



HYDRO
**SMALL AND MINI
HYDROPOWER
SOLUTIONS**

ANDRITZ

ENGINEERED SUCCESS



Compact Hydro – more than a small solution

STORTEMELK
South Africa



Global supplier
Compact Hydro
Short delivery Mechanical auxiliaries Quality
Automation Clean Governor
Upgrade **Customer** Ecological Kaplan Service
Worldwide Pre-assembled Economical
Low investment Electrical equipment Low environmental impact
Small Hydropower Efficiency Francis
Pelton Growing market Modernization Single source
Modular design Mini Compact Hydro
Sustainable Optimum solution Generator
Renewable "From water-to-wire"
Limited interfaces
Leader

Promising global market of small and mini-hydropower

Globalization, climate change and significant developments in demographic and social structures present a multitude of opportunities for small and mini-hydropower applications, in particular for decentralized off-grid solutions.

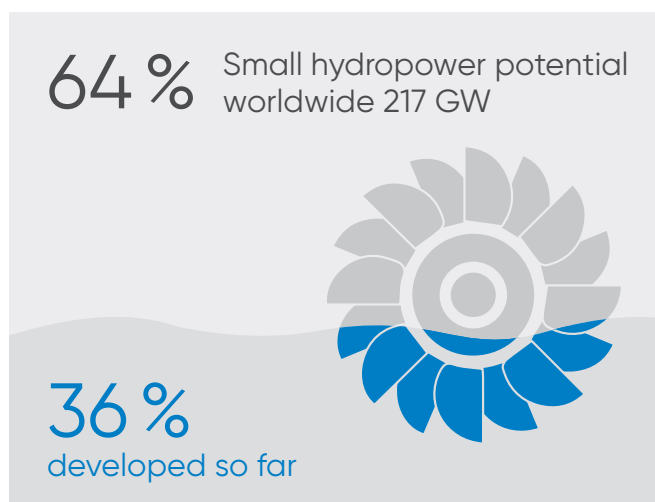
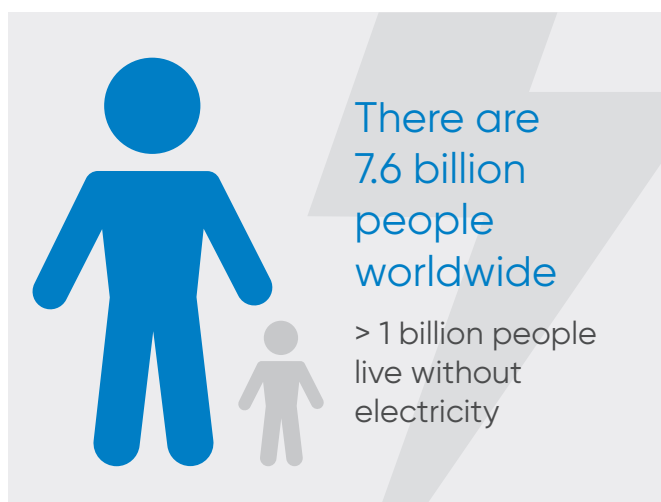
Even today more than one billion people worldwide have no access to electricity. Mostly living in remote rural areas with sparse populations, extending national grids to such regions is often technically difficult, if even possible, and costly. Small diesel generators and solar panels are typically used to provide a minimal supply of electricity, but diesel is expensive and solar panels provide energy only during daylight hours. Implementing decentralized mini-grid solutions or stand-alone systems, providing safe, clean and renewable energy, is therefore an important precondition for rural development. Access to electricity helps to alleviate poverty, improves health care, supports better education and creates jobs.

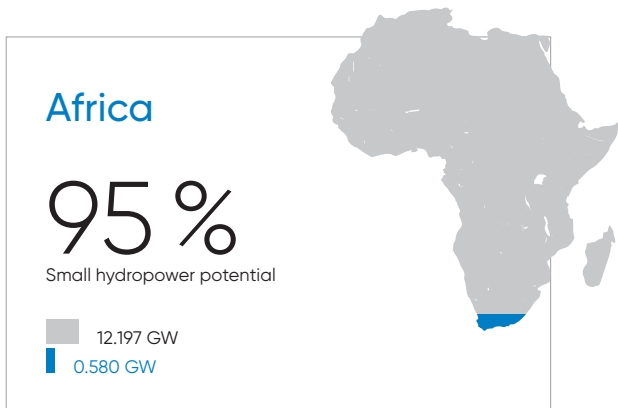
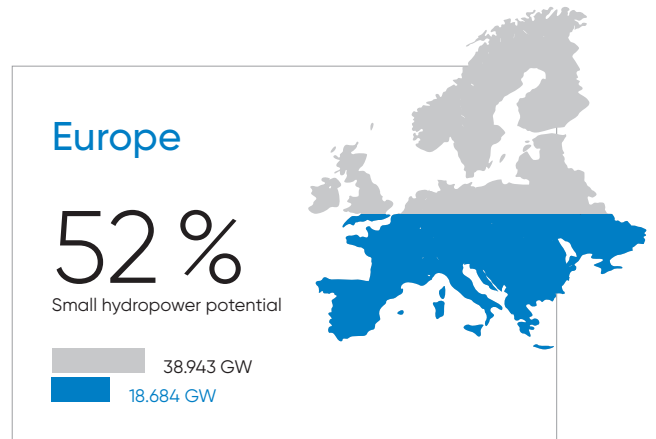
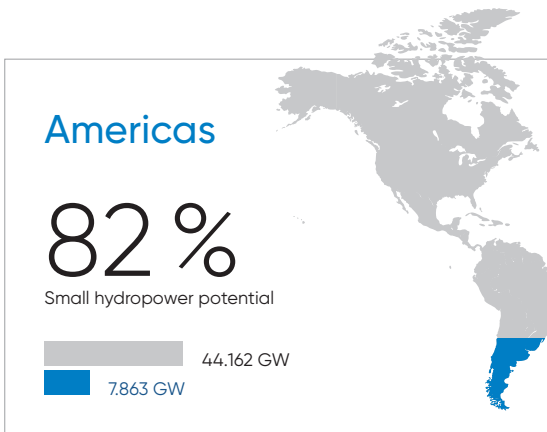
There is no international consensus on the definition of small-scale hydropower, the upper limit varying from 10 – 30 MW. The market may be further subdivided into mini-hydro (<500 kW) and micro-hydro (<100 kW). However defined, one thing remains constant – small-scale hydropower is cheap, clean, and reliable, one of the most environmentally benign forms of power generation available today. Moreover, small hydropower has a huge and as yet untapped potential in

most areas of the world. It can make a significant contribution to future energy needs. Largely reliant on well-proven and established technology, there is nonetheless considerable scope for further optimization.

Small hydropower may be developed through the construction of new facilities or through redevelopment of existing dams whose primary purpose is flood control or irrigation. Old hydro sites within urban areas may also be redeveloped, sometimes salvaging substantial investment in the installation, or water rights associated with an abandoned site may be reused. Such cost-saving advantages can make the use of existing sites for small hydro well worth the return on investment.

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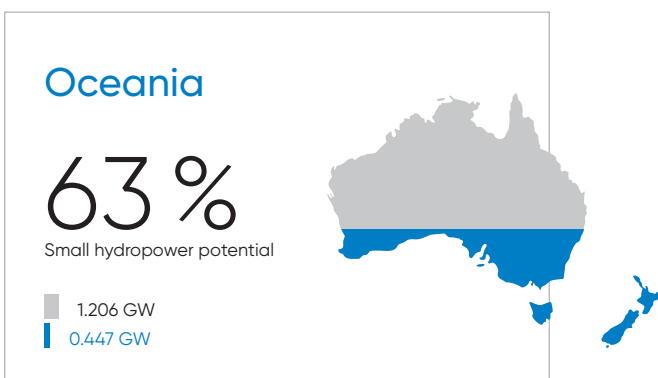
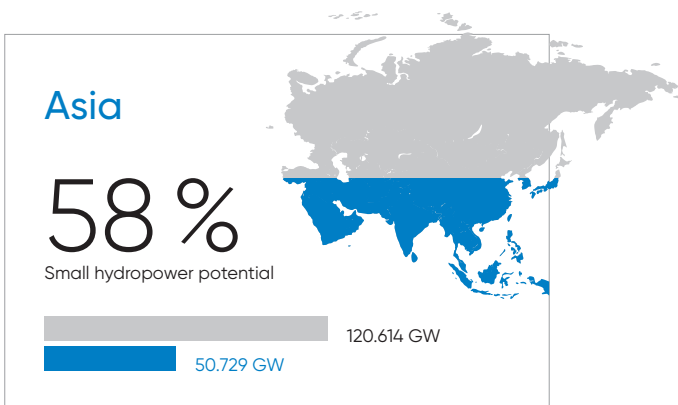




SMALL HYDROPOWER POTENTIAL PER REGION

■ Potential small hydro capacity (< 10 MW)
■ Installed small hydro capacity (< 10 MW)

Source:
World Small Hydropower Development Report 2016 by UNIDO



BENEFITS

- renewable electrical energy source
- non-polluting – no heat or noxious gases are released
- long lifespan
- responding within seconds to change in load demand
- no fuel cost, low operating and maintenance costs, inflation proof
- efficiencies of over 90 %
- proven technology offering reliable and flexible operation technologies
- most efficient of energy conversion technologies



From the historic pioneers of technology to a modern global market leader

The ANDRITZ GROUP is a globally leading supplier of plants, equipment, and services for hydropower stations, the pulp and paper industry, the metal-working and steel industries, and solid/liquid separation in the municipal and industrial sectors. ANDRITZ is always close to its customers, with more than 250 production locations and service and sales companies around the world.

ANDRITZ Hydro is part of the ANDRITZ GROUP and a global leading supplier of electro-mechanical equipment and services "from water-to-wire" for hydropower plants – with more than 175 years' experience in turbine technology and 120 years' experience in electrical engineering – ANDRITZ Hydro offers a comprehensive portfolio.

The cornerstone was laid by the turbine and generator pioneers in Europe and North America in the 19th century. Over time, growth, mergers, and cooperation agreements have created a state-of-the-art technology company with more than 7,200 employees.



Compact Hydro committed to our customers

In order to intensify the focus on standardized small hydro applications, in the 1990ties ANDRITZ Hydro formed a dedicated business unit for the purpose – Compact Hydro.

The history of small hydro applications goes back to the end of the 19th century, providing electricity to small industrial enterprises like the textile industry, water mills, and lumber mills. Central Europe was the heart of small hydro installations at that time, but by the beginning of the 20th century small hydro technology was being applied right around the world.

In 1903 Niagara Falls in Canada was the first overseas reference for ANDRITZ Hydro, swiftly followed by projects in Brazil and Japan in 1906, Venezuela and Mexico in 1908, and Indonesia in 1910. Such references confirm the strong international relationships ANDRITZ Hydro has formed and continues to build on in the global small hydro sector.

With this solid background and high degree of competence in small and mini-hydropower solutions, Compact Hydro focuses on the serious commitment to serve customers locally all around the world, offering the best hydro applications for the optimum return on investment. To date, the business has supplied and installed or rehabilitated almost 12,000 units world-wide, with a total capacity of more than 23,000 MW.

"About 120 renewable and sustainable generating units commissioned world-wide every year by ANDRITZ Hydro!"

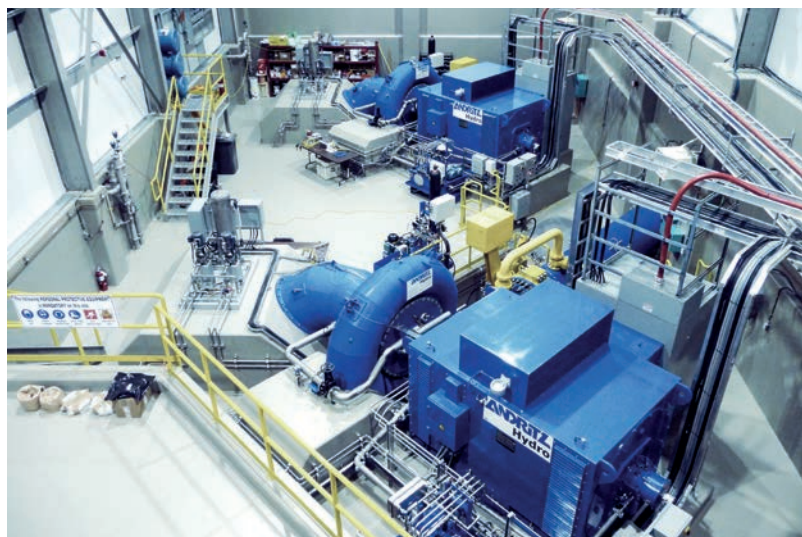
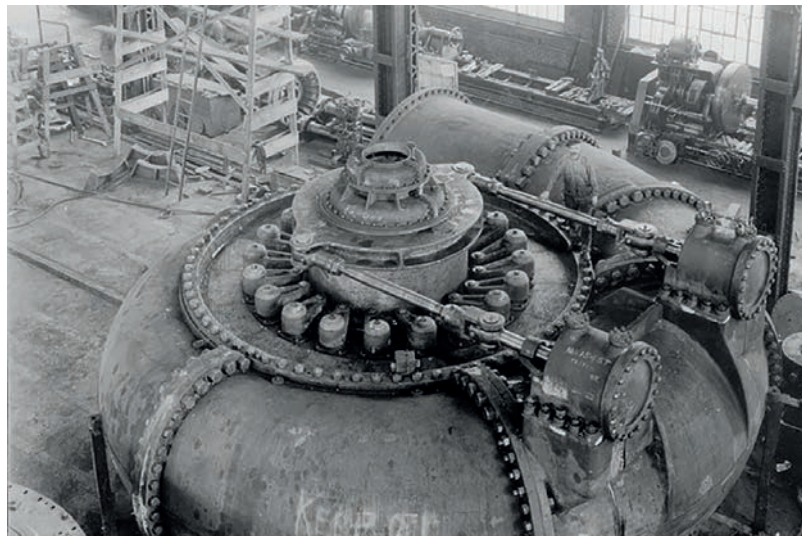



Foto: @redcor Inc.



Turbine
High voltage switchgear
Power transformer Generator
Medium voltage switchgear
Control & Protection
Automation
Inlet valve



Maximize your benefit through ANDRITZ Hydro single source solution

ANDRITZ Hydro's portfolio supports the entire lifecycle of a hydropower plant – from design and engineering to manufacturing, installation, and on through to commissioning and operator/staff training. Whether the project at hand concerns hydraulic and electro-mechanical equipment for new small or mini-hydropower plants or the modernization of existing facilities, ANDRITZ Hydro provides custom-tailored solutions. Everything from a single source – “from water-to-wire”.



A high quality product portfolio to meet customer needs

Compact Hydro's "from water-to-wire" concept covers the full span of electro-mechanical equipment. This includes the inlet valve, turbine, gearbox, generator, control and protection systems, as well as the entire mechanical and electrical balance of plant equipment.



Based on long-term experience and intensive research and development activities, Compact Hydro has developed a modular design concept for small and mini-hydropower plants. This design concept provides optimized solutions for the electro-mechanical equipment of all types of small hydropower plant, up to an output of 30 MW per unit.

The ANDRITZ Hydro modular design minimizes the number of pre-assembled components and sizes, covering all types of turbines across a wide range of applications. This allows the economic development of small and mini-hydropower potentials with powerhouses that perfectly fit into the landscape.

Compact Hydro solutions are complemented with a wide range of services. These include project management, engineering, manufacturing, quality control, transport, installation, commissioning, right through to training and site measurement.

ANDRITZ Hydro has the advantage of the use of synergies between installed technology and previously gathered experience of large installations. This translates into globally proven turbine models, guaranteeing higher efficiencies. Further resulting in an easier and shorter installation on site with plug and play features, as well as easier and simpler operation and maintenance, and, of course, lower costs.

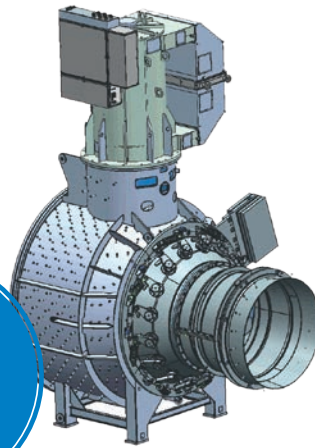
RESEARCH AND DEVELOPMENT

Commitment from the research and development engineers and employees of ANDRITZ Hydro contributes significantly to the company's global market leadership. Constant improvements and further developments of already proven technology – model tests, numerical flow simulations, electronics, and electro-technology innovations – are combined to optimize complete systems. The comprehensive approach of the ANDRITZ Hydro laboratories, manufacturing sites, and test benches around the world guarantee the high quality of ANDRITZ Hydro's Compact Hydro equipment.



“With over 300 units in operation, the Compact Axial Bulb Bevel Gear Drive turbine is our bestseller in Europe as well as overseas.”

> 300
UNITS
DELIVERED



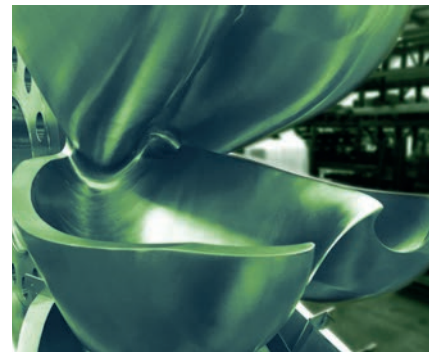
AXIAL FLOW TURBINES

Head up to 45 m and output up to 15 MW



FRANCIS TURBINES

Head up to 300 m and output up to 30 MW

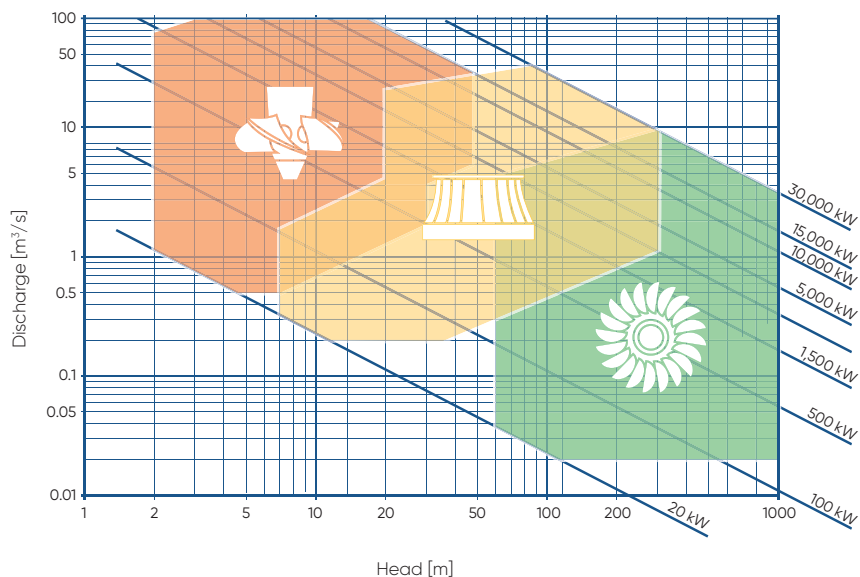


PELTON TURBINES

Head up to 1,000 m and output up to 30 MW

KEY FEATURES

- “From water-to-wire”
- Modular equipment design
- Single source responsibility
- Simplification of interfaces
- Short installation time
- Short commissioning time
- Low investment costs
- Low environmental impact
- Optimized ann. energy production
- Clean and renewable energy



Technical excellence creates solutions in harmony with nature

With concern over global warming and increasing environmental pollution growing, the demand for environmentally-friendly solutions is also expanding. This demand comes not only from international organizations and governments. Small communities are also striving to protect the environment and contribute to international goals to reduce emissions of greenhouse gases in parallel with economic growth and social progress.

Hydropower is the most proven and best-developed form of renewable power generation. Currently, approximately 16% of the world's electrical energy comes from hydropower. Hydropower is clean, waste-free, and neither emits pollutants nor significant amounts of greenhouse gases. Increasing demands for ecological performance have prompted changes not only in the mode of operation of hydropower plants, but also in the use of problematic substances such as governor and lubricating oils. The impact hydropower stations have on aquatic life has also become a major issue for both new plants and the refurbishment of existing hydraulic turbines.

Development of oil-free solutions for Bulb turbine runners was initiated many years ago. Within the last 20 years ANDRITZ Hydro has recorded more than 130 references for oil-free Kaplan runners. ANDRITZ Hydro also focuses intensely on the development of fish-friendly solutions to safeguard the viability of fish populations while maintaining high efficiency of the applied technology. Many theoretical approaches and computation models have been developed over the years. Combining hydraulic knowledge with biological understanding, ANDRITZ Hydro technology is able to minimize fish injury without major energy losses.

ANDRITZ Hydro is strongly committed to the sustained protection of the environment in parallel with economic growth and social progress. Compact Hydro plants harmonize optimally with the environment, even in areas where landscape protection takes priority.

Flitzenbach, Austria



“Small hydropower plants are cost-efficient, environmentally-friendly and preserve fossil fuel resources.”

The World of Compact Hydro



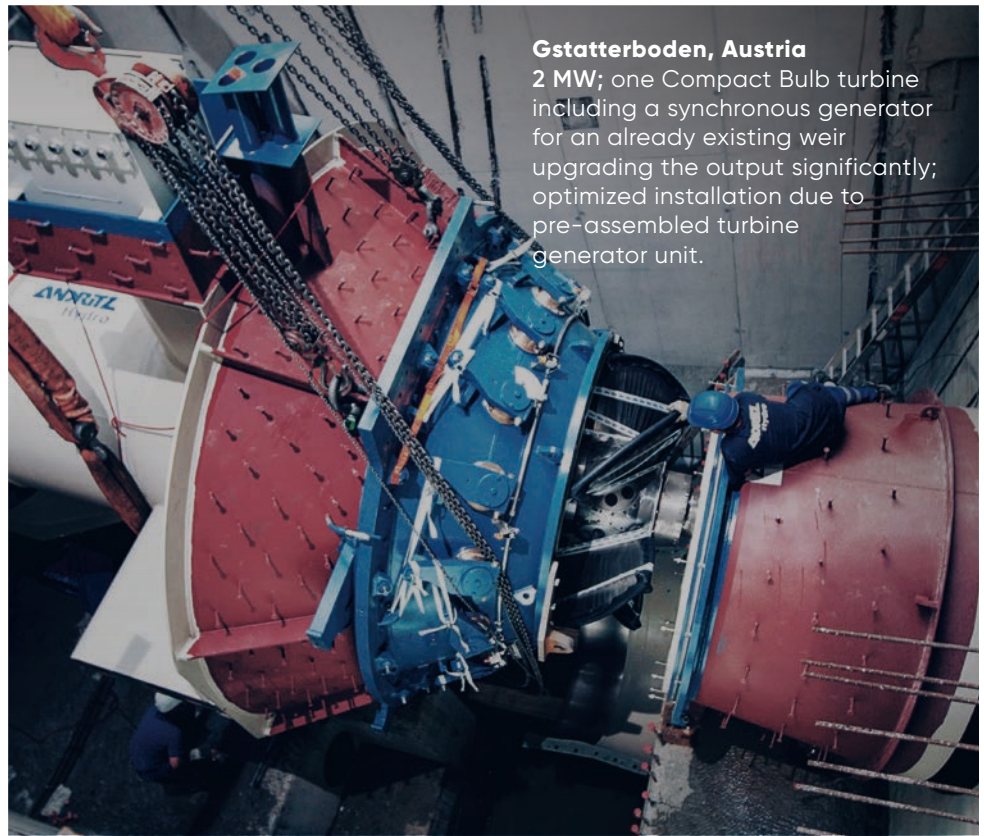
Chaudière Falls, Canada

8 MW; Complete “from water-to-wire” package including four 8 MW ECOBulb* turbines – one of the most powerful delivered by ANDRITZ Hydro so far – installed directly in the heart of the city of Ottawa at the oldest hydroelectric station in Canada still in operation.





Illerstufen V-VII, Germany
1.07 MW, 1.17 MW, 1.11 MW;
ecological replacement at three
Iller hydropower stations; Bevel
Gear Bulb turbines, replacing
existing Straflo turbines.



Gstatterboden, Austria
2 MW; one Compact Bulb turbine
including a synchronous generator
for an already existing weir
upgrading the output significantly;
optimized installation due to
pre-assembled turbine
generator unit.





Stortemelk, South Africa

4.4 MW; Kaplan turbine and electro-mechanical equipment installed at the existing Botterkloof Dam; the strict South African grid code describing the required behavior of a connected generator during system disturbances could also be implemented to the full satisfaction of the national network operator.



Cianten 1B, Indonesia

6.4 MW; The first of four in a cascade on the Cianten River (West Java)



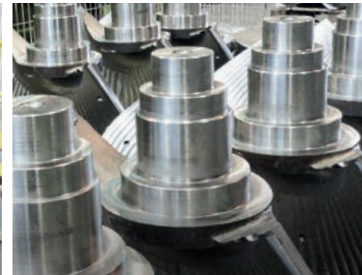
El Eden, Colombia

10.12 MW; first two horizontal three-jet Pelton turbines in Colombia



Forrest Kerr, Canada

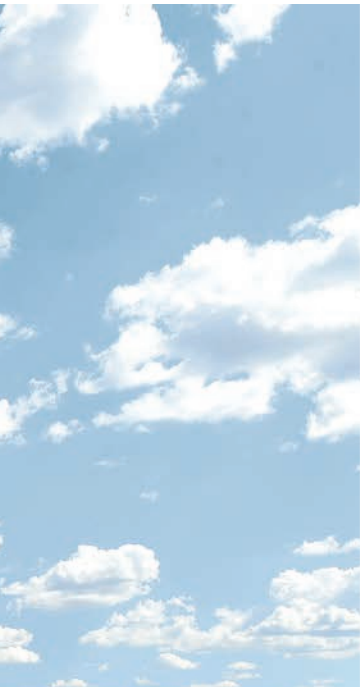
195 MW; Change from two large to nine small hydro units



Barro Blanco, Panama

13.7 MW; largest vertical axial Kaplan turbines





Renace 4, Guatemala
 30 MW; largest six-jet Pelton turbines; together with Renace 1, 2 and 3 the largest hydroelectric complex in Guatemala, with a total installed capacity of 300 MW.



Manolo Fortich 1 and 2, Philippines
 44,4 MW; 26,1 MW; Complete electro-mechanical equipment for two cascading hydropower plants consists of six Compact Francis and two Compact Pelton turbines; an important project in South-East Asia.



Rothleiten, Austria
 5.10 MW; important Bulb turbine reference in Europe



Sap Viet, Vietnam
 23.5 MW; two large horizontal Francis units in South-East Asia



Gosland, Norway
 3.7 MW; engineering challenge in remote area



Ambatomanoina, Madagascar
 100 kW; first Mini-Grid solution in Africa



Special solutions and new approaches for future demands

The changing social, political and economic world demands different perspectives. Today, environmental protection and health and safety are top priorities. Technology has to adapt and develop to support new ideas and to meet the new requirements.

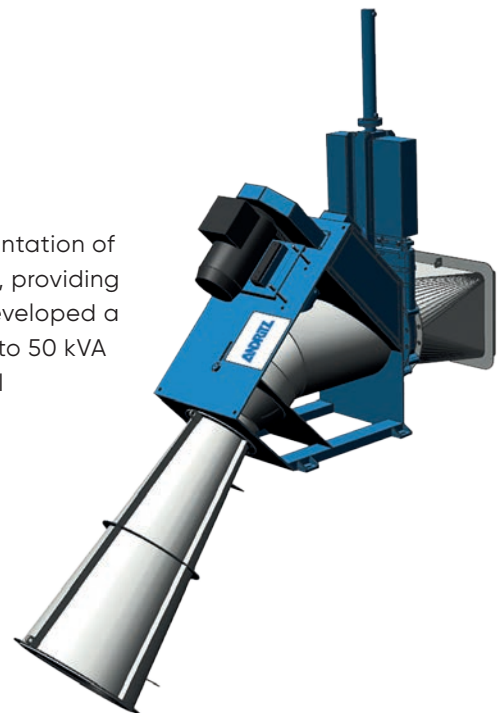
Besides the classical use – power generation – there are numerous alternative fields of application for Compact Hydro equipment. The range includes energy provision for agriculture, irrigation and flood control. Compact turbines may also be applied in the cooling circuits of thermal plants, pumps are used as turbines, power recovery turbines are installed in 3000 meter-deep mines to use energy otherwise lost in the re-cooling circuit. Compact turbines are found too in

desalination plants. In combination with pumps they recover about half the energy used to process drinking water for populations in dry and remote areas. Small pumped storage power plants combine the technical advantages of large hydropower stations with the economic assets of small hydroelectric plants. This provides profitability and independence for regional suppliers, adding to the stability of the local grid.

RURAL ELECTRIFICATION

An important aspect of rural development is the implementation of decentralized mini-grid solutions or stand-alone systems, providing safe, clean and renewable energy. ANDRITZ Hydro has developed a Mini Compact solution with a capacity range from 5 kVA to 50 kVA per unit. The main objective is to provide robust technical solutions which can be installed without support from specialists, providing affordable, sustainable, clean, and renewable energy for local communities.

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COMBINED RENEWABLES

Power generation based on wind, solar and biomass is increasing all over the world. The international climate target to limit global warming to less than 2°C will only be accomplished with extreme efforts. Integrated solutions that optimally combine renewable energies are already in demand today and will be even more so in the future. Compact Hydro solutions are adept at supporting and enhancing the performance of other forms of renewable energy generation. For instance, ANDRITZ Hydro has supplied the electro-mechanical equipment for a small pumped storage power plant on El Hierro, one of the Canary Islands off the northwest coast of Africa. This hydropower plant is stabilizing the variable energy production of a wind farm on the island and is successfully operating. This not only secures the self-sufficiency of the island, but even allows energy exports to neighboring islands.

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SUSTAINABLE ENERGY OUT OF URBAN INFRASTRUCTURE

In urban areas drinking water is supplied through pipes using high pressures. This high pressure can be effectively used for the generation of electricity in a mini-hydropower station before the water outlet. With this electrical energy small local communities are able to be supplied with power and thousands of tons of CO² emissions can be saved over time. After utilization, the water will be processed by further urban infrastructure, such as sewerage and waste water treatment plants. Hydropower plants developed by ANDRITZ Hydro are also able to use this water to generate electrical energy. From skiing villages in the Alps to treatment plants in the Jordan desert, small hydro units can be applied in any number of diverse locations to generate power. The only requirement is an economical combination of head and flow.

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