



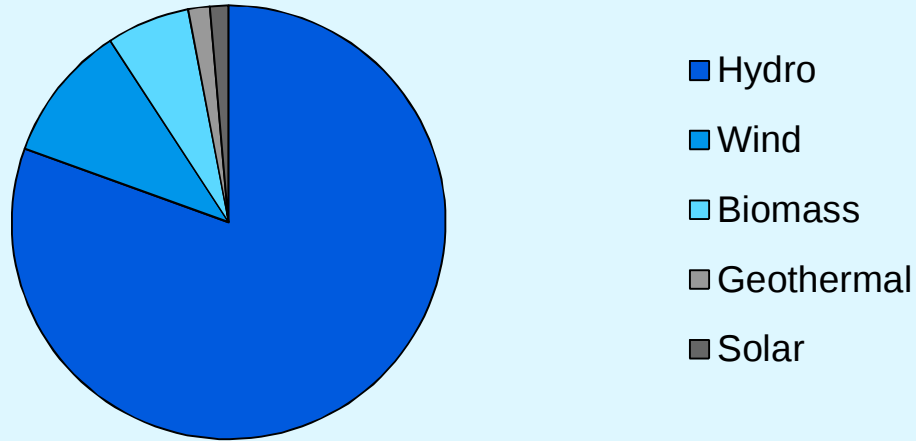
ABB Power Systems/Power Generation, October 2014

Solutions for hydropower made by ABB

Help you master current and future challenges in power generation

Hydropower

A sustainable energy source



Renewables contribute 20% of the world's electric power generation



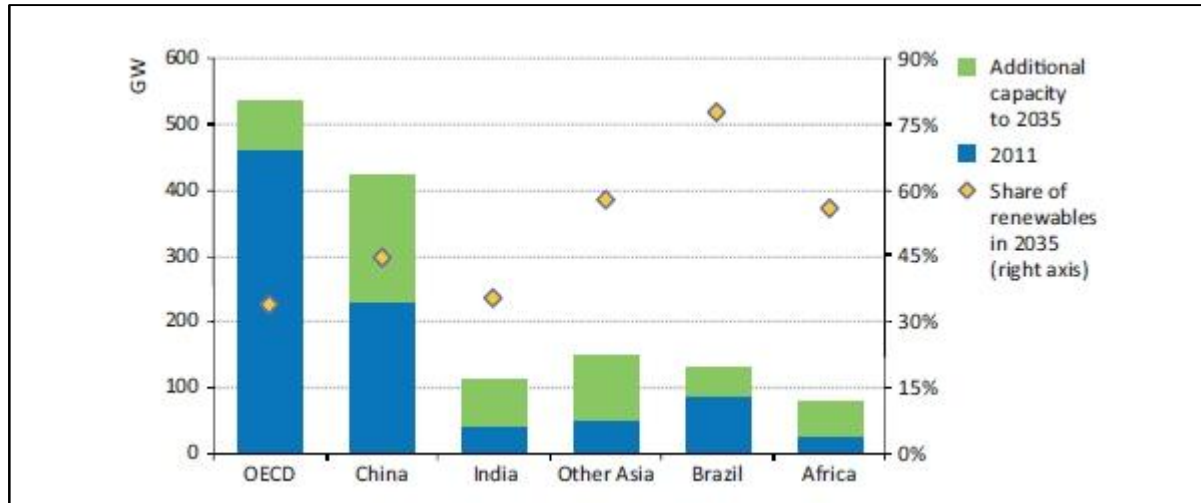
Hydropower delivers 80% of this "green energy" and continues to account for a major share of renewable energy

Hydropower is a cheap, reliable, economically stable and sustainable power source that essentially contributes to:

- ... support intermittent renewables and energy storage and thereby helping to balance regional grids (secondary & tertiary energy, power & frequency control) and to manage the global rise in energy demand
- ... enforce renewable energy targets and directives in various countries
- ... achieve socio-economic targets such as tackling global warming and poverty in less developed countries.

Hydropower

Market potential and landscape



Installed hydropower capacity in selected regions in the New Policies Scenario
(Source: IEA WEO2012, Chapter 7, Renewable energy outlook)

- **Build new large HPPs** - in countries with high untapped hydropower potential and fast growing electricity demand.
- **Revamp, upgrade & uprate** - in countries with lots of aging plants and an already high exploration rate of their hydropower potential.
- **Develop pumped-storage projects** - to supplement the rapidly growing generation from intermittent renewable energy sources.
- **Tap the potential of small hydropower** - both in emerging and mature markets.

Investors prefer experienced contractors with a sound economic background, capable to deliver low risk turnkey solutions with highest standards and performance guarantees.

ABB hydropower plants offering overview

Tradition, competence and leadership



- **Tradition** - developing technologies and providing solutions for the hydropower industry for more than 125 years, manifested in hundreds of hydro power plants worldwide
- **Competence** - throughout the entire value creation chain, in project execution and site management as well as in life cycle services, for all kind of hydropower projects.
- **Leadership** - as global supplier of just about every product in the power and automation range of hydropower plants, extending from generator terminals to grid.

... contributing to achieve the world's ambitious targets for the production of energy from renewable sources and their integration into *smart grids* and *energy efficient* applications

ABB hydropower plants offering overview

Our value propositions



- **Innovative**, energy efficient and reliable products from a global technology leader
- **Most complete** and flexible electrical equipment portfolio, including power converters and associated products for large pumped-storage plants
- **Best-in-class** scalable control and SCADA system
- **Comprehensive** process know-how for optimized and efficient plant operation, product service and lifecycle support

ABB hydropower plants offering overview

Reliable ABB solutions – just everywhere in the plant

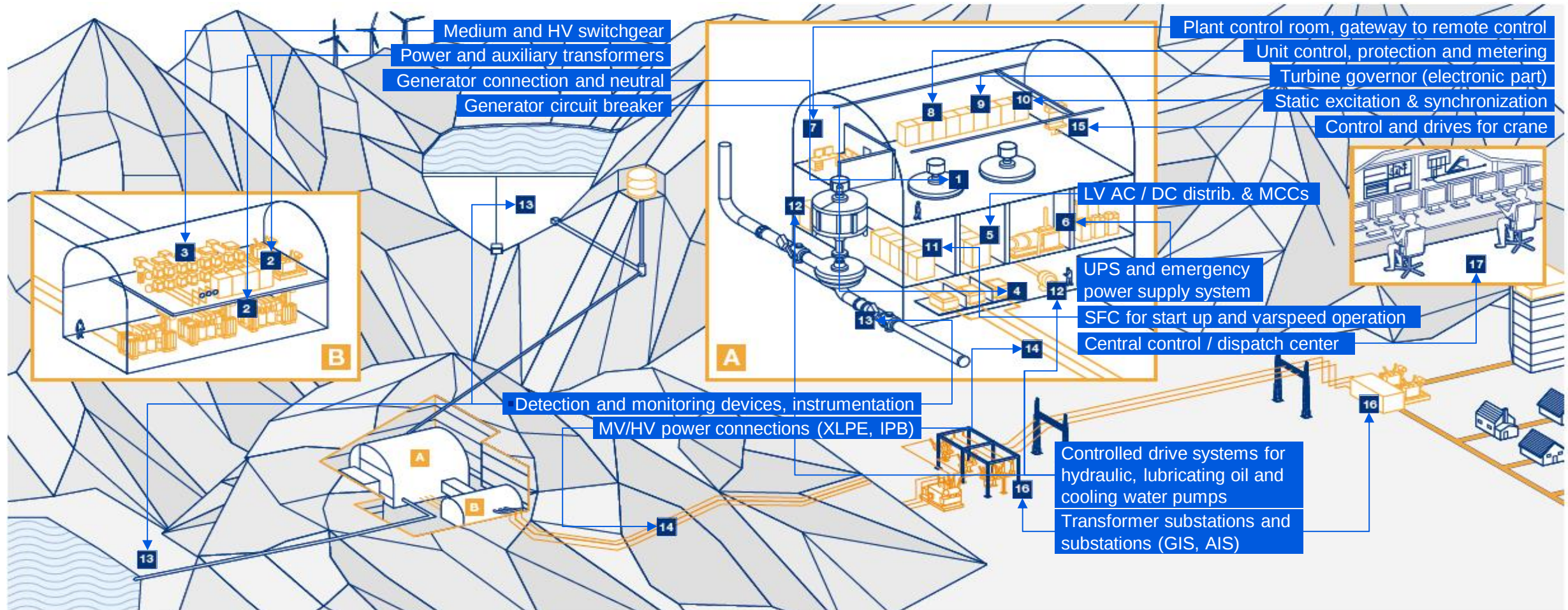
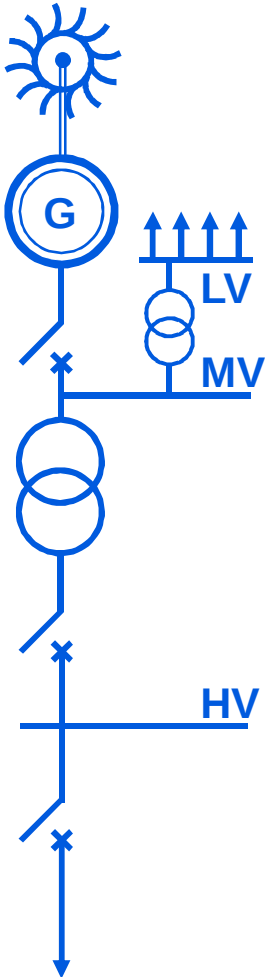


ABB hydropower plants offering overview

Benefits from water-to-wire (W2W) solutions

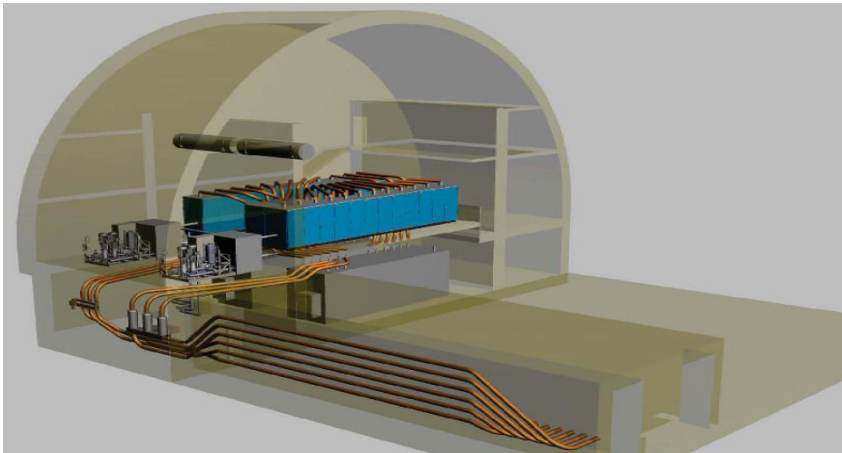
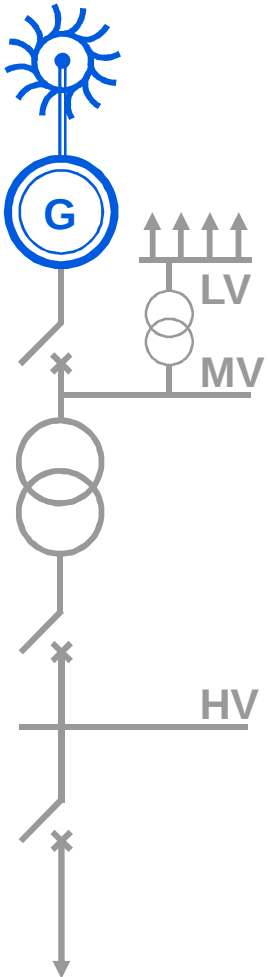


When contracting W2W solutions with ABB, customers enjoy these benefits:

- Optimum value through security of contract implementation with ABB as a bankable partner; either as sole contractor or leader/member of a consortium
- Single contract for complete water-to-wire package, comprising a technically integrated solution from water inlet to grid connection, including interfaces customer would be otherwise responsible for
- Complete portfolio of technical and financial guarantees provided on a joint and several liability base
- ABB can manage/mitigate customer's risk of contracting with market players

ABB hydropower plants offering overview

Electrical Balance of Plant (EBoP) package



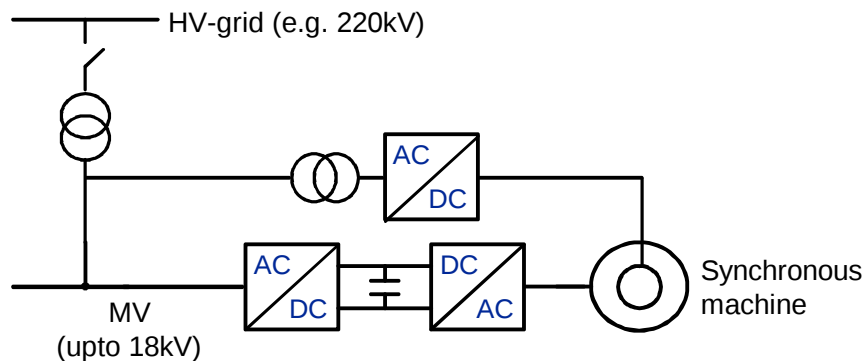
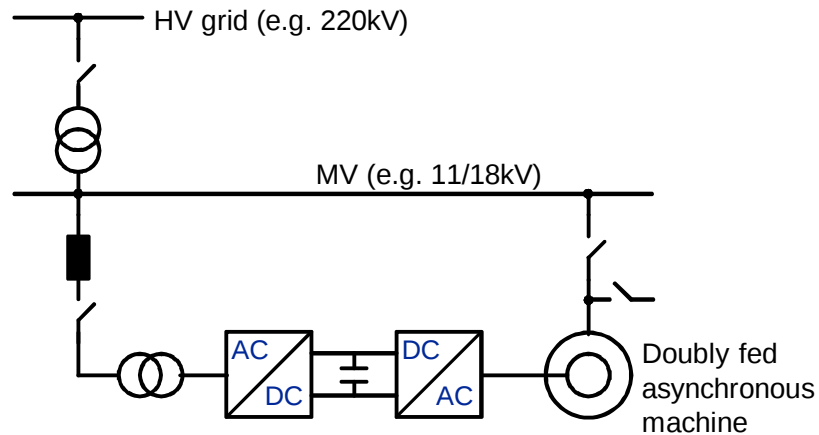
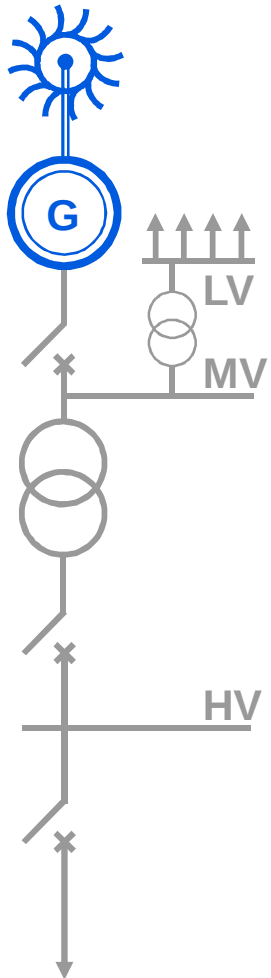
For an efficient and reliable operation
of turbines and generators

- Governors for all types of hydropower turbines
- Brushless and static excitation systems
- Power frequency converters as starting device in conventional PSP and for *variable speed applications*:
 - AC Excitation for DFAM
 - extra large drives for SyncG in variable speed applications

... highly customizable to meet a wide range of
technical requirements

ABB hydropower plants offering overview

Electrical Balance of Plant (EBoP) package



High performance power converter solutions for pumped-storage hydropower plants

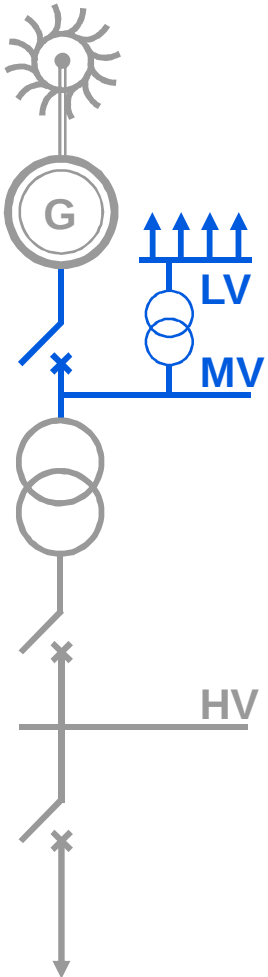
- Converter in AC excitation of async. Machines (DFAM)
- Full converter for synchronous machines (CFSM)

We are setting benchmarks in technology and performance of variable speed applications, leading to:

- flexible adaption of performance parameters (operating point) to actual demand for control/balance energy
- higher economic efficiency with adequate grid structures and power trading

ABB hydropower plants offering overview

Electrical Balance of Plant (EBoP) package



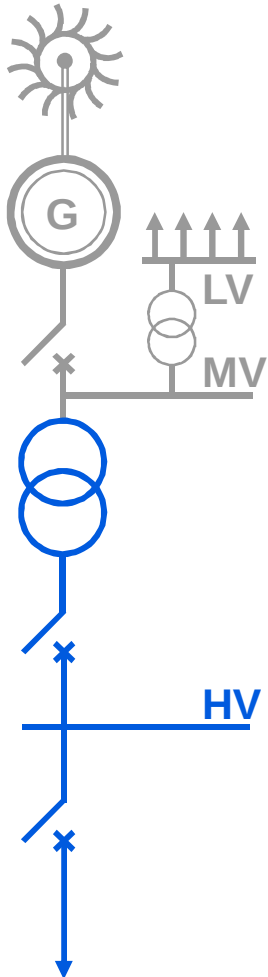
Cutting-edge integrated solutions for LV, MV and other auxiliary systems, with best-in-class reliability and availability

- MV & LV components and switchgears
- Generator circuit breakers
- Auxiliary transformers
- Emergency backup systems
- MV and LV cabling

... highly standardized for integration into an efficient plant system

ABB hydropower plants offering overview

Electrical Balance of Plant (EBoP) package



Pioneering HV technology
Hybrid air/gas insulated switchgears
High capacity HVDC systems

- Unit and station power transformers
- High voltage AC/DC power cables
- Circuit breakers and switchgears
 - Air-, gas-insulated or hybrid solutions
- HVDC components and systems
 - Light® and - Classic

... adding "a new chapter in the history of electrical engineering ..." with the world's first HVDC circuit breaker and the world's most powerful extruded HVDC cable system.

ABB hydropower plants offering overview Total plant automation with Symphony Plus



A future oriented control system must be able to cover more than just the usual automation of the HPP process.

- **Simple** and easily adaptable to a broad range of plant configurations and applications
- **Scalable** from small and server-less to large multi-system, multi-server architectures
- **Seamless** integration of field devices and systems
- **Secure** with built-in security features preventing from unauthorized access

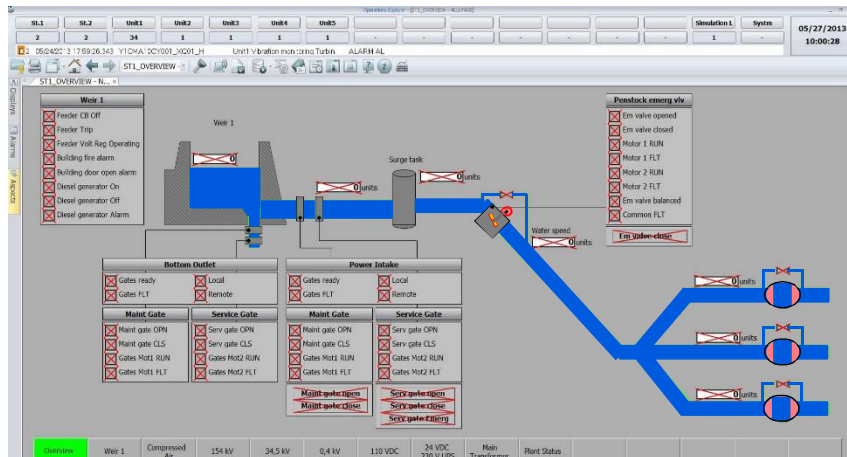
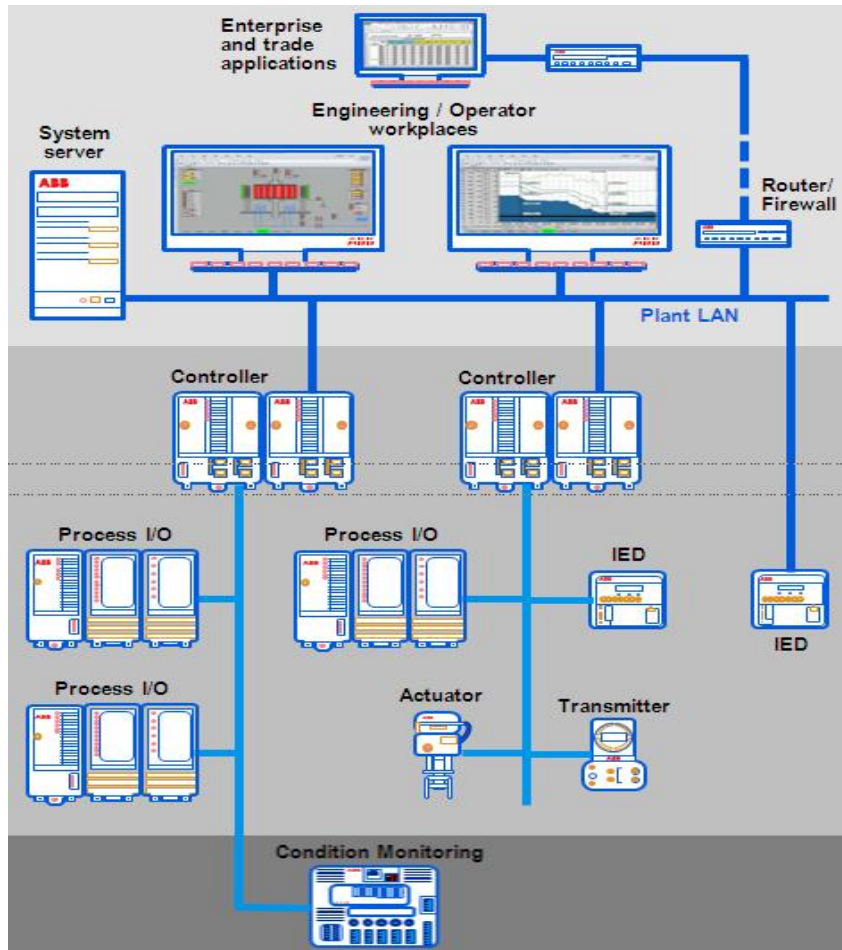


ABB hydropower plants offering overview

Total plant automation with Symphony Plus

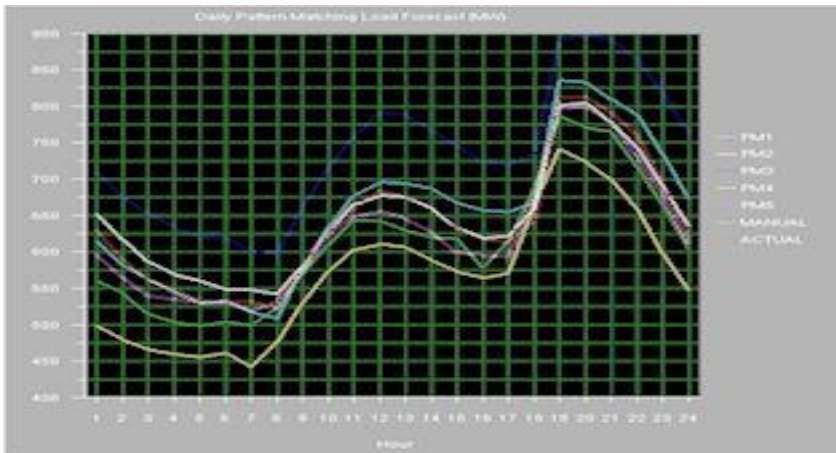
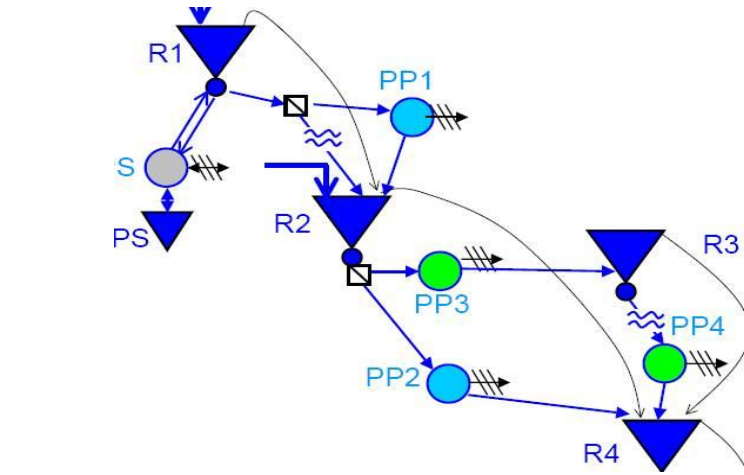


Total power plant automation solution designed to maximize plant efficiency and reliability.

- **S+ operations** - powerful and ergonomic
 - Greater awareness
 - Faster response
 - Better decisions
 - **S+ control & I/O** - versatile and scalable
 - Seamless integration
 - High availability
 - **Condition monitoring suite** - to monitor vibration and assess turbine and generator conditions for safe operation
- ... all along with a system wide **embedded cyber security** for secure and reliable operation.

ABB hydropower plants offering overview

Total plant automation with Symphony Plus

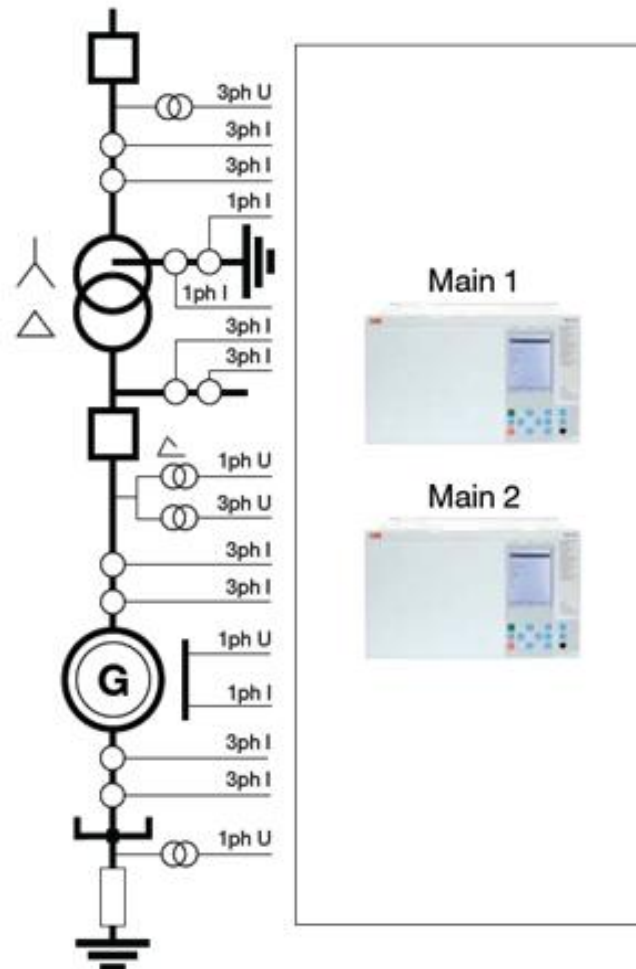


Manage complex energy generation processes
and reduce operating costs

- Solutions for operating multiple power plants such as:
 - Dispatch, area management
 - Joint Control & Optimization
 - Cascade Control
- Solutions for plants in deregulated markets:
 - Hydro scheduling
 - Predictive production costing
 - Planning, scheduling, billing
 - Operations planning

ABB hydropower plants offering overview

The Relion® product family for electrical protection



The widest range of products for the protection, measurement and supervision of power systems.

- **Best fit** for every need from power generation applications to interconnected transmission grids
- **Benchmark** for interoperability with integrated IEC 61850
- **Full support** from start to finish - consistently engineered from the process to the station level

... installed as "stand-alone" or integrated with our Symphony Plus automation system

ABB hydropower plants offering overview

Life cycle management for power plants



Advanced services provide continuous improvement for power generation assets.

Our philosophy is simple:

- We protect your investment through the stepwise evolution and upgrading of your electrical, control and instrumentation systems ...
- and help our customers to minimize the consumption of energy, prolong asset operating life, and minimize the cost of ownership ...
- with a portfolio based on extensive process and application know-how and one of the largest installed bases in the world.



ABB hydropower plants offering overview

Life cycle management for power plants



Some plant components inevitably approach the end of their useful service life.

ABB supports plant owners/operators in:

- **Extensions, upgrades and retrofits** - that enable low-risk and phased migration to the latest technology.
- **Maintenance** - with effective preventive and corrective measures to maximize the reliability of plant equipment, to reduce mean time to repair and increase plant performance.

... all with comprehensive ServiceGrid solutions that transform routine maintenance tasks and frees resources to proactively focus on power production.

ABB hydropower project references

Atatürk & Karakaya hydropower plants



Enduser/owner: DSI, Turkey
Project location: Turkey
Completion: 2011 (2014 for add. works)

With 8 x 300 & 6 x 300 MW these plants are essential assets for Turkey's link to the European interconnected network.

ABB's solution

- Modernization of turbine governors, excitation systems, process and station control system and integration of remote access function
- Replacement of generator protection and other electrical equipment

Customer benefits

- Compliance with ENTSO-E requirements
- Efficient and reliable operation with state-of-the-art control and protection systems

ABB hydropower project references

Porce III Hydropower Plant



Photo: <http://www.panoramio.com/photo/50671503>

Enduser/owner: Empresas Publicas de Medellin
E.S.P. (EEPPM), Colombia
Project location: Antioquia, Colombia
Completion: 2011

With 4 x 218 MW this HPP is one of the largest in Colombia and linked to the ISA interconnected grid.

ABB's solution

- Toshiba/ABB Consortium for generator package; partnership with Mitsui & Co. Ltd.
- ABB scope: electrical equipment associated to the generators, including GCBs, IPBs, neutral grounding, excitation & AVR, local control and vibration monitoring system

Customer benefits

- Installation of a complete generator package with highly integrated electrical equipment from a single source (ABB)

ABB hydropower project references

Grimsel II hydropower plant



Enduser/owner: Kraftwerke Oberhasli AG (KWO), Switzerland
Project location: Innertkirchen, Switzerland
Completion: 2013

With 100 MW, the world's most powerful full converter operating in a hydropower station.

ABB's solution

- Upgrade a hydro pumped storage unit from fixed to variable speed with a full size converter system
- Turnkey solution with PCS 8000 converter, transformer and cooling / control / protection units

Customer benefits

- Increased operation flexibility due to power control in pump mode, fast unit start-up and static reactive power compensation function
- Optimized use of stored water for energy generation and higher production of peak load energy

ABB hydropower project references

Aswan High Dam & Aswan II hydropower plants



Enduser/owner: Hydro Plants Generation Company (HPGC), Egypt

Project location: Aswan, Egypt

Completion: 2013-2014

These are the largest HPPs in Africa, essential for the regulation of the Nile river, Egypt's lifeline.

ABB's solution

- Rehabilitation of DCS - delivery of a new S+ system
- Rehabilitation of excitation and protection systems
- Rehabilitation of governor (including Hydraulic Power Unit)

Customer benefits

- Extended life cycle
- Improved reliability and availability
- Shortened response time on peak demand

ABB hydropower project references

Dikchu hydropower plant



Photo: http://www.greenkogroup.com/business/hydro_power.php

Enduser/owner : Sneha Kinetic Power Projects
Pvt. Ltd., India

Project location: Sikkim, India

Completion: 2015

Greenko - an Indian REN power developer - will add 96 MW to its current ~250 MW S&MHPP fleet.

ABB's solution

- Connect the power plant to the main national grid by designing, engineering, manufacturing and installing the complete electrical system, also including a 132 KV GIS

Customer benefits

- The integration of control and electrical components provides for highest system availability and reliability and thereby reduces operation and maintenance costs
- EBoP turnkey contract provides a single contact for all electrical equipment

ABB hydropower project references

Jenpeg Unit 1 Electrical Restoration Project



Enduser/owner: Manitoba Hydro, Canada
Project location: Manitoba, Canada
Completion: 2015

Manitoba Hydro operates the first generating station in North America that uses bulb-type turbine generators

ABB's solution

- Demolition of all equipment damaged by fire and condition assessment of equipment to be re-used
- Complete replacement of Unit 1 electrical equipment, including excitation, control & protection, MV generator terminal cubicle and other electrical components; governor controller

Customer benefits

- Bring back unit 1 into service at full rated capacity to recover loss caused by forced outage (fire)
- Integrated solution in both the refurbished and the new part of the plant

ABB hydropower project references

Kafue Gorge Lower hydropower plant



Enduser/owner: ZESCO Limited, Zambia
Project location: Zambia
Completion: 2015

The 6 x 160 MW, together with Victoria Falls HPP, are an essential asset for Zambia's network.

ABB's solution

- Modernization of unit control & protection system and integration of remote access function
- Replacement of generator protection and other electrical equipment

Customer benefits

- Efficient and reliable operation with state-of-the-art control and protection systems

ABB hydropower project references

Song Bung 2 hydropower plant



Enduser/owner: EVN, Vietnam
Project location: Quang Nam Province, Vietnam
Completion: 2015

This 2 x 50 MW plant is a further step in Vietnam's ambitious hydropower development plan.

ABB's solution

- Delivery of the complete power plant control and protection systems based on ABB's Symphony Plus and Relion solutions.
- Includes also device local control and LV components

Customer benefits

- The integration of control and electrical components provides for highest system availability and reliability and thereby reduces operation and maintenance costs.

ABB hydropower project references

Yamanli II Hydroelectric Power Plant



Enduser/owner: EnerjiSA, Turkey
Project location: Adana, Turkey
Completion: Stage 1 – 2015
Stage 2 – 2015

In two stages the cascaded power plants will produce 88 MW of power.

ABB's solution

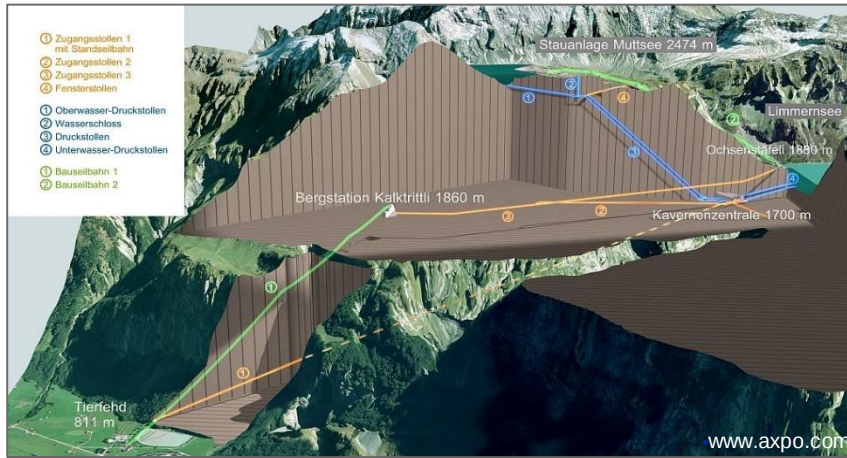
- W2W in consortium structure with T&G supplier.
- ABB delivers ICE package with 154kV AIS, including complete design, supply, installation, test and commissioning.

Customer benefits

- Common source for complete Water-to-Wire electromechanical package.
- Consortium deal structure provides for more competitive offering.

ABB hydropower project references

Limmern pumped-storage plant ("Linthal 2015")



Enduser/owner: Kraftwerke Linth-Limmern AG (KLL), Switzerland

Project location: Linth-Limmern, Switzerland

Completion: 2016

Switzerland's largest (4 x 250 MW) variable speed pumped-storage plant under construction

ABB's solution

- Single source contract for plant automation system, high voltage equipment (380kV power transformers and GIS) and complete electrical balance of plant (EBoP),
- IEC61850 based system integration

Customer benefits

- Higher revenues through highly flexible operation
- Single-point responsibility for the complete electrical package

ABB hydropower project references

Nedre Røssåga hydropower plant



Enduser/owner: Statkraft AS, Norway
Project location: Nordland County, Norway
Completion: Phase 1 - 2013
Phase 2 - 2017

In two phases Statkraft will renovate the 55 years old HPP and construct a new one connected to this.

ABB's solution

- Complete refurbishment/delivery of EBoP and automation systems for each phase, including step-up transformers, MV, LV, DC systems, plant and unit automation, protection systems, remote control

Customer benefits

- Improved reliability and efficiency of electrical components, contributing to a safe energy supply
- Integrated solution in both the refurbished and the new part of the plant

Power and productivity
for a better world™

