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Cover photo:  
The photo shows the Three Gorges generator rotor being lifted by the main powerhouse crane.

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Dear Business Partners

After years of solid growth, hydropower remains, a stabilizing factor in 2009 in the current climate of worldwide financial crisis and thus forms the basis for the business success of ANDRITZ HYDRO.

In Europe, the steadily rising demand for peak power, as well as the increasing utilization of wind, has led to additional investments in pumped storage. This trend is exemplified by the Baixo Sabor pumped storage power plant in Portugal for which ANDRITZ HYDRO received the order in early 2009.

The stability of the European market is further underlined by investments in the refurbishment of existing hydropower installations and environment-friendly run-of-river power plants such as Iffezheim in Germany or Gössendorf and Kalsdorf in Austria. Moreover, the implementation of innovative technologies such as HYDROMATRIX®, to be installed in Ashta, Albania, opens new opportunities for hydropower.

In North America, investments in renewables have been boosted in recent years by the launch of trading with green certificates. Several hydropower plants, including John H. Kerr, Mossyrock, High Falls and Sir Adam Beck, which were equipped by ANDRITZ HYDRO, were able to start their “green” electricity production in 2009.

For many years, South America in general and Brazil in particular, have relied on hydropower as a response to increasing energy demand. By mid 2012, the Jirau hydropower plant, with the world’s largest bulb units, supplied by ANDRITZ HYDRO, will contribute essentially to these endeavours.

In Asia, India has again demonstrated its ability for further development in difficult global times. Additional investments in hydropower have been triggered to counteract the permanent rise in energy consumption. International financing agencies such as the Asian Development Bank are supporting this trend, as shown by the Sawra Kuddu hydropower plant in the far northwest of the country.

ANDRITZ HYDRO’s solid technological background, excellent worldwide reputation and such positive market developments allow us to remain with a confident view of the future.

H. Heber
W. Semper
M. Komböck
Having acquired VA TECH HYDRO in 2006, ANDRITZ was also interested in gaining technological benefits and additional market presence through the takeover of GE Hydro.

GE Hydro in Canada has long enjoyed a global reputation as a manufacturer of hydropower turbines and generators. During the 1990s, the company had a cooperation agreement with MCE and Elin (former VA TECH companies) relating to both turbines and generators. These agreements were terminated when Sulzer Escher Wyss joined the Austrian firms.

Having acquired VA TECH HYDRO in 2006, ANDRITZ was also interested in gaining technological benefits and additional market presence through the takeover of GE Hydro.
Negotiations commenced in early 2008 and were successfully concluded by the middle of the year when GE Hydro became part of the ANDRITZ Group.

The former GE Hydro not only consisted of companies in Canada, but also the former turbine manufacturer Kvaerner and a joint venture with Inepar in Brazil. Canada was the location for R&D, two turbine and generator engineering offices and a manufacturing facility. The latter contained a stator bar plant, which was taken over by ANDRITZ during the acquisition. The joint venture in Brazil included sales, engineering and a cooperation agreement with Inepar’s large-scale production shop where complete generators, including the active parts, can be manufactured. GE’s shares in this joint venture were transferred to ANDRITZ so that ANDRITZ HYDRO has now a very strong basis in Brazil. Furthermore, there are also companies in Finland and Sweden, which have come from the former Kvaerner.

The addition of the previous GE Hydro companies has greatly enlarged ANDRITZ HYDRO’s portfolio. GE Hydro was well known as a manufacturer of very large equipment such as the generators for the Three Gorges scheme in China (840 MVA and 75 rpm) and Guri II in Venezuela (805 MVA and 112.5 rpm) and many other projects. The Brazilian operation also has extensive experience with large machines, especially in the South American market, and was a component supplier to GE Hydro Canada for the Three Gorges generators.

The diagram shows ANDRITZ HYDRO’s references including those from the former GE Hydro (Fig. 1).

As is evident, the combined references range from approximately 20 MVA to 840 MVA and the speeds vary from very low to 1,500 rpm, which corresponds with four-pole machines in the 50 Hz grid. As a result of this expansion, our generator portfolio covers every market requirement, except for very small units in the lower Compact range. Therefore, we can literally supply every need.

In addition to the references and vast generator experience acquired through the takeover, we have also expanded our generator technology. Until last year, our company only had Vacuum Pressure Impregnation (VPI) insulation available for the high-voltage insulation of the stator windings of large generators. Now, in addition, we possess a high quality Resin-Rich autoclave cure system, and in Brazil we also have a Resin-Rich press cure system. Both systems require completely different insulation material, manufacturing technology and equipment.

Although technologically dissimilar, both systems possess excellent insulation properties even under very tough conditions and with Resin-Rich in our technology portfolio, we are now able to meet specific customer requirements, especially in the North American market. The table lists the differences in properties and also in the production process and shows that the dielectric properties are comparable (Fig. 2).

As a result of its experience with very large, high-rating generators, the former GE Hydro had developed an excellent knowledge of rim duct ventilation systems. This is the most suitable ventilation system for very large machines, especially those with extensive stator core lengths.

It utilizes ducts in the laminated rotor rim as fans and therefore ensures balanced

<table>
<thead>
<tr>
<th>VPI</th>
<th>Resin Rich</th>
</tr>
</thead>
<tbody>
<tr>
<td>With heated molds</td>
<td>With asphalt pressure molding</td>
</tr>
<tr>
<td><strong>Strand insulation – dielectric strength</strong></td>
<td>Negligible difference between systems</td>
</tr>
<tr>
<td><strong>Insulation tape</strong></td>
<td>Mica paper with glass fabric carrier and without resin</td>
</tr>
<tr>
<td><strong>Number of insulation layers</strong></td>
<td>Depending on rated voltage no appreciable difference between systems</td>
</tr>
<tr>
<td><strong>Internal potential grading for optimized field distribution in the main insulation</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Corona protection with tapes</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Vacuum impregnation with epoxy resin</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Winding overhang section of bar</strong></td>
<td>Winding overhang and slot section - same materials</td>
</tr>
<tr>
<td><strong>Composition of main insulation</strong></td>
<td>approx. 65% approx. 28%</td>
</tr>
<tr>
<td><strong>Main insulation dielectric strength</strong></td>
<td>Negligible difference between systems</td>
</tr>
<tr>
<td><strong>Partial Discharges within the insulation (PD level)</strong></td>
<td>Pressed – slightly higher due to lack of vacuum</td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
<td>Very low, no micro voids; PD/single bar lower than 2 nC</td>
</tr>
<tr>
<td><strong>Low viscosity resin during heating results in very few retained voids</strong></td>
<td>Very low, no micro voids; PD/single bar lower than 2 nC</td>
</tr>
<tr>
<td><strong>void-free insulation by removal of air through the vacuum process</strong></td>
<td>Void-free insulation by removal of air through the vacuum process</td>
</tr>
<tr>
<td><strong>Penetration of impregnating resin into the insulation to fill the voids</strong></td>
<td>Presence of pre-impregnated tapes ensures maximum void fill particularly near bare bar</td>
</tr>
<tr>
<td><strong>Minimization of corona activity</strong></td>
<td>Achieve extremely low levels of PD</td>
</tr>
<tr>
<td><strong>Achieve very low levels of PD</strong></td>
<td>High temperature capability</td>
</tr>
<tr>
<td><strong>High temperature capability</strong></td>
<td>High temperature capability</td>
</tr>
</tbody>
</table>

![Thrust Bearing Assembly](Fig. 2 Comparison of VPI and Resin-Rich insulation systems)
cooling over the entire stacking length of the generator. This ventilation design know-how not only helps to achieve the required temperature limits within the generator, but also provides generally uniform temperature distribution with a positive impact on thermo mechanical stresses and component life.

On the basis of the vast dimensions of these generators, GE also acquired a great deal of experience with the on-site fabrication of large components such as stator frames, rotor spiders and bearing brackets. Transportation limits normally prohibit the passage of components with diameters larger than 6 – 8 m and therefore final assembly has to take place on site. The former GE Hydro utilized spring-supported bearing pads for thrust bearings, whereas we employ pivot-supported bearing pads.

For large bearing pad dimensions, the spring support provides superior bearing pad flatness and thus secures a higher load carrying capability with the same bearing surface area. Conversely, pivot-supported pads are subject to the thermal deflections emanating from the temperature difference between the upper and the lower side of the bearing pad. Spring-supported thrust bearings constitute a genuine advantage for very high bearing loads and even when higher specific bearing pressure is used, they ensure a sufficient oil film gap. A bearing failure only occurs when the oil film is bridged. This is influenced by the thickness of the oil film and is not dependent on the bearing temperature itself. The mattress bearing has the advantage of providing safe operation with a high specific bearing load. A higher bearing temperature is evident, which has no negative influences on the safe operation of the bearing, but reduces friction losses. In times of very high loss evaluations, clients are advised to take this into account.

In the course of our generator engineering integration process, we have already defined application limits for these two bearing technologies. This gives us the opportunity to optimize thrust bearing design according to the specific needs of a project, while also incorporating the economic benefits of lower friction losses (Fig. 3).

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Fig. 3 Thrust bearing load and speed
Ruacana 4
Extension Project in Namibia

Some thirty-five years ago, young graduate engineers witnessed the birth of a new company, which today is known as ANDRITZ HYDRO. At the time, the same engineers participated in the testing of turbine models for a hydropower plant project in Namibia, at the company’s hydraulic laboratory in Linz. Accordingly, they are justly proud of the fact that NamPower has again selected ANDRITZ HYDRO for the supply of the fourth unit for Ruacana, its most important hydropower plant.

Namibia, the former “German South West Africa”, is a nation famous for its extensive deserts and arid climate and therefore, visitors to the country are surprised to learn that hydropower is the main source of electricity. The only rivers with water throughout the year are those on the borders with South Africa in the south and Angola in the north, where the Ruacana project is located.

With its 240 MW installed capacity, Ruacana is by far the largest electricity generation plant in Namibia and accounts for more than 80 % of NamPower’s annual production. Due to increasing demand, NamPower decided to add a fourth unit to the existing cavern-type powerhouse. The civil works, such as the cavern and penstock tunnelling, were already completed 30 years ago, and as the client was completely satisfied with the existing equipment, ANDRITZ HYDRO was awarded the contract for the extension of the plant in a consortium with Alstom (France). After lengthy negotiations, the contract was signed on March 13th, 2009 at the ANDRITZ offices in Johannesburg, South Africa. The scope of delivery for ANDRITZ HYDRO consists of the complete mechanical equipment and hydraulic steel structures, including the inlet valve (3,600 mm), the penstock, the vertical Francis turbine and mechanical auxiliaries. Alstom is to provide the generators and the electrical equipment. The consortium will also carry out turnkey installation, commissioning and testing of the unit and the start of commercial operation is expected in 2012.

The plant, which is located on the Kunene River on the border with Angola, will contribute additional clean energy at an almost 95% efficiency rate to the Namibian electricity grid, which at present is largely dependent upon imports. The new unit with increased capacity and efficiency will also be the main operating unit during the dry season with its low water levels.

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**TECHNICAL DATA:**
- OUTPUT: 92 MW / 100 MVA
- HEAD: 131 m
- SPEED: 272 rpm
- RUNNER DIAMETER: 3,237 mm
Over the years, the Albanian power grid has been subject to lengthy and frequent power cuts due to drought, the dilapidated state grid of the communist era and a failure to build new generation capacity. As a result, a large percentage of national power demand has to be covered by energy imports from neighboring countries such as Greece.

The Albanian government is seeking to attract foreign investment and improve the country’s energy supply situation through the award of Build Operate Transfer (BOT) concessions for the construction of new hydropower plants like Ashta. In September 2008, ENERGIJ ASHTA Shpk, a 100% subsidiary of VERBUND-International, received the concessional rights for a period of 35 years, after which it will be obliged to hand over the power plant to the Albanian authorities.

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Concepts for the utilization of this section of the Drin River have existed since the 1990s. However, conventional hydropower technology proved to be infeasible at the proposed site. Therefore, the most important aspects of the development process were the optimization of economic feasibility and the minimization of environmental impact. Following the technical and financial assessment of available hydropower technologies, a two-plant arrangement using the HYDROMATRIX® system emerged as the best solution and this formed the basis for the concession bid. Astha will be the fourth plant on the Drin River but the first to be built for 30 years. After the award of the concession, VERBUND-International, PÖYRY ENERGY and ANDRITZ HYDRO started an intensive, tenmonth design phase during which the plant concept was jointly developed and subjected to detailed optimization.

General layout
The Ashta I & II hydropower scheme is located on the Drin River near the city of Shkodra and will feature two similarly designed power plants. Ashta I will be erected next to the existing Spathara weir, which is located downstream of the Vau i Dejes power plant. It will feature an intake trashrack along with a trashrack cleaning machine. The Ashta I tailrace will consist of a 6 km long canal linking the two plants and an additional diversion channel connecting the plant with the Drin River.

With the exception of one trashrack, the Ashta II plant will have a similar design to that of Ashta I and will be connected with its tailrace to the Drin River by a short canal. The chosen route for the canals allows independent use of the two plants during construction and avoids environmental impact on the existing infrastructure and valuable farm land.

The HYDROMATRIX® Solution
HYDROMATRIX® is a modular system in which a number of small Turbine-Generator (TG) units are installed in so-called modules to form matrix-like configurations. In HYDROMATRIX® plants, each module consists of one or more identical TG units, which are interfaced via integrated or separately installed draft tubes.

One of the great advantages of HYDROMATRIX® plants is provided by the fact that only a low tail water depth is required and therefore shallow powerhouse foundations are possible. This results in considerable construction cost savings. Moreover, the possibility for the removal of the TG units during flooding and for maintenance is another important feature and allows the Ashta projects to be built in a very short time period as compared to conventional run-of-
river hydropower plants. At the Ashta hydro project, each power plant will be equipped with forty-five HYDROMATRIX® TG units which will be mounted at the upstream face of a concrete gravity dam structure. The TG units are arranged in one row in front of the dam structure and can be lifted individually for service. The associated draft tubes are embedded in the dam structure. The hydraulic and electrical equipment is placed inside an underground gallery located above the draft tubes. Water flow can be stopped separately for each machine by a sliding gate on the downstream face of the dam structure. In the case of gate maintenance, the same lifting crane is used as that for the TG units.

Innovative generator technology and grid connection concept

The design of the TG units derives from the classic concepts for small, compact hydro turbines and has been further developed to address the need for high reliability, low-maintenance and easy grid interconnection. The TG units for the Ashta HPP will consist of unregulated turbines and be equipped with synchronous generators using state-of-the-art permanent magnet (PM) technology. ANDRITZ HYDRO has successfully developed and applied PM generator technology in its StrafloMatrix™ units and is now extending its application to the HYDROMATRIX® units. Although the frequency and voltage regulation provided by conventional hydro units are not possible, HYDROMATRIX® plants using PM-generators operate synchronously with the distribution system, which provides an advantage in applications where a large number of induction-type generators may not be feasible. The power generated at 3.3 kV will be transferred to the switchgear via underwater cable chains and subsequently stepped up to 20 kV using nine transformers located inside the underground gallery. The 20/110 kV main power transformers will be located in two switchyards at flood-free elevations close to the respective powerhouses. A medium voltage cable connection between the two switchyards will provide greater flexibility in scheduled maintenance work on the high voltage equipment. The proposed electricity scheme complies fully with the interconnection requirements of the Albanian grid and has been accepted by the Albanian authorities.

Fast track construction

Since the basic design of the two plants is already complete and detailed design is progressing rapidly, the manufacture of the plant components can already begin during this year. Site excavation and the construction work are planned to commence in January 2010 with the first draft tubes being installed in May 2010. Ashta I is scheduled to become operational in May 2012, with Ashta II following in autumn 2012. The award of the Ashta I & II contract is another important milestone in the continuous development and successful application of the HYDROMATRIX® product and confirms ANDRITZ HYDRO’s competences in the development of innovative hydropower projects in emerging electricity markets.

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TECHNICAL DATA: Ashta I
OUTPUT: 45 x 534 kW
TOTAL OUTPUT: 24.03 MW / 24.64 MVA
VOLTAGE: 3.3 kV
HEAD: 4.98 m
SPEED: 300 rpm
RUNNER DIAMETER: 1,320 mm

TECHNICAL DATA: Ashta II
OUTPUT: 45 x 1,003 kW
TOTAL OUTPUT: 45.14 MW / 46.29 MVA
VOLTAGE: 3.3 kV
HEAD: 7.53 m
SPEED: 375 rpm
RUNNER DIAMETER: 1,320 mm
During July 2009, in a consortium with Alstom, ANDRITZ HYDRO was awarded a contract by Dagachhu Hydro Power Corporation Limited (DHPC) for the supply of key electromechanical and hydro-mechanical equipment to a new hydropower plant in Bhutan. This award marked the successful end of an intensive negotiation process, which commenced in November 2008.

The Dagachhu hydropower project is located in the district of Dagana in south-west Bhutan. It uses the water of the Dagachhu River, which is a tributary of the Punatsangchhu (Sankosh) that drains into the Brahmaputra in India. The project is a run-of-river power plant, featuring a 20 m high diversion weir, a headrace tunnel of approximately 8 km in length and a surge shaft leading to the underground powerhouse. The high head power plant (annual energy of 515 GWh) is to be built over a period of roughly four years and should become operational by the end of 2012.

ANDRITZ HYDRO is to supply two, 6-nozzle Pelton turbines, the inlet valves and the hydraulic steelwork for the weir, the intake, desilter and powerhouse.

This project marks another milestone in the development of hydropower resources in the Kingdom of Bhutan. It is estimated that the country has total hydropower potential in excess of 20,000 MW, of which a mere 5% have been harnessed to date. The export of hydroelectric power is one of the primary sources of revenue for Bhutan and at present, accounts for some 45% of total revenues. Sustainable renewable energy development will contribute to two of the four pillars of Gross National Happiness (GNH) and is a means of raising national income. Current government plans foresee an increase in hydropower capacity of 12,000 MW by the year 2020.

The electricity generated by the Dagachhu project will be exported mainly to India, thus further increasing electricity export revenues. In addition, this project is being implemented under the Clean Development Mechanism (CDM) of the Kyoto Protocol, thereby generating emission certificates, which will be sold on the international carbon markets.

The Dagachhu powerplant is to be financed with equity from Bhutan’s Druk Green Power Corp., as well as from Tata Power in India. The Asian Development Bank (ADB) and the Oesterreichische Kontrollbank (OeKB) are supplying loan financing. The Austrian Development Cooperation (OEZA) paved the way to realization of this project through its many years of successful collaboration with the Bhutanese authorities, which has already resulted in the Basochhu power plant contract. The Upper Stage (2 x 14 MW) and Lower Stage (2 x 21.4 MW) were successfully completed in 2005. ANDRITZ HYDRO also supplied the complete mechanical equipment for both projects.

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**TECHNICAL DATA:**

| OUTPUT | 2 x 62.2 MW |
| HEAD | 282 m |
| SPEED | 277.7 rpm |
| RUNNER DIAMETER | 2,450 mm |
Gössendorf / Kalsdorf
New hydropower plants in Southern Austria

Following a lengthy tendering process, Energie Steiermark AG in Austria allocated ANDRITZ HYDRO a contract for the design, supply, installation and start-up of the electro-mechanical systems for the Gössendorf and Kalsdorf hydropower plants, which are to be built south of Graz.

ANDRITZ HYDRO is to deliver four bulb turbines along with speed governors, generators and exciter systems. Apart from providing of turbines and generators, the scope of deliveries from ANDRITZ HYDRO also includes plant installation. Energie Steiermark and VERBUND-Austrian Hydro Power AG (AHP) are to build the two hydropower plants, each of which will have an output of around 20 MW, which as planned will supply some 45,000 households with renewable energy from hydro power sources from 2012 and 2013 respectively. Owing to supplementary measures, in addition to energy generation the new power plants will also serve to provide flood protection. The plant construction project is being accompanied by extensive ecological engineering and following completion will enhance the quality of life available in the areas along the River Mur. The manufacture of the generators in Weiz and the turbine components in Graz guarantees both the shortest possible reaction times during the realisation and assembly phase, as well as a high level of local value added. The two production centers are located just a few kilometres away from the Gössendorf and Kalsdorf power stations.

With this contract, ANDRITZ HYDRO has again underlined the successful nature of its long-term teamwork with Energie Steiermark and its excellent market standing in the Austrian hydropower market.

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TECHNICAL DATA: Gössendorf
OUTPUT: 2 x 10.25 MW / 12.5 MVA
VOLTAGE: 6.3 kV
HEAD: 10.85 m
SPEED: 150 rpm
RUNNER DIAMETER: 3,600 mm
STATOR DIAMETER: 4,500 mm

TECHNICAL DATA: Kalsdorf
OUTPUT: 2 x 10.22 MW / 12.5 MVA
VOLTAGE: 6.3 kV
HEAD: 10.78 m
SPEED: 150 rpm
RUNNER DIAMETER: 3,600 mm
STATOR DIAMETER: 4,500 mm
Augst-Wyhlen and Laufenburg
Modernization of three Hydropower Plants on the River Rhine

During April 2009, ANDRITZ HYDRO Automation received an order for the modernization of the control technology equipment of the Augst-Wyhlen and Laufenburg hydropower plants on the River Rhine.

Augst-Wyhlen
The cantonal city of Basel and the Kraftübertragungswerke Rheinfelden built the Augst-Wyhlen barrage between 1908 and 1912. The plant consists of the Wyhlen power plant on the German bank of the Rhine and the Augst power plant, as well as the jointly managed weir and watergate on the Swiss bank of the river.

In both plants the powerhouses lie parallel to the direction of flow and the impound water is used for the production of electricity. The amount of water employed in the twin power plants is shared equally between Augst and Wyhlen.

The original turbine plant consisted of ten Francis turbines for each plant with a horizontal shaft configuration. Two smaller turbines of a similar type were used to actuate the exciter machines, which provided the magnetising current.

The Augst-Wyhlen twin power plants were totally rebuilt between 1990 and 1994. In the Augst power plant, six of the existing ten Francis turbines, the generators and the exciter machines were replaced with seven modern Straflo™ units. Furthermore, two Francis units were modernized and the other two decommissioned.

In the Wyhlen power plant, five of the existing ten Francis units were modernized, followed by two exciter machines, which were replaced by six state-of-the-art Straflo™ units. The rated water flow was thus raised from 850 m³/sec to 1,500 m³/sec.

All ten Francis turbines were replaced by ten Straflo™ units during a total plant rebuild in the years 1989 to 1994. The rated water flow was increased to 1,370 m³/sec and the power output to 106 MW. The four weirs are 17.3 m wide and consist of upper and under plates.

Scope of supply of these contracts
The scope of supply ANDRITZ HYDRO consists of all the control technology equipment for 23 Straflo™ and seven Francis turbines. All three power plants will be virtually identically equipped using our NEPTUN concept and modernization is to focus on the following parts:

- Start/stop sequence, mechanical protection, electrical turbine governor, all excitation and vibration devices, as well as the synchronization devices
- Redundant client/server control system for all three power plants
- LAN infrastructure according to IEC 60870-5-104 based on Ethernet for all three plants
- 6.8 kV busbar protection for the Augst power plant
- Generator and transformer protection.
- Complete automation system for the 50/110 kV substation realized using SICAM BC1703
- Complete automation system for the Augst and Wyhlen cooling and drainage systems
- Connection to the existing cooling and drainage system and the Laufenburg weir
- The Augst-Wyhlen water management system and sub-controllers for Laufenburg, consisting of a water management system, unit deployment control, emergency level and reservoir control
- Reservoir simulation for both Augst-Wyhlen and Laufenburg
- All auxiliary systems.

ANDRITZ HYDRO received the highest rating for the “economics” award criterion, the award of multiple lots, and the best rating for the technical solution. In view of these assessments, the commercially favorable offer was adopted. A fundamental aspect of these

Laufenburg
The Laufenburg Rhine power plant was built between 1909 and 1914. The ten Francis units originally installed were designed to produce power output of 40 MW. However, due to the high demand for energy, the power plant was modernized in the 1920s, when the water flow was increased, thus raising the power output to 81 MW.

All ten Francis turbines were replaced by ten Straflo™ units during a total plant rebuild in the years 1989 to 1994. The rated water flow was increased to 1,370 m³/sec and the power output to 106 MW. The four weirs are 17.3 m wide and consist of upper and under plates.

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ratings was the detailed and optimized project timetable. Due to the combination of project activities and the strategic timing for unit disassembly and reassembly, which accounts for summer and winter water levels, the project execution phase is to be reduced from an original three years to 30 months. Due to the NEPTUN concept and the use of international standards, a fully integrated system with a consistent communication structure is to be provided, which will offer a solid basis for further extensions. The partial replacement of the excitation system poses a technical challenge. In the coming years, 28 excitation systems will be replaced by ANDRITZ HYDRO GMR3 voltage regulators. This highly sophisticated and durable voltage regulator, which is an ANDRITZ HYDRO in-house development, can be used easily for excitation systems from other suppliers, as impressively demonstrated by this project. The new components will be installed in the existing racks using a retrofitting procedure. The core component will be mounted in a 19” swinging frame. Simple handling and access to all components are the key factors in this solution. The scope of supply with regard to the protection devices consists of generator protection for all units, as well as full transformer and busbar protection. The DRS digital relays meet system the differing demands of this project due to their freely configurable protection function. As an integral part of the NEPTUN concept, DRS uses the existing communication channels for data transmission and disturbance records. This project shows impressively, that through the optimised use of the integrated NEPTUN concept together with the retrofit procedure for the easy mounting of parts into existing cubicles, maximum adaptability and flexibility can be achieved.

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TECHNICAL DATA: Augst
OUTPUT: Straflo™ 7 x 5 MVA
VOLTAGE: 6.8 kV
HEAD: 6.7 m
SPEED: 93.75 rpm
RUNNER DIAMETER: 3,800 mm

OUTPUT: Francis 2 x 2.8 MVA
SPEED: Francis 107 rpm
RUNNER DIAMETER: Francis 1,500 mm

TECHNICAL DATA: Wyhlen
OUTPUT: Straflo™ 6 x 5 MVA
VOLTAGE: 6.8 kV
HEAD: 6.7 m
SPEED: 93.75 rpm
RUNNER DIAMETER: 3,800 mm

OUTPUT: Francis 5 x 2.8 MVA
SPEED: Francis 107 rpm
RUNNER DIAMETER: Francis 1,500 mm

TECHNICAL DATA: Laufenburg
OUTPUT: Straflo™ 10 x 12 MVA
VOLTAGE: 10.5 kV
HEAD: 10.1 m
SPEED: 107 rpm
RUNNER DIAMETER: 4,250 mm
In 2004, Comisión Federal de Electricidad (CFE), the main electricity producer in Mexico, awarded ANDRITZ HYDRO with Phase I of the upgrading project at the La Villita Power Plant. The contract comprised the replacement of two Francis turbines, modifications to the stay vanes and the draft tube, and other site repairs. During 2006, the performance tests were successfully concluded with better results than were contractually required, which added up to weighted efficiency of 91.5% and an increase in power output from 76 MW to 82.5 MW (regulating ring only 85% open). Other benefits included a more than 30% reduction in vibration levels and minor downstream water turbulence, as compared with the old turbines.

As a consequence, CFE decided to upgrade the Infermillo power plant, which is Mexico’s third largest hydropower facility. Awarded in 2006, the contract defined the replacement of four Francis runners, the modernization of the corresponding turbine and generator guide bearings, equipping with new oil cooling systems and instrumentation. The Swiss CFD study with the optimization of the hydraulic profile and runner’s behavior allowed an increase in turbine output of 25% from 160 to 200 MW. A semi-homologous model test was carried out to validate the guaranteed increase in efficiency and turbine output power. The results of the performance tests (Gibson Method) in February 2009 were again very pleasing: 205 MW output and 93.44% measured weighted efficiency (as opposed to the contractually required 200 MW and 92.21%) gave CFE a remarkable payback period of seven months. On the basis of these outstanding results, in April 2009 CFE decided to accelerate the rehabilitation and upgrading of a further five HEPPs and started the corresponding bidding process. In August 2009, ANDRITZ HYDRO Mexico was awarded with the five contracts with the following characteristics and scope of supply:

**La Villita II**
The La Villita power plant is equipped with four vertical Francis turbines, which were installed by Mitsubishi in 1973. CFE’s objectives for this second phase of the modernization process is to increase the power output and efficiency values of the remaining units 1 and 4. The scope of supply includes two 52 t Francis runners, the stay vanes, hydraulic profile modifications, new fins for the aeration system and modifications to the draft tube hydraulic profile. The project is scheduled for completion in less than two years and commissioning of the second unit for June 2011.

**Santa Rosa**
The Santa Rosa power plant, which is located in Amatlán, Jalisco, very close to the city of Tequila, the original home of the world-famous alcoholic drink was put into operation in 1964. The plant is equipped with two Toshiba Francis turbines and CFE intends to increase both its output and weighted efficiency. The preliminary hydraulic engineering was completed by our experts in Zurich, Switzerland on the basis of the drawings of the existing units provided by our local engineering department in Morelia, México. The excellent cooperation between the two departments allowed ANDRITZ HYDRO to guarantee CFE that, apart from the new runners, no further modifications would
be required to achieve the specified values. Start-up of the second unit is scheduled for October 2011.

Cupatitzio
The Cupatitzio HEPP is located near the city of Uruapan, the aptly named "World Capital of the Avocado", which has an ideal climate for the growth and ripening of this fruit. Cupatitzio’s two Ansaldo vertical Pelton turbines, dating from 1962, are to be replaced by new units together with four nozzles, their respective jets / deflectors and the complete speed governors (hydraulic and electronic supplies). The new runners will be manufactured at ANDRITZ HYDRO’s facility in Morelia, Mexico, using HIWELDTM technology, forged discs and individually cast buckets. The engineering and manufacturing of the speed governors will also be completed in Morelia, Mexico, while the nozzles and deflectors will be designed and manufactured in Switzerland.

El Cóbano
The El Cóbano HEPP is also located close to the city of Uruapan. Its two vertical Francis turbines were supplied by Voith in the 1950s and, due to small differences in design, the runners are not interchangeable. The units mainly present operating problems in the upper combined generator bearings and in the lower guide generator bearings and therefore, in addition to increases in output and efficiency, the combined and guide generator bearings are to be totally redesigned. The preliminary hydraulic engineering was carried out by ANDRITZ HYDRO Zurich on the basis of drawings of the existing units provided by our local engineering department in Morelia, Mexico. Morelia will also complete the redesign of the bearings, including the new lubrication and oil cooling systems. Although the two original runners are different, our experts in Zurich have been able to create a common hydraulic design with only marginal differences on the external part of bands and crowns, and minor adjustments in the fixed parts of one of the turbines. This new design will guarantee the output and efficiency values, and commissioning of the second unit is scheduled for October 2011.

Colotlupa
The Colotlupa power plant is situated on the confluence of two rivers in the town of Chilpancingo, near the famous Bay of Acapulco on the Mexican Pacific coast. James Leffel delivered the four small horizontal Francis turbines between 1947 and 1956. CFE will receive new runners with optimized hydraulic profiles in order to match the new operating conditions. Due to the water limitations in the region and the existing generator capacity, CFE has decided to maintain the original output values and increase the weighted efficiency to 90%. In this case, the work of our Swiss hydraulic specialists has allowed us to guarantee CFE’s goals without modifications to the fixed parts of the turbines. After positive experience gained at La Villita I and Infiernillo, Comisión Federal de Electricidad is very confident with regard to ANDRITZ HYDRO's technical ability to realize these new modernization projects, which will enhance the reliability of the units and provide major benefits from existing hydraulic resources.

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<table>
<thead>
<tr>
<th>TECHNICAL DATA: La Villita II old / new</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTPUT: 4 x 76 / 80 MW</td>
</tr>
<tr>
<td>HEAD: 41.8 m</td>
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<tr>
<td>SPEED: 120 rpm</td>
</tr>
<tr>
<td>RUNNER DIAMETER: 5,300 mm</td>
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<table>
<thead>
<tr>
<th>TECHNICAL DATA: Santa Rosa old / new</th>
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<tr>
<td>OUTPUT: 2 x 30.6 / 35 MW</td>
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<tr>
<td>HEAD: 71 m</td>
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<tr>
<td>SPEED: 225 rpm</td>
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<td>RUNNER DIAMETER: 2,740 mm</td>
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<table>
<thead>
<tr>
<th>TECHNICAL DATA: Cupatitzio old / new</th>
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</thead>
<tbody>
<tr>
<td>OUTPUT: 2 x 36 / 40 MW</td>
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<tr>
<td>HEAD: 450 / 456 m</td>
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<tr>
<td>SPEED: 450 rpm</td>
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<td>RUNNER DIAMETER: 3,173 mm</td>
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<table>
<thead>
<tr>
<th>TECHNICAL DATA: El Cóbano old / new</th>
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</thead>
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<tr>
<td>OUTPUT: 2 x 26.01 / 30 MW</td>
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<tr>
<td>HEAD: 335 m</td>
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<tr>
<td>SPEED: 600 rpm</td>
</tr>
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<td>RUNNER DIAMETER: 1,750 mm</td>
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<table>
<thead>
<tr>
<th>TECHNICAL DATA: Colotlupa</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTPUT: 4 x 2,125 kW</td>
</tr>
<tr>
<td>HEAD: 60 m</td>
</tr>
<tr>
<td>SPEED: 600 rpm</td>
</tr>
<tr>
<td>RUNNER DIAMETER: 800 mm</td>
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Statkraft - Bundle Buy Contracts

New Francis and Pelton Runners for Norway

With reference to our article in Hydro News No. 13 / 2008 relating to the upgrading of Francis turbines owned by Statkraft and BKK, we are pleased to report that the client is very satisfied with both the technical performance and the project execution. Francis package No. 1 has been completed and Francis package No. 2 is running smoothly.

Statkraft is a demanding and professional client, who not only evaluates price and performance. The company also has a very high focus on health, safety & environment (HSE) and is aiming at a zero-incident goal. On schedule delivery is vital, as plant downtimes are critical for the Norwegian electricity grid. Grid operations are planned and decided upon well in advance and, therefore, predictable. Reliable monthly reporting of progress and possible deviations from all the ANDRITZ HYDRO companies involved is an important issue, along with the ability to take corrective action. The positive experience from three completed bundle buy upgrading projects resulted in the issue of tender documents for three new bundle buy projects in late 2008. In the face of strong competition and after negotiations, ANDRITZ HYDRO AS, Norway was awarded the two largest contracts. These were signed in Statkraft's offices in Oslo on June 10, 2009.

The bundle buy contract for the No. 4 Francis package includes:
- Höyanger K5, 68 MW
- Leirdöla, 125 MW
- Lio, 43 MW
- Vinje, 100 MW
- Option for two remaining units in Vinje.

The original supplier of these medium to high head Francis turbines was Kvaerner. The new runners will be manufactured in our workshops in Madrid Spain and Ravensburg Germany.

The bundle buy contract for the No. 2 Pelton package includes:
- Skjømen, 103 MW
- Grytten, 149 MW
- Svelgen II, 2 x 15 MW
- Nore I, 3 x 26 MW
- Option for two more units in Nore I.

The original suppliers of these turbines were Kvaerner, Voith and Neyrpic. All the new MicroGuss™ Pelton runners will be manufactured in Kriens.

In total, including options, the two contracts add up to 21 newly upgraded runners, as some of the Pelton units consist of horizontal twin turbines. Several hydraulic layouts, FEM and CFD analyses for all the plants are being carried out by the R&D department in Zurich Switzerland. No more model tests are foreseen for the two packages. Project management will be provided by ANDRITZ HYDRO AS, Norway and well-proven procedures, developed and tuned to fit the client's wishes during the previously completed projects will be again be followed. The projects include the refurbishment and modification of the existing surroundings of all units, which adds up to more than 70,000 workshop man-hours for ANDRITZ HYDRO AS, spread over the years of completion. Naturally, this provides important basis use of capacity workload for our Norwegian set-up and this figure does not even include the workshop hours for runner manufacture. Installation supervision and commissioning will be carried out from Norway. Statkraft will monitor this concept and they have announced another bundle buy invitation to tender in due course. Furthermore, a similar process is to be launched for Kaplan runners in Sweden, and Statkraft is currently preparing internal feasibility studies to determine the profitability of the projects in its Swedish fleet.

There is no green certificate system or subsidies of any kind on investments in renewable energy in Norway. Accordingly, ROI has to be generated out of the income from future electricity production. The Norwegian power market was liberalized in 1991 and electricity is traded on the “Nord Pool power exchange”. Electricity prices are determined by market demand. On this basis the marketing departments in different utilities have to estimate the long-term electricity price trend, which decides the payback and viability of each individual project. In this respect, Statkraft is an important player, as it is by far the largest Norwegian power utility. Its actions send signals to the other utilities along with inputs regarding assessments of future electricity price development. In addition to the Statkraft bundle buy projects mentioned above, we have 14 upgrading projects for other Norwegian power utilities at present in our order backlog.

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Cameroon is a West African country with an area of 475,650 km², bordered to the west by Nigeria, to the south by the Democratic Republic of Congo, Gabon and Equatorial Guinea, to the east by the Central African Republic and to the north-east by Chad. The population of Cameroon is estimated to number approximately 17 million.

It is said that Cameroon is Africa in miniature. The forested south, which is located in the maritime and equatorial zones, is characterised by dense vegetation, a vast hydrographical network and a hot, wet climate with abundant rainfall. The south is also the location of the country’s two main cities, Yaounde, the capital, and Douala. The high plateaus of the west form an area of rich volcanic soil, which favors to agriculture. The north is an area of savannah and steppe where cattle breeding is the predominant occupation. In the south-west, Cameroon has a maritime border of more than 420 km, running along the Atlantic Ocean. During the colonial era, both France and Britain controlled the country, which as a result has French and English as its official languages. The French-speaking part of Cameroon gained independence in 1960 and was followed by the English-speaking region in 1961. Executive power is exercised by a president elected for seven years and with one renewable mandate. His Excellence Mr. Paul Biya currently occupies this function. The National Assembly composed of 180 deputies exerts the legislative power. Judicial authority is in the hands of the Supreme Court.

Energy in Cameroon
Cameroon has large gas reserves, but unfortunately extraction is limited. Studies are currently under way in order to start large-scale exploitation in the very near future. Oil production, which boomed in the 1970s, has been slowing down for a number of years. Reserves are declining year by year and, therefore, if new fields are not discovered soon, Cameroon will become dependent upon imports for domestic consumption.

Cameroon also has significant forestry potential. The Cameroonian forests are sources of wood energy for the vast majority of the population. However, the forests are shrinking because of intensive industrial exploitation and agriculture using slash and burn methods.

Hydropower in Cameroon
As far as hydropower is concerned, after the Democratic Republic of Congo, Cameroon has the second highest capacity in Africa, with an electricity production park estimated at 1,337 MW and also possesses hydropower potential of approximately 20 GW. At present, only 6% of this energy capacity is used, but the scope for exploitation is considerable.

From 2000 to 2006, hydropower park production varied very little. However,
Edéa hydroelectric projects

The Edéa sales team at the contract signing ceremony

slight growth in electric output installed was evident between 2003 and 2006, especially following the rehabilitation of the Song Loulou power plant by ANDRITZ HYDRO.

The problems involved in the power sector are related to the overall lack of production capacity and in particular, to delays with regard to investments, the obsolescence of the installations, the saturation and low availability of production equipment, the state of the roads (material and labor transport), the failure to adhere to replacement dates, and a general shortage of maintenance.

Moreover, the sector is characterized by a low level of household access to electricity, especially in rural areas. This is due primarily to the high costs of connection to the transmission lines. The development of street lighting in Cameroonian cities is also extremely slow and those systems that do exist are in a state of advanced disrepair owing to vandalism and the difficulties encountered with regard to maintenance.

ANDRITZ HYDRO in Cameroon

Last year, the ANDRITZ HYDRO Group opened a branch in Douala in order to supervise the rehabilitation of the Edéa power plant, a very important project that is entering completion and which consists of the replacement of three alternator turbine propeller units, which have been in service for over 50 years. However, the rehabilitation of the Edéa power plant is not ANDRITZ HYDRO’s first project in Cameroon, as in early 2000, due in particular to Swiss financial aid, the Company of Electricity of Cameroun was able to proceed with the rehabilitation of the Song Loulou power plant in partnership with the Group.

Furthermore, the relations between ANDRITZ HYDRO and the local electricity companies are excellent, and there are many formal and informal contacts take place throughout the year in both Cameroon and Switzerland.

Song Loulou rehabilitation

The contract for the rehabilitation of the Song Loulou hydropower plant meant that ANDRITZ HYDRO had to modify seven of the eight Francis turbines, which had been commissioned in two phases during 1981 and 1988. Each runner with a diameter of 4.5 m operates at a head of 39.2 m.

With a capacity of 400 MW, the Song Loulou plant produces the main part of the 700 MW available for Cameroon’s southern electricity grid. Thus, its reliable operation is vital for the economic welfare of the country. The Song Loulou power plant is owned and operated by AES-Sonel.

The aim of the rehabilitation was to provide the turbines with sustainable protection against the external stress caused by evolutive, chemical conversion in the building concrete which causes expansion. On some units, the deformation of the turbine labyrinth seals has reduced the mechanical gaps between turbine runners and the fixed parts, causing contact between the runner and the lower labyrinth seal and friction-related surface damage, which necessitated specific turbine modifications.

Due to the strategic importance of the Song Loulou power plant, it was essential to have the shortest possible unit outage. In order to achieve this, ANDRITZ HYDRO hired skilled local mechanics and welders for whom several containers of equipment and tools were shipped in. AES-Sonel also authorized ANDRITZ HYDRO to carry out the repair of existing, unused on-site camp housing, which thus reduced travel times.

ANDRITZ HYDRO invested in the procurement of a large vertical lathe equipped with a 6.3 m capacity turntable, which enabled the team to drastically reduce the duration of on-site machining of the turbine covers. This step shortened the outage of the last units from 12 to less than five months and this was not only a key factor in the success of this project, but also opened the door to further contracts in Cameroon.

The rehabilitation work was completed in June 2005 and today, the repaired units continue to function perfectly. In 2007, the penstock and gates for units 5 to 8 were repaired and work is currently continuing on the penstock and gates for units 1 to 4.

Edéa Rehabilitation

The rehabilitation of the Edéa power plant falls under the scope of the agreement signed in 2007 between the European Investment Bank and AES-Sonel, involving a sum of EUR 65 million for the partial
financing of a capacity overhaul program. Work started in 2008 and should be completed in 2011.

Leader of the consortium, ANDRITZ HYDRO SA of Switzerland, in collaboration with the French Cegelec, will perform the engineering, manufacturing, procurement and installation of new Kaplan units with an increased power of 44% for units 1 and 2 and of 31% for unit 3. Furthermore, new generators with 33% more power output, new gantry and swiveling cranes, draft tube stop logs, intake bulkheads and intake radial gates governor systems, transformers, mechanical and electrical auxiliaries, are all to be installed and commissioned.

Edéa’s power plant operates on a flow basis on the Sanaga River and any temporary drop in the output of the equipment set creates an immediate fall in the volume of power available. The extension of the activities of the nearby aluminum company, as well as the needs of the public sector, fully justify the realization of this giant project, which is of prime importance to the entire Cameroonian economy.

Two units with an output of 11 MW each were commissioned in 1953, followed by seven other units between 1954 and 1958, thus creating total installed capacity of 159 MW. In 1967, five other units were installed bringing the total of units to 14. Twelve of these units were manufactured by the Ateliers Mécaniques de Vevey, which is now part of ANDRITZ HYDRO, and this greatly facilitated the current rehabilitation process. This project is part of the long collaboration between AES-Soneland ANDRITZ HYDRO.

The future of hydropower in Cameroon
In partnership with the American-Cameroonian company AES Sonel and ANDRITZ HYDRO Ltd, the authorities are to employ strategies, the following main aspects of which, will contribute greatly to improving hydropower cover in Cameroon:

- The modernization of existing electrical installations through foreign investment
- The building of new, modern equipped hydropower plants, f.i. in Lom Pangar (50 MW), Nachtigal (400 MW), Memvélé (230 MW), Songmbengué (900 MW), Bini-Wara (75 MW), Vogzom (80 MW), Ngassona (2 MW), in order to step up electricity production in rural areas
- The complete refitting of public lighting networks
- The improved access of domestic households to electricity.

In addition to these broad outlines, it will be necessary to strengthen ties with the neighbouring states of Chad, the Central African Republic, Nigeria and the Democratic Republic of Congo, whose electricity supply systems are already partially linked to those of Cameroon. This is the main reason for the current study concerning the rehabilitation of the Lagdo power plant, which is located in north-east Cameroon. Other projects of varying degrees of importance are also under discussion. It is therefore vital that these projects be pursued and that power plant construction or rehabilitation takes place as soon as possible, in order to answer the needs of both the local population and commerce. Without doubt, Cameroon and ANDRITZ HYDRO will have opportunities to work within Cameroon today and in the future. Our long and profitable collaboration over more than 10 years in the field of rehabilitation, has increased electricity production and provided the complete or partial restoration of some of the installations, thus improving electricity distribution at both a national and interregional level.
**AUSTRIA**

**LAASKIRCHEN**

ANDRITZ HYDRO signed a contract for the major overhaul of a gas turbine generator (type A06), including the supply and installation of a new stator winding and the shop refurbishing of the rotor to the end of 2008.

The power station, which is located on the premises of SCA Graphic AG Laaskirchen, is owned and operated by Cogeneration-Kraftwerke Management OÖ GmbH. The power generated by the 55 MVA gas turbine unit is fed entirely into the grid of the paper mill. Plant availability is the operator’s prime concern, as an unplanned outage would cause tremendous energy purchasing costs. In order to secure such high availability, several recommended inspections and overhaul services had been assigned to ANDRITZ HYDRO.

In the course of a minor inspection in 2005, a dielectric breakdown on a single stator bar was noticed and as a consequence, the owner decided to change the complete stator winding in 2009. Apart from this replacement, which involved a thermally optimized stator winding, and the recommissioning process, rotor refurbishment was carried out in the work shops in Weiz. In the course of this work, the design of the flexible winding connectors was optimized. The very short time slot of just 27 days, which was specified for the overhaul and repair work, posed a massive challenge, but the generator was nonetheless back online punctually.

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**TECHNICAL DATA:**  
OUTPUT: 55 MVA  
VOLTAGE: 10.5 kV  
SPEED: 3,000 rpm  
POWER FACTOR: 0.8

**AUSTRIA**

**ST. GALLEN**

In February 2009, Kraftwerke St. Gallen Ltd. awarded a contract to ANDRITZ HYDRO for the delivery of the turbine equipment for the St. Gallen power plant. Kraftwerke St. Gallen Ltd. is a subsidiary of the multinational Gebr. Haider Group.

The weir at the intake is to be equipped with a flap gate designed for once-in-a-century-flooding. The waters of the River Billbach will first be led to a desilter through a side intake chamber and then conducted along a 4,300 m long, underground GRP penstock to the powerhouse. A 400 V generator driven by the Pelton turbine is to be synchronized to the low voltage side of a 1,600 kVA (0.4 / 30 kV) transformer and connected to the public grid by means of a 30 kV circuit breaker. The entire construction work on the weir, powerhouse and penstock will be carried out by the customer’s own construction company.

ANDRITZ HYDRO’s scope of supply comprises a six-nozzle vertical Pelton turbine, the penstock connection pipe, the butterfly valve (1,000 mm), the hydraulic power supply unit, and spare parts. Furthermore ANDRITZ HYDRO will be responsible for the installation and commissioning of supply. Operations are scheduled to start in April 2010.

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**TECHNICAL DATA:**  
OUTPUT: 1,375 kW  
HEAD: 87.5 m  
SPEED: 428.6 rpm  
RUNNER DIAMETER: 865 mm

**GERMANY**

**WEHR**

In mid 2009, ANDRITZ HYDRO received an order to renew the motor-generator poles of the Wehr pumped storage power plant in Germany.

This underground power plant, which is owned by Schluchseewerk AG, generates peak load electricity and is also used for grid stabilization. The motor-generators, supplied by Siemens between 1970 and 1977, were and still are close to limits of conceptional capacity. During stator rehabilitation, cracks were found at the T-shaped dovetails of the pole end plates.

The poles weigh 11 t each, making them among the largest worldwide, and in view of the extreme stresses involved (2,400 times earth gravity acceleration), the rotor was already modelled in 3D and all the rotating parts were checked by finite element computer programs during the tendering phase. In the course of parameter design studies, the new shape of the pole endplates was created in combination with the laminated rim rotor. This new design created a vital reduction in mechanical stress and a final analysis proved that the expected lifetime should be tripled. This unusual procedure demonstrated ANDRITZ HYDRO’s superior technical competence to the client and resulted in securing of the contract.

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**TECHNICAL DATA:**  
OUTPUT: 4 x 300 MVA  
VOLTAGE: 21 kV  
SPEED: 600 / 1,070 rpm  
POWER FACTOR: 0.75
EDF has awarded ANDRITZ HYDRO an order for the refurbishment of four excitation systems at the La Coche pumped storage power plant.

Following Vouglans in 2005, EDF has now selected ANDRITZ HYDRO know-how for a second time for the renewal of complex excitation systems in a pumped storage power plant. The La Coche power plant is equipped with four pump turbines and generators. The new THYNE excitation systems will replace the obsolete analogue systems dating from 1978. A special challenge regarding regulation and control is posed by the change of the start-up mode of the pump turbines from the previous asynchronous start, to "back to back" starting with the new excitation systems. As an additional highlight, the power supply for the excitation systems will be provided by a separate auxiliary generator, which is also to be regulated by the new system. Thus, each of the four THYNE systems will regulate two independent generators (main and auxiliary generator) simultaneously. The new excitation systems will employ a modbus to communicate with the control system, which is also to be renewed by EDF at the same time.

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LUETSCHENTAL

ANDRITZ HYDRO Switzerland has received an order from Jungfraubahnen AG for the delivery of two Pelton turbines as part of the upgrading of the Luetschental power plant.

This power plant was built in 1908 and received a new licence in 1999. A partial retrofit with a new weir structure and desilter was completed in 2004-2005. Jungfraubahnen AG now intends to raise the plant’s output from 6.6 MW to 11.5 MW without the need for major constructional modifications.

In terms of annual energy production, this means an increase of more than 50% from about 34 GWh per year to 55 GWh per year. As a result, five old machine units from ESCHER WYSS are to be replaced by two units from ANDRITZ HYDRO with a significantly higher flow and improved efficiency.

The scope of supply from ANDRITZ HYDRO includes two butterfly valves for the turbine inlet, two 6-jet vertical Pelton turbines with auxiliaries, turbine governors and secondary equipment. In cooperation with the client, the building contractor and the consortium partners (Berger for the bifurcation pipe and Indar for the generator), the first machine unit will go into operation in autumn 2011.

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TECHNICAL DATA:
OUTPUT: 6,117 kW
HEAD: 153.1 m
SPEED: 375 rpm
RUNNER DIAMETER: 1,330 mm

FRANCE

LA COCHE

EDF has awarded ANDRITZ HYDRO an order for the refurbishment of four excitation systems at the La Coche pumped storage power plant.

Following Vouglans in 2005, EDF has now selected ANDRITZ HYDRO know-how for a second time for the renewal of complex excitation systems in a pumped storage power plant. The La Coche power plant is equipped with four pump turbines and generators. The new THYNE excitation systems will replace the obsolete analogue systems dating from 1978. A special challenge regarding regulation and control is posed by the change of the start-up mode of the pump turbines from the previous asynchronous start, to "back to back" starting with the new excitation systems. As an additional highlight, the power supply for the excitation systems will be provided by a separate auxiliary generator, which is also to be regulated by the new system. Thus, each of the four THYNE systems will regulate two independent generators (main and auxiliary generator) simultaneously. The new excitation systems will employ a modbus to communicate with the control system, which is also to be renewed by EDF at the same time.

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ITALY

SAN COLOMBANO

After lengthy negotiations, in June 2009 ANDRITZ HYDRO, Schio received a modernization order of the San Colombano hydropower plant, including the delivery, site installation and commissioning of components for one vertical Pelton and one Francis unit.

The power plant belongs to Trentino Servizi, the Trento multi-utility company, and is located in the heart of the beautiful Pasubio mountain area, 30 km from the ANDRITZ HYDRO subsidiary in Schio.

Scope of supply:
- New components for a vertical 5-jet Pelton turbine, consisting of the injectors, runner, shaft, shaft seal and guide bearing
- New vertical Francis turbine, except embedded components
- Inlet valves, water cooling system, turbine governor and the HPU for both units.

The new equipment will replace the old supplied in 1964 by Neyricp and will offer a significant improvement in efficiency. Because of higher discharge the increase in output is expected to be 10% in total. ANDRITZ HYDRO is leading a consortium with INDAR, who will supply the two generators. Commissioning of the Francis unit is planned for December 2010 and that of the Pelton unit for May 2011. The result of the complete modernization of the power plant will be more reliable and better performing equipment, and will allow the client to benefit from Green Certificate tariffs.

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TECHNICAL DATA: Francis / Pelton
OUTPUT: 2.4 / 18.4 MW
HEAD: 45.2 / 382 m
SPEED: 600 rpm
RUNNER DIAMETER: 921 / 1,704 mm
**ITALY**

**REZZALASCO**

In February 2009, Tozzi Sud placed an order with ANDRITZ HYDRO France for the supply of three Pelton turbines for the Rezzalasco hydropower plant.

With this new project, ANDRITZ HYDRO France has consolidated a long-term partnership with Tozzi Sud. The collaboration with this special client started in 1998 and since then, Pelton, Francis and Kaplan turbines have been successfully installed. For example, the commissioning of the twelfth turbine for Tozzi Sud (one 1,284 kW CAT for the Poschiavino hydropower plant) was completed in August 2009. In February 2009, Tozzi Sud confirmed its confidence in ANDRITZ HYDRO France by placing this order for the supply of three Pelton turbines for its new plant in the northern Italian region of Lombardy. The scope of delivery consists of three 2-jet, horizontal Pelton units. Two of the units will have an output of 4.6 MW each and the third, an output of 2.0 MW. The contract of supply includes the complete turbines and inlet valves and manufacturing will be concluded by the end of 2009, to allow site installation at the beginning of 2010. With this planning, commercial operation is expected by April 2010.

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**TECHNICAL DATA:**  
OUTPUT: 4,591 / 2,053 kW  
HEAD: 400 m  
SPEED: 750 / 1,000 rpm  
RUNNER DIAMETER: 1,080 / 810 mm

**NORWAY**

**SOEBERG**

Småkraft AS and ANDRITZ HYDRO Norway have a long and close relationship, which has been formalized by a framework agreement for the delivery of compact Pelton and Francis turbines. In May 2009, the Pelton turbine for Soeberg was “called up” under the terms of this contract.

The deliveries under the framework agreement always include the turbine and HPU delivered ex-works from the shop floor. Erection and commissioning are negotiated separately at a later stage. The Soeberg project is located in the Bindal district in northern Norway. Turbine installation will start next summer and commissioning in the autumn. Småkraft, which is owned by Statkraft and three of the larger Norwegian utilities, is a streamlined organization that only develops compact hydropower plants in Norway in cooperation with private landowners. The company completes plants from the concession application through to construction and then supervises plant operation for an agreed 40-year period in cooperation with the private landowner, who subsequently assumes full ownership of the plant. Småkraft builds around six plants annually and has created a standardized concept with beautiful and immediately recognizable power plant buildings, which employ modern design with large, open glass walls combined with neatly stacked stone edifices.

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**TECHNICAL DATA:**  
OUTPUT: 5,410 kW  
HEAD: 181 m  
SPEED: 500 rpm  
RUNNER DIAMETER: 1,040 mm

**CANADA**

**RAPIDE 2**

In mid 2009, ANDRITZ HYDRO Canada received an order for the conversion of four stator windings from 6.9 kV to 13.8 kV at the Rapide 2 hydropower plant. For Pointe Claire, this is the first direct purchase order from Hydro Québec after the takeover by ANDRITZ. The order comprises the supply of parts, site installation and the commissioning of all four units.

When Hydro Québec initially purchased these generators from GE Hydro in the early 2000’s, it planned to modernize the power plant in the future, and therefore the windings were designed to allow the subsequent change of the voltage from 6.9 kV to 13.8 kV by making alterations to the circuit ring connections. This voltage modification will allow Hydro Québec to complete the modernization of Rapide 2 within its highly modern guidelines and thus improve the overall station reliability in its network. Work at the site started on August 10, 2009 and with a three-month interval for each unit will be completed in early summer 2010.

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**TECHNICAL DATA:** old / new  
OUTPUT: 19 MVA  
VOLTAGE: 6.9 / 13.8 kV  
SPEED: 120 rpm  
POWER FACTOR: 0.8
SIR ADAM BECK
In June 2009, ANDRITZ HYDRO Canada received an order for the refurbishment of the turbine for unit 9 at the Sir Adam Beck I generating station following a competitive tendering process conducted by Ontario Power Generation.

This contract nicely complements the previously received contract for the supply and installation of a new generator for G9 and both will be completed jointly. The order includes the supply of parts, general refurbishment, and the on-site installation and commissioning of unit 9. Ontario Power Generation is upgrading the turbine and replacing the generator as part of a program of modernization and the elimination of the last of its 25 Hz generating sets. The Sir Adam Beck I Generating Station, with ten units, went into service between 1922 and 1930. An upgraded runner has been purchased separately and will be installed by ANDRITZ HYDRO also. The wicket gate operating system is to be modified to greaseless design and the scope of the turbine replacement order also includes the dismantling and scrapping of the old generator. Work on site started on July 6, 2009 and is scheduled to be completed in November 2010.

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TECHNICAL DATA: SIR ADAM BECK
OUTPUT: 55 MW
HEAD: 89.9 m
SPEED: 120 rpm
RUNNER DIAMETER: 2,873 mm

CANADA

SAN CLEMENTE AND MARIPOSA
Chile is obtaining an increasing amount of energy from renewable sources, the bulk of which is supplied by hydropower. The country is extremely rich in undeveloped sites. 60% - 70% of the total potential is not yet exploited.

Geopolitical issues (the gas crisis with Argentina) and the high price of conventional fuels are driving the country’s strategic decisions with regard to a differentiation of the energy matrix, the encouragement of small-scale power plants with a very low environmental impact and improvements in delocalized energy production. In this connection, the two new San Clemente and Mariposa hydropower plants both utilize the Kaplan CAT concept with a relatively high head. ANDRITZ HYDRO has already supplied two turbines (one for each project) to the site and these will be installed and commissioned in the coming months. The delivery to Mariposa only consisted of the turbine with HPU, but San Clemente follows the “Water to Wire” concept and is to receive the full scope of supply consisting of a turbine, generator, HPU, auxiliary systems, low and medium voltage cubicles, transformers, control units, and the SCADA system.

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TECHNICAL DATA: Mariposa
OUTPUT: 6,640 kW
HEAD: 34.8 m
SPEED: 500 rpm
RUNNER DIAMETER: 1,600 mm

TECHNICAL DATA: San Clemente
OUTPUT: 5,800 kW
HEAD: 35.5 m
SPEED: 428.6 rpm
RUNNER DIAMETER: 1,600 mm

CHILE

LA YESCA
ANDRITZ HYDRO has been awarded a contract for the supply of the auxiliary generating group for the La Yesca hydropower plant, a large Comisión Federal de Electricidad (CFE) project, which is currently under construction.

The auxiliary unit will provide the power necessary for a black start of the two main units installed in the powerhouse. Key factors in this success in Mexico were the high level of confidence regarding ANDRITZ HYDRO’s products and the close relationship with both the final owner, CFE, and the Power Machines company, to whom ANDRITZ HYDRO is already supplying the governor and excitation systems.

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TECHNICAL DATA: LA YESCA
OUTPUT: 2,838 kW
HEAD: 136 m
SPEED: 1,200 rpm
RUNNER DIAMETER: 545 mm

MEXICO
HYDRO NEWS

SOUTHERN AFRICA

ELANDSRAND

In South Africa, the exploitation of minerals such as gold and platinum at constantly increasing depths has changed the climatic mining conditions. Working temperatures underground can exceed 40° C in the stopping areas and working without cooling is impossible.

As a result, cooling water from central refrigeration plants on the surface is brought down to reduce the temperature. However, such systems suffer from the disadvantage of high energy costs, which derive mainly from the pumping of warmed water back to the surface. Energy costs and friction losses can be partly compensated for by the installation of power recovery turbine units. The Elandsrand Gold Mine, a division of Harmony Gold Mining Company Ltd., is currently undertaking the implementation of a deepening project at the Elandsrand Mine and has therefore decided to install an energy recovery system on the level 92 (2,624 m below the surface). Harmony Gold Mining Company Ltd. has placed an order with ANDRITZ HYDRO for a 2-jet horizontal Pelton turbine. ANDRITZ HYDRO has already installed more than 50 underground turbines with a total capacity of over 80 MW in various mines in South Africa.

BAHRAIN

AL DUR

A large seawater desalination plant is to be built in Bahrain. The plant will be equipped with 26 units, for which ANDRITZ HYDRO will provide the energy recovery turbines.

The desalination plant will apply the reverse osmosis principle, in which brine accrues as a by-product in high concentrations and at high residual pressure.

The water remaining after the process will be conducted to a Pelton turbine for generation, which is directly coupled to the high-pressure pump/motor unit. With this system, more than 30% of the energy needed for the process can be recovered. 26 twin-jet Pelton turbines are to be delivered and due to the highly corrosive medium, the turbines will be entirely manufactured in Superduplex material. The delivery period of the machines will extend from November 2009 to February 2010. Due to the shortages of fresh potable water in the countries of the Near and Middle East, the Mediterranean and Asia, drinking water in these regions is often produced by seawater desalination and this technology is set to gain importance in years to come.

ANDRITZ HYDRO, India signed a contract with the Traxom Hydropower Joint Stock Company, Quy Nhon City, Binh Dinh province, Vietnam on April 22, 2009 for the supply of a complete range of electro-mechanical equipment and technical services for installation and commissioning.

The 4-jet vertical Pelton turbines for this hydropower project will be manufactured in India. The scope of delivery comprises everything from water to wire.

TECHNICAL DATA:

OUTPUT: 3,830 kW
HEAD: 620 m
SPEED: 2,986 rpm
RUNNER DIAMETER: 350 mm

INDIA

KUT

The Kut hydropower project is being realized by Kut Energy Pvt Limited of Chandigarh. The project is located in the interior of the Himalayan region, in the Kinnour district of the state of Himachal Pradesh.

The Kut hydropower project is a run-of-river scheme that envisages the utilization of the water from Kut Nalla for power generation. The project consists of three units with 2-jet horizontal Pelton machines. The scope of works will involve the design, supply, storage, installation, testing and commissioning of all the equipment. The project was awarded to ANDRITZ HYDRO, India in May 2009, with a completion period of 22 months.

VIETNAM

TRAXOM

ANDRITZ HYDRO, India signed a contract with the Traxom Hydropower Joint Stock Company, Quy Nhon City, Binh Dinh province, Vietnam on April 22, 2009 for the supply of a complete range of electro-mechanical equipment and technical services for installation and commissioning.

The 4-jet vertical Pelton turbines for this hydropower project will be manufactured in India. The scope of delivery comprises everything from water to wire.

TECHNICAL DATA:

OUTPUT: 13.8 MW
HEAD: 656 m
SPEED: 750 rpm
RUNNER DIAMETER: 1,390 mm

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TECHNICAL DATA:

OUTPUT: 2 x 10 MW
HEAD: 487.6 m
SPEED: 750 rpm
RUNNER DIAMETER: 1,180 mm

TECHNICAL DATA:

OUTPUT: 1,046 kW
HEAD: 750 m
SPEED: 2,986 rpm
RUNNER DIAMETER: 350 mm

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TECHNICAL DATA:

OUTPUT: 13.8 MW
HEAD: 656 m
SPEED: 750 rpm
RUNNER DIAMETER: 1,390 mm
In 2009, ANDRITZ HYDRO Brasil and ANDRITZ HYDRO Inepar participated in important events in connection with the hydropower generation market, such as the 23rd ICOLD – International Congress on Large Dams; the V Small Hydro Conference; and the VIII Simpase – Symposium on Electric System Automation.

A new stand with a state-of-the-art layout was created as a standard feature for all exhibitions and trade fairs with the aim of establishing the new corporate communication directives and raising awareness levels with regard to the ANDRITZ HYDRO Brasil and ANDRITZ HYDRO Inepar do Brasil brands. This change was noted by attendees, as well as by the press and photographers covering the events.

23rd ICOLD – International Congress on Large Dams, May 21-25, 2009
ANDRITZ HYDRO, the gold sponsor of this event, received around 700 visitors of different nationalities during the technical exhibition held concurrently with the congress, which took place at the Centro de Convenções Ulisses Guimarães in the city of Brasília. The lectures addressed such subjects as the high-tech and expertise used in large dam projects and designs. This year, the event was held in Brazil due to the huge opportunities offered by the country for investments in this sector, which has 87,000 MW of installed capacity and constitutes a major reference point for designers, investors and scholars in general.

Over 1,000 large dams are currently in place in the country, 650 of which are intended for hydropower generation. In addition, around 85 hydroelectric power plants are undergoing construction at present, in order to meet the annual 5,000 MW increase in demand. Another 739 hydropower plants, ranging from small to large units, are also in the design phase and should provide 37,000 MW of production.

V Compact Hydro Conference, Brasil, August 5 and 6, 2009
Held in the city of São Paulo, the fifth staging of this Brazilian event, which offers a major forum for business, reflection and solution development activities in connection with compact hydropower plants, focused on the analysis of the scenarios, opportunities and challenges resulting from both the Administrative Act 343 from ANEEL (Agência Nacional de Energia Elétrica) and the global crisis. What followed was a broad debate of the proposals meant to extend the role played by compact hydropower stations in the Brazilian energy matrix, which constitutes a widely expanding market.

ANDRITZ HYDRO Brasil, one of the sponsors of the event, not only took part in the technical exhibition, where it received more than 500 people, but also presented new solutions and technologies for compact hydro implementation, with lectures by Joel de Almeida (Commercial Director) and Roberto Barce (Compact Hydro Proposal Engineering Manager) on the last day of presentations.

VIII Simpase – Symposium on Electricity System Automation, August 9 -14, 2009
The eighth staging of this traditional Brazilian power industry event was attended by more than 800 visitors. Since it was first held in 1992, the event has established itself as the main forum for debate and the interchange of information and experience on automation issues between companies and bodies involved in the electric power segment. Major innovations in the sector were presented in the course of technical papers, mini-courses and discussions with national and international experts.

As an event sponsor, ANDRITZ HYDRO took part in the technical exhibition and also contributed to the meeting with its presentation of a pre-selected paper (IEC 61850 part 7-410 – major modifications and respective impacts) by Marcelo Malafaia, the company’s Automation Engineering Manager.

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HYDRO AUTOMATION DAY 2009

Custmized Automation Solutions - From Small Hydro to Large Hydro Plants

This year’s HYDRO AUTOMATION DAY, which was held on May 28, 2009 in the Palais Ferstl in Vienna, again attracted a sizeable number of Austrian and international guests.

The focus of this year’s HYDRO AUTOMATION DAY was on tailor-made automation solutions for small-scale hydropower plants, new capacity and the updating of existing plants. The specific challenges involved were examined from a variety of perspectives and innovative approaches presented.

In addition to interesting, specialist talks and product demonstrations, the meeting also provided sufficient space for an intensive exchange of information among all the attendees. Moreover, as was the case last year, the 2009 event saw another marked increase in the number of specialists attending, who came from 20 countries. The contributions of our customers matched the themes of the meeting to perfection:

- The Automation of the Danube Power Plants (Wolfgang Leeb, VERBUND-Austrian Hydro Power AG, Austria)
- Modernization of Automation and Protection for Pumped Storage Hydro Power Plant Markersbach (Ulrich Voigt, VATTENFALL EUROPE Generation AG & Co KG, Germany)
- The Mittelbünden power plants and automation projects (Markus Clavadetscher, Elektrizitätswerk der Stadt Zürich, Switzerland).

Traditionally, this event consists of a technically-oriented specialist congress and an evening get-together in a pleasant atmosphere.
This year, the perfect ambience for the latter was provided by the Suitehotel Kahlenberg high above Vienna. South American sounds during the reception set the tone for the evening, which offered a generous gala buffet and breathtaking views of Vienna and the blue ribbon of the Danube as further highlights.

The evening was rounded off with entertainment from percussionists, Capoeira performers and a Latin American dance formation.

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Customer Days
November 12 - 13, 2009
Kriens, Switzerland

ASIA 2010
March 29 - 30, 2010
Kuching, Malaysia

HydroVision 2010
July 27 - 30, 2010
Charlotte, USA
Water is generally a source of fascination and inspiration. But to us at ANDRITZ HYDRO, it means even more because it represents a constant challenge to create up-to-date technological innovations. Utility companies from all over the world value our know-how and commitment, and trust in the safety and reliability of our tailor-made energy generation solutions. From equipment for new, turnkey hydropower plants, and the refurbishing and overhaul of existing installations, to comprehensive automation solutions. **We focus on the best solution - from water to wire.**