



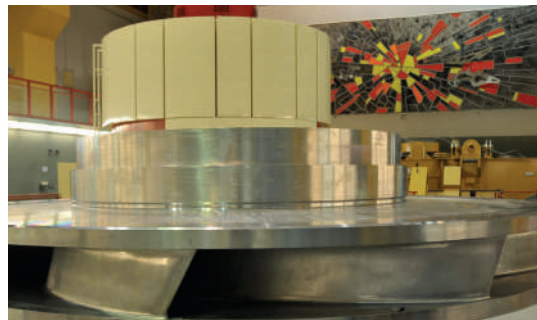
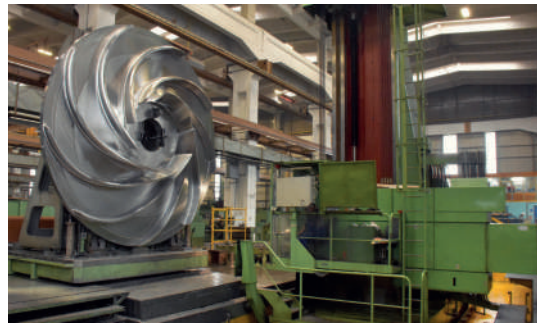
PSHPP Dlouhé Stráně

PSHPP Dlouhé Stráně

PSHPP Dlouhé Stráně is situated on the river Desná in Moravia, in the Czech Republic. The construction of the power station began in May 1978. It was designed as an underground hydropower station with two units set.

From 1996, Litostroj Power carried out minor works, and in the years 2012-2018, the company performed refurbishment of both units.

The new runner increases the annual production by 7 million kWh which equals the annual electricity consumption of approx. 3000 households. In addition to its higher efficiency, the new runner also has a wider operational range and longer service life.



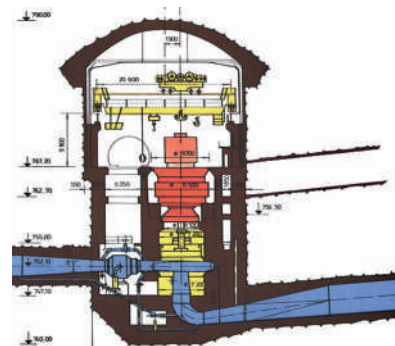
HIGHLIGHTS

The largest pump-turbine in Europe
The highest head among all hydropower stations in the Czech Republic

Turbine type: Reversible Francis
 Projected capacity: 2x 327 MW
 Runner diameter: 4 540 mm
 Rated head: 554 m
 Date of commissioning: 1996

New runner 2012: 328 MW (Turbine mode)
 New runner 2018: 330 MW (Turbine mode)

Project location: Czech Republic
 Type of work: Refurbishment
 Client: ČEZ



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PSHPP Häusling

PSHPP Häusling

PSHPP Häusling is located between upper reservoir Zillergründl and bottom reservoir Stillup. The power plant was built in the years 1974 – 1987, and it was put into operation in 1988. PSHPP Häusling boasts world primacy with its max net head of 728 m which equals two Eiffel Towers.

PSHPP Häusling is a pump storage hydropower plant with two sets of machines, each consisting of turbine, hydraulic converter and two-stage pump arrangement with vertical through shaft with generator/motor.

Litostroj Engineering designed a new runner using CFD computational methods. The compliance with the guarantees was confirmed by model tests which were carried out in its hydraulic laboratory in 2018. Both runners were manufactured by Litostroj Power. Replacement of the runners improved efficiency and output of the turbines.

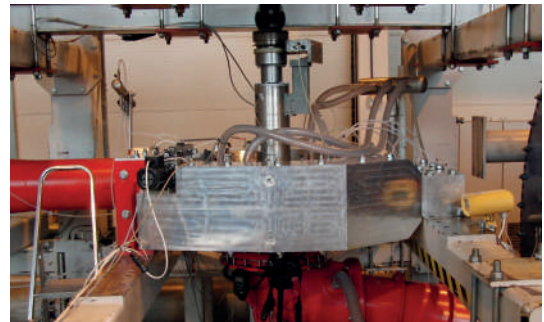
The turbines are capable of operating within the range of net heads from 558 m to 728 m, and output range from 30% to 100% without any limitations.

HIGHLIGHTS

The runner of PSHPP Häusling operates under maximum net head of 728 m, which is the world's highest value for Francis turbine.

Turbine type: Francis
 Max. turbine power: 233 MW
 Runner diameter: 2777 mm
 Max net head: 728 m
 Total turbine power: 466 MW
 Number of units: 2
 Date of commissioning: 2019, 2020

Project location: Austria
 Type of work: Refurbishment
 Client: VERBUND Hydro Power GmbH



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HPP Innertkirchen

HPP Innertkirchen

HPP Innertkirchen 1E is located at the spring of the mighty Aare River in Innertkirchen, Berner Oberland, Switzerland. It is a hydropower plant with one turbine of design output 154 MW, and it is operated by Kraftwerke Oberhasli AG (KWO).

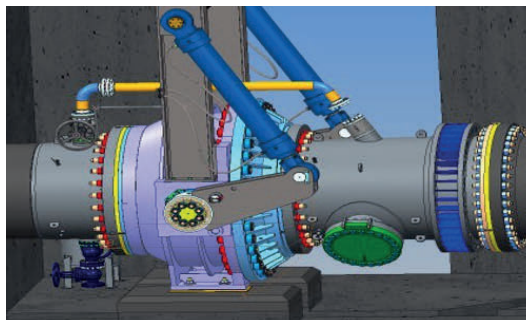
Litostroj Power designed, manufactured, and supplied 1 x new high head turbine inlet spherical valve, supervised its erection, and commissioned it.

HIGHLIGHTS

The spherical valve is distinguished by its high design pressure – 80 bar, and servomotors driven by the water from the penstock in both directions – opening and closing.

Valve inner diameter: 1800 mm
 Design pressure: 80 bar
 Rated discharge: 25.5 m³/s
 Date of commissioning: August 2016

Project location: Innertkirchen, Berner Oberland, Switzerland
 Type of work: New main inlet spherical valve
 Client: Kraftwerke Oberhasli AG



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PSHPP Limberg I

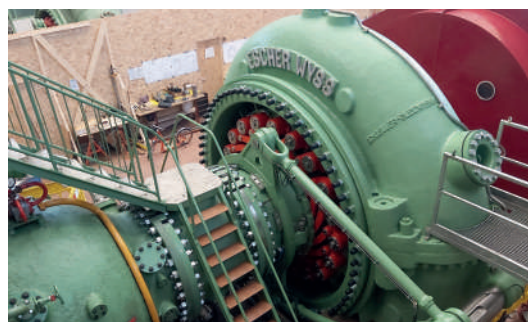
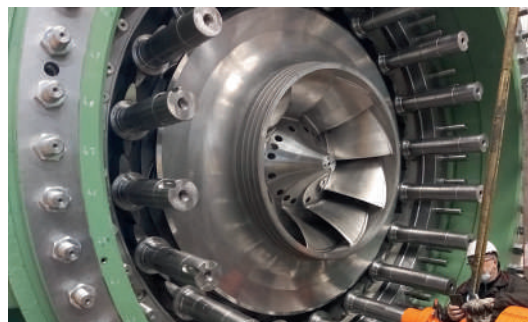
PSHPP Limberg I

PSHPP Limberg I connects the famous high altitude alpine dams Mooserboden and Wasserfallboden located above the city of Kaprun. Original units from 1956 consisted of synchronous generator, Francis turbine and double intake two stage storage pump – all in horizontal arrangement. To meet the demand for more flexibility and higher operational range mainly in pump operation, the original setup was replaced with a cutting edge, one stage reversible turbine with motor-generator and frequency converter which allows operation in variable speed range. Litostroj Power took part in this major refurbishment of both original units as the supplier of turbine mechanical parts. The works included development of new hydraulic profile respecting and utilizing the original structures as much as possible, model test and realization, delivery of all main turbine parts including Francis reversible runner, new stay vane ring for spiral case, draft tube, regulation mechanism and bearings, disassembly and assembly, and commissioning.

HIGHLIGHTS

Our hydraulic engineers developed a new hydraulic profile with a wide operational range. The use of frequency converter enables to keep high efficiency both in pump and turbine mode despite limitations presented by original spiral case of the turbine. Horizontal reversible unit with such power output, operational head and wide operational band is unique worldwide.

Turbine type: Reversible Francis
 Maximum turbine/pump power before refurbishment Pmax: 56/65 MW
 Maximum turbine/pump power after refurbishment Pmax: 80/80 MW
 Runner diameter D1/DIEC: 2338 mm/1300 mm
 Rated gross head: 288 m to 446 m
 Total turbine power: 2 x 80 MW
 Number of units: 2
 Speed: Fully variable 400 - 750 rpm
 Date of commissioning: 2022



Project location: Kaprun – Oberstufe, Austria
 Type of work: Rehabilitation
 Client: VERBUND Hydro Power GmbH

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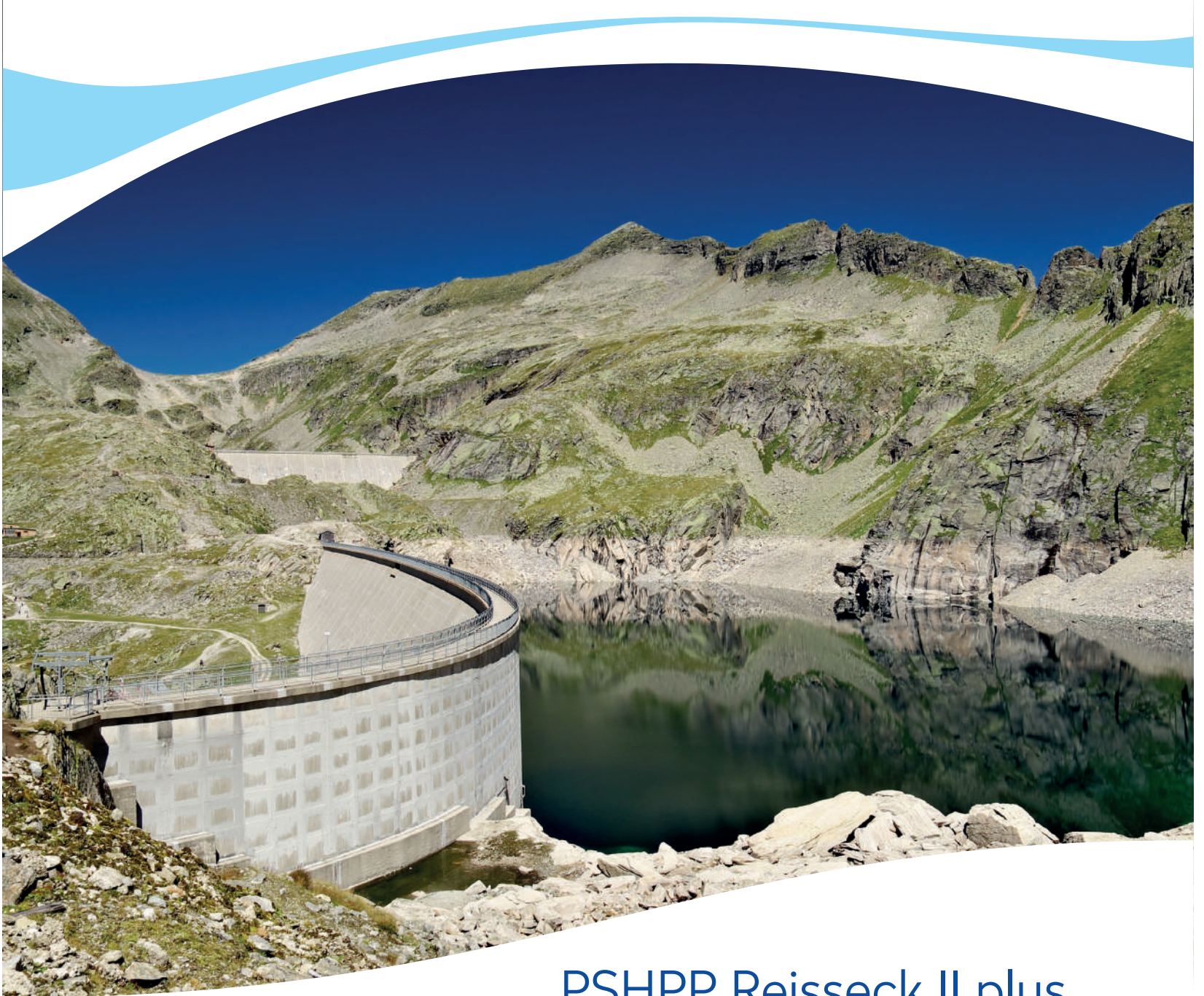
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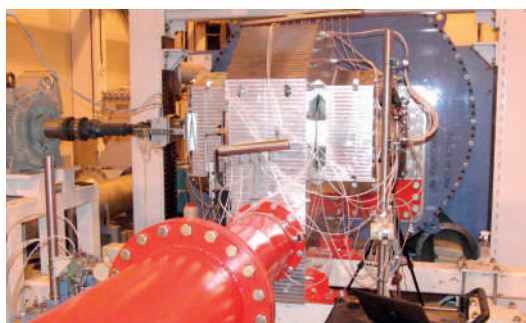
PSHPP Reisseck II plus

PSHPP Reisseck II plus

The pump-storage hydropower plant Reisseck II plus is located between Grosser and Kleiner Mühdorfer See reservoirs in Carinthia in Austria, and it is built as a cavern-facility. Reisseck II plus belongs to the Malta-Reisseck power plants group, the efficiency of which increased significantly with its construction.

Litostroj developed new hydraulic design of 2 double runner variable speed pump-turbines, specifically, model mechanical design, model manufacturing, model testing, model acceptance test, and model test report. Litostroj also carried out the CFD optimization of suction piping.

As the outcome, the simultaneous operation of Reisseck II and Reisseck II plus, combining various modes (pump or turbine), is possible, as well as the individual operation of Reisseck II plus in pump or turbine modes.



HIGHLIGHTS

The hydraulic solution was designed as 1 unit with 1 motor-generator, 2 pump turbines with double runners and frequency converter for speed variation. This compact solution allows to operate only 1 pump-turbine, the wide range of operations in both modes, and the regulation of pump input.



Turbine type: Horizontal double runner variable speed pump-turbine

Projected capacity: 2 x 22.5 MW

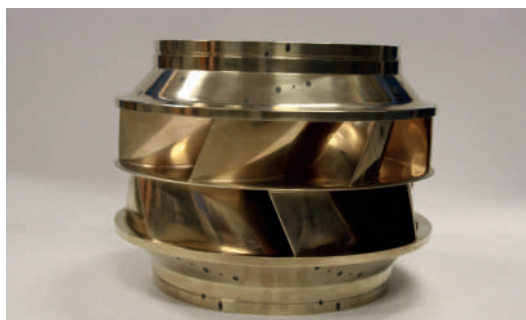
Head range in turbine mode: 35 ÷ 110 m

Head range in pump mode: 45 ÷ 115 m

Discharge range

in pump/turbine mode: 15 ÷ 55 m³/s

Rotational speed (variable): 250 ÷ 550 rpm



Project location: Grosser and Kleiner Mühdorfer See reservoirs, Carinthia, Austria

Type of work: Engineering works including hydraulic development and model testing

Client: Verbund Hydro Power GmbH, Austria

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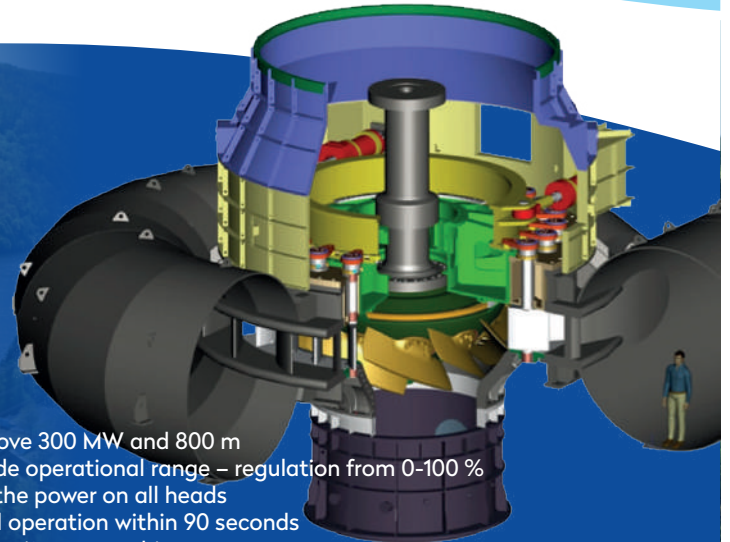
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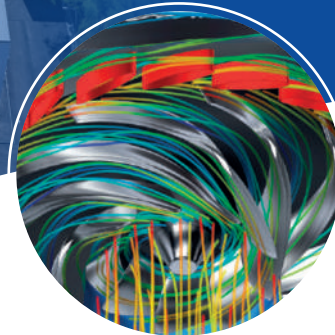
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- Above 300 MW and 800 m
- Wide operational range – regulation from 0-100 % of the power on all heads
- Full operation within 90 seconds
- Francis pump turbines
- Deriaz double regulated pump turbines



Pump Turbines and Storage Pumps

Customized, highly reliable solutions for water applications.

Litostroj, uniting Litostroj Power (Slovenia), Litostroj Engineering (Czechia), Litostroj Hydro (Canada), and Litostroj US (USA), is one of the leading global suppliers for hydropower generation with more than 100 years of history.

Litostroj designs, develops and produces hydro turbines and hydropower plant related equipment, and offers a portfolio of customized solutions for new plants as well as for the installed base that includes wide range of products and services – from the individual equipment to complete water-to-wire turnkey solutions.

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Litostroj's production programme covers a wide range of sizes and parameters of Francis pump turbines. All machines are optimized to meet the required parameters of a new or a renovated machine of the respective hydropower project. We cover everything from hydraulic and mechanical design, auxiliary systems design, manufacturing, installation, controls and governor, to unit start-up and tuning.

New installations

Our specialists ensure the supply and assembly of Francis pump turbines and storage pumps based on our own development and research – runners produced in Litostroj are based on hundreds of years of tradition and experience, the CFD computational hydraulic design and hydraulic shape optimizations.

Moreover, all the designed turbines are tested by means of measurement carried on physical models in Litostroj's hydraulic laboratory located in Blansko, Czech Republic.

Upgrading of existing units

Company's expertise includes designs of new runners, guide vanes and modifications of stay vanes aimed at a higher efficiency, output and operational reliability with minimum investment expenses.

The latest reference, upgrading and optimization of runner at Dlouhé Stráně PSHP, resulted in unrestricted turbine operation between 5 MW and maximum output of 328 MW in all range of heads while maintaining acceptable efficiency level in operating ranges below 40% of unit output. Such unique ability was assured by designing a special hydraulic shape of the runner that eliminates negative influence of vortex and pulsations over the wide operating regime.

Double regulated Deriaz pump turbines

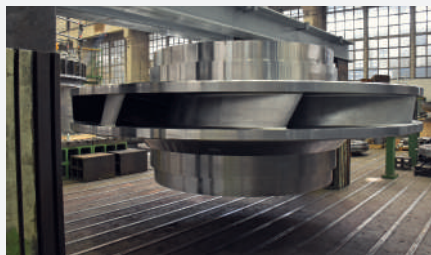
Having experience with Deriaz pump-turbines for more than 40 years our newly designed pump-turbines are suitable for wide head variation of low head pumped storage plants. Double regulation feature enable altering of power consumption in pumping operation without installation of frequency converters. Power range 0-100%. The pump-turbine parameters have been successfully verified with model tests in the hydraulic laboratory in Blansko.

SELECTED REFERENCE LIST

Project	Country	Delivery	PSP Type	Hr (m)	Pr/ unit (kW)
Rosshag	Austria	2022	Ternary	580	65.000
Limberg I	Austria	2022	Reversible	434	80.000
Reisneck2+	Austria	2022	Reversible	110	45.000
Häusling	Austria	2020	Ternary	680	210.000
Dlouhé Stráně	Czech Republic	2019	Reversible	532.9	328.000
Dalešice	Czech Republic	2004	Reversible	89	121.500



Deriaz turbine installation, Liptovská Mara PSHP



Francis reversible turbine, Dlouhé Stráně PSHP

APPLICATION RANGE

Francis pump turbines

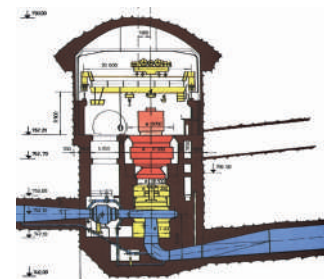
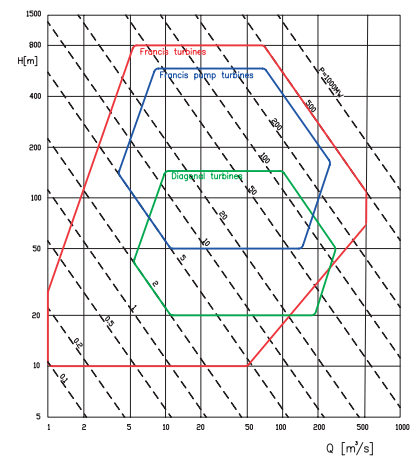
- Heads: from 20 m to 600 m
- Runner/impeller diameter: up to 6000 mm
- Outputs/inputs: from 5 MW to 500 MW

Deriaz pump turbines

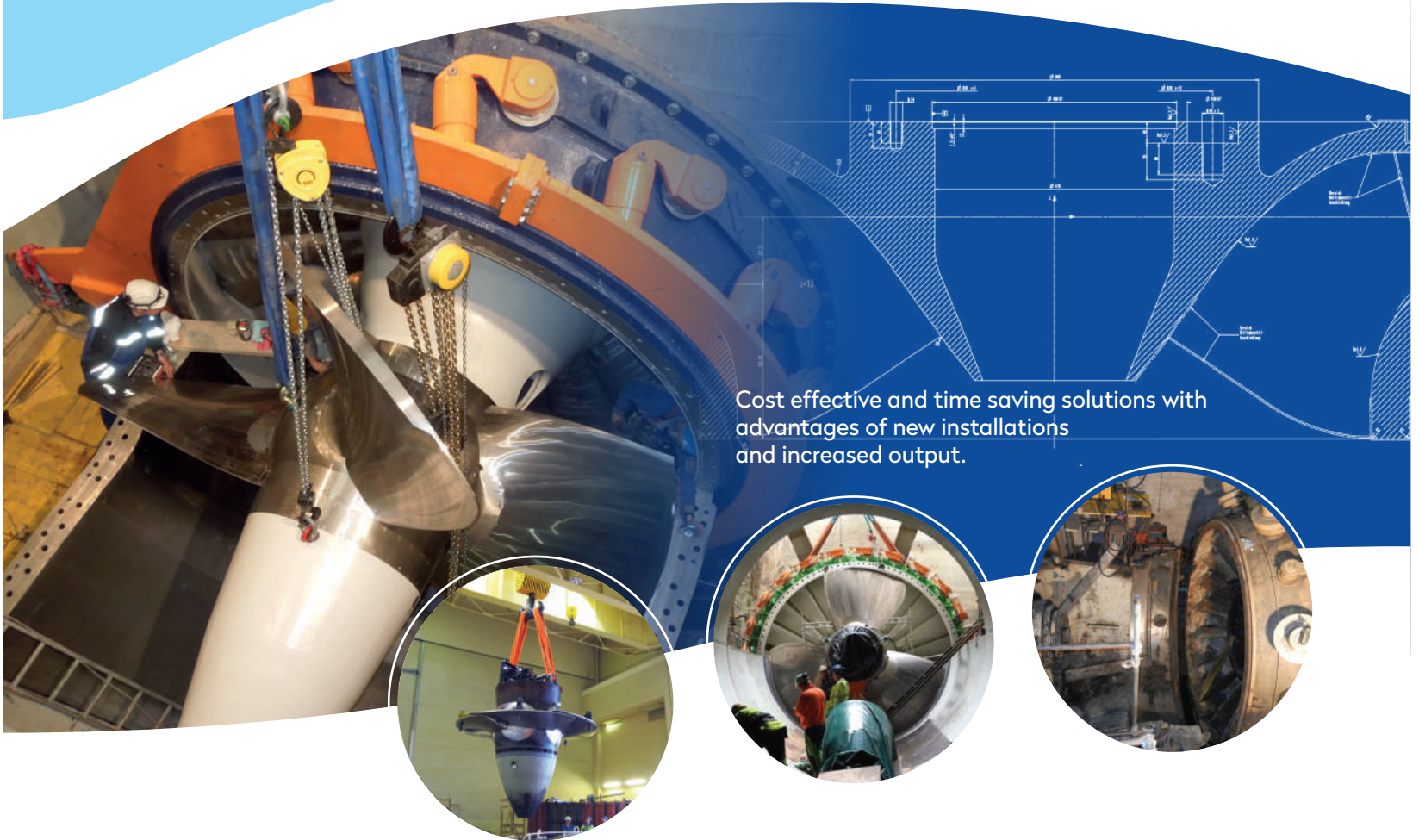
- Heads: 20 m to 85 m
- Runner diameter: up to 7000 mm
- Runner: with up to 10 blades

Storage pumps

- Delivery heads: from 20 m to 800 m
- Inputs: from 10 MW to 150 MW
- Impeller diameter: up to 2500 mm



Dlouhé Stráně PSHP



Cost effective and time saving solutions with advantages of new installations and increased output.

Refurbishment and Upgrading

Customized, highly reliable solutions for water applications.

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Scope of Litostroj's solution can vary from small-scale repairs, replacement of wearing parts, complete sub-assemblies such as shaft seal, main shaft bearings, etc., to the replacement of complete units. RMU projects may consist of refurbishment of turbine and hydromechanical equipment, generator equipment, EBoP, governor and unit control equipment. Litostroj implements RMU projects worldwide. Litostroj offer flexibility of local machining and production for refurbished parts with its established network of competent local partners and delivery of newly machined parts from Litostroj's production facility.

Refurbishment by Litostroj

- TURBINES, PUMPS & PUMP TURBINES
- GENERATORS
- EBoP & CONTROLS

Services offered

Site condition assessment

- Analysis of existing components and preliminary feasibility study
- Pre-commissioning before dismantling

Engineering & Consulting

- Consulting to optimize RMU project
- Hydraulic design and model testing
- Mechanical design, reverse engineering and FEM analysis of existing equipment, mechanical redesign
- Mechanical part lifetime expectancy assessment

- Preparation of units for participation in primary regulation of the grid frequency
- Auxiliary systems redesign

Project execution

- Dismantling of existing unit
- Refurbishment of existing equipment
- Cleaning and sandblasting, NDT examination, DIM measurements, welding repair, machining, corrosion protection
- Manufacturing of new equipment
- Workshop assembly and function tests

Site work and unit startup activities

- Site erection, commissioning
- Education of staff
- Post-guarantee inspections

Advantages

- Improved efficiency
- Higher output
- Eco-friendly solutions (self-lubricating bearings, oil-free Kaplan runners, biodegradable oil, water lubricated shaft bearings, etc.)
- Avoiding existing equipment failure and long shut-down periods
- Increased lifetime expectancy
- Reduced maintenance work
- Fish friendly
- Modern solutions for auxiliary systems
- HPU & governor replacement for sophisticated turbine controls



Francis unit: Before and after RMU Rama HPP, BIH; 100 MW, 2 units



Bulb unit: Dismantling of old unit and erection of new one. Weinzödl HPP, Austria; 8,66 MW, 2 units

SELECTED REFERENCE LIST

Project	Country	Delivery	Machine Type	Hr (m)	Pr/ unit (kW)
Bjurfors Övre	Sweden	2024	Kaplan	13.5	20.000
Lagarfoss	Iceland	2022	Kaplan	15.8	20.200
Limberg I	Austria	2022	Pump-turbine	434	80.000
Kuurna	Finland	2022	Kaplan	7.2	9.910
Spjutmo	Sweden	2021	Kaplan	20.1	33.610
Piva	Montenegro	2021	Francis	162	117.800
Stejaru	Romania	2021	Francis	126.5	54.060
Hull2-U4	Canada	2021	S-	10.7	10.444
Lay	USA	2020	Diagonal	24.7	30.155
Häusling	Austria	2020	Francis	680	210.000
Slapy	Czech Republic	2020	Kaplan	56	53.000
Dlouhé Stráně	Czech Republic	2019	Pump-turbine	532.9	328.000
Tainionkoski	Finland	2019	Kaplan	8	16.750
Lipno	Czech Republic	2017	Francis	162	67.000
Klosterfoss	Norway	2016	Bulb	5	7.130
Dubrovnik	Croatia	2016	Francis	269.7	113.166
Pyhäkoski	Finland	2015	Kaplan	32	49.820
Rama	Bosnia and Herzegovina	2015	Francis	293.6	95.700
Chrami	Georgia	2013	Pelton	370	38.000
Zlatoliče	Slovenia	2013	Kaplan	31.9	79.280
Dubrava	Croatia	2011	Bulb	18.8	43.500
Perućica	Montenegro	2005	Pelton	526	59.100
Dalešice	Czech Republic	2004	Pump-turbine	89	121.500