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

ENERGETYKA WODNA

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TRMEW

From The Editorial Office

Time to go! The President of the Republic of Poland signed into law on April 14th a law on the preparation and implementation of projects involving the construction of pumped storage power plants, giving them the status of public purpose investments. Investors have less than a year's time, until June 30th, 2024, to prepare the necessary documentation. The law provides a number of procedural simplifications, which includes the lack of need to adopt a local zoning plan, or facilitated acquisition of real estate earmarked for PSH infrastructure, which will pass to the State Treasury with the payment of compensation. The law covers the preparation and construction of new pumped storage power plants, as well as the modernization of existing facilities. Among the potential projects to be implemented, PSH Młoty, PSH Rożnów 2 and PSH Jawor have the best chance of success. Time seems rather short, especially the last pumped storage power plants were built in Poland in the 1970s. Nevertheless, this special law represents a significant facilitation and opportunity for the development of large-scale hydropower in Poland (by our national standards, of course). It will translate into increased stability of the power system and enable further development of wind power and photovoltaics. Currently, the Polish power system needs new PSH-type facilities with a minimum capacity of 3–4 GW.

The second quarter of this year has been very busy for our editorial team due to the HYPOSO project in which we were involved. Our task was to organize and lead a study tour for representatives of the hydropower sector from Latin America and Africa, including visits to hydropower plants and production facilities of leading European hydropower equipment suppliers in Germany, Austria and Italy. You can read how the exchange of knowledge and experience between the participants of the trip and the establishment of cooperation with European business partners took place in the summary prepared by Michal Lis, Managing editor of "Energetyka Wodna" magazine, responsible for the coordination of this project.

The following pages of this issue present a comprehensive modernization of SHP Łabędy, consisting in the construction of the entire facility from scratch, dictated by the poor technical condition of the existing structure. This is an excellent example of full utilization of the hitherto unused hydropower potential, through the use of the latest technological advances and the selection of optimal solutions. This is evidenced, among other things, by the increase in the maximum instantaneous capacity achieved by the power plant from 70 kW to 340 kW, already in the phase of the first tests. The article was compiled by Wioleta Smolarczyk and Lukasz Kalina from IOZE hydro.

Another topic of the issue worth mentioning is an article by Aneta Nycz, M.Sc., Jacek Bieńkowski, M.Sc., Przemyslaw Szulc, Ph.D., and Artur Machalski, Ph.D., from Wroclaw University of Technology, presenting the results of a study involving the identification of the impact of Francis turbine operation at part load on flow phenomena in the draft tube, as well as the determination of the impact of these phenomena on the stability of turbine parameters.

Finally, I suggest reading an article written by Alberto Scotti, Senior consultant for flowing water ecology from APEM, presenting the results of a first-ever assessment of the long-term environmental impact of a small hydropower plant. The results showed no significant impact of the SHP on the ecology of the studied stream, further proving that responsibly designed, implemented and operated hydropower plants are a source of clean energy, produced in accordance with the idea of sustainable development and respect for the environment.

I wish you a pleasant reading!

Michał Kubecki
Editor-in-Chief

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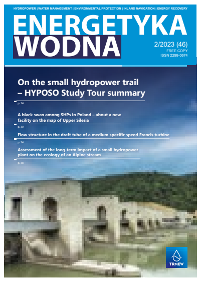

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TRMEW

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Amendment to the RES Act approved by the Senate

The Senate unanimously approved an amendment to the Law on Renewable Energy Sources, recommending a number of amendments. A key amendment clarifies the rules for renewable energy production under cable pooling.

The latest amendment to the Law on Renewable Energy Sources was approved by the Senate on July 28th. The Act comes into force on 1 October 2023. All senators present at the session voted in favor of it. At the same time, the Senate recommended dozens of amendments to it. The key amendment concerns a concept known as cable pooling, which allows wind and photovoltaic power plants, for example, to share a connection to the grid. Sharing grid infrastructure, particularly by wind and photovoltaic sources, could be a major boost to RES investments in Poland in a situation of increasing problems in obtaining grid connection conditions for new projects. The Senate amendment stipulates that generators wishing to share a grid connection will enter into an agreement indicating, among other things, which of them will apply for connection conditions.

The amendment to the Act on Renewable Energy Sources, which is being processed in Parliament, introduces a number of changes for the renewable energy market. Some of them result from the provisions of the EU Renewable Energy Directive (RED II), which European Union countries had until mid-2021 to implement into national law. Among other things, the purpose of the amendment, developed at the Ministry of Climate and Environment, is to clarify the rules for energy clusters and introduce systemic solutions that will encourage investors to operate as part of such entities. The new regulations stipulate that clusters will be allowed to cover the territory of 1 county, 5 neighboring municipalities and, in addition, are to operate in the area of one distribution network operator. There will be an obligation to enter the cluster register, to be maintained by the Energy Regulatory Office. The clusters are to be encouraged by preferences in the settlement of generated energy. Energy produced and then consumed by the parties to the cluster will be exempt from the RES fee and the cogeneration fee, as well as from obligations related to certificates of origin and energy efficiency. An additional incentive, prompting greater consumption of the energy produced within the cluster, is to be a discount on the variable components of distribution fees for self-consumption in excess of 60%. To take advantage of these exemptions, clusters will have to meet a number of new requirements. By the end of 2026, at least 30% of the energy generated and fed into the grid by the parties to the cluster agreement must come from RES, and the total capacity of the installed installations in the energy cluster – not to exceed 150 MW, and to allow covering during the year not less than 40% of the total annual demand of the customers included in the energy cluster. The capacity of energy storage facilities within the energy cluster should be at least 2% of the total capacity of the generation facilities in the cluster.

The amended RES Act also includes provisions for "hybrid renewable energy installations". According to the new regulations, hybrid RES installations will only be allowed to operate in conjunction with an energy storage facility. The new regulations, which are included in the amendment being processed in parliament, also concern the rules for concluding energy sales agreements known as PPAs. They impose an obligation on a RES energy producer selling energy under a PPA to provide information on the most important terms and conditions of the agreement to the Energy Regulatory Office.

Other changes introduced by the amendment adopted by the Senate include simplification of administrative procedures, including an exemption from a construction permit for photovoltaic installations of up to 150 kW, as well as the creation of a National Renewable Energy Contact Point. Its task is to support entrepreneurs in the implementation of RES investments.

GRAMWZIELONE.PL

Editorial office
gramwzielone.pl

GE Renewable Energy will modernize pumped storage hydropower plant in Poland

GE Hydro Solutions will replace four 125 MW pumped turbines and generators of Porąbka-Żar, supporting Poland in accelerating its energy transition. The modernisation project will extend the lifetime of the hydropower plant for several decades and help stabilize the grid in the country.

Photo. Upper reservoir PSH Porąbka-Żar

Source: Wikimedia Commons, Jendrusk

On the twenty-seventh of May GE Renewable Energy has signed a contract with PGE Odnawialna S.A. to replace the four 125 MW pumped turbines and generators of the Porąbka-Żar pumped hydro storage plant in Poland. This rehabilitation contract aims at extending the lifetime of the hydropower plant for several decades by completely replacing the more than 40-year-old turbines with new, reliable and high efficiency pumped turbines and motor generators.

Pascal Radue, President and CEO of GE's Hydro Solutions, said, "This rehabilitation project is the first large-scale rehabilitation project of its kind in Poland in 40 years. We are delighted to be part of it and support PGE Odnawialna S.A. in this upgrade process. This demonstrates that Poland makes every effort to achieve the Net Zero goal by 2050. This new equipment will help increase the flexibility and reliability of the plant and consequently stabilize the grid in the country".

GE Hydro Solutions will be responsible for the design, the manufacturing and the supply of the new equipment as well as the excitation and governing systems. GE will also supervise the erection and commissioning of the four new units. The special feature of this project is that GE Hydro Solutions will replace the existing stay rings as well as the existing stay vanes by new ones specially designed for Porąbka-Żar. Due to the confined workspace, the technology used, the cutting and welding processes will be specific to this project.

Porąbka-Żar is the second largest pumped storage power plant in Poland with an installed capacity of 500 MW. It plays a significant role in power generation in the country and provides important ancillary services to the Polish electricity system. The commercial operation of the four units is expected beginning of 2028.

Waldemar Oldenburger
Communications, Hydro Solutions
GE Renewable Energy

ZEW Niedzica will be the integrator of "green" assets of the Azoty Group

ZEW Niedzica will be the integrator of the group's "green" energy assets, Azoty Group President Tomasz Hinc indicated in an interview with PAP. He added that ZEW Niedzica will be the headquarters of the newly established company for this purpose.

"We have established the Azoty Energia Group company, which will bring together all green energy assets of the capital group. Capital integration with the Niedzica hydropower plant complex (ZEW Niedzica), the Brzezinka photovoltaic power plant and RES assets located in factories or in close proximity to the group's factories will be carried out by Grupa Azoty Energia", Tomasz Hinc, told PAP. He added that this company is already in operation. "We are ready to successfully merge with ZEW Niedzica", he said. – he assured. As he said, Azoty Group's activities are aimed at making ZEW Niedzica an integrator of Azoty Group's energy assets.

"The Azoty Group is a large, strong organization and has a bright outlook. We want to expand our green energy assets strongly. In ZEW there are experienced specialists with unique competencies who have been successfully involved in green energy for years. It is difficult to find such specialists on the market today. This is a great opportunity for development, through integration for both companies and Małopolska province". – Tomasz Hinc explained.

Azoty Group announced in September 2022 that, following due diligence and valuation of the Niedzica hydropower plant complex, it had decided to apply to the State Treasury, the sole shareholder of ZEW Niedzica, for capital integration of the company within the Azoty Group. As Azoty Group indicated at the time, "further steps regarding the potential implementation of this integration and its optimal structuring will be subject to arrangements with the State Treasury"

Editorial office
CIRE.pl

Tauron plans a pumped storage hydropower plant in Rożnów

The Tauron Group plans to build a 700 MW pumped storage hydropower plant in Rożnów, Małopolska, by 2027 at the latest. The final investment, the cost of which is estimated at around PLN 6 billion, still depends on a number of factors, including an environmental decision. However, the company's CEO Paweł Szczeszek stresses that this type of investment, which is the most popular form of energy storage in the EU, is a necessity.

We are planning to start an investment at Rożnowskie Lake, involving the construction of a pumped storage hydropower plant with a installed capacity of 700 MW and storage capacity of 3,500 MWh. It is easy to calculate that a power plant with such parameters will be able to operate at full capacity of 700 MW for five hours", says Pawel Szczeszek.

The cost of the investment was initially estimated at about PLN 6 billion, but Tauron stipulated that the final decision on the construction of the ESP in Rożnów depends on the environmental inventory and "on the preparation of the financial assembly". The company has not given more details so far, but its planned investment was included in last year's document "The Role of pumped storage power plants in the national electricity system: conditions and directions for development", prepared by a team of experts appointed by the prime minister. The timetable adopted therein stipulates that the feasibility study for the Rożnów PSH is to be completed before the end of this year, while the construction permit and signing of the contract with the general contractor are to take place in the last quarter of 2025 and the first quarter of 2026, respectively. Significantly, the investment planned by Tauron is one of three considered by the Expert Team for the construction of pumped storage hydropower plants and possible to be implemented within the next decade. The other two are the 750 MW ESP Młoty, near Bystrzyca Klodzka, an investment by the PGE Group, and Tolkmicko (Neo Energy Group, 1,040 MW) on the Vistula Lagoon.

Experts also note that Poland, after years of stagnation, is returning to the concept of building pumped storage hydropower plants, which is also reflected in the law on pumped storage hydropower plants and associated investments, signed at the end of May this year. The purpose of the newly adopted regulation is primarily to simplify and shorten administrative.

GRAMWZIELONE.PL

Editorial office
gramwzielone.pl

Oder special act approved by the Council of Ministers

The Council of Ministers accepted the draft of The Oder River revitalization act, submitted by the Minister of Infrastructure on May 17th. The law aims to introduce systemic solutions that will allow the restoration of natural resources on the Oder and in its basin, prevent future events similar to last summer, better respond to existing threats, and ultimately reduce pressure on the aquatic environment.

The draft of The Oder River revitalization act contains solutions divided into three key areas. The first is investments, for which funding of PLN 1.2 billion will be provided. Support will include restoration projects and investments to increase water levels on the Oder and its tributaries. Additional support is also planned for investments in the area of water and wastewater management in the Oder basin, including the construction or modernization of 123 wastewater treatment plants and the construction or modernization of 259 investments in sewerage networks. The cost of the planned necessary investments was estimated at PLN 4.53 billion, including PLN 2.9 billion for the construction of a new sewage network and PLN 1.63 billion for investments in sewage treatment plants. As a result of these investments, about 2,100 kilometers of sewerage network will be built and more than 230 kilometers will be modernized. In addition, the law provides for the retrofitting of firefighting units in the Opolskie, Silesian, Lower Silesian, Lubuskie and West Pomeranian provinces with motor boats, as well as Environmental Protection Inspection research centers with the necessary equipment to improve laboratory testing. The new regulations will also provide changes to the water service fee system, which will mobilize entrepreneurs to apply pro-environmental solutions to saline water discharge, including through the construction of drought retention reservoirs or wastewater treatment facilities.

The second area of the bill's impact is procedural facilitation for planned investments to speed up their implementation. To this end, the bill introduces the possibility of applying the provisions of the Flood Control Act to investments on the Oder, shortening the administrative deadlines for obtaining, among other things, construction permits, or putting these investments into operation.

The law also introduced new solutions in the area of inspection and sanctioning, including the establishment of the Water Inspectorate within the structure of the State Water Holding Polish Waters, a uniformed service that will allow, among other things, faster disclosure of incidents or violations that could cause damage to the water environment. The service will have a number of inspection powers, including the right to block illegally constructed wastewater discharge points or impose fines for illegal water use. In addition, the bill provides for an increase in fines for water management offenses.

Press office
Ministry of Infrastructure

Capacity of Rzeszów reservoir doubled

State Water Holding Polish Waters in Rzeszów has completed the implementation of the task titled "Reconstruction of the original capacity of the Rzeszów Reservoir on the Wisłok River". The main objective of the project was to improve water retention conditions in the Rzeszów Reservoir. Thanks to the investment, the volume of the reservoir has doubled and is now about 1.2 million m³.

Source: State Water Holding Polish Waters

Photo: Water barrage on the Wisłok River in Rzeszów

The ceremonial acceptance of the task took place on April twenty-eighth at the Rzeszów Reservoir. The event was attended, among others, by Grzegorz Witkowski – Undersecretary of State at the Ministry of Infrastructure, Mr. Krzysztof Sobolewski – Secretary General of the Law and Justice party and member of the Polish Parliament, Ewa Leniart – Voivode of Subcarpathia Province, Jerzy Borcz – Chairman of the Subcarpathia Province Regional Assembly, Jan Jodłowski – Director of the Department of Environmental Protection at the County office and Deputy Mayor of the City of Rzeszów – Dariusz Urbanik and Jolanta Kaźmierczak. Deputy President of the State Water Holding Polish Waters, Pawel Rusiecki, stressed that the completion of the de-silting of the Rzeszów Reservoir provides a guarantee of safety for residents. "Safety is the key word in the context of this investment. In the flood control area, the deepening of the reservoir gives a chance to flatten the flood wave. In the retention aspect, it gives security in times of drought, of course, as a reservoir that guarantees drinking water for the residents of Rzeszów" – he said.

Work on the Rzeszów Reservoir began in October 2019, while acceptance of the work took place in December 2022. The start of the work required the prior relocation of the protected water caltrop to other water bodies. A bird nesting barge, filled with gravel and sand, was also anchored to create favorable nesting conditions for the common tern. The project was divided into two phases. Stage I covered an area of 1.1 kilometers from the dam upstream, while Stage II was implemented over a further 3 kilometres, all of which were protected within the Natura 2000 area. A total of about 720,000 m³ of silt was excavated from 32 hectares of the reservoir. A specialized bucket-wheel excavator, suction dredger and excavatorss with bucket attachment, on pontoons, were used to remove the deposited sediment. The sludge was transported to the shore by conveyor belts and pipelines, and then taken by trucks to Siedliska in Lubenia municipality. The proper conduct of the de-silting work on the Rzeszów Reservoir was supervised by a nature supervisor, and the rules for conducting the work were established by the Regional Director for Environmental Protection in Rzeszów. Thanks to the implementation of the task by State Water Holding Polish Waters, the anti-flood safety of Rzeszów residents has increased, among other things, and access to drinking water resources has improved, as the city's water intake is located in nearby Zwięczyca (district of Rzeszów).

The total value of the investment was nearly PLN 70.5 million, while the subsidy obtained from the "Operational Program Infrastructure and Environment Measure 2.5 Improvement of the quality of the urban environment, priority axis II Environmental protection, including adaptation to climate change" is more than PLN 42 million.

Press office
State Water Holding Polish Waters

Lesser Poland – step to build reservoir in Dąbrowa County

State Water Holding Polish Waters, Regional Water Management Authority in Cracow has signed a letter of intent with the municipalities of Dąbrowa County (Lesser Poland Voivodeship) regarding cooperation in the implementation of the Żelazówka Reservoir on the Breń River.

The construction of the reservoir will increase the retention of the catchment area of the Breń River and thus contribute to the growth of surface and groundwater resources. At the same time, flood protection of the area and Dąbrowa Tarnowska will increase. The flood capacity of the retention reservoir will make it possible to collect water carried by a flood wave and avoid losses. The facility will be located in the Dąbrowa Tarnowska municipality. The investment is included in the list of activities for the Vistula River basin area in the flood risk management plan for the Vistula River basin area, as well as in the Drought mitigation plan. The construction of a retention reservoir on the Breń River was already included by Dąbrowa Tarnowska councilors in the Żelazówka village renewal plan of March 2011. The planned 19-hectare facility will have a total capacity of 252,000 m³. Its task is to protect against recurring floods in Dąbrowa Tarnowska, Swarzów, Podbórz and Smęgorzewo caused by flooding of the Breń River.

Wojciech Kwinta
inzynieria.com

TRMEW news

The General Assembly (this year's electoral) and the Hydropower Congress 2023 are behind us. The few days spent with you have passed in a blink of an eye! "Batteries" recharged and I am looking forward to our next meeting, which traditionally, will take place at the end of this year. I will certainly keep you informed about it!

Source: Wioleta Smolarczyk

Photo 1. From the top; commemorative photo of congress participants at Sulejów II SHP, presentation given by Łukasz Kalina and Michal Kubecki on repowering and automation of SHPs, visit to IOZE hydro production facility

I know that many of you, for various reasons, could not attend our meeting, so it is with great pleasure that I present the TRMEW authorities elected during the General Assembly. TRMEW Executive Board is composed of:

- President: Ewa Malicka,
- Vice Presidents: Radosław Koropis, Mieczysław Majewski,
- Board Members: Rafał Gawlikowski, Rafał Kochanowski, Marcin Kamiński and Marcin Sypek,
- Audit Committee: Andrzej Grześ, Waldemar Jęcek, Mirosław Bereźnicki,
- Colleague Court: Walenty Kobus, Artur Barański, Włodzimierz Majewski.

We wish the new authorities every success, determination in achieving the Association's goals and a lot of patience!

And what happened during the Congress? As usual, our speakers imparted a lot of substantive knowledge and clarified the doubts of the meeting participants. In addition, we visited the IOZE hydro production plant in Szczukowice. In the evening, there were also heated discussions during dinner – on the topic of hydropower, of course! On the second day, courtesy of a member of the TRMEW member and owner of Sulejów II SHP, Mr. Tadeusz Jakubec, we were able to visit this facility and also visited Smardzewice SHP, owned by PGE Energia Odnawialna.

I would like to thank our speakers – both those who participated stationary – Ewa Malicka – TRMEW, Radek Koropis – REN-PRO Sp. z o.o., Michał Lis – "Enegetyka Wodna" Editorial office, Łukasz Kalina and Michał Kubecki – IOZE Hydro, as well as the participants in the panel discussion: Ms Paulina Grądzik – Lewiatan Confederation, Mr Artur Leśniak – Veolia Energia Polska S.A., Mr Paweł Jabłoński – Ministry of Infrastructure and Mr Janusz Markowski – BNP Paribas Bank Polska S.A. Thank you also for your participation in the meeting. I am pleased to inform you that our Association has joined the ranks of the Vistula Employers' Association Lewiatan. This is a great support for us, because although we have so far closely cooperated and submitted joint positions on legislative matters with the Lewiatan Confederation, today, as formal members, we can benefit the additional privileges of participation in this organisation.

Source: Wioleta Smolarczyk

Photo 2. Smardzewice SHP powerhouse

After my extended absence from the TRMEW office since mid-September, I am back to work full-time, with many ideas and, most importantly, I will be able to communicate with you more often and pass on industry news. I am very much looking forward to that!

See you and hear from you!

Monika Grzybek
Office manager
TRMEW

News of the Polish Committee of Large Dams POLCOLD

Representatives of Polish Large Dams Committee POLCOLD attended the annual meeting of the International Committee on Large Dams, held June 10–16 in Gothenburg, which included a plenary meeting of national committee delegates.

We made changes in the composition of the Board of Directors, appointed a new ICOLD Vice President in the person of Lisa Bensasson from Greece, responsible for Europe, and a new President of the European Club (EURCOLD), also from Greece, Serafina Lazaridou. The financial balance sheet for 2022 was approved, and we approved the financial plan for 2024. ICOLD is an organization in which functions are performed socially, and the income of the organization is the contributions of member countries and sometimes participation in projects such as ETIP HYDROPOWER, about which more below.

The meeting was also saturated with substantive content. Presentations dealt with current topics, related to the impact of climate change on dam safety, or the design and construction of dams with sustainable development principles. In addition, there were panel discussions addressing issues of women's participation in hydroengineering, or caring for public perception of hydrotechnical investments. It is worth mentioning that the indicated problems are similar all over the world, as well as familiar to representatives of the Polish branch of ICOLD.

In parallel, meetings and deliberations of Technical Committees were conducted with the participation (online) of Polish representatives, especially Tailings Dams & Waste Lagoons, Levees Technical Committee, Dam Safety and Historical Water Structure.

We have also made a selection of topics for the ICOLD Congress, which is planned for Chengdu, China, in 2025. These are:

Q1: Adaptation of new dams and reservoirs to climate change, Q2: Dam and embankment safety in a changing world,

Q3: Safety of dams and embankments in the face of extreme events and climate change,

Q4: Behavior and safety of dams with high retention and hydropower functions under earthquake conditions.

The conference also included a meeting of EURCOLD, where current issues of cooperation between national committees were discussed, and a delegate from Poland gave a short presentation on large dams in our country and invited to the 20th International Conference on Technical Control of Dams, to be held September 12–15 in Chorzow, included in ICOLD's "Events". This Conference is organized by the Warsaw University of Technology, and POLCOLD is its co-organizer. During this Conference, there will be a special session dedicated to the Upper Silesian Water Supply Company on the occasion of its 140 years of existence.

In February of this year, a Young Engineers Club (Technical Committee ZX2, YOUNG ENGINEERS) was established at POLCOLD, whose activities are coordinated by Dagmara Zelaya-Wziątek, who is responsible for the work and contacts with the international club. As part of this activity, a series of webinars was initiated under the title: "The future of tailings pond engineering: An Introduction to a diverse career with enormous opportunities". It is hoped that the initiative will arouse interest in the club and attract a multitude of young engineers. The doors of the Club are wide open!

The call for work in the ETIP HYDROPOWER hydropower program (2022–2025), which will be led by EURCOLD, is still ongoing. The project has a budget of about €1 million and will run for the next 3 years. The main objectives are:

1. launching a financially stable organization to support and represent hydropower and dams in the European Union,
2. communicating, disseminating and presenting hydropower as part of the SET Plan (Strategic Energy Technology Plan – a committee of representatives of member countries planning an energy system for the Union),
3. facilitate direct implementation of research results and strategic activities by promoting and supporting industry collaboration.

Those interested in participating are welcome to do so, or register for the program directly through https://hydro-consultation.eu/participant-area/.

Piotr Śliwiński
Chairman
Polish Committee of Large Dams POLCOLD

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Calendar

11–12.09.2023 Rzeszów, Poland	**VIII Scientific Conference Energy Security Pillars and Development Perspective** Organizer – Ignacy Lukasiewicz Institute for Energy Policy	www.instytutpe.pl
12–15.09.2023 Chorzów, Poland	**XX Technical Dam Control International Conference** Organizer – Warsaw University of Technology	www.tkz.is.pw.edu.pl/
28–29.09.2023 Zurych, Switzerland	**Digitalisation in Hydropower 2023** Organizator – vgbe Energy	www.vgbe.energy
4–6.10.2023 Rytro, Poland	**XXXI Technical and Science Conference Design & Exploitation of Electrical Machines & Drive** Organizer – Lukasiewicz – Upper Silesian Institute of Technology	www.git.lukasiewicz.gov.pl/ konferencja-pemine/
9–10.10.2023 Lublin, Poland	**National Economic Summit OSG 2023** Organizer – European Business Center	www.szczytosg.pl
16–18.10.2023 Edinburgh, Scotland	**HYDRO 2023** Organizer – Aqua-Media International	www.hydropower-dams.com/ hydro-2023/
19–20.10.2023 Uniejów, Poland	**VIII Smart Development Forum** Organizer – Smart Development Forum	www.irforum.pl/wydarzenie/
25–27.10.2023 Wrocław, Poland	**Polish Hydropower Conference HYDROFORUM 2023** Organizer – Polish Hydropower Association	www.hydroforum.tew.pl

Towarzystwo Elektrowni Wodnych

TRMEW

Polish Hydropower Conference

HYDROFORUM 2023

Scandic Wroclaw Hotel, Wroclaw (Poland), October 25-27th, 2023

HYDRO FORUM

The programme includes:

- Legal-economic constraints and development strategy
- New projects - technological trends
- River cascades (including a study visit to Malczyce HPP)
- Hydropower and water management
 - environmental impacts and socio-economic aspects
- HYDROFORUM Debate:
 Pumped storage hydropower and its dillemmas
- European Union for hydropower
 - promotional and research & development projects
- Non-conventional plants, including: energy recovery, hybrid, hydrokinetic, gravity, fish-friendly units and installations
- Impeller pumps in hydropower and water management, including pumps in turbine operation
- Operation & maintenance, including: auxiliary equipment, performance and diagnostic tests, repair
- Research and research & development works

Organisers:

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Polish Association for Small Hydropower Development
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Szewalski Institute of Fluid-Flow Machinery of the Polish Academy of Sciences
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Wroclaw University of Science and Technology, Faculty of Mechanical and Power Engineering
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Honorary patronage and partnership:

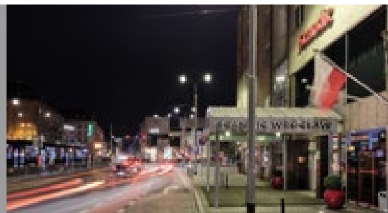
- **„Polish Waters" State Water Holding, *https://wody.gov.pl/***
- **Association of Polish Electrical Engineers, *https://sep.com.pl/en/***
- **Life NEXUS Project, *https://www.lifenexus.eu/***

Editorial collaboration and media patronage

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

WYDAWNICTWO IMP PAN

ENERGETYKA WODNA



Water Power & Dam Construction

From the World

22.03.2023 World first as Sebzor project certified against Hydropower Sustainability Standard

The Sebzor hydropower project in Tajikistan has become the first project in the world to be certified against the Hydropower Sustainability Standard, the hydropower sector's independent sustainability certification scheme which accredits hydropower projects that meet and exceed good practice in a wide range of sustainability topics. The 11 MW project, which is owned by Pamir Energy, was assessed 30 September – 5 October 2022, with a 60-day public consultation period following, which ended on 23 February 2023.

23.03.2023 US hydropower industry set to benefit from $200 million funding boost

More than $200 million in funding has been announced by the Biden-Harris Administration, through the US Department of Energy (DOE), for the modernization and expansion of hydroelectric power throughout America and the advancement of new marine energy technologies.

The funding will be available through the Hydroelectric Incentives Program, which is focused on maintaining and enhancing hydroelectric facilities to ensure generators continue to provide clean power, while improving dam safety and reducing environmental impacts. Applications are being accepted through two solicitations, with guidance issued by the DOE.

The Hydroelectric Production Incentives will provide up to $125 million in incentive payments to qualified hydroelectric facilities for electricity generated and sold in calendar years 2021 and 2022, while the Hydroelectric Efficiency Improvement Incentives will invest $75 million to enable the implementation of capital improvements to boost efficiency.

28.03.2023 EGP invests in satellite monitoring for hydropower plants

Enel Green Power (EGP) has announced it has successfully experimented with satellite positioning technology to monitor the infrastructure of hydropower plants and the mountainous areas where they are built.

In the innovative project, GPS Hydro, GNSS has been adopted for the specific requirements of systematic monitoring of the hydroelectric infrastructure. The feasibility and suitability of the technique had to be verified, even in unfavorable conditions for satellite visibility such as mountainous terrain, tall buildings and other structures, or vegetation. The company began an experiment at four sample sites, three in Italy and one in Spain: two dams (Gusana in Sardinia and Alanno in Abruzzo) and two hydraulic pipelines (Gandellino in Lombardy and Pampaneira in Andalusia). Gioacchino Bellia, Head of Hydro Innovation at Enel Green Power said these facilities were chosen because they were representative of four different types: an earthen dam, a concrete dam and two pipelines.

"At each of the four sites, the validity of the technology was tested for both signal reliability and data accuracy", Bellia explained. "The results have been decidedly positive, so much so that we have already initiated two additional projects in Italy and are considering others, in Spain and other countries where we are operative.

19.04.2023 Vattenfall plans major investments for new hydropower in Sweden

Vattenfall has announced plans to construct new hydropower stations with a total capacity of 720 MW in four locations across Sweden – the company's first investment in new hydropower in the country in more than twelve years.

The potential new hydropower stations could be built starting from 2026 and into the 2030s, with feasibility studies already underway to prepare future planned investment decisions. The aim of these new tations is to meet the increasing demand for fossil-free electricity, which is a prerequisite for achieving climate goals. The hydropower reservoirs are Sweden's green batteries, and by building new flexibility and control capabilities, a greater share of wind and solar power in the electricity system is also made possible.

The four locations for the potential hydropower stations are in Lake Storjuktan adjacent to Umeälven, Västerbotten, Lule river in Porju's power station and Harsprånget's power station, and Lule river in the Messaure power station. Final investment decisions have not yet been made and are subject to positive results in the feasibility studies.

25.04.2023 N:I:A team appointed on project to expand Greenland's largest hydroelectric plant

Greenland's largest hydroelectric power plant – the 45 MW Buksefjord project in Buksefjorden – is set to undergo an expansion with N:I:A, consisting of NIRAS, Inuplan, and AFRY, appointed as client consultant for the project. The expansion project will increase hydropower production from a maximum of 255 GWh to an expected future capacity of potentially 660 GWh annually. The builders of the project are Greenlandic company NunaGreen A/S and utility company Nukissiorfiit. The expansion of the power plant will involve connecting another lake to the power plant, as well as establishing a new 16 km transfer tunnel

From the World

from the current intake at Lake Kangerluarssunnguup Tasersua to Lake Isortuarsuup Tasia. This will increase the available amount of water from 352 million m³ to 1,248 million m³.

In addition to the 16 km long transfer tunnel, the project also includes creating a new power station with two turbines next to the existing plant, as well as the construction of several access, transport, and transverse tunnels. According to the current schedule, it is expected that the new part of the hydropower plant will be operational at the beginning of 2029.

09.05.2023 Hydropower companies launch the European Hydropower Alliance

Major players in the hydropower sector have announced the launch of the European Hydropower Alliance, which aims to promote the benefits of hydropower and its role in achieving the European Union's social, climate, and strategic objectives.

The alliance includes Statkraft, EDF, Enel Group, Iberdrola, EDP, Vattenfall, Fortum, VERBUND AG, Uniper, and ENGIE, who together represent a total installed hydropower capacity of over 110 GW. The alliance aims to recognize and promote the many benefits of hydropower, including its ability to compensate for the variability of intermittent renewables such as wind and solar through its flexibility and storage capacity.

The European Hydropower Alliance hopes to work closely with the European Union and other stakeholders to promote hydropower's many benefits and to ensure that the sector continues to play a vital role in achieving Europe's energy goals.

22.05.2023 SSE unveils plans to redevelop Sloy power station into pumped storage project

SSE Renewables has announced it is planning to convert the 152 MW Sloy hydropower Station into a pumped storage facility, with the transformed facility expected to deliver up to 25 GWh of long-duration electricity storage capacity, enabling it to provide firm and flexible renewable energy for up to 160 continuous hours. The announcement was made during a visit by Scotland's First Minister, Humza Yousaf, as part of the 80th-anniversary celebrations of the 1943 Hydro Electric Development (Scotland) Act, which pioneered hydroelectric power in the Scottish Glens. SSE's decision comes as the company awaits the UK Government's decision on supporting long-duration electricity storage, as outlined in the "British Energy Security Strategy" released last year.

06.06.2023 Nova Kakhovka dam breached in Ukraine, operator says it is beyond repair

The Nova Kakhovka dam located in the Russian-controlled southern part of Ukraine has been breached, with the dam's operator Ukrhydroenergo stating it is 'beyond repair'. Ukraine has claimed that Russia deliberately destroyed the dam, while Russia has suggested it is Ukraine who is responsible for the damage.

Images are being circulated on social media of water surging through the central section of the 30 m high dam, which is located on the Dniper river.

Ukrhydroenergo said in a statement: "As a result of detonation of the engine room from the inside, the Kakhovskaya HPP was completely destroyed. The station cannot be restored. According to the preliminary forecast, the reservoir is expected to be drained within 4 days. As of 9:00 a.m. on June 6, the water level in the Kakhovka reservoir is rapidly decreasing, and evacuations have begun from potential flood areas. Ukrainian personnel are monitoring all indicators.

08.06.2023 Global hydropower capacity grows by 34GW, but falls short of net zero 2050 targets, says IHA's World Hydropower Outlook

The International Hydropower Association (IHA) has released its inaugural World Hydropower Outlook, which reveals that global hydropower capacity grew by 34 GW in the past year. This includes 10 GW of pumped storage, and marks the first time since 2016 that over 30 GW of hydropower capacity has been added in a single year. Hydropower currently accounts for more than 15% of the world's electricity generation.

The report also highlights a pipeline of 590 GW of hydropower projects currently under development, including 214 GW of pumped storage. However, despite the positive growth, there is still a significant shortfall in capacity to meet the net-zero targets for 2050. Even if all planned developments are completed, there remains a gap of over 700 GW, which is roughly equivalent to the combined electricity generation capacity of India and Japan.

In terms of regional growth, China led in increasing its hydropower capacity by 24 GW, while Europe experienced unprecedented success with a capacity increase of 3 GW. North and South America added 1 GW each, and central and southern Asia installed nearly 2 GW, including notable projects in Pakistan and India.

On the small hydropower trail – HYPOSO Study Tour summary

In the first half of May, twenty three representatives of hydropower industry from Latin America and Africa had an unique opportunity to take part in a business study tour and visit hydropower plants and industry's equipment production facilities around Germany, Austria and Italy. This study tour was the culminating part of the HYPOSO project and it's aims were to exchange of knowledge and experience between participants and bring together business partners with the European hydropower industry.

Between the third and the thirteenth of May, the HYPOSO Business Cooperation Study Tour took place, hosting, twenty three participants from Cameroon, Uganda, Bolivia, Ecuador and Colombia. All of them were directly connected with a hydropower sector in their target countries, in positions of presidents or general directors of hydropower plants operator companies, HYPOSO pilot sites owners, hydropower project developers, general managers or projects managers representing design offices, lord mayors, civil engineers and energy planning specialists. They had the opportunity during the tour to learn about the offerings of leading European hydropower equipment manufacturers, as well as to visit hydropower plants, including new facilities built to the highest applicable technical and environmental standards (St Anton, Obervellach II, Sellrain, Fotsch), as well as the Jochenstein and Möhne hydropower plants, which boast an interesting history and many years of service to the national electricity systems. The route crossed Bavaria, the picturesque alpine areas of Austria and Italy, the vast lowlands of North Rhine-Westphalia and the Netherlands, leading all the way to the North Sea. The Study Tour culminated in the Netherlands at the Final Event, which took place at IHE Delft Institute for Water Education. During this conference the results of the HYPOSO project were summarised and participants could take part in a discussion concerning challenges of small hydropower development in Africa, Latin America and Europe. The Study Tour was fully organised from scratch and leaded by Michał Lis and Dominika Wójtowicz (TRMEW, "Energetyka Wodna" magazine) with a support of Bernhard Pelikan (Frosio Next). Other project partners involved in organisation of the Study Tour included Ingo Ball (WIP Renewable Energies) assisting in obtaining visas by participants, Miroslav Marence (IHE Delft) organising the Final Event and Ewa Malicka (TRMEW) executing the overall project monitoring.

Day 1

The starting point of HYPOSO Study Tour was Munich, providing convenient air travel connections. Due to different arrival times, this day was reserved for grouping of the attendees. The tour started with Munich's Old Town guided tour, during which participants had a chance to meet each other and learn about rich Bavarian history. The first point on city tour was Hofbrauhaus, the historic brewery and beer hall, where participants could try regional cuisine and experience Bavarian culture, including live music performances. Later in the tour the group has seen such iconic sites as: Marienplatz, Frauenkirche, King Maximilian Joseph Platz surrounded among others by National Theatre and Munich Residence, as well as Fünf Höfe shopping mall, an example of contemporary architecture designed by Jacques Herzog and Pierre de Meuron. The first day was ended with reception dinner, during which participants were welcomed by Michał Lis, the organiser of the Study Tour and Ingo Ball, the HYPOSO project coordinator.

Day 2

The group started the second day of HYPOSO Study Tour from sightseeing the Jochenstein hydropower, the facility with eye-catching architecture, 132 MW capacity and 850 GWh annual production, operated by Verbund AG. Jochenstein was the first Danube power plant in Austria after the Second World War and the biggest run-of-river power plant in Central Europe. It remains Germany's biggest run of-river power plant to this day. The weir system lies on the Austrian side of the river, the locks on the German side.

Photo 1. From above: registration booth at the Leonardo hotel in Munich, interior of the Hofbrauhaus restaurant

Located between them is the powerhouse, in which five Kaplan turbines are installed vertically. HYPOSO Study Tour group visited also Global Hydro Energy and Voith Hydro companies, where participants learned about water to wire solutions, remote controlling systems, including digital power plant and digital support centre concepts, water turbines designed for small hydropower (including M-Line and Stream Divers solutions), as well as they had a possibility to see how work their impressive production facilities. Thank you kindly: Ewald Karl, Thomas Sageder, Natalia Silva Vera from Global Hydro Energy and Radu Cârja, Stuart King, Sebastian Mayerhofer from Voith Hydro for kind welcome, hospitality and sharing interesting and valuable information about your companies, products and possibilities of cooperation.

Day 3

At the third day the route directed the group to Gugler Water Turbines company, where in a family friendly atmosphere and in beautiful headquarters in Feldkirchen

Photo 2. From left: Jochenstein hydropower plant, Global Hydro production facility, Voith Large Hydro division

attendees learned about company's hydropower units and possibilities of their application on examples from Latin America and Africa. One hundred year Gugler family experience in the field of hydropower and one thousand units designed and delivered worldwide were a great topics for endless discussions. Then attendees visited modern Andritz Hydro laboratory in Linz, where hydro units are carefully tested to guarantee the highest efficiency for the most demanding customers. The third point on the route was Braun Maschinenfabrik company, presenting us their wide offer of the highest quality hydropower equipment, including racks, trash rack cleaners, radial gates, flap gates, bottom outlet gates, standing and roller gates, stop logs and other custom made special structures. It was a pleasure to visit outstanding production facility with historical exhibition, remembering the times of Emperor Franz Joseph I, who visited this factory in 1890 year (producing files at that time). The last thematic visit that day was at 905 kW small hydropower plant owned by Braun family and built in 2019, which represents modern, state of art and sustainable way of hydropower engineering, delivering around 3 GWh of clean energy annually. For the most important technical specification of this SHP Ager can be count: 1,805 mm diameter and four baldes Kaplan turbine utilising 17 m³ flow rate and 5.95 m net head, horizontal chain-driven trash rack cleaner and active fish pass based on hydropower screw. The group finished this day with a pleasant Salzburg city tour. Attendees could admire the historic centre, which was enlisted as a UNESCO World Heritage Site in 1996, including Hohensalzburg Fortress, Salzburg Cathedral, Residentplatz, Café Tomaselli (the oldest café in Western Europe) and Mozart's birthplace. This city tour ended with the dinner at Zipferbeerhaus restaurant, one of the oldest beer taverns in Salzburg's city center. Thank you kindly for the warm welcome: Alois Gugler, Gerhard Gugler, Lukas Peer, Florian Altendorfer from Gugler, Schneeberger Markus, Peter Grafenberger from Andritz, Lennart M. Braun and Alfred Mayr from Braun.

Day 4

HYPOSO group spent the whole fourth day visiting Obervellach II hydropower plant owned by ÖBB, which is now under construction. After the Obervellach power plant reached the end of its technical life, intensive construction and blasting work has been going on

Photo 3. From above: presentation at Gugler headquarters, Study Tour participants at Andritz Hydro laboratory, sightseeing Salzburg – Kapitelplatz, Ager SHP owned by Braun family

in the area for some time. Among others, intensive work is being carried out on the concrete structures of the water intakes on Mallnitzbach, Dösenbach and Kaponigbach. The Obervellach II project will replace the existing facilities at the Obervellach and Mallnitz locations. The planned systems will increase production by more than 30%. The construction of this facility started in 2020 and the commissioning of the newly established power plant is planned for March 2024. The technical data of this hydropower plant are presented below:

- capacity – 37 MW,
- annual energy production – 125 GWh,
- flow rate – 9 m^3/s,
- head – 488 m,
- storage capacity – 60,000 m^3,
- volume of balancing pond 60,000 m^3.

The group was lucky to be in a perfect moment in time to see all equipment prepared in power house for installation and walk inside the surge tank cavern, which will be filled with water during hydropower plant operation. As the layout of the power plant with three intakes, penstocks, cavern, powerhouse, balancing pond and additional SHP is quite complicated and spread over a large area, it took the while to understand this sophisticated beauty of this hydrotechnical project. It is interesting the produced energy in this plant will be fully used for Austrian railway, which has another frequency (16.7 Hz) that usual in the electrical grid. In this case the investor decided to build a second small hydropower plant to fulfil the internal electrical energy needs of the bigger plant. Constructing the new hydroelectric power plant Obervellach II offers many advantages for the environment. Despite the increase in the self-generation of traction current, the overall ecological situation will also be improved vastly. Minimum flow rates are achieved in line with state-of-the-art technology. The lives of residents in the vicinity of existing power plants will be significantly improved by relocating the power plant to the existing industrial site thus reducing operational noise and vibrations. The new penstock laid underground, unlike in the past, will contribute significantly the beautification of the landscape. All participants and organisers would like to kindly thank the OBB Infra company and especially Clemens Oberlechner for great presentation of the hydropower plant and transfer participants by buses around the whole facility.

Day 5

At the fifth day HYPOSO group moved near Bolzano in Italy and had a pleasure to visit open to visitors St. Anton hydropower plant, equipped with hydro units produced by Troyer with total 90 MW capacity. This state of art, flexible hydropower plant replaced the current power plant, which was taken out of operation. The first hydropower plant was built between 1948 and 1951 with a head of 600 m and a maximum capacity of 72 MW. The St. Anton hydropower station was renovated and modernised between 2016 and 2019 and is a model project for technical innovation and environmentally conscious, sustainable use of renewable energy sources throughout Europe. New concept including underground gallery performing the function of 90,000 m^3 balancing tank, solved some previous problems with "hydropeaking" on Talfer river, causing people and river organisms. The underground gallery was originally designed to be open for visitors, who can have a unimaginable walk on a special platform above the water level and admire colourful light show. The day was finished with pleasant guided tour around the historic city centre of Bolzano, which charmed participants with it's amazing architecture and interesting history. On the walking route there were some must-have points to see, among others: Piazza Walther, Via dei Portici, Duomo di Bolzano, Palazzo Pro-





Photo 4. From left: Obervellach II hydropower plant – powerhouse, intake, participants ready for the tour around the site, switchyard and pipeline in the background, surge tank cavern

Photo 5. From left: St. Anton hydropower plant – underground powerhouse, balancing tank, Bolzano – Piazza Walther and Duomo di Bolzano, Rencio – 7th century well " Zigglbrunnen"

vinciale, Palazzo Mercantile, Piazza delle Erbe. At the end of the day, participants were able to enjoy the South Tirol cuisine and spirit in the Franziskaner Stuben restaurant. Our group would like to kindly thank Eisackwerk company for enabling us visiting St. Anton hydropower plant and Rafael Farfan from Troyer company for the plant's presentation and sharing us great knowledge about this facility.

Day 6

The sixth day was intended for visiting Troyer company, where attendees could take a closer look at the whole production process of high quality hydropower turbines, ball valves and control and automation systems. The modern and extensive production facility includes the following departments: mechanical production, welding, varnishing, preassembly, electrotechnics, software and automation and service and maintenance. The participants could also learn about the challenges concerning operation of hydropower plants on rivers with glacier characteristic, carrying increased amount of bedrock material. This causes rapid erosion of turbine runners, which demands the application of special protective coatings to increase their durability. An unplanned point of this day was a visit in SHP Wiesen in Vipiteno, owned by Wiesen Konsortial and equipped with Troyer's three Francis turbines, having total capacity 3,295 kW. They were chosen in that way, each of them has a different capacity and can work independently or together in any configuration, which enables the SHP to operate in optimal range and achieve the maximum production, due to variable river flows. The last point of this day was a visit in Wild Metal company. The modern and motorbike style headquarters was an ideal place to admire the metal artwork of company's specialists. Producing in the company water intakes systems which feature many smart details, ensuring not to miss any drop of water. The company offers among others: various intake screens, including Coanda screens, trash rack cleaning machines, debris handling systems, gates, pipes, water intake boxes and desander basins. The visit was eventful as well as completed with the possibility to experience the wonderful sound of Harley-Davidson motorbike and enjoy the delightful snacks. Thank you kindly for the warm welcome: Norbert Troyer, Federico Bruccoleri from Troyer and Markus Wild, Daniel Polig from Wild Metal.

Day 7

At the seventh day of HYPOSO Study Tour the road took the group to Tiroler Rohre, one of the biggest European producers of ductile iron pipes, which have many possible applications: drinking water, disposal and wastewater, hydropower, snow-making, extinguishing water and sponge city solutions. During the exciting tour, participants had a possibility to learn about the whole process of producing pipes from the raw material to high quality final product, which could be utilised up to 100 years. What is interesting, Tiroler Rohre works in circular economy, what means the company uses scrap to produce pipes, so in some cases old pipes can be used for production of the new ones. The next points on our route were Sellrain and Fotsch SHPs, which are equipped with Tiroler Rohre pipes and utilise the potential of Melach and Fotscherbach streams. The Sellrain hydropower with approx. 12 MW

Photo 6. From left: Troyer production facility, Wiesen SHP powerhouse, Wild Metal production facility

capacity delivered by two 4-jet Pelton turbines consists of two water intakes (delivered by Wild Metal), pipelines of approximately 9,24 km and the power plant, which is located in a cavern. The construction of the power plant began in autumn 2021 and the cost of this investment is approximately €52.0 million. On the other hand, SHP Fotsch is equipped with 2,23 km pipeline, 5-jet Pelton turbine with 2 MW capacity. What is interesting, Sellrain SHP utilises water used earlier by Fotsch SHP. Generators to these power plants were delivered by Nidec Leroy-Somer and AEM-Anhaltische Elektromotorenwerk Dessau. These small hydropower plants are an initiative of a group including 6 local communities. The group would like to kindly thank Thomas Fritz from Tiroler Rohre and Charly Jansenberger, representing Sellrain and Fotsch SHPs for great hosting.

Day 8

The eighth day of HYPOSO Study Tour welcomed the group with rain, however it didn't reduce the enthusiasm of the participants, because for this morning a visit in Linderhof Palace was planned. The palace is located in southwest Bavaria near the village of Ettal and was built by King Ludwig II. During this visit, Study Tour participants had an unique occasion to admire outstanding example of Neo-Baroque architectural style of the late 19th century. The palace and surrounding landscape park were an amazing background for networking and creative discussions for the entire group. After sightseeing the group took a long route to Weißenburg in Middle Franconia, where the headquarters of Ossberger company is located. During an interesting presentation, participants could learn about the scope of the company's production profile and patented Crossflow Turbines, which are Ossberger's core business. The simplicity of this kind of hydro turbines with only three moving parts ensures minimum maintenance and maximum technical reliability, which is a crucial factor for hydropower projects located in remote areas. What is

Photo 8. From above: Linderhof Palace – a commemorative photo of the participants, Ossberger company presentation

Photo 7. From above: Tiroler Rohre pipes strength demonstration, Sellrain SHP – underground powerhouse, water intake

Photo 9. From left: Möhne Dam – general view from lower water side, powerhouse, bottom outlets

more, Crossflow Turbines require 5% of the design water volume to start operation and cope with fluctuating water volumes, which makes them a perfect solution for off-grid implementations. After theoretical introduction, the attendees were invited to the factory, where could see individual stages of turbine's production, including preparation of initial components, results of complicated welding process and finished products ready for shipment worldwide. The group would like to kindly thank Dr. Karl-Friedrich Ossberger, Jessica Mayer, Markus Sauerbeck and Holger Franke for warm-family atmosphere and excellent hosting.

Day 9

The ninth day of HYPOSO Study Tour was mainly a "travel day" due to the fact the group had to reach Delft in Netherlands, which was the final point of the tour. Nevertheless, there was planned one more important visit at Möhne Dam, operating by public company Ruhrverband, which construction created one of the largest water reservoirs in Europe at that time. It was put into operation in 1913, after merely five years of construction work. The Möhne Reservoir used to be the backbone of the Ruhr area's water supply and still accounts for 28% of total storage capacity, thus making an essential contribution to controlling the River Ruhr's runoff. The masonry dam with its slightly arched shape is made of quarry stones. It is 650 m long, up to 40 m high and can hold up to 134.5 mln m³ of water. This dam was breached by RAF Lancaster bombers ("The Dambusters") during Operation Chastise on the night of 16–17 May 1943, together with the Edersee dam in northern Hesse. Bouncing bombs had been constructed in that way, they were able to skip over the protective nets that hung in the water. A 77 m by 22 m hole was blown in the dam with the resulting flood wave killing at least 1,579 people. The Möhne Dam was repaired by 23 September 1943. Visiting the dam and walking on the central part of the crest six days before 80th anniversary of its bombardment was conducive to reflection and contemplation about history, present and future. Since the original hydropower station was completely destroyed in 1943, a replacement had to be built. The new main power station was built between 1950 and 1954 about 250 m downstream the dam, on the left bank of the compensation pond. A maximum of 24 m³/s flow is supplied to two vertical axis Kaplan turbines, which can generate up to 12.9 GWh of electricity on an annual average with generator outputs of 3,500 kW each. Nowadays Möhne hydropower plant is operating as peaking power plant, adjusting production to the current demand for energy in the electrical grid, ensuring production at a time when energy prices are at their highest point. What is surprising, hydropower plant does not operate nowadays with installed 7 MW capacity, due to the fact of unfavourable rates for facilities over 5 MW, so it is more profitable for the operator to limit its capacity. The group would like to kindly thank Ludger Harder for unforgettable tour around this timeless facility.

Photo 10. From left: welcome speech given by Eddy Moors, Director of IHE Delft, discussion panel

Day 10

The last day of the HYPOSO Study Tour was wholly devoted to participation in the HYPOSO Final Event organised by Miroslav Marence and Ingo Ball at IHE Delft Institute for Water Education. The early morning was reserved for B2B talks, matchmaking and mini exhibition, where IOZE hydro brand and Turbulent company were presenting their products. The audience was welcomed by Eddy Moors, Director of IHE Delft. After introduction performed by Ingo Ball and Miroslav Marence, a keynote speech was given by Hélène Chraye, Deputy Director Clean Planet and Head of Unit Clean Energy Transition, DG Research & Innovation, European Commission. Then a second presentation was delivered by Dirk Hendricks, Secretary General from EREF about European efforts to support the hydropower sector. In the next part of conference participants learned about the HYPOSO project results and took part in a concluding discussion. Petras Punys from Vytautas Magnus University presented the HYPOSO Map, a useful tool for academia and the industry. Capacity building, which was a part of HYPOSO


Photo 11. HYPOSO Study Tour participants at Möhne Dam

project was summarised by Miroslav Marence. The next presentation was executed by Bernhard Pelikan from Frosio Next. He described and commented on the 15 pilot sites in five countries. The last presentation "Framework conditions for small hydropower – experiences from three continents" was delivered by Ewa Malicka (TRMEW). Next, the following experts from Latin America, Africa and Europe were invited to the discussion panel: Sergio Gómez Echeverri, Project Manager from Consultora Endémica S.A.S. (Colombia), José Estuardo Jara Alvear, Energy planning specialist / Coordinator Research Group CIENER from CELEC EP (Ecuador), Jose Maria Romay, the President of BOLCOLD (Bolivia), Mbaine Benard, Developer from Sebei Hydro Uganda Limited (Uganda), Nkue Valerie, Director of Renewable Energy from Ministry of Energy and Water (Cameroon) and Bernhard Pelikan from Frosio Next (Austria). During the discussion panel, experts presented current situation in hydropower sector in countries of their origin, underlining issues limiting the development of this industry. Similarly as in Europe, one of the most important obstacles is a time-consuming and complicated administrative procedure, which requires a level of complexity for small hydropower plants as well as for large investments. The recommendations included proposals for an international exchange of experience in the field of investing in small hydropower as well as training tours for representatives of the public sector responsible for issuing permits for the construction of small hydropower plants.

Summary

Summarizing the Study Tour, the group visited eight hydropower plants, nine producers of hydropower equipment, ten cities and travelled around 2,500 kilometres. Organisers achieved positive feedback from the participants about the Study Tour, confirming the comprehensive preparation of the tour, including: assistance in getting from the airport to the first hotel, itinerary, content selection of welcome kits, quality of the information in Study Tour brochure, daily organisational commitment, interesting selection of companies and hydropower plants to visit, comfortable accommodation, a variety of meals, arrangement of free time and networking, comfortable travel conditions and assistance to those participants who came after the Study Tour started. The main organisational problem included difficult and long visa procedures, impending the participation of many stakeholders selected for the tour. As mentioned before, many participants couldn't obtain visas on time, despite submitting the applications in advance or were refused to obtain visas at all. As a result, some of the selected participants joined the group later in the trip and some stakeholders couldn't participate at all. The organisers hope participants of the Study Tour took many inspirations with them and established valuable business relationships, which will enable to develop new hydropower projects and tighten the international cooperation.

The author of this article would like to thank all those involved in organizing the study tour, especially Dominika Wójtowicz, Bernhard Pelikan, Ewa Malicka, Ingo Ball and Miroslav Marence for your effort in making it happen, your exceptional commitment and excellent cooperation.

Michał Lis
Organizational specialist
TRMEW Sp. z o.o.

Managing editor
"Energetyka Wodna" magazine

Photos come from **HYPOSO** project and **Ossberger** company archives.

Photo 1. Water mill in Lugny Lès Charolles – beneficiary of the ADEME support program
Source: Lilian Geney

What are the support mechanisms for small and micro hydropower in France?

In France, citizens are very interested in small hydropower solutions and projects. Some tools have been structured to help project development. In the following lines we will present some of them, which can be national public instruments, non-profit or privately owned solutions.

First, the non-French reader needs to understand a key point about the French mechanism for hydro power selling contracts. Up to 500 kW on installed power, the producer may choose to sell its production to the State. This option is often a good choice as the buyer commits to buy the whole production during 20 years at a law defined price. The price per kWh is recalculated and adjusted each year following national economical index. This thanks to the guarantee, of a good price paid for energy the model is designed to motivate private organisations in investing on small hydro power. However the government explains that he cannot buy an energy to a private owner who received some public funds to build its power plant. Therefore this mechanism excludes all the public funding in the powerplant construction.

Even if this feed-in-tariff offers a strong asset to discuss with a bank, it is not enough to cover the project costs, especially in the development phase. This is exactly where the ADEME program fits. ADEME offers to finance pre-project studies. Actually, the study is bounded by a complete schedule of conditions. The mandatory analysis are defined in order to establish the feasibility and steps to repower a hydro power plant. Depending on the specific context of each project, additional analyses are sometimes required. Obviously, in order to be financed from public funds, the studies are carried out by a specialized and independent consulting firm. The analysis is only intended to study the administrative, technical, environmental, legal and economic/financial aspects. For administrative reasons that will not be developed in this article, the consideration of ecological continuity (defining of the following structures: fish pass, sediment discharge gate) is studied in parallel. For a better conciliation between actors and users of the river and a facilitation of the project owner organisation, the ADEME recommends a large consultation between stakeholders. Thus, the study office will contact, generally, the services of the water police, the French Office for Biodiversity, the fishing federation, the river unions, other river users, as soon as the study starts in order to address the particular stakes of the site.

Qualifying feasibility studies

At a minimum, the studies to be carried out to support the feasibility of the operation address the following aspects:

- the administrative study, where the framework of the authorization is specified and taken up. For example, is the mill approved for use? For how long is the plant still approved? What flow and what falls can be exploited? What are the steps to be taken?
- the environmental study includes a hydrological aspect (regime, morphology), a physicochemical aspect on the quality of the water. The living aspect is not forgotten paying a specific attention to the aquatic fauna and the riparian vegetation, the impact on humans, by identifying other water uses, the landscape impact or even noise,

- the technical study presents the selected equipment scenario with its assets and constraints,
- the economic and financial study presents how much it costs and how much it brings in. Obviously, by detailing the figures. To avoid unpleasant surprises, the study always indicates a dry year, where the yield is therefore lower.

Facilitation and communication are also market enablers

Complementary to this technical and administrative assistance, ADEME has developed communication tools such as:

- a website playing the role of resource center: https://rencontre-hydro-bfc.site.ademe.fr/ (web pages and documentation in French), where one can find specific and regularly updated guidance documentation to help the project leader for the realization of his project;
- a detailed phone book of professional actors and enterprises of the sector;
- an annual fair or professionals including workshops and conferences;
- newsletters and support to medias dedicated to small hydropower.

Burgundy-Franche-Comté leading on hydrotechnical heritage

If hydropower is the most popular renewable energy in France (SER survey 2021), small scale projects are also accepted by citizens because the question of hydraulic heritage and amenities goes well beyond the renewable energy development. For instance, ADEME is also working on the possibility to use the ELENA facility (European Local Energy Assistance) of the European Investment Bank to set up a dedicated assistance mechanism on the global renovation of hydraulic built heritage: water mills, forges, and factories powered by hydropower. To be followed in 2024!

The role of ADEME as a national public institution is key in France in order to bring visibility and support to the sector of small hydropower. Active for more than 10 years in Burgundy, we see now more and more initiatives and projects developed all over different regions in France, even in the most unsuspected areas, especially in a lowland region like the North or the Loire Valley.

Testimonial

Jean Denis owns an old wool factory that once used hydro power to operate. When the factory moved to another place the hydraulic structure remains. He likes to use this asset to produce hydro power. At the beginning Jean-Denis hoped to have enough power for his own consumption. A first quick study let him believe he could have more power than needed. Because he could benefit from the ADEME program, a local engineering office went in deeper details. After a few months of study, Jean-Denis now has more accurate information regarding the administrative power, the production potential. The consultant asked for the recognition of the authorisation and follow the process.

E-training tools

In the same way Large hydropower is different from small hydro, the small hydro

Source: ADEME

Photo 2. French guidance documentation dedicated to small hydropower project developers (left), quarterly newsletter of ADEME in Burgundy Franche-Comté (right)

differs from the micro (or pico) hydro. The quantity of energy, the budget and decision cycles are nothing alike. Thus the authors of this article set up a training dedicated to project management in repowering old water mills. Even if there is no clear limit the focus is for sites between few kW and few tenth of kW. Of course such a small hydropower generates small incomes. It then become very important to select the elements (becomes tangible or not) that can be kept. Let's take the example of an existing waterwheel that works with only 80% of the discharge. The first idea would be change this to increase the power by 25%, return on investment will be faster. But when you deal with 20 kW changing a waterwheel may cost €30,000 (without the civil work). Let's do the math then: the power increase will be 5 kW, admitting we can benefit from them 3,000 hours per year, so 15,000 kWh (15 MWh). In France the state pays €169 per MWh. So this 25% improvement will generate €2,535 per year. It will need 12 years production to be paid off, plus the lead time for the work to be done. This is the kind of arbitrage that will vary with the power given by the river. Indeed very little people do have the mindset adapted to this small projects. Thus project owners are not being helped and have no other choice than "learning by doing". The aim is to build up a community of people with a dedicated mindset for watermill renovation. The more people can help the faster the projects, the better for the environment.

Of course this kind of training would be great on a real watermill. However as watermills are along rivers on the whole territory, people following this course are spread all over France. Therefore the training is made thru visio conference platform that allowed people to interact. A nice time is dedicated to work on real project brought by the trainees.

What is ADEME?

ADEME (National Agency for Ecological Transition) is a French State public body created in 1992, with more than 1,000 employees and 17 regional directorates. For more than 10 years now, the regional directorate of ADEME in Burgundy-Franche-Comté has developed dedicated support mechanisms for small hydropower project developers, either from public or private sphere.

Renewable Energy Communities

In France we see more and more projects beared by citizens in order to develop small scale renewable energies: solar and wind energies are largely represented in this framework, there are only a few projects emerging on small hydropower. As an example, the project "Réveil des Moulins du Quercy" has been selected by the European Commission disposal RECAH (Rural Energy Communities Advisory Hub) in order to structure a citizen community around 4 pilot sites of water mills. Dedicated experts are missioned in each country in order to accompany the emergence of citizen and renewables energy communities. This link is to know more about this European initiative RECAH to help citizens energy communities in all Europe, in rural areas https://rural-energy-community-hub.ec.europa.eu/index_en.

Apart from this pilot project, public institutions such as regional councils and ADEME, and citizens networks such as Energie Partagée or Centrales Villageoises, have set up several support mechanisms to help these projects: that is the case for the Occitanie Region where "Moulins du Quercy" benefits from a budget of k€50 (70% granted) for the feasibility studies and may have access to a citizen "bonus". For each Euro given by a citizen (or private body) there is a grant of €1 for Citizen as for the investment phase (In any case the grant can not be greater than k€100 per project).

Elodie Denizart
Consultant ecological transition in Europe

Clement Van Straaten
Consultant small hydro

................we believe in the power of nature

Water Turbines Works

WTW Poland sp. z o.o. is a leading Polish manufacturer of water turbines as well as mechanical and electrical equipment for Small Hydroelectric Power Plants. We have been present on the Polish market since 1989 and so far we have produced 209 turbines with a capacity of> 15.5 MW. Our turbines also work in Italy, Estonia, Ukraine, Belarus and Germany. We provide high efficiency of turbines, professional advice on the selection of devices for a specific location, as well as warranty and post-warranty service. We design and supply Kaplan turbines for heads from 1.5 m to 24 m in many different configurations. Please visit our website where detailed information about our offer is available.

SHP Glebocko, Poland

6x136 kW (d=1090mm, H=3.1m)

SHP San Secondo, Italy

1x92 kW (d=720mm, H=5.4m)

SHP Naviglio, Italy

1x84 kW (d=560mm, H=7.6m)

SHP Chancza, Poland

1x177 kW (d=590mm, H=11.9m)

+48 695 639 657

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11-200 Bartoszyce, POLAND

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Corrosion protection of screw joints

A screw flange, butt or lap joint is a special part of an installation, structure or foundation. Despite the identical environment of the whole installation/structure, the corrosion exposure is different, more intense, more dangerous in the zone of the joint itself than in the rest of the area.

The reason for this is the geometry and variety of materials of the joint components. An additional factor accelerating corrosion is stresses that sometimes reach high values, which can, for example, initiate a crack in the steel and thus create new areas of potential corrosion. While the coating of the structure is sufficient to protect against general corrosion, in the case of a flange joint, for example, there is usually a defective coating or even no coating at all.

Corrosion

Corrosion, as a natural process resulting in the deterioration of materials, usually metals/alloys, occurs as a result of direct contact and interaction of the corroding surface with the environment. The simplest protective measure is therefore to limit or even block access of the environment to the surface (create a barrier). Direct "metallic" flange-to-flange contact, with the wrong choice of materials (different potential values, i.e. greater than 0.05 mV), is the reason for increased electrochemical corrosion. Depending on the potential, flanges (photo. 1a) or, worse, bolts or nuts (photo 1b.) may corrode. Furthermore, crevice corrosion can occur in almost all types of screw joints, resulting from uneven oxygenation in the gaps between hole and bolt or gasket and rabbet, or between the components of a lap joint. This type of corrosion also requires a continuous "supply" of corrosive agents such as oxygen, chlorides and moisture from the surroundings, i.e. the environment. Pitting and other corrosion damage on joint components can result in the loss of full cathodic protection, even though the protective potential is maintained throughout the pipeline/structure. The value of the local corrosion potential at the point of damage will depend on the surface area of the damage, and therefore another source of local corrosion will develop over time. As always when dealing with point corrosion, i.e. usually of a spontaneous nature, the effects of the corrosion are difficult to predict and are usually charged with sudden failure e.g. leakage, loss of fasteners etc. The common denominator of the corrosion mechanisms mentioned in the article is that, in order for them to emerge and operate in full development, it is necessary – in addition to the initiation of the process – contact with the environment. In other words, if a section of the structure were separated from contact with the environment, corrosion would not occur. This is what was used in the idea of protecting flexible screw joints with a membrane coating.

Photo 1a. Corrosion of the flange

Photo 2. Screw lap joint with visible dangerous corrosion of the nut

Belzona® 3412

The coating surrounding the flange joint should fulfil at least two basic functions, i.e. protect against corrosion (corrosive environment) and allow easy and reproducible access to all parts of the joint in the event of repair. Such functions are fulfilled by the special flexible coating (membrane) Belzona® 3412, which acts as a barrier preventing moisture, chlorides and other contaminants from reaching the protected surfaces. The flexibility of the coating material is maintained down to a temperature of –22°C, and the total elongation (determined in turn for 20°C) according to ASTM D412 guidelines is 260%. The tensile strength of this material, which is 3,180 kg/m, is one of the most important mechanical parame-

Photo 2. Flange protection chemical tank with membrane Belzona® 3412

Photo 3. Belzona® 3412 – protection of bridge structure screw joints

Photo 4. Belzona® 3412 – sealing membrane for anchors and foundation of wind turbine towers

Photo 7a. Belzona® 3412 membrane just after cutting

Photo 5. Belzona® 3412 as airtight and barrier protection of underground gate valve – saline groundwater

Photo 7b. Full access to the joint

Photo 6. Corrosion protection of the butt joint of the hall structure with Belzona® 3412

Photo 8. Belzona® 3412 during brush application

ters and represents the value of the force required to rupture and maintain a crack until the specimen fails, and is therefore calculated based on the thickness of the specimen as a function of force. However, the key parameter for the Belzona® 3412 coating, demonstrating its barrier properties, is primarily its tightness (impermeability), as determined by a test conducted in accordance with the requirements of ASTM B117, during exposure of the coating material in a salt chamber to a 5% NaCl solution at 35°C. After three thousand hours of exposure, it was found that there was no corrosion damage under the Belzona® 3412 membrane, while the unprotected part of the pipe of the tested joint corroded significantly. In addition, the coating is resistant to UV radiation.

Advantages of Belzona® 3412 coating

Photos 2–6 show the various applications of the Belzona® 3412 coating. The coating is easily applied by brush or spray (photo 7.) and is reusable (photo 8a, 8b). Together with the required Belzona® 8411 primer, which acts as a separating agent (the membrane can be peeled off the metal surface) and contains corrosion inhibitors (to form a protective layer), it provides a very effective barrier system to inhibit corrosion processes.

Thanks to the method of application using simple hand tools, the product can protect both typical and regular joints, as well as parts with more complex shapes.

Roman Masek
Technical Director
Belse Sp. z o.o.

Photos come from the archive of **Belse Sp. z o.o.**

Reform of the electricity market in the European Union

The European Commission has proposed changes to the rules of the electricity market in the European Union. The Commission's legislative proposal is a direct response to the problem of the occurrence of dynamic energy price changes caused by Russia's invasion of Ukraine. The proposed changes include increasing the role of long--term contracts.

The European Commission's legislative proposal was published on 14 March 2023 and revises the existing directives and regulations governing the Electricity Market Design (EMD for short), including in particular changes to two existing pieces of legislation:

- Regulation (EU) 2019/943 of the European Parliament and of the Council on the internal market in electricity;
- Directive (EU) 2019/944 of the European Parliament and of the Council on common rules for the internal market in electricity;

Even before the publication of the legislative proposal, there were opinions according to which the electricity market in the European Union required changes of a revolutionary nature – including, inter alia, the abandonment of the marginal pricing mechanism for energy market (Merit Order). The European Commission has not opted for such significant changes to the rules of the EU energy market.

The aim of the EMD is to protect consumers and investors from electricity price spikes mainly by complementing short-term markets with long-term instruments, notably: two-way contracts for difference and long-term power purchase agreements. Currently in the legislative process – the Council of the European Union and the European Parliament are working on proposals to amend the texts of the legal acts included in the European Commission's proposal. There are calls to extend the intervention mechanisms introduced under Council Regulation (EU) 2022/1854 on an emergency intervention to address high energy prices (hereinafter: 'Regulation 2022/1854') beyond the originally planned time horizon.

Two-way contracts for difference

The European Commission has proposed that public support for new investment in low-carbon projects should only take place through two-way contracts for difference, defined as contracts between a generator and a counterparty, usually a public entity, that provide both minimum wage protection and limitation of overcompensation. New investments include both investments in completely new generating units as well as investments to modernise, expand or extend the life of generating units.

The European Commission's proposal introduces an enumerative catalogue of energy sources covered by the obligation to conclude two-way contracts for difference. The energy sources covered by the above obligation are: wind energy (onshore and offshore), solar energy, geothermal energy, hydroelectric energy from power plants without storage reservoirs and nuclear energy. This catalogue may be subject to change in the course of the legislative work – controversy at the level of the Council of the European Union has been aroused by, among other things, the inclusion of nuclear energy in the catalogue.

Adoption of the legislation as proposed by the European Commission could have a significant impact on the functioning of support schemes in Member States – unless additional regulations appear in the final wording of the legislation, the provision will apply to projects regardless of their power capacity. It can already be argued that the auction support system for renewable energy sources operating in Poland works on the basis of a two-way contract for difference. The question arises whether the other support systems for renewable energy sources – feed-in tariffs and feed-in-premium subsidies dedicated to, among others, small hydropower plants – will not have to be changed after the EMD comes into force.

Long-term power purchase agreements

Another proposal by the European Commission is to impose obligations on Member States to facilitate the development of the market for long-term power purchase agreements (PPAs for short). The Commission's proposed definition of a PPAs is a contract whereby a natural or legal person agrees to purchase electricity from a electricity producer on market terms. According to the European Commission, the main barriers to the development of PPAs in the Member States are the insufficient availability of guarantee instruments to reduce financial risk and the lack of availability of PPAs for small energy consumers. Hence, the legislative proposals include increasing the availability of guarantee instruments, through the intervention of Member States, with the proviso that PPA guarantee instruments should not lead to a reduction in the liquidity of electricity trading and should not provide support for the purchase of fossil fuel based energy.

In addition, the European Commission has proposed that, when developing support schemes dedicated to renewable energy sources, Member States should allow the participation of projects that reserve part of their electricity production for sale by the PPAs. The criteria for admission to the support scheme may give priority to projects that include a concluded PPA or a commitment to conclude a PPA in future. Unlike in the case of two-way contracts for difference – the rules proposed by the Commission do not contain a catalogue of sources for which PPAs are dedicated.

As indicated in the report summarising the activities of the President of the National Regulatory Authority in Poland for the years 2021–2022 – less interest in auctions of renewable energy sources in favour of PPAs, should be expected in the coming years. The EMD, as proposed by the European Commission will reinforce this trend – popularising PPAs in Poland even further. The Commission's legislative proposals therefore represent an opportunity for energy producers, especially operating installations in renewable technologies, to obtain alternative (to the support system) financing for investments in generation sources.

Intervention mechanisms under the EMD

The EMD is not limited to promoting the long-term contracts described above – it also contains provisions to promote the use of electricity storage and flexibility sources. In the course of the legislative work, there were also calls for the regulation of intervention mechanisms – in the shape and similarity of those introduced by Regulation 2022/1854. Particularly relevant for energy producers, including in small hydropower plants, is the so-called market revenue cap. This mechanism allowed the income of energy producers in infra-marginal installations to be limited to a maximum of 180 €/MWh of electricity produced. Formally, this mechanism ceased to apply on 30 June 2023.

During the legislative work on the EMD within the Council, a request was made to extend the market revenue cap established for energy producers in infra-marginal installations until 30 June 2024. Independently, the EMD as presented by the European Commission contains provisions implementing systematic response by European Union bodies in the event of an electricity price crisis. Also for this response a market revenue cap of up to a maximum of 180 €/MWh is called for as a permanent element of the energy market in future electricity price crisis.

The European Parliament is likely to adopt its negotiating position in July. Informal negotiations between the Council and the Parliament will start in the second half of 2023 and the adoption of the act can be expected towards the end of the year. The Council's work is currently coordinated by Spain, which is one of the countries strongly in favour of extending the intervention mechanisms until 30 June 2024.

Report on the functioning of intervention mechanisms

An important voice in the discussion on the future of intervention mechanisms, including in particular the market revenue cap for energy producers in infra-marginal installations, is the European Commission's report published on 5 June 2023 on the review of emergency interventions to address high energy prices under Regulation 2022/1854. The European Commission recommended that Regulation 2022/1854 should not be extended and the intervention mechanisms phase out, which was argued, mainly by risked stalling the development of the PPA market in Member States.

With regard to the revenue cap for infra-marginal generators – based on Member State reports – differentiated implementation was observed not only with regard to the level of the revenue cap (180 €/MWh), but also the duration or retroactivity. According to the report:

- 17 Member States have set a cap below 180 €/MWh;
- 11 Member States will apply a revenue cap after 30 June 2023;
- 7 Member States have implemented the cap retroactively.

The European Commission noted that the rules introduced have undermined investor confidence in long-term contracts, reduced liquidity in futures markets and, in the longer term, could have a negative effect on the development of the electricity market in the European Union.

Summary

The legislative work on the EMD is slowly entering the crucial phase of negotiations between the Council and the European Parliament. The adoption of the EMD will be important for all actors within the electricity market especially for electricity producers. Of particular importance is the issue of extending the market revenue cap. Already today, the renewable energy industry is publicly expressing its opposition to the continued maintenance of intervention mechanisms, indicating that the economic situation in the European Union is gradually stabilising.

Artur Leśniak
Lead Regulatory Specialist
Veolia Energia Polska S.A.

Photo 1. View of the new Łabędy SHP

A black swan among SHPs in Poland – about a new facility on the map of Upper Silesia

It is gratifying to see the current modernisation boom in the SHP industry, which is a direct result of the favourable investment climate. In the pages of "Energetyka Wodna", we recently told about a typical repowering project focusing mainly on the replacement of obsolete turbines. This time, we present a facility whose modernisation involved building everything from scratch, in a vastly improved design, of course. We are talking about the Łabędy SHP.

The first small hydropower plant at the cascade inlet to Lake Dzierżno Duże was built in the early 2000s (mid--2002). The facility was built using the economic method on the basis of a building permit obtained in 2000 and was equipped with four propeller turbines of varying technical parameters, with a total installed capacity of 360 kW. These units were installed near the fourth cascade, on an I-beam steel structure connected to the tin building structure of the SHP. Water was supplied to the facility by a steel pipeline. The power station as described continued to operate for years to come. Unfortunately, the technology of construction began to take its toll on the operation of the facility over time – greater failure rates of the hydrosets and increasingly cumbersome maintenance, which, together with other factors, eventually led the original owner to decide to sell. The SHP needed a major modernisation and recapitalisation to achieve the full potential of the site.

The old gives way to the new

In 2017, the Łabędy SHP was subjected to an acquisition audit at the request of a potential investor. The study, carried out by specialists from the Instytut OZE, dealt extensively with technical, formal and financial issues, identified the steps needed to be taken and recommended upgrading to the construction of the new SHP, as the existing infrastructure did not allow full use to be made of the opportunities offered by the waters of Kłodnica River in the cross-section of the cascade weir. Eventually, the facility changed its owner and came under the auspices of IOZE hydro for further development.

The technical modernisation concept carried out in the next step involved the demolition of the old plant and, in its place, the construction from scratch of the SHP equipped with modern high-efficiency generation technology, fully automated, whose stable operation will allow an acceptable return on the financial investment to be made.

Despite being a modernisation by design, the project has gone through the complete administrative process from obtaining an environmental decision, a water permit and conditions for connection to the power grid to obtaining a building permit. This was finally obtained in the spring of 2020 and during the following

Photo 2. Preparation stage for concreting the water supply structure for the turbines

year (a pandemic year, we should add, and therefore bringing with it a number of logistical or formal and legal difficulties), funding was obtained and the work began. The executive team carried out the demolition of the old SHP and associated infrastructure, and built a new facility in its place. The scope of work included, in addition to the erection of the power plant building with the necessary installations, the expansion and reconstruction of the reinforced concrete water intake, the reconstruction of the water supply pipeline to the turbine chamber together with the installation of fittings in the throttle chamber, and the renovation of the existing weir by replacing the closure system (including its lifting mechanisms) and its automation.

The above synthetic list does not adequately reflect the advancement of the hydro technical works carried out by the contractor's team, so it is worth giving the floor to the person directly supervising the work (report in box).

It is worth being aware that hydro technical construction has its own rules. Although the SHP construction site occupies a relatively small area, the effort that the construction team puts into maintaining it in the face of the many practical challenges associated with the specifics of the project is definitely worth noting, not only in the case of the Łabędy SHP (photo 2), but also in other numerous investments of this type. In addition, many issues only come to light in the course of the construction work, so employees and contractors have to react on an ongoing basis and find solutions, e.g. structural or logistical ones, allowing you to move on to the next stage of your work.

> *Before the modernisation, the SHP achieved a maximum instantaneous power of 70 kW, while the new solution already achieved 340 kW in the testing phase.*

Decisions of this kind are often taken under time pressure, involving issues at the intersection of different areas, e.g. mechanical, electrical, construction, so it is important for the contractor to have an interdisciplinary team of designers and specialists from many branches. Comprehensive project management is the recipe for successfully bringing a construction project to completion.

Szymon Głowacki, site manager:

Work on the Łabędy SHP facility proceeded smoothly despite complications related to the location of the construction site in the immediate vicinity of the frequently rising riverbed, which was a direct result of the unpredictable hydrological characteristics of the Kłodnica River. The river behaves like a mountain stream – after heavy rainfall or snowmelt, its current becomes rushing. Situations of this nature led, among other things, to a threefold necessity of reconstructing the water enclosure for the worksite associated with the water intake for the SHP or to frequent flooding of the construction site. In addition, the worksite was heavily waterlogged at all times – the low cohesiveness of the soil with its predominantly sandy fraction results in increased water migration, which caused numerous leaks, but was also the cause of the poor bearing capacity of the soil at the foundation level of the building. However, based on the results of the earlier CPT soundings, we prepared for the works by using longer sheet piles of tight walls and introducing additional soil reinforcement below the foundation level of the facility. Of the issues that had already surprised us in the course of the work, but which we also dealt with, was the different location of supply pipelines than was shown in the archived post-completion documentation produced by the surveyor. Following this, we made adjustments to the design of the water intake to optimally match the existing infrastructure.

Tailor-made technology

The achievable head of more than 6 m and flows of more than 6 m^3/s, as well as the curves of the sums of flow durations, were the starting point for the design and manufacture of two 800 mm-diameter Kaplan turbines in a vertical arrangement and with radial inflow with a 360° (photo 3) spiral chamber. Water is piped into the turbines. The water in front of the turbines is separated into two chambers by a T-piece with an inspection manhole and is routed directly to the turbines via a spiral chamber of reinforced concrete construction. The entire system, including the reconstruction of the water intake, the water feed system to the turbines; the water drainage has been optimised to minimise losses in electricity production.

Photo 3. Kaplan turbine at different design stages, just before installation and inside the SHP building after installation

It is worth adding that the production results obtained from the old SHP installation may have been misleading, if they were taken into account in the design of the technology, as the available hydro technical potential actually offers the possibility of producing much more energy than the achieved values for each year showed. However, it is not only the hydroelectric potential of the site and the advanced turbine technology, but also the control and automation system that determines the production results achieved by the power plant. The one implemented at the Łabędy

Sebastian Wites, chief automation officer at IOZE hydro:

The facility was equipped with a control and automation system dedicated to small hydropower. For the Łabędy SHP, we designed and manufactured a unique turbine regulator system. It is the only hydroelectric power plant equipped with PMG generators, not supported by an inverter. Generators of this type have a very high efficiency (up to 97%), significantly higher than asynchronous generators. In the case of a system equipped with a generator with permanent magnet excitation, there is no need to compensate for reactive power, which translates into major savings for the start-up equipment and operation of the facility (including avoiding the periodic replacement of worn-out capacitors, which pose a fire hazard when heavily used). The turbines at the Łabędy SHP are operated by two generators of 200 kVA each. The control and automation system, in addition to the basic functionality of optimising hydropower parameters, also controls the entire SHP facility, i.e. the gates of the main weir, the water intake and the trash rack cleaner.

Investor, owner of SHP:

Our cooperation with IOZE hydro began when we became aware of an opportunity to purchase a facility which, as it turned out from the audit, required the construction of a completely new infrastructure, but allowed us to take full advantage of the potential of the location. A multi-faceted collaboration with the consultancy, design and construction team has brought us to the point where we are now past the first commissioning of the facility and will be able to start permanent energy production after final testing. The new Łabędy SHP is a completely different – in the sense of incomparably better – class of control and operation, turbine technology, turbine efficiency, compared to what it was and what we know, especially as we own another SHP and have a comparison in terms of operation and maintenance. We are confident that with the new plant, we will use the river's full disposal potential. The solutions used are based on advanced calculations and modelling. This makes them ideally suited to the location and our business objectives. To illustrate the differences, it should be mentioned that the facility achieved a maximum instantaneous power of 70 kW before the modernisation, while the new solution already achieved 340 kW in the testing phase.

It is worth mentioning that the individual approach to the client – i.e. to us and our needs – and the high level of care taken in the provision of services are of great value in the course of the entire project. As a result, we feel that the IOZE hydro team has taken care of all aspects required for the facility to operate within the optimum formal range (the facility is covered by 15 years of guaranteed Energy Regulatory Office support under the FIT/FIP tariff) and generate the maximum possible revenue.

Photo 4. Old and new SHP

SHP stands out from others of its kind. In a few technical words, the main automation specialist of IOZE hydro talked about it. The technology implemented at Łabędy SHP is so promising and, above all, technically and financially sound that another project is already underway, also in southern Poland, in which permanent magnet induced generators with a total output of 900 kVA will be installed. The solution described here has numerous advantages and offers advantages over standard solutions.

Repower=comfort

The new facility on our country's hydropower map is further proof that repowering has tangible benefits and is worth undertaking. With modern technology (embedded either in a completely new infrastructural setting or in a still well-performing SHP building), it is possible to increase revenue from electricity production while reducing operating costs. The status of a new installation in the current support system gives higher electricity sale prices. However, it is important that the entire scope of the modernisation is chosen from the outset to ensure that the project is in optimum shape, not only formally but also technically. Everything has to blend together perfectly.

Referring to the statement of the owner of the Łabędy SHP, but also assessing the repowering process from the perspective of many successfully implemented investments, it is important to emphasise how easy the modernised facilities are becoming to operate. In the case of old plants, at least one person is employed to operate them, and often the owners of the plant are additionally involved in the day-to-day running of the plant, so that they have to subordinate their daily routine to the work of the plant. The need for constant supervision generates costs that are often inadequate to the production revenue generated. Modernised SHPs, on the other hand, are essentially maintenance-free (photo 4). Their correct operation is supervised by a dedicated control and automation system and remotely by IOZE hydro service technicians, who ensure that production continues at the highest possible value. Service personnel can be limited to part-time staff who periodically turn up to look after the facility, possibly turning up when necessary but not working there full-time. Repowering is not only a benefit in technological, financial or visual aspects, but also a comfort closer to human nature in working with the facility.

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Photos come from the archive of **IOZE hydro**.

Flow structure in the draft tube of a medium specific speed Francis turbine

The draft tube is an integral part of the hydrosystem affecting the energy and operational properties of the machine.

Its function is both to enable the use of the geometric head contained between the turbine rotor and the lower water level and to recover the kinetic energy of the fluid flowing out of the rotor. Although the utilisation of the head is guaranteed by a duct with a constant cross–section, the recovery of kinetic energy results from the diffuser shape of the suction pipe.. It causes a reduction in static pressure below the value resulting from the geometric height of the turbine's suction due to the occurring velocity difference between the inlet and outlet of the suction pipe [1, 2].

Water leaving the rotor of a reaction turbine at speed c_3 carries with it kinetic energy equal to the dynamic pressure head $c_3^2/2g$. The value of the kinetic energy leaving the rotor increases with the specific speed of the turbine . This results in the fact that, for high specific speed Kaplan and propeller turbines, this value can translate into up to 50% of the turbine's generated power [3]. Slow specific speed reaction turbines are less sensitive to the quality of the draft tube operation due to the low contribution of the discharge kinetic energy to the total head. Poland is a lowland country, which is why the significance of suction pipe operation in domestic hydropower is crucial, determining the highly efficient energy conversion.

The operation of draft tubes is related to the head losses occurring in them. The source of the first type of loss is the inter–particle friction of the water and friction against the pipe walls. The second type is caused by the flow of water with a swirlaround the axis of the draft tube. In the case of turbines with stationary blades (such as Francis or propeller turbines), the outflow of water with minimal swirl (design without swirl) occurs at the flow corresponding to the highest efficiency, while for operation outside of BEP, there is an outflow with swirl. For turbines with movable rotor blades, the swirl in non-optimal conditions occurs much less frequently or is less intense. Assuming constant velocity distribution in the axial and circumferential directions, the definition of draft tube efficiency can be determined:

$$\eta_{rs} = \frac{\eta_u \cdot \frac{c_{3u}^2}{2g} + \eta_m \cdot \frac{c_{3m}^2}{2g}}{\frac{c_{3u}^2}{2g} + \frac{c_{3m}^2}{2g}}, \tag{1}$$

Where:
c_{3u}, c_{3m} – averaged velocities in axial and circumferential directions,
η_u – efficiency of recovery of peripheral velocity in the draft tube,
η_m – meridional speed recovery efficiency in the draft tube.

Putting the equation in order, we obtain:

$$\eta_{rs} = \eta_u(\sin^2(\alpha_3)) + \eta_m(\cos^2(\alpha_3)) \tag{2}$$

According to formula 2, the energy recovery efficiency in the draft tube depends on the recovery efficiency coefficients of the individual components and the angle contained between the radial component and the absolute velocity – α_3. A straight–axis draft tube, like any diffuser, only recovers the meridional velocity energy. This takes place with efficiency η_m = 0.8 – 0.85 [1]. The circumferential velocity, on the other hand, is irretrievably lost here. This leads to the conclusion that, in the case of turbines with a single control (guide vane) and a high variability of the operating point position, it is advantageous to use solutions that allow partial recovery of the circumferential velocity component as well.

During the flow with a swirl in the draft tube, circumferential velocities are inversely proportional to the radius *r*, resulting in a dependence of the pressure values in the plane of the cross–section on this radius. A decrease in pressure in the central part of the draft tube below the saturation pressure at a given temperature will lead to a phase change and the occurrence of cavitation. The structure of the cavitation vortex depends on the position of the operating point of the turbine, negatively affecting the performance and operating range of the machine [1,4–7].

The complexity of the processes described above is evidenced by the observation of Coriolis (de Saint–Venant) coefficients in excess of 10 [3]. The design of

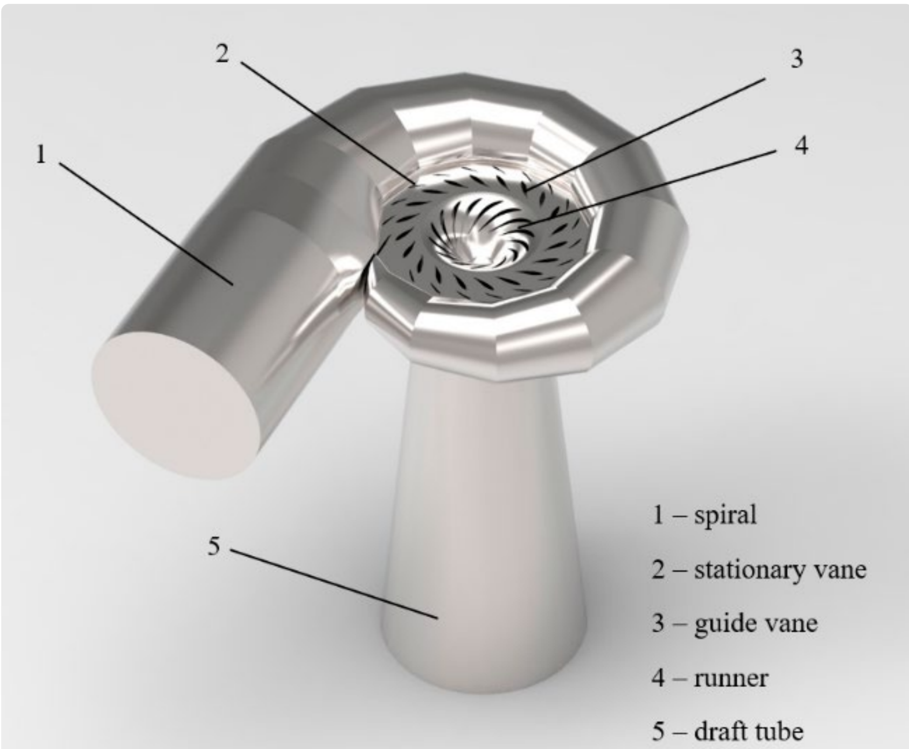

Fig. 1. Francis turbine model analysed

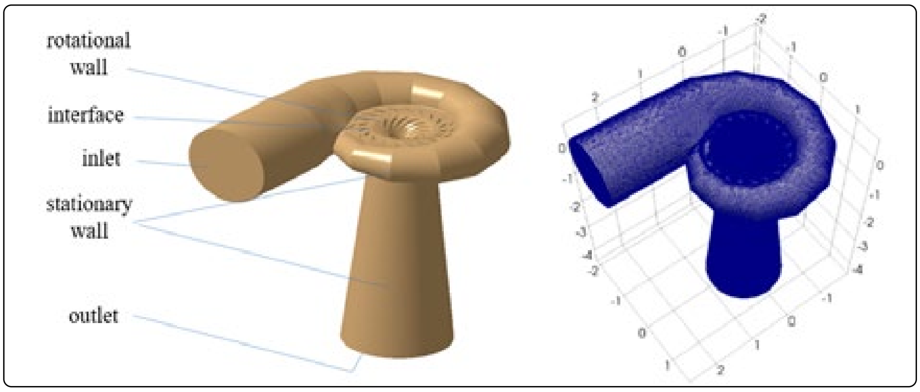

Fig. 2. Analysed Francis turbine model

draft tubes is therefore an important process that requires care, in order to ensure their correct operation, possibly over the entire operating range of the water turbine. Therefore, understanding the nature of the flow phenomena observed in the draft tubes in relation to the machine load becomes extremely helpful. This paper presents numerical modelling of the flow phenomena occurring in the draft tube of a medium specific speed Francis turbine during its non–optimal operation and for maximum efficiency.

Subject of the analyses

The object of the study was a Francis turbine with a specific speed n_{sN}~296. Fig. 1 shows the hydraulic model of the machine in the form of a three–dimensional flow system. It is a water turbine with a vertical axis of rotation, fed from a pressure derivation pipeline, having a segmented spiral made of steel and a straight–axis draft tube. The length of the draft tube was 3.7D and the bifurcation angle was 11°.

The purpose of the conducted analyses was twofold: first, to ascertain how non-optimal operation of the Francis turbine affects flow phenomena within the draft tube; second, to assess the impact of draft tube phenomena on the stability of turbine parameters, all while visually identifying unfavourable pressure and velocity distributions.

Numerical model

Numerical modelling is an important tool that streamlines the design process for various machines and aids in identifying fluid and mechanical phenomena. The technique of numerical flow modelling, using the laws of motion, builds a virtual model of a machine in the form of mathematical equations describing the phenomena and flows occurring in it. CFD methods make it possible to simulate flows in various applications by iteratively solving the equations of mass, momentum and energy.

The test object was divided into four components: spiral casing, Fink guide vane, impeller and draft tube. The discretisation of the model was performed using unstructured meshes. The number of grid elements was approximately 60 million for the entire model. Through the use of local grid refinements, the boundary layers were discretized with individual adaptation for each geometry. The developed model is presented in fig. 2, showing the adopted boundary conditions and mesh.

Numerical analysis of the flow through the turbine was performed using the MRF model. The tests were carried out as non–stationary URANS for fixed boundary conditions. The parameter with which the turbine operation was adjusted was the opening of the guide vanes. The simulation was stopped when the flow and torque on the blades diagrams were stabilised. A convergence criterion of 0.0001 was adopted. The turbulence intensity factor was defined as I = 5%. The working medium was pure water with density p_{h20} = 998.2 kg/m³ and dynamic viscosity μ_{h20} = 0,001003 *Pa·s*.

The *y*+ value was controlled during the simulation. The numerical modelling carried out enabled quantitative and qualitative identification of flow phenomena through the turbine.

Results of numerical simulations – turbine operation at the optimum point

The flow structure of the machine operating in the optimum condition was taken as the reference point for assessing the performance of the hydrosystem. fig. 3 and fig. 4 show the results obtained in the individual hydraulic components of the turbine. The nature of the results obtained in the form of distributions of velocity and pressure parameters is regular. Areas with pronounced flow separations are not noticeable. The pressure distribution is normal and the hydraulic loss on the control element is small. In the vicinity of the blade leading edge, areas of reduced velocity are discernible, related to the stagnation effect caused by the width of the profile. A detailed analysis of the velocity vectors shows that the fluid in this area does not change its direction of flow but only decelerates slightly. The flow in the turbine rotor area is characterised by regularity in the course of the water particles. There are no flow disturbances. The velocity vectors follow the direction defined by the geometry of the rotor blades, both in the meridional section and in the conformal projection.

The fluid flowing out of the rotor is characterised by the retention of a small value of the circumferential velocity component, especially in the area of the rotor's outer diameter, which is indicative of optimal turbine operation. Analysing the static pressure distribution – fig. 4 – it should be concluded that the draft tube is operat-

Fig. 3. Relative velocity vectors in the cross–section of the guide vane –rotor system

ing correctly, which is due to the uniformity of the velocity profile at the inlet to this component and the appropriately selected diffuser opening angle. Adequate diffusivity causes the draft tube to operate almost the entire cross-section – fig. 4.

Numerical simulation results – turbine operation at partial load

By examining the flow in the area of the rotor and the guide vanes of the turbine operating at the non–optimum point, it can be seen that it is characterised by regularity, as presented in fig. 5. When analysing the operation of the guide vane, analogous to the optimal point, it can be noted that it changes the direction of the fluid flow smoothly, the medium does not break away from the blade walls. The pressure distribution is correct. Near the leading edge of the vanes, areas of reduced velocity are discernible. There are no flow disturbances. The velocity vectors follow the direction defined by the rotor blade geometry.

The velocity distribution in the draft tube is strongly unfavourable. In fig. 6, the streamlines are presented, indicating strong curvature at the rotor outlet during turbine operation beyond the optimum point. The analysis of the static pressure distribution in the draft tube – fig. 6 – provides important information regarding the flow structure. The results obtained indicate that the diffuser is not working properly. The extensive zone of reduced velocity located in its inner part does not participate in the flow. The diffuser was not designed to operate in a non–optimal state, as the formation of an extensive, centrally located dead zone resulted in a narrowing of the active cross–section of the draft tube. The consequence of this phenomenon is a limited possibility to recover kinetic energy carried away from the rotor and improper operation of this hydraulic component. Numerous areas of high pressure gradient are noticeable here.

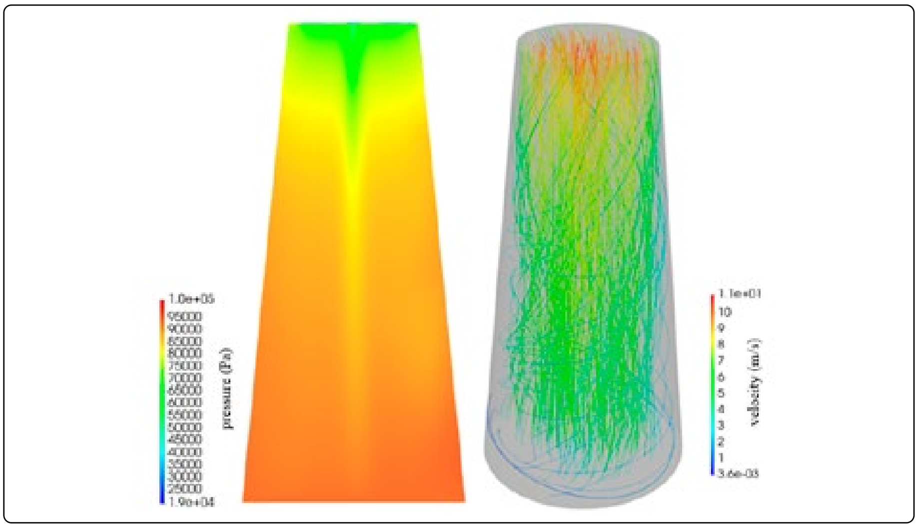

Fig. 4. Static pressure distribution in the draft tube

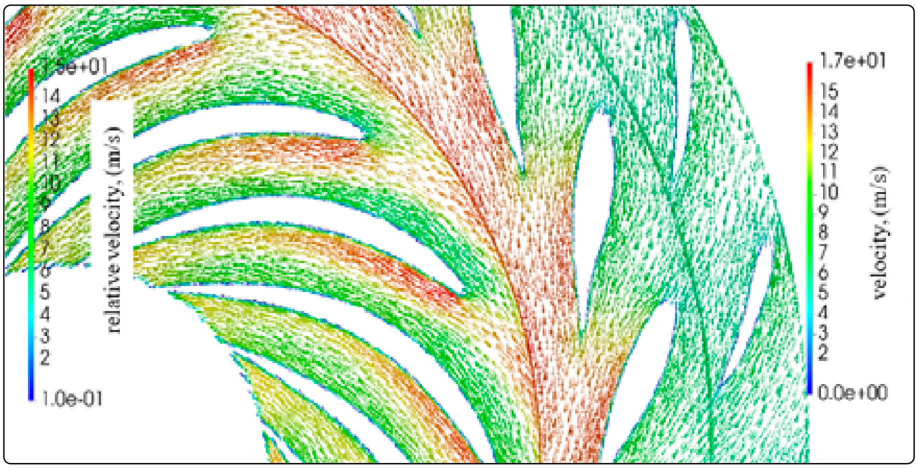

Fig. 5. Velocity vectors in the transverse direction of the guide vane–rotor system

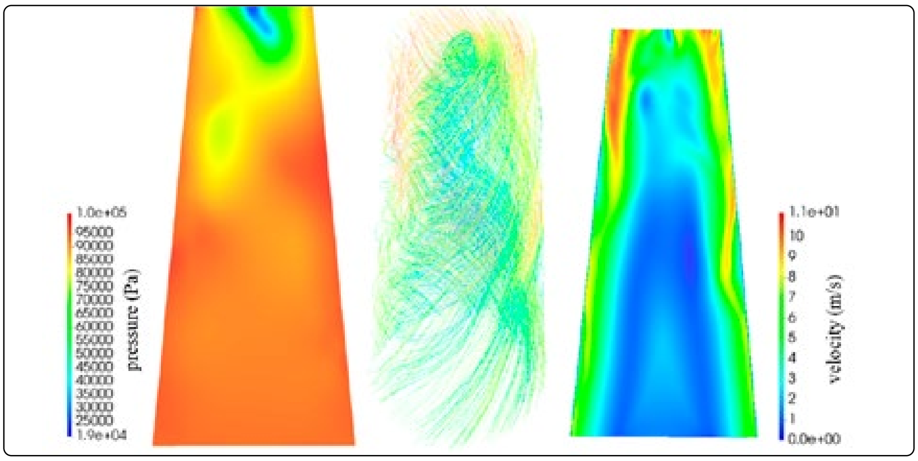

Fig. 6. Static pressure distribution in the draft tube

Comparing the results for the optimal point and partial load conditions, a characteristic change in velocity distribution is evident. In the optimal state, the lowest velocity values are observed near the walls of the discharge element, while under partial load conditions, they are found in the core of the draft tube. Additionally, there is a tendency for the formation of a boundary ring - cavitation vortex. This is illustrated in fig. 7. In the central part of the pipe, an area with a helix structure is noticeable, breaking away from the flat part of the turbine rotor hub, with its axis being close to the axis of the draft tube. This vortex represents the area of the lowest static pressure throughout the entire turbine.

Summary

Numerical simulations indicated significant differences in the operation of the draft tube in the two control states of the turbine: optimal and non–optimal. Irrespective of the control depth, the spiral casing as well as the impeller and guide vane work properly. During turbine operation near the optimum point, the flow structure in the impeller–draft tube system corresponds to the design assumptions, and the flow in the liquid discharge element can be considered as uniform. In contrast, the flow pattern in the impeller–draft tube system is deteriorated during turbine operation at the non–optimum point. In the described control condi-

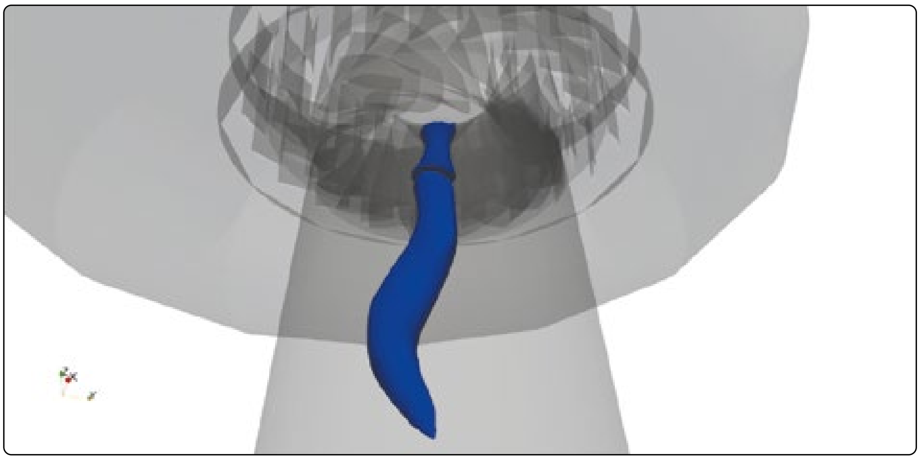

Fig. 7. Cavitation string vortex behind the rotor hub

tion behind the impeller, in the central part of the draft tube, there is an area of lowest pressure in the entire geometry analysed. The shape of this area indicates the possibility of a cavitation vortex rope occurring there. This vortex, entering the high–pressure area, can implode causing disturbances in the operation of the machine.

Based on the numerical simulations carried out, it can be concluded that the occurrence of cavitation in the draft tube is significantly influenced by the degree of flow regulation correlated with the suction height of the water turbine. The draft tube typically constitutes an integral part of the power plant building, so the occurrence of cavitation vortex is undesirable due to its detrimental effect on the machine's lifespan. The cause of this is vibrations induced by fluctuations in hydraulic parameters, transmitted to the pipe walls and the rotating assembly.

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Photos come from author's archive.

Industry catalog

Assessment of the long-term impact of a small hydropower plant on the ecology of an Alpine stream

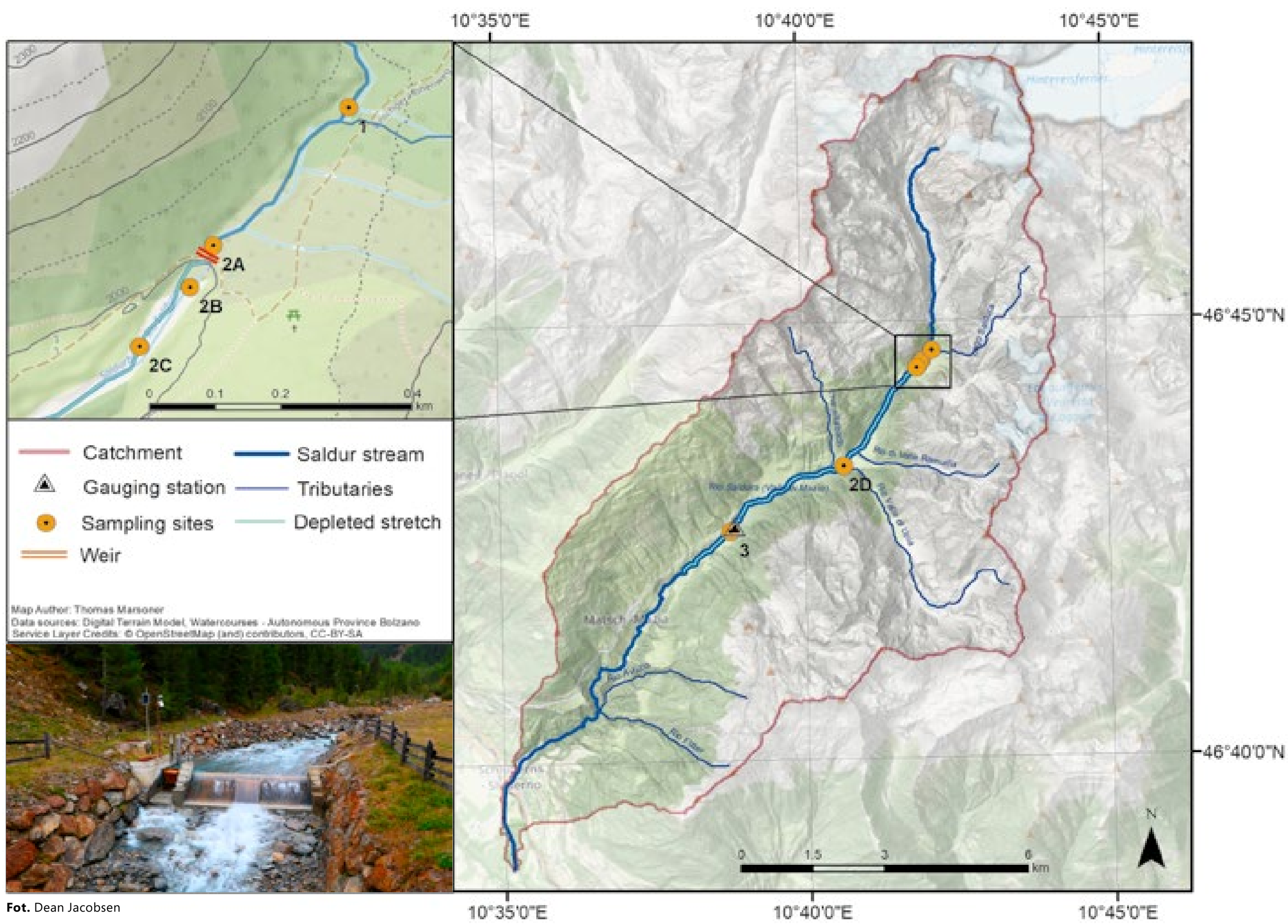
For the first time ever, the environmental impact of a small "run-of-river" hydropower plant has been assessed on a long period – 5 years – and no remarkable effect was found. The specific characteristic of the catchment played a major role, but also the application of good design and engineering principles greatly contributed to this unexpected result.

The Saldur stream, a glacier-fed, fish-free, stream located in the mountainous region of South Tyrol (Italian North-Eastern Alps), has been studied before and after the implementation of a small "run-of-river" hydropower plant. Benthic macroinvertebrates, well-established bioindicators of ecological quality, were used to perform a long-term assessment of the ecological status of the stream: using data of 5 consecutive years, and applying a true "Before-After-Control-Impact" approach through different statistical techniques, it was not detected any detrimental impact of the hydropower plant on the ecology of the stream. More specifically, neither the community structure, nor the functional roles of the benthic macroinvertebrates, measured in 4 to 6 sampling sites, were modified by the activity of the hydropower plant. However, further studies considering the different sizes, designs, and operational measures of hydropower plants – including sharing of good design principles and practices among professionals – are vital for feeding an informed debate on hydropower development.

Background

The Saldur stream catchment is located in the Italian Central-Eastern Alps (N 46°, E 10°), in the territory of the Autonomous Province of Bolzano/Bozen (Italy), and it drains an area of 101 km² (fig. 1). The climate in the catchment is relatively dry with an average annual precipitation of about 500 mm, with a distribution pattern showing a minimum in precipitation during winter and a maximum in summer[1]. The Köpper Geiger climate classification for the catchment spans from Et to Dfc following a decreasing elevational gradient, and the main land cover types present in the catchment are bare rocks (27.14%), sparsely vegetated areas (24.10%), coniferous forests (21.21%), pastures (6.55%), natural grasslands (6.41%), transitional woodland-shrub

[1] Hydrographical Office of the Autonomous Province of Bolzano/Bozen



Fot. Dean Jacobsen

Fig. 1. Map of the geographical framework of the study area and the location of the sampling sites along the Saldur stream. The upper left map shows a magnification of the geographical area close to the "Tyrolean type" weir of the "run-of-river" hydropower plant (bottom left corner) [5].

(5.61%) and glaciers and perpetual snow (4.38%)[2]. The Saldur stream, about 21.5 km long, originates from the Matscher glacier and is a tributary of the Adige river, the second longest Italian river. The hydrological dynamics characterising the stream are nivo-glacial, with the snow melting generally occurring between June and July and the glacial melting occurring in August. Concerning discharge of the stream, at a gauging station at 1.632 m a.s.l. run by the Hydrographical Office of the Autonomous Province of Bolzano/Bozen – about 11 km from the glacial source – typical base-flow conditions show discharge values around 0.6 m³/s, whilst during the melt season, these values span between 5 m³/s and 10 m³/s, with peaks up to 15 m³/s in the case of storm events. Sectors that rely on Saldur stream's water are household, tourism, aquaculture but, above all, agriculture and hydropower production. The whole catchment and the Saldur stream have been part of the ILTER network since 2014[3].

One of the requirements to be admitted in this reputable ecological network is the availability of long-term data. Indeed, along the Saldur stream, the sampling of benthic macroinvertebrates has occurred since 2010, carried out by the Institute for Alpine Environment of Eurac Research[4]. The choice of the organisms to sample was motivated by the fact that aquatic macroinvertebrates have a very high bioindicator power [1], and that fish are not present in the upper part of the catchment. Thus, starting from 2010, a collection of regular samplings of benthic organisms in specific sites along the stream, with a regular time frame (one sampling event per month from April/May to September/October, depending on accessibility of the sites), was started. The goal was to establish a dataset capable, in a long-term perspective, to provide insights to better understand the ecology of glacier-fed streams like the Saldur stream, and to monitor how this sensitive ecosystem will react to the effects of climate change. As a result, already before the start-up of the hydropower plant in 2016, some valuable research that investigated the baseline characteristics of the ecosystem of the Saldur stream was performed and released [2], [3].

[2] European Environment Agency, http://www.eea.europa.eu

[3] Site code IT-25, see: https://deims.org/11696de6-0ab9-4c94-a06b-7ce40f56c964).

[4] https://www.eurac.edu/en

Sampling design and methodology

A specific study design, conceived to maximise the possibility of detecting any potential negative effect of the hydropower plant on the benthic macroinvertebrate fauna, was conceived in 2014 and put into practice from 2015 onwards (one year before the actual start-up of the hydropower plant, see Scotti & Bottarin, 2021). Six different sampling sites were identified along the stream: site 1 acted as the control site, while the sites in the water diversion area of the hydropower plant, i.e., from 2A to 2C were selected based on their relative position to the technical infrastructures of the plant: site 2A was upstream of the weir, site 2B downstream of the weir, and site 2C approximately 150 m downstream of the weir and immediately downstream of the outlet pipe of the desilting tanks. Sites 2D and 3 were selected as sites located at about 3 and 6 km downstream of the weir, respectively (fig. 1). Technical characteristics of the hydropower plant are presented in table 1.

At each site and for each sampling event, aquatic macroinvertebrates were collected through a total of 12 quantitative Surber samples (22 × 23 cm, mesh – size 500 μm) within a 20–50 m segment of the stream. In the laboratory, benthic macroinvertebrates were separated from the debris, counted, and identified to the lowest possible taxonomic level, under a stereoscopic microscope at at 50 times magnification, referring to appropriate literature. To measure potential differences in discharge, the previously mentioned gauging station run by the Hydrographical Office of the Autonomous Province of Bolzano/Bozen, located in the water-depleted stretch about 6 km downstream of the weir, provided water discharge data throughout the entire length of the study.

Despite the benthic macroinvertebrates were collected monthly from April/May to September/October, for the analysis carried out here only the samples collected in late April/mid-May and in late September/mid-October were considered, between 2015 (year where the hydropower plant was not yet working) and 2019, for a total of 34,836 organisms collected and identified. Indeed, in these months the percentage of abstracted water is proportionally higher in comparison to the total discharge and thus, also the potential for detecting a detrimental environmental impact [4].

Source: Own Study

Weir height and type	Weir elevation	Turbine elevation and type	Diverted water	Environmental flow	Power generated
2 m, "Tyrolean type"	2,000 m a.s.l.	1,545 m n.p.m, "5-nozzle Pelton turbine"	359 l/s (average) 900 l/s (maximum)	96 l/s (all year around) + 20% total discharge (1st April – 31st October)	1606.53 kW

Table 1. Summary of the technical features of the "run-of-river" small hydropower plant located on the Saldur stream. The hydropower plant was designed and engineered by "Ingegneri Patscheider & Partner srl".

Effect on structure of the communities of aquatic macroinvertebrates

The potential negative effect of the hydropower plant on the benthic macroinvertebrate communities was assessed using different independent statistical techniques:

- Generalised Linear Mixed Models -GLMMs;
- analysis of similarities – ANOSIM;
- distance-based redundancy analysis – dbRDA;
- spatial and temporal β-diversity;
- indicator species analysis – IndVal.

Despite the usage of different approaches, each one investing a specific negative effect of the hydropower plant on the composition of the benthic macroinvertebrate community, we did not detect any detrimental effect of the hydropower plant. For instance, through the GLMMs, the whole community was analysed applying a true "Before-After-Control-Impact" (BACI) framework concerning six different faunal metrics:

- taxonomic richness,
- density of organisms,
- %EPT (Ephemeroptera-Plecoptera-Trichoptera)
- macroinvertebrate groups deemed to be particularly sensitive to environmental disruptions,
- Shannon and Simpson evenness (these two being indicator of diversity).

None of these metrics showed significant difference in the scenario before/after or upstream/downstream the hydropower plant. The same was found when investigating spatial and temporal β-diversity, where the temporal β-diversity was found to be influenced by the abundance of benthic macroinvertebrates, and not by the appearance or disappearance of new species, as was also confirmed by the IndVal analysis. Indeed, we did find some variation of the benthic communities in year-to year comparison, but these were mainly caused by natural fluctuations in densities for the whole community at catchment level, and were indeed equally detected in control site 1 and in the sites potentially impacted by the hydropower plant (e.g. 2A, 2B, 2C), ultimately suggesting that the variation was due to natural causes not depending on the hydropower plant presence and operations (fig. 2).

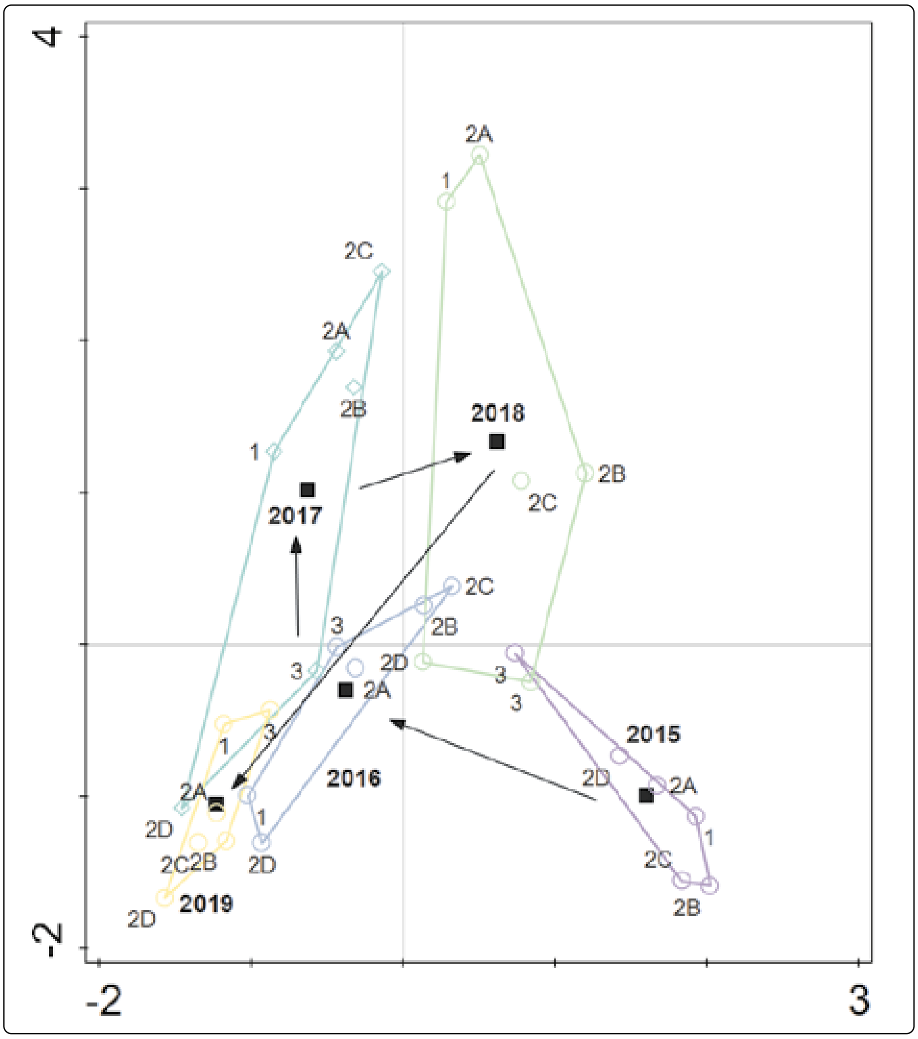


Fig. 2. Distance-based redundancy analysis (db-RDA) where the centroid of each sampling year (black squares) is surrounded by the respective six sampling sites (empty, coloured circles or squares). Black arrows indicate how the centroids of the community are moving through years. The analysis highlights the presence of an interannual variation that does not appear to be influenced by the small hydropower plant [5].

Effect on function of the communities of aquatic macroinvertebrates

Similarly, also the analysis of the benthic macroinvertebrate communities from the functional perspective (i.e. giving a focus on what the species do in the ecosystem, instead on the species themselves) did not revealed any negative influence of the hydropower plant. The study of benthic communities with respect to functional characteristics complements taxonomic studies (see previous section), and it is based on the theoretical concept of "environmental filtering": organisms are progressively filtered out from global and regional pools on the basis of their functional traits, that ultimately express the tolerances or the requirements of each taxonomical group of benthic invertebrates. Thus, local communities possess the traits that are most adapted to specific (local) environmental conditions, while organisms with less adapted traits are present at a low abundance or not present at all. The approaches used for evaluating functional differences among the benthic macroinvertebrates of the Saldur stream included analysis of the community weighted mean – CWM, and statistical comparison of a set of functional indices calculated at community level:

- functional richness,
- functional identity,
- functional dispersion,
- functional divergence,
- functional evenness,
- functional originality,
- functional specialization.

None of the 7 selected functional traits that could have potentially shift following the start-up of the hydropower plant (i.e. microhabitat/substrate preference, current preference, feeding type and mode of life, horo or merolimnic status, locomotion and substrate relation, resistance forms, and potential number of cycles per year) showed a variation across time (before vs. after implementation of the hydropower plant) or space (control vs. impacted sites). The same happened for the indices examining specific aspects of functional diversity (fig. 3).

Conclusions

The main finding of this study is that an impact of the Saldur stream's hydropower plant on benthic macroinvertebrates, which were used as a proxy for detecting changes in the ecological structures and functions of the riverine environment, was not detected.

The structure of the benthic macroinvertebrate communities continued, even after the implementation of the hydropower plant, to show a clear trend of increase in dissimilarity and diversity with increasing distance from the glacial source, a commonly recorded pattern in glacier-fed streams worldwide, and in the Saldur stream itself when the hydropower plant was not yet operating [2]. Thus, even if the choice of sampling time (April/May, and September/October) was made to minimise the effect of glacial meltwater and consequently to maximize the possibility of detecting an effect of the SHP on the benthic macroinvertebrates, the community patterns remained clearly driven by the influencing dynamics of glacial melting, and the overlapping of a potential disrupting factor caused by the activities of the hydropower plant had no detectable effects on the macroinvertebrate assemblages. Additionally, we did not measure any perturbation to the riverine ecosystems even when investigating the functional aspect of benthic macroinvertebrate communities, suggesting that key ecosystem functions in which benthic macroinvertebrates participate, such as detritus decomposition, or depend on, such as periphytic algae production, were unaffected by the hydropower plant.

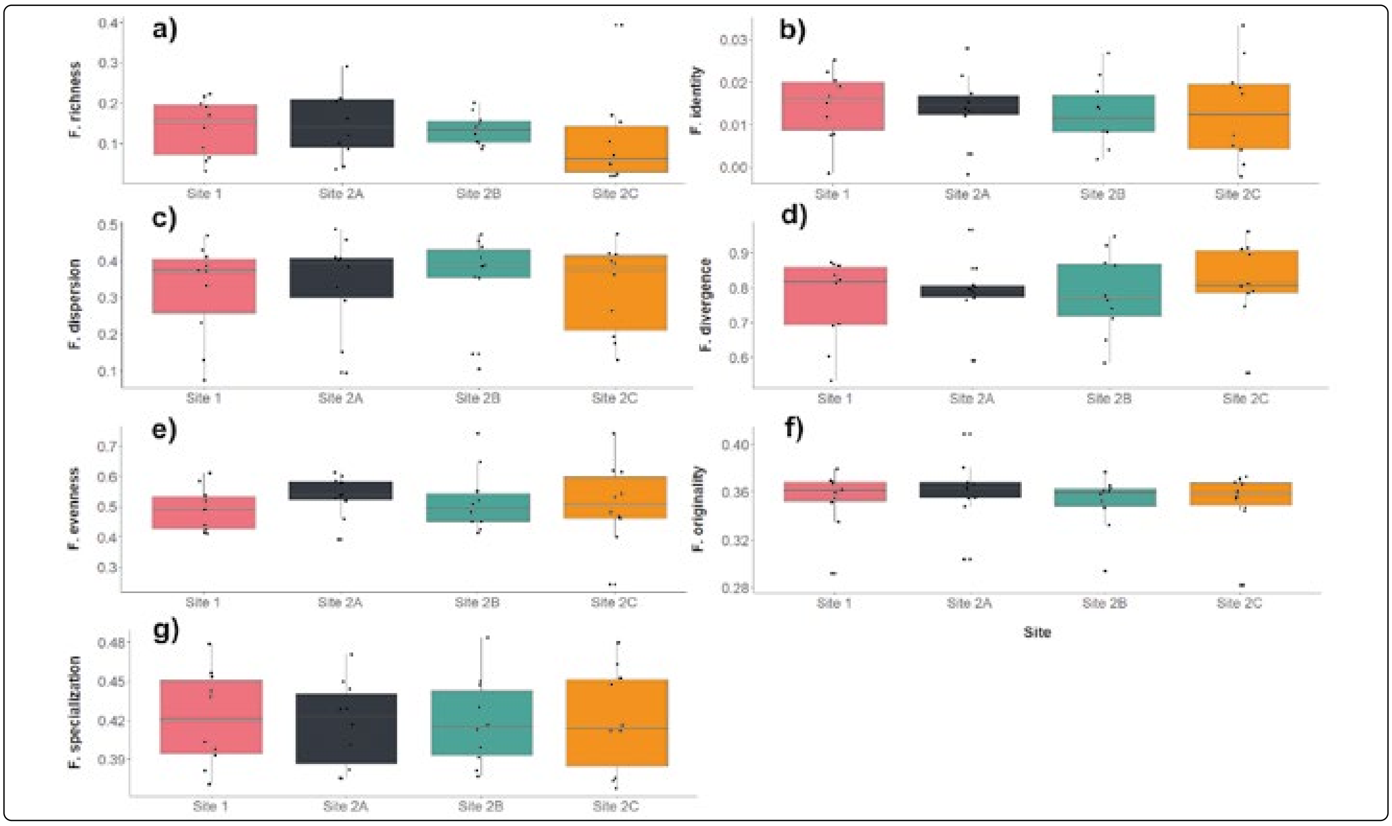


Fig. 3. Boxplots representing the functional diversity values at control site (site 1) and at the sites close to the weir area (2A, 2B, 2C) for the following indices: (A) functional richness; (B) functional identity; (C) functional dispersion; (D) functional divergence; (E) functional evenness; (F) functional originality; (G) functional specialization. Each black dot represents an observed value at each of the 10 sampling occasions (10 dots per site per index) [6].

Industry catalog

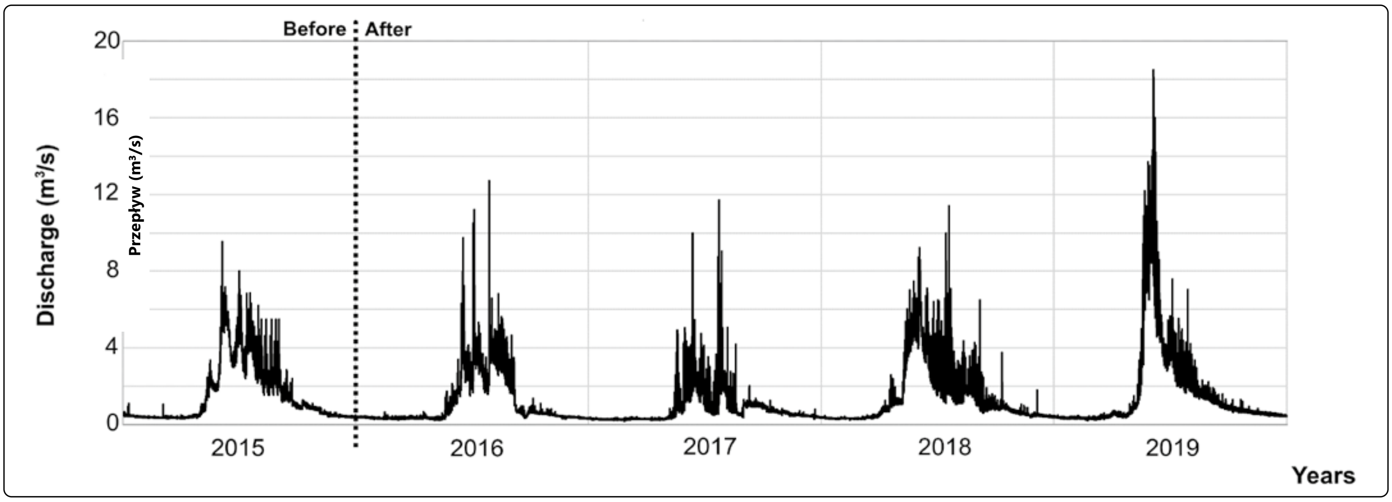


Fig. 4. Hydrograph representing the water discharge in the Saldur stream, measured at site 3 (6 km downstream of the weir), throughout the whole study period. "before" and "after" refer to the start-up of the small hydropower plant. Despite being measured in the depleted stretch, the discharge did not show any pattern variation comparing "before" and "after" situations. It is anyway important to remark that some tributaries, whose discharge is however very limited and variable throughout the year – are located between the weir and site 3. Data from Hydrographical Office of the Autonomous Province of Bolzano/Bozen [5].

Reason behind that is that the hydrologic and sediment regime did not vary following the start-up of the hydropower plant since, even in the water-depleted stretch, the longitudinal connectivity of the stream was always present (Fig. 4). In addition, it is likely that also the catchment slope contributed to minimise the potential impact of the hydropower plant, favouring the continuous flowing of turbulent waters. Thus, the specific conditions of the Saldur stream and its catchment contributed to counteract the negative environmental impacts that could have been potentially introduced by the hydropower plant. This long-term case study, thus, remarks the importance of always assessing environmental impacts keeping in mind the specificities of the sites (e.g. presence of fish, needs of the riparian vegetation, glacial origin of the stream or not, etc.).

It is important to highlight that, to allow a broad generalization of the results explained here, further studies considering the different sizes, designs, operational measures, and cumulative impacts of hydropower plants – as well as the sharing of good design principles and practices among professionals – are vital, also for supporting both informed scientific debates and policy decisions [7]. This study represents a first step in this direction, empirically demonstrating that small hydropower plants may represent an opportunity in the energy planning process, and an important resource for pursuing the climate and sustainability target plans set by the international community, especially at the local level, given the limitations of large hydropower plants concerning carbon neutrality [8]. Moreover, especially in light of the increasing number of plants whose construction is expected, and given the paucity of studies on the topic (Couto and Olden, 2018), we argue that more researchers should aim to assess, in the long term, the impact of small hydropower plants, particularly from a functional point of view. An important aspect, so far greatly overlooked, would be the reporting of the design scheme, power capacity, and size of the systems under study (Kelly Richards et al., 2017), together with the description of their "unimpacted" ecology. In this way, a more conscious differentiation between small hydropower plants that represent added value for the environment in terms of sustainable energy production and those that may represent a serious disruptive factor for aquatic ecosystems will become increasingly possible.

Information on the various statistical analyzes performed was taken from Scotti, A., Jacobsen, D., Ștefan, V., Tappeiner, U., & Bottarin, R. (2022a) and Scotti, A., Jacobsen, & Bottarin, R. (2022b).

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Graphics come from the author's archive.

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