THE MULTIPLE ROLES OF HYDROPOWER IN THE WATER AND ENERGY INDUSTRY

Electricity for transportation, heat, power and light

Water storage for flood mitigation, irrigation, water supply and navigation

Energy Storage for peak load generation, energy balancing and grid stability
POSSIBILITIES AND OPPORTUNITIES OF THE GLOBAL HYDROPOWER MARKET

Technically feasible potential: ~ 15,800 TWh/year | Hydropower generation: ~ 4,180 TWh/year

North America: 62% Hydropower potential
- 1,964,300 GWh
- 733,807 GWh

Europe: 57% Hydropower potential
- 1,957,700 GWh
- 572,642 GWh

China: 56% Hydropower potential
- 2,720,000 GWh
- 1,188,830 GWh

South America: 73% Hydropower potential
- 2,859,200 GWh
- 793,474 GWh

Africa: 93% Hydropower potential
- 1,647,300 GWh
- 121,667 GWh

Asia (excl. China): 85% Hydropower potential
- 5,470,400 GWh
- 839,480 GWh

Source: Hydropower & Dams World Atlas, 2018

- Technically feasible hydropower potential (GWh/year)
- Hydropower generation in 2017 (GWh/year)
1) Annual storage reservoir
2) Short-term storage reservoir
3) Conventional river power plant
4) Small hydropower plant
5) Mini hydropower plant
6) Urban river power plant
7) Low-head hydropower plant
8) Tidal power plant
9) Pumped storage power plant (fresh water); energy storage for solar power plant
10) Pumped storage power plant (salt water); energy storage for wind park
11) Energy island; off-shore pumped storage power plant for wind/solar/tidal
12) Tidal stream power array
13) Irrigation System
14) Desalination plant
15) Flood control pump station
We are a global supplier of electro-mechanical systems and services (“from water-to-wire”) for hydropower plants and a leader in the world market for hydraulic power generation.

More than 175 years of turbine experience (1839)

Over 31,600 turbines (more than 434,600 MW) installed

Complete range up to more than 800 MW

Over 120 years electrical equipment experience (1892)

Leading in service and rehabilitation

More than 120 Compact Hydro units per year
FROM THE HISTORIC PIONEERS OF TECHNOLOGY TO A MODERN MARKET LEADER
ANDRITZ HYDRO – FACTS AND FIGURES IN SHORT

LARGE HYDRO
hydro- and electro-mechanical equipment for large turn-key / expansion projects; as well as modification of existing plants

COMPACT HYDRO
world's leading provider for small and mini hydropower plants - providing the full spectrum of electro-mechanical equipment

SERVICE & REHAB
solution oriented state-of-the-art service and rehabilitation solutions to increase profitability and extend plant life span

PUMPS
pumps that meet the demand for ever-larger, higher performance units, whether for low flow rates or wear-resistant applications

KEY FINANCIAL FIGURES 2018:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
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</thead>
<tbody>
<tr>
<td>Order intake</td>
<td>1,445.8 MEUR</td>
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<tr>
<td>Order backlog</td>
<td>2,667.9 MEUR</td>
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<tr>
<td>Sales</td>
<td>1,517.5 MEUR</td>
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<tr>
<td>EBITA</td>
<td>113.8 MEUR</td>
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<tr>
<td>Employees (without apprentices)</td>
<td>7,002</td>
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THE GLOBAL PRESENCE OF ANDRITZ HYDRO – CLOSE TO OUR LOCAL CUSTOMER

North America
- Canada: Boucherville, Chambly, Lachine, Paris, Peterborough, Point-Claire, Vancouver
- USA: Charlotte, Spokane
- Mexico: Morelia

Central and South America
- Brazil: Ararâquara, Sao Paulo
- Chile: Santiago de Chile
- Colombia: Bogota
- Peru: Lima
- Venezuela: Caracas

Europe
- Austria: Graz, Linz, Vienna, Weiz
- Czech Republic: Prague
- Germany: Berlin, Ravensburg
- Switzerland: Jonshwil, Kriens, Vevey
- Turkey: Izmir
- Ukraine: Kiev

Central Asia
- Kazakhstan: Almaty
- Tajikistan: Dushanbe

East Asia
- China: Beijing, Chengdu, Foshan
- Japan: Tokyo
- South Korea: Seoul

South Asia
- India: New Delhi, Faridabad, Bhopal, Jammu, Calcutta
- Nepal: Kathmandu

South-East Asia
- Indonesia: Jakarta
- Lao PDR: Vientiane
- Malaysia: Kuala Lumpur
- Myanmar: Yangon
- Philippines: Manila
- Vietnam: Hanoi

Africa
- Angola: Luanda
- Congo: Brazzaville
- DRC: Kinshasa
- Mozambique: Maputo
- South Africa: Johannesburg

Australia and Oceania
- Australia: Sydney
- New Zealand: Christchurch
OUTSTANDING SOLUTION – “FROM WATER-TO-WIRE”

1) Gates
2) Penstocks
3) Inlet valve
4) Turbine
5) Generator
6) Automation, control and protection
7) Medium voltage switchgear
8) Power transformer
9) High voltage switchgear
10) Transmission line
LEADING TECHNOLOGY BY
GLOBAL RESEARCH AND DEVELOPMENT

• Global test facilities
  • 14 hydraulic test rigs
  • 5 generator laboratories
  • pump laboratory
• Advanced numerical calculation methods

• Highlights
  • Turbine test facilities for all types:
    • High heads up to 2,000m
    • Low head Bulb turbines
    • Pump turbines
  • Generator test fields for:
    • Large rotating electrical machines up to 850 MVA
    • Bearings
    • Electrical insulation
• Main Products
  • Hydro-mechanical components
  • Turbines and turbine components
  • Hydro and turbo generators
  • Electrical components
• Locations
  • Europe, Asia, North and South America
• Capacities
  • In-house manufacturing capacity
    • ~ 2,500,000 hours/year
  • On-site assembly capacity
    • ~ 800,000 hours/year
  • Total manufacturing area
    • > 170,000 m²
**LARGE HYDROPOWER SOLUTIONS TO SECURE ELECTRICAL ENERGY PRODUCTION**

Large Hydro

- **Scope:**
  - Turnkey electro-mechanical package for hydropower plants “from water-to-wire” (W2W)
  - New hydropower plants
  - Large rehabilitations and upgrades

- **Highlights:**
  - Market leader in Pelton turbines
    - Bieudron / Switzerland: 423 MW, 1,874 m (2 WR!)
  - Large Francis turbines
    - Guri II / Venezuela: 770 MW
  - Market leader in Bulb turbines
    - Santo Antoño / Brazil: 76.55 MW
  - Large hydro generators
    - Three Gorges / China: 840 MVA
STRONG HYDRO-MECHANICAL STRUCTURES TO GUIDE THE WATER

Penstocks and Gates

• Scope:
  • Steel structures for hydropower plants, water supply and irrigation
  • Penstocks, pipe bridges, steel tunnel linings, manifolds and bifurcations, gates, hydraulic steel constructions

• Highlights:
  • Large gates:
    • Pimental / Brazil
  • Large penstock
    • Tarbela Dam 3 / Pakistan: Ø 13.26 m
  • Large manifold
    • Tarbela Dam 3 / Pakistan: 16 m height
  • High head
    • Cleuson-Dixence / Switzerland: 2,070 m
RISING MARKET
FOR SMALL AND MINI HYDROPOWER

Compact Hydro

• Scope:
  • Turnkey solutions “from water-to-wire” (W2W)
    • Small (< 30 MW/unit), Mini (20 kW - 5,000 kW/unit)
  • Off-grid solutions
  • Modular system design - Pre-assembled at workshop

• Highlights:
  • Large Compact Pelton turbine
    • Renace II / Guatemala: 30.3 MW
  • Drinking and waste water turbines
    • Val Mila / Switzerland: 200 kW
    • Las Vacas / Guatemala: 6 MW
  • Energy recovering turbine (mines)
    • Saaiplaas / South Africa: 3x 1.54 MW

Each week two new Compact Hydro units start!
MODERNIZATION OF HYDROPOWER PLANTS TO EXTEND THE LIFETIME

Service & Rehabilitation

• Scope:
  • Solutions, products and services over the entire life-cycle of a hydropower plant
  • General overhaul, rehabilitation, uprating, upgrading, modernization, plant assessment, technical studies, residual life analysis, risk assessment

• Highlights:
  • 40% uprating
    • Ambuklao/Philippines: + 40% Electricity production
    • Simon Bolivar II/Venezuela: + 400 MW more production
  • Replanting and uprating (unit replacement - 12 by 5)
    • Lochaber/UK: + 20% (5x 17.3 MW)
  • Rehabilitation of largest single phase hydro generator
    • Langenprozelten/Germany: 94 MVA, 34 t pole weight
• Scope:
  • customized operation and maintenance solutions based on experience and comprehensive know-how of hydraulic, electro-mechanical, and automation equipment
  • scalable service concept for maintenance
  • Metris DiOMera – digital solutions for O&M

• Highlights:
  • “24 / 7” operation and maintenance
    • Teesta Stage II / India: 6 x 200 MW Pelton
  • Monitoring system Metris DiOMera
    • Montrose / Canada: 2 x 47 MW Pelton
ELECTRICAL POWER TRAIN TO FEED THE ENERGY INTO THE GRID

Electrical Power Systems

• Scope:
  • Solutions, products and services for complete range of electrical equipment for hydropower plants
  • Plant and power engineering including system and grid studies
  • Integration of all systems (“from water-to-wire”)

• Highlights:
  • Electrical system for pumped storage
    • Tong Bai / China: 4x 300 MW
  • Complete electrical equipment for
    • Karahnjukar / Iceland: 6x 130 MW
  • Turnkey electrical equipment including 420 kV high-voltage substation
    • Beles / Ethiopia: 4x 130 MW
SECONDARY EQUIPMENT – THE HIDDEN HEART OF THE POWER PLANT

Automation

• Scope:
  • Complete automation solutions for
    • all sizes of power plants
    • new, rehabilitated or upgraded power plants
    • integration of existing systems

• Highlights:
  • Large excitation
    • Simon Bolivar II / Venezuela: field current 3,200 A
      (generators 10x 850 MVA)
  • Integrated platform HIPASE
    • protection, excitation, turbine governor and
      synchronization
  • Large dispatch center
    • Landshut / Germany: Regional dispatch center for 110 HPP’s of EON
    • Statkraft / Norway: Dispatch center for Norway
PUMPS AND MOTORS
FOR HYDROPOWER, AGRICULTURE, AND INDUSTRY

Pumps

• Scope:
  • Standard and customer-specific pumps:
    • Water, waste water or sea water
    • Cooling water pumps (power plants)
    • Offshore
    • Mining
    • Industry (pulp, paper, sugar, chemical or food)
    • Mini hydro power generation

• Highlights:
  • Very large flowrates
    (e.g. water infrastructure in India and China)
  • Highly abrasive applications
  • Modular multistage concept with highest efficiencies
  • Engineered multistage pumps up to 35 MW
  • Pump storage operations
GAS AND STEAM TURBINE GENERATORS FOR THE THERMAL POWER INDUSTRY

Turbo Generator

• Scope:
  • Turbo generators and related services for gas and steam turbines from 8 MVA up to 350 MVA
  • 50 and 60 Hz
  • Type
    • Air-cooled
      • TEWAC (air-water-cooled)
      • Open ventilated
      • CACA (air-air-cooled)
    • Hydrogen-cooled

• Highlights:
  • > 1,146 turbo generator units
  • > 147,000 MVA total output
  • Turbo generators for
    • Heavy duty gas turbines (HDGT)
    • Aeroderivative gas turbines
LOW HEAD SOLUTIONS
FOR EXISTING INFRASTRUCTURES

Hydropower market outlook

• Trends:
  • Request of an innovative energy solution for:
    • existing structures like dams, gates, weirs, etc.
    • greenfield projects
  • Usage of ecological flow for additional power
    generation

• Highlights:
  • Largest HYDROMATRIX® plant
    • Ashta I / Albania: 45x 534 KW
    • Ashta II / Albania: 45x 1,003 kW
  • Usage of abandoned shiplocks
    • Chievo / Italy: 5x 270 kW StrafloMatrix™
PROMISING POTENTIAL FOR ELECTRICAL ENERGY FROM THE OCEAN

Hydropower market outlook

• Trends:
  • Technology for power generation from tidal lift and tidal currents
    • Tidal lagoon (energy island)
    • Tidal array
    • Tidal barrage

• Highlights:
  • World largest tidal power plant
    • Sihwa / South Korea: 10x 26 MW
  • First commercial tidal current turbine
    • EMEC / UK: 1x 1,000 kW
  • First commercial tidal array
    • MeyGen / Scotland: 3x 1,5 MW
  • New developments for tidal lagoons
PUMPED STORAGE POWER PLANTS
BALANCING THE WIND AND SOLAR PRODUCTION

Hydropower market outlook

• Trends:
  • Storage solutions for grid balancing effected by volatile wind and solar electricity production
  • “from water-to-wire” (W2W)
    • Fixed or variable-speed
  • Electrical grid compatibility
    • Grid code compliance

• Highlights:
  • First variable-speed pumped storage plant in Europe
    • Goldisthal / Germany: 4x 325 MW (2 x 340 MVA variable-speed units)
  • High speed pumped storage (750 rpm)
    • Reisseck II / Austria: 2x 240 MVA
  • Fast operation mode change (+540/-540 MW in 20 sec)
    • Kops II / Austria: 3x 200 MVA
FIT FOR THE FUTURE – DIGITALIZING HYDROPOWER

Hydropower market outlook

• Trend:
  • Global push of digitalization (IoT, Industry 4.0) for all parts and processes

• Highlights:
  • Digital secondary equipment (microprocessor based)
  • Seamless digital communication based on Ethernet (protocol) and internet (Cloud)
  • Cyber security solutions
  • SCADA for operation of a virtual power plant, one dispatch center for 150 hydropower plants
  • Digital online monitoring system DiOMera
  • Utilizing Finite Element Analysis (FEA) and Computerized Flow Dynamics (CFD)
All operational divisions and subsidiaries worldwide are certified according to the standards ISO 9001, ISO 14001 and OHSAS 18001.