. The fundamental difference between the small hydro sectors in the EU member states and other countries under consideration lies in the ownership structure. Large corporations and companies (even if private) heavily prevail in the former Soviet republics whereas small private enterprises dominate among the EU member states. This has of course an impact on the investment structure, as large companies are often reluctant to invest in small dispersed installations with profitability heavily dependent on the unstable support systems.

Before World War II numerous water plants (mills, forges, granaries, but also hydroelectric plants) were in operation at the current territories of Czech Republic, Poland and some other countries. In 1930s numerous

state-owned SHPs were erected also at the Soviet territory. After brief post-war revival most of SHPs in the region fell into economical plight and physical degradation as they were unable to compete with large installations, including large hydro, intensively developed in fifties and sixties. In mid eighties the process of small hydro sector restoration started in the Czech Republic and Poland resulting in ca 1,500 and 766 SHPs (< 10 MW) run nowadays in the two countries, respectively. Some other countries joined this trend in 1990s. Due to different economic conditions, the progress among regional members of the Commonwealth of Independent States (all of them previous Soviet republics) was much slower. Following the country report, the number of SHPs with capacity below 10 MW is still at most 101 in the European Russia and only 112 in the whole Russian Federation. On the other hand efforts are made to improve substantially this statistics by 2024. According to the same source, there are 12 SHPs currently under construction across the country with total installed capacity about 170 MW. RusHydro alone plans construction of the SHP plants with a total installed capacity of 850 MW. The value of 42 MW planned for installation in the European Russia till 2024 comes from the Ministry of Energy programme adopted in 2017. Unfortunately, all the numbers available in the country report refer to installations with capacity up to 25 MW and without a deeper study it is impossible to assess what capacities below 10 MW are really planned for the coming years.

Several dozens of abandoned and severely degraded small hydropower power installations are reported from Belarus and Moldova, but without a relevant state programme there is little chance for their revival in the next years. Complete reconstruction of civil works may be needed on numerous occasions. No major development is expected in Hungary where the authorities have set their economical potential evaluation of 55 MW as the ultimate target for the country

The situation in the other EU member states is quite diverse. For a longer time a rather slow, but systematic growth – in accordance with the revised National Renewable Energy Action Plan – could have been observed in the Czech Republic. The feed-in-tariff (FIT) and feed-in-premium (FIP) sys-tems have been used here successfully so far. Unfortunately, in 2020 ca. 550 SHPs are expected to loose the state support. According to Mr P.Štípský, chairman of the Czech Entrepreneurs' Union for the Use of Energy Sources (SPVEZ) [16], over 20 micro-installations were decommissioned between 2016 and 2018. Stagnation follows also from the official data of the Ministry of Economy [17]. Poland seems to have passed the worst time after the collapse of the green certificate system and multi-year decline without any effective support mechanism and with uncertain future. As follows from the country report, 162 SHP projects, with total capacity of 56 MW, were under construction or in the process of obtaining permits in 2017. A significant impulse is expected from the public sector. As announced in 2018 by the Polish Minister for Inland Navigation and Maritime Economy, the state owned enterprise "Wody Polskie" (Polish Waters) is going to erect 27 new barrages at Oder river. Most of them equipped with low head SHPs. Even more ambitious plans follow from the "Assumptions on the Programme of Counter-Measures against Water Scarcity..." as published by the Polish Cabinet in September 2019 [18] and from the information announced during the Polish Hydropower Conference HYDROFORUM 2019 [19].

Despite these positive signs, the situation remains economically unsafe for existing installations with capacity above 1 MW, especially the small storage ones - subject to heavy fiscal burdens and usually having lost the possibility to return to the peak-load operation due to environmental reasons. As reported by the Energy Regulatory Office, in 2019 the small hydropower installed capacity in the country rose to the level of 2015 after two years of continued decline [20]. The small hydropower sector situation in Romania has deteriorated since the previous report due to prolonging uncertainty on further support mechanisms after year 2016 when green certificates became unavailable for new projects. Despite previous announcements, no alternative support mechanism has been introduced so far. In addition, Romania preserves its unfavourable water fee system. Probably the worst in the whole European Union. Nevertheless, numerous sources showed continuing growth of the sector up to 2016. The unconsumed contracts for grid connection, as indicated by the country report, show also belief in better times still present among investors in 2017.

Significant deterioration of the mood is reported from Slovakia where green movements rose substantially in power and the Ministry of Environment has left only 58 potential installation sites as conditionally acceptable out of 375, still present in the original issue of the "Concept of developing the hydropower potential of Slovak watercourses" [21]. In consequence of this unfavourable trend, the country report states "little activity amongst investors because of the fears of a long return of investment, and of the complex process of obtaining permits". Bulgaria is prob-

Table 3. Feed-in-tariffs and some other small hydropower support mechanisms within the region [1].

Country	Limit MW	Tariff USD/MWh	Comments and other mechanisms
Belarus	-	-	no data
Bulgaria	≤ 10	66÷132	The feed-in-tariff system to be replaced by that of FiP since Janu-ary 1st 2019
Czech Rep.	≤ 10	100÷124	feed-in-premium
Hungary	5	70÷120	The higher value applies for installations > 5MW; feed-in-premium; auction system
Moldova	-	-	no data
Poland	≤ 1 ≤ 5 ≤20	120÷132	Feed-in-premium; green certificates (till 2020) auction system
Romania	-	-	15-year green certificates for plants commissioned before 2016; no support for new projects
Russian Federation	≤ 25	ca. 220	Tariffs attained in auctions with 14%/a pay-back rate
Slovakia	≤ 10	-	Auctions have replaced the feed-in-tariffs established previously on individual basis
Ukraine	≤ 10	120÷160	green tariff minimum values

ably the country with the highest sector growth since the previous WSHPDR issue. The country report mentions a number of measures undertaken in order to promote the renewables. However, as the text was written, Bulgaria was still in a transitional period between the feed-in-tariff system cancelled for new projects in 2015 and expected to be replaced by the feed-in-premium mechanism in the beginning of 2019. A positive result has been achieved also in Ukraine, which implemented a number of incentives some time ago in an effort to integrate its renewable energy policy with that of the European Union. One may expect continuation of this rising trend if incentives are kept, the emerging green movements do not block the progress and the general situation in the country does not destabilise.

After bad experiences with green certificates in several European countries, feed-in tariff and feed-in-premium systems have been introduced for the smallest installations. For larger ones the auction system is often applied (Table 3). In most cases the duration of support under auction systems and stipulated tariffs is 15 years. The support period is almost twice shorter in Russian Federation where higher pay-back rates are assumed. Generally, the support package includes also obligation of public electricity providers to acquire the electricity generated in RES installations although this obligation may be subject to limitations. Some other support measures, like exemption of taxes and access to support funds are also available locally. Further details are to be found in the country reports.

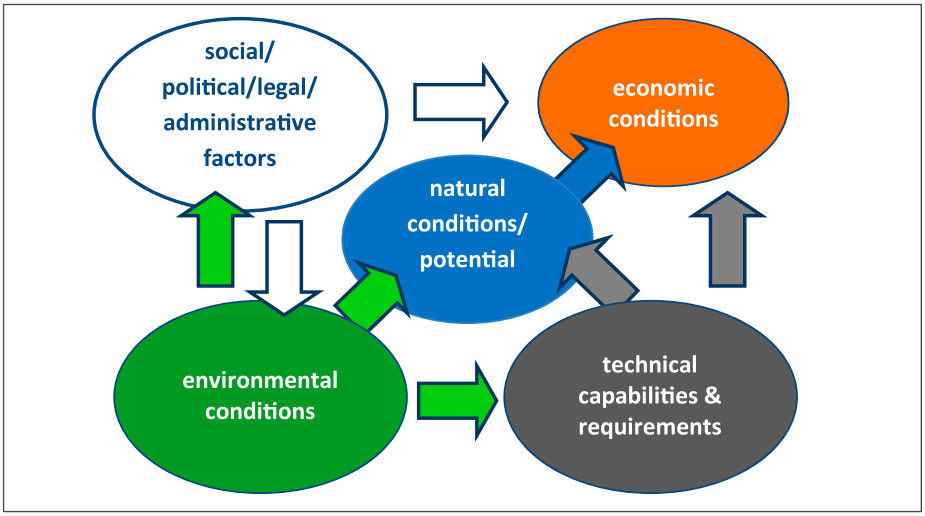
With exception of Romania and Slovakia, there is a feeling the situation of the sector has not deteriorated significantly since the previous WSHPDR issue. However, the general conditions were much worse than in the beginning of the decade. The general trend is to support the investment by shortening the pay-back period rather than subsidising generation in a long term horizon. At the same time, the feeling of uncertainty, instability and balancing at the edge of economic profitability prevailed in the EU member states throughout the recent period. As profitability of the existing plants became endangered, refurbishments have been often considered a tool to regain the public support. On the other hand some positive signs have been noticed - both internally and from the international community, ever more committed to mitigate the climate change effects. An important – although often disregarded - component of the sector is represented by its technical background which includes providers of services and equipment, as well as design and consulting offices, R&D centres, individual professionals. While large hydro orientation has prevailed for long decades in Russia and Ukraine, long year tradition in small hydro has survived in the Czech Republic. Irrespective of privatised state companies, numerous small enterprises with highly skilled staff emerged here on various background after the political and economic transition in the beginning of nineties. A somewhat similar phenomenon could have been observed in Poland where the first efforts to develop the small hydro industry - practically from nothing – were undertaken already in eighties. At that time within the existing state owned companies. Today harsh competition is a characteristic feature of Polish small and difficult market, heavily affected by the sector general condition. A much longer tradition – with due support in relevant research centres - has existed in Romania and Hungary. However, while the main Hungarian hydraulic turbine manufacturer withdrew from this activity already a long time ago, the recent plight of UCM Resita is surely a severe blow to the Romanian manufacturing capacities today.

The SHP sector in most East European EU member states is represented by relevant small hydropower associations. Their long-term significance in promoting and/or defending their sector in contacts with relevant national authorities can be hardly overvalued although their true effectiveness depends always on local conditions. As the legal system of EU member states is generally harmonised with EU directives and other components of the EU policy, the activities at the European Commission level are high priority. Polish and Romanian associations have remained highly active at the European scene for a longer period - previously as members of the European Small Hydropower Association (ESHA), now as members or partners of the SHP Chapter of the European Renewable Energy Federation (EREF). Ever more present at the EU small hydro scene is the "Hydropower of Ukraine" association, whereas "Hydropower of Russia" remains focused on the large hydro sector and reluctant to contacts with potential East European partners.

Barriers to small hydropower development

As shown schematically in Fig.7. there exists a number of variously interrelated constraints exerting more or less direct impact on the hydropower status within the region. Of course, natural conditions are an outcome point for any consideration, but environmental policies shrink severely the available potential whereas technical progress allows extending it slightly by allowing to develop sites with extremely low head and/or mitigating the environmental impact of planned installations. An example is Archimedes screw "reinvented" in the Czech Republic in nineties as a hydraulic gravi-tational engine and used now extensively in Europe, especially in lowland countries. Also in a double screw configuration – active as a bidirectional fish passage which makes it widely acceptable from environmental point of view while still economically and technically reasonable. Eventually, technical/economic and

Fig. 7. Schematic representation of the main constraint groups for East European small hydropower sector development including some of the interrelationships



legal/administrative constraints are decisive whenever decision on invest-ment in a specific site is to be taken.The survey of country reports shows that insufficient small hydropower potential is an essential sector development barrier in Belarus and Hungary. Lacking state support prevents redevelopment of previously used sites in Belarus. In Hungary, most of economically feasible sites have been al-ready developed. A vast untapped small hydro potential exists in Russian Federation. However, it is here where harsh environmental conditions form a barrier preventing development of numerous sites in the northern territories. Another potential linked barrier in Russia is lack of sufficient data on available sites and potential. The same problem is reported also from Bulgaria and Poland. In fact it is only Slovakia, from where a national programme of hydropower sector development is report-ed. Unfortunately, recent years have seen a number green NGOs attacks on the hydropower sector resulting in reducing the originally planned number of SHPs by a factor of 6 in this country.

Lack of technical resources - both human and technological - is considered one of main sector barriers in Moldova where a number previously developed sites remain still abandoned. Local deficit in hydropower professionals and lack of state supported programmes for small hydro technology development is reported also from Russia - one of world leaders in large hydro technology. Grid connection is also a frequently encountered technical and administrative problem in Russia, Ukraine and Moldova. Involvement of environmentalists in political life is an experience of a number of EU countries, in-cluding Romania and Czech Republic where prioritising fossil and nuclear fuels is considered another obstacle for small hydro development. The rising influence of green movements is reported also from Ukraine. Resulting instability in state policy towards the sector is a real nuisance for investors. The problem is reported from Poland, but it is known also from other countries having abandoned their previous support system in the beginning of this decade and failing to replace it by a stable alternative mechanism.

One sided approach to environmental and water management problems stands often behind the policy leading to loss of previous income, additional economic burdens and eventually loss of profitability. The problems are reported from Poland where various fees and taxes (e.g. for the civil engineering structures, for the flooded area) constitute often a meaningful component of indirect operation and maintenance costs [22] and Romania where no support mechanism is currently avail-able for new installations and water use fees are a significant factor stopping low head SHP devel-opment. High O/M costs are considered significant factor in the Czech Republic. Lacking or insufficient state support is the essential reason for an economic barrier in the non-EU countries - Belarus, Moldova and Russia.

Lengthy, complex and expensive administrative procedures form severe problem in the majority of countries. Especially lengthy Environmental Impact Assessment (EIA) procedure is reported from Bulgaria, Romania and Slovakia whereas lack of sufficient transparency has been stated in Ukraine. The common background for all administrative and most of economic problems encountered is poor image of hydropower in the eyes of European societies. The sector is often perceived solely as a source of moderate amounts of green energy and easy income to the owner at the cost of significant interference into the environment. The multipurpose character of SHP installations and numerous benefits for water management and environment as well as local power grids are usually disregarded. This position of some highly influential NGOs requires strong counterbalance. The capacities of national hydropower associations are usually not sufficient for this purpose. Some hopes may be linked with ever better understanding of the climate change consequences as well as the need for their mitigation and relevant counteraction wherever possible as a global top priority.

Janusz Steller
President of Polish Hydropower Association
The Szewalski Institute of Fluid-Flow Machinery of the Polish Academy of Sciences

Ewa Malicka
President of Polish Association for Development of Small Hydropower

Eva Kremere
International Consultant
University of Latvia UN Industrial Development Organization (UNIDO), Vienna

References

1. Liu, D., Liu, H., Wang, X., and Kremere, E., eds. (2019). World Small Hydropower Development Report 2019. United Nations, Industrial Development Organization; International Center on Small Hydro Power. Available from www.smallhydroworld.org .
2. UN geoscheme for Europe, Wikipedia (2018) https://en.wikipedia.org/wiki/United_Nations_geoscheme_for_Europe
3. World Atlas and Industry Guides 2018, 2019, Hydropower & Dams (2018, 2019), Aqua-Media International, Surrey, UK
4. EUROSTAT Energy, https://ec.europa.eu/eurostat/web/energy
5. Websites of the United Power System Operator, http://so-ups.ru/index.php?id=ees, http://so-ups.ru/index.php?id=tech_disc (in Russian)
6. Steller J., Lewandowski S., Malicka E., Kremere E., Popa B., Punys P. (2018): Hydropower in the East European region - challenges and opportunities. International Journal of Hydropower and Dams, Vol.25 (2018), Issue 5, pp.39-50
7. List of sovereign states in Europe by GDP, Wikipedia (2018); https://en.wikipedia.org/wiki/List_of_sovereign_states_in_Europe_by_GDP_(nominal)
8. Levytskyi M., Landau I., Kraynik V. (2019): Prospects for the development of hydropower of Ukraine, con-sidering the strategy of development of energy systems of Ukraine and the EU, IXth Polish Hydropower Conference HYDROFORUM 2019, Polanczyk/Solina, https://drive.google.com/file/d/1kyCF-rpd_B_gopU9P1kK1LWJsn4YXz8U/view
9. ENTSO-E at glance. https://www.entsoe.eu/publications/general-publications/entso-e-at-a-glance/Pages/default.aspx
10. ACER/CEER Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2017, https://acer.europa.eu/en/Electricity/Market%20monitoring/Pages/Current-edition.aspx
11. Hancher L. and Winters B.M.: The EU Winter Package. Briefing Paper, Allen & Overy LLP 2017, http://fsr.eui.eu/wp-content/uploads/The-EU-Winter-Package.pdf
12. Popa B.: Small hydropower plants in Romania at the end of 2017 , RONDINE, RO06 Renewable Energy, SEE 2009-2014, http://www.rondine.ro/wp-content/uploads/2017/11/10_bogdan_popa.pdf
13. Romanian Small Hydropower Association: Statistical data (kindly shared by Prof. B.Popa, President)
14. Energy 2017, Slovak Statistical Office, Bratislava 2018
15. Authors' calculation based on various data
16. Czech Entrepreneurs' Union for the Use of Energy Sources (SPVEZ): Statistical data (kindly shared by Mr P.Štípský, Chairman)
17. Renewable sources of energy in 2018, Ministry of industry and commerce, Czech Republic, September 2019 (in Czech)
18. Assumptions on the Programme of Counter-measures against Water Scarcity to be Implemented in the Years 201-2027 with 2030 Perspective. Monitor Polski, 4.10.2019, pos. 941, pp. 2-29 (in Polish)
19. Niemiec-Butryn M.: Intensifying the use of hydropower potential in the context of developing the inland navigation routes. IXth Polish Hydropower Conference HYDROFORUM 2019, Polanczyk/ Solina, https://drive.google.com/file/d/1kyCF-rpd_B_gopU9P1kK1LWJsn4YXz8U/view (in Polish)
20. Polish Renewable Energy Potential https://www.ure.gov.pl/pl/oze/potencjal-krajowy-oze/5753,Moc-zainstalowana-MW.html
21. The draft update of the concept of harnessing the hydropower potential of the Slovak Republic watercourses till 2030, SR Cabinet debate material (in Slovak), http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=26163
22. Lewandowski S.: The analysis of costs indirectly linked with electricity production in hydropower plants, Polish Hydropower Association, Reda 2014, 29 p. (in Polish); http://www.tew.pl/biblioteka/opracowania/20141124_Koszty_posrednie_EWo_analiza.pdf

Water Turbines Works

...we believe in the Power of Nature

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)**

+48 695 639 657
info@wtw-poland.com

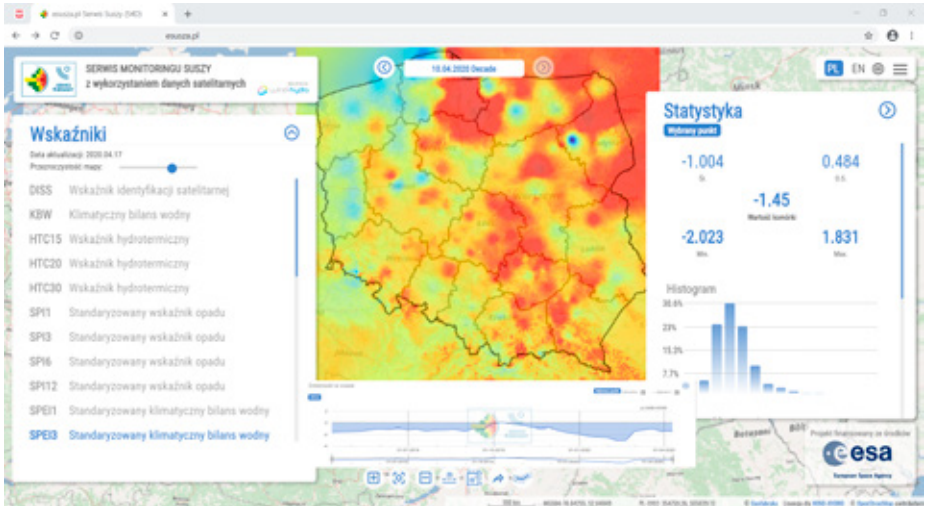
ul. Konopnickiej 2 F
11-200 Bartoszyce, POLAND

www.wtw-poland.com

ABOUT DROUGHT AND WATER RESOURCES – **ESUSZA.PL**

The new drought monitoring and forecasting service - esusza.pl. Presented information and data are adjusted to needs of users in the field of water management, agriculture, as well as insurance and energy. Geoportal with well-developed customer service functions for data search and analytics is the result of the Service 4 Drought project financed by the European Space Agency.

The information about the state of water resources from the point of view of precipitation recharge, as well as the water balance also the state and forecast of drought indexes are the elements of the service esusza.pl. The service address the drought risk management and problems arising from water resources deficit. The knowledge of past atmospheric condition is a key factor to monitor current state of the drought day by day and estimate short-term risk of its occurrence. A geoportal with extensive data search and analysis functions are tools developed as part of the Service 4 Drought project funded by the European Space Agency under the Polish Industry Incentive Scheme.



Source: esusza.pl

RAINFALL RECHARGE AND DROUGHT MONITORING

The esusza.pl is the web portal which is intended to be mostly dedicated for users interested in the following subject matters:

1. current drought and rain recharge of water resources (2020);
2. short term prediction of a selected drought indices based on the most current state of monitoring sites and a numerical weather prediction models;
3. archive data series of droughts across Poland (2013 – 2019).

The drought monitoring is based simultaneously on reference data of reanalysis of the WRF (Weather Research and Forecasting) model and current meteorological data from WMO (World Meteorological Organization) monitoring implemented by models of drought indexes. Additionally during growing season analysis are run also on satellite data. The spatial resolution of information is delivered in 4x4 km grid cell and covers entre territory of Poland. The drought monitoring and rain recharge of water resources is based on the set of indexes, e.g.:

- THE CLIMATIC WATER BALANCE (KBW) values refer to 2 months periods (6decades) and is calculated daily for the recent 60days;
- STANDARDIZED CLIMATIC WATER BALANCE – (SPEI) for 1month to 12months accumulation periods – calculated for the end of each decade. SPEI is the difference between the amount of available water from precipitation and the highest possible sum of evapotranspiration (the maximum demand for atmospheric water). Unlike the CWB (climate water balance), SPEI allows to compare areas and has an assessment scale to identify drought and rain water recharge;
- STANDARDIZED PRECIPITATION INDEX (SPI) is calculated in the same scheme as SPEI but is based only on rainfall data. Also refers to drought types conditions and rainfall recharge conditions.

The SPI and SPEI different accumulation periods allow to estimate different potential impacts of a drought, i.e. identification of periods with meteorological drought, but also serve the preliminary assessment of agricultural, hydrological and hydrogeological drought conditions.

SHORT TERM PREDICTION OF DROUGHT INDICES

Forecast module of the esusza.pl is highly desirable in agriculture sector for the assessment of drought development. The forecast is done for the next 3 days (i.e. 72 hours) and is based on the simulations of the Weather Research and Forecasting model (WRF). The products for the user are the maps for the chosen atmospheric parameters (e.g. near-surface air temperature, precipitation, wind speed) and also prediction of all drought indexes.

SOLUTIONS FOR INDUSTRIES

All analysis and the idea of esusza.pl have a focus on further dissemination and development of tailor made solutions for different industries struggling with the risk of drought and water deficits. Within service are presented exemplary solutions for agriculture, insurance and water management and energy industry. Data on drought indexes and precipitation recharge of water resources are the input data for development of 4 dedicated models. Three of models are successfully implemented by stakeholders:

- model of drought risk reduction for the State Water Holding Polish Waters
- model of crop yield reduction for the Central Statistical Office,
- model of drought risk pricing model for one of the polish insurance representative.

And two models are generally focused on the monitoring of drought results and individual assessment within each enterprise and deliver for them Best Management Practices (BMP's) for drought risk reduction. Which are BMP's for drought risk reduction in water supply services and BMP's for energy sector – comparative analysis of energy production and drought intensity. All dedicated drought risk solutions are available in a formula of closed domain after login. Further development of the service is continued, we invite you to use the esusza.pl.

Grzegorz Łukasiewicz
WIND-HYDRO
esusza.pl

WORLD WATER DAY 2020:
WATER AND CLIMATE CHANGE

World Water Day (WWD) is celebrated this year for twenty-sixth time. A quarter of a century ago the problem of water and its importance for environment and humanity became obvious.

In 1968 some scientists, economy leaders and others formed a group which was called the CLUB OF ROME. After four years of work in 1972 they published a report entitled the Limits of Growth. The basic conclusion of this report was the statement, that if the development of the world will continue in the present direction, i.e. with such a consumption of raw materials and energy, as well as the pollution of the environment, humanity will be endangered by a severe crisis.

In the United States the Environmental Protection Agency was formed as the result of the state of environment rapidly decreasing in this country. The Agency had important rank and authority in the system of government administration.

In 1987 the report of a special commission under the leadership of Mrs. Bruntland entitled Our Common Future was published. In this report, the principle of Sustainable Development was formulated for the first time. Considering the problems of water on our globe it was apprehended that sustataniable development is the essential aspect, for human life and development. It can be applied to many spheres of our lives, but predominantly in relation to fresh water resources and environment.

The notion of sustainable development was generally accepted in 1992 at the conference of the United Nations in Rio de Janeiro. Resulting considerations took into account the whole environment, social and economic aspects as well as benefits for all humanity now and in the future.

These were very important signals showing that the world is going in the wrong direction and in consequence there is the danger of catastrophe. However, these considerations unfortunately did not always get through, neither to the politicians, who take the decisions nor to the societies, which do not take these statements as a serious warning. The conference of the United Nations in Rio de Janeiro (1992), mentioned above, the first on such important scale, was called the Summit of the World and was devoted to Environment and Development. As the result from the decisions of this conference the General Assembly of the UN, considering the important significance of water in the development of humanity, established World Water Day, to be celebrated each year on the 22nd March.

Source: www.worldwaterday.org

WHY ARE WE CELEBRATING WORLD WATER DAY?

For the first time World Water Day was celebrated in 1993. That same year the Committee on Water Research published under the auspices of the UNESCO a report on Water in Our Common Future. To a certain extent it was equivalent to the Bruntland Report, but exclusively concerning water problems.

Each year WWD was celebrated under an one important headline. Thus it was possible to select certain very important problem of water resources management and concentrate special attention on it. In the course of the years it appeared that water problems on our globe, especially problems of fresh water, are becoming more and more compound and concern numerous spheres of our life. It also apppeared that there are many factors which influence the state and management of water resources. In Poland the celebration of WWD was initiated by the Committee of Water Resources of the Polish Academy of Sciences together with the Ministry of Environment.

It is necessary to raise the question why we celebrate WWD? The answer is as follows.

- It is necessary to enlighten societies, politicians and decision makers about water being indispensable for life, in that it carries numerous industrial, energy, and agricultural processes, and that without water economic and social development cannot be realized.
- Assumed headlines have to present selected global, regional, and local problems, which is very important for solutions from social, economic and ecological aspects.

Can the problems presented in the headlines each year possibly be solved during one year? The answer to this question is absolutely negative, because the solution of these problems requires many years and large financial resources. Pointing them out has to show how important they are for economy, environment and society.

Numerous facts in the realm of water resources management show how important they are.

- About one billion people (approximately 1/8 of world population) have no access to the safe drinking water, and about two

billion people have no access to appropriate sanitary facilities.

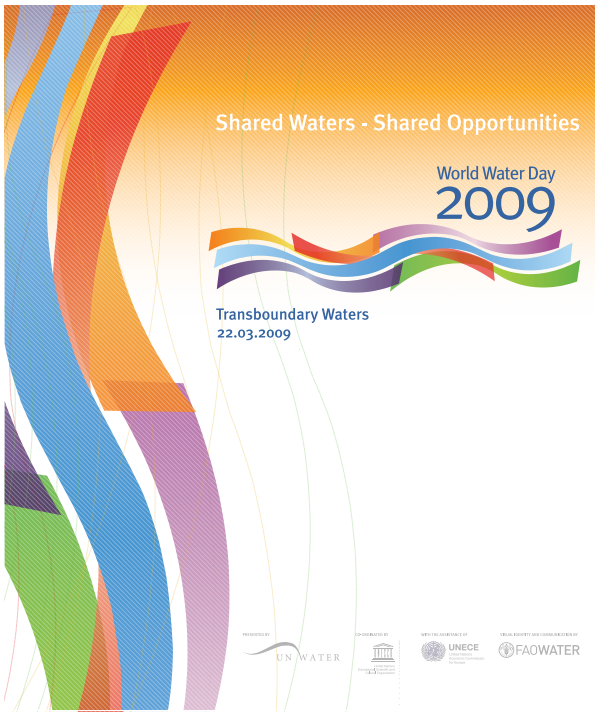
- About six thousand children die every day because of diseases caused by polluted water, inadequate sanitary facilities, and lack of appropriate hygiene.
- The lack of safe drinking water and appropriate sanitary facilities results in 80% of all diseases in the developing countries.
- Unequal access to water is shown by the fact that one toilt flush requires the same amount of water, which is at the disposal of the average person in developing countries for daily drinking, meals, washing, and the preparation of food.
- In developing countries during the last three decades consumption of water increased twice as fast as the population. The countries in the Middle-East, North Africa, and East Asia experience a constant lack of water.
- In developing countries nearly 90% of the sewage is discharged directly into natural waters without purification, which restricts the possibilities of their use for other purposes in a significant way.
- The excessive use of ground waters for agricultural irrigation resulted in many regions in the decrease of the water table by several meters, thus forcing people to use river water of low quality.
- In the nineties last century world population was endangered by natural disasters. 75% of them were floods and 33% losses due to these.
- Water is the resource, without a substitute and connected simultaneously with various activities of human civilization, from agriculture and industry to numerous values of culture and religion, in our society.

PREVAILING HEADLINES OF WWD AND THEIR IMPORTANCE

For the first time WWD was celebrated on 22 March, 1994. Its headline was Caring for our Water Resources is Everybody's Business. Although twenty six years have passed, this headline is still valid and has kept its great significance. It is worthwhile to recall headlines of past WWDs, which presented diverse but very important water problems. Here are these headlines.

1995 – Women and water
1996 – Water for Thirsty Cities
1997 – The World's Water: Is there enough?
1998 – Groundwater – The Invisible Resource
1999 – Everyone Lives Downstream
2000 – Water for the 21st century
2001 – Water for Health
2002 – Water for Development
2003 – Water for Future
2004 – Water and Disasters
2005 – Water for Life 2005–2015
2006 – Water and Culture
2007 – Coping With Water Scarcity
2008 – Sanitation
2009 – Transboundary waters
2010 – Clean Water for a Healthy World
2011 – Water for cities: responding to the urban challenge
2012 – Water and Food Security: The World is Thirsty Because We are Hungry

Fig. Examples of several posters showing the slogans of the World Water Days



Source: www.worldwaterday.org

2013 – Water Cooperation
2014 – Water and Energy
2015 – Water and sustainable development
2016 – Water and Jobs
2017– Water and Waste Water
2018 – Nature for Water
2019 – Leaving no One Behind
2020 – Water and Climate Change

WATER AND CLIMATE CHANGES

This year we celebrate WWD, for the first time, under a very essential headline: Water and Climate Changes. During previous years this headline became very important for humanity. It resulted from numerous extreme situations such as floods, heat waves and droughts, as well as social problems such as very spectacular forest fires, and hurricanes of very strong wind velocities. These disasters demonstrated in a very drastic way that forecasts, which some people considered as fantasy are very real and cannot be neglected. In every such situation water was mentioned in various arrangements.

Considering climate changes we must be aware that these changes include not only water, but also a wide range of ecological and social problems such as famine, diseases, lack of education or people migrations for food. It is necessary to raise a question – what is the reason of such problems? The answer is relatively simple – the increase of temperature on our globe. It was confirmed that since the beginning of the industrial era (at the end of the 18th century), the average temperature on our globe increased by about 1.5°C and continues to rise.

The next question is – what was the main reason for this temperature increase? The answer is also relatively simple – it results from the increase of greenhouse gases, which are produced by human management based on the burning of natural resources of coal, oil and gas. These resources are not renewable and will be exhausted sooner or later.

Here are some examples of posters representing headlines of WWD.

Considering this year's headline (WWD water and climate changes) we must look at it from various points of view.

- There is a constant increase of the human population on our globe and it is necessary to secure it with home, food, education and health care.
- Accessible resources of fresh water, their magnitude, distribution and management.
- Growing urbanization
- Increase of life standard.
- The Increased number of people will require an increased amount of food and energy.
- It is indispensable to determine the influence of these factors on the hydrological cycle.

CLIMATE CHANGES

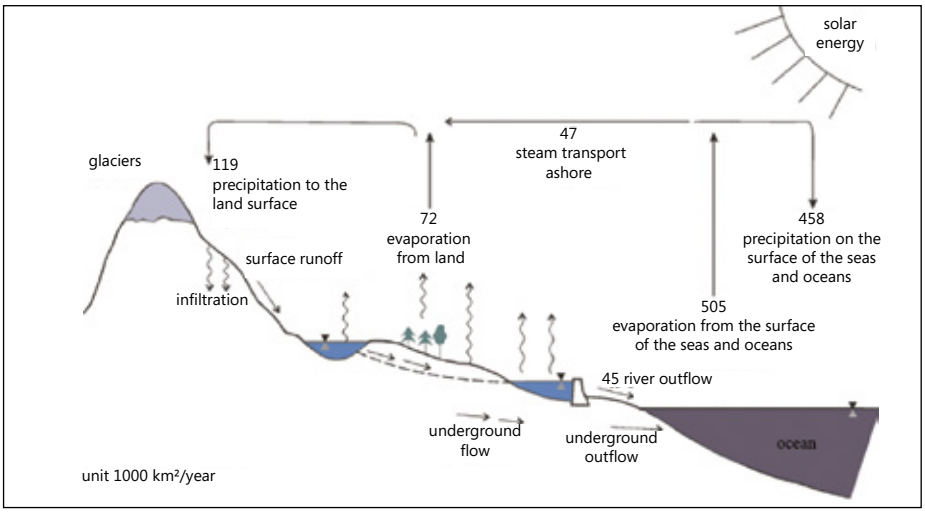
For the first time in many years this headline of WWD appears – Water And Climate Changes. It is necessary to understand that climate changes have a decisive influence on water resources and their exploitation and not vice versa. In the situation of this headline it is worth mentioning that glancing at climate changes comprises more than only water aspects.

In December 2018 in Poland the COP 24 (the 24th Conference of the parties) was held, devoted to climate changes. As Parties we understand 196 countries, which take part in the Organization of the United Nations. The Polish Academy of Sciences together with Centre National de la Research Scientifique (France) and the Pontifical Academy of Sciences organized a special scientific session devoted to the problem of climate changes. Many important scientists from Poland and abroad presented their views concerning this problem. All of them unanimously stated that the world is changing in an unfavorable direction. At present we already have global temperature at about 1.5°C higher than the initial temperature arbitrarily assumed as the temperature at the end of the 18th century as the beginning of the industrial era.

Responsible for this increase of the temperature is the activity of people in the form the emission of greenhouse gasses (mainly CO_2 and methane) by industry, thermal power plants, agriculture and households. This is accomplished mainly as the result of burning coal, oil and gas. Forecasts indicate that if we do not change these development trends radically, then during our lives we will witness catastrophic floods, droughts, waves of excessive heat, typhoons, and the increase of the water level in the oceans as the result of melting glaciers. All this will result in spreading famine, the disruption of the development of many organisms, in the lack of drinking water and even the migration of whole nations searching for food. Unfortunately the voice of scientific world very weakly finds access to the conscience of societies and decision makers, because they very often think and act in the perspective of only few years. The warnings presented in the Katowice Memorandum (final document accepted by the participants of the session 2018) may seem trivial and absurd. Some present events (forest fires in Australia) indicate, however, the reality of these forecasts which might be present very soon. Then all of it will confirm that the world is going in the wrong direction.

The main recommendation is the restriction of temperature increase on our globe and this is possible by the limitation of the emission of greenhouse gasses. This is possible to achieve by the transfer to renewable sources of energy and restriction in

Fig. The scheme of hydrologic cycle



Source: Majewski W., Woda w Inżynierii Środowiska, 2017, Warszawa

burning coal, oil and gas. Evidently it is not possible to implement it overnight, but it is necessary to take such decisions and consequently realize them. Poland, which produces 80% of electric energy in thermal power plants using coal and lignite, is in a very difficult situation.

The final aim of the convention, which took place in Katowice in December 2018, is to achieve for the future a stabilization in the concentration of greenhouse gasses in the atmosphere to the level, securing a safe existence of the climatic system.

CLIMATE CHANGES AND WATER

It is worthwhile to direct the attention to the fact that climate changes, and in particular the increase of air temperature, have a very important influence on water resources and especially on the hydrologic cycle and this in turn on the life of many living organisms on our planet and the development of plants, connected with the production of food. World water resources can be estimated by the average outflow of rivers to the sea. Taking into account that the present world population amounts to 7.7 billion and the average outflow of rivers to the sea is 47 thousand cubic kilometers (surface and ground waters) we receive the coefficient of water availability of 6.0 thousand cubic meters per capita annually.

It is necessary to remember that fresh water resources being at our disposal are limited and will not increase but decrease, because there is a visible decrease of rivers runoff to the sea due to increased aerial evaporation and increased abstract of water from the rivers for communal, industrial and agricultural purposes. The world population will also increase and in several years will reach 8 billion people. As a consequence the coefficient of water availability will drop down to the value of 5.9 thousand cubic meters per capita and year.

The water resources of Poland at our disposal are very modest. The indicator of water availability in our country amounts to 1 600 m³ per citizen and year, which is at present nearly threefold smaller (2020) than the European average (4 500 m³) and nearly fourfold smaller than world average (6 000 m³).

There are many controversies concerning climate changes. All, however, agree to the fact that extreme situations (floods, droughts, high temperatures, hurricanes etc.) occur more frequently and moreover, that these extremes are ever higher and bring important social and economic losses.

The drought of 2003 and 2015 in Poland brought significant losses and also demonstrated the fact that with our modest water resources we do not possess sufficient water reserves in the form of retention reservoirs.

At the conference in Katowice (December 2018), a large group of delegates took the decision to limit rise in the increase of average global air temperature to 1.5°C in relation to the pre-industrial temperature of our planet (at the end of the 18th century). There are optimists, who believe in achieving this aim, but there are also pessimists, who disagree.

A very important opinion was voiced among of Polish scientists [Academy, Climate Changes 2019] during the scientific session organized by the Polish Academy of Sciences. Prof. P. Rowiński – Too Much Feedback, Prof. Z. Kundzewicz – Keeping Our Heads above Water, Prof. Sz. Malinowski – Not to Be Ignored. In their papers the state of our water resources in view of the forecast of climatic changes was presented.

In connection with climate changes based on the increase of global air temperature we can expect more intensive evaporation and simultaneously faster circulation in the hydrologic cycle. This will result in the increase of a more irregular, atmospheric precipitation than now, and its intensity. Consequently there will be a higher useless outflow of river waters to the sea and longer periods of low and very low discharges in rivers. These situations will result in flood losses on the one hand and on the other in long periods of water deficiency. Evidently, full security against these phenomena is not possible. There is, however, the possibility of significantly mitigating both these situations.

PROPOSALS OF HYDRAULIC ENGINEERING AND WATER RESOURCES MANAGEMENT

One of the very essential proposals is a significant increase of water volume in retention reservoirs. Today we have a volume in the range of 3.6 km³, which is only about 6% of the average river annual outflow to the sea from the terrain of Poland. Our neighboring countries have this indicator 10 or even 15%. Polish state enterprise Polish Waters recently initiated the action Stop to the Drought, which has the main aim to increase the volume of large and small reservoirs to 10 or even 15% of the average river annual outflow. This is a very ambitious task requiring large financial expenditures, significant engineering, and social effort. It will not be possible to realize this aim in a short time, but it will require many years of hydro engineering actions.

It is necessary to direct attention to the fact that river management must be complex. It is not possible to show the domination of one sector, but it must be directed to numerous aims such as water supply, flood protection, hydro energy, inland navigation or even recreation. The scientific and engineering society has the aim to present for governing authorities real proposals concerning the solution of difficult problems. Today river management must be complex and sustainable. Decisions about their realization belong to politicians, who resume full responsibility for these decisions.

It is worthwhile to consider what should be done in the near future, taking into account perspective aims as well as actions, which will allow to decrease the negative climate changes in relation to water resources. The basic problem is the decrease of global air temperature. This is possible by the decrease of emission of greenhouse gasses by gradual transfer to renewable energy sources. This trend was determined for the period till 2050. In this respect Poland is in a very difficult situation, because currently 80% of its electric energy is produced in thermal power plants.

prof. Wojciech Majewski
Instytut Budownictwa Wodnego PAN w Gdańsku
w.majewski7@chello.pl

References

1. Majewski W., 2017, Woda w Inżynierii Środowiska, Monografia IMGW PIB Warszawa
2. Akademia, Zmiany Klimatu, Magazyn PAN, Wydanie specjalne 1/6/2019

HYDRO 2020

Strategies for future progress

International Conference and Exhibition

Strasbourg, France ~ Palais de la Musique et des Congrès

26-28 October 2020

Organized by:

THE INTERNATIONAL JOURNAL ON HYDROPOWER & DAMS

Supporting organizations include:

CIGB ICOLD · CHINCOLD · IDA HYDRO · UNIDO

Regular updates will be posted on our website, and published in Hydropower & Dams

Email: hydro2020@hydropower-dams.com • Tel: + 44 20 8773 7244

www.hydropower-dams.com

Instytut
oze
engineering company

WE BUILD YOUR IDEAS

COMPLEX LEGAL AND FORMAL SERVICE

+ MODERNIZATION OF SHPP
+ ENERGY PRODUCTIVITY
+ WATER PERMITS
+ ENVIRONMENTAL DECISIONS
+ CONSTRUCTION AND TECHNOLOGICAL DESIGN

INSTYTUT OZE SP. Z O.O.
SKRAJNA 41A STREET
25-650 KIELCE, POLAND

PHONE: +48 41 301 00 23
FAX: +48 41 341 61 03
www.instytutoze.pl

CONTACT: MICHAŁ KUBECKI
E-MAIL: michal.kubecki@ioze.pl
PHONE: +48 505 176 479