ENERGY IS US

Hydropower Industry Guide 2021/22

Innovative Products and Services

2nd Issue

Individual success through exchange of experience
VGB PowerTech e.V. | Essen, January 2022

HYDROPOWER INDUSTRY GUIDE 2021/22

Innovative Products and Services

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The "Hydropower Industry Guide" is an annual guide that gives a comprehensive and up-to-date overview of the newest products and services offered by the Hydropower sector. It provides an easy-to-use directory of companies providing key products and services to the worldwide hydropower market. These products and services can assist you in your business and provide support and advice.

Essen (Germany), January 2022

Content

* vgbe energy is VGB PowerTech's new brand name.

Foreword

Karl-Heinz Gruber

Mario Bachhiesl

The EU Green Deal sets the guidelines for Europe's path to a secure, environmentally compatible and economically successful future. In this process, energy supply will be sustainably switched towards renewable energies.

Electricity generation from hydropower offers considerable potential for meeting the ambitious targets. The multiple advantages of run-of-river, storage and pumped storage power plants make an important contribution to supply security and guarantee controllable supply in an increasingly decentralised and volatile generation fleet.

The stable and largely plannable availability, the high degree of efficiency, the flexibility within seconds, the storage capacity and the long service life are indisputable advantages for the increased use of hydropower in the future energy mix which will be dominated by volatile renewable energy sources.

However, most of the existing hydropower plants have been in operation for several decades. Reliable and safe operation over such a long period of time can only be guaranteed by regular maintenance and repair measures. The associated costs can be stabilised or, in some cases, even reduced through innovative technological measures. This is a decisive factor for the future competitiveness of hydropower.

Especially in view of additional legal requirements, great efforts are further needed to maintain the cost stability and efficiency of hydropower. In this context, the increasing demands of nature conservation and environmental protection in harmony with the goals of increasing renewable hydropower generation is just one example to be mentioned.

In order to maintain hydropower competitive over the coming decades, innovative strategies are being jointly developed within the framework of international exchange of experience.

vgbe energy, the international technical association for the generation and storage of electricity and heat, offers an excellent platform for developing such strategies and policies, especially in the field of hydropower.

With the second edition of our yearbook "Innovative Hydropower Products and Services", we are pleased to provide a comprehensive and up-to-date overview of the latest products and services in the hydropower industry.

We hope that you will enjoy reading the articles about our innovative hydropower products and services and that you will derive maximum benefit for any of your future activities.

Dr. Karl-Heinz Gruber
VERBUND Hydro Power GmbH
Managing Director

Dr. Mario Bachhiesl
VGB PowerTech e.V.
Head of Department
Renewables

Sector Information

The Hydropower Industry Guide provides some information on current activities in the hydropower sector in Europe.

Content

Hydropower Indispensable for secure power supply in Europe

On January 8, 2021, Europe was on the verge of a blackout. Once again, the significant contribution of hydropower in stabilizing the European power systems in critical situations was demonstrated impressively. Thanks to the reserve it is able to maintain and the balancing power, hydropower is indispensable for the security of energy supply in Europe.

A frequency drop caused by the tripping of an overcurrent protection in a substation in Croatia on January 8, 2021, nearly led to a large-scale blackout in the European power grid. As a result of the breaker tripping, a cascade of power line and switchgear failures in south-eastern Europe led to a crisis in the operating condition of the interconnected European power grid, resulting in the automatic disconnection of the south-eastern from the north-western part of the grid. Since electricity had been exported from east to west before the fault occurred, the generation surplus in the eastern part resulted in a frequency rise to 50.60 Hz and the generation deficit in the western part resulted in an underfrequency of 49.74 Hz. Since the European high-voltage power grid is normally synchronized to 50 Hz, frequency deviations can lead to disconnections and shutdowns of subgrids and thus also to power outages.

However, a blackout was avoided by targeted countermeasures on due time. Given the underfrequency in the north-western subgrid, large power plants of all generation types made up for the generation deficit after the initial interception by the flywheels of the rotating machine sets (Synchronous Inertia) with rapid increase in output. In addition, contracted loads, i. e. industrial consumers with a total capacity of 1.7 GW, were taken off the grid, primarily in France and Italy. Automatic and manual countermeasures were also activated in the south-eastern subgrid due to the increase in frequency. On the one hand, excess power was reduced by withdrawing generation and shutting down of generation plants, and on the other hand, forced pumping operation in pumped storage power plants was initiated for this region in order to take energy out of the system.

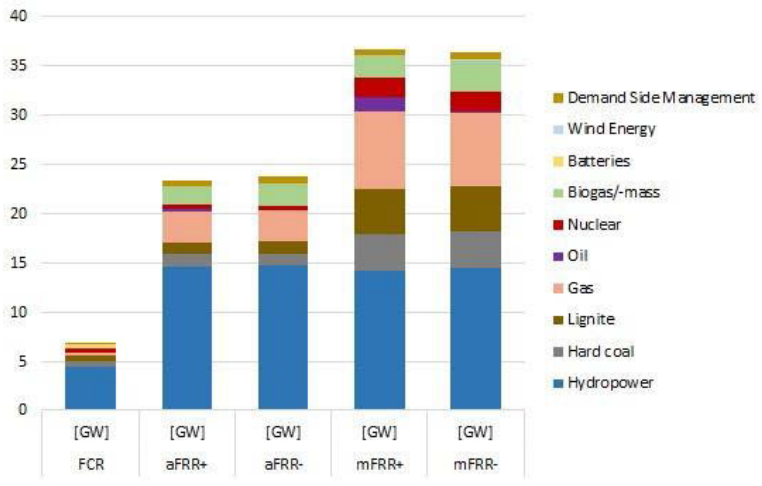

Figure 1. Prequalified reserve capacity for the German power system, Sept. 2020 (Ref.: www.regelleistung.net).

Reserve powers equalize fluctuations in the power grid within seconds "Frequency Containment Reserves (FCR)", five minutes "automatic Frequency Restoration Reserves (aFRR)" or quarter of an hour "manual Frequency Restoration Reserves (mFRR)".

ENTSOE's recently published interim report on this event gives evidence on the substantial contribution of hydropower plants in managing this critical system situation.

The decarbonization process of the European power system, combined with the partial nuclear phase-out, is progressing rapidly and will be further intensified in the coming years in order to achieve the now more stringent EU climate targets. Together with hydropower, the large thermal generation units currently are the backbone for system flexibility in all time domains (for the example of Germany, see Figure 1 for prequalified reserve capacity).

With the drop out of large thermal units, the system will gradually lose a substantial part of its flexible services (flexibility facilities), including inertia. The importance of hydropower, and in particular of highly flexible storage and pumped storage power plants, will therefore continue to increase. This topic is focused by the regulatory framework of the EU (e.g. TEN-E Regulation) or the strategic planning documents of ENTSO-E (Ten-Year Network Development Plan TYNDP 2020 including accompanying documents), in order to ensure the high level of stability of the European power grid.

In countries with hydro storage and pumped hydro storage power plants, this renewable source of energy is an integral part of technical crisis management in grid operation. If a blackout occurs, the European interconnected system will be disintegrated into several subgrids in an extreme case and generation and loads will be largely decoupled from the grid. In such a case, mainly with the help of hydropower plants, which are capable of black start, grid islands are built up one after the other in accordance with defined process steps. The load behaviour is stabilized with pumps if possible, conventional loads and further power plants are gradually connected to the island, and subsequently the subgrids are synchronized again to restore the pan-European system network. Without any external power supply, plants, capable of black start, can start-up themselves stably, provide voltage, balance the reactive power budget and, when islanded, operate the grid island stably (grid restoration). Large hydropower plants are particularly suitable to perform this duty due to their large flywheel masses (rotating inertia) and high controllability.

Even in normal, trouble-free operation, the role of hydropower in ensuring security of supply and extremely far-reaching grid stability. Depending on the location and technical equipment, the additional grid services provided by hydropower plants vary. With regard to the possible grid and system services (ancillary services), three different types can be distinguished:

Grid and system services	
Frequency stabilization	Frequency maintenance refers to the provision of system services in the form of primary control (Frequency Containment Reserve – FCR), secondary control (automatic Frequency Restoration Reserves – aFRR) and minute reserve (manual Frequency Restoration Reserve – mFRR).
Voltage maintenance	To maintain voltage, power plants provide reactive power in so-called phase-shifting operation.
Grid restoration	The grid is primarily restored by plants capable of black start, which can start-up by auto-supply (without external power supply) and without the specification of a grid frequency. They are supported by island-operational plants.

The services of hydropower for European grid stability and security of supply can be detailed as follows:

Services	Contribution of hydropower
Backup and reserve capacity	Hydroelectric power plants can be reliably and predictably held in reserve at low costs, emission-free without needing fuel, can be started-up within seconds when needed without external assistance, and can feed energy into the electrical system.
Quick start capability	The quick start capability of hydropower is unprecedented and takes only a few seconds.
Black start capability	The black start capability of hydropower is almost unprecedented. With restrictions and in combination with battery storage, gas-fired power plants are also suitable.

Services	Contribution of hydropower
Redispatch	With the aim of avoiding or eliminating grid bottlenecks, the transmission system operator requires redispatch capacity, which can be provided, for example, by pumped storage power plants from standstill in the positive (generation) or negative direction (consumption or load).
Short circuit-Power	According to ENTSO-E requirements, a minimum level of short-circuit power must be maintained in order to keep up voltage and ensure grid protection. In this respect, hydropower has always made a substantial contribution. With the increasing retirement of thermal plants, the importance of hydropower continues to grow.
Power-frequency control	Hydropower helps keeping frequency within specified limits by continuously modulating active power and countering moment-to-moment fluctuations in system power demand. The fast response capability of hydropower makes this energy particularly suitable to counter steep (residual) load gradients (ramp rates) by fast load tracking (i.e., generation change) in both energy directions. These flexibility services are provided, among others, by entire groups of power plants (flexibility facilities) inter alia in the Alpine region for the European interconnected system for all time ranges.
Balancing	In addition to control functions for the benefit of system operation, hydropower compensates for energy deficits in all time ranges. The seasonal storage capability of large hydropower storage and pumped storage to cover the winter gap is of increasing importance, especially with increasing PV generation. These flexibility services are provided, among others, by entire power plant groups (flexibility facilities) inter alia of the Alpine region for the European interconnected system for all time ranges.
Voltage maintenance, reactive power Balance	Hydropower plants can control the reactive power and thus ensure the reactive power balance in the grid. This is one of the essential prerequisites for stable grid voltage.
High-capacity change (load alternation rate)	Hydropower storage and pumped storage can compensate for power surges in the grid for a very short time by means of fast and flexible starts and stops. With the hydraulic short-circuit method, an extremely rapid change in the operating state of pumped-storage power plants from pumping operation (consumer) to turbine operation (generation) can be brought about.
Peak load control	Hydropower storage and pumped storage can respond highly flexible to load peaks.
Rotating masses (inertia)	Large hydropower plants have enormous flywheel masses of their rotating machine sets (Synchronous Inertia). These stabilize the interconnected system at the very beginning of grid disturbance. With the increasing loss of thermal units, so-called "synthetic inertia" can be provided as a conditional replacement with the aid of power electronics.

Industry experts consider the latest incident on January 8, 2021 as warning signal and further indication of the increasing risk of a blackout. Crisis-prevention experts are already predicting that a Europe-wide blackout can be expected within the next five years unless further coordinated measures are taken immediately.

Switzerland is also acting bearing security in mind: In the latest overall risk analysis for Switzerland, a blackout is identified as one of the highest ranked potential hazards. To mitigate a national blackout risk and to bridge the expected winter gap as a result of the accelerated PV and wind power expansion programme, the subsidized expansion of 2 TWh of large-scale storage power has been decided and is planned to be enshrined in law in 2021.

In addition to the expansion and conversion of the supply network, a further intelligent combination of power generators and consumers in the network is required. In this context, hydropower, as part of the "renewable family", has a key role to play as service provider for security of supply and grid stability, in particular because of its high efficiency, reliability, flexibility, and storage capability.

Therefore, hydropower remains an indispensable renewable energy source that must be further developed and preserved within the framework of an ambitious energy and climate policy.

The report was prepared in cooperation with the members of vgbe energy I Hydro Power.

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Hydropower in Europe as a catalyst for the energy transition

Hydropower has a long tradition in Europe and contributed in the first half of the last century significantly to the industrial development and welfare in most of the countries in Europe. The ambitious plan for energy transition in Europe seeks to achieve a low-carbon climate-resilient future in a safe and cost-effective way serving as a worldwide example. The key role of electricity will be strongly reinforced in this energy transition. In many European countries, the phase out of nuclear and coal generation has started with a transition to new renewable sources comprising mainly solar and wind for electricity generation. However, solar and wind are variable energy sources and difficult to align with demand. Hydropower already supports integration of wind and solar energy into the supply grid through flexibility in generation as well as its potential for storage capacity. These services will be in much greater demand in order to achieve the energy transition in Europe, and worldwide. Hydropower has all the characteristics to serve as an excellent catalyst for a successful energy transition.

Situation of hydropower in Europe

Hydropower has a long tradition in Europe and contributed in the first half of the last century significantly to the industrial development and welfare in most of the countries in Europe. Reaching today some 650 TWh of yearly generation in an average hydrological year, the economically feasible hydropower potential is used about 65% so far within Europe including Turkey (Figure 1). Since 2014 the yearly production stagnates near 650 TWh and the total installed capacity slightly above 200 GW reaching today 230 GW.

The situation of the hydropower use and untapped potential in the Europe region strongly varies from country to country (Figure 2). Many countries have still a considerable potential of development: the highlighted countries in Figure 2 have developed less than 50% of the economical feasible potential if the market conditions would ask for it.

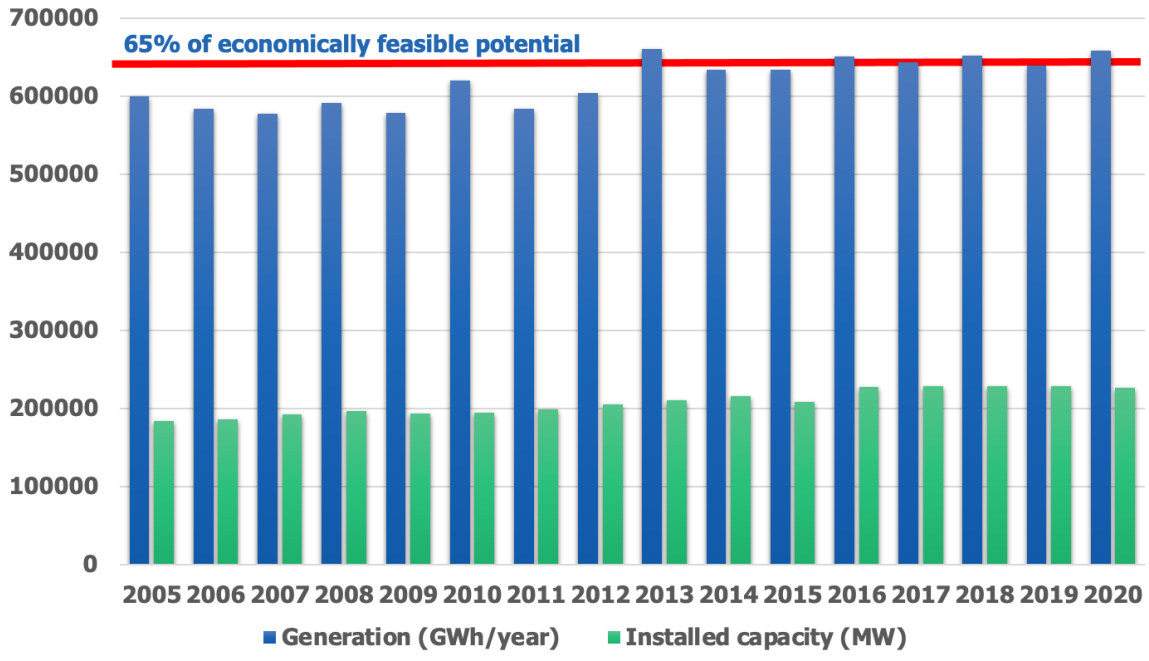

Figure 1. Evolution of yearly production and installed capacity of hydropower in Europe including Turkey since 2005 (according to Hydropower & Dams World Atlas 2021).

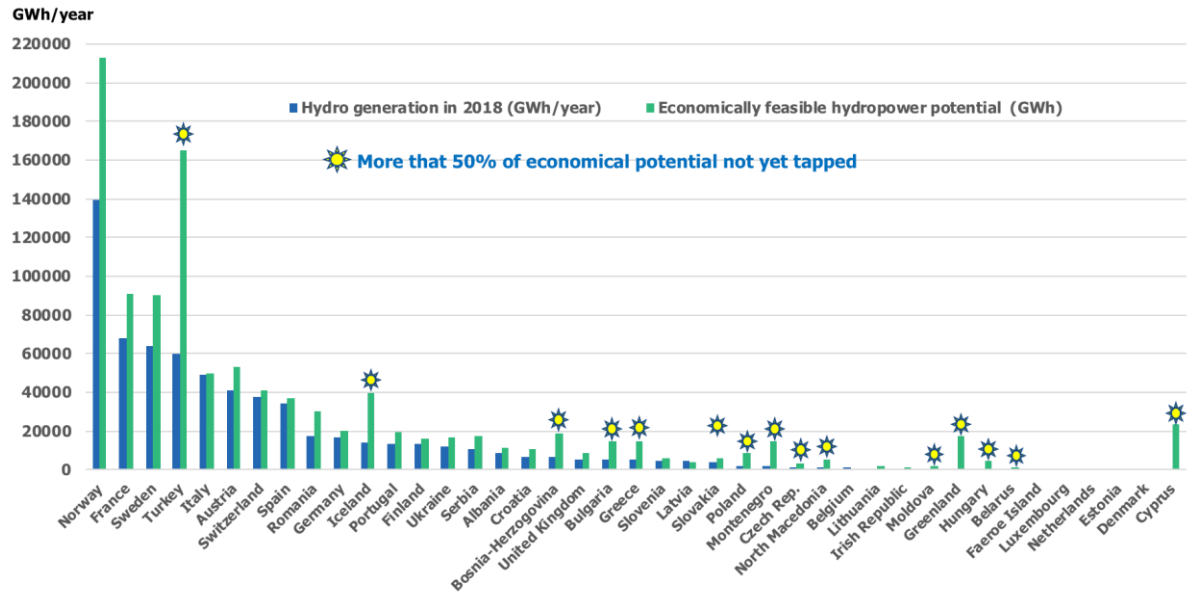

Figure 2. Generation and extension potential of hydropower in countries in the European region (according to Hydropower & Dams World Atlas 2019).

Nevertheless, relatively little investments have been done in the last decades as can be seen in Figure 3 showing the installed capacity under construction since 2006. In 2012, a quite significant increase of the construction of new power plants reaching almost 10'000 MW can be noticed. This may be attributed to the Fukushima catastrophe leading many countries to redefine their energy strategy towards renewables with planned phase out of nuclear energy. Since then, construction activity has been decreasing until 2020 to 4400 MW.

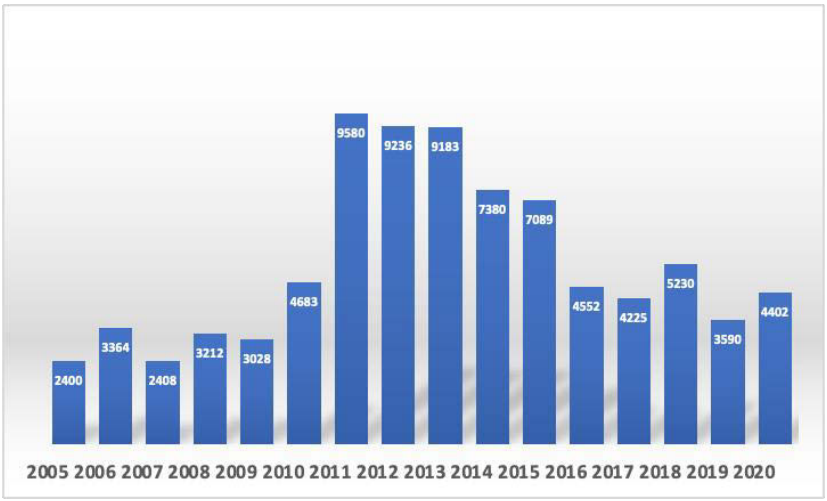

Figure 3. Installed capacity in MW under construction in Europe since 2006 without Turkey (according to Hydropower & Dams World Atlas 2021).

Challenges for future development of Hydropower and dams in Europe

The still low investments today can be attributed to fact that in the last decade the electricity prices at the European spot market were very low because of the high production capacity compared to the low economic growth and the still quite low cost of CO_2 certificates. Furthermore, the actual market (merit order) was distorted due to the high subsidize of new renewable energy as solar and wind in many countries, which penalized strongly hydropower. But after reduction of these subsidies and actual market price distortions, and after economic recovery in Europe, the attractiveness of the extension and upgrading of the existing hydropower plants, with the purpose to make them more flexible by refurbishment of equipment and increasing storage where possible, together with the construction of new pumped-storage power plants, will increase strongly.

The recent significant price increase in the energy markets also gave a positive signal for the attractiveness of future investments in hydropower. Furthermore, in many countries there exists still an important untapped hydropower potential as already mentioned (Figure 2). Nevertheless, in view of environmental and socio-economic constraints, the partial use of the remaining potential is extremely challenging and can be reached only by innovative and sustainable solutions for new hydropower plants designed as multi-purpose projects.

Hydropower projects are not only complex, but they are in interaction with a complex environment. In to obtain wide public acceptance the critical factor influencing the complex have to be known, which will allow to define the most promising design actions as well as the most effective research and development directions. Thus, to assess the complex environment hydro-power is confronted with in Europe in particular, a complex system analysis was carried out by using the network thinking approach. This allowed to identify 103 factors from the seven studied sectors, namely Hydropower, Energy and economy policy, Electricity market, Environment and public society, Research and development as well as Legal framework and Climate change, which influence the hydropower market in Europe. The activity of these factors is shown in the circular visualization in Figure 4.

low-carbon climate-resilient future in a safe and cost-effective way serving as a worldwide example. The key role of electricity will be strongly reinforced in this energy transition. In many European countries, the phase out of nuclear and coal generation has started with a transition to new renewable sources comprising mainly solar and wind for electricity generation. However, solar and wind are variable energy sources and difficult to align with demand. Hydropower already supports integration of wind and solar energy into the supply grid through flexibility in generation as well as its potential for storage capacity.

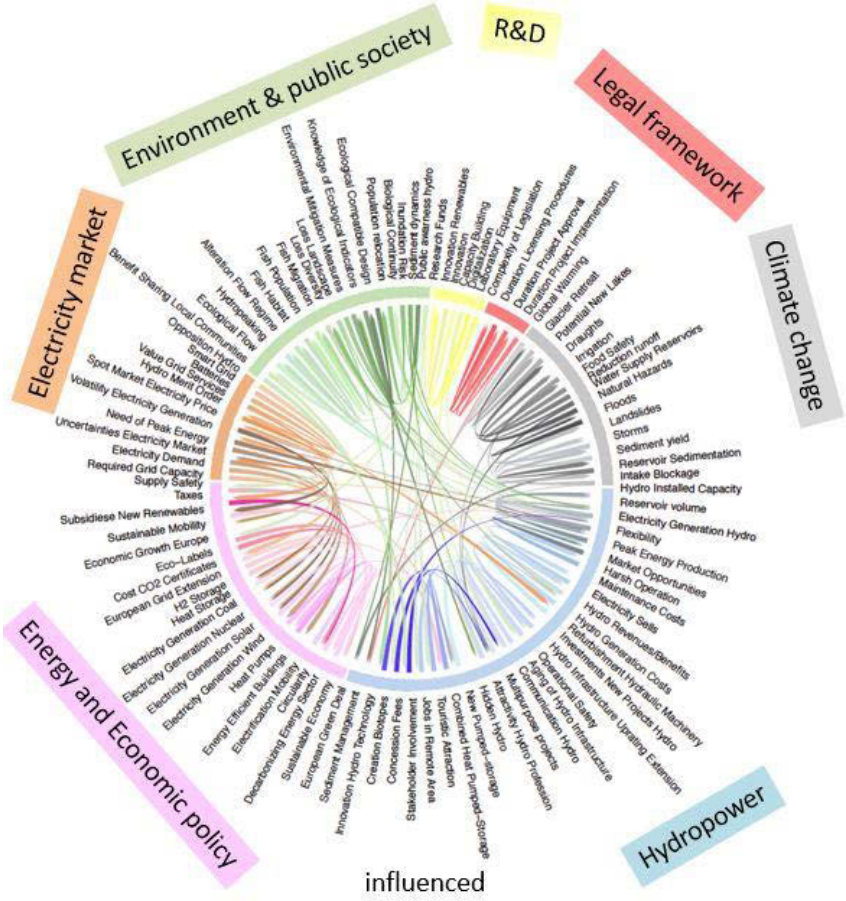

Figure 4. Circular visualization of factors of the hydropower system in Europe showing their activity (influencing intensity).

Future role of hydropower in Europe as a catalyst for the energy transition

Hydropower has already an important role today and will become even more important in the next decades, since hydropower can be a catalyst for the energy transition in Europe. The ambitious plan for energy transition in Europe seeks to achieve a

These services will be in much greater demand in order to achieve the energy transition in Europe, and worldwide.

Hydropower, with still a considerable untapped potential as mentioned before, has all the characteristics to serve as an excellent catalyst for a successful energy transition.

However, this will require a more flexible, efficient, environmentally and socially acceptable approach to increasing hydropower production to complement wind and solar energy production.

In particular:

I. Increasing hydropower production through the implementation of new environmentally friendly, multipurpose hydropower schemes and by using hidden potential in existing infrastructures.
II. Increasing the flexibility of generation from existing hydropower plants by adaptation and optimization of infrastructure and equipment combined with innovative solutions for the mitigation of environmental impacts.
III. Increasing storage by the heightening of existing dams and the construction of new reservoirs, which have to ensure not only flexible energy supply, but which also support food and water supply and thus contribute to the Water-Energy-Food NEXUS and achievement of the Sustainable Development Goals of the United Nations.
IV. Strengthening the contribution of flexibility from pumped-storage power plants by developing and building innovative arrangements in combination with existing water infra-structure.

Climate change will also be an important issue for such a hydropower development in Europe. The effect of climate change will not only change the availability of water resources in time but also change the behaviour of the catchment areas by an increased sediment yield and more frequent natural hazards, and thus considerably endangering hydropower production in the near future. Reservoirs of hydropower plants will be become vital in many regions and will have to contribute more and more to the mitigation of climate effects.

POWERING EUROPE IN A SUSTAINABLE WAY – THE ROLE OF THE HYDROPOWER EUROPE FORUM

The HYDROPOWER-EUROPE project was built on the ambition to achieve a research and innovation agenda and an industrial roadmap for the hydropower sector, based on the synthesis of technical fora and transparent public debates through a forum that gathers all relevant stakeholders of the hydropower sector. Through an extensive program of review and consultation addressing the whole hydropower sector and stakeholders (including construction, production, environmental and social issues), the Hydropower Europe Forum provided a focal point for reviewing and developing hydropower in Europe, and subsequently European hydropower in the wider world. Building from the extensive programme of consultation, the Hydropower Europe Forum was developing a Research and Innovation Agenda (RIA) as well as a Strategic Industry Roadmap (SIR).

RESEARCH AND INNOVATION NEEDS FOR FURTHER DEVELOPING HYDROPOWER IN EUROPE

The Research and Innovation Agenda (RIA) provides recommendations on the R&I priorities for hydropower to the EU institutions and national authorities to contribute towards shaping public spending for R&I. The RIA is not limited to only technological issues, such as equipment and infrastructure improvement and extension or advanced operation managing systems. It also includes environmental, social and economic issues with a view for sustainable development and to understand how community and the wider public react to hydropower projects and how social acceptance can be enhanced. However, the RIA looks at these issues exclusively through a research and development perspective. The R&I needs have been prioritized according to criteria defined with the support of the Consultation Expert Panel (CEP). The research themes identified are grouped according to the challenges which hydropower in Europe must address, namely:

- Increasing Flexibility
- Optimisation of operations and maintenance
- Resilience of electromechanical equipment
- Resilience of infrastructures and operations
- Developing new emerging concepts
- Environmental-compatible solutions
- Mitigation of the impact of global warming

In total 18 research themes (see Figure 5) comprising several research topics for each of them have been formulated based upon the wide consultation feedback.

Hydropower Europe recommended R&I themes	Challenges	Research Themes	Consultation Feedback: Priorities	Recommended Call	Recommended Funding Scheme
	Increasing flexibility	3.1.1. Innovation in flexibility, storage design and operation	Very High	before 2025	€ 26-35 million
		3.1.2. Innovative design of turbines including reversible pump-turbines and generators	High	before 2030	€ 16-25 million
		3.1.3. New models and simulation tools for harsher operational conditions	High	before 2030	€ 8-15 million
		3.1.4 Development and application of a business model for flexibility	Very High	before 2025	€ 8-15 million
	Optimisation of operations and maintenance	3.2.1. Digitalisation and artificial Intelligence to advance instrumentation and controls	High	before 2030	€ 16-25 million
		3.2.2. Monitoring systems for predictive maintenance and optimised maintenance intervals	High to Very High	before 2030	€ 2-7 million
	Resilience of electro-mechanical equipment	3.3.1. New materials for the increased resistance and efficiency of equipment	Medium High to High	before 2030	€ 8-15 million
	Resilience of hydropower infrastructure and operation	3.4.1. New materials and structures for increased performance and resilience of infrastructure	Medium High to High	before 2030	€ 8-15 million
		3.4.2. Databases of incidents and extreme events, integrated structural risk-analysis models and innovative solutions for multi-hazard risk analysis	High	before 2030	€ 8-15 million
		3.4.3. Innovative sediment management technologies for sustainable reservoir capacity and river morphology restoration	High to Very High	before 2025	€ 8-15 million
		3.4.4. Innovative techniques for enhancing the working life of concrete structures	Medium High to High	before 2030	€ 8-15 million
		3.4.5. Innovative techniques for enhancement of overtopping safety of embankment and rockfill structures	High	before 2035	€ 2-7 million
	Developing of new emerging concepts	3.5.1. Development of innovative storage and pumped-storage power plants (e.g. multipurpose PSH, sea water PSH, etc.)	Very High	before 2030	€ 16-25 million
		3.5.2. Marine energy	Medium High to High	before 2030	€ 8-15 million
		3.5.3. Hybrid & virtual power plants	High to Very High	before 2030	€ 8-15 million
	Environmentally compatible solutions and mitigation of the impact of global warming	3.6.1. Flow regime management, assessment of environmental flow release, innovative connectivity solutions for fish and biodiversity protection and improvement of stored water quality in reservoirs	Very High	before 2025	€ 16-25 million
		3.6.2. Assessment of the general impact and contribution of hydropower to biodiversity and the identification of innovative approaches and guidelines to support more sustainable hydropower development	Very High	before 2025	€ 8-15 million
	Mitigating the impact of global warming	3.7.1. Innovative concepts of hydropower infrastructure adaptation and tapping hidden hydro	Very High	before 2030	€ 16-25 million

Figure 5. Research themes as obtained by Hydropower Europe through a wide stakeholder consultation with indication of priority levels, time perspective and needed budget. The numbering of the research themes corresponds to the chapters of the full RIA report available under www.hydropower-europe.eu.

STRATEGIC ACTIONS REQUIRED FOR THE DEVELOPMENT OF HYDROPOWER AS A CATALYST FOR THE ENERGY TRANSITION IN EUROPE

Based on the feedback of the wider stakeholder consultation and the Consultation Expert Panel (CEP), the following detailed strategic actions, grouped according to the challenges identified also by the complex system analysis, have received a very high priority:

Increase social acceptance

- Collect a catalogue of examples of best practice of successful multi-purpose projects creating a win-win situation between all stakeholders
- Develop innovative approaches to address environmental issues and biodiversity protection with comprehensive approaches allowing compromises
- Increase awareness of European citizens to the importance of hydropower development

Develop environmental mitigation measures

- Develop sustainability best practices with the help of international associations (IHA, ICOLD, World Bank, etc.) including taxonomy for sustainable finance and biodiversity strategies
- Develop sustainable sediment management strategies for ensuring sustainable reservoir capacity and sediment dynamics in rivers
- Protection of biodiversity in hydropower projects by innovative compensation measures
- Collect experience with the water framework directive and lessons learnt solutions to maintain or improve water quality in rivers and reservoirs

Better hydropower deployment

- Solve the "missing money" issue with adequate remunerations in future flexibility markets
- Contribute to supply security, decentralization and independence of the European energy system with PSH
- Increase resilience by mitigating the impact of ageing and maintaining the high safety level of power plants

Adapt regulation to energy transition

- Research and development for regulation improvements (increase CO_2 cost, abolishment of the double taxation of pumped storage hydropower, concessions, safety, taxes, etc.)
- Development of a more stable regulation framework which promotes green renewable power with a fair price, tax policy and subsidy model designed for a level playing field amongst different technologies, based on a comprehensive analysis of the carbon footprint and life cycle
- Strategic action to simplified approval procedures and legislation
- Enhanced dialogue between civil society and the European Commission to define appropriate ways and tools to deploy more hydropower and to balance environmental protection legislation and climate friendly energy legislation.

The full report of the RIA and the SIR as well as summary brochures can be found under https://hydropower-europe.eu.

The HYDROPOWER EUROPE Forum is supported by a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 826010. Project partners are: International Commission on Large Dams (ICOLD), European Association for Storage of Energy (EASE), European Renewable Energies Federation (EREF), Association of European Renewable Energy Research Centres (EUREC), International Hydropower Association (IHA), Samui France SARL (SAMUI), VGB PowerTech e.V. (VGB) and ZABALA Brussels SPRL (ZABALA).

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vgbe's Interpretation Note on the EU Taxonomy & Hydropower: Criteria on Climate Change Mitigation and Adaptation

The European Commission set a clear target following the announcement of the Green Deal: Europe should become the first climate-neutral continent by 2050. The new reporting requirements associated with the EU taxonomy are likely to significantly increase the informative value of non-financial reporting by establishing a link between financial and non-financial matters for the first time.

vgbe energy has published an **Interpretation Note on Hydropower & the EU Taxonomy Climate Delegated Act** (C/2021/4987 final) as a step within the dialogue process with the European Commission and several other affected stakeholders, aiming to provide guidance for the application of the EU Taxonomy for the hydropower sector. vgbe's hydropower members and experts fully support the ambition to become the first climate-neutral continent by 2050 and are ready to invest into and further develop sustainable hydropower generation and storage across Europe. The EU Taxonomy is seen as a crucial instrument in this regard, helping to scale up sustainable investment and to implement the Green Deal. Since the technical criteria for hydropower generation and storage are inadequate as they are not as clear and specific as they should be in order to be ready for immediate use and implementation, vgbe energy initiated in-depth discussions across the sector to reach both, a common understanding as well as aligned interpretations. On behalf of the affected industry, vgbe energy publishes this Interpretation Note, providing commonly agreed as well as feasible definitions and presenting possible solutions, mainly related to current shortcomings and potential misunderstandings:

Key messages & motivation for the publication of the Interpretation Note:

- **The EU Taxonomy does not provide a level playing field**, neither for renewable electricity generation technologies nor for storage technologies.
- Hydropower is the only renewable technology that is split into different economic activities that all have to fulfil a long list of requirements, marked by **unspecific and unclear terminology, hindering a direct, immediate and swift application.**
- EU Taxonomy Climate Delegated Act does not take into account the complexity and multipurpose use of hydropower generation and storage facilities, and simultaneously introduces **new terms that have not been previously defined in existing EU legislation or in valid technical standards**.
- The EU Taxonomy criteria use **similar but not the original wording of EU legislation**, which might lead to legal uncertainty.
- **Numerous requirements and documentation duties** are imposed to manufacturers as well as to operators, which may still apply in cases where they are not in charge of fulfilling the requirements or do not have a specific mandate to do so.

To find out how to overcome the current shortcomings and clarification requirements, please download vgbe's Interpretation Note on the EU Taxonomy & Hydropower in the publication section of the website.

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Benefits of modernizing the hydropower fleet and innovative hydropower

The interaction between hydropower and river protection is a controversial topic. Hydropower companies and energy agencies promote the use of hydropower, especially in light of the renewable energy targets. Hydropower plays the most significant role in terms of energy generation and flexibility (620 TWh/y in Europe) and it is a multipurpose source. On the other side, environmental agencies perceive hydropower plants (HPPs) as a main factor of environment degradation, due to its impacts on rivers. Hence there is the need of better understanding which is the optimal compromise between hydropower benefits and environment protection, in order to develop hydropower in a sustainable way.

Within this context, the SustHydro exploratory activity at the European Commission aims at performing European assessments on hydropower opportunities in Europe, with focus on: (1) emerging technologies, (2) energy benefits from the modernization of the existing European hydropower fleet (to increase production and flexibility without adding environmental impacts) and (3) hidden hydropower potential in non-powered structures, e.g. water wheels in historic mills, turbines in pressurized water networks, and hydrokinetic turbines (generally HPPs < 100 kW). These assessments will support ongoing integrative work in the context of the WEFE Nexus, guiding hydropower companies in better planning their investments, and government institutions to better evaluate the potential of the hydropower fleet, helping in better understanding the future evolution of hydropower in Europe.

In Quaranta et al., (2020) a collection of innovative case studies is presented, covering (1) ecologically improved, low head hydropower converters (Vortex turbine, Hydrostatic Pressure Machine, VLH and Girard-optimized turbines, hydrokinetic turbines) and hydropeaking reduction, (2) new control systems, governors and digitalization, (3) hydropower as a strategy for local sustainable development, and (4) energy recovery in existing hydraulic infrastructures and aqueducts. It was found that better-governing systems can extend the life span of runners, for example avoiding the runner uplift during a trip. Digitalization can improve efficiency by 1.2%.

New sustainable practices and turbines with better ecological behavior can minimize environmental impacts, like the reduction of fish mortality, improvement of fish habitat availability, reduction of lubricant oil and generation of economic incomes for local development. The use of existing structures reduces the total installation cost: one example in Italy reports a total saving of 277 €/kW by reusing irrigation pipes and reservoirs. Innovative low head hydropower converters can exhibit good ecological behavior, with reduced costs (< 5,000 €/kW) especially when installed in existing weirs.

The assessment on the modernization of the European hydropower fleet is described in Quaranta et al., (2021). Hydropower modernization allows to increase generation and flexibility, but also to improve water management (e.g., flood control and water storage). By the dam heightening, the head loss reduction in waterways, the increase of the weighted efficiency of electro-mechanical equipment, and digitalization, the overall energy generation could be increased by 8.4% for European Union and 9.4% for the whole Europe. Additional strategies, that were not discussed because they are very site-specific, can further improve the expected energy benefits. For example, floating PV potential in Europe is 729 GW, new waterways can double the peak power in certain plants, and a better inflow forecast (spill reduction) can increase annual generation by 11% in certain cases. The additional energy storage achievable by reservoir interconnection within 20 km and coordinated operation within 3000 km has been estimated in literature as 169 TWh. Novel materials are also being developed to improve efficiency, lifespan and durability of hydropower equipment (Quaranta and Davies, 2021). This suggests that the modernization of HPPs can generate significant benefits in terms of energy, and should be considered as an important element of energy policy, also considering the additional benefits in terms of reliability and flexibility of the energy system that it may deliver.

Micro hydro plants installed at existing barriers and in water networks would allow to optimize the existing structures, providing decentralized electricity and supporting R&D and market development. The retrofitting of old mills would also promote the valorization of the cultural heritage. The discussed options, insofar as not entailing a worsening of the hydro-morphological alterations, are also expected to cause limited or no conflict with the environmental objectives of water policies in Europe.

References

Quaranta, E., & Davies, P. (2021). Emerging and Innovative Materials for Hydropower Engineering Applications: Turbines, Bearings, Sealing, Dams and Waterways, and Ocean Power. Engineering, https://www.sciencedirect.com/science/article/pii/S2095809921003581

Quaranta, E., Bonjean, M., Cuvato, D., Nicolet, C., Dreyer, M., Gaspoz, A., ... & Bragato, N. (2020). Hydropower case study collection: Innovative low head and ecologically improved turbines, hydropower in existing infrastructures, hydropeaking reduction, digitalization and governing systems. Sustainability, 12(21), 8873, https://www.mdpi.com/2071-1050/12/21/8873

Quaranta, E., Aggidis, G., Boes, R. M., Comoglio, C., De Michele, C., Patro, E. R., ... & Pistocchi, A. (2021). Assessing the energy potential of modernizing the European hydropower fleet. Energy Conversion and Management, 246, 114655. https://www.sciencedirect.com/science/article/pii/S0196890421008311

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Activities in the European Energy Research Alliance Joint Programme Hydropower

The European Energy Research Alliance (EERA) expedites a low-carbon energy research platform for 250 organisations and 50,000 researches from 30 countries. The Joint Programme Hydropower is one of 18 programmes and supports the role for hydropower as an enabler for the renewable energy sector – vgbe energy builds the bridge from operation to research.

The European Energy Research Alliance

The official mission of EERA is bringing together European energy research to reach carbon neutrality in the EU by 2050. The Joint Programme (JP) Hydropower is one of its 18 programmes. The main target is the support of current demands and R&D activities in the hydropower sector. The programme is governed by a Steering Committee and will be supported by an Advisory Board. vgbe energy as well as its cooperation partner Eurelectric have now been elected to the Advisory Board of the JP Hydropower (at present for 2 years) and will represent an essential link between research centers and universities with the operative hydropower sector.

EERA is an association of European public research centers and universities active in low-carbon energy research. It is the research pillar of the European Union's Strategic Energy Technology Plan (SET-Plan), which aims to accelerate the development and deployment of low-carbon technologies. EERA is Europe's largest energy research community and is structured in several Joint Programmes. EERA represents more than 250 organisations and about 50,000 researchers from 30 countries.

The Joint Programme Hydropower and its Sub-Programmes

The JP Hydropower facilitates the role for hydropower as enabler for the renewable energy system by aligning and targeting research efforts in Europe. Thematically, the JP Hydropower spans the entire energy chain from water catchment to system integration. It includes cross-cutting elements such as markets and market design as well as environmental impacts, effects of climate change and policy and societal issues.

The JP Hydropower will emphasize cross-disciplinary cooperation between its Sub-Programmes (SP), synergies with other EERA Joint Programmes and existing European and projects, as well as actively engagement with the industry in order to secure relevance and impact for the hydropower sector and the renewable energy system.

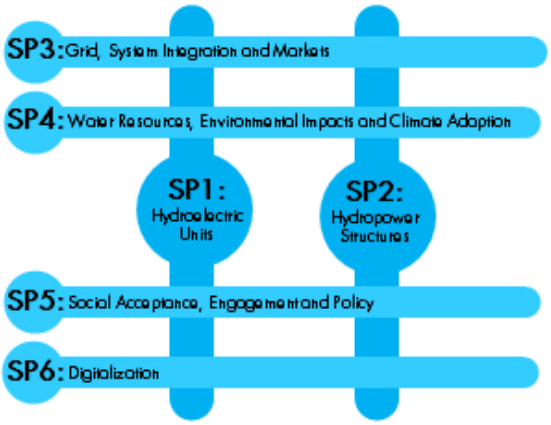


Figure 1. Structure of the Sub-Programmes.

SP1: Hydroelectric units – Coordinated by Pål-Tore Selbo Storli, NTNU (Coordinator) and Giovanna Cavazzini, University of Padova (Vice-Coordinator)

SP2: Hydropower structures – Coordinated by Jochen Aberle, EFZN/TU Braunschweig and Robert Boes, ETH Zürich (Vice-Coordinator)

SP3: Grid, System Integration and Markets – Coordinated by Michael Belsnes, NTNU (Coordinator) and Robert Schürhuber, TU Graz (Vice-Coordinator)

SP4: Water resources, environmental impacts and climate adaptation – Coordinated by Staffan Lundström, LTU (Coordinator) and David Finger, RU (Vice-Coordinator)

SP5: Social acceptance, engagement and policy – Coordinated by Berit Köhler, NINA (Coordinator) and Patrick Hendrick, BERA (Vice-Coordinator)

SP6: Digitalization – Coordinated by Eduard Doujak, TU Wien (Coordinator) and Johanna Schmidt, VRVis (Vice-Coordinator)

Activities in focus

The JP Hydropower organises many activities to ensure that participation in the JP brings relevant results and impact on research in the sector. The main engagement happens in the organisation of consortia for research calls, both at EU and national (or intra-national) level. Members explore the calls available and collaborate to foster coordination between organisations from different countries, a fundamental requisite for many research calls.

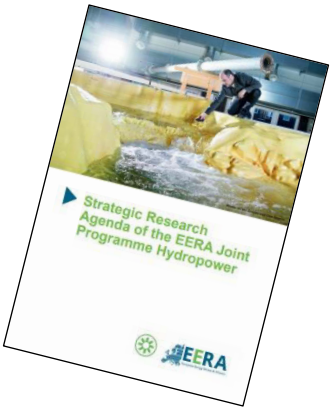
In addition to networking activities, which represent the main focus of the JP, researchers also use the arena to collaborate on research topics, with the aim to publish joint papers and other documents. Special Issues have been published featuring JP members as main editors.

Workshops, events and other meetings are also coordinated at JP level, together with joint participation in international conferences.

JP Hydropower Strategic Research Agenda

The "Strategic Research Agenda" of the EERA Joint Programme Hydropower identifies key challenges and opportunities for hydropower development and provides guidance to policymakers about future research needs.

The Strategic Research Agenda represents a holistic cross-disciplinary approach and addresses technological, economic, environmental and societal challenges. It aligns research efforts across Europe to facilitate the new role for hydropower enabler of the clean energy transition and contributes to the implementation of SET-Plan priorities and the European Green Deal.



Hydropower companies show their commitment in research and development to spur innovation and to foster ecologically, economically and socially sustainable hydropower. vgbe energy builds the new link between JP Hydropower and the operative hydropower sector as a valuable pillar for the consequently, continuous innovation and research pathway for solving the challenges of hydropower in the future.

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Expert Contributions

Contributions from experts give an insight of some aspects in the hydropower sector. Read the articles written by experts on specific topics.

Content

Secure IT-/OT-devices according to IEC 62443-4-2: a worldwide solution

Introduction

At the latest since the dispute about whether products from the company Huawei are classified as secure regarding the expansion of the 5G infrastructure in Europe, a broad public has become aware that even the best Intrusion Detection System or Intrusion Prevention System is useless if the device is not secure. In the new German IT Security Act 2.0 [01] (May 2021), for example, the legislator requires manufacturers of critical components to provide a warranty declaration on their devices. This warranty declaration must refer to the entire supply chain. In principle, you can first certify everything on a piece of paper. But ultimately it is a question of what the basis for this security is. Security in Industrial Automation and Control Systems (IACS) is a core issue worldwide. Therefore, this question should not be left to lawyers or politicians but to standards experts, computer scientists or engineers who prefer uniform standards worldwide. IACS represents all parts such as systems, components and processes that are necessary for the safe operation of a power plant. In addition to the components above, software components, applications and organisational parts are also included.

Many people believe that certification according to ISO/IEC 27001 [02] would already provide them with a standard for proving IT security and OT security. However, ISO/IEC 27001 [02] is a system standard and not a product-related standard. We also need a standard for energy generation or energy distribution that has an industrial background. A globally valid series of standards for the industrial environment is the IEC 62443 family of standards. Since we want to have a test basis with which we can test and confirm the safety of a critical component, the globally recognised IEC 62443-4-2 [03] is a suitable standard.

However, security already comes from development. For this reason, the development process must of course be integrated. The development process is normatively regulated in IEC 62443-4-1 [04]. Certification according to IEC 62443-4-2 [03] (based on IEC 62443-4-1 [04]), which should be carried out by an accredited certification body, would provide us with a globally recognised basis for a safe critical component. One could still argue that it is not ensured that accredited certification bodies really deliver the same quality worldwide. For this reason, it is suggested that a penetration test would have to be carried out for the national deployment of such a critical component. Of course, the outcomes of penetration tests vary depending on the standards and methodologies used.

Standardising penetration tests worldwide will certainly not succeed. In the end, this is also not necessary, as you only test the quality of the security of the product. Many national authorities, such as the Federal Office for Information Security in Germany, do this for government units anyway, so that there would only be an expansion of testing activities.

Manufacturers of critical components invest a lot of money in the development of their products and are afraid that the source code of their products could be lost through industrial espionage during a penetration test. But there is a solution for this too: black box penetration tests, which do not have to reveal any source code.

With product certification according to IEC 62443-4-2 [3] by internationally accredited certification companies followed by a black-box penetration test by a national authority, it would be possible to achieve the security everyone wants, based solely on verifiable facts. Of course, all this costs money. But security cannot be purchased for free.

Product life cycle and the IEC 62443 family

For our understanding, a product supplier should develop products using process compliant to IEC 62443-4-1 [04]. Conformity to IEC 62443-4-2 [03] must be achieved for this product. Those products should be integrated later, usually by a system integrator, into an Automation Solution, using a process compliant to IEC 62443-2-4 [06]. Afterwards the Automation Solution is installed at a particular site and becomes part of an Industrial Automation and Control System (IACS).

Of course, security measures according to IEC 62443- 3-3 [07] must be considered as well as the IEC 62443-3-2 [05]. For the asset owner IEC 62443-2-1 [08] and IEC 62443-2-4 [06] are relevant.

Of course, this can only be a very simplified representation of the interrelationships between the relevant IEC 62443 standards. Nevertheless, this representation and Figure 1 give an overview of the dependencies between the individual standards.

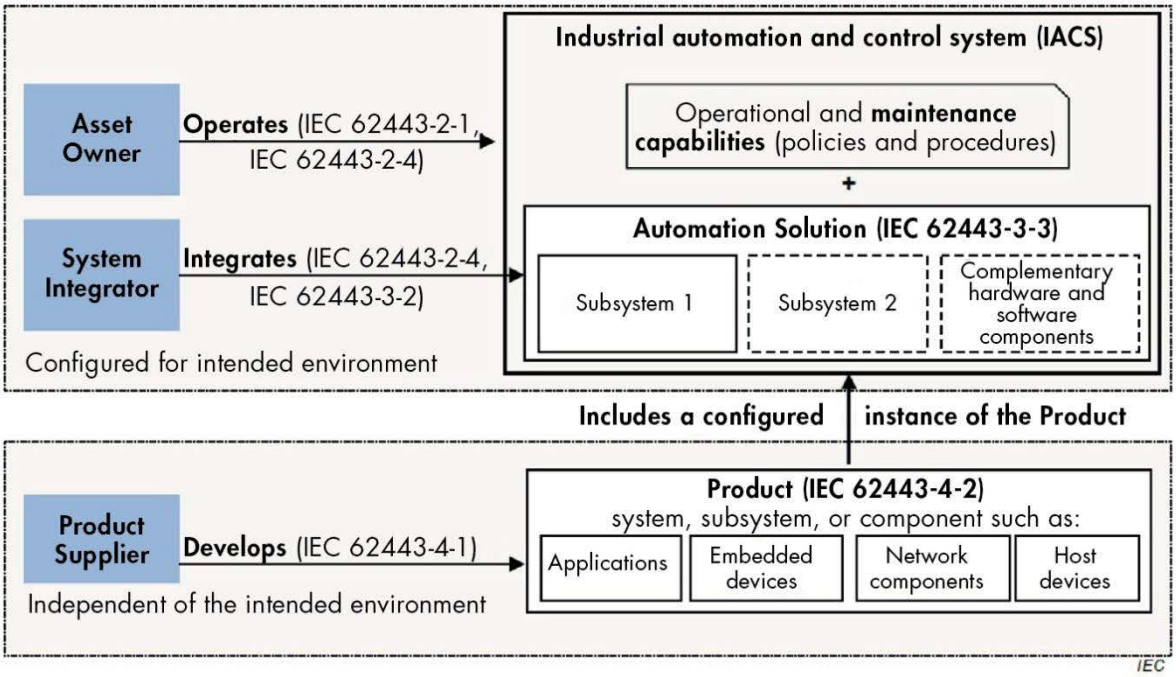


Figure 1. Example of a product life cycle, Source: IEC 62443-4-1.

Structure of the test/audit according to IEC 62443-4.2

Industrial components according to IEC 62442-4-2 are divided into four device types:
– Embedded Devices
– Host Devices
– Network Devices
– Applications

The way chosen here for a test according to IEC 62443-4-2 is to select an SL level with associated requirements (CR) and resistance level. This allows the manufacturer's view of the Critical Component to be followed. The manufacturer can carry out an evaluation of the security properties of the various possible applications.

For this purpose, the target level of the security properties must be defined via the SL level. This is preceded by an analysis of the component's operational environment.

The SL Capability (SL-C) is defined by:
– defined attacker type
– selection of requirements (CR)

IEC 62443-4-2 recognises the following types of attacks:
– SL-1: Protection against casual or coincidental violation.
– SL-2: Protection against intentional violation using simple means with low resources, generic skills, and low motivation.
– SL-3: Protection against intentional violation using sophisticated means with moderate resources, IACS specific skills and moderate motivation.

– SL-4: Protection against intentional violation using sophisticated means with extended resources, IACS specific skills and motivation.

When dealing with SL-4, one cannot avoid considering the specific safety concepts according to IEC 62443-3-2 [05]. For a better introduction to the subject, however, this essay will not refer to them.

And once again, it is pointed out here that the requirements for the secure development process for manufacturers of critical components in accordance with IEC 62443-4-1 [04] must be considered in any case. For our testing scheme, the following aspects from IEC 6244-4-1 should be used in any case in our testing scheme according to IEC 62443-4-2:
– SM-6 (File Integrity)
– SM-9 (Security requirements for externally provided components)
– SM-10 (Custom development components from third party suppliers)
– SR-1 (Product security context)
– SR-2 (Threat Model)
– SR-3 (Product security requirements)
– SR-4 (Product security requirements content)
– SR-5 (Security requirements review)
– SD-1 (Secure design principles)
– SD-2 (Defense-in-depth design)
– SD-3 (Security design review)
– SD-4 (Secure design best practices)
– SVV-1 (Security requirements testing)
– SVV-2 (Threat mitigation testing)
– SVV-3 (Vulnerability testing)
– SVV-4 (Penetration testing)
– SVV-5 (Independence of testers)
– SUM-2 (Security update communication)
– SUM-3 (Dependent component or operating system security update documentation)
– SG-1 (Product defense-in-depth)
– SG-2 (Defense-in-depth measures expected in the environment)
– SG-3 (Security hardening guidelines)
– SG-4 (Secure disposal guidelines)
– SG-5 (Secure operation guidelines)
– SG-6 (Account management guidelines)
– SG-7 (Documentation review)

Components of the test/audit according to IEC 62443-4.2

The following steps must be completed sequentially during a component test according to IEC 62443-4-2 [3]:
– Intended Use Verification
– Design Documentation
– User Documentation
– Conformity Assessment
– Vulnerability Analysis

For step 1 we must:
– define the component´s operational and security requirements (e.g., assumptions about the operational environment)
– establish and define a security concept / product security context (SR-1)
– establish and define a threat model (SR-2)

The component specification must include at least:
– Short component description
– Component identification
– Component label
– Component version
– Identification during operation, installation, and updates
– Proof of component integrity, primarily software (SM-6)
– Component category
– Excluded parts of the component.
– Component functionalities which are not considered
– Declaration of security requirements (by stating a security level: SL-x or by listing individual requirements)
– Specification of the assumed attacker type (resistance level) by stating a security level: SL-x or by describing the attacker.

In step 1 we need documented information of:
– Security concept / product security context (SR-1)
– Use cases
– Threat model (SR-2)
– Operational environment
– Product security requirements / Security functionality (SR-3 / SR-4)
– Implementation mechanism for security properties
– Information whether PKI techniques are supported or not

For step 2 we must:
– make a direct reference is made between the attack resistance and the absence of vulnerabilities.
– assigns the postulated design documentation to the before mentioned levels SL-x (resistance level).

The technical implementation has been adequate to the chosen security level (resistance), which is to be represented by the design documentation. This requirement results from the definitions of the seven Foundational Requirements (FR) given at the beginning of each chapter of the IEC 62443-4-2 [03]:

In this step 2 we reflect as well first "only" on the Component Requirements (CR) of the seven Foundational Requirements (FR), because these are the foundation for defining control system security capability levels:

FR-1: Identification and Authentication Control:
– CR 1.1 Human user identification and authentication
– CR 1.2 Software process and device identification and authentication
– CR 1.3 Account management
– CR 1.4 Identifier management
– CR 1.5 Authenticator management
– CR 1.6 Wireless access management
– CR 1.7 Strength of password-based authentication
– CR 1.8 Public key infrastructure certificates
– CR 1.9 Strength of public key authentication
– CR 1.10 Authenticator feedback
– CR 1.11 Unsuccessful login attempts
– CR 1.12 System use notification
– CR 1.13 Access via untrusted networks
– CR 1.14 Strength of symmetric key-based authentication

FR-2: Use Control:
– CR 2.1 Authorization enforcement
– CR 2.2 Wireless use control
– CR 2.3 Use control for portable and mobile devices
– CR 2.4 Mobile code
– CR 2.5 Session lock A
– CR 2.6 Remote session termination
– CR 2.7 Concurrent session control
– CR 2.8 Auditable events A
– CR 2.9 Audit storage capacity
– CR 2.10 Response to audit processing failures
– CR 2.11 Timestamps
– CR 2.12 Non-repudiation
– CR 2.13 Use of physical diagnostic and test interfaces

FR-3: System Integrity:
– CR 3.1 Communication integrity
– CR 3.2 Protection from malicious code
– CR 3.3 Security functionality verification
– CR 3.4 Software and information integrity
– CR 3.5 Input validation
– CR 3.6 Deterministic output
– CR 3.7 Error handling
– CR 3.8 Session integrity
– CR 3.9 Protection of audit information
– CR 3.10 Support for updates A
– CR 3.11 Physical tamper resistance and detection
– CR 3.12 Provisioning product supplier roots of trust
– CR 3.13 Provisioning asset owner roots of trust
– CR 3.14 Integrity of the boot process

FR-4: Data Confidentiality:
– CR 4.1 Information confidentiality
– CR 4.2 Information persistence
– CR 4.3 Use of cryptography

FR-5: Restricted Data Flow:
– CR 5.1 Network segmentation
– CR 5.2 Zone boundary protection
– CR 5.3 General purpose person-to-person communication restrictions

FR-6: Timely Response to Events
– CR 6.1 Audit log accessibility
– CR 6.2 Continuous monitoring

FR-7: Resource Availability:
– CR 7.1 Denial of service protection
– CR 7.2 Resource management
– CR 7.3 Control system backup
– CR 7.4 Control system recovery and reconstitution
– CR 7.5 Emergency power
– CR 7.6 Network and security configuration settings
– CR 7.7 Least functionality
– CR 7.8 Control system component inventory

For step 3 the following content of the user documentation is required:
– installing security updates for the component (SUM-2) additional independent components or underlying operating systems (SUM-3)
– rolling out security updates (SUM-4)
– describing the component's defense-in-depth strategy (SG-1)

– requirements of the defense-in-depth strategy on the operational environment
– performing security hardening via component configuration (SG-3)
– secure decommissioning/disposal (SG-4)
– secure operation (SG-5)
– account management (SG-6)

According to IEC 62443-4-1 [04], 3.1.15 defense-in-depth is an approach to defend the system against any attack using several independent methods:
– Security guidelines
– Specification of security requirements
– Security by design
– Secure implementation
– Security V&V testing

Step 4 refers to conformity assessment.

The IEC 62443-4-2 part of the standard specifies requirements (Component Requirements, CR). The requirements for the test case must be specified for each concrete component. Acceptance criteria are defined for this purpose, which are taken up as tester expectations during test case creation. In contrast to the standard, the acceptance criteria can be specified technologically. It is possible to name currently recommended technologies in concrete terms.

The procedure model for transferring the requirements looks as follows and would also have to be documented accordingly:
– requirements of the standard part
– definition of the acceptance criteria
– component-specific test cases

Let us look at how requirements are structured normatively in IEC 62443-4-2. Each component requirement consists of the following subtitles:
– Requirement
– Rationale and supplemental guidance
– Requirement enhancements
– Security levels

For example, let us examine CR 3-1 (Communication integrity):

For CR 3-1 we would have for SL-C1 the requirement: "Components shall provide the capability to protect integrity of transmitted information." For SL-C2 to SLC4 we would have additionally the requirement: "Components shall provide the capability to verify the authenticity of received information during communication".

In this case we would define the following acceptance criteria for SL-1 to SL-3:

SL-1:
– capability to protect integrity of transmitted information
– use of CRC (protection against casual or coincidental manipulation)
– use of standardized cryptographic protocol
– use of recommended protocols

SL-2:
– capability to authenticate information during communication

Not accepted would be in SL-2:
– use of error detection codes, weak hashing or weak signature functions
– authentication of information is not possible
– fallback to not recommended protocols

SL-3:
For SL-3 we would define no further requirements.

In the test we would check connections for https and FTP under predefined test conditions. The following test steps would be:
– Establish connection
– Manipulate network packets
– Observe is data is still transmitted, received, and processed.

After these tests we have to our test results with the test expectations. Only if all cases are accepted, the result would be pass.

This process must be repeated for all requirements.

Step 5, vulnerability analysis, is the supreme discipline.
We begin with the vulnerability assessment methods. The following methods can be used:
– ISO/IEC 18045 [09]
– Common Methodology for Information Technology Security Evaluation [10]

Now the most used assessment model is the "Vulnerability Assessment (AVA) methodology from the Common Methodology for Information Technology Security Evaluation (CEM). In order to apply the AVA methodology to the IEC 62443 the security levels of the IEC 62443 must be adapted to the numerical values of CEM. For example:

Security Level	Sufficient Resistance Threshold
SL-1	> 0
SL-2	> 4
SL-3	> 14

The characteristics used as a basis for an attack are:
– Time needed for the design and for the execution of the attack
– Expertise
– Knowledge of the component
– Window of opportunity
– Attacker´s equipment

The following IEC 62443-4-1 practices can be used to identify vulnerabilities:
– Threat model (SR-2)
– Threat mitigation testing (SVV-2)
– Vulnerability testing (SVV-3)
– Penetration testing (SVV-4)

The goal must be achieved that all known and exploitable vulnerabilities are assessed.

According to SVV-5 of IEC 62443-4-1 [04], the auditor must have the necessary independence in the performance and evaluation of the results. The aim of the vulnerability analysis must be that at the end of the audit there are no vulnerabilities that could be successfully exploited with the attacker type defined via the SL levels of IEC 62443-4-2 [03].

In the context of the documentation of the vulnerability analysis, not only the vulnerability as such but also the entire path must be documented. For the evaluation of possible countermeasures, it is necessary to refer to the security architecture according to SD-2 of IEC 62443-4-1 [04]. For important vulnerabilities there should be an evaluation according to the Common Vulnerability Scoring System (CVSS).

CVSS is a free and open industry standard for assessing the severity of computer system security vulnerabilities. The Common Vulnerability Scoring System attempts to assign severity scores to vulnerabilities, allowing responders to prioritize responses and resources according to threat. Scores are calculated based on a formula that depends on different metrics that approximate ease of exploit and the impact of exploit. Scores range from 0 to 10, with 10 being the most severe.

Metrics are:
– Access Vector
– Access Complexity
– Authentication
– Confidentiality
– Integrity
– Availability

A Common Vulnerability Scoring System calculator can be found at:
https://nvd.nist.gov/vuln-metrics/cvss/v3-calculator

Finally, let us look at how a conformity report of a component should look in relation to IEC 62443-4-2, so that comparability can be achieved and a government body has a basis for decision-making to define whether a component is secure or not.

Structure of a conformity report according to IEC 62443-4.2

1. Scope
1.1 Introduction
1.2 Intended Operational Environment
1.3 Basic and extended Security-Level
1.4 Abbreviations
1.5 Definitions
1.6 References
2. System Architecture
2.1 Architecture
2.2 Lifecycle Phases
3. Component Definition
3.1 Component Scope Definition
3.1.1 Short Component Description
3.1.2 Component Identification and Label
3.1.3 Component Version
3.1.4 Security Functions in terms of IEC 62443-x-x
3.1.5 Additional Security Functions
3.2 Component Type
3.3 Component Security Assumptions
3.3.1 Physical Assumptions
3.3.2 Logical Assumptions
3.3.3 Assumptions on Integrators
3.3.4 Assumptions on Supplier
3.4 Component Threats
4. Security Requirements
4.1 Use-Case Security-Level Capability
4.2 Component Requirements (CR) and Use-Case Security-Level Capability
4.2.1 Reasons for not selecting CR's
4.2.2 Modification of CRs
4.3 Additional Requirements
5. Evaluation
5.1 Required Test Environment
5.2 Required Test Interfaces

5.3 Acceptance Criteria
5.3.1 Acceptance Criteria for IEC 62443 Requirements
5.4 Acceptance Criteria for Additional Requirements
5.5 Binding Vulnerabilities
5.6 Countermeasure for Binding Vulnerabilities
5.7 CVSS classification

Evaluations would have to be carried out and documented at periodic intervals, but also when new vulnerabilities or a change in the state of the art become known.

Black box penetration test

Without a black box penetration test national authorities will (probably) not accept a conformity report according to IEC 62443-4-2. Even if we do not want to propose a specific test, we would like to refer to the following criteria of the Cybersecurity & Infrastructure Agency [13], which are more than excellent in their quality and quantity to date:

Ease of use:
– Intuitive and easy to use for users new to automated testing tools
– Easy to install
– Tasks can be accomplished quickly, assuming basic user proficiency
– Easy to maintain automated tests, with a central repository that enables users to separate GUI object definitions from the script

Tool customisation:
– Fully customizable toolbars to reflect any commonly used tool capabilities
– Tool customisable
– Fully customized editor with formats and colours for better readability
– Tool support for required test procedure naming convention

Breadth of testing:
– Can be used with non-Microsoft platforms
– Tests for common website vulnerabilities
– Evaluates the test environment as well as the software
– Supports standard web protocols for fuzzing and domain testing

Test coverage and completeness:
– Coverage refers to the ability of the tools to test for all (known) categories of vulnerabilities relevant to the product that has been developed.

Accuracy/False-positive rate
– Is there a large number of false positives?
– Is there a large number of unidentified vulnerabilities?

Test language features:
– Allows add-ins and extensions compatible with third-party controls
– Does not involve additional cost for add-ins and extensions
– Has a test editor/debugger feature
– Test scripting language flexible yet robust; allows for modular script development
– Scripting language not too complex
– Scripting language allows for variable declaration and use and for parameter to be passed between functions
– A test script compiler or an interpreter used?
– Published APIs: Language Interface Capabilities
– Tool is not intrusive
– Allows data-driven testing
– Allows automatic data generation
– Allows adding timers for timing transaction start and end
– Allows adding comments during recording
– Allows automatic or specified synchronization between client and server
– Allows object data extraction and verification
– Allows database verification
– Allows text (alphanumeric) verification
– Allows wrappers (shells) whereby multiple procedures can be linked and called from one procedure
– Allows automatic data retrieval from any data source for data-driven testing
– Allows use of common spreadsheet for data-driven testing
– Ease of maintaining scripts when application changes

Test management:
– Supports test execution management
– Support for industry standards in testing processes
– Interoperability with tools being used to automate traditional testing
– Application requirements management support integrated with the test management tool
– Requirements management capability supports the trace of requirements to test plans to provide requirement coverage metrics
– Test plans can be imported automatically into test management repository from standard text files

– Can be customized to organization's test process
– Supports planning, managing, and analysing testing efforts; can reference test plans, matrices, product specifications, in order to create traceability
– Supports manual testing
– Supports the migration from manual to automated scripts
– Can track the traceability of tests to test requirements
– Has built-in test requirements modules
– Can check for duplicate defects before logging newly found defects
– Allows measuring test progress
– Allows various reporting activities
– Allows tracking of manual and automated test cases
– Has interface to software architecture/ modelling tool
– Is integrated with unit testing tools
– Has interface to test management tool
– Has interface to requirements management tool
– Has interface to defect tracking tool
– Has interface to configuration management tool
– Provides summary-level reporting
– Includes error filtering and review features
– Enables metric collection and metric analysis visualization

Interoperability:
– Major test automation suites provide functionality that is useful in any largescale testing process.

Load and stress test features:
– All users can be queued to execute a specified action at the same time
– Automatic generation of summary load testing analysis reports
– Ability to change recording of different protocols in the middle of load-recording session
– Actions in a script can be iterated any specified number of times without programming or rerecording of the script
– Different connection speeds and browser types can be applied to a script without any rerecording
– Load runs and groups of users within load runs can be scheduled to execute at different times
– Automatic load scenario generation based on load testing goals: hits/second, number of concurrent users before specified performance degradation, and so on
– Cookies and session IDs automatically correlated during recording and playback for dynamically changing web environment
– Allows for variable access methods and ability to mix access methods in a single scenario: modem simulation or various line speed simulation
– Ability to have data-driven scripts that can use a stored pool of data
– Allows for throttle control for dynamic load generation
– Allows automatic service-level violation (boundary value) checks
– Allows variable recording levels (network, web, API, and so on)
– Allows transaction breakdown/drilldown capabilities for integrity verification at the per client, per session, and per instance level for virtual users
– Allows web application server integration
– Supports workload, resource, and/or performance modelling
– Can run tests on various hardware and software configurations
– Support headless virtual user testing feature
– Requires low overhead for virtual user feature (web, database, other?)
– Scales to how many virtual users?
– Simulated IP addresses for virtual users
– Thread-based virtual user simulation
– Process-based virtual user simulation
– Centralised load test controller
– Allows for reusing scripts from functional test suite
– Compatible with SSL recording
– Compatible with which network interaction technologies?
– Compatible with all relevant platforms?

Monitor test features:
– Monitors various tiers: web server, database server, and app server separately
– Supports monitoring for server frameworks?
– Supports monitoring of different platforms?
– Monitors network segments
– Supports resource monitoring
– Synchronization ability in order to determine locking, deadlock conditions, and concurrency control problems
– Ability to detect when events have completed in a reliable fashion
– Ability to provide client-to-server response times
– Ability to provide graphical results and export them to common formats

Conclusion

With the application of IEC 62443-4-2 (in conjunction with IEC 62443-4-1), we have a way of demonstrating the conformity of critical components with stringent safety requirements. A final black box pentesting then allows verification that the product certification is sufficient to confirm the security requirements.

References

[01] IT-Security Law 2.0, https://www.gesetze-im-internet.de/bsig_2009/BJNR282110009.html.

[02] ISO/IEC 27001 Information technology - Security techniques– Information security management systems– Requirements.

[03] ISO/IEC 62443-4-2 Security for Industrial Automation and Control Systems, Part 4-2: Technical requirements for IACS components.

[04] ISO/IEC 62443-4-1 Security for Industrial Automation and Control Systems, Part 4-1: Secure product development lifecycle requirements.

[05] ISO/IEC 62443-3-2 Security for Industrial Automation and Control Systems, Part 3-2: Security risk assessment for system design.

[06] ISO/IEC 62443-2-4 - Security for Industrial Automation and Control Systems Part 2-4: Security program requirements for IACS solution providers.

[07] ISO/IEC 62443-3-3 Security for Industrial Automation and Control Systems Part - Part 3-3: System security requirements and security levels.

[08] ISO/IEC 62443-2-1 Security for Industrial Automation and Control Systems Part - Part 2-1: Establishing an Industrial Automation and Control System Security Program.

[09] ISO/IEC 18045 Information security, cyber security and privacy protection – Evaluation criteria for IT-security – Methodology for IT-security evaluation.

[10] Common Methodology for Information Technology Security Evaluation, April 2017, Version 3.1, Revision 5.

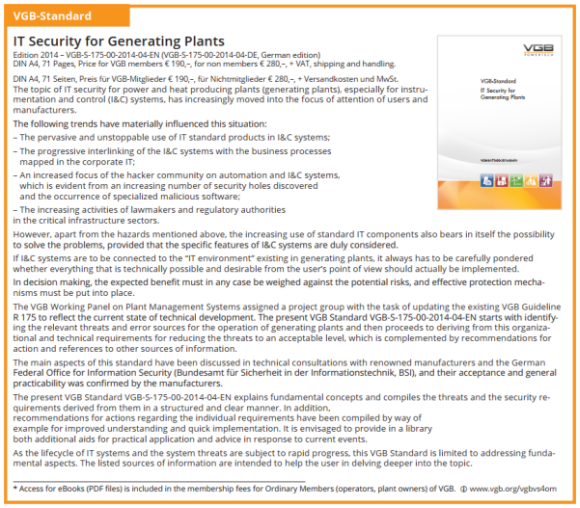
[11] Common Criteria for Information Technology Security Evaluation, April 2017, Version 3.1 Revision 5, Part 1: Introduction and General Model.

[12] Common Criteria for Information Technology Security Evaluation, April 2017, Version 3.1 Revision 5, Part 2: Functional Security Components.

[13] Common Criteria for Information Technology Security Evaluation, April 2017, Version 3.1 Revision 5, Part 3: Assurance Security Components.

[13] https://us-cert.cisa.gov/bsi/articles/tools/black-box-testing/black -box-security-testing-tools.

IT Security for Generating Plants


VGB-Standard

IT Security for Generating Plants

Edition 2014 – VGB-S-175-00-2014-04-EN (VGB-S-175-00-2014-04-DE, German edition)
DIN A4, 71 Pages, Price for VGB members € 190,–, for non members € 280,–, + VAT, shipping and handling.

DIN A4, 71 Seiten, Preis für VGB-Mitglieder € 190,–, für Nichtmitglieder € 280,–, + Versandkosten und MwSt.

The topic of IT security for power and heat producing plants (generating plants), especially for instrumentation and control (I&C) systems, has increasingly moved into the focus of attention of users and manufacturers.

The following trends have materially influenced this situation:

- The pervasive and unstoppable use of IT standard products in I&C systems;
- The progressive interlinking of the I&C systems with the business processes mapped in the corporate IT;
- An increased focus of the hacker community on automation and I&C systems, which is evident from an increasing number of security holes discovered and the occurrence of specialized malicious software;
- The increasing activities of lawmakers and regulatory authorities in the critical infrastructure sectors.

However, apart from the hazards mentioned above, the increasing use of standard IT components also bears in itself the possibility to solve the problems, provided that the specific features of I&C systems are duly considered.

If I&C systems are to be connected to the "IT environment" existing in generating plants, it always has to be carefully pondered whether everything that is technically possible and desirable from the user's point of view should actually be implemented.

In decision making, the expected benefit must in any case be weighed against the potential risks, and effective protection mechanisms must be put into place.

The VGB Working Panel on Plant Management Systems assigned a project group with the task of updating the existing VGB Guideline R 175 to reflect the current state of technical development. The present VGB Standard VGB-S-175-00-2014-04-EN starts with identifying the relevant threats and error sources for the operation of generating plants and then proceeds to deriving from this organizational and technical requirements for reducing the threats to an acceptable level, which is complemented by recommendations for action and references to other sources of information.

The main aspects of this standard have been discussed in technical consultations with renowned manufacturers and the German Federal Office for Information Security (Bundesamt für Sicherheit in der Informationstechnik, BSI), and their acceptance and general practicability was confirmed by the manufacturers.

The present VGB Standard VGB-S-175-00-2014-04-EN explains fundamental concepts and compiles the threats and the security requirements derived from them in a structured and clear manner. In addition, recommendations for actions regarding the individual requirements have been compiled by way of example for improved understanding and quick implementation. It is envisaged to provide in a library both additional aids for practical application and advice in response to current events.

As the lifecycle of IT systems and the system threats are subject to rapid progress, this VGB Standard is limited to addressing fundamental aspects. The listed sources of information are intended to help the user in delving deeper into the topic.

* Access for eBooks (PDF files) is included in the membership fees for Ordinary Members (operators, plant owners) of VGB. www.vgb.org/vgbvs4om

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Contribution of German hydropower plants to the system Inertia

The structural transition towards climate-neutral power generation is changing the generation structure in Germany and Europe. This leads to a reduction in rotating masses due to the phase-out of fossil and nuclear power plants and thus to a reduction of their stabilizing inertia. As a result the probability of unacceptable frequency deviations and gradients caused by power deficits, for instance following grid separations, increases. In order to limit frequency deviations and gradients after disturbances to a permissible level in the future, the transmission system operators are increasingly focusing on the inertia of the remaining generation units. Hydropower plants, for example, will continue to provide inertia. This study therefore quantifies the contribution of German hydropower plants to frequency stabilization.

The contribution of German hydropower plants to system inertia is evaluated based on two criteria: First, the kinetic rotational energy stored in the hydropower plants - as a measure of their inertia- is compared with the rotational energy of large fossil and nuclear power plants. Second, the share of a power deficit allocatable to Germany or Bavaria is determined which the inertia of the hydropower plants in Germany or Bavaria in combination with the self-regulating effect of the German or Bavarian load, respectively, can still compensate without violating permissible frequency deviations and gradients. Therefore, the idealized assumption is applied that the system inertia is distributed evenly in proportion to the respective load in the European transmission grid.

The investigations prove that the kinetic rotational energy of the German hydropower plants is comparable to that of a large nuclear power plant. The inertia of the German hydropower plants alone, together with the self-recovery effect of the German load, allows the control of a disturbance in which Germany accounts for a power deficit of 463 MW to be compensated. If only the load and hydropower plants in Bavaria are considered, a share of a power deficit of 102 MW attributable to Bavaria can be controlled.

1 Introduction

Hydropower plants already offer a number of advantages, such as high efficiency, high full-load hours, climate-neutral power generation, and base-load and balancing power capability to stabilize the grid and ensure reliability of supply.

The transition process towards climate-neutral power generation is changing the generation structure and leading to a reduction of the stabilizing inertia of fossil and nuclear power plants in the power grid. Therefore, the provision of inertia by the remaining rotating generation units is increasingly attracting the attention of the transmission system operators.

The system inertia describes the intrinsic inertia of the grid, which limits the frequency gradient in the event of a power deficit, e.g. as a result of a power plant outage or grid separation. A reduced gradient also leads to lower frequency deviations until other time-delayed frequency-supporting measures such as primary control apply. System inertia is inherently available due to the rotating masses of generators and turbines of conventional and nuclear power plants. The phase-out of nuclear power and coal power plants reduces these system-supporting properties, increasing the probability of unacceptable frequency deviations, for example, as a result of a grid separation. Just recently, on January 08, 2021, such a grid separation occurred in the European transmission grid [1].

In the future, too, unacceptable frequency gradients and deviations must be limited by the available system inertia so that the stability of the grid is not endangered. Even after grid separations, it is necessary to maintain sufficient inertia in each of the resulting subgrids. As a consequence, the system inertia has to be kept distributed in the European transmission grid.

Within the scope of the present study, it is therefore idealistically assumed that the system inertia is distributed evenly in the European transmission grid in proportion to the respective load and that each grid area must contribute its share of the stored system inertia to the stabilization of an occurring power deficit.

In order to quantify the contribution of the hydropower plants to the system inertia, chapter 2 first uses the kinetic rotational energy as a measure for their inertia to compare the German hydropower plants with large fossil and nuclear power plants. In chapter 3, a method is presented, which determines the maximum shares of a power deficit that the inertia of the hydropower plants in Germany and Bavaria, respectively, together with the self-regulating effect of the load, is able to compensate without violating admissible frequency deviations and gradients. Finally, chapter 4 presents the results of this method.

2 Inertia

In order to determine the existing inertia in the hydropower plants, the kinetic rotational energy of the rotating masses of the generator and turbines of all hydropower plants is applied as a measure. This measure can be determined by aggregating the kinetic rotational energy of all hydropower plants. The individual plants are taken from the Market Data Register (German: Marktstammdatenregister (MaStR)).

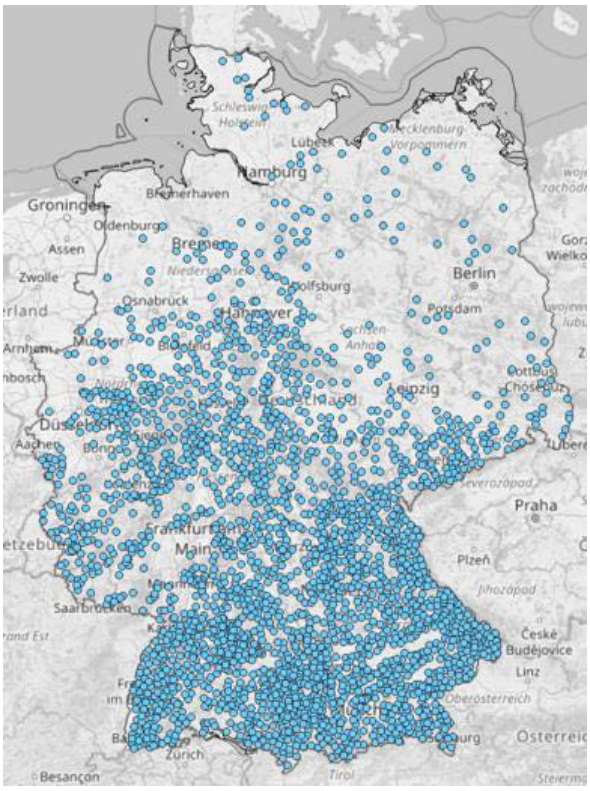

Figure 2-1: Germany-wide distribution of hydropower plants based on the MaStR.

2.1 Market Data Register

To determine the installed capacities of hydropower plants in Germany, the Market Data Register of the Federal Network Agency is used [2]. As a central register, MaStR contains the data of all generation plants.

According to MaStR, there are 7988 hydropower plants in operation. The hydropower plants are distributed decentral mainly in central and southern Germany (see Figure 2-1), where the major share of loads are located, so that no long-distance power transports via the trans-mission grid are required for the generated power. The hydropower plants have a total rated power of around 6.28 GW.

2.2 Kinetic Rotational Energy of one Unit

The system inertia is a non-delayed power reserve that is provided by the kinetic energy of the rotating masses of synchronous generators and turbines. In its context, the inertia constant H is usually used instead of the moment of inertia J, which is commonly used in physics. As described in formula (2.1), for each synchronously connected generation unit, the inertia constant can be calculated from the moment of inertia J, the angular frequency of rotation ω, and the rated power S of the unit.

$$H = \frac{\frac{1}{2} \cdot J \cdot \omega^2}{S} \qquad (2.1)$$

For the rotational kinetic energy E_{kin} of a system follows:

$$E_{kin} = H \cdot S \qquad (2.2)$$

In Table 2.1 typical values for inertia constants of different types of power plants based on different primary energy sources are given. These constants are used, for example, by ENTSO-E to evaluate future system inertia. Hydropower plants are divided into two different plant classifications "hydro conventional" and "hydro small scale". Compared to thermal power plants, hydropower plants have a lower inertia constant. Like photovoltaic power plants or battery storages, wind power plants connected via power electronics have an inertia constant of H=0, so that the plants currently installed in the grid without adaptation of the control concepts do not contribute to the system inertia. Thus, the already existing inertia in hydropower plants gains importance for frequency stabilization.

Type of power plant	Hydro conventional	Hydro small scale	Nuclear	Other thermal	Wind
Inertia constants H [s]	3.0	1.0	6.3	4.0	0

Table 2.1: Average inertia constants for different types of power plants [3].

Type of power plant	Plant classes	Inertia constant [s]	Rated Power [MW]	Kinetic Energy [MWs]
Hydro conventional	> 30 MW	3.0	2,527.4	7,582.0
Hydro small-scale	5 … 30 MW	1.0	1721.0	1,721.0
Mini compact hydro	< 5 MW	0.5	2,029.3	1,014.6
Lignite power plant Weisweiler Block H	-	4.0	600.0	2,400.0
Nuclear power plant Isar/Ohu 2	-	6.3	1,410.0	8,883.0

Table 2.2: Calculation of kinetic energy within the plant classes.

To determine the existing kinetic energy within the hydropower plants, the inertia constants are assigned to the hydropower plants on the basis of the rated power. ANDRITZ HYDRO GmbH divides its hydropower plants into the following categories, depending on the rated power [4]:

- "Mini compact hydro" – less than 5 MW
- "Hydro small-scale" – betw. 5 and 30 MW
- "Hydro conventional" - above 30 MW

Since ENTSO-E does not specify an average inertia constant for the "Mini compact hydro", it is estimated to be 0.5 s in the following investigations.

2.3 Kinetic Rotational Energy of the Hydropower Plants

Based on the inertia constants and the installed capacity of the hydropower plants, the available kinetic rotational energy of the German hydropower plants can be calculated and compared with the kinetic rotational energy of large fossil and nuclear power plants, as shown in Table 2.2. This results in a total kinetic energy of about 10.32 GWs, which is stored in the rotating masses of the hydropower plants in Germany.

As a comparison, a lignite power plant and a nuclear power plant currently connected to the grid are presented. For the lignite power plant Weisweiler Block H, the kinetic energy is equal to 2.40 GWs, and for the nuclear power plant Isar/Ohu 2, the kinetic energy is 8.88 GWs.

3 Method

After power deficits, the inertia in the grid has a particular effect on the maximum dynamic frequency deviation and the frequency gradient, the so-called rate of change of frequency (RoCoF), as shown in Figure 3-1. The available system inertia limits the initial rate of frequency change and thus the maximum dynamic frequency deviation.

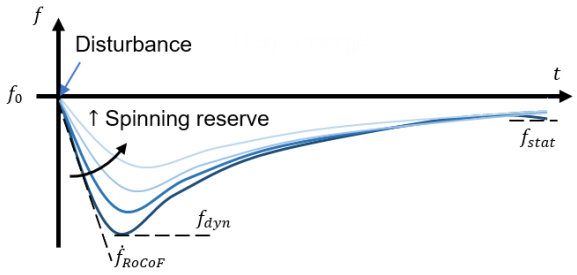

Figure 3-1: Exemplary frequency trajectories after power deficit with different available system inertia.

To maintain stable grid operation and to ensure that loads and generation plants do not disconnect from the grid in the event of major frequency deviations or gradients, maximum permissible dynamic frequency deviations f_dyn must be adhered to after disturbances and the rate of frequency change f ̇_RoCoF must be limited for different time intervals [5]:

|f_dyn |≤0.8 Hz

500 ms: |f ̇_RoCoF |≤2 Hz/s

1,000 ms: |f ̇_RoCoF |≤1.,5 Hz/s

2,000 ms: |f ̇_RoCoF |≤1.25 Hz/s

A simplified dynamic system model is used to evaluate the influence of the available inertia from hydropower plants in Germany and Bavaria.

Under the simplifying, but in the context of subsequent investigations permissible assumption that the system inertia is distributed evenly in the European transmission system in proportion to the respective load, that the self-regulating effect of the load in the European interconnect-ed system is uniform and that the influence of the grid impedances is negligible, all grid areas participate equally in the compensation of a power deficit in proportion to their load or system inertia, so that the dynamic behaviour of a grid area can be considered isolated from the other grid areas in the European transmission system. This assumption leads to the system model shown in Figure 3-2, which is applied to model the German and Bavarian grid area and is usually used in studies of this kind [6]. The system model is used to determine time-dependent frequency responses, taking into account intrinsic mechanisms such as the inertial response of synchronous generation units and the self-regulating effect of frequency-dependent loads, as well as primary control after the occurrence of a power deficit.

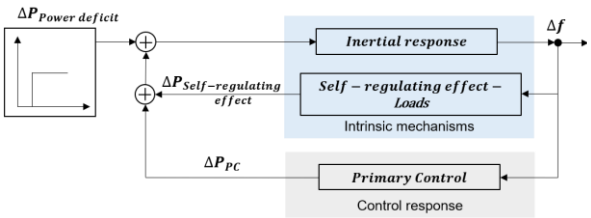

Figure 3-2: Block diagram of the applied system model [6].

The frequency dependency of the load in a grid area influences the short-term dynamic behaviour of the system in addition to the system inertia. Its influence increases with the total load P_Load in the grid area as well as the so-called self-regulating effect of the load, which is defined here, as in comparable studies, at 1 %/Hz.

In order to be able to determine the minimal contribution of a power deficit that the German or Bavarian grid area is able to compensate, in the following, a load situation is considered in which the contribution of the load's self-regulating effect to the frequency support is minimal. This is the so-called minimum grid load. For the German grid area, the minimum grid load in 2018 of approximately 35.7 GW is used [7]. The minimum grid load of the Bavarian grid area is estimated to be 5.26 GW. For the estimation, the minimum German grid load was scaled down in the ratio of the total consumption of electricity of Bavarian and Germany [8, 9].

The inertia response is derived from the available system inertia. On the basis of the kinetic energy of all generation plants, a so-called acceleration time constant T_an can be derived for a grid area under consideration according to the formula (3.1), which is used to parameterise the inertial response in the system model.

$$T_{an} = \frac{2 \cdot E_{kin}}{P_{Load}} \qquad (3.1)$$

Since the contribution of the German or Bavarian hydropower plants to the compensation of power deficits is the focus of the investigations, other generation plants are hypothetically considered in the system model without their inertia. For a grid load of 35.72 GW and a stored kinetic energy of about 10.3 GWs of all hydropower plants, according to formula (3.1), the acceleration time constant for Germany results in T_(an.GER)=0.58 s. Analogously, for the Bavarian grid area with a grid load of about 5.26 GW and a kinetic energy of about 5.05 GWs of the Bavarian hydropower plants, an acceleration time constant of T_(an,Bavaria)=1.92 s results.

In this study, primary control is performed via the other generation units in the system model. In all investigations, the primary control power is dimensioned according to the amount of the power deficit to be compensated by the grid area.

The amount of power deficit to be compensated that is allocated in the grid area under consideration is varied in the system model in order to be able to determine the maximum deficit power that the inertia of the hydropower plants in combination with the self-regulating effect of the load in the grid area is able to compensate without violating the permissible values of frequency deviations and gradients.

For the different grid areas considered, the parameters of the system model are summarized in Table 3.1.

Grid area	Germany	Bavarian
Load	35.72 GW	5.26 GW
Installed rated power hydropower plants	6.28 GW	2.94 GW
Kinetic energy hydropower plants	10,317 MWs	5,048 MWs
Acceleration time constant	0.58 s	1.92 s
Power deficit	variable	variable
Primary control	according to power deficit	according to power deficit

Table 3.1: Parameters of the grid areas to be considered.

4 Results

In the following investigations, a stepwise increase in the power deficit allocated to a grid area is used to determine the amount of the power deficit at which the frequency limits are violated.

German Grid Area

With a grid load of 35.72 GW, the German hydropower plants in combination with the load regulation effect of the German load are capable of compensating power deficits up to ⟦ΔP⟧ _Deficit ≤462.5 MW. As shown in Figure 4-1, larger power deficits would exceed the maximum permissible dynamic frequency deviation of -0.8 Hz after disturbance occurrence.

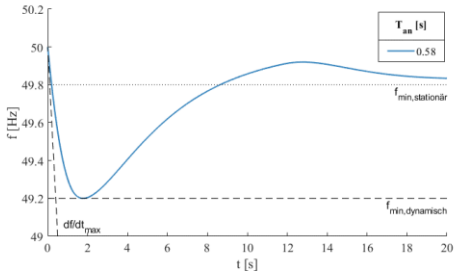

Figure 4-1: Frequency response to a power deficit of ⟦ΔP⟧ _Deficit=462.5 MW for the German grid area.

Due to the system responsibility for a stable grid operation, the German transmission system operators will have to maintain system inertia in the future and the hydropower plants installed in Germany can contribute to this [10].

Bavarian Grid Area

With a grid load of 5.26 GW, the Bavarian hydropower plants together with the load regulation effect of the Bavarian load are capable of compensating power deficits up to ⟦ΔP⟧ _Deficit ≤102 MW. Analogous to the investigations on the German grid area, the dynamic frequency deviation has a limiting effect, as can be seen in Figure 4-2.

Compared to the previous investigation, the higher acceleration time constant results in a lower rate of change of frequency, whereby the frequency minimum is reached at a later point in time after fault occurrence.

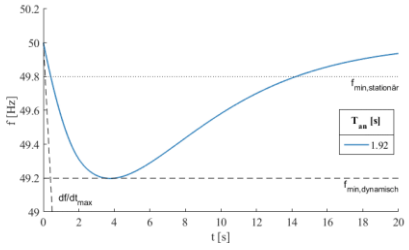

Figure 4-2: Frequency response to a power deficit of ⟦ΔP⟧ _Deficit=102 MW for the Bavarian grid area.

5 References

[1] ENTSO-E, System separation in the Continental Europe Synchronous Area on 8 January 2021. [Online]. Available: https://www.entsoe.eu/news/2021/01/26/system-separation-in-the-continental-europe-synchronous-area-on-8-january-2021-2nd-update/

[2] Bundesnetzagentur, Marktstammdatenregister. [Online]. Available: https://www.marktstammdatenregister.de/MaStR

[3] ENTSO-E, "Nordic report Future system inertia," Feb. 2018. [Online]. Available: https://docs.entsoe.eu/dataset/nordic-report-future-system-inertia

[4] ANDRITZ HYDRO GmbH, Small and mini hydro solutions. [Online]. Available: https://www.andritz.com/products-en/hydro/markets/small-mini-hydropower-plants

[5] ENTSO-E, "Rate of Change of Frequency (RoCoF) withstand capability: ENTSO-E guidance document for national implementation for network codes on grid connection," Jan. 2018.

[6] ENTSO-E, "Frequency Stability Evaluation Criteria for the Synchronous Zone of Continental Europe: Requirements and impacting factors," Mar. 2016.

[7] ENTSO-E, Statistical factsheet 2018.

[8] Umweltbundesamt, Stromverbrauch: Entwicklung des Stromverbrauchs. [Online]. Available: https://www.umweltbundesamt.de/daten/energie/stromverbrauch

[9] Bayerisches Staatministerium für Wirtschaft, Landesentwicklung und Energie, "Monitoring-bericht: Zum Umbau der Energieversorgung Bayerns," Oct. 2020.

[10] Vier deutschen Übertragungsnetzbetreiber, "Bewertung der Systemstabilität: Begleitdokument zum Netzentwicklungsplan Strom 2035, Version 2021, zweiter Entwurf," Apr. 2021.

[11] Deutsche Energie - Agentur GmbH (dena), "Momentanreserve 2030: Bedarf und Erbringung von Momentanreserve 2030," Feb. 2016. [Online]. Available: www.dena.de

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Simulation and training system for hydropower plants on the lower Neckar

The great benefit of simulation systems

Almost all Central European power plant companies are now more than ever confronted with massive increases in the requirements for the operation of hydropower plants and power plant chains. In addition to the changes in the energy market and the changes in the discharges induced by climate change, it is above all the demographic situation that are emerging as a new challenge. On the Neckar, for example, around 50% of the staff in charge for the operation of the hydro power plants will change within 3 years.
Thus, simulation and training systems represent an important pillar for the training of personnel and for the preparation for specific situations. Using tailor-made simulation systems, training can be supported in a focused and efficient manner. By building on existing models and integrating existing knowledge about the key points of the HPP's operation, a valuable contribution to quality assurance and increasing safety standards can be achieved.

1 Securing knowledge – passing on knowledge

Initial situation and motivation

As the operator of almost 40 hydropower plants on the Neckar and its tributaries, EnBW AG - like practically all other energy producers - will face several specific challenges in the coming years:

- Due to the age structure of the workforce, there will be a significant change in the number of employees responsible for operating the power plants and thus for controlling the systems - keyword "managing the discharges".
- The tight framework conditions on the energy market result in new requirements for the use of the water supply and the resulting specific questions about the hydrodynamic processes in the water system.
- The need for hydrodynamic analyses and targeted training arises from new questions in connection with possible incidents (e.g., network disruptions) or spontaneously necessary adjustments to energy generation (keyword "handling new aspects of renewable energy production").

To prepare specifically for these challenges, EnBW AG commissioned the development of a pilot system for a simulation and training system for hydropower plants on the lower Neckar.

Simulation and training – approaches of "serious gaming"

The simulation system was created for the approximately 55 km long section of the Neckar from Guttenbach to Schwabenheim. There are seven power plants and six lock sites in this section. During the development, the focus was on the fact that users could familiarize themselves with the hydraulic dynamics of the river in an intuitively usable system:

- **The real SCADA system as a reference**
  Designing the user interface, we took the real SCADA system as a model in terms of content, operation, and colours. However, the design and handling were deliberately simplified to focus on hydraulics and on the aspect of "managing the discharges".
- **Analysis versus training**
  The analysis focuses on the answers to specific questions:
  For example, how do lock operation affect water levels, or how quickly can the failure of a turbine be compensated for by relocating the flows to the weirs.

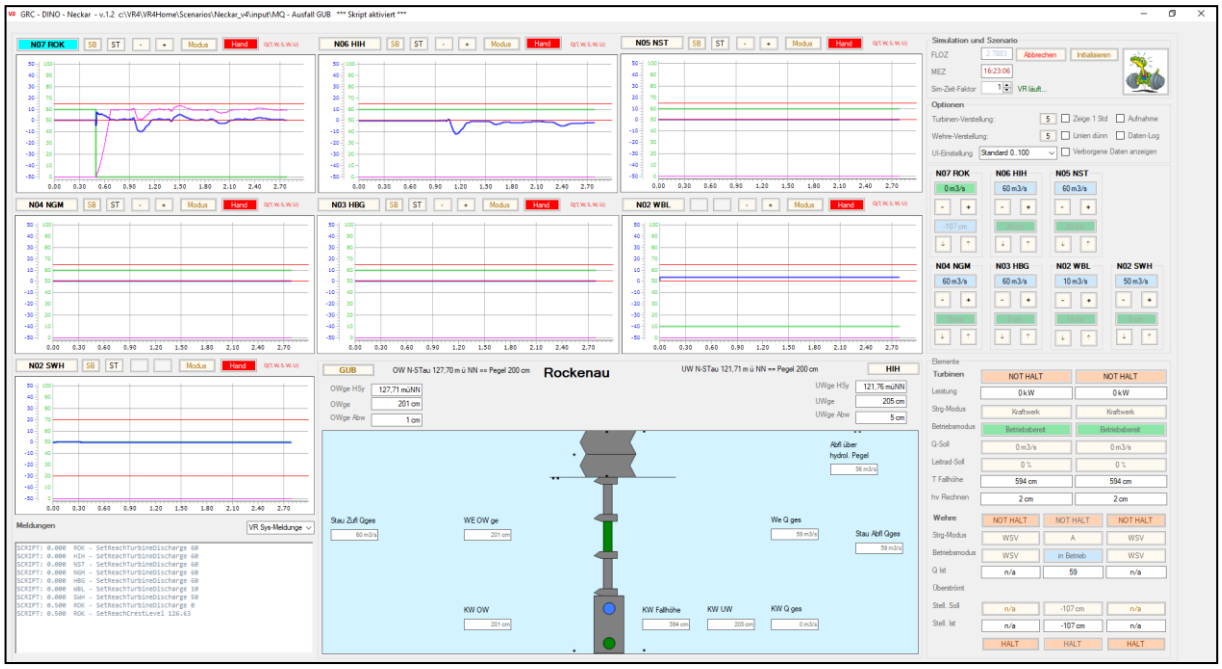

Figure1. User-Interface of the trainings- and simulation systems.

Training is about learning, practicing and internalizing processes to such a level that they can be carried out automatically by the staff under all (!) circumstances.

While, when doing analysis, a simulation should run as quickly as possible to provide the searched answer to a question promptly, in training it is important that the processes take place just as quickly - or slowly - as in reality. Thus, doing training we prefer to have the simulation in real time.

- „Serious gaming"
  The central idea of "serious gaming" is the recognition that people learn more easily and sustainably by applying knowledge. Accordingly, the concept of "serious learning" is used extensively in civil and military training in a wide variety of training simulators. A central aspect is that many skills are built up through unconscious processes and impressions. In contrast, we see the "analysis", where the focus is on the systematic ordering of details and processes – in both the formulation of the question and the interpretation of results and findings.

2 Design and implementation of the system

Hydrodynamic simulation as a numerical basis

The numerical basis of the simulation system is an unsteady 1D model that depicts the approximately 55 km long section of the Neckar from the underwater of the Guttenbach power plant to the underwater of the Schwabenheim power plant (see Figure. 1).

The model uses river cross-sections at a maximum distance of 100 m and usually calculates with a temporal resolution of 3 seconds. Accordingly, highly unsteady processes, such as surge and sink, are still well modelled when the flow rate changes rapidly (e.g., when an emergency stop of turbines).

The detailed modelling of the processes occurs in the various objects of a power plants site in specifically implemented modules.

The calculations take into account, for example, the exact behaviour of the weir elements when opening and closing as well as the temporal variation of the flow when filling and emptying locks.

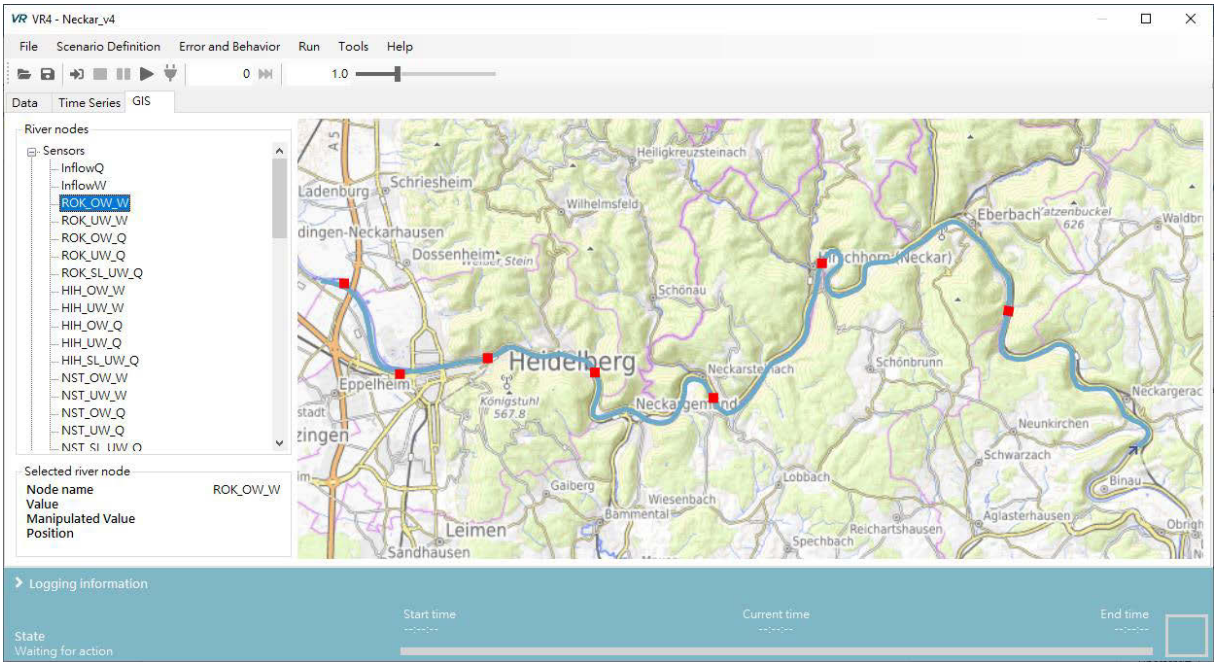

Figure 2. Hydrodynamic modelling – embedded into VIRTUAL RIVER 4.0.

The hydrodynamic modelling is embedded in VIRTUAL RIVER 4.0 (Fig. 2). VIRTUAL RIVER is a simulation system that uses a numerical model as its core, in which the hydraulic processes in the river are calculated with a high temporal resolution. FLORIS, MIKE1D and HYDRO_AS-2D are currently available as models. The communication between the model and connected user interfaces takes place via standardized interfaces so that models and user interfaces work completely independently.

Implementation as an "integrated simulation system" - focus on what interests us

The entire operation of the simulation system takes place via a user interface and the users can concentrate on the points of interest.

No knowledge of any kind about models and numeric in the background is required and all additionally required programs are started and terminated automatically in the background.

Even though the system is a pilot system, it contains many well-engineered details that are of particular importance for practical use:

- **Prepared inflow data - can be changed spontaneously**

  Several characteristic **inflow scenarios** are prepared for the simulation, covering the range from low water to flood events.

  In addition, these data can be interactively adapted before the simulation in order to quickly and easily create any scenario.

- **Initial values for the headwater level and flow rates**

  For many questions it is interesting how operating a hydropower plant at different upstream water levels affects the dynamics and water levels. Correspondingly, the starting values for headwater and discharges can be specified simply and directly.

  Then, the initial numerical conditions are automatically calculated in the background by the so-called "pre-simulation".

- **Record and playback interaction**

  All user interactions, such as changing the flow rates through turbines or setting weirs, can be **recorded during the simulation, and can be played back from previous recordings**.
  In this way, on the one hand, specific scenarios can be prepared in which certain processes and events are saved as a framework for later training (e.g., an emergency stop of a turbine). On the other hand, all activities of the users can be analysed after the simulation in order to deepen the know-how through appropriate feedback.

- **Make "hidden information" visible**

  A central aspect that we must consider at practically all power plants is the fact that we have to do **operation based on incomplete and incorrect data**. This arises when, for example, we calculate flows from water levels or the power or when we simply have no information on some processes - e.g., lock operation or lateral inflows.

  With the **"show hidden facts and figures"** option, we can display such information and relationships and thus achieve two goals: On the one hand, we give the user an impression of the magnitude of these values. On the other hand, we consciously draw the focus to these values and relationships.

- **Quick adjustment operation of individual elements**

  With the quick adjustment, turbine flows or weir positions can be operated at the level of the power plant location and the corresponding specifications are distributed internally to the various water-carrying elements in the program. This is helpful if, for example, the hydrodynamic behaviour of the river is considered without the impact on the individual elements being important. In contrast, individual turbines and weirs can also be operated, whereby the options for operation are based on the options in the real SCADA system (e.g., flow rate or diffuser opening for turbines).

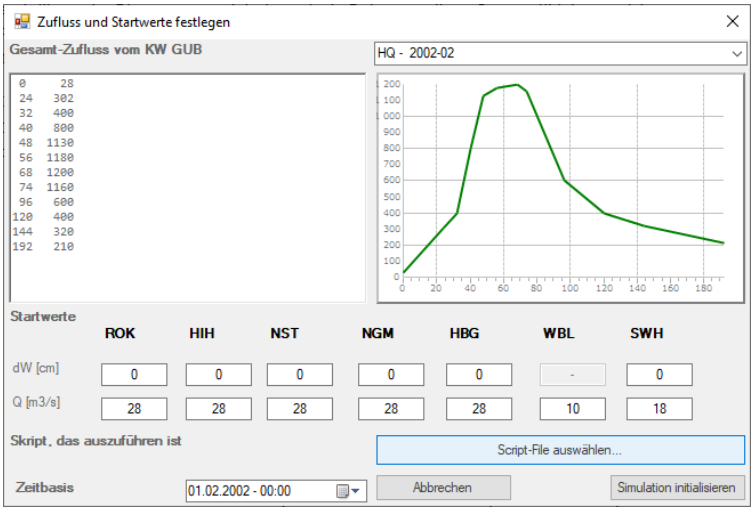

Figure 3. Select scenario and start values for a simulation.

Suggestions from default values are given for all start values. These are, for example, the lower value of the tolerance range for the OW level or the start value from the inflow profile used for the flow.

The user inputs for specific determinations - e.g., the start value for the OW level - are possible in a predefined range that is based on the real tolerance ranges.

The simulation with Virtual River is started without specific know-ledge of Virtual River or the hydro-dynamic calculations being necessary.

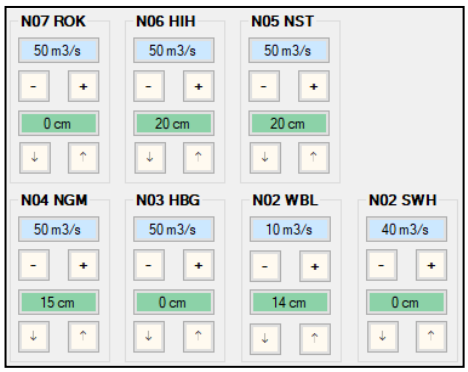

Figure 4a. Quick adjustment.

The quick adjustment allows a swift, direct change in the total flow rate at a power plant cross-section.
The flows changed via [-] and [+] are - analogous to a power-plant controller - distributed to the available turbines by an internal algorithm.

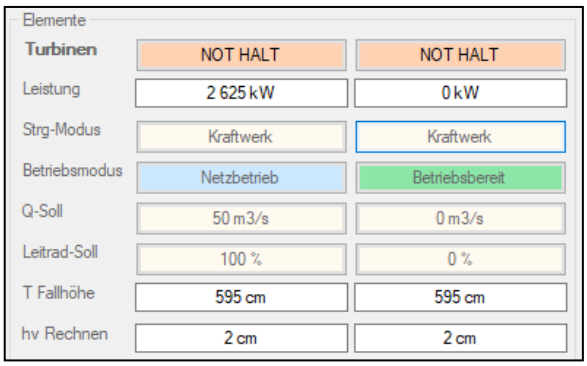

Figure 4b. Individual operation of elements.

The individual operation of elements allows specifications for individual turbines and weir fields.
The input options are based on the real SCADA system, whereby the operational processes have been deliberately simplified.

Figure 5. Select scenario and start values for a simulation.

While all entries in the simulation system for the Neckar are currently made via the integrated user interface, the direct integration of hardware, such as we find in on-site emergency controls, is also conceivable as a specific extension.

The desk shown in the picture was developed for a training system that consciously only works with rudimentary inputs and outputs.

For communication with VIRTUAL RIVER, the console is equipped with AD / DA converters that allow direct communication via USB.

Simplified user interface versus connection to the real SCADA system

The entire simulation system - and thus also its user interface - was designed for use on a standard computer.

This means that the user interface has been significantly simplified compared to the real SCADA system and that visualizations from several diagrams are combined in one view in the user interface. Thus, the system can be used on any computer without requiring any specific high performance.

On the other hand, if the aspect of "training" is to be placed more in the foreground, the system can be adapted easily by using a copy of the real SCADA system as the user interface. Linking can be implemented via the existing data interfaces.

Furthermore, it is even possible to use hardware interfaces. It would be conceivable, for example, to integrate on-site emergency controls, as we can still find in old systems.

3 Outlook and options

Simulation systems as tools for knowledge transfer

Hydrodynamic modelling can take on an important task in the field of knowledge management: When working with training and simulation systems, users can simply gain an insight into dynamics and processes that cannot be achieved in real life or can only be achieved with a correspondingly long period of service.

Therefore, the systems are particularly suitable for conveying knowledge more quickly and sustainably, whereby questions can also be addressed that only arise due to the new, high dynamics on the electricity market.

Further development to the assistance system

The models and approaches implemented in simulation systems can take on an additional task through direct coupling with SCADA systems or embedding in them.

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VGB oil laboratory tests oil blends to avoid cost-intensive oil change in a hydropower plant

The energy transition and the associated priority feed-in of renewable energy require a high degree of flexibility from conventional, plannable generation plants, which is often associated with serious problems due to the design of conventional thermal power plants (frequent load changes, start-up and shut-down, etc.). In contrast to volatile renewables (wind and solar), hydropower is a renewable source of energy that is reliably supplying power due to its base load capability and plannability, i.e., some of the most important requirements – namely security of supply and system stability – are met by hydropower.

Service for oil ensures safe operation

Similar to any conventional power plant, hydropower plants and their components such as turbines and hydraulic systems as well as drives for gates, slides and flaps, require large quantities of lubricating oils. Often, several thousand litres of lubricating oil are used in the entire plant. Due to the low thermal load in hydropower, these oils can usually be operated for very long lifetime of several decades (20 to 40 years on average, Figure1). Regular inspections and thus the early detection of system malfunctions and impending damage ensure the safe and smooth operation of power plants and prevent unscheduled unavailabilities and repairs.

Particularly oil losses as a result of small leakages, require regular refilling of oil in order to maintain the oil level needed. However, operators and maintenance engineers are often faced with major challenges in this regard: The original oils used according to design are often no longer available on the market. The procurement of replacement oils is difficult, and often there are also no longer any data sheets available that can provide information on the composition of the original oil, in order to be able to use equivalent oils according to the properties of the original materials.

Figure 1. Mineral oils change under the influence of temperature, humidity, air and metals such as copper or iron.

Figure 2. Since 2018, VGB PowerTech Service GmbH offers all technical services of the VGB Group bundled together. Here, tailor-made and individual solutions which are characterised by efficiency and technical competence.

Oils cannot necessarily be blended with each other. Different oil qualities can cause incompatibilities, which in turn pose considerable risks, e.g. loss of oil properties or tearing of the oil film. This can lead to damage ranging from bearing damage to machine damage up to total turbine failure. In order to avoid a complete oil change, the VGB Oil Laboratory (Figure 2) supports VGB members and customers in identifying oils that can be blended with the oils still in use and guarantee safe and reliable further plant operation.

It's all about the right oil mix

In the current case, the VGB Oil Laboratory carried out tests which proved that blends of suitable oil types allow the continued operation of the plant without cost-intensive complete oil changes. In these oil blending tests, a temperature profile is used to simulate several years of operation and oil ageing (Figure 3). Different blend ratios also show how these oils could possibly affect operation. A wide variety of blends can be set, leading to the identification of the optimum oil combinations for a particular system.

Only a few national and international laboratories have the know-how to carry out such tests. One of the experts in this field is the VGB Oil Laboratory, which, as an independent, supplier-neutral service provider, offers tailor-made support to VGB members and customers. Thanks to the expertise and experience of the laboratory team, the operator of the particular hydropower plant was able to save about 50 T€. In addition, costs were saved that would otherwise have been incurred for a complete oil change.

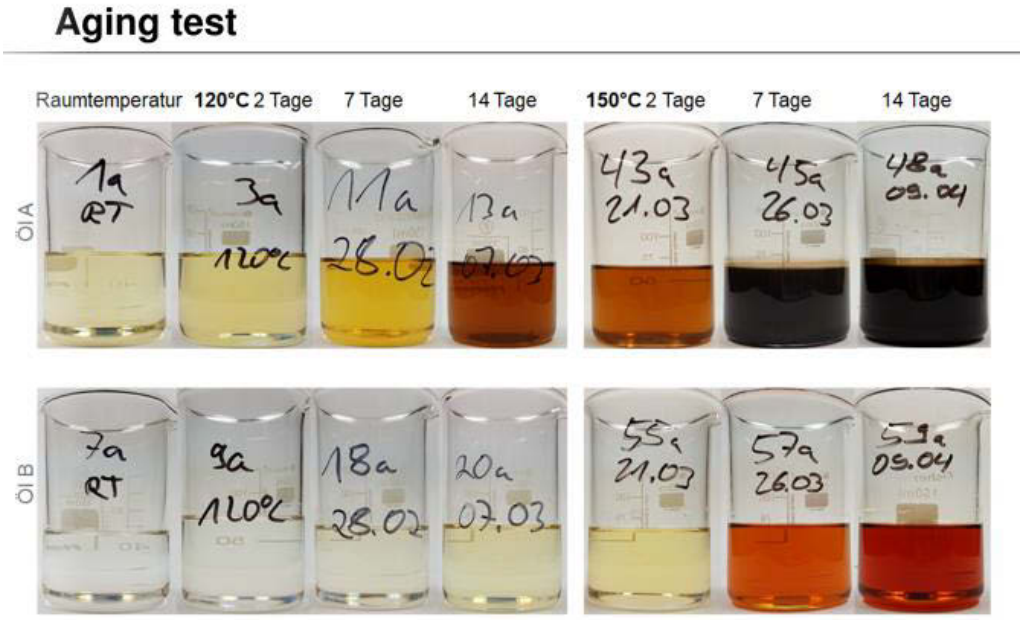

Figure 3. The laboratory team of VGB PowerTech Service GmbH has more than 30 years of experience in the testing and the evaluation of lubricating and insulating oils. In addition to the analysis of oils, the service team carries out interdisciplinary damage analyses and is also on site for sampling, inhibition and support of oil changes.

Tailored support improves also the environmental balance

In addition to the actual cost savings due to the blending of oils, the CO_2 balance of the operator is also improved. The production of one litre of turbine oil, for example, produces around 700 grams of CO_2. If now a complete oil change is avoided by the blending tests carried out in the VGB oil laboratory, the emission balance is improved accordingly. In this respect, the VGB oil laboratory also contributes to the Corporate Social Responsibility (CSR) of its customers, because sustainable and resource-saving solutions are of great importance for entrepreneurial action in order to remain competitive in the market.

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Company Profiles

Leading providers present their new and innovative products and services in detail. Read their offers and get a quick overview and well-founded, structured information on the offers for your business.

Content

AIT Austrian Institute of Technology GmbH

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The AIT Austrian Institute of Technology is Austria's largest research and technology organization. Among the European research institutes, AIT is a specialist in the key infrastructure issues of the future.

AIT Center for Energy

The AIT Center for Energy is developing solutions designed to ensure a sustainable energy supply for the future.

At the AIT Center for Energy over 200 experts are developing sustainable solutions for our future energy system. The Center combines longstanding experience and scientific excellence with high quality laboratory infrastructure and a global network to offer companies innovative applied research services, providing them with a competitive edge in this promising market. The thematic portfolio of the Center for Energy focuses on three key systems: Sustainable energy infrastructure, decarbonization of industrial processes and facilities, and innovative technologies and solutions for cities and the built environment.

AIT SmartEST Laboratory.

Topics (Excerpt)

- Power system modelling & simulation
- Design & Validation Methods
- Energy Management & Optimization
- Machine Learning
- Data Management & Analytics
- Local Energy Communities
- Blockchain applications

Research Field: Power System Digitalization

The AIT Center for Energy positions itself as a competent partner in questions of digitalization of electrical energy supply. Digital innovations are investigated within the scope of cooperative research together with manufacturers, network operators and energy suppliers. Our strength is the precise knowledge of specific system requirements in the energy domain, and at the same time scientific competence in the field of the digital methods used, such as virtualization, digital twins, data analysis, Internet-of-Things technologies, ICT architectures, cyber security and co-simulation of ICT and power networks. We work on the further development of scientific methods and tools for automated development processes with a focus on validation methods for digital system solutions and new functionalities This empowers operation and maintenance personal to keep initiative to optimize costs and minimize unplanned downtime.

Smart Electricity Systems and Technologies

The SmartEST (Smart Electricity Systems and Technologies) Laboratory established by the AIT Austrian Institute of Technology provides a unique research and simulation infrastructure to analyse the interactions between components and the grid under realistic conditions. Potential devices under test range from inverters, storage units, grid controllers and CHP units to charging stations for electric vehicles.

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ANDRITZ HYDRO GmbH

ANDRITZ is one of the leading global suppliers of electromechanical equipment and services for hydropower plants.

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Member of vgbe energy I Hydro Power

With over 180 years of accumulated experience and more than 33,000 turbines installed, totalling approximately 470 GW output, the business area provides the complete range of products, including turbines, generators, and additional equipment of all types and sizes – "from water to wire" for small hydro applications to large hydropower plants with outputs of more than 800 megawatts per turbine unit.

ANDRITZ has a leading position in the growing modernization, refurbishment, and upgrade market for existing hydropower plants.

Pumps (for water transport, irrigation of agricultural land, and applications in various industries) and turbogenerators for thermal power plants are also assigned to this business area.

Find your local contact at
https://www.andritz.com/hydro-en/about-andritz-hydro/locations

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ANDRITZ HYDRO GmbH

Let's connect

Synchronous condensers for EnergyConnect, Australia

The synchronous condensers provided by ANDRITZ will be part of EnergyConnect, the new interconnector between South Australia and New South Wales. EnergyConnect is a new 700 km transmission line and will significantly increase the power transmission capacity between the two regions. In addition, it will make the electricity supply more reliable and support Australia in its transition towards renewable energies. Completion is expected by 2024.

The new interconnector will be equipped with the two synchronous condenser plants Buronga and Dinawan to provide system strength services including synchronous inertia. These services are needed to provide grid stability and will allow to connect additional largescale renewables, such as wind and solar, into the National Energy Network.

Each plant will be equipped with two salient pole synchronous condensers, each with a rated capacity of 120 MVA. The features of the synchronous condensers allow the operator to manage the reactive power of the network (+100/– 50 MVAr) at 330 kV, in addition to services such as short circuit contribution, fault level support and large amounts of synchronous natural inertia.

ANDRITZ applied a salient pole technology with the advantage of a higher natural inertia, lower losses and less maintenance requirements compared to the round-rotor technology. In addition to the performance related advantages, these machines will specifically meet the technical performance requirements from the end-user Transgrid, because it is a bespoke design.

ANDRITZ' synchronous condensers are a cost-effective and reliable solution for new grid requirements. They help balancing the increasing volumes of variable renewable energy and a corresponding loss of system inertia, hence providing important grid stability and a secure electricity supply.

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ANDRITZ HYDRO GmbH

Strong partners for decarbonization

Solar PV, Wind … and Pumped Storage

Hydro Power from the Desert - Dubai, Hatta

Dubai has the clear goal to diversify the emirate's energy mix and increase the share of renewable energy from the current level of 7 to 75% by 2050. To achieve this ambitious target, DEWA decided not only to increase the share of power generation from renewable sources, but also to build the necessary hydro-pumped storage capacity required to balance the volatility of these renewable energy sources.

Hatta is the first project of its kind on the Arabian Peninsula. The concept is based on a shaft-type powerhouse close to the existing reservoir, built by STRABAG. It hosts two pump turbine and motor-generator units with a capacity of 125 MW each. Capable of producing a total net power of 250 MW over a six-hour generation cycle in turbine mode and a 7.4-hour storage cycle in pumping mode, the project provides an overall storage capacity of some 1,500 MWh Due to the relatively limited reservoir capacities, the available head varies significantly, changing between 175 and 125 m during the charge-discharge cycle. To overcome this large head variation while keeping the units running at a high efficiency over the complete cycle, both pump turbine units are equipped with double-fed asynchronous motor-generators. They allow the units to operate at variable speed.

Startup is expected for the first quarter of 2024.

Read more

Wises and Eldridge Pits act as the upper and lower reservoirs

Kidston pumped storage plant, Australia.

Featuring an innovative approach to integrating of solar power, wind and low-cost energy storage, Kidston is set to be the world's first co-located solar pumped storage hydropower plant. Located in an abandoned gold mine in Queensland, Australia, once complete it will deliver 'Renewable Energy on Tap'. ANDRITZ is supplying all electro-mechanical and two 125-MW reversible pump turbine units as well as full operation and maintenance services of more than 10 years. The plant will be fully managed by ANDRITZ and remotely connected to the ANDRITZ control center in Schio, Italy.

Once filled up with water, it will operate as a closed-loop system and generate, store and dispatch renewable energy on demand during peak periods. Additionally, the plant can be operated in a synchronous condenser mode to provide grid services such as reactive power management and synchronous inertia.

The facility is to be connected to the grid through a new 275 kV transmission line, currently being built by a major Australian construction company. This line will stretch approximately 200 km to a new switchyard on the East Coast of Queensland.

After completion in 2024, the Kidston project will generate enough electrical energy to supply approximately 280,000 households with clean and sustainable energy, the equivalent of taking 33,000 cars off the road.

Read more

ANDRITZ HYDRO GmbH

Hand in Hand, Agile and Predictive

A Milestone in Innovative O&M Approaches

Cerro del Áquila (500 MW), Peru

Cerro del Águila HPP was equipped by ANDRITZ and commissioned in 2016.

Now, under a new long-term O&M contract, ANDRITZ is providing a Metris DiOMera platform and all related services. The ANDRITZ "Smart Spares" concept has been specified by the customer. This forecasts the delivery of a selected volume of spares which is kept available at the Cerro del Águila site and is available to be used on demand by means of an innovative "Use and Stock" mechanism.

The most relevant aspect of this O&M agreement is the implementation of an "Integrated Maintenance" concept. It helps to forecast rehabilitation works for major components such as all the plant units, valves and so on. It includes both major and minor rehabilitation works as well as repairs for worn components.

For the first time in the hydropower business, this new model provides a guarantee for defined key performance indicators in the period between major service intervals. ANDRITZ guarantees core client KPIs like annual water availability under well-defined and measured constraints such as limits on operations, sediment contents and so on. Digitalization is the key enabler for this new concept.

All information collected in Cerro del Águila, is sent via secure online communication to the ANDRITZ Hydro Global Control Center (GCC) in Schio, Italy, and analysed there based on sophisticated mathematical models and algorithms by ANDRITZ experts with decades of experience.

Metris DiOMera becomes an important tool to make well-founded predictions of future output and expected wear on basic components, such as bearings, runners or generators.

With the Global Control Center (GCC) ANDRITZ Hydro has established an advanced remote monitoring and control center for worldwide operations and maintenance

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Member of vgbe energy I Hydro Power

The leader in non-chemical, environmentally friendly biofouling control of invasive mussels.

For more than a decade Atlantium Technologies has been working to apply our environmentally sustainable Hydro-Optic™ (HOD) ultraviolet (UV) disinfection technology to help hydroelectric facilities prevent biofouling from invasive mussel species and their profound operational effects.

In large numbers, mussels (zebra, quagga, golden etc.) can devastate aquatic biodiversity and water quality. And because they can attach to and quickly clog up water intake and delivery pipes and foul dam intake and pipes, and the decay of dead mussels can corrode steel and cast-iron pipelines, they pipes, and the decay of dead mussels can corrode steel and cast-iron pipelines, they pose substantial economic headaches. Particularly at risk are hydropower facilities, whose power production can be severely hampered by mussels that can latch onto on intake structures and trash racks, penstocks, gates and valves, cooling water systems, raw water fire protection systems, service and domestic water systems—and even instrumentation.

Long-term and full-scale commercial evaluation of Atlantium's HOD UV technology has been completed with facilities across Australia, Canada and the United States.

The HOD UV technology has achieved extraordinary efficacy in settlement control and mussel mortality not seen with traditional UV. The HOD UV solution is proven to control aquatic invasive species, such as invasive mussels, with the ability to achieve 100% inactivation even under conditions with less than 50% UV transmittance (%UVT). Before the introduction of the HOD UV technology to provide mussel prevention, hydroelectric facilities were predominantly reliant on chemically-based prevention or manual cleaning technologies.

Atlantium's Hydro-Optic™ (HOD) UV achieves 100% inactivation of invasive mussels even under conditions with less than 50% UVT.

Atlantium Technologies Ltd.

Reclamation Showcase

Most notable has been the extensive review undertaken by the U.S. Bureau of Reclamation (Reclamation) Lower Colorado Region who began a series of feasibility studies in 2007 to assess risk from mussel fouling, outline best low-ecological- impact management practices for coping with invasion, and identify control options for raw water systems to prevent invasion and infestation.

Following their review of various chemical and non-chemical treatment methodologies, in 2013.

RECLAMATION
Managing Water in the West

Reclamation selected the HOD UV technology as their preferred treatment option. The HOD UV technology was installed at Davis Dam in 2013, Parker Dam in 2015 and Hoover Dam in 2018.

In April 2019, the Bureau of Reclamation's Science and Technology Program selected the research pro-ject, "Control of biofouling in hydropower cooling systems using hydro-optic ultraviolet light," as Project of the Year.

And continuing with the recognition, in July 2019 Reclamation's Parker Dam was awarded the 2019 Top Water Plant award by POWER Magazine.

In addition to Reclamation, leading environmentally-oriented companies such as Ontario Power Generation, the US Army Corps of Engineers, the Salt River Project and more have selected the HOD UV treatment solution to help prevent mussel infestation given its safety and proven performance.

Ontario Power Generation Profile

The Ontario Power Generation (OPG) DeCew II Generating Station, a hydroelectric generating station with a nameplate capacity of 144 MW, undertook an evaluation of innovative environmentally friendly and cost-effective methods to control invasive mussels without the use of hazardous chemicals.

As a result, OPG installed and commissioned a HOD UV system in 2017 to undertake a six-month pilot study of a full-scale demonstration of this non-chemical and sustainable disinfection method to control invasive mussels at DeCew II.

Atlantium Technologies Ltd.

During the six months of operation, no viable individual mussels settled in the test biobox while settlement was recorded in the control biobox. The results demonstrated that the HOD UV system is providing settlement control within DeCew II generating station and that the system met and exceeded the treatment objective of achieving 95% control of settlement. This result was achieved under varying UVT conditions ranging as low as 49.79% UVT and as high as 98.99% UVT.

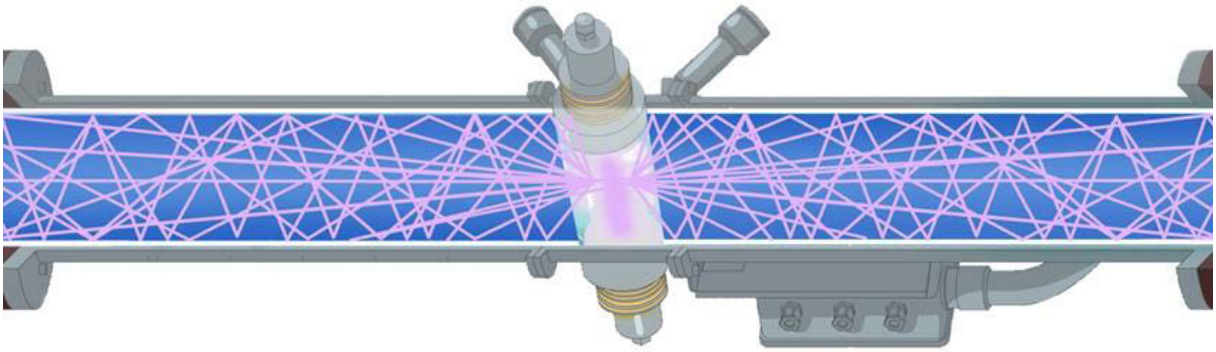
Atlantium's Hydro-Optic™ (HOD) UV demonstration unit installed at OPG DeCew II Generating Station.

Why HOD UV?

Unlike chemical treatment approaches, UV systems employ a physical process for disinfection. When bacteria, viruses and protozoa are exposed to the germicidal wavelengths of UV light, they are rendered incapable of reproducing.

HOD UV systems feature the unique Total Internal Reflection (TIR) technology that recycles UV light energy, ensures homogenous UV dose distribution and provides superior power (kW) efficiency compared to traditional UV. The system's patented TIR technology, which is similar to fiber optic science, recycles UV light energy within the HOD UV chamber. The core of the technology is its water disinfection chamber made of high-quality quartz surrounded by an air block instead of traditional stainless steel.

This is especially important given that in traditional UV systems metal adsorbs or "detracts" the UV dose the closer it gets to metal, whereas the TIR enhances the UV dose. This configuration uses fiber optic principles to trap the UV light photons and recycle their light energy. The photons repeatedly bounce through the quartz surface back into the chamber, effectively increasing their paths and their opportunities to inactivate microbes.



Atlantium's medium pressure Hydro-Optic™ (HOD) UV lamp and chamber. The system's patented Total Internal Reflection (TIR) technology recycled UV light energy within the HOD UV chamber.

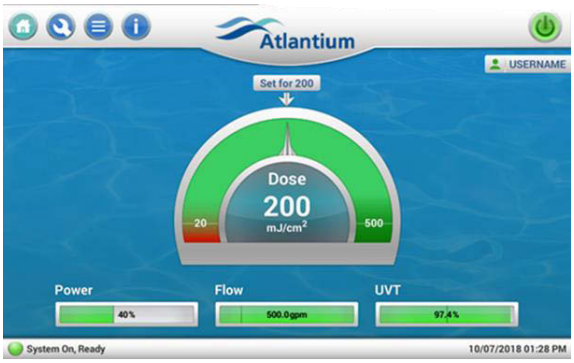
Atlantium Technologies Ltd.

Real-time Monitoring and Control

HOD UV features a comprehensive control and monitoring system. Atlantium's proprietary UV system includes a dedicated UV sensor per lamp, integrated UVT sensor and feed from a flow meter to maintain the required UV dose to meet application specific needs. This is a feature unique to the HOD UV technology.

The novel control of the HOD UV technology promotes stability, assures water safety, provides operator flexibility and guarantees quality.

HOD UV systems also come equipped with an intuitive, user-friendly and comprehensive control interface to track system operation in real-time. This provides operators with live data on the operation of their system.



Atlantium's Hydro-Optic™ UV systems feature the All-in-One (AiO) controller that sets a new standard in precision, monitoring and operation.

Global Service & Support

HOD UV systems are globally supported and spare parts, such as UV lamps, are readily available 24/7.

Not all UV is equal— Hydro-*Optic™ (HOD) UV is designed to* achieve unmatched inactivation levels.

Advanced Control Systems

- Continuously displays UVT, flow, power and UV dose
- Provides real-time data on operation and efficiency
- Features built-in data logging, up to six months
- Integrates with the control SCADA system
- Easy integration with the control SCADA system
- Customized with user settings for alarm signals

Contact

Ytzhak (Itzik) Rozenberg
CTO

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E ytzhakr@atlantium.com

Augmensys GmbH

Make industrial data usable for everyone, to increase the value of existing data – any time, any place!

Schleppe Platz 5, 2/3
AT I 9020 Klagenfurt
www.augmensys.com
office@augmensys.com

Augmensys was founded to turn an ambitious idea into reality: the establishment of Augmented Reality (AR) in industrial processes.

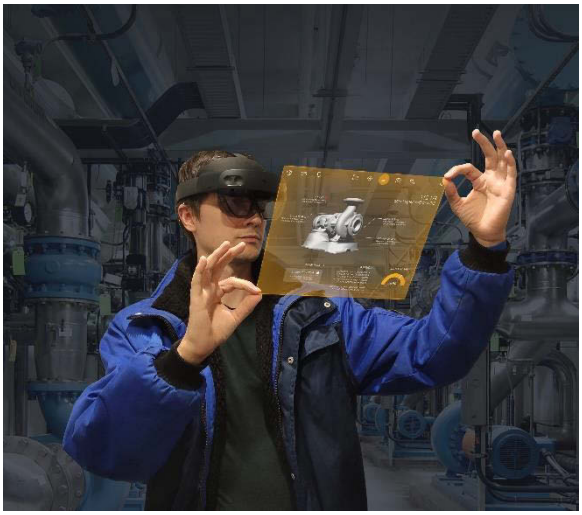
The company's many years of experience, both in industry and in the field of industrial software, is the key to closing the gap between aspiration and reality. With the mobile and AR solution UBIK, Augmensys provides a powerful tool for the entire industry, branch independent and application oriented and offers the chance to significantly simplify everyday work. The focus here is clearly on productively applicable tools and solutions.

- Years of experience
- Innovative technologies
- Customized solutions

The Augmented Reality Software UBIK is a mobile data management software for mobile devices (smartphones, tablets, wearables) which is mainly used in industrial environments.

It enables the user to access data and documents from various source systems. Due to the advancing digitalization under the term Industry 4.0, a constantly growing amount of data is generated. The challenge is not only to extract valuable data for the user, but also to represent it intuitively on the mobile device.

UBIK on a mobile device.



Augmented Reality makes us unique.

UBIK accompanies an industrial plant already throughout the paperless commissioning process, directly at the construction site.

A big amount of different data sources is not a problem anymore, since they are seamlessly consolidated for efficient use.

Through the whole life cycle of a plant (construction, commissioning, operation and maintenance, shutdown management) UBIK offers an intuitive, mobile and channelled access to all the digital systems in the background of a plant, for inspectors, maintenance workers, engineers and operators.

The possibility to work mobile with the entire data asset of a company, edit information right on site and sent back photos and voice memos that automatically end up in the right systems, creates a highly effective work environment for anyone who has work to do in the plant.

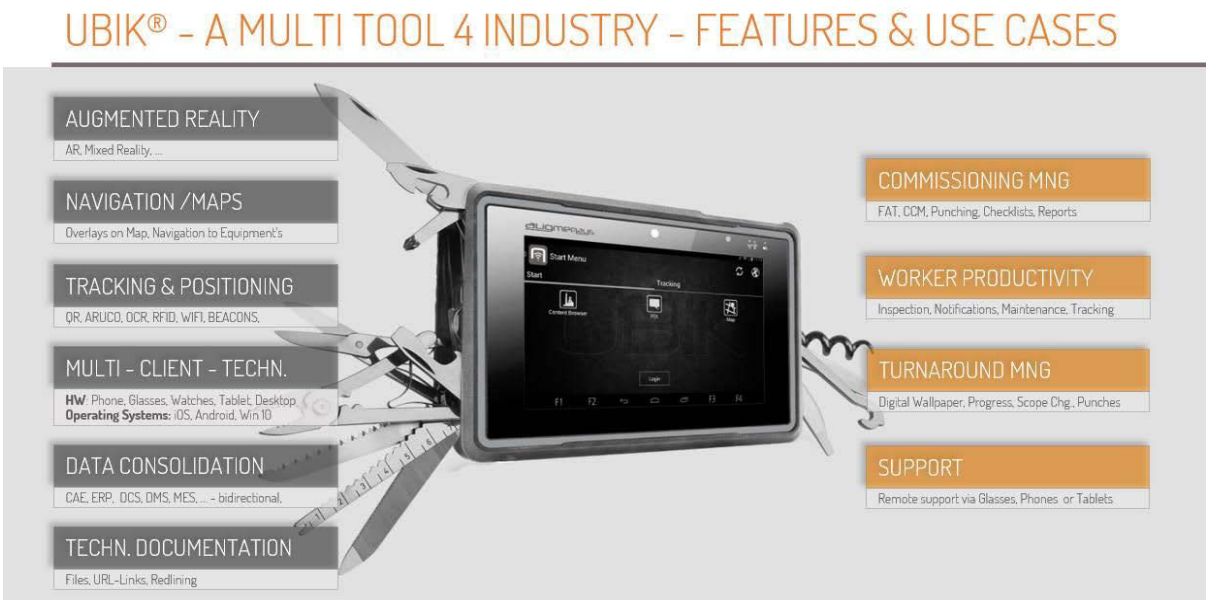
But UBIK doesn't only identify what the user sees, it also helps people in finding what they are looking for. Using Augmented Reality Tags and its unique navigation functionality, UBIK directs external staff and subcontractors through the plant on efficient and safe routes.

Augmensys GmbH

Augmensys provides companies in the energy supply market with new technologies to support switching operations in medium-voltage networks. AR overlays make switching operations simpler, error-free and, above all, safer.

The employee is guided through the entire switching process. The required information is defined in the network control system as a switching letter with the switching point information and the switching sequence and automatically transferred to UBIK.

Switching operations in a medium-voltage network.



UBIK, our Augmented Reality Software, is a powerful tool with cross-industry usability through its application-oriented configuration.

UBIK completely digitizes the customer's workflows, which were previously mostly carried out manually. All data at the right time, in the right place for the right user. Due to the fact that UBIK is individually adapted to the customer's needs, there are many different profitable application possibilities on the customer's side (inspection tour, maintenance, commissioning of new plants, etc.).

User acceptance is high due to user-friendly and customizable user interfaces. The quality of the data is increased due to direct, digital and thus immediate feedback from the on-site employees to the source systems.

In addition, the safety of the employees is increased with UBIK, which improves the quality of the entire work process.

Thanks to UBIK, robust mobility and AR is entering the industry and enables to connect reality with any available data. The client-part of UBIK runs on mobile-devices.

UBIK is already used at a significant number of well-known industry companies. It has therefore proven its value and robustness through various projects and use-cases, where each of them in return contributed to the constant improvement of the product. It also passed several scalability, quality and security audits from major corporate IT's.

Contact

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AvailabilityPlus GmbH

LEXATEXER
next generation predictive analytics

Ringbahnstr. 10-14
DE I 12099 Berlin
www.lexatexer.com
contact@lexatexer.com

LexaTexer – next generation predictive analytics.

LexaTexer is the analytics platform for the digital power plant. Power producers globally need to constantly improve operations, reduce unplanned outages, identify optimal operations parameters and manage variations in market conditions, fuel costs and weather patterns. LexaTexer provides a comprehensive answer, based on physics, machine learning and artificial intelligence, that gives power companies the means to transform operations with actionable insights that drive improved business decisions.

LexaTexer analytics provides these benefits:

Transform data into actionable intelligence by combining robust analytics with domain expertise. Create a single source of data for all power generation or renewables assets across a fleet, utilizing predictive analytics to identify issues before they occur, reducing downtime and extending asset life while still balancing maintenance costs with operational risk. Operations optimization: Deliver enterprise data visibility across power plant and fleet-wide footprints, providing a holistic understanding of the operational decisions that can expand capabilities and lower production costs. Predict remaining-useful (RUL)-live of turbines and adjacent equipment like pumps and deliver optimal operational parameters to optimize KPIs like RUL, downtime or costs per MW/h.

Predictive Maintenance

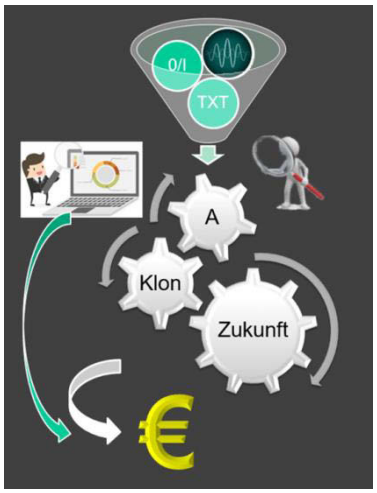
Predictive maintenance anticipates equipment failures to allow for advance scheduling of corrective maintenance, thereby preventing unexpected equipment downtime and improving service quality. LexaTexer introduces a new level of quality.

Predictive Maintenance at Hydropower Plants

Many hydropower facilities do show prototype characteristics, bespoke architectures, adapted to geographic and business needs with highly individual technical parameters and are integrated into a fleet of interacting assets.

These individual settings make it difficult to apply off the shelf analytics. However, using historic data and advanced analytics it is possible to predict the remaining useful life for major assets and to identify anomalies, which common SCADA-systems are not able to identify.

We use data from a number of sources (SCADA, maintenance reports, weather, …) and create digital models, using data analytics and machine learning, to predict the current and future states of assets, providing the results in an interactive way, to enable the technical personal to not only see the results, but also to modify operational parameters to identify optimization opportunities.



Predictive analysis with artificial intelligence.

This empowers operation and maintenance personal to keep initiative to optimize costs and minimize unplanned downtime.

Contact

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CEO

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E hoffmann@lexatexer.com

Brno University of Technology, V. Kaplan Department of Fluid Engineering

Brno University of Technology is the second largest technical university in the Czech Republic, Faculty of Mechanical Engineering is the largest of its kind in the Czech Republic.

Brno University of Technology
Faculty of Mechanical Engineering
V. Kaplan Department of Fluid Engineeing
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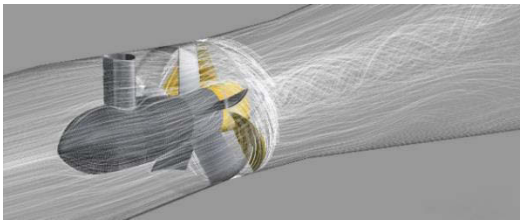
CZ I 61669 Brno
www.vutbr.cz/en

V. Kaplan Department of Fluid Engineering

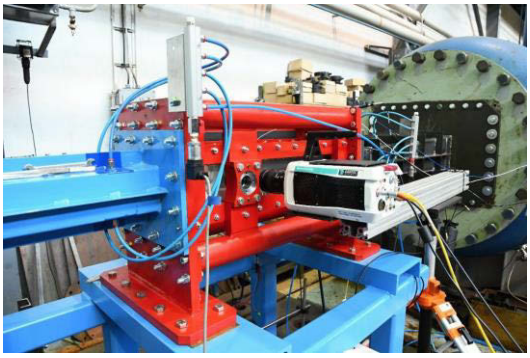
V. Kaplan Department of Fluid Engineering has more than 120 years history in design, analysis and testing of hydraulic machines and systems. The department focuses on research and education in the field of hydraulic machines, fluid systems and applied fluid mechanics.

Group of experienced researchers is capable of design of small hydraulic turbines, pumps, analysis of water hammer, flow pulsations, rotor-dynamics, machine vibrations, fluid-structure interaction problems, cavitation.

Heavy hydraulic laboratory is suitable for testing hydraulic turbine models and pumps up to max parameters: 300 kW, 180 meters head, dis-charge 800 l/s, offers measurement of energy curves, cavitation characteristics, vibrations, noise, flow visualization using high-speed camera.



Low head turbine design and flow simulation.



Fluid-structure interaction analysis of hydraulic profile in cavitation tunnel.

Department is equipped with commercial CFD codes ANSYS Fluent, CFX and open source software OpenFOAM and large cluster for massive parallel computations.

Department is active in research projects funded by grant agencies and industrial companies.

Department members are involved in EERA (JP Hydropower, JP Energy Storage), IAHR, Euromech.

Pump turbine testing.

Installation of siphon low head turbine.

Brno University of Technology, V. Kaplan Department of Fluid Engineering

Research activities and topics for collaboration

- Design of hydraulic machines (hydraulic turbines and pumps)
- Testing of pumps and hydraulic turbine models (energy and cavitation performance)
- Measurements of fluid systems on site
- Computational fluid dynamics
- Analysis of pressure pulsations and vibrations
- Cavitation erosion testing
- Design of experimental fluid circuits
- FSI analysis
- Multiphase flow simulations and experiments
- Complete education in fluid engineering branch (applied fluid mechanics, CFD, hydraulic machines design, experimental methods in hydraulic machinery and systems, specialized courses for companies

Contact

assoc. prof. Pavel Rudolf, Ph.D.
Head of Department

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E rudolf@fme.vutbr.cz

DAGOPT Optimization Technologies

Experts in mathematical modelling and process optimization, revolutionizing your energy production plans.

Im Bäckerfeld 19
AT I 4060 Leonding
www.dagopt.com
office@dagopt.com

DAGOPT uses mathematical modelling to digitalize industrial processes, which helps our clients simplify their day-to-day business.

Our clients come from the energy industry, financial sector and industrial sectors. For a wide range of business challenges, we create a digital twin, digitalizing their individual processes and workflows.

Together with the client our team of experts analyses the existing processes and creates an individualized concept for their needs. In the end we implement a tool that respects all conditions and constraints discussed. The User Interface (UI) suits our customers´ necessities from a simple front end to a polished interactive software.

We are passionate about mathematics and love to solve complex industrial problems!

With a multitude of mathematical tools beyond state of the art at our disposal, we set ourselves apart from the competition and solve problems where other modelling software fails.

@dagopt.

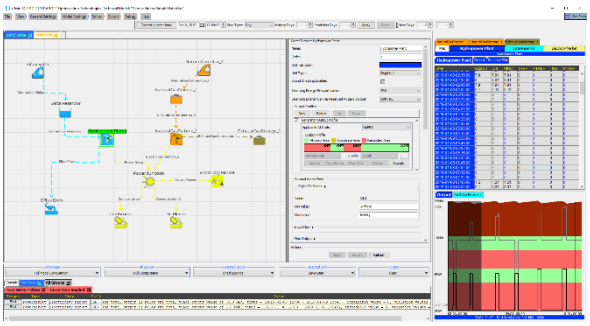
The eTwin Framework and Modelbuilder

The eTwin framework is our award-winning technology to create a digital twin of technical systems, especially in the energy industry.

Some of the advantages eTwin can offer our clients are:

- Modelling of energy markets (spot, futures and intraday market)
- Optimal operation of power plants and grids
- Short, medium and long term price and consumption forecasts
- Optimal energy price hedging
- Smart grid and smart metering solutions
- Long term investment prediction for power plants

A key component of eTwin is the Modelbuilder. It creates an exact mathematical model of the technical system, capturing all its requirements and constraints.



The eTwin user interface.

Depending on the goals of our clients, their individualized eTwin solution leads to significant technical and economic benefits for our clients.

Automated updates ensure adaptions to changing circumstances, while maintaining a powerful, yet easy-to-use UI.

DAGOPT Optimization Technologies

"eTwin enables us to automatically adjust the optimized energy schedules of our hydropower plants as little as possible, that even those constraints and restrictions that cannot be mapped in our optimization system are satisfied. This means that we are ideally equipped for the short-term intraday and balancing energy markets."

Gotthardt Bernhard, Salzburg AG

@Salzburg AG, Kraftwerk Sohlstufe Lehen.

Applications in Hydropower

Hydropower operations face constant changing conditions, which they have to take into consideration when creating production plans.

eTwin digitalizes existing manually created production plans. With this system our client simulates the plans, checks for errors and optimizes the projects.

Our industry partners in the Hydropower sector have been using eTwin with great success for over two years.

Based on its mathematical model, eTwin performs production planning of hydropower plant networks, containing dozens of individual power plants.

The system considers all constraints necessary for operation, like for example:

- Dependencies between individual plants (e.g., surge constraints)
- Environmental influences
- Storage capacities
- Physical restrictions of the turbines
- Financial constraints

Including these and more constraints, the system re-creates real life operation conditions and offers faster and easier solutions.

eTwin employs advanced mathematical methods to compute extremely precise forecasts. It automatically detects errors in the data points, even during real-time operation.

Possible predictions include load, demand, peaks, balancing energy, or grid losses.

Furthermore, eTwin incorporates a dynamic model of the power market. This allows our clients to optimize their operations, maximizing profits while complying with all market rules and restrictions.

We support our partners right from the start of the modelling process to the development of individualized optimization algorithms, as well as deployment and live maintenance of the system.

Are you interested in simplifying your processes with mathematical accuracy? Get in touch with us now to find your perfect solution.

Contact

Mag. Franz Haller
CEO

T +43 664 516 35 60
E haller@dagopt.com

DIVE Turbinen GmbH & Co. KG

Hydropower turbine
2 m – 120 m head, 100 kW to 4 MW

Am Grundlosen Brunnen 2
DE I 63916 Amorbach
www.dive-turbine.com
info@dive-turbine.de

Turbines for hydropower plants up to 4 MW

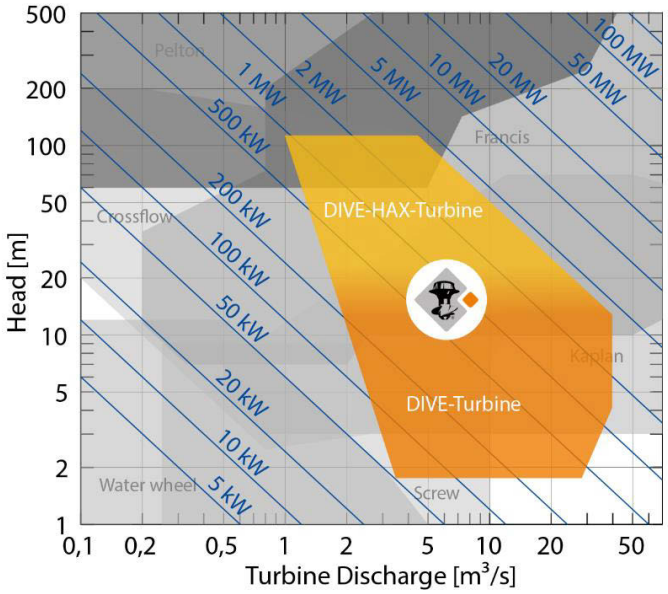
DIVE Turbinen GmbH & Co. KG is designing and manufacturing hydropower turbines up to 4 MW per turbine. They are installed in municipal power plants or industry power plants starting at 100 kW at a head range from 2.00 m up to 120.00 m.

Applications

- Medium head (double regulated)
- Low head
- Fish friendly power plants
- Ecological flow
- Residual head (out flow of power plants)
- Irrigation canals
- Unexploited hydro power potential at dams (flood control/irrigation)
- IN-PIPE applications (e.g. process water)
- Saline water (e.g. fish farms)
- Submersible power plants

More than 45 DIVE-Turbines have been connected to the grid since 2006.

Medium head DIVE-Turbine in France.
Installed capacity 600 kW.



Range of Application

The range of application for DIVE-Turbines is:

- Head: 2 m – 120 m
- Discharge:
  0,5 m^3/s – 40 m^3/s
- Capacity per turbine:
  100 kW – 4 MW

DIVE Turbinen GmbH & Co. KG

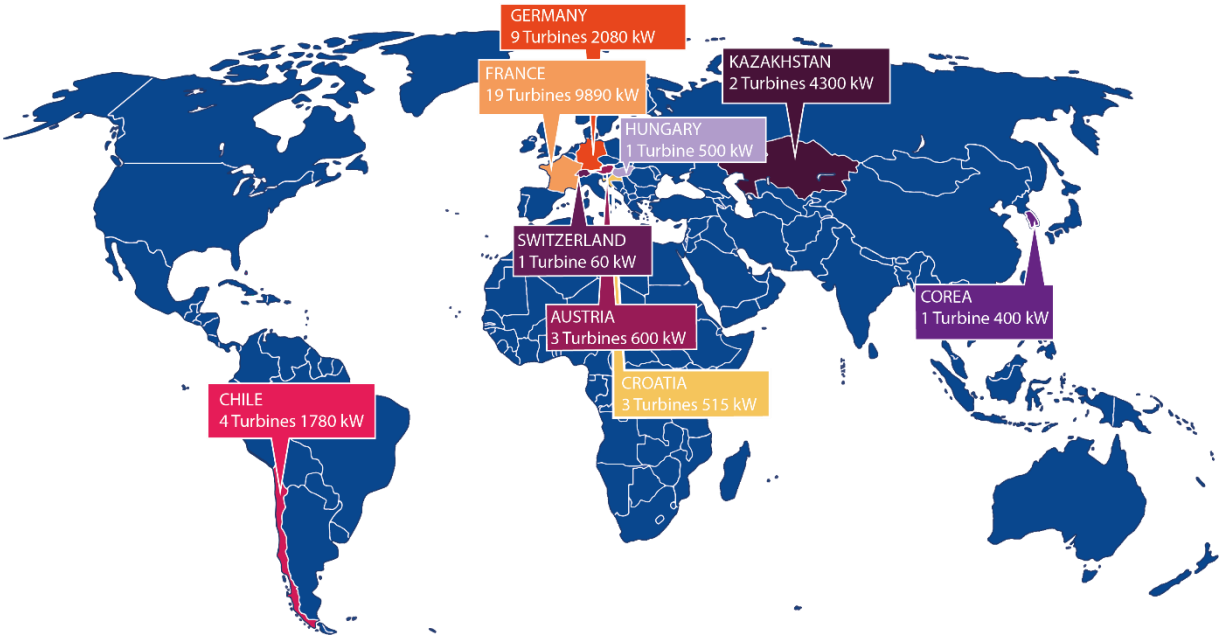
Fully assembled turbine for easy installation

The DIVE-Turbine is fully assembled and pretested in factory.

Therefore, the installation on site is simple and has very low restriction on civil works tolerances. The service and maintenance works are minimal due to the patented and wear and tear free sealing system of the DIVE-Turbines.

DIVE-Turbines in Chile: the turbines are fully assembled in factory. The tolerances to the civil works on site are very big.

DIVE-Turbines worldwide



We have local partners and regional offices all over the world. Don't hesitate to contact us for further details.

Contact

Christian Winkler
Sales Manager

T +49 9373 9749-39
E winkler@dive-turbine.de

ELIN Motoren GmbH

Elin-Motoren-Strasse 1
AT I 8160 Preding/Weiz
www.elinmotoren.at
contact@elinmotoren.at

We are your lifecycle partner for rotating electrical machines and solutions, working for the best companies around the world.

WE KEEP THE WORLD IN MOTION.

Technology is not a buzzword for us – it is our lifelong promise.

Maximum availability, high efficiency, compact motor sizes: when it comes to performance and sustainability, leading companies rely on ELIN Motoren. We are the preferred partner in development and complete solutions for exacting technical requirements.

As a specialist and inventor of water jacket cooling in electric motors, we know all the interfaces in the electric drive chain. Active flexibility is a part of our performance philosophy and enables us to develop perfectly tailored solutions. From electric motors, up to 35 MW, to generators in the power range up to 65 MVA: our technology is proven for a lifetime.

Quality is a mindset that knows no bounds.

The unique quality advantage of our solutions is based on integrated quality management, which includes all development and manufacturing stages.

Our products are tested in-house and comply with all relevant international standards. To ensure the high-quality standard for the future, we continually train our employees and keep our production facilities on the cutting edge of technology.

The development and manufacturing center of ELIN Motoren is among the most modern worldwide and possesses one of the most advanced testing laboratories. Our company maintains a certified and integrated management system based on the standards ISO 9001 Quality Management, ISO 14001 Environmental Management and ISO 45001 Occupational Health and Safety Management.

Power plants

As a planning partner for high-quality low- and medium voltage generators, motors and controlled system solutions we implement innovative drive concepts for the next generation of power plants

You will benefit from our decades of experience in the requirements of the power industry and our expertise as the leading drive technology specialist.

Our rotating electrical equipment for electric power generation is characterized by high efficiency and reliability.

Through active investigation of interfaces, the assembly of tailored packages and dedicated, flexible project management, we bring your project forward safely and efficiently. As a full-range supplier, we support all the companies in the supply chain of power stations (owners / planners / general contractors / OEMs) with generator and motor solutions for all kind of power plant applications.

ELIN Motoren painting facility.

The synchronous generators are used worldwide for steam turbines, hydro turbines, gas turbines, as well as for gas and diesel engines. The 4-pole range extends from 1 to 65 MVA and the higher pole ranges from 500 kVA to 35 MVA for voltages from 3 to 15 kV.

We develop synchronous and asynchronous generators specially designed for hydro turbines, tailor made and customized to the needs of each specific customer and each specific project. This, whether for Pelton-Francis- and Kaplan-turbines, as well as for small matrix or submersible turbine applications.

ELIN Motoren GmbH

Global partnership is far more than merely thinking and acting globally.

You have our word.

We have evolved as a high-tech company, with a long industrial tradition in the heart of Europe. Thanks to a global network of certified partners, we are also, literally, always close to our customers – from America to Asia through to Australia. As a specialist, we are right at home in demanding market segments; we meet the highest technical and application-specific requirements with innovative technology.

Quality, efficiency and reliability throughout the entire product life-cycle: this is why we can include leading companies among our long-standing customers.

We develop motors and generators that keep the world in motion.

Service

Whenever you need technical support: we are standing by 24/7. Our mobile and specially trained team of experts guarantees help throughout the entire life-cycle of your plant – fast, reliable, worldwide. A global network of certified partners supports our mission to offer service with the decisive quality advantage.

A variety of services can be carried out on-site (e.g. maintenance and refurbishment for all makes and models). Repairs are also carried out on our premises at the highest quality level by using advanced technology.

As your life-cycle partner, we guarantee the most efficient, sustainable solution. In addition to mechanical work, our scope of services also includes winding analysis such as Tan Delta measurements and partial discharge measurements as well as vibration analyses.

ELIN Motoren GmbH, Preding/Weiz/Austria.

Project Schattenhalb: Synchronous generator for a Pelton Turbine.

- Rated Power: 13,750 kVA
- Rated Voltage: 10 kV
- Rated Speed: 750 rpm

Contact

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Director Business Division Power Plants

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M +43 664 80 838 2801
E christian.fauland@elinmotoren.at

etaeval GmbH

Independent measurements and simulations
Reliable expert activities

Altsagenstrasse 3
CH I 6048 Horw
www.etaeval.ch

etaeval is an engineering company offering its services mainly in the field of hydroelectric power plants and water supplies. We measure efficiency of turbines, pumps, or plants using state of the art instruments and techniques. We are experts of thermodynamic efficiency measurements, acoustic (ultrasonic) discharge measurements, and measurements with propeller type current-meters in low head power plants.

We have access to numerical flow simulations (CFD) and system simulation tools for optimization our flow measurements and to round up our consultancy services. Based on scientific inquiries we provide added value for our customers regarding plant operation and optimization. We offer IEC- and ASME PTC-standard compliant measurements and advisory services.

Utilities benefit from our independent services, when measuring and simulating their tasks. Our independency is valued by power plant owners and operators, by consulting companies, as well as by turbine manufacturers.

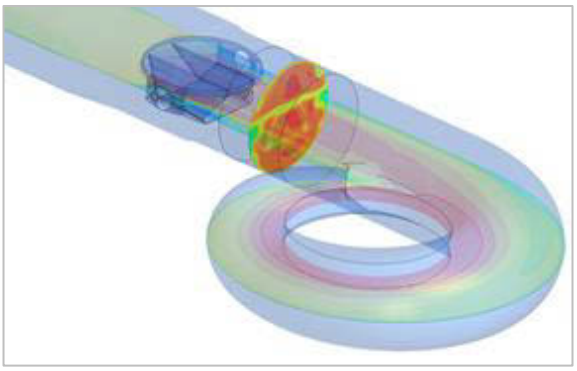
Studying hydro-abrasive erosion, AXPO, Switzerland.

Acoustic discharge measurement at HPP Pradella, EKW, Switzerland.

Pelton jet visualization at HPP Lünersee, VORARLBERGER ILLWERKE, Austria.

Low pressure measuring section at HPP Tannuwald, ALPIQ, Switzerland.

etaeval GmbH



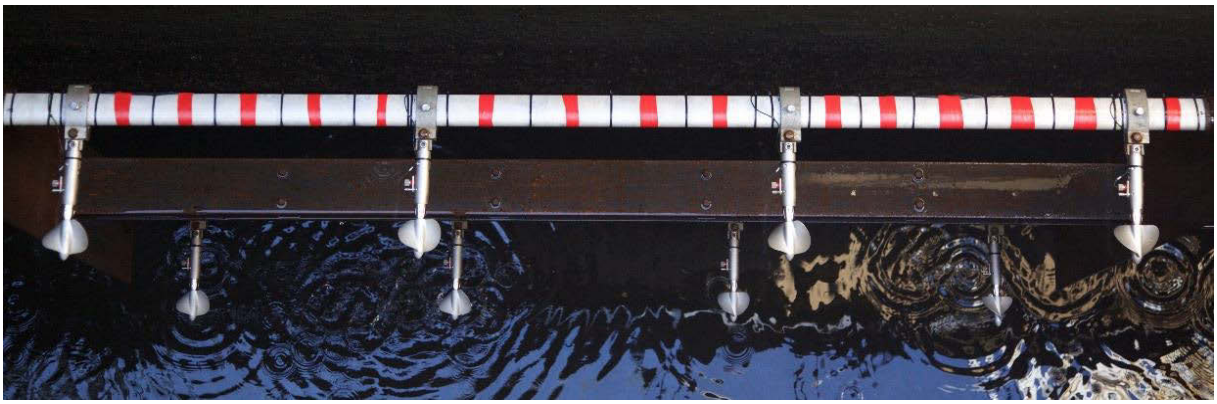
CFD study for an acoustic discharge measurement at HPP Ralco, ENEL, Chile.

Death weight manometer at HPP Silz, TIWAG, Austria.

Our services

- Efficiency measurements with primary methods
- Efficiency monitoring implemented in the control system
- Comprehensive hydro power plant monitoring and analysis
- Pump storage energy cycles (hydro certificates)
- Transient simulations and water hammer analysis
- Transient measurements, vibration measurements and analysis
- Expert activities accompanying acceptance tests conducted by turbine manufacturers
- Pelton jet visualization
- Numerical flow simulations (CFD)

Our mission is to satisfy customer requirements efficiently. Our services are completed by comprehensive, professional documentations.



Current-meter measurements at HPP La Rance, EDF, France.

Current-meter measurements at HPP Erlabrunn, UNIPER, Germany.

Contact

André Abgottspon
Prof. Dr. Thomas Staubli
Executives

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E andre.abgottspon@etaeval.ch

GEISSELER LAW

Legal advice in respect of contracts (e.g. for the supply of machines or the erection of power plants and other large infrastructure projects worldwide).

GEISSELER LAW – Germany
Bettina Geisseler – Lawyer

Im Rebstall 1
DE I 79112 Freiburg
www.geisseler-law.com
geisseler@geisseler-law.com

GEISSELER LAW offers a wide range of legal services regarding the drafting and negotiating of contracts for - among others - the supply / procurement of machines or the erection, rehabilitation, maintenance ("O&M") and acquisition of power plants and other infrastructure projects such as dams, tunnels or bridges - worldwide.

GEISSELER LAW advises regarding

- Conventional power plants
- "Renewables" (wind, hydro and others)

The law firm advises different industry sectors, mainly the civil, mechanical and electrical engineering industry.

Bettina Geisseler, Lawyer, has a long-time experience as legal counsel and later on as Head of Legal in the civil, mechanical and electrical industry (ABB Switzerland; Babcock Borsig Service GmbH, Germany; Losinger AG, Switzerland, a company of the Bouygues group, France).

Legal Services

- Supply resp. Procurement Contracts
- EPC and Turnkey Contracts
- Contracts with IPPs or state utilities
- Contracts under BOT/ BOOT schemes
- Power Purchase Agreements
- Consortium or Cooperation Agreements
- Operation and Maintenance Agreements
- Engineering Contracts
- Claim Management
- Dispute Resolution

Barrage Ouljet Es Soltane, Maroc, 2017 (under construction at that time); © Bettina Geisseler.

Centrale hydroélectrique de Romanche-Gavet, France; © Bettina Geisseler.

Nuclear Power Plant, Containment Liner (at that time under construction); © Babcock Noell GmbH (nowadays Bilfinger Noell).

GEISSELER LAW

Converter Station offshore windfarm Meerwind Süd/Ost; © Alstom Grid (nowadays: GE Grid Solutions).

Working languages

- German
- French
- English

GEISSELER LAW advises

- Suppliers or Buyers
- Owners/ Operators

Storebælt Bridge, Denmark; © Sund & Bælt Holding A/S.

Oxyfuel Pilot Plant; © Babcock Noell GmbH (nowadays Bilfinger Noell).

Contact

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GEOS3D, Geodetic and Industrial Surveying GmbH

Niedere Munde Str. 15d
AT I 6410 Telfs
www.Geos3D.com
office@geos3d.com

Industrial Laser Scanning and CAD Data for Digital Twins, BIM and As-Built Data

Building Information Modelling (BIM)

Building Information Modelling (BIM) enables architects, designers, engineers, manufacturers, CGI experts, developers, and contractors to work together to create a 3D building information model.

The effect: Projects can be designed, constructed and managed more efficiently and accurately. Terrestrial laser scanning enables you to create a factually accurate foundation that captures and expands the dimensions of complex environments and geometries required for your BIM.

As-built documentation

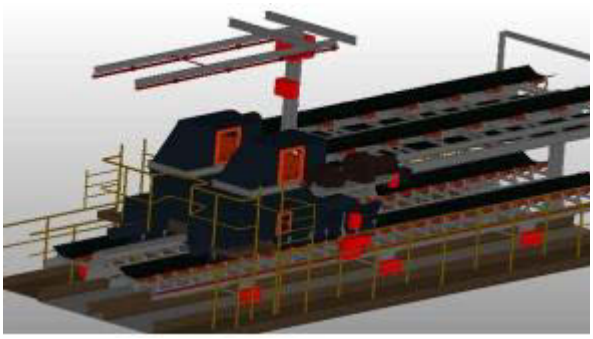
Whether plant parts, lines or buildings – we scan complete factories and plants for your documentation.

With 3D laser scanning, we generate high density and accurate point clouds. From these a CAD model is created. You then receive the data for example in DXF, DWG, STEP, JT.

Filter Scan and remodelling Spare Parts are Produced from the Data. of 12x5x6 meter.

Thermal Spa.

Detailed Remodelling of a complete Thermal Spa Inside and outside including the Piping and acquisition of 3D building data with the laser scanner, then we create a CAD model for you, e.g. in AUTO CAD REVIT format – this then serves the architect or planner as a basis for further planning and modelling.



(Scan and CAD remodelling Industrial Conveyor belt) approx. 20 meter length.

Industrial Conveyor belt Scan and remodelling Spare Parts are Produced from the Data.

Contact

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Sales

T +43 5262 62559
M +43 664 8822 6008
E bernhard.rotteneder@geos3d.com

GR-Consult e.U.

Integrating more than 30 years of experience in designing and developing software for water resources management.

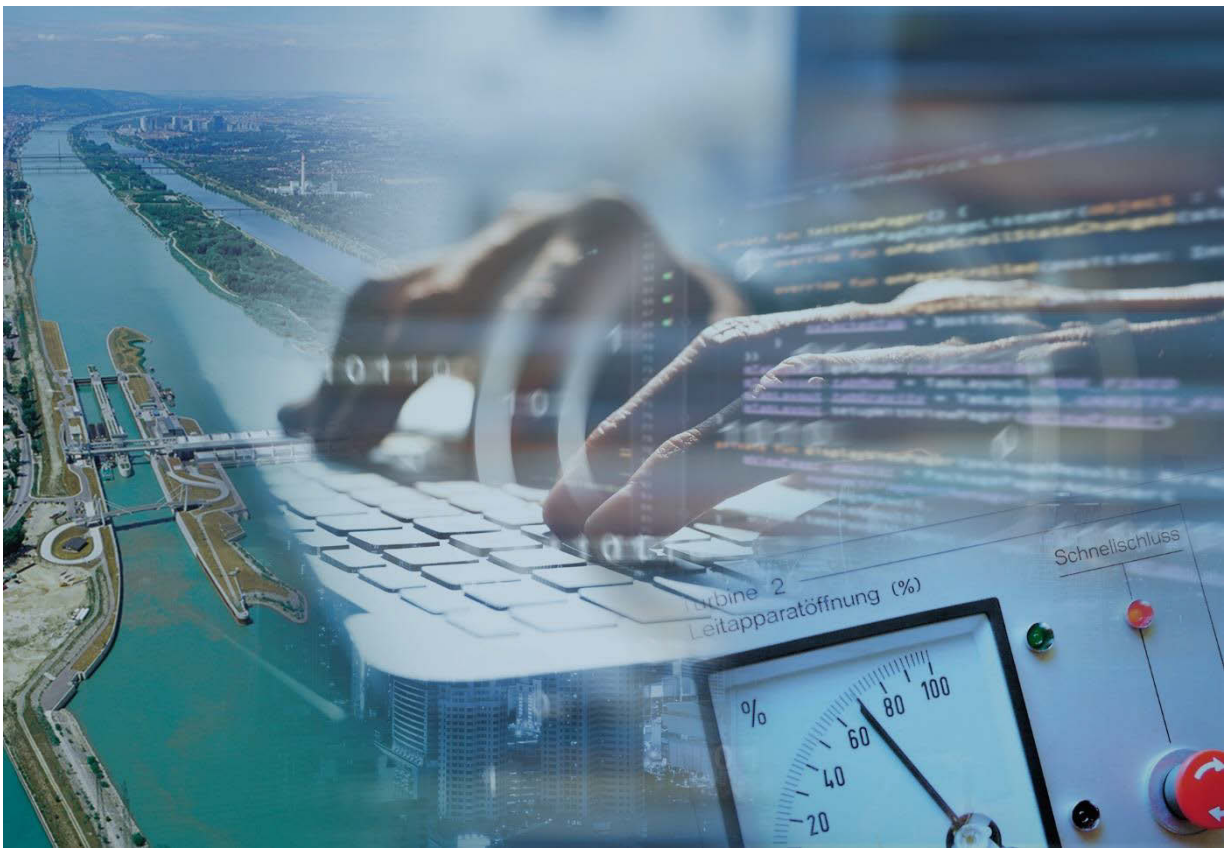
Luise Hummel Weg 3a
AT I 4040 Linz
office@gr-consult.at

In cooperation with various universities, software engineers and experts in the field of civil engineering, we have developed large software packages for flood forecast, damage estimation, inflow prediction, and optimization.

Modelling rivers and lakes, which are influenced by hydropower plants and hydraulic structures, is one of our core competences. Thus, we have implemented models and simulation systems for many large mid-European rivers, like Danube, Main, Lech, Inn, Aare, Rhine, etc.

Besides, GR-Consult has broad experience in providing technical opinions and expert assessment focusing on the hydraulic aspects of hydropower plant (HPP) operation and the influence of HPP chains.

Thus, we have significantly contributed to the reconstruction of flood events and to elaborate the impact of HPP during flood events. Thereby we provide services for operation companies, administration, and courts.



GR-Consult e.U.

VIRTUAL RIVER 4.0 – reliable testing and sustainable training

Overview

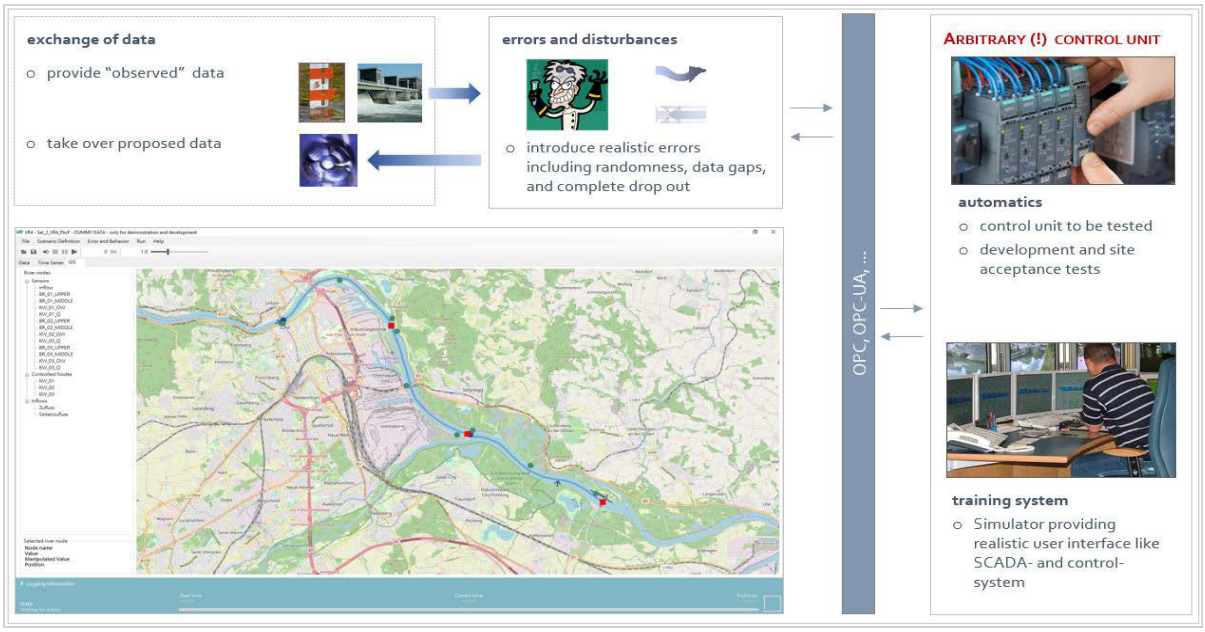
Virtual River 4.0 is a simulation system, which can substitute the river for various purposes: It is utilized for testing control systems, as a core system in training facilities and as a virtual twin.

We provide VR-systems as made-to-measure and ready-to-use systems. All systems are designed specifically based on our customers' needs.

VR systems combine a hydrodynamic model with a standard interface, typically OPC or OPC-UA. Thus, any arbitrary control unit or control system can be linked to VIRTUAL RIVER.

For providing a realistic environment, we emulate various types of errors and failures. They affect both, the data provided by VIRTUAL RIVER and the data provided by the systems being linked to VIRTUAL RIVER.

VIRTUAL RIVER 4.0 and VR-based systems are being implemented in close cooperation with DHI and Hydrotec.



Three tasks – one solution

Being a model-based digital image of real rivers, VIRTUAL RIVER 4.0 is designed for three major applications:

Development and acceptance tests of control units and strategies

Being a model based digital image of the real river, VIRTUAL RIVER 4.0 serves as the perfect environment for developing and testing control strategies, parameterising automation facilities (e.g. "water supply automatics").

Training of technical personnel – even for extreme situations

Applying VIRTUAL RIVER, you can prepare and train yourself and your team for every specific situation – no matter when and as often as you want.

VIRTUAL RIVER as an additional source of information to manage the real process

Use Virtual River as a digital twin running in parallel to the real river and supplying you with data to widen the information about the real world.

GR-Consult e.U.

Based on hydrodynamic simulation

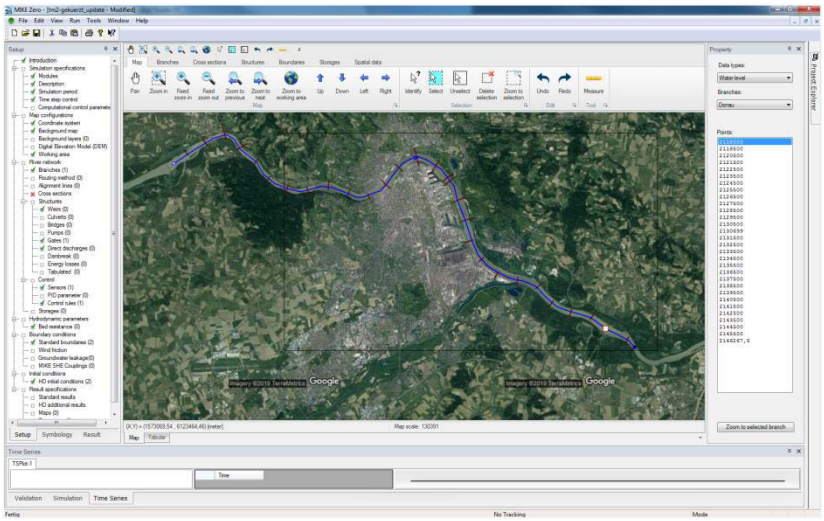
VIRTUAL RIVER 4.0 uses FLORIS and MIKE1D as numerical engines. MIKE1D is DHI's completely revised numerical core of MIKE11 that is also being used in MIKE HYDRO RIVER and MIKE URBAN+.

This type of 1D-simulation fits perfect for describing the relevant hydrodynamic processes that we use to face in our river system.

Virtual River 4.0 as a core system for training and education

When being used in a training system, Virtual River is typically linked to a copy of the original SCADA system. Thus, the trainee faces the same user interface as it is used for the real operation.

For communication between SCADA and VIRTUAL RIVER, OPC and OPC-UA are supplied by default. Other protocols can be implemented project-related on short notice.



In the first step, the base model is designed applying standard tools. Thus, we use Mike Hydro River when building a model for Mike1D, Flux$^{DSS/Designer}$ when building FLORIS-models or SMS for building HYDRO_AS-2D-models.

In a second step, specific adaption is made for setting virtual gauges, parameterising communication, defining inflows and – if wanted - for specifying error emulation.

However, when 2D simulation is required, we have available interfaces to integrate HYDRO_AS-2D or we can build interfaces for using MIKE21. Furthermore, we can build systems combining the modelling of surface runoff and urban water systems.

From an IT's perspective, services on the internet and especially "Software as a Service" (SAAS) can be implemented.

In VHP's central control room at the HPP Freudenau close to Vienna, the 10 HPP located along the Austrian section of river Danube are managed. *VHP's training system utilizes VIRTUAL* RIVER as a substitute for the real river.

www.futurezone.at

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Stress test for water resources management

We use Virtual River when we prepare ourselves for conditions we hope will never or at least rarely occur. Thus, we aim to provide an environment that is as realistic as possible.

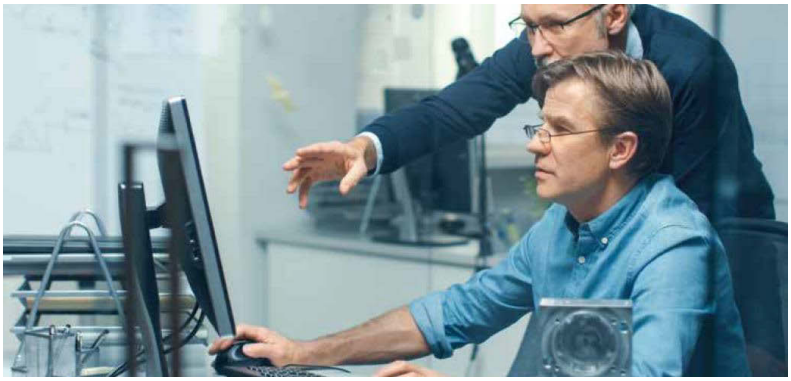
Measurement errors, malfunctions, and breakdowns are part of reality – above all in extreme cases. As another taste of reality, Virtual River can introduce errors to both, measured/ displayed data and the processing of input data:

We emulate random and systematic errors, data failure and transmission errors. Those malfunctions can be parameterised easily and combined in any desired setting.

Providing "ready to use" System

For the application of Virtual River, we focus on made-to-measure and ready-to-use systems:

A team of highly specialized modelers identifies and implements all the relevant aspects and parameterises models and interfaces for you. Our teamwork is based on cooperation agreements with DHI and/or Hydrotec. As a result, you get a model-based "digital image" of your river which covers all your needs.



When using Virtual River, you shall be free to focus on your specific business and your core tasks. Like preparing yourself and your team for any situation – including extreme ones like flood, malfunction, and breakdowns.

Thus, we take responsibility to provide ready to use systems including the hydro-dynamic model and all settings to ensure communication with your systems.

However, before developing the models, all the details that are to be considered, are discussed with you and defined based on your requests.

The entire development of model systems is being done by hydraulic experts under the supervision of the Virtual River team. We thus offer you a reliable foundation for your work – no matter if you are testing, developing or training personnel.

GR-Consult – your team for acceptance and quality assurance

In many projects VIRTUAL RIVER is used as a formal basis for acceptance tests and quality management systems for hydropower plants' automatization system.

We are pleased to support the formal acceptance and we execute all the necessary preparations and evaluations regarding water control management.

Contact

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HEICO Befestigungstechnik GmbH

HEICO Group - Quality. Innovation. Service.

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DE I 59469 Ense-Niederense
www.HEICO-GROUP.com
sales@heico-group.com

Fastening Technology - Made in Germany

More than 100 years of experience and know-how in the field of fastening technology make the HEICO Group a competent partner for the hydropower industry.

The family-owned company in its fourth generation attaches great importance to highest quality and the production site Germany. All HEICO products are exclusively made in Germany. From its two production sites in Ense, North Rhine-Westphalia, and its 14 sales offices with its own warehousing, the HEICO Group supplies its bolt technology products to customers in over 68 countries around the world. An extensive distribution network of well-known dealers and authorized trading partners worldwide additionally ensure short delivery routes and a fast delivery capability of the products.

Customers benefit from a professional customer support and technical advice by HEICO's experienced sales engineers and certified fastener engineers. Furthermore, the company owned test laboratory offers numerous test procedures to find optimal product solutions for each individual customer application.

HEICO Group production site in Ense, North Rhine-Westphalia.

HEICO-TEC® Tensioning Systems

Tightening large bolt connections in hydropower plants usually requires expensive electrical, hydraulic and pneumatic tools. The efforts and costs of this procedure are often excessively high. By the use of HEICO-TEC® tension nuts the efforts and costs for large bolt connections can be reduced.

The ingenious construction of the mechanical tension nut enables the assembly personnel to assemble the bolted joint with a conventional hand-held torque wrench by distributing the pre-tensioning force from the main thread to many smaller pressure bolts that are located around the main bolt.

HEICO-TEC® Tensioning Systems.

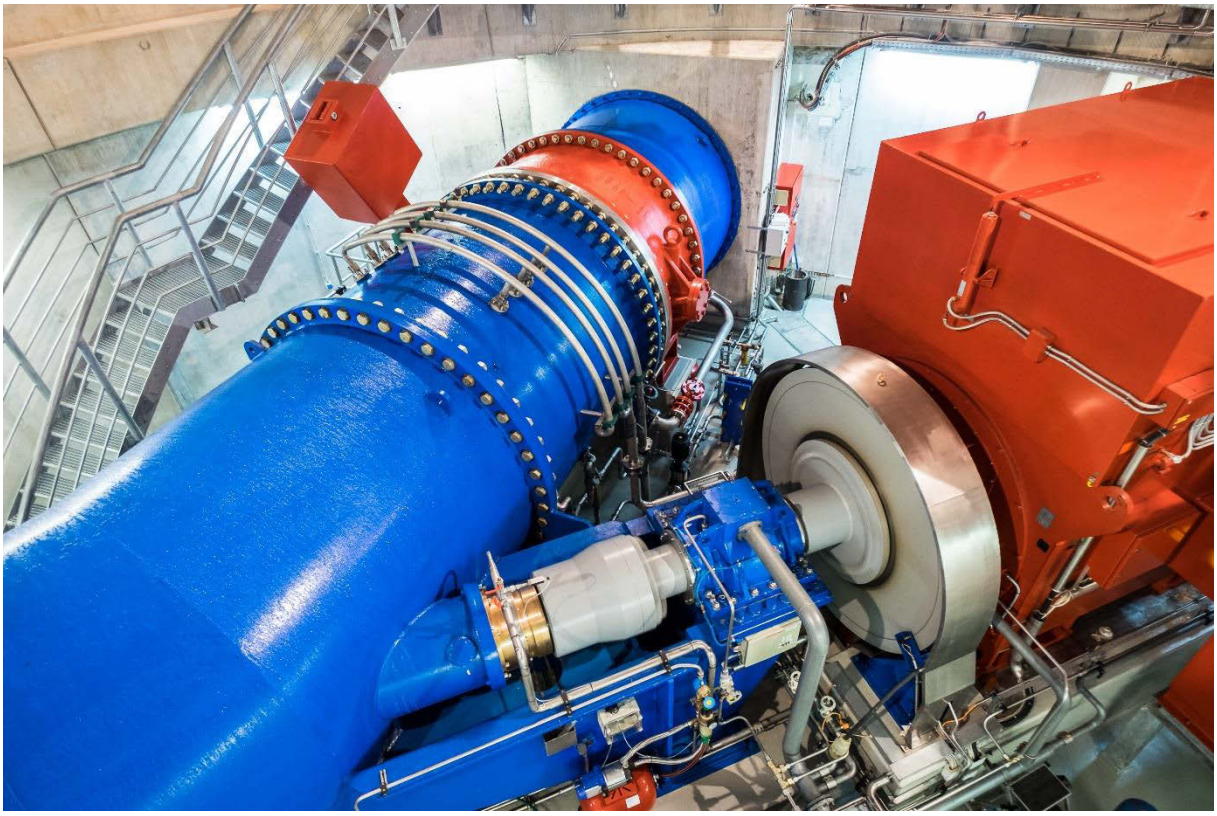
The HEICO Group launched its broad standard product range of HEICO-TEC® tension nuts in class 8 and 10 which covers the majority of applications. By introducing a standardized range of tension nuts, customers benefit from short delivery times and lower costs. As the HEICO-TEC® tension nuts meet all requirements of ISO 898-2, hexagon nuts of the same strength class can easily be replaced by the tension nuts. The usage of tension nuts allow an easy, quick and reliable assembly of large bolted joints.

HEICO Befestigungstechnik GmbH

HEICO-LOCK® Wedge Locking Systems

For a sustainable securing of bolt connection the HEICO-LOCK® wedge locking systems offer a varied range of bolt securing products. All HEICO-LOCK® products are based on the HEICO-LOCK wedge locking principal which secure bolted joints effectively by constantly high kept preload. Even under extreme vibrations and dynamics loads, bolt connection, which are secured by HEICO-LOCK® products are safely protected against self-loosening of the bolt.

HEICO-LOCK® Wedge Locking Systems.



Products from the HEICO Group are successfully used in a variety of applications in the field of hydropower.

Find more information under www.HEICO-GROUP.com.

Contact

MBA & Eng. / Certified Fastener Engineer (DSV)
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University of Applied Sciences Western Switzerland Valais/Wallis

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CH I 1950 Sion
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The HES-SO is one of the largest universities in Switzerland, spread over the entire French-speaking cantons of Switzerland. One of the strategic research areas of the HES-SO Valais/Wallis is energy research which has become one of the most active places for energy research in Switzerland.

Institute of sustainable Energy

Research in energy-related areas has been done inside HES-SO Valais/Wallis for several years. Since 2019 all these activities have been brought together in one institute. As such, the institute brings together researchers from different schools of the HES-SO Valais/Wallis, thus merging technical, digital, economic and social skills.

The activities of the Institute of sustainable Energy include the production, management and storage of renewable energies, the management of multi-energy grids and electric mobility. All addressed issues and developed solutions include a strong assessment of their environmental impact.

Topics (Excerpt)

- Energy Market operations
- Energy Management & Optimization
- Data Management & Analytics
- Modelling and simulating of fluids
- Design & optimization of turbines and hydraulic systems
- Mini & Micro hydro power installation

Research Field: Hydropower

In the research field of hydropower different expert worked in different aspects of hydropower are grouped together. The research field hydropower starts with traditional areas in modelling and simulating fluids to investigate potential threads of cavitation, but also covering field like the design of novel turbines, enabling more flexible use cases.

The aspect of the digitalization of hydropower there is on the one the options that can be realized by addressing new ways of sensing and sensor-data analysis, which can lead to approaches of predictive maintenance. On the other hand, the digitalization of hydropower installations allows for better synchronized operations of various installations, and therefore a more flexible operation management of complex cascades to valorise market opportunities, in flexibility markets.

Furthermore, is it necessary in countries like Switzerland, where hydropower provides nearly 60% of domestic energy production, to consider the importance of the change in the energy mix, its future modes of operations where its flexibility can be valorised on different grid-levels, and its potential consequences for hydropower operations, and long-term technical developments and investments.

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HollyFrontier LSP Europe B.V.

Providing lubricants solutions beyond today's standards.

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1043 AL Amsterdam
Netherlands
www.hollyfrontier.com/hfls
www.lubricants.petro-canada.com

Member of vgbe energy I Hydro Power

Commitment to quality

Our products set the bar for quality and performance well above standards. Our long-standing commitment to quality is demonstrated by our extensive registrations:

CERTIFIED
ISO 9001: 2015
ISO 14001: 2015
IATF 16949: 2016

Contact

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HollyFrontier LSP Europe B.V.

A pure advantage

Petro-Canada Lubricants specialty fluids, lubricants and greases have a pure advantage in quality and performance. We create 99.9% crystal-clear base oils – some of the purest in the world.

Most finished lubricants formulations are composed of over 70% base oils, so base oil selection is critical. The purer the base oil, the better it works with specialty additives, resulting in advanced performance and longer lasting lubricants.

Our goal is to save you time and money by making sure you have the right lubricant for the job. By identifying your needs, we can help you extend maintenance intervals; prolong the life of your equipment; simplify your lubricant requirements. Because more uptime means more profitability for you.

High viscosity index

PURITY™ base oils have a naturally high viscosity index, which allows for performance across a wider temperature range.

Petro-Canada Lubricants are available in a wide range of package sizes and are stocked at many strategic locations around the world by either HollyFrontier Lubricants & Specialties or one of our many global distributors.

To help our customers select the right lubricant for the job, request a copy of our Lube Source Product Catalogue. It is an informative guide, which narrows your lubricant choices to a primary recommendation.

Low temperature properties

The low temperature properties of our base oils keep them fluid at extreme low temperatures, which protects equipment and allows for easier cold weather start-ups.

Oxidation & thermal resistance

PURITY™ base oils exhibit excellent thermal stability for high temperature performance and excellent resistance to oxidation, contributing to long lubricant life in finished products.

At HollyFrontier Lubricants & Specialties, we do not just produce lubricants; we deliver lubricant solutions – tangible savings solutions – to increase productivity for your manufacturing operation.

Low volatility

Next-generation engine oils have very stringent NOACK volatility requirements, which is largely dependent on the base oil volatility.

HollyFrontier LSP Europe B.V.

Hydro power and related industries lubricants for power generation

When your job is to manage, protect and optimize some of the largest, most complex and expensive equipment in the industry, every operational decision you make is critical, especially when it comes to the lubricant.

LUMINOL™ TRi inhibited insulating oils are suitable for use in large power and distribution transformers operating at peak capacity. This product offers the added safety provided by negative gassing technology as well as improved low temperature performance.

The lubricant plays a key role in overall productivity: it is critical to meeting operational goals; it protects and prolongs the life of the machine and it is the lifeblood of the equipment. We want operators to get the most out of their equipment and that includes choosing the best lubricants for the job.

TURBOFLO™ – extends intervals between oil top-up or change-outs. TURBOFLO turbine fluids handle the extreme conditions facing your gas, steam and hydro turbines. In fact, TURBOFLO turbine fluids out-perform many leading competitive lubricants in various tests.

Unlike competitive products formulated with naphthenic mineral oils, LUMINOL TRi uses Petro-Canada Lubricants ultra-pure isoparaffinic base oils to deliver worry-free, corrosive sulphur-free performance in your transformer.

Gas, steam and hydro turbines operate at high temperature and pressure extremes. TURBOFLO turbine fluids reduce overall maintenance costs by extending intervals between oil top-up and complete change-outs.

HollyFrontier LSP Europe B.V.

Petro-Canada Lubricants premium product lines of HYDREX™ and ENVIRON™ hydraulic fluids are engineered to resist thermal and oxidative breakdown, provide extended drain intervals, and protect against equipment wear. They minimize sludge and varnish deposits for smoother equipment performance and reduced maintenance.

Our hydraulic fluids perform year-round in wide temperature ranges, and the ENVIRON line has been specially formulated for operations working in environmentally-sensitive areas.

Our no-nonsense lubricants warranty

"HollyFrontier Lubricants & Specialties will repair damaged equipment, or replace damaged equipment parts resulting from a failure due to defects of the Petro-Canada Lubricants product, as long as the lubricant is used in accordance with your equipment manufacturer's and our recommendations."

It's more than just a warranty.

It's a commitment.

PETRO-CANADA LUBRICANTS

A HOLLYFRONTIER BRAND

Hovering Solutions Ltd.

Calle de María Tubau 4
ES I 28050 Madrid
www.hoveringsolutions.com

Changing the condition monitoring process from a manual, subjective to an automatised, data-driven approach.

The problem

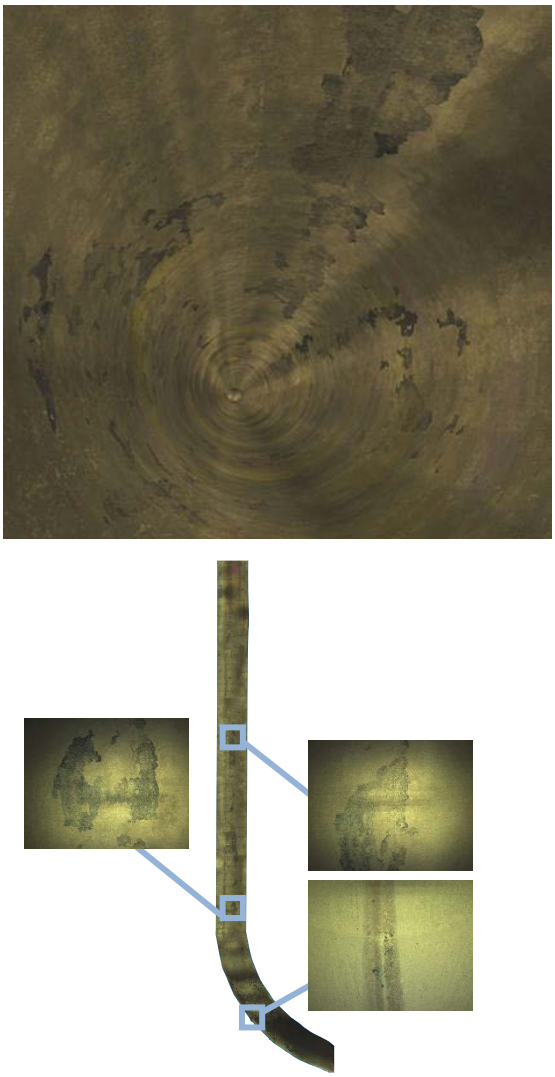
Infrastructure operators such as utilities and hydro companies need to inspect and monitor their assets on a regular base. This process is time consuming and expensive, yet unable to provide high quality information and in several cases entails a considerable risk for human operators.

Our approach

Hovering Solutions has developed aerial robots (a kind of drones) capable of flying autonomously, with no pilot, in absence of light, Global Navigation Satellite System (GNSS) or any other kind of wireless radio communication system. Those robots are capable to fly indoor and can be used for inspection and 3D mapping purposes. Following this approach, the inspection time can be reduced increasing the quality of the retrieved information significantly, whilst reducing the human risk to an absolute minimum. In contrary to current inspection approaches, we are recording a complete data stream not being limited to certain areas, which are supposed to be relevant based on the subjective assessment of the operator.

Our service

Hovering Solutions is not selling its in-house developed robots but providing the acquired data to the customer. Post-processing of those data enables the customer to gain unprecedented insights about the infrastructure condition. This allows to improve and re-think the entire maintenance processes and to reduce unplanned downtimes to a minimum thanks to the findings resulting from the analysis of the available datasets.



Penstock corrosion maps with geolocational information

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HYDAC International GmbH

HYDAC – Your Professional Partner for the Hydropower Industry.

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Member of vgbe energy I Hydro Power

HYDAC has decades of experience in oil hydraulics and process water treatment. With individual components constantly being added to the product range, such as filters, accumulators, valves, pumps, coolers and sensors, HYDAC has built up an extensive and complete product portfolio over the years that leaves nothing to be desired when it comes to designing systems for the hydropower industry. In addition to supplying individual components, HY-DAC also provides complete systems for almost all hydropower applications. These are comprehensive systems which are specially tailored to suit the customer's needs.

HYDAC was founded in 1963 as a company for hydraulic accessories and is today an international, family-run company group with over 9000 employees, 50 subsidiaries and 500 sales and service partners worldwide. Our motto is: global yes local. HYDAC components and systems can be found in all sectors of industrial and mobile hydraulics. In the hydropower industry, HYDAC is represented in the following applications for both large and small hydropower stations:

- Hydraulic steel structures and trash rack cleaners
- Shut-off devices
- Turbines
- Process and cooling water treatment
- Generators

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HYDAC International GmbH

Hydraulic steel structures and trash rack cleaners: hydraulic units and cylinders for gates, sluice, weirs and trash rack cleaners.

Shut-off devices: hydraulic systems for main inlet valves, shut-off valves and needle valves, piston and bladder accumulator stations for storing closing power and water-powered servo motors with corresponding protective filters.

Turbines: bearing lubrication systems, hydraulic turbine controllers, piston and bladder accumulator stations for **the emergency shut-down function**, control valves.

HYDROBox

Process and cooling water treatment: for the filtration of seal water, cooling water and extinguishing water, the required components – e.g. the automatic back-flushing filter RF3 (are mounted on compact frame = skid), TwistFlow Strainer (ATF) and pump-stations for closed cooling circuits.

RF3

ATF

WGK

Generators: lifting and brake cylinders, oil lubrication cooling systems and cooling water systems, high-pressure discharge systems (HP systems), brake lifting systems, oil mist separators.

Breaking Cylinder

STENO

HYDAC also supplies products for **Condition Monitoring**, such as sensors for monitoring water content (Aqua sensor), metallic contamination (MCS sensor) and the automatic monitoring oil cleanliness (CS sensor) along with service instruments for maintenance such as dewatering units (FAM), offline filtration units (OLF), nitrogen charging units for accumulators (N2 server) and mobile units for measurements and data acquisition (HMG).

CSM-E

HYDAC also provides **worldwide services** from commissioning to proper maintenance and inspection.

The HYDAC portfolio is rounded off with extensive fluid engineering services which help to optimize your key components and fluid power systems. We are very happy to support you in areas such as energy efficiency, process and system reliability, conservation of resources and system availability.

HydroPower Engineering

Your hydro manufacturing partner. It is not just machining, it is engineering.

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www.hydropower.com.tr
info@hydropower.com.tr

A leading manufacturing company in the Hydro-Electric sector.

Bullet points:

- Experience and quality
- End to end projects
- Complete project documentation

HydroPower Engineering is a Turkish firm, experienced in building and manufacturing the hydro-electric turbines whether it is Pelton turbine, Francis turbine, or Kaplan turbines.

Ever since its establishment it has been ISO9001 certified. It offers high precision machining which makes it suitable for the highly accurate machining applications and fields. With the help of our 6-axes machines, it is pioneer in manufacturing and machining the turbine runners. It offers all the required and necessary non-destructive tests -NDT-, the balancing that the runners require. The machines' capabilities make it able to provide Francis runners whether it is a mono-block runner, or welded bi-blocks with the help of its certified and experienced welders and welding shop.

Pelton runner being machined on a 6-axes machine.

Get benefit of our free quotations for your projects and inquiries now. NDA can be signed upon request.

Always at your service!

Also with the help of its coordinate measuring machine -CMM-, its able to accurately and precisly inspect its products' dimensions up to the satisfaction of its customers.

Although it has been established for 5 years now, its turbines and turbine equipment are located all over Europe, Asia and even Australia.

2 finished Francis runners before dispatch.

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Hydrotec

Water and Environment Consulting Engineers GmbH

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www.hydrotec.de
mail@hydrotec.de

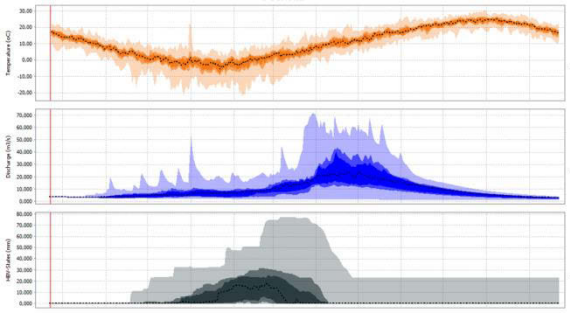
Experts for Operational Flow Prediction and River System Modelling

Delft-FEWS Flood Early Warning System

The forecasting system can be used to optimize the operation of run-of-river and storage power plants. It provides important information for energy planning and secures decision-making in the event of flooding. Energy suppliers can react flexibly to fluctuations in prices and supply, while at the same time safely complying with legal requirements.

Delft-FEWS discharge forecasting system

- Rapidly available, operational forecasts
- Forecast data with high reliability
- Flexibility to meet customer requirements
- Ease of use
- Generation and dispatch of reports



Ensemble Streamflow prediction in Delft-FEWS.

Forecasting discharges for the power industry

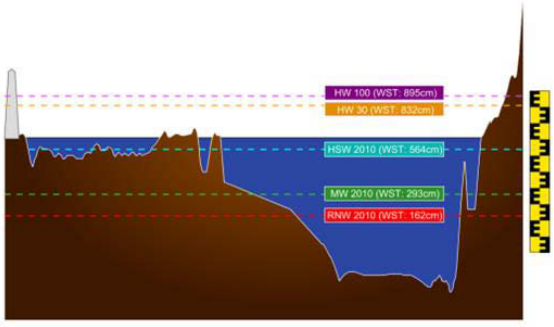
- Power plant scheduling
- Scheduling by the load dispatcher
- Storage and pump deployment planning
- Short-term revision planning
- Support of medium-term planning

Delft-FEWS serves as a data integration and simulation shell that automatically maps all operational processes of a model. Statistics and reports from the system are freely configurable.

Rainfall-runoff models, continuously driven by the output of numerical weather prediction models, rainfall radar data or rain gauges, are used to calculate forecast inflows to power plants.

Inflow prediction for power plant operation

- Use of model predictive control for optimal operation of structures and valves
- Fulfilment of regulatory requirements
- Anticipatory action in case of flooding



Delft-FEWS clearly shows the flow conditions in schematic status displays.

Hydrotec

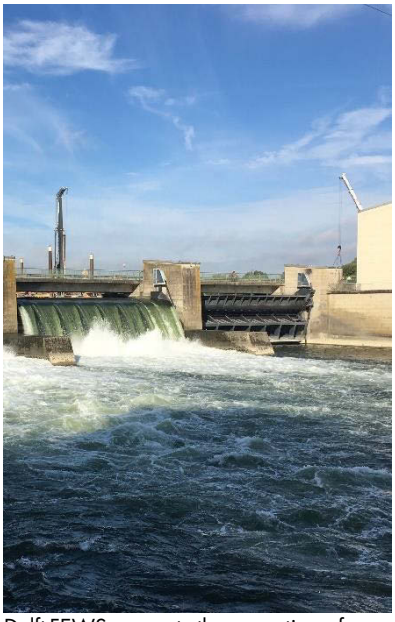
Delft-FEWS for Run-of-River Power Plants

Delft-FEWS continuously imports recorded water levels, discharges and operating conditions in the barrages, at the weirs and turbines and evaluates this information with the calculated forecast data.

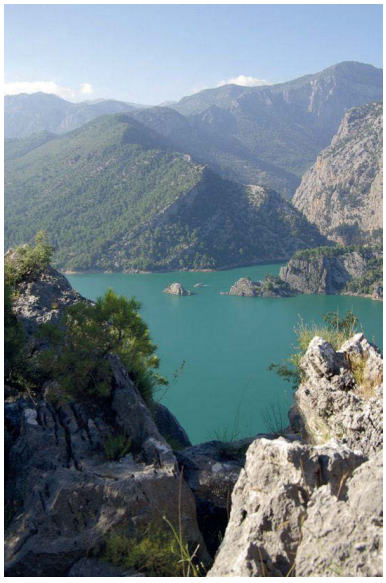
With the help of RTC tools, 2 the discharge from the reservoirs can be optimized using the weir height as a control variable. Specified target values regarding energy generation, flood protection and water ecology are thus met.

When a flood wave is expected, the operator can provide retention space in good time by lowering the reservoir water level in advance.

The re-storage can be initiated as quickly as possible to minimize the impact of the flood on the safety of the hydropower supply.



Delft-FEWS supports the operation of Run-of-River Power Plants.



Storage Power Plants can be run more efficiently by the forecasting system Delft-FEWS.

Delft-FEWS for Storage Power Plants

Delft-FEWS is scalable from simple to highly complex systems representing complex topologies with several hydropower plants and interconnected reservoirs.

The forecasting system provides concrete inflow forecasts based on hydrological calculations and thus supports the management of the reservoirs. RTC tools 2 can be used to optimize control processes.

Based on measured reservoir levels, power generation schedules and forecast data, a predicted balance of levels is determined. In this way, trends can be identified at an early stage, especially for storage facilities managed during the year.

With the integrated decision support module, users can simulate and visualize processes and control them in the forecast both rule-based and interactively.

Delft-FEWS is an operational model-based system for flood and runoff forecasting. It is developed by Deltares, The Netherlands and used worldwide. It is free of licence fees.

Hydrotec configures forecasting systems based on Delft-FEWS according to customer specifications and provides support and maintenance.

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KELAG-Kärntner Elektrizitäts-Aktiengesellschaft

Your energy, our nature.

Arnulfplatz 2
AT I 9020 Klagenfurt am Wörthersee
www.kelag.at

Member of vgbe energy I Hydro Power

Kelag is one of the leading energy service providers in Austria that is active in generation, distribution and district heating. The company head quarter is located in Klagenfurt, Carinthia.

The international activities in renewable energy generation from hydro, wind and photovoltaic as well as energy trading are bundled in Kelag daughter company KI-KELAG International GmbH.

Kelag with almost 100 years of experience in developing, designing, construction and operation of hydro power plants provides the full range of competence and knowhow from the project idea to the successful project realization.

After the completion of a power plant, our experts guarantee reliable operation, specified maintenance service and performance orientated refurbishment.

From the acquisition, developing, designing and operation of our wind and photovoltaic power plants in and outside of Austria we could intensify our competences within these technologies.

Based on our wide experience, Kelag provides to our partners excellent support from the development to the realization of a power plant project. Furthermore, we support our partners with operation and maintenance and energy trading services in international markets.

Contact

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Head of Power Generation
and Technical Services

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M + 43 676 8780 5237
E christian.rupp@kelag.at

KELAG-Kärntner Elektrizitäts-Aktiengesellschaft

Project development and design

We identify a first project idea followed by concept studies and bring the project to an optimized design. Our evaluations are based on technical and commercial feasibility studies considering the project risks and the current market situations. Our experts provide the required competences and licenses in the field of civil, electrical and mechanical engineering and design works.

Intake with fish pass, hpp Kremsbrücke, Austria.

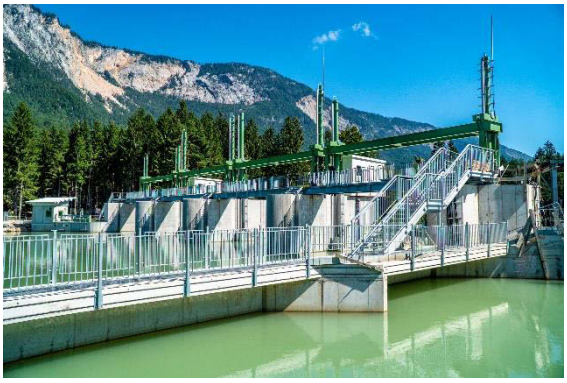
Design, permit procedures and procurement

We provide the relevant documentation including design drawings, studies and calculations in the permitting procedure and support the entire administrative process.

Within the design process, we are preparing the tender documentation and specifications tailored the project requirements either in single lots or for EPC tenders.

We support through the entire procurement process to ensure the purchase order in the required quality, time and cost objective.

Beside the entire project management, we also cover the contract and claim management.



Renewal of 80 years old weirs structure and steel mechanical equipment, hpp Schütt, Austria.

Machine room in Zapeće, Bosnia.

Project realization and commissioning

We support the entire project execution phase with documentation review and approvals, factory and site acceptance tests, installation coordination and site supervision and coordination as well as quality control and management.

Designing, manufacturing, installation and commissioning of steel mechanical equipment is also in our scope of services.

After completion of construction and equipment installation, we are leading and managing the commissioning process through the trial run period to the successful takeover of the power plant.

KELAG-Kärntner Elektrizitäts-Aktiengesellschaft

Operation and maintenance

After successful project execution, we support our customers with operation and maintenance excellence and optimized power plant operation scheduling. Beside revision and overhaul work, we also offer qualified training of our customer's staff.

Complete power plant refurbishment or rehabilitation of single power plant equipment is part of our services.

Generator maintenance.

Energy management and trading

Through qualified production forecasts and market analyses, we provided optimized sales of the produced energy.

We offer energy trading services, PPAs operational generation scheduling and balance group management and guide through the relevant market rules.

Restoration of the inlet guiding cone at Wurtenspeicher, Austria.

Pump Oschenik, hpp Innerfragant, Austria.

Your advantages

- Turn-key solution for power plants
- Production optimization of your power plant
- Full support in all technical and energy management issues
- Independent and competed consulting services in the field of electrical, mechanical and civil engineering
- We are your reliable partner with almost 100 years of experience in the energy business.

KISTERS

We provide professional software solutions for observation, forecasts and optimization of water and energy resources.

Pascalstr. 8+10
DE I 52076 Aachen
www.water.kisters.de/en
water@kisters.de

In addition to retrofitting existing dams, power companies are maximizing value by increasing hydraulic efficiency at hydropower plants. Even when water flows and levels are tightly regulated, the same amount of water can produce more energy if the head is optimized. Generators also have the option to better time energy production to coincide with higher demand or price as much as possible.

A few centimetres of flexibility have been demonstrated to generate as much as 10% more revenue.

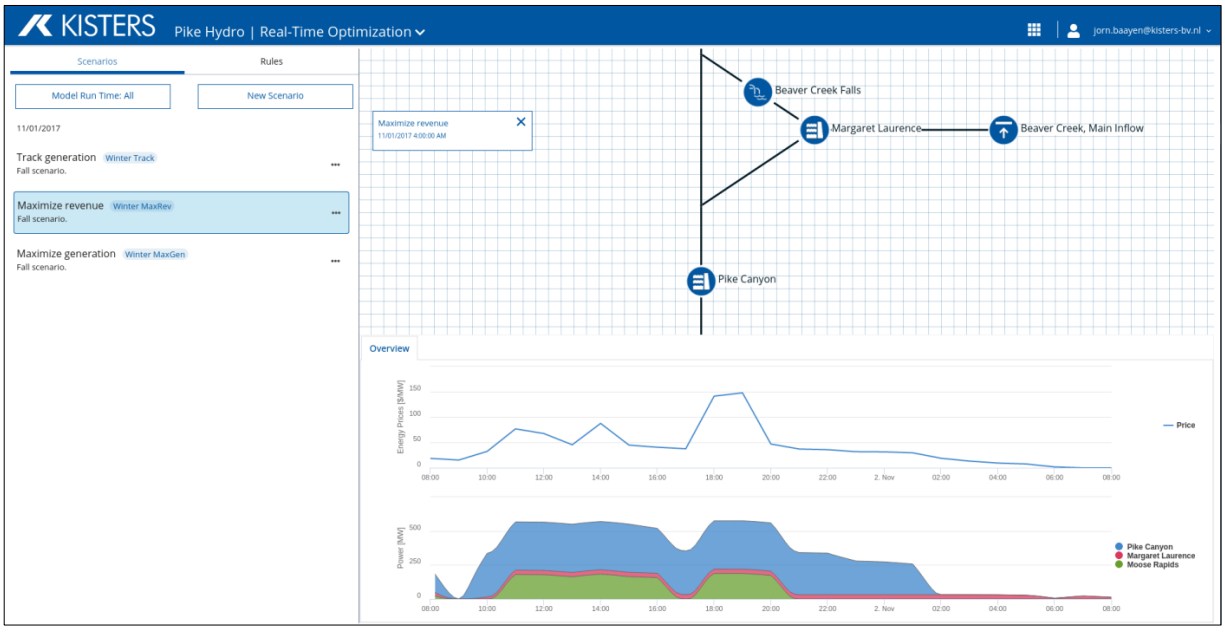
Hydroelectric companies can bolster cost-efficient innovations that integrate with energy storage technologies and align with community values of generating energy sustainably and achieving ecological benefits.

KISTERS Real Time Optimization works on the basis of your existing river models. It takes into account non-linear effects such as wave propagation and head-dependent power generation.

Built upon patent-pending technology, it solves a fully customizable prioritized list of optimization objectives, which allow you to:

- Schedule generation during price peaks and maximize revenue.
- Maximize hydraulic efficiency and maximize total generation.
- Reduce water level fluctuations and dampen flood waves.
- Improve compliance with environmental flow requirements.

Solution optimality guarantees are provided at each stage.



Intuitive Web application for configuration and operation control.

KISTERS

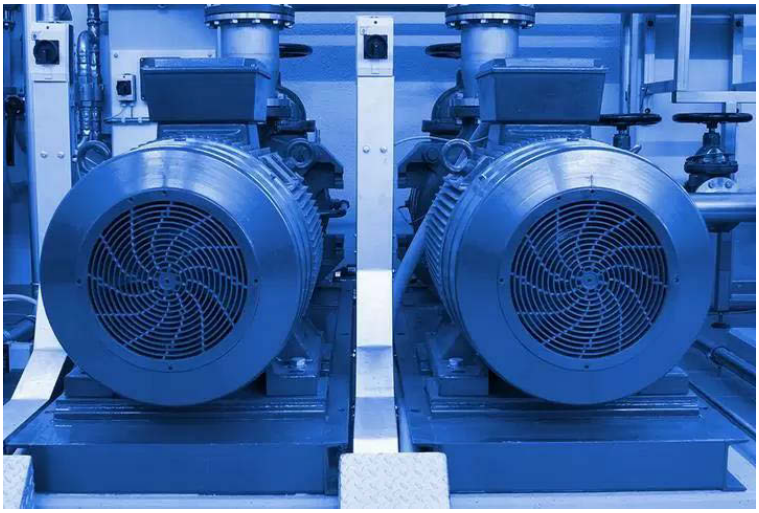
Maximize revenue

Contribute to the green economy by operating your hydroelectric plants when the clouds are out and the wind lies down – and prices are high.

All the while, stay within regulatory commitments and leverage synergies between efficient operation and ecology.

Maximize e-flow compliance

Minimize your exposure to legal action by maximizing environmental flow compliance, prior to maximizing generation and/or revenue in a subsequent optimization stage.



Increase effective flood retention capacity

Prepare for extreme events by dynamically creating retention capacity when storm events are predicted. Is it going to rain? Our software suggests how much to draw down your reservoirs and river reaches to make space, without compromising other operational requirements.

We are ready for your challenge.

Contact

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KISTERS Group

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KWS Energy Knowledge eG

Knowledge – Workmanship – Safety

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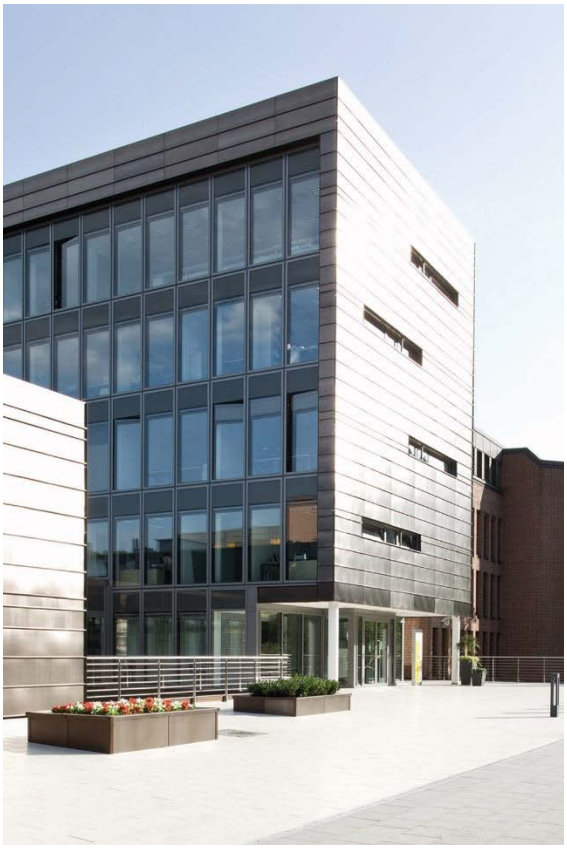
KWS Energy Knowledge eG (KWS), formally known as KWS PowerTech Training Center (KRAFTWERKSSCHULE E.V.) is an educational institution and service provider for the German and international energy sector and has been offering modern and customer-specific training and consulting for more than 60 years. Beginning more than 17 years ago, KWS has also been conducting training measures for hydropower plant operating personnel. The two-week course "Basic Training Control Room Operator" was developed with the assistance of the vgbe expert committee on hydropower installations.

387 participants from 17 businesses were trained in 23 courses and received their graduation certificate following their successfully concluded final examination. This certified degree provides responsible personnel in their respective companies with greater legal security regarding their organizational functions.

Complementing basic training is a one-week consolidation seminar offered by KWS since 2010. This seminar focuses in depth on operational demands. Other topics are flood control, occupational safety and efficient operations under changing market conditions.

Beside these standardized German-language training courses in our training center in Essen, Germany, we also offer customized on-site training measures tailored to the needs of international clients. We are happy to assist our customers, plant operators and component manufacturers in the selection and training of operating personnel for new hydropower installations.

With its training offerings, KWS keeps pace continually with new developments in energy technology and assures high personnel qualification standards in energy sector businesses. It thereby makes a significant contribution to a company's success in the marketplace – a valuable investment in the future!



KWS Training Center.

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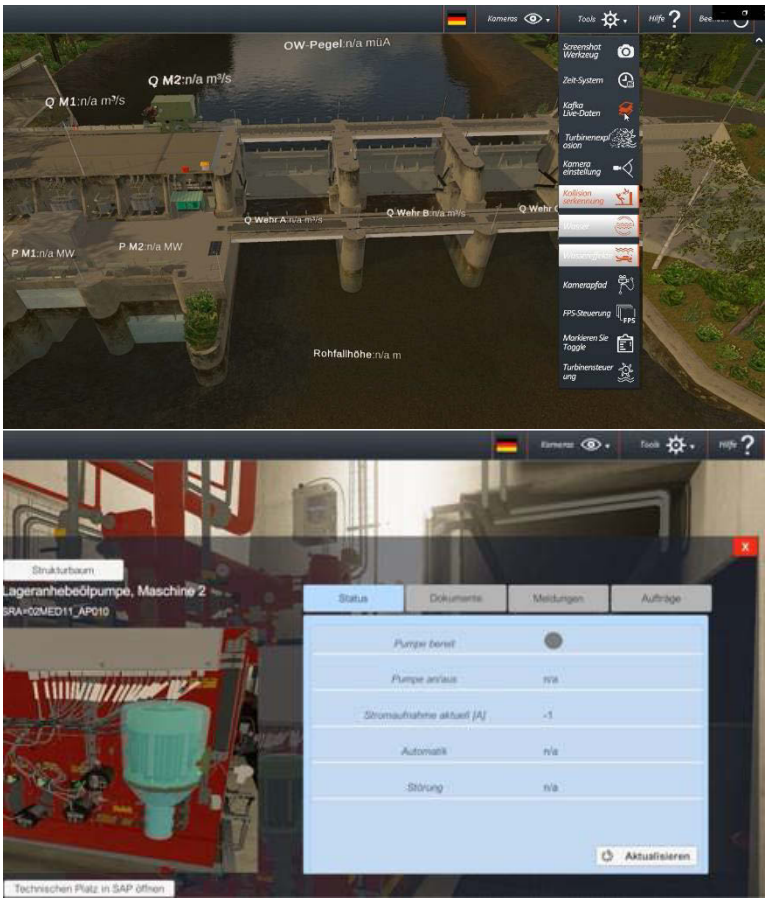
LocLab Consulting GmbH

The Digital Twin Company
Wherever our 3D digital twins come into action: they form the modern basis for sound decisions.

Groß-Gerauer Weg 1
64295 Darmstadt, Germany
www.loclab-consulting.com
info@loclab-consulting.de

Our digital twins will revolutionise your business processes. As object-based virtual images of existing or planned buildings, technical facilities or other built assets, they provide a completely new intuitive access to your asset data. In addition to semantics as a prerequisite for systems integration, data analyses and simulations, our models are characterised by extremely high performance, the smallest data volumes and a remarkably realistic appearance.

The Wedtlenstedt lock was built in 1939 and needs to be modernized and expanded. Our 3D model of the existing lock and the environment, generated from terrestrial photographs and videos, was used for early stakeholder engagement and communications.



Real-time semantic 3D model connected to SAP and Apache Kafka.

Case Study: Rabenstein Hydropower Plant

The aim of the pilot project of VERBUND, Austria's leading electricity company and one of the largest producers of electricity from hydropower in Europe, is to create an interactive VR model of Rabenstein hydropower plant, including the immediate environment, based on 3D survey data and photos. New possibilities are expected from VR models in the following areas, among others: safety instructions, training / education environments e.g. simulation of floods or of incidents, intuitive access to relevant information.

Technical documents, IoT and live sensor data from process control technology have been successfully integrated into the 3D digital twin Rabenstein.

Output	Real-time semantic 3D model connected to SAP and Apache Kafka
Functionality	Existing layout, mini map, time system (shadow analysis), water effects, fault reporting tool, turbine simulation, real-time data connection to SAP and Apache Kafka
Production time	▪ Data acquisition 1 day ▪ Modelling 6 weeks ▪ Application development 10 days
Advantages	▪ Improved troubleshooting and reporting ▪ Improved simulation of scenarios ▪ Shortening of asset management processes through better understanding of the context ▪ Model is used for other use cases (Web-GIS, training)

Case Study breakdown.

GIS and 3D Digital twin connection

With the WebGIS "GeoWeb", created and operated by the company rmDATA from Vienna, an application is available in Austria and Germany for obtaining information from diverse 2D geodata. Designed as a self-service portal, users obtain the desired information via an interactive map.

The goal is to provide a network of employees with a central system for geo-related information and to integrate all relevant data directly or indirectly into it.

The distinctive aspect of this project is that direct access and interaction with a complex 3D digital twin is enabled within the GIS application.

In a first integration step, the existing WebGIS of VERBUND has been extended to include a link to the virtual power plant model Rabenstein.

The WebGIS serves the user as a navigation/entry point to a VR model or to the interaction between the power plant exterior (2D) and the power plant interior (3D).

The user is offered the possibility to "dive" directly into the interior of the power plant via defined entry points and to move around in it.

WebGIS GeoWeb application – GIS & 3D outside view.

WebGIS GeoWeb application – GIS & 3D inside view.

The Verbund 3D-Rocket Player for bathymetry data to visualize water survey data in a real-time 3D environment

Bathymetry is the survey of underwater depth to map ocean, lake, or river floors.

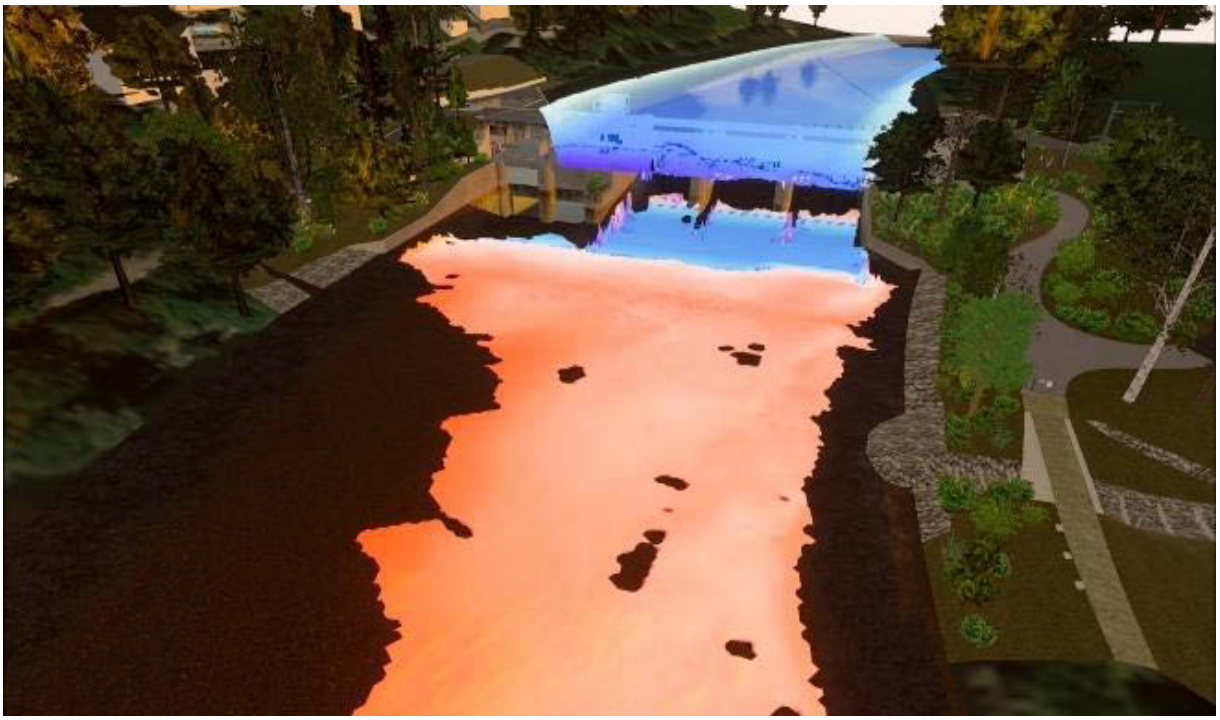
The underlying approach of the project is the linking of the 3D-Rocket Player of LocLab Consulting GmbH with the HIS'3D database of Verbund. The manufacturer of the database as well as the add-on programs is Simutech GmbH.

Simutech provides the software for handling the bathymetry data. The bathymetry data are stored in the form of triangle meshes (3D OBJ data) with textures in the HIS'3D database by Simutech. LocLab focuses on the visualization of the data.

From the database, the triangle meshes provided by Simutech can be loaded into the 3D Rocket Player. The user of the player is then able to view the bathymetry data in real time. The data is automatically inserted into a Digital Terrain Model, with existing Digital Twins of power plants. The user can move freely around the scene and view the 3D riverbed in detail.

Via the loading of triangle meshes, which originate from data collections of different years, geo-metric comparisons over the years can be created. In this way, for example, outwash or accumulations of soil material can be made visible directly in the 3D model. In addition, the user can load existing differencing calculations to historicized data and analyse them.

The basis for the display of the triangle meshes of the bathymetry data is a geographic survey (georeferencing) inside the 3D software.

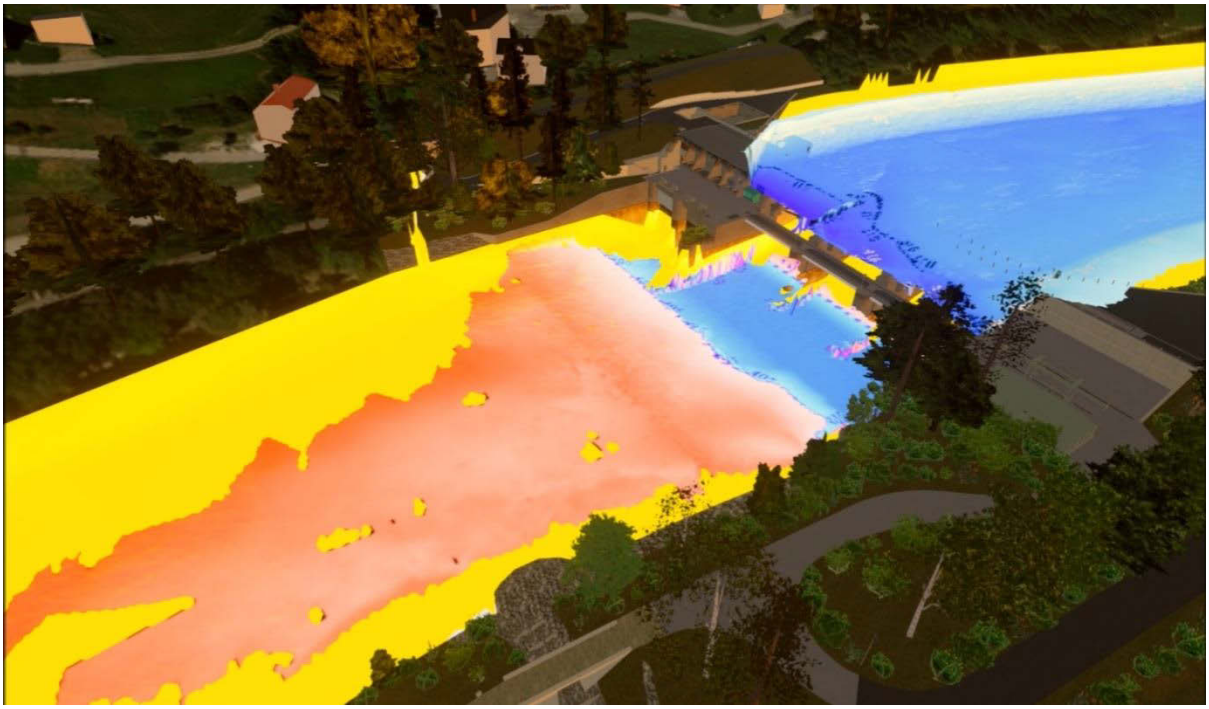


Visualization of 3D Bathymetry data at Powerplant Rabenstein.

The 3D-Rocket Player for Verbund already contains a low level of detail 3D model of Austria, which is displayed when the player is started.

Georeferencing is the basic requirement for loading the triangle meshes of the bathymetry data in a combinable way. The correct location also ensures that the data can be combined with other data sources. As the user approaches with the camera, the coarse LoD of the terrain models in the area being viewed is replaced by a higher resolution one, as can be seen in Google Earth, for example.

In the future, live values measured by sensors on site could also be used to display the water level. The interface of the 3D-Rocket Player to Verbund's Apache Kafka Server already exists. The values are currently displayed in the digital twin of the Rabenstein power plant. However, it is also possible to process the values directly and include them in the visualization. This would mean that the displayed water level corresponds exactly to the currently prevailing water level on site.



Visualization of 3D Bathymetry data at Powerplant Rabenstein.

Find more Information here:

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MJ2 TECHNOLOGIES S.A.S.

MJ2 Technologies S.A.S. is the designer and manufacturer of the Very Low Head turbine called VLH.

Route de Millau
Zone d'activités Millau-Larzac
FR I 12230 La Cavalerie
www.vlh-turbine.com
vlh-turbine@vlh-turbine.com

This revolutionary new concept integrates the most advanced technologies available in the power generating sector such as directly driven variable speed PMG, and frequency converter.

MJ2 is also designer and manufacturer of direct driven low speed Permanent Magnet Generators (PMG) for low head hydro application in replacement of speed increasers and asynchronous generators.

Very Low Head VLH Turbines

The VLH offers an unmatched opportunity to harness existing hydraulic infrastructure, with a reasonable profitability thanks to the savings in civil work infrastructure costs.

It addresses the most demanding environmental integration conditions in terms of noise, vibration, fish migration through the running turbine, or visual impact.

The approach is to have an Integrated Generating Set (IGS) built around a large Kaplan runner directly coupled to the generator, the trash rack and trash rack cleaner all integrated in one block installed in sluice passage of existing dams.

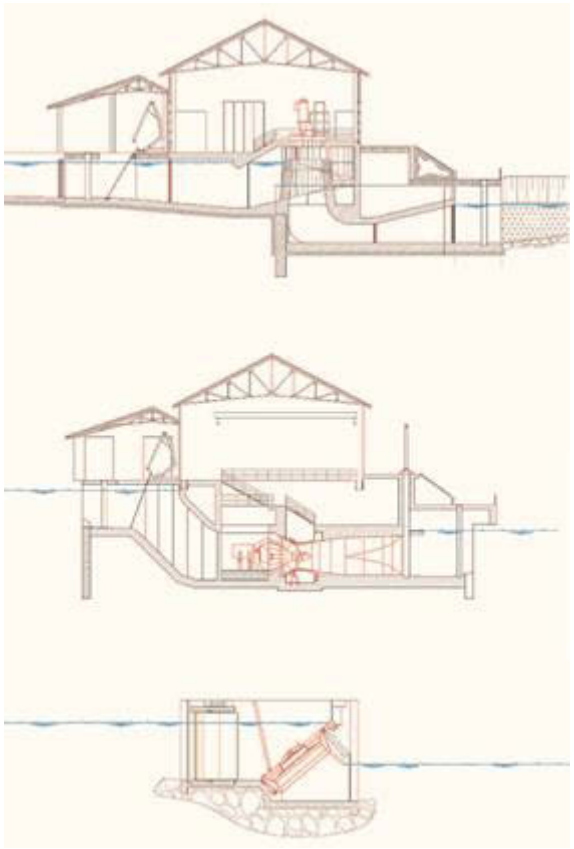
The large runner diameter running slowly, (30 to 50 rpm) the water velocity at both end of the turbine is reduced and the needs for complex civil structures are eliminated.

The VLH is a standardised line of turbines including five different size of runners. It addresses the following range of heads and flow:

- Heads: from 1.5 m up to 3.4 m in standard design and up to 4,5 m in customised reinforced design
- Flows: from 8.8 up to 35 m^3/s per unit
- Outputs: from 100 kW up to 700 kW per machine at frequency converter terminal box

MJ2 Technologies has installed more than 120 VLH in 7 different countries.

A VLH in lifted maintenance position.



Required Civil Work infrastructure for the same head and Flow with different technologies: Upper figure shows a Vertical Kaplan.

Intermediate Figure Shows an Axial Kaplan in Pit configuration: The lower figure shows a VLH.

MJ2 TECHNOLOGIES S.A.S.

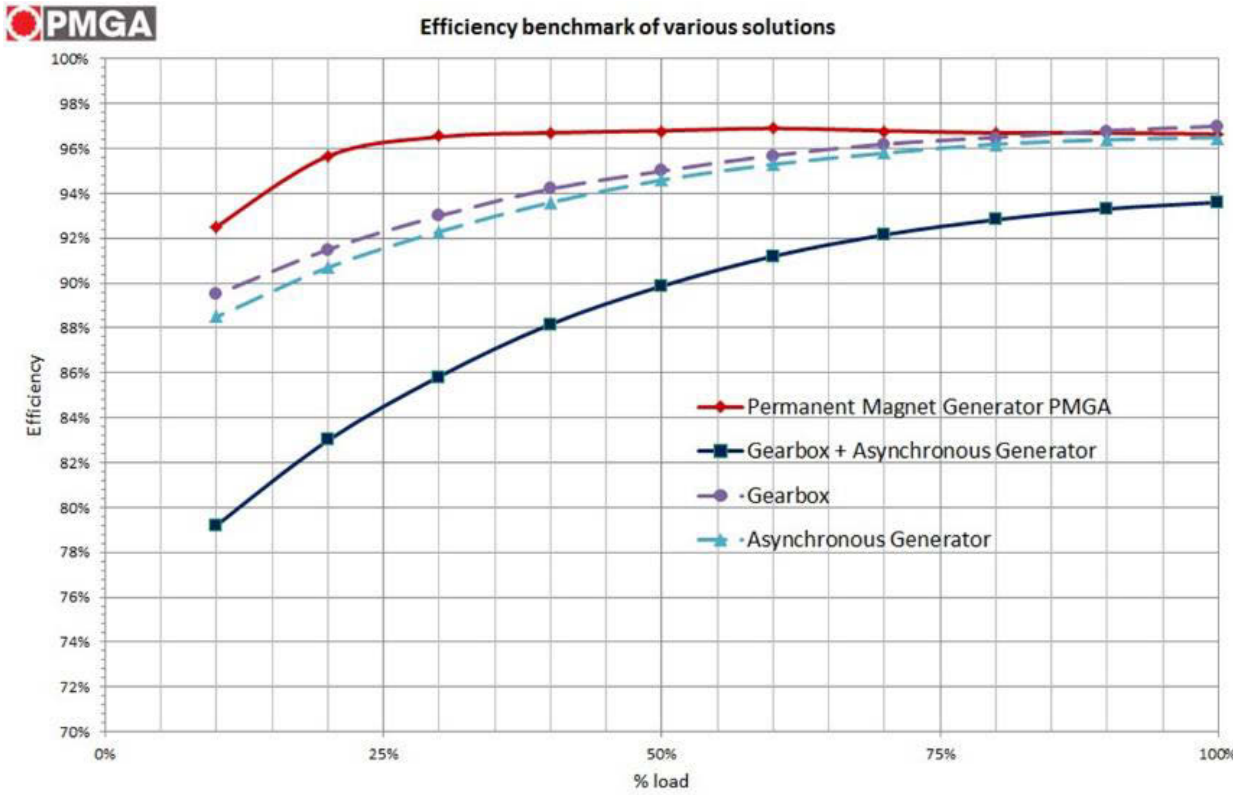
Permanent Magnet Generators (PMG)

- Our goal: provide to the hydropower market low speed & high efficiency generators
- PMG can integrate Thrust bearings, Hollow shaft for Kaplan blade mechanism control
- Output: from 100 kW to 3,000 kW
- Speed: from 60 rpm to 250 rpm

MJ2 has delivered more than 150 PMG in the last 15 years. Each unit is custom designed to the specification of each site.

St. Gery HPP 3 Vertical PMG 650 kW.

Las Rives HPP 3 Horizontal PMG 800 kW.



Efficiency gain compared to a conventional application with speed increasers from 5 to 10%.

MJ2 TECHNOLOGIES S.A.S.

Kaplan Turbines

Kaplan Turbines

A range of modern turbines for very small heads

- Gross heads: from 2 to 6 m
- Nominal Flows: 6 to 55 m^3/s
- Outputs from 200 kW à 2,000 kW
- Verticals, horizontals o inclined Kaplans
- Double regulation or simple regulation
- Hydraulic profiles moderns and customised
- Exclusive use of PMG Generators

Axial Horizontal Kaplan Runner Ø 2,800 mm 2,000 kW.

Vertical Kaplan Runner Ø 3,150 mm.

Wicket Gate mechanism for the same Turbine Runner Ø 2,800 mm 2,000 kW.

Contact

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President

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Prof. Dr. Jaberg und Partner GmbH

We are among the leading experts for fluid technology issues in application-oriented mechanical engineering for turbines, pumps and systems. Based on our extensive modular methodology, we support our customers' success and reliably keep our promises.

Kerscheckstrasse 41
AT I 8074 Vasoldsberg – Graz
www.jabergundpartner.com
info@jabergundpartner.com

FIELDS OF ACTIVITIES

We offer high performance numerical simulation for multidimensional calculations and – as of our tight interlocking with research and educational institutions – extraordinary experimental and metrological competence, especially test rigs in accordance with the IEC/ISO standard and also highly performant and exact measurement technology for plant measurements.

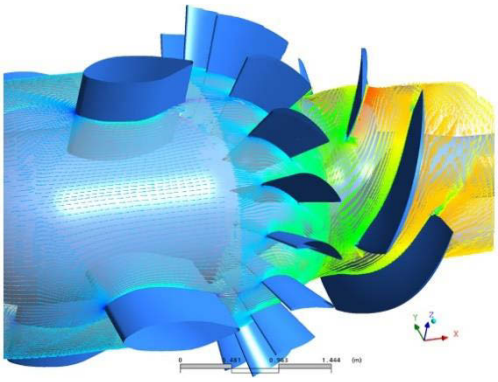
We are independent and work as a team with our partners and customers from industry, research and science. With our expertise, we cover the entire value-added process – from market requirements to implementation.

RESEARCH & ENGINEERING

Numerical Simulation

One of the ways to solve problems regarding fluid mechanics is numerical simulation, which we successfully apply for decades now. Numerical fluid mechanics / CFD often represent a rather cost-efficient and fast method compared to experimental research.

- Analysis, design and optimisation of hydraulic fluid machinery, components and systems
- Water hammer and pressure surge as well as transient conditions of water and gas flows
- Fluid-structure interaction



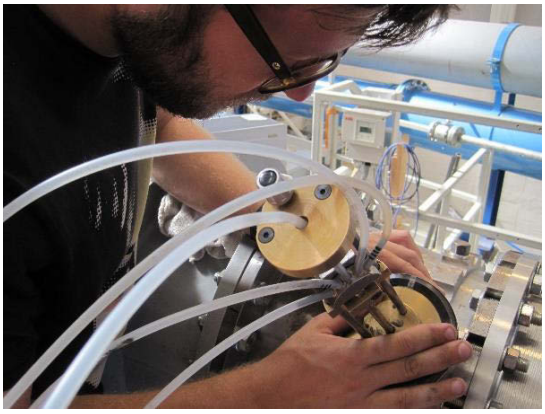
Assessment & Consulting

Our profound know-how, experience and well-established numerical as well as experimental methodology ensures the quality of our work on innovations and independent expertise.

- Feasibility studies
- Modernisation of power plants and systems
- Product development
- Support with regard to Environmental Impact Assessments
- Damage events

Prof. Dr. Jaberg und Partner GmbH

Test Rig



Our modern laboratory - interlocking with research and educational institutions - equipped with numerous state-of-the-art test rigs and reliable measurement technology allows for industry-oriented as well as application-oriented research and development work.

- Acceptance tests and model tests according to IEC 60193, ISO 9906, IEC 60534, IEC 62006
- Plant, operation and life cycle tests
- Endurance test
- Comparison of experimental data with numerical simulation (3D-CFD)

On-Site Measurements

A competent team of engineers provides independent measurements and consulting for the optimisation of industrial plants / power plants according to IEC 60041 and IEC 62006.

- Thermodynamic eff. measurements
- Acoustic flow measurements
- Pressure loss measurements
- Vibration and voltage measurements
- Winter Kennedy

POST GRADUATE TRAINING & TEACHING

In our tailor-made trainings in all fields of hydraulic fluid machinery, we provide user-oriented and profound knowledge. These programmes are founded on our well-established know-how and our expertise.

- 8th Practitioners' Conference
  Hydropower / Turbines / Systems
  September, 2023 | Graz, Austria
  www.wasserkraft-graz.at

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Our Joint Vision

From the materials and components to the digitalized system.

IAEW researches solutions for the energy transition.

Technically. Economically. Regulatorily.

IAEW comprises a team of more than 120 employees including around 90 research associates at the professorial chairs for

- High Voltage Equipment and Technology
- Transmission Grids and Energy Economics
- Active Energy Distribution Grids

Transmission Grids and Power Economics: High Expertise in Energy System Analysis

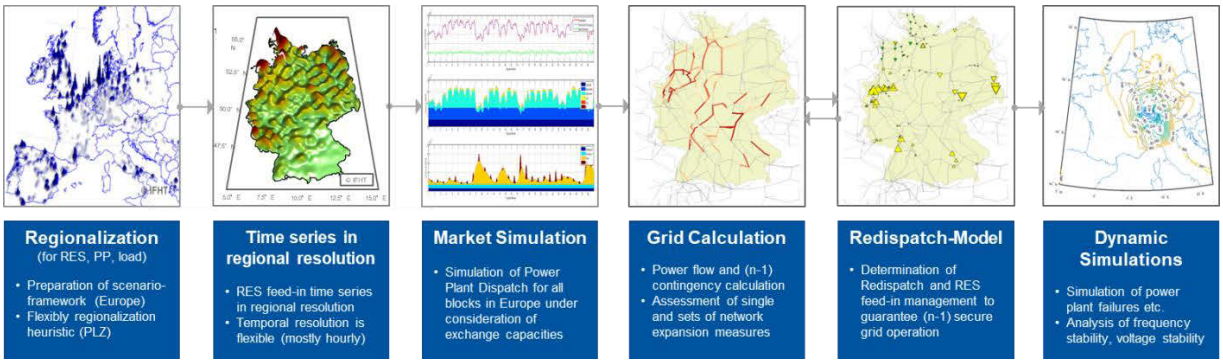
Exemplary research questions:

- Is the operation of a particular hydropower plant economically efficient?
- To what extent can hydropower plants and their ancillary services contribute to the integration of renewable energies by using storage capacities?
- How do individual plants contribute to the stability of the grid and what voltage support can be provided?

Our Solution: IAEW-Toolchain

Modelling environment for the whole process of energy system analysis

- Regionalization / Feed-in of renewable energies
- Energy market simulation
- Stationary and dynamic grid calculations



IAEW-Toolchain for Energy System Analysis.

Related Research Topics

- Operation and planning of future energy systems under consideration of energy sector coupling
- Design and simulation of energy markets
- Investigations of security of supply and system stability

References: Application and validation of IAEW-Toolchain in a broad variety of public projects and in collaboration with industry partners.

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Salzburg AG für Energie, Verkehr und Telekommunikation

Full digitalisation of a power plant with a Digital Twin.

Bayerhamerstraße 16
AT I 5020 Salzburg
www.salzburg-ag.at
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Member of vgbe energy I Hydro Power

Salzburg AG is a local energy and telecommunication provider and utility operator in Austria, with decades of experience in operation and maintenance of hydro power plants.

Ocean Maps offers a wide range of services and solutions, based on state-of-the-art measurement equipment and world's leading 3D software engine.

Ocean Maps as well as Salzburg AG are combining their strength and experiences and are continuously looking for innovative solutions.

With the Digital Twin solution, we offer a complete power plant digitalization, which includes the visualization of the underwater area, the dam, the power plant building as well as the internal machinery and operating data.

Examples of visualization and analyses of sedimentation at a hydro power dam.

The Digital Twin allows for any kind of interaction, in particular free location selection, data integration, data analytics, first-person simulation and much more. With our product we set new standards in terms of appearance and intuitive usability. Whether Windows 10, MacOS, Android or iOS – Ocean Maps supports all common platforms!

Our team has the expertise needed to professionally survey large-scale underwater terrain using Multibeam Sonar, as well as surveying terrains and structures over water using drones and photogrammetry.

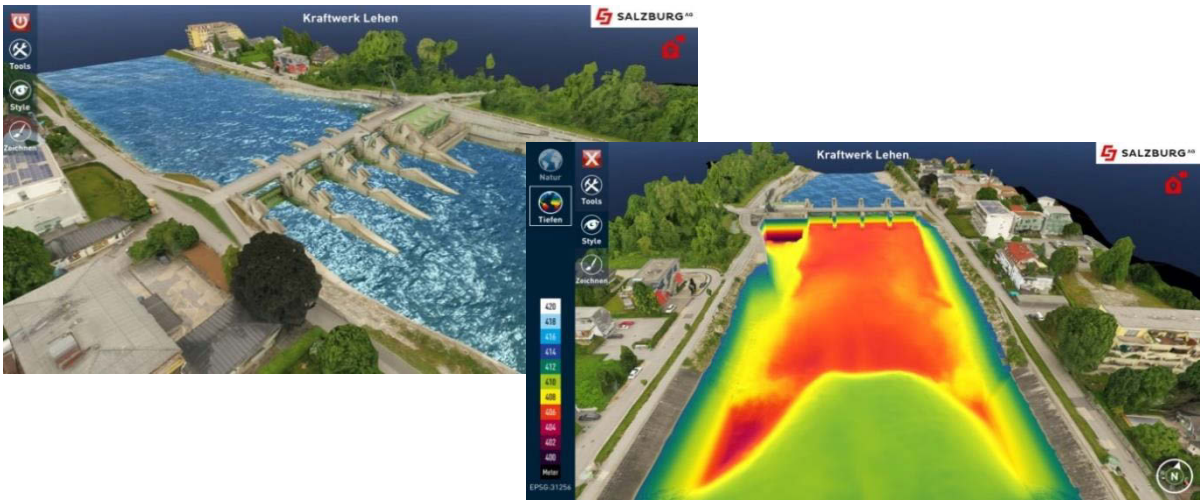
The correct generation, processing, visualization and analyzation of data and results are the key factors for future success in digitalization projects. In a world of increasing complexity, we need to find ways to decrease complexity for our personal by implementing the best fitting tools for each job.

For example, the visualisation in 3D can be a very practicable way to provide land or field survey data or site data in a useful and future orientated way.

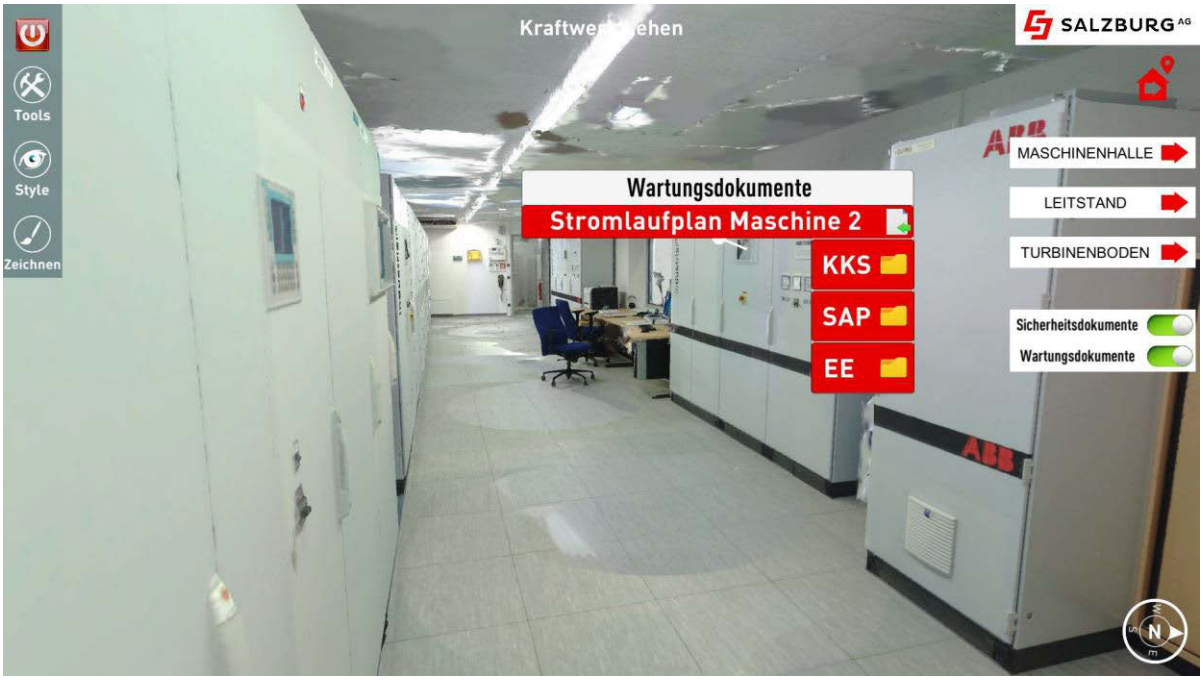
This opens the opportunity to

- analyse data in a better way,
- store data in a new structure which supports human cognition,
- present data and information,
- improving communication with 3rd parties,
- train personal virtual (Knowledge Management, Safety Management, …),
- and so on.

Salzburg AG für Energie, Verkehr und Telekommunikation



Examples for visualization of the river bed situation (HPP Sohlstufe-Lehen, Salzburg AG).



Visualization tool used to find documentation in an easy way.

Salzburg AG is successfully using such tools, provided by OCEAN MAPS, to analyse the underwater situation in river beds for flood prevention or to provide underwater measurement data for maintenance purposes, within interactive 3D applications based on sonar-, laser- and other surveying data.

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SEAMTEC GmbH

SEAMTEC GmbH is an international company based in Upper Austria in the field of cloud automated solutions.

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Österreich
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office@seamtec.at

Master digitization with SEAMTEC

SEAMTEC has set itself the goal of using the energy sources water and biomass efficiently and sustainably in harmony with nature. Since the company was founded in 2009, SEAMTEC has completed projects in more than 15 countries and implemented more than 130 power plants.

The aim of our solutions is to optimize processes, network systems, save resources and increase efficiency. We pursue a holistic approach, think networked and combine the best of the worlds of mechatronics and IT.

Award-winning SEAMTEC cloud

SEAMTEC develops the SEAMTEC cloud, a web application that is used in a wide variety of industries since 2011. 2016 the system was awarded the 1st prize of the Constantinus Awards in the Industry 4.0/IoT category as the best project.

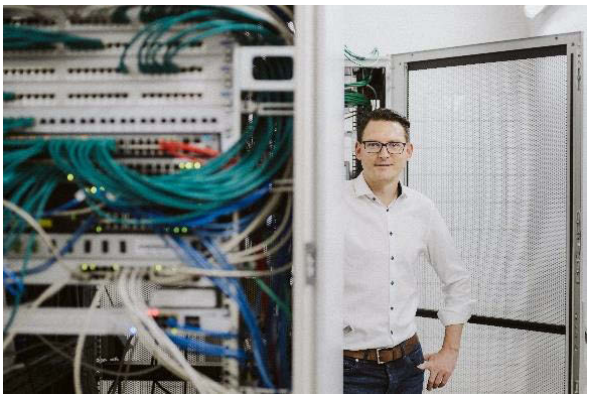
The advantage of this solution is that real-time values can not only be visualized, but systems can also be actively controlled remotely.

The best of two worlds

SEAMTEC GmbH has the necessary know-how and the corresponding expertise in the areas of mechatronics, electrical engineering, automation technology, control technology as well as software and web development inhouse. SEAMTEC not only reads data and displays it online, but also understands the entire platform of its customers.

Advantages of the SEAMTEC cloud:

- State-of-the-art/safest cloud
- Technology in our own data center in Austria (ISO 27001 certified)
- Real browser-based solution without plugins (HTML5, SVG, Javascript)
- Modular structure: quickly adaptable
- No additional software required
- Networking several systems: quick & easy
- User administration with different roles
- Multilingual



Peter Reiter founded SEAMTEC in 2009.

HPP Dagbasi (Turkey): Control for hydropower plant and cloud integration

HPP Vardenik (Armenia): Control for hydropower plant and cloud integration

WKW Pollinger (Styria): Control for hydropower plant and cloud integration

Digital Power plant of the future

The SEAMTEC portfolio includes the following products and services in the field of hydropower:

1) Automation and control technology for hydropower plants

Our service includes:

- Turbine controllers for all types of turbines
- Hydraulic steel engineering control
- Planning and implementation of the entire electrotechnical system
- Plant optimization
- Innovative visualization in the SEAMTEC cloud

2) SEAMTEC cloud - way to the digital power plant

Our specially developed SEAMTEC cloud makes it possible to control these power plants remotely, so that users are always up to date, no matter where they are.

Optimization on all levels

With SEAMTEC you have a strong partner for your requirements in the hydro sector: We implement digitalized documentation for your power plant. In addition, you can visualize data in the cloud and thus summarize the control systems; all relevant data is displayed automatically.

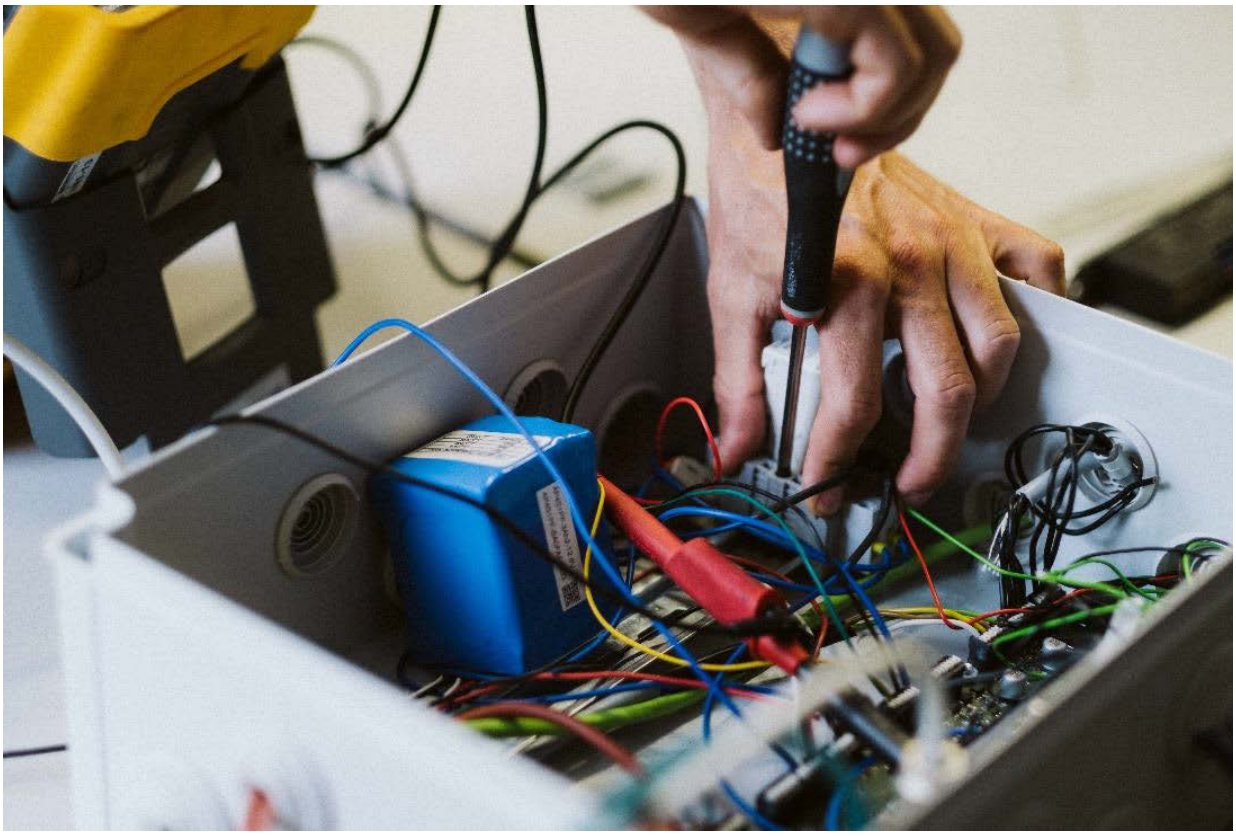
Better predictability and intelligent operational management of the individual systems are just a few of the advantages.

With the SEAMTEC solution, power plant control technology and energy technology merge, allowing you therefore to optimize production. With the SEAMTEC solution your power plant thinks for itself - predictive maintenance is made possible by processing the existing measurement data and corresponding evaluations.

As a complete supplier of electrical and control solutions for hydropower plants, SEAMTEC supplies everything from electrotechnical planning to installation and commissioning that guarantees carefree and optimized operation of hydropower plants. With this, SEAMTEC intends to support and modernize the use of further power plants in Austria in the future and thus optimize and simplify it for operators.

"We are cloud experts, pioneers and solution providers when it comes to automation technology and control processes", says Peter Reiter, who founded the company in 2009. He and his team are always trying to develop the optimal solution for its customers.

The right solution for every customer - that's what Peter Reiter and his team are working on.



SEAMTEC relies on research and development in order to stay up to date with your requirements.

Free digitization check

Do you have questions about our services or are you not sure whether you have come to the right place? We definitely find the right solution together with our customers – just **contact** us!

Contact

Ing. Peter Reiter
Founder & CEO

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E p.reiter@seamtec.at

Software AG

Experts for Operational Flow Prediction and River System Modelling

Tech Gate Vienna, Donau-City-Straße 1
AT I 1220 Wien
www.softwareag.com
daniel.ebner@softwareag.com

Cumulocity IoT

The IoT platform Cumulocity makes it easy to integrate existing and new sensors to monitor or analyze data.

Operational benefits:

- Fastest integration of non-digitized equipment into a comprehensive Industry 4.0 platform
- Graphical components that can be orchestrated into dashboards by the experienced end user

Technical capabilities:

- Ease of device integration with the ability to expand the solution
- Preconfigured device management with the possibility of enhancement
- Set of graphical components that can be re-usable extended by developers
- Self Service, fast and easy integration into your existing IT Landscape

TrendMiner

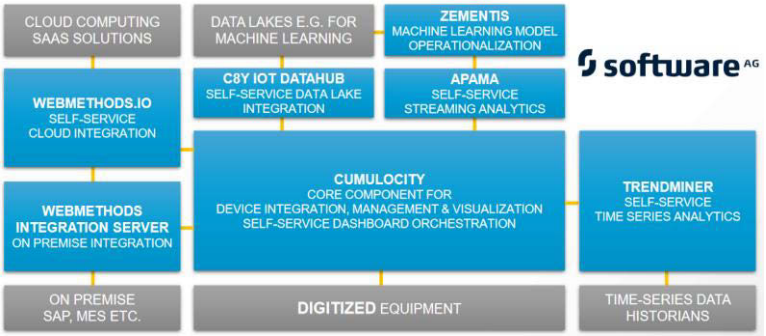
TrendMiner helps to Improve plant availability, production quality and overall asset effectiveness through self-service search, diagnostic, and predictive analytics using pattern recognition and seamless machine learning technology.

Operational benefits:

- Increases the throughput of analysis per time unit and thus the added value of analysis in general
- Ease of use – no need for data scientists
- Can replace or accelerate quality assurance

Technical capabilities:

- Easy deploy on premises or consume from the cloud
- Plug-and-play connections to a wide range of historian systems
- Establish golden batch monitoring



In the graphic you see Software AG´s Industrial IoT platform architecture with a self-service focus to leverage Industry 4.0.

With our solutions you can upgrade your existing plants to Industry 4.0 standard and enable your on-site employees to easily analyse and understand the status of the plant.

We would also be pleased to arrange an individual meeting to assess the potentials in your hydropower plant.

For questions or further information do not hesitate to contact us.

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Technical University of Graz
Institute of Electrical Power Systems

Power-Hardware-In-The-Loop laboratory for variable speed hydro power plants

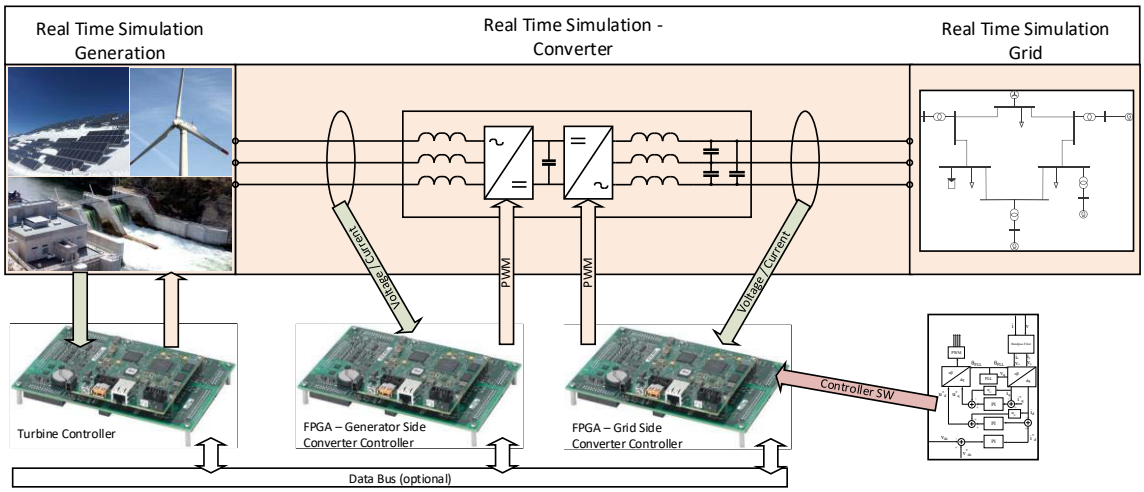
Inffeldgasse 18/1
AT I Graz I 8010
www.iean.tugraz.at
office.iean@tugraz.at

Hardware-in-the-Loop-Laboratory

The PHILlab (Power-Hardware-In-The-Loop Laboratory) at the Institute of Electrical Power Systems offers the possibility to evaluate the converter and its control, which are key components of a variable speed hydro power plant. Based on advanced Power/Controller Hardware in the Loop technology, PHILlab offers an environment that provides an accurate approximation of real-world events for the device under test, where its actual control system can be evaluated and investigated.

Equipment

- Real-time simulator up to 2 MHz
- Programmable FPGA Controller
- 2 × 30 kVA power amplifier



Structure of Controller Hardware in the Loop system.

Evaluation Methods

State of the art methods for evaluation of variable speed hydro power plants are:

- Controller Hardware in the Loop (CHIL)
  - Evaluating actual controller
  - Test special control conditions
- Power Hardware in the Loop (PHIL)
  - Evaluating real equipment behaviour
  - Test grid-critical situations

Applications examples

Test of grid code compliance, test of unit protection, interaction of different controllers, behaviour in case of grid disturbances and unbalances.

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Head of Institute

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Technical University of Graz
Institute of Hydraulic Fluid Machinery

We are one of the leading academic research institutions for hydraulic fluid machinery and systems. Due to our comprehensive expertise on all issues related to hydraulic machinery and plants we are recognised as problem solver.

Kopernikusgasse 24
AT I 8010 Graz
www.hfm.tugraz.at
sekretariat.hfm@tugraz.at

Main focus of the Institute

The Institute of Hydraulic Fluid Machinery engages in basic research, analysis and optimisation of hydraulic systems and complete plants consisting of

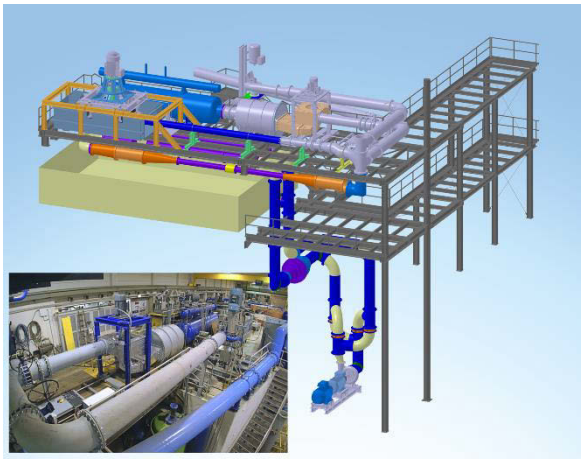
- Hydraulic machinery
- Shut-off devices
- Piping and related components

Research

Our institute is independent and disposes of a laboratory in which we research on fluid mechanical problems. For this purpose, a powerful test bench as well as numerical tools and methods are available.

In addition, the practical suitability of the scientific measurement methods can be tested and proven through plant measurements.

Thus, we provide solutions for industrial and hydro power plants



4-quadrant model test bench

Experimental setup and measurements at the test rig

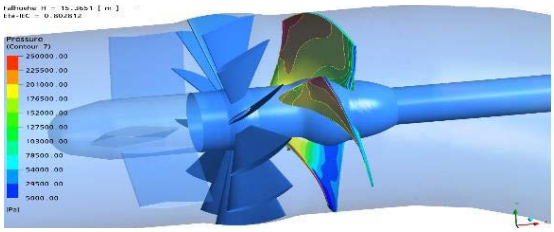
Model tests

Our modern laboratory equipped with state-of-the-art test rigs and reliable measurement technology allows for industry- and application-oriented research.

- Model tests acc. to IEC 60193
- Acceptance tests of centrifugal pumps acc. to ISO 9906
- Valve acceptance tests acc. to IEC 60534
- Long-term tests for mechanical seals and shaft seals
- Comparison of experimental data with numerical simulation results (CFD)

Numerical Simulation

- Analysis, design and optimisation of hydraulic fluid machinery, components and systems
- Transient numerical simulation (1D) of plants with liquid and gaseous fluids
- Fluid structure-interaction



CFD visualisation

Power Plant measurement

On-Site Measurement Technology

Measurements of industrial plants and power plants according to IEC 60041 and IEC 62006.

- Thermodynamic efficiency measurement
- Current meter method and ultrasonic flow measurement
- Dynamic pressure method
- Vibration measurement

Expertise

Our profound know-how, experience and well-established numerical as well as experimental methodology ensure the quality of our work on innovations and independent expertise. Expert opinions and damage analyses, as well as troubleshooting, round off our portfolio. This way, the knowledge developed from research can be applied in a target oriented and practical manner.

- Expert opinions
- Damage analysis
- Plant modernisation and optimisation

Education

In addition to traditional on site teaching at the university we also offer Master degree distance learning courses on waterpower engineering with following main topics:

- Hydraulic machinery
- Pumps and compressors
- Numerical methods and CFD
- Plant hydraulics and calculation
- Hydraulic measurement technology
- Project development and operational management

Praktikerkonferenz Wasserkraft

- **8th Practitioners' Conference**
  Hydropower / Turbines / Systems
  September, 2023 | Graz, Austria

www.wasserkraft-graz.at

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Head of the Institute

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Tractebel Engineering GmbH

We are a global community of imaginative experts engineering a carbon-neutral future.

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info-de@tractebel.engie.com

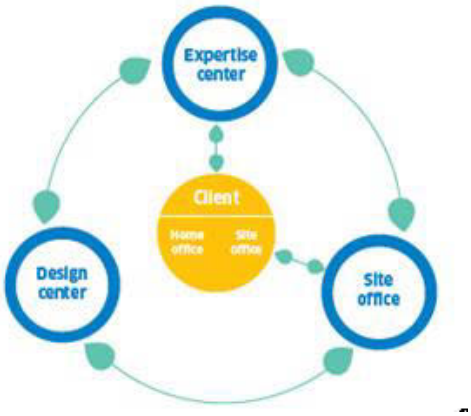
Member of vgbe energy I Hydro Power

Specialised Engineering Services in Dams & Hydropower

Our international project teams for construction design are organised in three categories:

- Expertise centers: responsible for project management, definition of design orientations and provision of customised expertise.
- Design centers: dedicated to the mass production of high quality construction drawings.
- Site design offices: assisting the technical interface and coordination with clients on site.

Dam and hydropower projects are site specific, complex infrastructures with unique challenges. Tractebel provides high level engineering solutions worldwide to public and private organisations for the design, implementation and operation of dams and hydropower infrastructures, respecting project timelines while maintaining the highest quality standards.



Global capabilities enabling cost-advantageous services.

At Tractebel, we anticipate and innovate as we adapt to markets' needs.

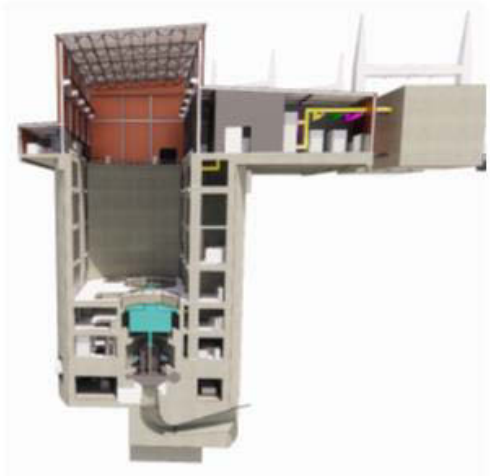
- Our teams work smarter in a connected environment.
- Latest technologies to enable greater project visibility, control and reduced risk.

Design optimisation all the way

We offer end-to-end design optimisation for cost effective outcomes guaranteeing the safety of the facilities.

BIM 3D modelling.

BIM is at the heart of our construction design activities for dams and hydropower plants. It allows a collaborative approach that turns complex projects into collective success.



Virtual design and construction simulation.

Contact

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TÜBİTAK
Marmara Research Center

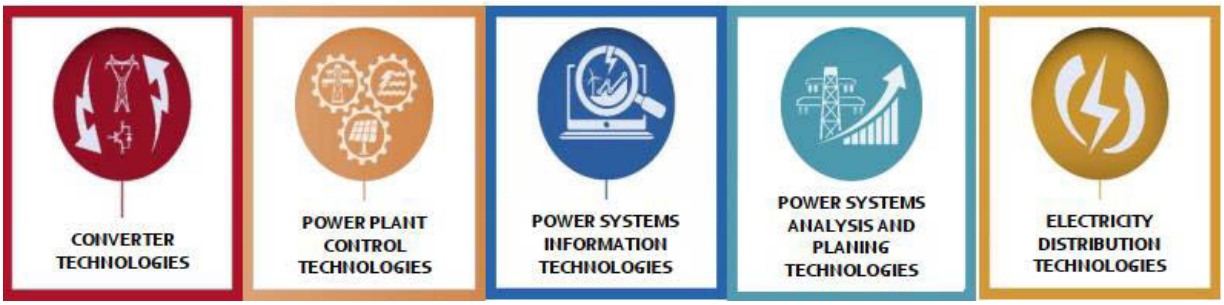
TÜBİTAK MRC is one of the oldest and largest research centers of TÜBİTAK and conducts applied research and development activities.

METU Campus
TR I 06531 Ankara
www.mam.tubitak.gov.tr/en

TUBITAK Marmara Research Centre (MRC)

Energy Institute performs its research and development activities in Gebze and Ankara. The groups in Ankara focus on generation and transmission of electricity: The power plant control technologies group mainly conducts refurbishment projects for hydroelectric power plants. The power system analysis and planning group, coordinated with Turkish TSO, conducts technical analysis on the Turkish transmission network including ENTSO-E regulations.

The power systems information technologies group focuses on forecast of renewable energy resources, operation optimization of hydroelectric power plants, and monitoring of power quality across the transmission network. The converter technologies group performs projects in power electronics domain mainly in the areas of renewable energy power electronics interfaces, flexible alternating current transmission systems and generator excitation systems.



TÜBİTAK Marmara Research Center

Products & Qualifications

- SCADA, Protection and Synchronization System
- Unit Controller
- Switchyard and Joint Controller
- Power Plant Control Level
- Protection and Synchronization System
- Auxiliary AC&DC System
- Cyber Security System
- Speed Governor System
- Excitation System
- Vibration, Cavitation Performance and Efficiency Analysis for Water Turbines

Analysis, design, manufacturing, testing, implementation, commissioning of the refurbishment projects. Approximately 3 Gigawatts design, implementation and commissioning experience of aged hydropower plants in Turkey.

Keban HEPP – 1.4 GW.

Some visuals of recent projects.

First national HEPP turbine and generator design, increasing the power output from 8.8 MW to 9.5 MW.

Contact

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Group Leader

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Umwelt-Pollution Messtechnik GmbH

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www.upm-gmbh.de
verkauf@upm-gmbh.de

Oil alarm device for continuous and reliable monitoring of the water on floating oils, hydrocarbons and other floating materials.

Oil on water surface

Our Oil on water monitors are detecting the presence of a very thin oil-film floating on the surface.

A scanning laser beam system provides enhanced detection even under rough surface conditions, such as the presence of floating debris, bubbles or curved oil surface.

The measuring method is without contacting the water-surface, nor taking samples. A laser beam is scanning the water-surface.

The enhanced optical design allows the detector to be installed at heights of 0.3 up to 10.0 m above the surface of the water.

This extensive range enables you to install the detector in locations where the water level fluctuates greatly or where it is difficult to come close to the surface of the water.

View inside the detector with heated sight glass to prevent condensation

For further information, please be so kind and contact us.

Model ODL-1610A (DKK/TOA Product)

Benefits

- Special version for greater distances above water
- Based on standard model (same laser scanning etc.)
- Enhanced optical design
- Can be mounted up to 10 m above water surface - Can cope with greater water level variations
- Better protection from abnormal conditions such as flooding, high tidal conditions
- Suitable for “difficult” installation conditions

Contact

Friedrich Kümmerer
Position

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Université Catholique de Louvain (UCLouvain) / BERA

The group for the Security and Performance of Networked Systems at UCLouvain works on intrusion and anomaly detection systems to protect Industrial Control Systems and IoT from cyber-attacks.

Place Sainte Barbe 2 bte L5.02.01
BE I 1348 Louvain
www.secperf-uclouvain.bitbucket.io

About the group

Founded in 1425, UCLouvain is the largest French-speaking University in Belgium. UCLouvain currently has more than 28,000 students (including 4000 foreign students from more than 100 different countries), 3,000 teaching and research personnel, and 1,800 technical and administrative personnel. UCLouvain hosts more than 1,000 external research contracts and is the nucleus of an industrial park containing almost 100 companies.

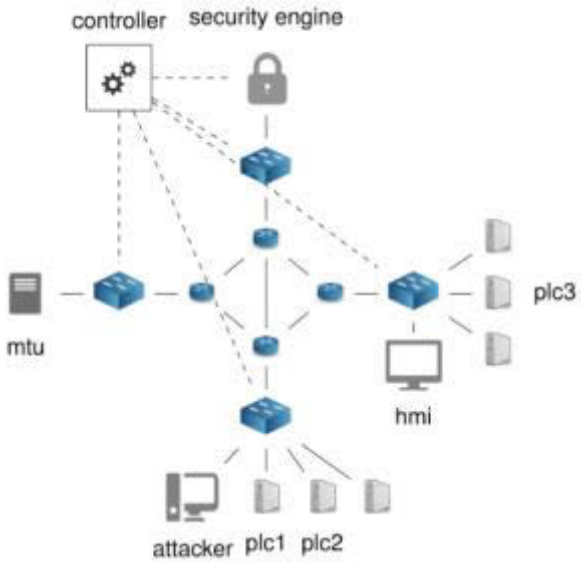
The group for the Security and Performance of Networked Systems is part of the Institute for Information and Communication Technologies, Electronics and Applied Mathematics (ICTEAM) at UCLouvain. The group is led by Ramin Sadre. Our research fields are the security and the modelling and analysis of networked systems, with a focus on Industrial Control Systems (ICS) and on the Internet of Things (IoT).

Our research interests and activities

We work on techniques to monitor and secure networked systems and to detect and mitigate cyber-attacks. Application fields are the Industrial Control Systems and the Internet of Things. We are particularly interested in scalable techniques, such as Software Defined Networking, that allow to distribute the monitoring and detection overhead over the network instead of relying on single hosts. We use Machine Learning methods to build self-learning and adaptive attack/anomaly detection systems.

In the past decade, experts interested in the security of the energy sector have mostly focused on the protection of the electricity distribution grid against cyber-attacks. This was a development triggered by new trends, such as the Smart Grid. We believe that similar trends will take place in the Hydropower sector.

We are interested in understanding the specific risks and vulnerabilities present in Hydropower and how new developments, for example the introduction and interconnection of small Hydropower plants, impact the cybersecurity.



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Security and Performance of Networked Systems group

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VERBUND Hydro Power GmbH

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Power for the Future
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information@verbund.com
Member of vgbe energy I Hydro Power

VERBUND Hydro Consulting – Our experience. Your benefit.

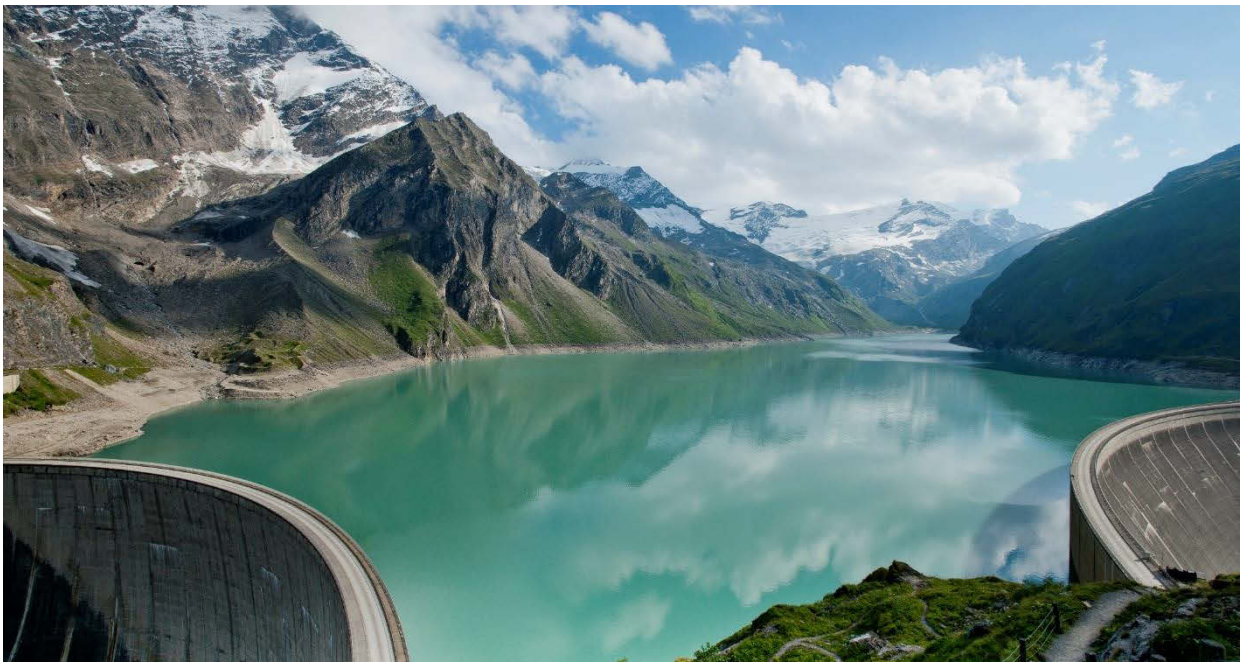
VERBUND is one of the largest producers of hydropower in Europe and a pioneer in innovation, secure operations and cost leadership. This has given us a great insight into the needs and interests of our customers.

As an investor in and operator of hydropower plants, you face many challenges such as creating profitable investments, ensuring sustained operations, complying with strict environmental standards and fulfilling regulatory requirements. With VERBUND, you have a competent partner at your side to offer you the customised solutions you need.

In the field of Hydro Consulting we offer our experience in the planning, construction, operation and maintenance of hydropower plants. Our portfolio includes asset management, asset support, asset services as well as environmental services.

Consulting Services for Global Costumers

- Asset Management
- Asset Support
- Asset Services
- Green Assets



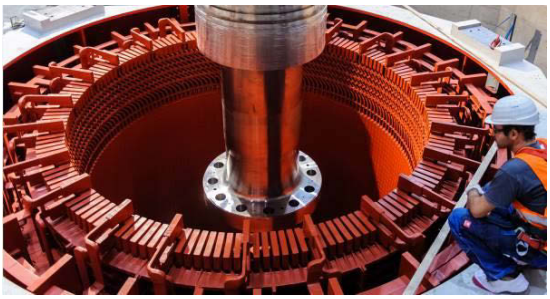
VERBUND Hydro Power GmbH

Asset management: Assessment, optimisation, operation

Hydropower plants should be used in a way, which ensures electricity generation in the most efficient way. For this reason, we develop strategies to optimize power plant portfolios and assist during the technical and organisational implementation process.

Our services

- Assessment of the plant condition
- Development of strategies and implementation concepts to optimise your power plant portfolio considering the market climate, the technical possibilities and economic options
- Development of implementation concepts for operation and maintenance
- Organisational analysis and development as well as human resources development, technical training and continuing education
- Execution of the hydropower plant operations



Generator diagnosis.

Cavern construction site of the project Unterer Tuxbach.

Freudenau hydropower plant on the Danube River (Vienna).

Birecik hydropower plant on the Euphrat River (Turkey).

Asset support: General services

Professional diagnosis and monitoring of all hydropower plant types are necessary to secure cost-optimised maintenance, which is based on the plant conditions. To supplement our routine servicing activities, we have developed an extensive package of services which is used our own plants. These services consist of inspections and objective assessments of conditions as well as planning, selecting and implementing the necessary repair and renovation projects.

Our services

- Electrical engineering: generator diagnosis, protection technology and measurement technology
- Mechanical engineering: materials inspections, calculation and construction of steel hydraulic installations, efficiency measurements
- Civil engineering: dam construction supervision

VERBUND Hydro Power GmbH

Asset services: Project planning and implementation

You plan to build a greenfield plant? You want to renovate or expand your existing plants? We implement and manage your power plant projects. Take advantage of our many years of experience with plants of varying sizes and in the management of the entire plant lifecycle.

Our services

- Preparation of feasibility studies for new construction and expansion projects, efficiency increases, refurbishment and concession renewals
- Energy efficiency evaluations and profitability analyses
- Project management (assisting the asset owner or owner's engineer)
- Support and execution of the approval management process
- Organisation of the design planning and approval process inclusive supervision of all planning, assembly and commissioning activities
- Support in the stakeholder management as well as in the tendering and contract management
- Development of the operational structure and training of the operating personnel

Green assets: Environmental services

The consideration of environmental aspects due to the EU Water Framework Directive is significant when building and operating hydropower plants. Here as well, we want you to benefit from our experience in economic implementation of efficient environmental measures.

Our services

- Development of strategies and concepts for cost-effective implementation of projects that are in legal compliance with the applicable environmental requirements
- Planning and implementation of measures and projects in environmentally sensitive regions in harmony with nature
- Support the implementation of fish bypasses and other structural environmental measures

Fish bypass at the hydropower plant Greifenstein.

Project LIFE+ to restore the estuary stretch of the Traisen River in Lower Austria.

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VGB PowerTech Service GmbH
Oil Laboratory

VGB´s Technical services are an integral part of vgbe energy´s* work and cover all aspects of engineering, operation and maintenance in power plants.

Deilbachtal 173
DE I 45257 Essen
www.vgbe.energy
pts-produktion@vgbe.energy

Member of vgbe energy I Hydro Power

Our Know-how – Your benefit

The technical services comprise:

- Materials Laboratory
- Water Chemistry
- Oil Laboratory
- Engineering Consultancy
- Supervision of Construction and Installation

Companies make use of these services worldwide to achieve sustainably safe, trouble-free and cost-effective operation. We listen to your problems and establish solutions which are notable for their cost-effectiveness and technical expertise.

Oil analysis in vgbe´s oil laboratory.

Oil Laboratory

All services around oil management are carried out in our state-of-the art oil laboratory for analysing lube and insulating oils. The oils investigated range from oils used in hydropower plans, conventional electricity generation and in plants for further renewable energy conversion up to industrial plants of the chemical and steel industry.

*vgbe energy has been the new brand identity of VGB PowerTech since September 2021.

Oil examination leads to safe operation and cost optimisation, i.e. the avoidance of unnecessary oil changes results. Sub-inhibition of lubricants is a particular service of VGB oil management, because the addition of inhibitor according to needs often increases lifetime of oils thus avoiding oil changes.

The oil laboratory is dealing with:

- Independent oil analysis in own laboratory
- Assessment of lube and insulating oils
- Tailor-made solutions to extent lube oil lifetime inhibition with additives
- General consulting in oil issues optimisation of lubricant systems
- Support during oil changes
- Certification of oil suppliers

Oil analysis in VGB´s oil laboratory.

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Voith Hydro Holding GmbH & Co. KG

Voith Group – a global technology company.

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www.voith.com
info@voith.com

Member of vgbe energy I Hydro Power

With its broad portfolio of systems, products, services and digital applications, Voith sets standards in the markets of energy, oil & gas, paper, raw materials and transport & automotive. Founded in 1867, the company today has more than 19,000 employees, sales of € 4.3 billion and locations in over 60 countries worldwide and is thus one of the larger family-owned companies in Europe.

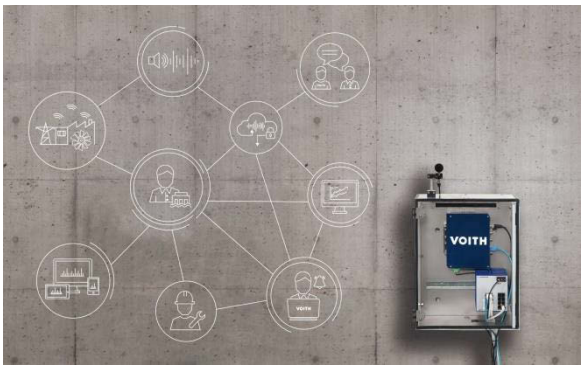
The Group Division Voith Hydro is part of the Voith Group and a leading full-line supplier as well as trusted partner for equipping hydropower plants. Voith develops customized, long-term solutions and services for large and small hydro plants all over the world. Its portfolio of products and services covers the entire life cycle and all major components for large and small hydro plants, from generators, turbines, pumps and automation systems, right through to spare parts, maintenance and training services, and digital solutions for intelligent hydropower.

Intelligent hydropower

The increasing demand for energy and the use of different energy sources worldwide require greater flexibility and more precise data from hydropower providers. Plants are therefore networked with the power supply grid, centrally managed, and software algorithms control many processes on their own. Hydropower is already highly automated; now Voith is making it intelligent.

Intelligent sound analysis for hydropower plants with Voith OnCare.Acoustic

With OnCare.Acoustic Voith supports hydropower plant operators in discovering potentially dangerous incidents by detecting sound anomalies, classifying them into warnings and alarms, and allocating them to specific equipment. This allows information to be derived for smarter recommendations and decisions with regard to maintenance and operations. OnCare.Acoustic is based on Voith's Industrial Internet of Things (IIoT) OnCumulus platform, and can be extended with more functionality by adding OnCumulus.Suite to the package.



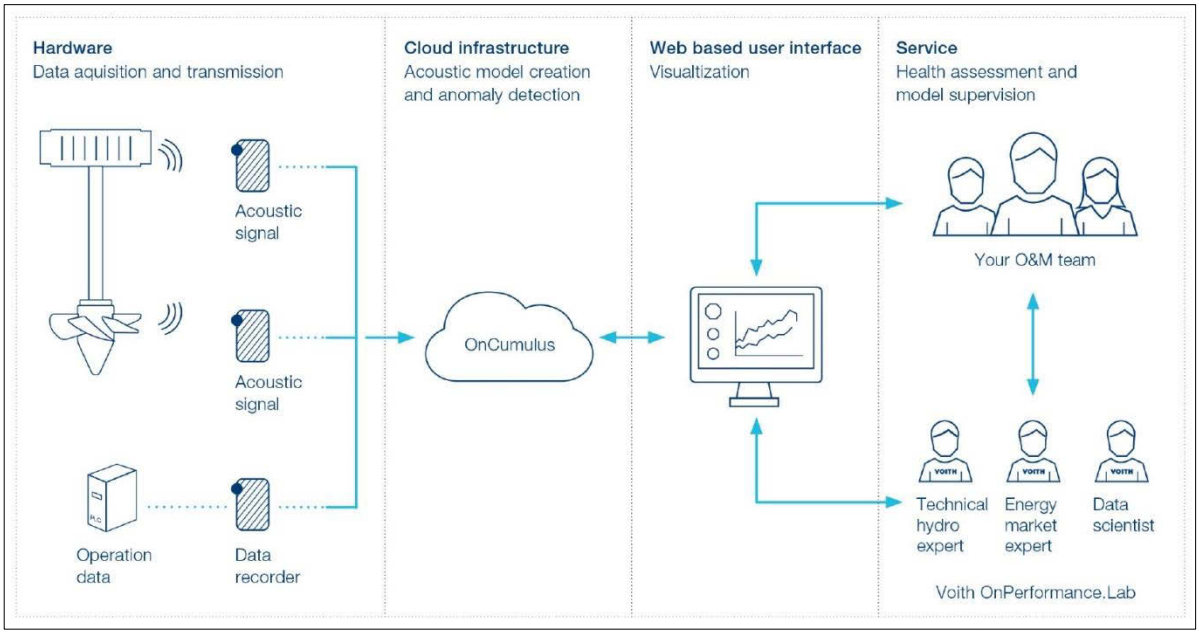
OnCare.Acoustic supports hydropower plant operators in discovering potentially dangerous incidents by detecting aural anomalies.

Benefits

- Alert in case of sound anomalies
- Acoustic sensor provides 24-hour monitoring
- Easy to retrofit in existing power plants
- On average three Sub Systems are covered by one microphone
- Cloud-based application and highest security industry standards
- Machine diagnosis support by Voith engineers
- Already more than ten tera-byte of data analysed

Voith Group

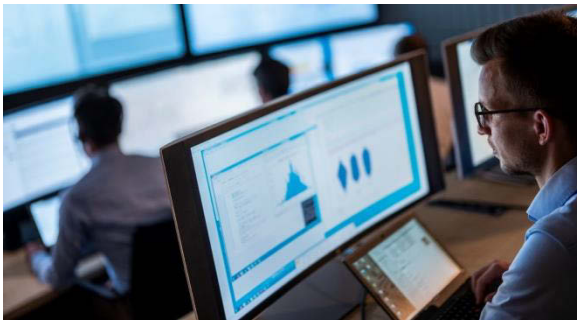
Functional principle



All data is collected on the On.Cumulus cloud, visualized and then evaluated by Voith experts.

OnPerformance.Lab

Voith experts in the OnPerformance.Lab help hydropower operators to reduce maintenance costs and standstill times by remote support and the provision of digital health assessments. Our expert team combines domain know-how with state-of-the-art data analytics to enhance maintenance and operation of your plant.



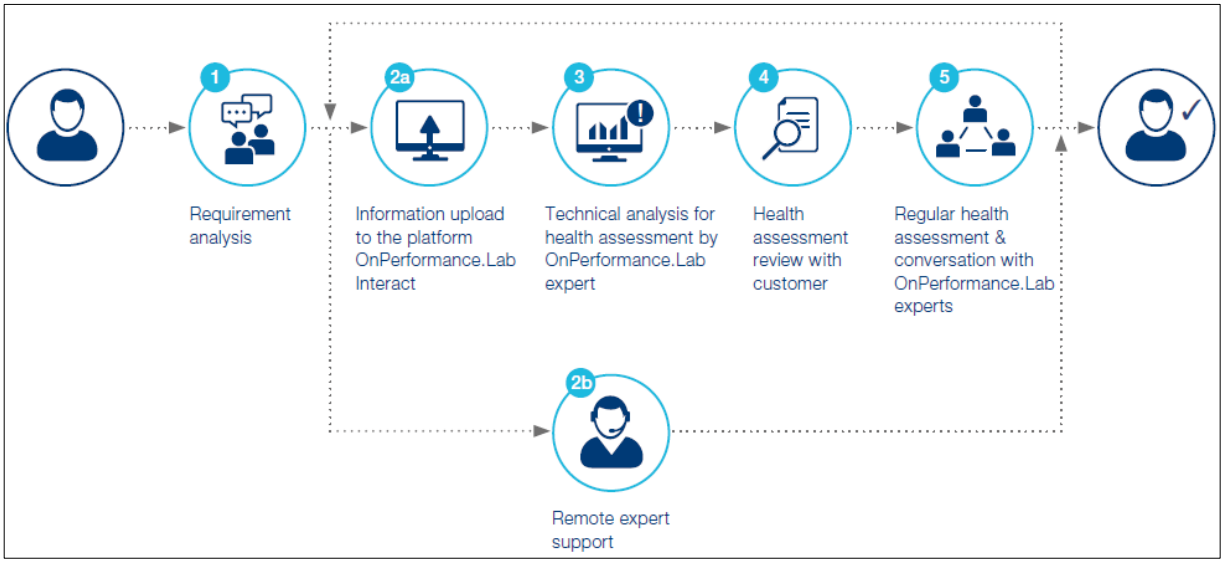
Voith's solution for condition-based maintenance: OnPerformance.Lab.

Benefits

- Early anomaly detection
- More than 25 pending system malfunctions are covered
- Concrete and personalized advice
- Optimized maintenance planning
- Online asset health log
- More than one million euros of lost production revenues avoided

Voith Group

Health assessment and remote expert support procedure



Our expert team combines domain know-how with state-of-the-art data analytics to enhance maintenance and operation of your plant.

Small Hydro

Small hydro power plants are an important component of the energy mix. They have the potential to ensure a stable local power supply. The development of renewable energies can also be boosted with hydropower. Around 64% of the worldwide hydropower resources remain unused – the majority of which would be ideal for small hydropower solutions.

- River-water lubricated bearing design with outstanding lifetime Completely oil- and grease-free operation
- Modular design for sites with high flow (parallel generation of multiple units)
- Civil concepts with flexible integration into existing structures
- Additional options such as variable speed and fail-safe stop mechanisms

StreamDiver – Compact, reliable, environmentally friendly

The StreamDiver provides an industry-wide unique design that allows for simplification of the entire powerhouse design. Lubrication and cooling water systems are not required, and actuation systems for control and start-up are reduced to a minimum. A flexible and modular integration into the civil infrastructure, ease of installation and maintenance allow cost savings throughout the project phase.

Benefits

- Highly efficient propeller turbine (runner regulation as option)
- Direct-driven permanent magnet synchronous generator

Voith has developed an innovative, reliable, and eco-friendly turbine – the StreamDiver.

Voith Group

Voith HydroSchool provides global and individual courses, such as condition assessment, rehabilitation and modernization of turbines or generators, regardless of manufacturer, with a goal of improving on-the-job performance.

HydroSchool

HydroSchool is paving the way for a new, knowledge-based future for customers and partners – with the whole world in its sights. HydroSchool delivers training solutions for all hydropower-related topics, thus, bridging the gap between technology and industry experience.

Voith HydroSchool offers three training types: public courses – open to the general public – which cover topics of all hydropower plant types, dedicated trainings for customers and partners as well as comprising training programs tailored to specific needs.

By accommodating a range of professionals, from engineers to maintenance and repair specialists, technical personnel and members of management, HydroSchool offers customers and partners the opportunity to identify, expand and fully utilize their team's resources.

Contact

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Global Business Partner Voith Hydro

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VSB Technical University of Ostrava

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Department

The university has seven faculties. The Faculty of Electrical Engineering and Computer Science is one of the largest faculties of the VSB - Technical University of Ostrava. Department of Electronics is a part of it which deals with modern technics which is also applied in the field of renewable and sustainable energy.

We have a team of qualified staff for education and science and research activities involving post-graduates.

The department concern knowledge and experience in renewable energy at all or individual parts, where it can be used. We deal mainly with electric parts of the solution to provide better results, new visions and ideas with special impact on the environment, efficiency and sustainability. Our laboratory and equipment provide possibility of practical verification of theoretical assumptions and ideas.

Possible cooperation topics

- Simulation in Matlab (Simulink) and OrCAD
- Microcontrollers, embedded systems, control systems, communication, RT control
- SW development
- Power semiconductor system
- HIL testing
- Measurement and diagnostic
- Electric drives
- Power electronics
- Automotive electronics
- Electrical drives

Small hydro power plant laboratory model.

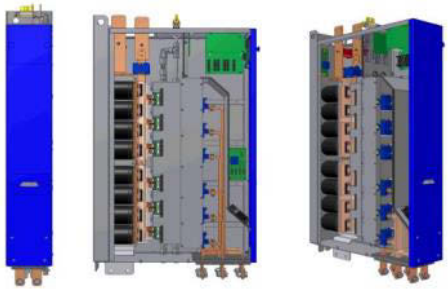
Prototype design of electronics devices, microprocessor control systems and converters.

Control system with DSP TMS320F28335 + data acquisition extension.

VSB Technical University of Ostrava

Research Activities

- Research of power converters for renewable energy sources include energy storage.
- Research of power semiconductor systems with soft switching.
- Research of accumulation systems.
- Research and application of active power filters.
- Hardware-In-the-Loop simulation and testing.
- Development of MATLAB/Simulink models.
- Measuring and Testing of systems.
- Electronic systems for autonomous mobility.
- New control methods for sensorless AC drives using non-linear observers and soft computing methods, sensor fault tolerant control.
- Improving efficiency and reliability of electric devices.
- Development of microcomputer control systems with modern DSP.
- Design, modernization and realization of electrical drives for the industry and renewable energy.
- Development of electronic systems for industry. Electrical Drives, Analog and Microcomputer Control Technique.



Reversible voltage inverter for an accumulation unit.

In the field of hydropower research, we are focused on conversion of hydraulic energy into electrical energy, accumulation process monitoring and control. There are different electric topologies to fulfil grid conditions for varying condition. Interesting task is also increasing energy efficiency under variable operating conditions and increasing reliability in case of sensor failure. Testing and verification of control algorithms.

Further projects

- Technology Agency of the Czech Republic – Centre for Intelligent Drives and Advanced Machines Control (CIDAM), Centre of Competence, 2014-2019
- IT4Innovations Centre of Excellence, Research Programme VP5, (R&D for Innovations Operational Programme), 2011-2014
- ENET – Energy Units for Utilization of Non-Traditional Energy Sources, (R&D for Innovations Operational Programme), 2010-2014
- Ministry of Industry and Trade: External Fixation, 2011-2013
- Škoda Electric a.s.: Research of Algorithms for Regulating Drives with the Asynchronous Motor without the Sensor Speed, 2010
- GA CR - Research of Applications of Artificial Intelligence in the Control of Electrical Drives, 2005-2007
- GA CR - New Structures and Algorithms of Mobile Hybrid Systems, 2008-2010

Cooperation with practice

Department of Electronics cooperates with many important companies and technical universities in the areas of the applied electronics, industrial electronics, automotive electronics, microcomputer control systems, power semiconductor systems and electrical drives.

- Škoda Auto a.s.
- ABB s.r.o
- Siemens s.r.o.
- ELCOM, a.s.
- Škoda Electric, a.s.
- LEM SA (Switzerland)

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VUM Verfahren Umwelt Management GmbH

Visual inspection, documentation and surveying using UAV`s (Unmanned Aerial vehicles)

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AT I 9020 Klagenfurt am Wörthersee
www.vum.co.at
umwelttechnik@vum.co.at

VUM Verfahren Umwelt Management GmbH (VUM) has been dealing with energy infrastructure (feasibility, approval, implementation, maintenance and aftercare) for many years. In particular VUM is increasingly pursuing the goal of incorporating innovation into its activities and deals with the use of remote sensing in the energy industry, particularly in the hydropower sector.

VUM offers a wide range of drone-supported services. The experienced team has the specific expertise for status documentation visual inspections of technical infrastructure and aerial surveying as well as for the collection of environmental data. The information generated supports constructors, operators and maintenance staff of infrastructure in a variety of ways as decision support and forms an important basis for planning and documentation.

VUM also deals with R&D-projects concerning aerial surveying. One focus is for example the development of a method for an extensive snow depth detection to improve snowmelt forecasts in alpine terrain.

Our drone-experience especially in the hydropower sector is:

- **Inspection of technical infrastructure**
  - Condition Monitoring at Power Plants and Power Lines
- **Environmental & Construction Progress Monitoring (surveying)**
  - Digital Elevation Models, Volume and length measurement e.g. of excavation
  - Change Detection of terrain or surface e.g. Snow height measurement in alpine regions to improve forecast models
  - Orthofotos for visual documentation, comparison and surveying
- **Video- & photo- documentation**
  - Image brochures, Illustrations, panoramic views

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Environmental & Project Management

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VUM Verfahren Umwelt Management GmbH

Insulation liquid analysis of high voltage equipment – Monitoring in the 21st Century

Physico-chemical laboratory

VUM Verfahren Umwelt Management (VUM) runs a physico-chemical laboratory specialized in the analysis of oil-immersed high voltage equipment (e.g. transformers). With more than 250 customers and manufacturer all over Europe and more than 25,000 analysed specimen of high voltage equipment, VUM has built a strong and decade-long expertise on this field. VUM is a reliable partner for standard routine-analyses, state-evaluations, oil-regeneration and post-mortem analyses, equipped with all necessary analytical tools according to the newest normative standards, highly-trained personnel and cutting-edge database-assisted evaluation technology.

The analysis tool helps the customer to easily gain an overview about the status of their high voltage assets and compare them to historical data. This helps to formulate precise recommendations for future revision-measures wherever needed.

The analysis tool also opens new possibilities for innovation, as the experts are now able to extract more information out of historical data. Taking analytical data from the database and combining it with environmental data, such as weather, temperature or geographical region can help to identify unknown risks and brings new possibilities and chances to improve existing routine methods and asset monitoring.

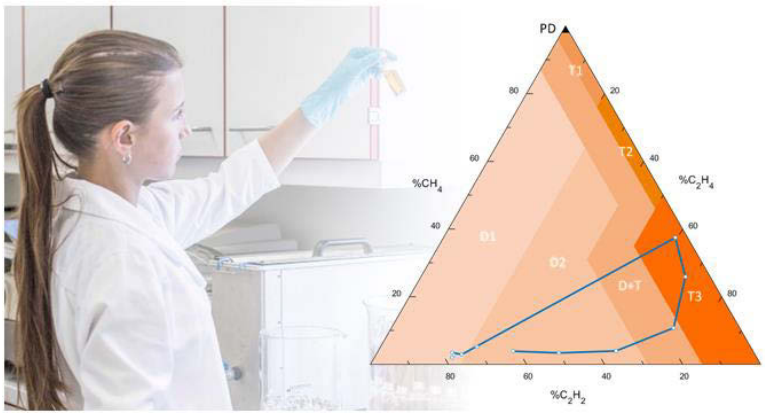

Diagram - An exemplary Duval triangle generated with the data available from historical routine analyses, summarized and evaluated via the innovative VUM analysis tool for insulation liquids. This simplified and quick visualization enables the customer to evaluate the high voltage assets at a glance, indicating the evolution of a thermal fault. In this case, the customer had sufficient time to react upon the possible thread. The efficiency of the repair measures taken is easily visible respectively can be tracked in the analysis tool.

Analysis tool for insulating liquids

The 2018 newly launched innovative insulating liquid database improved customer-service even further. The software-assisted evaluation system combines the expertise of our chemists and engineers with an automated recognition system for electrical and thermal faults, alongside their exact categorization according to standardized criteria. The system utilizes acknowledged international methods and standards to display analytical data, graphical representations (e.g. Duval-triangle) and color-coded indications for the overall state of the analysed assets.

VUM strives to broaden the field of expertise and to face new challenges in the analysis of insulating liquids. VUM is also always open to engage in innovative research-projects and industry-cooperation.

Contact

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Media Partner Profiles

Leading media partners promote comprehensive knowledge exchange on technical, economic, environmental and legal events in the hydropower sector via its various channels.

Content

Energetski portal IN000200

Energy portal is business portal on clean energy with daily news, mainly in the sectors of renewable energy sources and energy efficiency in the Balkan region and Europe.

Energy portal (EP) is a specialized news portal, in Serbian and English, on sustainable energetics. We offer daily updates and information necessary for investors and other parties in renewable energy sources (RES), improvement of energy efficiency in industry, transportation and buildings (EE) in Serbia and the Western Balkans, as well as for broader audience interested in "clean" energy, energy efficiency improvement and sustainable development.

EP has also a role of a mediator for implementation of sustainable projects and cost-effective "green" investments.

The portal serves as up-to-date guide through regulations, procedures, materials, design, technologies, research, sources of funding.

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energate

energate stands for up-to-date and independent information on energy topics as well as for tailor-made content for B2B communication.

energate is the leading B2B media brand in the energy market. Since the liberalization of the energy market about 20 years ago, the information and communication services have provided customers with a decisive know-how advantage. A team of around 15 energy journalists in Essen, Berlin, Brussels and Switzerland researches the relevant events on the German and European energy market every day and prepare them for information services, industry reports and magazines.

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Global Goals Yearbook

17 Goals / 1 Yearbook

The Global Goals Yearbook is a publication in support of the SDGs and the advancement of corporate sustainability globally.

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www.globalgoals-yearbook.org

Dr. Elmer Lenzen
Chair of macondo foundation

T +49 251 200 782 0
E contact@macondo-foundation.org
W www.macondo-foundation.org

About the Goals Yearbook

The Global Goals Yearbook offers proactive and in-depth information on key sustainability issues and promotes unique and comprehensive knowledge-exchange and learning in the spirit of the SDGs and the Ten Principles of the UN Global Compact.

Copies are distributed to UN organizations, many sustainable companies, relevant NGOs, stakeholders, journalists, and analysts as well as to international book fairs and related conferences.

The Global Goals Yearbook helps to advance corporate transparency, promotes the sharing of good business practices, and, perhaps most significantly, gives a strong voice to the regional and global stakeholders that are at the heart of the sustainability agenda.

The Global Goals Yearbook is published under the patronage of the macondo foundation. It is a non-commercial publication and emerges from the renown "Global Compact International Yearbook" (2009-2017).

GoingPublic Magazin

(E-)MAGAZINE – ONLINE – EVENT - NETWORK

GoingPublic Magazine is a modern capital markets publication for securities issuers and investment professionals. It represents the top tier of corporate finance business and is the leading IPO publication in the German-speaking regions of Europe.

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DE I 81379 Munich
www.goingpublic.de

Anna Bertele
publishing director
capital market media

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E info@goingpublic.de

About GoingPublic Magazine

The monthly magazine gives issuers an insight into being public trends and investor relations issues, as well as covering any relevant capital market innovations. Leading law firms contribute their expertise in the form of specialist articles on tax and legal issues, whilst the M&A section charts developments from the spectrum of public takeovers to companies going private.

In addition, the magazine sees itself as being the leading public platform and as a channel for communications between issuers, institutional investors, service providers and the financial community. The crossmedial approach of the platform is completed by

- the GoingPublic Magazine
- the HV Magazine
- the newsletter KapitalmarktUpdate
- the website www.goingpublic.de and
- a series of networking events.

gwf Wasser|Abwasser

The technical-scientific journal gwf Wasser|Abwasser informs experts in all important questions of the water field. Technical updates, latest scientific findings and industry news from politics and business provide a wide range of knowledge for the demanding tasks in the water and wastewater management.

The thematic spectrum ranges from hydrogeology and water treatment to hygiene and microbiology, analytical, metrological and regulatory developments, wastewater treatment and sludge treatment, as well as legal issues and economic concerns.

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Dr.-Ing. Hildegard Lyko
Editor in Chief

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The main part consists of peer-reviewed papers. The practical part consists of interviews, topics and discussion papers, news from the industry, as well as research and development.

About 2,200 copies of gwf Wasser|Abwasser are circulated, mainly in German speaking countries. The journal is read by experts of the water and wastewater treatment sector, construction industry and scientific institutes. gwf Wasser|Abwasser is the official journal of Bundesverband der Energie- und Wasserwirtschaft e.V. (BDEW), Bundesverband der Firmen im Gas- und Wasserfach e.V. (figawa), Österreichische Vereinigung für das Gas- und Wasserfach (ÖVGW), Fachverband der Gas- und Wärmeversorgungsunternehmen, Österreich, Arbeitsgemeinschaft Wasserwerke Bodensee-Rhein (AWBR), Arbeitsgemeinschaft Rhein-Wasserwerke e.V. (ARW), Arbeitsgemeinschaft der Wasserwerke an der Ruhr (AWWR), Arbeitsgemeinschaft Trinkwassertalsperren e.V. (ATT).

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JOBVERDE.de is the green career portal for sustainable employers and their jobs.

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JOBVERDE.de - Germany's career platform for JOBS with a sense of purpose and sustainable employers. We bring together what belongs together: People with the right skills and the right mindset for a sustainable economy and society. As a digital, regional and analogue interface, JOBVERDE creates encounters between candidates who want to give their careers meaning and sustainable employers. A career platform with a course for the future!

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Lorenz Kommunikation

Lorenz Kommunikation is a German business and communication consulting agency. The objective of Lorenz Kommunikation is the strategic consulting and support of companies or institutions. Lorenz Kommunikation is also an organizer of own or customer congresses /conferences/trade fairs in the field of new technologies and renewable energies – also virtual.

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Klaus Lorenz
Managing Director

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Lorenz Kommunikation offers a comprehensive package of measures tailored to the target group in order to support customers in all aspects of press and public relations work or in the implementation of events. In addition to the classic press and public relations work such as press releases, press reports or press meetings, online communication and online events are also an important aspect to reach the specific target group in this case.

Lorenz Kommunikation - range of services:

- Strategy consulting
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- Public Relations
- Event management (analog & online)
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Moritz Schäfer GmbH & Co. KG

Wasserkraft & Energie

International quarterly magazine for renewable and clean energy

4 issues per year, average circulation 1,300 copies, distribution: Germany 88%, abroad 12% with a focus on Austria and, Switzerland and Italy.

It provides detailed editorial contributions on technical issues of environmental friendly energy production as well as expert papers on energetic turbine optimization, dam raising techniques, and automation enhancement. With up-to-date information on technical and economic events, legal comments, and expert literature.

More information:

www.wasserkraft-und-energie.de

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NaturEnergy

The Alternative Energy portal

Since 2013 NaturEnergy give information and news for all alternative industry are open for cooperation with specialists from the field and with companies involved in green energy.

The most important sections of the portal are:

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- Other renewable news

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NaturEnergy with his two versions (Romanian and English) are one of the oldest alternative news portal in Romania.

Editor of NaturEnergy.ro is CYCLON TECH SRL.

Newspaper Energie & Management

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With a circulation of around 5,500 copies and its current reports, features, interviews and analyses, the bi-weekly newspaper Energie & Management has been one of the leading specialist media in Europe since 1994.

Around 20 journalists and correspondents throughout Europe work daily to ensure that Energie & Management, as an independent medium, sets the standard for well-founded and neutral specialist information on the energy industry in Germany. Around 2,000 subscribers rely on the information for better decisions by Energie & Management. The language of the newspaper is german.

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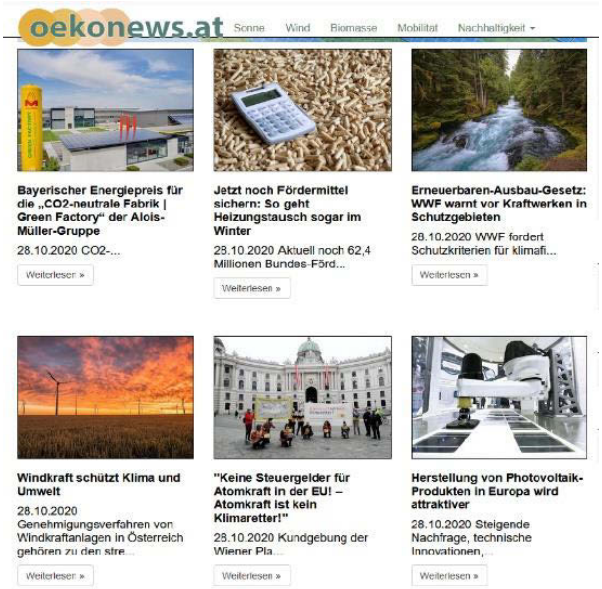
OEKONEWS

Daily news about renewable energy and sustainability



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VGB PowerTech Service GmbH

vgbe energy journal – International Journal for Generation and Storage of Electricity and Heat

The "vgbe energy journal" is among the leading international technical journals for power plant operation and engineering. 11 bilingual German/English issues per year reflect on all important and current topics of power and heat generation with qualified technical papers and latest news on operational, plant safety, environmental compatibility, economic efficiency, research and development and relevant legislation.

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About 3,500 copies of the vgbe energy journal are circulated (increased number for vgbe events and other events of the industry) in 42 countries worldwide. The journal is read by experts, decision makers and opinion leaders of the energy industry. Make advantage of this renowned medium and advertise in vgbe energy journal as well as additional event publications – a unique option to address customers and markets.

Visit us on YUMPU for a free online access. All issues from 1/2 (2019) until now are currently available as a special service in times of the Corona-virus: https://www.yumpu.com/user/vgbpowertech

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zek-Hydro

zek is a leading trade magazine specialising in international hydropower and future technologies with six German and one English edition a year.

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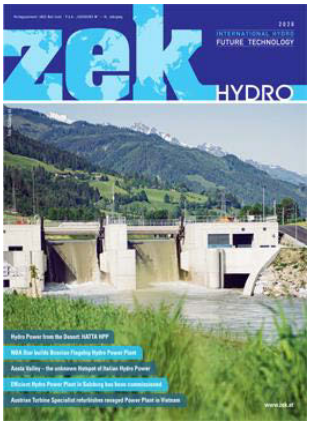


Circulation

zek has a total circulation of 10,000 throughout Austria, Switzerland and the German federal states of Bavaria and Baden-Württemberg.

zek provides full coverage of many major international hydropower events to its broad readership of governmental authorities, industry-specific businesses and power plant operators.

vgbe energy – Range of Services

Get an overview of vgbe´s range of services: Catalogue of hydropower events, vgbe Expert Events 2022, Technical Programmes, Publications, vgbe-Standards in hydropower.

Content

Catalogue of Hydropower Events in Europe 2022

The catalogue of hydropower events jointly published by vgbe energy includes event information about congresses, conferences, symposiums, seminars, workshops and in Europe related to

- engineering,
- construction and commissioning,
- operation and maintenance,
- ecology and fish protection, and
- legal frameworks.

Please note that all event dates are based on the current state of knowledge 12/2021 and are subject to change. For the latest information please visit the event website.

Date 2022	Titel	Location	Event	Organiser	Link
14.01. - 15.01.	ICHPG 2022 – 16. International Conference on Hydroelectric Power Generation	CH – Zurich	CONF	International Research Conference	https://waset.org/hydroelectric-power-generation-conference-in-january-2022-in-zurich
21.01. - 22.01.	ICHT 2022 – 16. International Conference on Hydropower Technologies	UK – London	CONF	International Research Conference	https://waset.org/hydropower-technologies-conference-in-january-2022-in-london
25.01. - 26.01.	Erfurter Gespräche zur Wasserrahmenrichtlinie	DE – Erfurt	SEM	DWA	https://eva.dwa.de/details.php?id=4610&lv=1
08.02. - 10.02.	E-world energy & water	DE – Essen	CONF	conenergy	https://www.e-world-essen.com/de/
16.02. - 17.02.	6th International Congress and Exhibition: Hydropower Caspian and Central Asia	TJ – Duschanbe	CONG	Vostock Capital	https://www.hydropowercongress.com/en/
17.02. - 18.02.	ICRASHP 2021 – 16. International Conference on Recent Advances in Small Hydropower Plants	IT – Rome	CONF	International Research Conference	https://waset.org/recent-advances-in-small-hydropower-plants-conference-in-february-2022-in-rome
17.02. - 18.02.	ICREE 2022 – 16. International Conference on Renewable Energy and Electricity	IT – Rome	CONF	International Research Conference	https://waset.org/renewable-energy-and-electricity-conference-in-february-2022-in-rome

Date 2022	Titel	Location	Event	Organiser	Link
03.03.-04.03.	RENEXPO INTERHYDRO – Conference 2022	AT – Salzburg	CONF	Messe-zentrum Salz-burg GmbH	https://www.renexpo-interhydro.eu/de/
10.03. - 11.03.	45. Dresdner Wasserbau-kolloquium 2022	DE – Dresden	COLL	TU Dresden	https://wasserbaukollo-quium.de/2021/
22.03.	Interalpine Wassertagung	IT – Vahrn	CONF	IBI - Euregio Kompetenz-zentrum	https://www.ibi-kompe-tenz.eu/veranstal-tungen/
26.03. - 27.03	Energiemesse 2022	DE – Osnabrück	TF	Messe Osna-brück	https://www.die-ener-gie-messe.de/cms/front_content.php
25.04. - 27.04.	HYDRO 2022	FR – Strasbourg	CONF	International Journal on Hydropower & Dams	https://www.hydro-power-dams.com/hydro-2022/
26.04. - 28.28.	19. Deutsches Talsperren-symposium	DE – Lindau	CONG	Deutsches Tal-sperren Komi-tee e.V.	https://www.talsperren-symposium.de/
05.05. - 06.05.	ICWS 2022 – 16. International Conference on Water and Soci-ety	IT – Rome	CONF	International Research Conference	https://waset.org/wa-ter-and-society-confer-ence-in-may-2022-in-rome
26.05. - 27.05.	ICHE 2022 – 14. International Conference on Hydroscience & Engineering	TR – Izmir	CONF	IAHR	https://www.iche2022.org/
27.05 - 03.06.	ICOLD 27th Congress – 89th Annual Meeting	FR – Marseille	CONG	ICOLD	https://cigb-icold2022.fr/en/
30.05. - 31.05.	9. Workshop – Forum Fischschutz und Fischabstieg	DE – Dessau	WS	Ecologic Institut	https://forum-fisch-schutz.de/9-workshop
30.05. - 03.06.	IFAT Eurasia 2021	TR – Istanbul	TF	MMI Eurasia Fuarcılık	https://ifat-eura-sia.com/en/
01.06 - 02.06.	**vgbe Expert Event: River Ecology and Environment**	**Online**	**CONF**	**vgbe energy**	**https://events.vgbe.energy/events/eehpp-2022/7274/LKW22/**
13.06. - 14.06.	XII. Mittweidaer Talsperrentag **Messtechnische Über-wachung von Stauanlagen**	DE – Mittweida	CONF	Hochschule Mittweida	https://www.for-schung.hs-mittweida.de/veranstal-tungen/mittweidaer-tal-sperrentage/talsper-rentag-2022/

Date 2022	Titel	Location	Event	Organiser	Link
26.06. - 01.07.	IAHR2022 – 31. Symposium on Hydraulic Machinery and Systems	NO – Trondheim	CONG	Norwegian University of Science and Technology (NTNU)	https://www.ntnu.edu/iahr2022
12.07. - 14.07.	HYDROVISION International 2022	US – Denver, Colorado	CONF	Hydro Review	https://www.hydroreview.com/hydrovision-connect/
28.07. - 29.07.	ICHST 2022 – 16. International Conference on Hydropower Systems and Technologies	AT – Vienna	CONF	International Research Conference	https://waset.org/hydropower-systems-and-technologies-conference-in-july-2022-in-vienna
27.07. - 29.07	GEET-22 – 2. International Conference on Green Energy and Environmental Technology	IT – Rome	CONF	Sciknowledge European Conferences	https://geet-2020.com/
16.08. - 17.08.	ICPSESTEPSH 2022 – 16. International Conference on Power System Energy Storage Technology and Pumped Storage Hydropower	IT – Venice	CONF	International Research Conference	https://waset.org/power-system-energy-storage-technology-and-pumped-storage-hydropower-conference-in-august-2022-in-venice
24.08. - 26.08.	5. International Conference on Renewable Energy and Environment Engineering	FR – Brest	CONF	REEE	http://www.reee.net/
30.08. - 31.08.	ICHTA 2021 – 15. International Conference on Hydropower Technologies and Applications	AU – Sydney	CONF	International Research Conference	https://waset.org/hydroelectric-technologies-and-applications-conference-in-august-2021-in-sydney
07.09. - 09.09.	6. IAHR Europe Congress	GR – Athens	CONG	IAHR	http://www.iahreuropecongress.org/
16.09. - 17.09.	ICHT 2022 – 16. International Conference on Hydropower Technologies	NL – Amsterdam	CONF	International Research Conference	https://waset.org/hydropower-technologies-conference-in-september-2022-in-amsterdam
16.09. - 17.09.	ICHSPP 202 – 16. International Conference on Hydropower Systems and Power Plants	NL – Amsterdam	CONF	International Research Conference	https://waset.org/hydropower-systems-and-power-plants-conference-in-september-2022-in-amsterdam

Date 2022	Titel	Location	Event	Organiser	Link
16.09. - 17.09.	ICHSTA 2022 – 16. Interntional Conference on Hydropower Systems, Technologies and Applications	NL – Amsterdam	CONF	International Research Conference	https://waset.org/hydropower-systems-technologies-and-applications-conference-in-september-2022-in-amsterdam
21.09. - 22.09.	Österreichs Energie Kongress 2022	AT – Vienna	CONG	Österreichs Energie Akademie	https://veranstaltungen.oesterreichsenergie.at/oesterreichs_energie_kongress_2022/?pk_campaign=Domain-Energiekongress&pk_kwd=
21.09. - 23.09.	HydroES 2022	FR – Lyon	CONF	SHF - Société Hydro-technique de France	https://www.shf-hydro.org/en/events/events-archive-themes-from-h-to-r/hydroes-2021/
22.09. - 23.09.	25. Anwenderforum Kleinwasserkraftwerke	AT – Innsbruck	CONF	Conexio-PSE GmbH	http://www.kleinwasserkraft-anwenderforum.de/home/
xx.09.	9. Bayerisches Wasserkraft-Forum	DE –	FOR	Bayerische Gemeinde Zeitung	https://www.bayerisches-wasserkraft-forum.de/
18.10. – 20.10.	AQUA UKRAINE 2022	UA –Kyiv	TF	International Exhibition Centre	https://www.iec-expo.com.ua/en/aq-uaen-2022.html
28.10. - 29.10.	ICRASHP 2022 – 16. International Conference on Recent Advances in Small Hydropower Plants	US – Los Angeles	CONF	International Research Conference	https://waset.org/recent-advances-in-small-hydropower-plants-conference-in-october-2022-in-los-angeles
21.10. - 22.10.	5. Interalpinen Energie- und Umwelttage 2022	IT - Mals	CONF	IBI - Euregio Kompetenzzentrum	https://www.ibi-kompetenz.eu/energieumwelt/
21.10. - 22.10.	ICHTSA 2022 – 16. Interntional Conference on Hydropower Technologies, Systems and Applications	GR – Athens	CONF	International Research Conference	https://waset.org/hydropower-technologies-systems-and-applications-conference-in-october-2022-in-athens
25.10. - 26.10.	ICHTD 2022 – 15. International Conference on Hydropower Technology and Development	ES – Barcelona	CONF	International Research Conference	https://waset.org/hydropower-technology-and-development-conference-in-october-2022-in-barcelona
09.11. - 10.11	5. International Summit and Exhibition Hydropower Balkans	TR– Ankara	CONF	Vostock Capital	https://www.hydropowerbalkans.com/

Date 2022	Titel	Location	Event	Organiser	Link
09.11. - 11.11.	Viennahydro 2022 – 21st International Seminar on Hydropower Plants	AT – Vienna	SEM	TU Wien	https://www.viennahydro.com/
17.11. - 18.11.	vgbe Expert Event: **Digitalisation in Hydropower 2022**	**AT – Vienna**	**CONF**	**vgbe energy**	**https://events.vgbe.energy/events/digihpp-2022/7280/TNYAV/**
23.11. - 24.11.	Hydrometry 2022	FR – Grenoble	CONF	SHF - Société Hydro-technique de France	https://www.shf-hydro.org/en/events/
16.12. - 17.12.	ICHTA 2022 – 16. International Conference on Hydropower Technologies and Applications	ES – Barcelona	CONF	International Research Conference	https://waset.org/hydropower-technologies-and-applications-conference-in-december-2022-in-barcelona

Event Abbreviations	
COLL	Colloquium
CONF	Conference
CONG	Congress
CWG	Closed Working Group
FOR	Forum
SEM	Seminar
SYMP	Symposium
TF	Trade Fair
WG	Working Group
WS	Workshop

vgbe Expert Events in 2022

SAVE the date for the upcoming vgbe Expert Event

River Ecology and Environment
European Regulations | River Management | Hydropower

Environmental protection and preservation of nature are a crucial global challenge for the entire society as well as for the hydropower sector.

Following the successful first event in 2021, the upcoming vgbe Expert Event River Ecology and Environment will take place on June 01/02, 2022 as online-event (both days in the afternoon). Similar to the previous event, a European-wide view will focus on all important ecological and environmental aspects related to hydropower.

Session 1: European R&I on Hydropower

Hydropower, with its mature and proven technology faces various challenges and opportunities alike, such as refurbishment, flexible operation/grid balancing and sustainability. Here R&I strategies require continuous efforts to maintain the European hydropower research and industry value chains. In this session, possibilities and results of R&I on hydropower will be presented.

Session 2: European framework and regulation in Hydropower

Different European frameworks and regulations, such as the Water Framework Directive (WFD, 2000/60 / EC) or the EU Taxonomy, impose requirements to be met by hydropower operators. In this session, experiences with these different frameworks and regulations will be presented.

Session 3: Sediment management strategies and approaches for operating with hydropeaking

Management of sedimentations, which can have negative impacts on the safety of dams and may reduce energy production, storage, discharge capacity and flood attenuation capabilities, as well as hydropeaking, the artificial increase and decrease of water levels in rivers, require appropriate management techniques that improve maintain operations of dams and hydroelectric facilities. Scientists and operators report from approaches of optimal ecological operation.

Session 4: Lessons learned from fish migration and monitoring systems

The development of techniques for fish protection and fish migration is an important prerequisite for maintaining and expanding hydropower. Harm to migrating fish along the various hiking trails must be prevented or reduced and at the same time the continuity down the river must be ensured. Leading operators report on their practical experiences with measures taken so far.

Find more details on our event website:
https://events.vgbe.energy/events

SAVE the date for the upcoming vgbe/VERBUND Expert Event

Digitalisation in Hydropower

Experiences from implemented digital projects

Our upcoming vgbe/VERBUND Expert Event Digitalisation in Hydropower – Experiences from implemented digital projects will take place on 17/18 November 2022 in Vienna/VERBUND, Austria.

Enhanced digital controls can contribute to improving the performance of hydropower fleets, plants and equipment by reducing costs and optimising asset management. Digital control systems can also play a major role in improving decision-making and supporting operations to work more efficiently. The fact that a growing number of the world's hydropower plants needs to be refurbished and modernised in the next few years makes the transformation process so highly challenging.

However, as digital technologies are changing rapidly there are many challenges, which make the application so highly demanding. Networked platform solutions in hydroelectric power plants have to combine previously isolated data and information systems. Data should be available locally and centrally at the push of a button across all areas and enable rapid analyses.

Topics are:

- Asset Management
- Workforce Management
- Advanced Data Analytics
- Platform Solutions
- Digital Twins
- Cyber Security
- 3D Printing
- Inspection & Measurement
- Visualisation (VR, AR, 3D GIS,…)
- Infrastructural Requirements
- …

This international event will again provide a comprehensive overview of digitalisation in hydropower and offers a unique platform for the transfer of knowledge, the exchange of experiences as well as establishing contacts to operators, project developers, investors, energy providers, scientists, research institutes and the industry.

Find more details on our event website:
https://events.vgbe.energy/events

Technical Programmes

vgbe energy with its leading role in understanding good and best practices in hydropower operation and development launches jointly with its members different Technical Pro-grammes. These programmes are part of the comprehensive activities of vgbe energy for the hydropower sector to support daily operation routines, maintenance and plant optimisation as well as techno-economic, environmental and strategic challenges. Therefore, the pro-grammes are open for vgbe members as well as vgbe non-members.

To learn more about the approach, expected types of analyses provided, participation, etc. please follow this Link and download the Technical Programme.

Technical Programme: Workshop series on digital measures in hydropower

Numerous digital measures have already been tested by operators or are already being used successfully. The workshop series brings together experts from leading operators to discuss the challenges and opportunities of digital trans-formation for the operation of hydropower plants. The workshop series will start in 2022 with two individual workshops on the topics:

- Workshop I: Digital workforce management
- Workshop II: Aerial Survey

Using practical examples, you will gain insights into how digital solutions are already being successfully implemented and applied.

Further workshops regarding digitalisation in hydro-power are in preparation.

- Download Programme
- May 2022 – Sep 2022

Technical Programme: Value of Hydropower – A campaign to increase the awareness of the positive impact of hydropower for a sustainable energy future in Europe

The hydropower industry needs to raise awareness of the positive impact of hydropower on a sustainable energy future in Europe to ensure the efficient operation of existing plants as well as the development of new hydropower plants across Europe.

The aim of this programme is to underline the value of hydropower and the indispensability of hydropower for Europe in the context of climate neutrality and security of supply. The hydropower industry in Europe therefore needs a stakeholder-focused tool box consisting of a structured dissemination strategy "Thinking Outside the Bubble", a jointly agreed implementation plan and an image campaign based on existing data and publications.

- Download Programme
- Mar 2022 – Jun 2023

Technical Programme: Implementing the EU Taxonomy in the Energy Industry: Part I – the Climate Delegated Act

The EU Taxonomy Regulation (2020/852) establishes a classification system of environmentally sustainable economic activities. As detailed technical criteria have to be fulfilled and documented, vgbe energy supports the energy industry (utilities, manufacturers, etc.) in assessing their environmentally sustainable activities, applying the Climate Delegated Act of the EU Taxonomy.

Activity-specific workshops will enable participants to exchange and discuss approaches, to share their experience and expectations related to the EU Taxonomy as well as to align ways of fulfilment and documentation.

- Download Programme
- Mar 2022 – Oct 2022

Technical Programme: Occupational Health & Safety in hydropower

To meet the high expectations of latest health and safety standards in hydropower plants, the existing processes in the companies must be continuously reviewed and also adapted to new findings.

In this context, vgbe energy will start a new exchange-oriented platform that will become a driving factor to improve occupational Health & Safety in hydropower. The platform is aimed at operators, manufacturers and suppliers alike and will provide valuable insights in current developments in the industry. As a user-driven platform, it will expand the Health & Safety culture. In this way, experience and know-how can be shared to prevent safety risks and achieve the overarching goal of zero occupational accidents and work-related diseases.

- Download Programme
- Feb 2022 – Dec 2024

Technical Programme: Cost-comparison for run-of-river power plants

Cost-comparison can help operators of power plants (such as hydropower operators) to maintain their competitiveness by not just relying on growth options, but through permanent improvement of their efficiency, which can be achieved primarily through optimisation.

Cost-comparison for run-of-river power plants is based on a proven and unique methodology which assures an objective and best-in-class benchmarking of all O&M cost-components taking into account the vast variety of such plants and their specifications. The objective of this cost-comparison method is solely to establish a comparable basis for O&M cost-performance and is designed to systematically analyse the complex relation of O&M cost-types, cost-drivers and resulting cost-performance. The profitability of individual run-of-river plants is explicitly not taken into account in the analyses.

- Download Programme
- Feb 2022 – Sep 2022

Technical Programme: Operations management comparison for storage and pumped storage power plants

The demands on operations management have changed over the last decade due to new technical achievements and changing market conditions. This new environment poses new challenges for operators in terms of operational management and adaptation of internal processes. A transparent qualitative comparison of different operational management concepts and the flow of relevant processes leads to the identification of improvement potentials.

vgbe energy starts the comparison of storage and pumped storage power plants with a moderated approach on operational management strategies and processes and their results. This approach offers a deep insight into the differences in operation and maintenance of such plants and thus helps to adapt and optimise one's own approaches and strategies.

- Download Programme
- Sep 2021 – Jan 2022

Technical Programme: Digitalisation barometer for hydropower operators

Digital transformation is an ongoing process in many different areas, where established business models and processes are being significantly changed by new concepts, methods and models such as Industry 4.0, machine learning, the Internet of Things and the Internet of Services. Digitalisation will also have an impact on the maintenance and operation of hydropower plants and holds untapped potential for reducing costs and increasing the effectiveness of personnel deployment. With the developed "Digitalisation barometer for hydropower operators", the companies are provided with a tool for their digitalisation self-check, with which they can assess (i) their current status of digitalisation and (ii) their desired target status in digitalisation in three years compared to the industry average. In this way, the companies gain a comprehensive insight into their level of digitisation.

- Download Programme
- Apr 2019 – ongoing

Publications

Our hydropower network produces a range of publications on hydropower's role, new trends and developments in the sector. The following latest publications are also available for download in the publication section of our website.

vgbe-Interpretation Note | EU Taxonomy & Hydropower: Criteria on Climate Change Mitigation and Adaptation

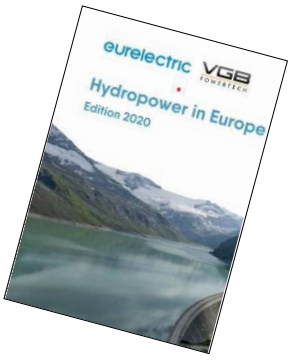
Interpretation Note of vgbe energy | Hydro Power on Hydropower & the EU Taxonomy Climate Delegated Act as a step to provide guidance for the application of the EU Taxonomy for the hydropower sector.

➢ Download Publication

vgbe Position Paper | Position regarding EU Taxonomy Regulation

Position of vgbe energy | Hydro Power regarding EU Taxonomy & Hydropower in the context of the EU Sustainable Finance ambitions and their impact on hydropower generation and storage.

➢ Download Publication



Hydropower in Europe Facts and Figures

Hydropower provides significant amounts of balancing power, enabling the efficient integration of the constantly increasing shares of variable renewables such as wind and solar power. Due to the projected increase in variable renewables, the importance of hydropower will even rise in the future.

➢ Download Publication

Hydropower Fact Sheets

To properly advocate the important role of hydropower, Eurelectric and vgbe energy | Hydro Power have developed a set of fact sheets outlining hydropower's capabilities, challenges, recommendations and key figures in 2018.

➢ Download Publication

vgbe-Standards in hydropower

vgbe-Standards represent the current best practice for the generation and storage of power and heat and are developed in close cooperation with operators and manufacturers.

Areas of application are:

- Engineering and Design (E&D)
- Procurement and Manufacturing (P&M)
- Construction and Commissioning (C&C)
- Operation and Maintenance (O&M)
- Dismantling and Recycling (D&R)

Ordinary members of vgbe energy have access to vgbe-Standards in electronic format (eBook) free of charge. Special conditions are offered to Affiliated and Sponsoring vgbe´s members (hereinafter both referred to as other vgbe members).

Ordering Number	Areas of application	Titel Media are available in the languages according to the country codes in the ordering number.	ISBN Print ISBN eBook
VGB-S-002-02-2014-06-EN	E&D	Hydro Power - Definitions and Indicators	eBook only 978-3-86875-811-5
VGB-S-025-00-2012-11-EN	E&D	Electrical Generating Unit Protection	978-3-86875-410-0 978-3-86875-674-6
VGB-S-175-00-2014-04-EN	E&D O&M	IT-Security for Generating Plants	978-3-86875-744-3 978-3-86875-775-0
VGB-S-034-00-2014-10-EN	O&M	Assessment of fatigue loaded components in hydro power plants	978-3-86875-837-5 978-3-86875-838-2
VGB-S-823-01-2015-09-EN-DE VGB-S-823-31-2014-12-EN-DE	E&D O&M	Reference Designation System for Power Plants (RDS-PP®) - Application Guideline Part 01: Power Plants, General RDS-PP® – Application Guideline, Part 31: Hydro Power Plants	978-3-86875-845-0 978-3-86875-846-7 978-3-86875-388-2 978-3-86875-389-9
...	...	...	....

Furthermore, vgbe energy provides the two designation systems KKS (Power Plant Identification System) and Reference Designation System for Power Plants (RDS-PP®). Both are two essential international known basics for the designation of systems and components of energy plants, especially with regard to digitalisation, cost-efficient planning, construction, operation, maintenance and dismantling.

Sales and distribution

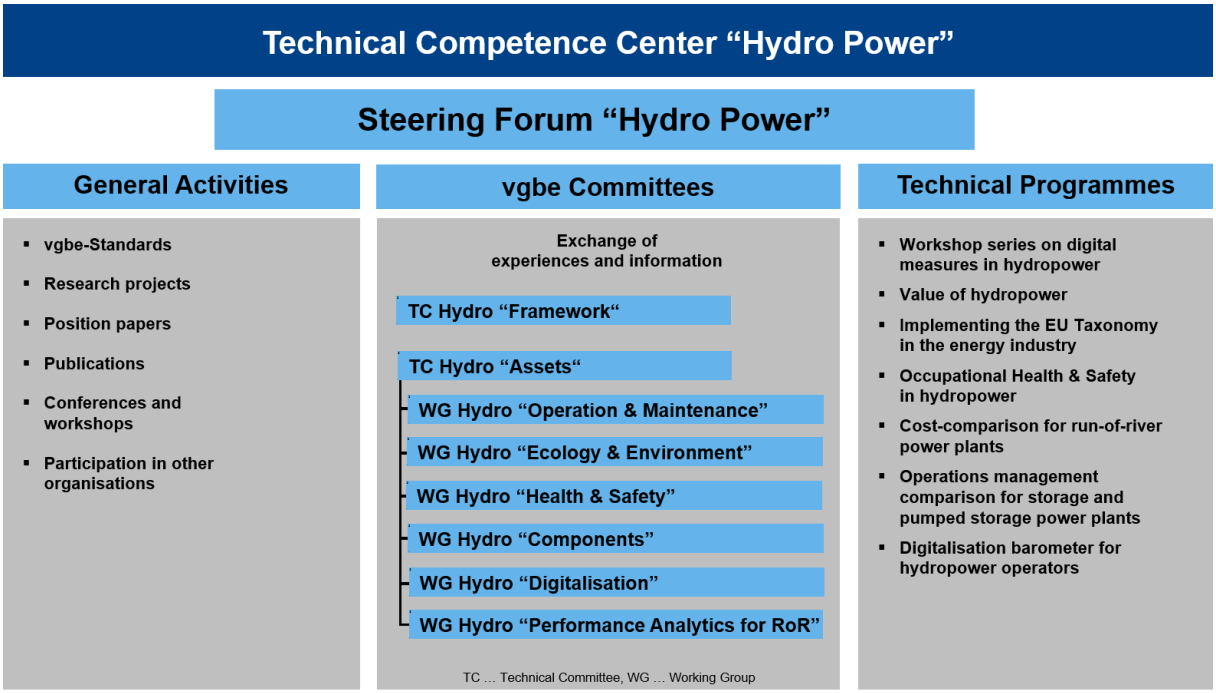
VGB PowerTech Service GmbH Deilbachtal 173 45257 Essen, Germany Germany/Deutschland	Tel. +49 201 8128 271 Fax +49 201 8128 302 Email: sales-media@vgbe.energy Shop: https://www.vgb.org/shop/	Ask for the vgbe-Standard catalogue with all available vgbe-Standards.

About vgbe energy

VGB PowerTech e.V. (vgbe energy) is the European technical association for electricity and heat generation with head office located in Essen (Germany). Currently vgbe energy has 437 members, comprising operators, manufacturers, and institutions connected with energy engineering. The members come from 33 countries and represent an installed power generation capacity of 302,000 MW.

vgbe energy | Hydro Power as part of vgbe energy is the first address for interested parties in techno-economic, ecological and strategic issues concerning hydropower and performs as the collective European platform and key representant for operators, manufacturers and suppliers of the hydropower community.

In this context, our hydropower community has been sharing experiences and knowledge on a high level of expertise since the year 2000. Currently, experts from 29 operating companies, 22 equipment suppliers and 18 consultants are actively participating in vgbe´s Technical Competence Center "Hydro Power" and benefit from our offers as a member of the successful hydropower network.



Individual success through exchange of experience within **vgbe energy | Hydro Power**

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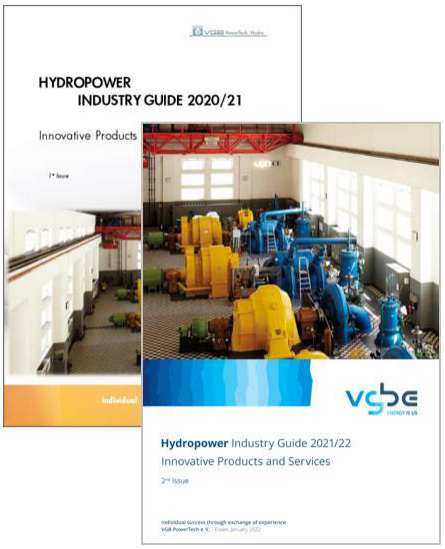
Grab the opportunity to present your innovative products and solutions or provide us with a contribution for the next edition

1. Background

At vgbe energy | Hydro Power, we are constantly striving to expand our services and tools to respond to important questions or issues on old and new topics in the hydropower sector. The hydropower industry has become a successful sector worldwide in recent decades due to its innovative strength, cost efficiency and flexibility. However, technical innovations are crucial to maintain its competitiveness.

2. Publication



The guide will be published annually at the beginning of the following year and distributed annually to the hydropower community in Europe with the help of our media partners and our social media channels. It will be available for free download on the vgbe homepage and offers you a great and easy way to present your new products or services to a wide hydropower audience.

Our first edition "Hydro Power Industry Guide 2020/21" had more than 4,000 downloads from our website.

3. Interested in submitting contribution for the next edition

For the upcoming "Hydropower Industry Guide 2022/23" we offer you once more the opportunity to participate with an article or a company presentation including the presentation of your innovative products and solutions. Participation is free of charge. Please request the template by 18 October 2022 at the latest.

Contact

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vgbe energy has been the new brand identity of VGB PowerTech since September 2021.

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