HyPower

Voith Hydro customer magazine

Grids as the lifelines of modern civilization | Lower CO_2 emissions from hydro generators | Hydro sustainability 2009

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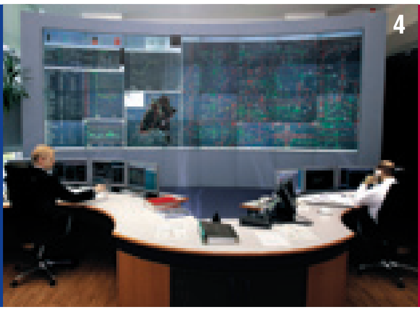
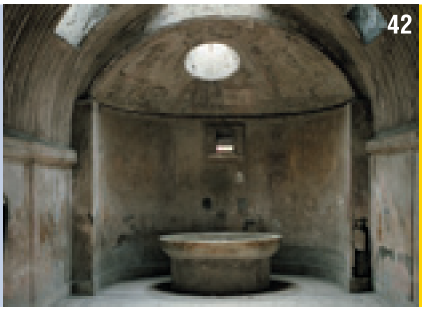
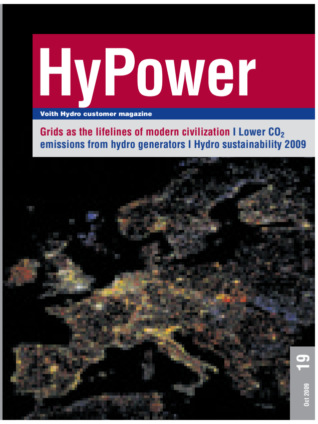






Researchers of Brown University in Providence, USA, took satellite pictures to show the worldwide allocation of wealth.

Germany Land of Ideas
Official Partner

Dr. Roland Münch
President and CEO of Voith Hydro
Member of the Board of Voith AG

Dear readers,

Clean energy generation, along with many other initiatives to tackle climate change and to set the scene for a low-carbon world, is on the top of any current agenda. It is still amazing, however, how little hydro power is contributing to this low-carbon scenario. When I listened to the keynote speech of this year's Waterpower Conference in Spokane, Washington, USA, I had to admit that – politically – we do not make a point that is strong and thus visible enough.

Though, some political signals, for example from the U.S., are positive: The U.S. Energy Secretary Steven Chu recently pledged that he will push the addition of hydro power plants to already existing water infrastructures in order to tap what he called "a massive amount of power […] with minimal impact to the environment".

This to us clearly can be achieved by rehabilitation of equipment and efficiency increase resulting in more generation at existing sites, and by utilization of all multipurpose opportunities that hydro offers.
We cannot help but simply support this approach as the silver bullet to sustainable hydro installations with little impact to environment and social groups. This is especially visible in countries with many hydro power plants operating for years.

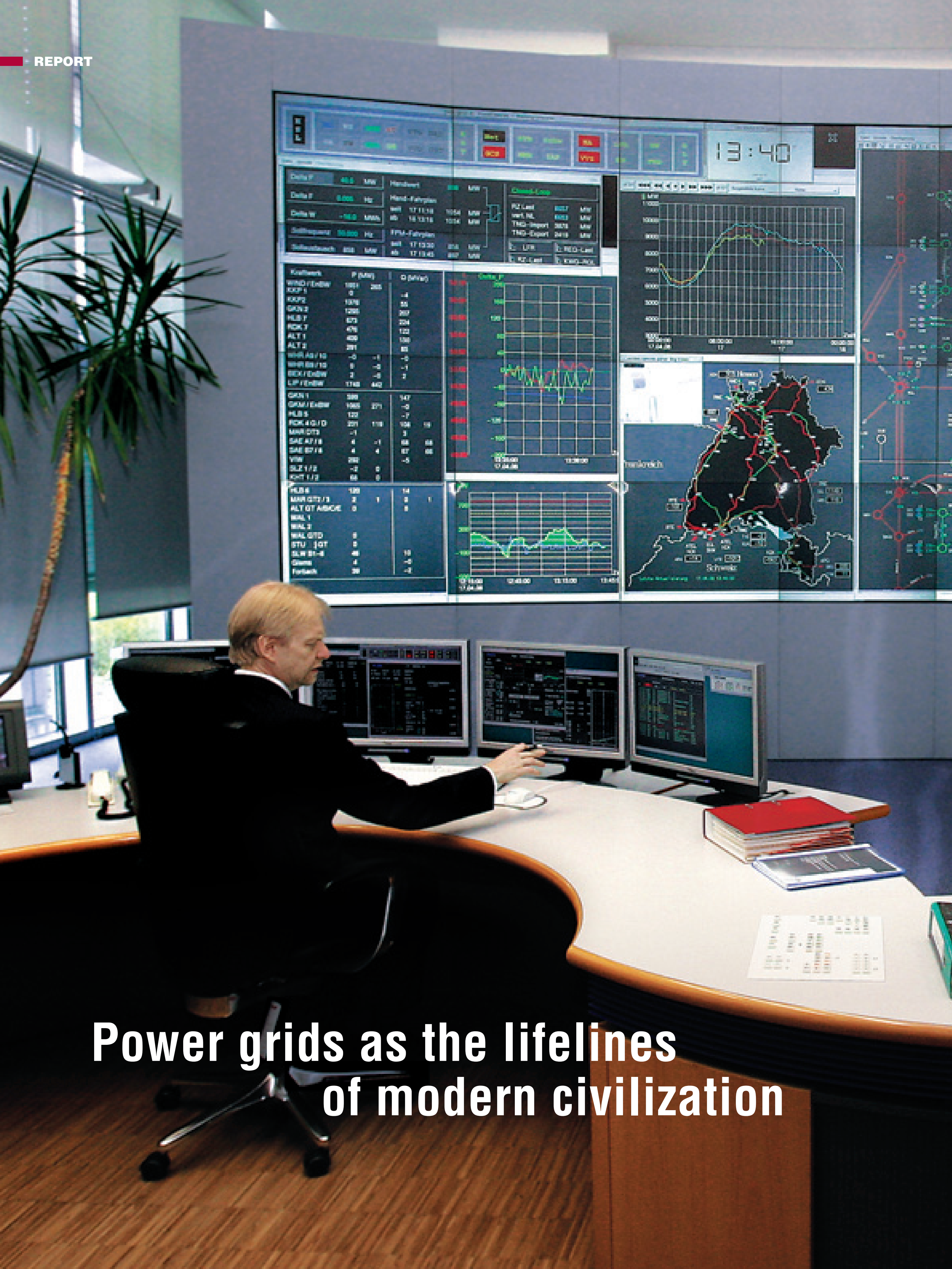
However, when we talk about new projects, we have to make sure that they are also environmentally and socially friendly. Only then we will be successful in making hydro power a crucial part of the future energy generation mix and getting full public acceptance. And this is not done by doing business as usual, but by reaching out to decision making bodies and presenting hydro power with all its benefits.

For that reason Voith Hydro closely cooperates with the International Hydropower Association (IHA). It is our intention to apply the new draft of the Hydro Sustainability Assessment Protocol wherever possible. Then we can prove that sustainability in hydro power plants can be planned, implemented and measured. This future standard is to be the instrument that is to provide applicable, objective, measurable, and repeatable findings.

It will help our industry as a whole: planners, investors, policy makers, suppliers and all public stakeholders who still might think that hydro power is renewable but not sustainable. The burden is on us to prove that it is – by joining forces now.

If you have any comments or questions, please simply contact me at Roland.Muench@voith.com.

Roland Münch



Power grids as the lifelines of modern civilization

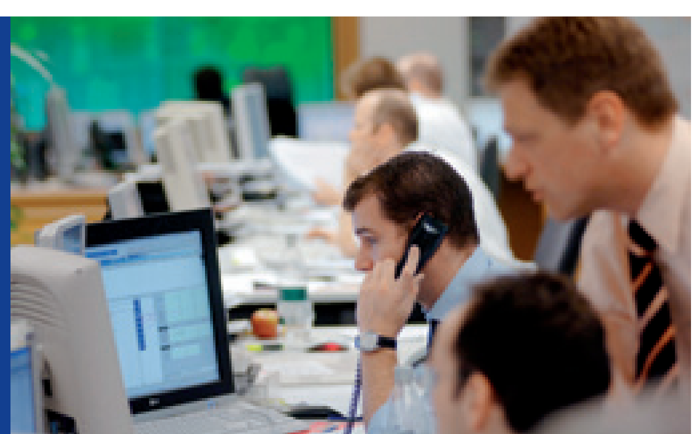
Grids are the lifelines of our world. They link rivers to ports, and railway tracks to railway stations. Every form of communication is based on grids or networks. Nothing highlights this more than the World Wide Web, which today is an essential part of a globalized world. Less in the public eye are the power grids and yet they play a key role in shaping social change and creating wealth.

At 7 a.m. in the morning, the world is no longer such an easy place for Bernd Theuner and Alexander Wilhelm. Looking at the data from the system in the main nerve center of the Southern German utility EnBW, the EnBW Transportnetze AG (TNG) in Wendlingen, the engineers can see that the German state of Baden-Württemberg is waking up. They can follow the welcome light which the lamps above people's kitchen tables are delivering and the washing and cleaning taking place in bathrooms. They can track how IT systems are booted up and machines are run up to speed. It is peak load time and it is the time of day that requires a great deal of concentration from Bernd Theuner and Alexander Wilhelm. Their role is to maintain the delicate equilibrium in balancing the amount of power fed into the system and the amount of power consumed.

A large LCD screen measuring eight meters by three meters supplies the engineers with the up-to-date information they require. Every change in the system is displayed on an oversized map of Baden-Württemberg. When looked at in this way, the southern tip of Germany is made up of green and red lines which symbolize the high-voltage lines. Green represents the 220 kilovolt lines and red represents the 380 kilovolt lines. Circles in between symbolize the transformer stations. Different colors, shapes and symbols represent individual operating states within the grid.

Europe's electricity hub

Baden-Württemberg plays a key role in the transportation of electricity. Because of its geographical position within Germany there exist close transport-connections to France, Switzerland and Austria. However, when you examine the situation in detail, the whole of Germany is effectively Europe's electricity hub. No other country has more neighbors. This makes the Federal Republic of Germany the key transit route when it comes to the exchange of electricity. 1.8 million kilometers of power lines and 550,000 transformers crisscross the country.



A tightly meshed transport grid zigzags Europe.

35,000 kilometers of these power lines transport the electricity in the maximum-voltage range of between 220 and 380 kilovolt nationwide. Through the regional and local distribution grids, this electricity ultimately reaches consumers in the high-voltage, medium-voltage and low-voltage range.

“Today we are running the grid often at its physical and technical limit”, states Klaus-Wolfgang Tapp. The electrical engineer is responsible for network safety at TNG. He spent eight years working at the company’s main control center. He knows what he is talking about.

"Today we have to intervene in the processes taking place on a much more frequent basis." In Klaus-Wolfgang Tapp's opinion, two developments have had a lasting impact on this situation: The liberalization of the electricity market and the increasing supply of renewable energies.

Territorial monopolies fall

In the mid-1990s, the liberalization of the electricity market was only being talked about in an abstract sense. In Germany, the utility companies managed the territorial monopoly until 1998 and an exchange of electricity took place – if at all – mainly between direct neighbors. The impetus for liberalization came at European level with the aim of producing a market based around competition. The first states to follow this approach included the Nordic countries, a short time later Germany and Austria opened up their markets, then came the Netherlands.

In 2007 Italy signed up and the liberalization standards came into force in Spain on July 1 this year. "Today we face a market framework for which the established grids are not designed", explains Klaus-Wolfgang Tapp.

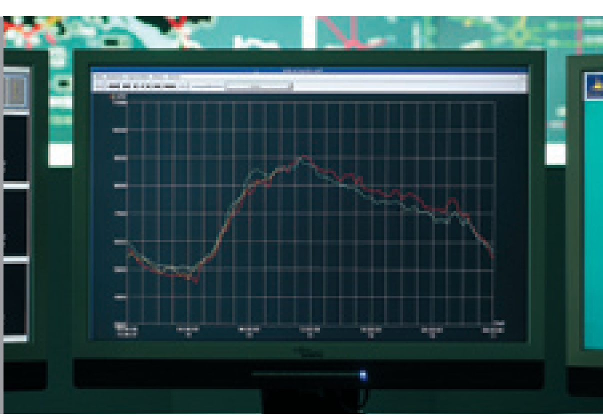
Expansion of wind energy

The electricity highways are also being affected by the feeding in of renewable energies, in particular wind power. Spain, one of the main producing countries, boasts approximately 14,000 megawatts of installed wind power, and Germany now has approximately 24,000 megawatts. This benefits the environment. But as it is not possible to store wind power, the fact that the supply of wind constantly changes has resulted in an increased need for energy regulation. Another factor in Germany is that the southern part of the country, where industry is strongest, in fact requires the wind power produced in the north.

Everyday life in the nerve center

Alexander Wilhelm's view is fixed on the large screen in front of him. At this very moment, the wind feed-in across Germany comes from 698 megawatts of which 96 megawatts are taken by Baden-Württemberg. That means, at this moment wind is on a very low level – compared to the installed 24,000 megawatts. The operating modes of individual power plants are shown in tabular form. The engineer is responsible for control power dispatch and intraday trading of wind power. He must coordinate the import and export schedules of the electricity traders. He must also manage the exchange of electricity with other control zones and monitor frequency fluctuations within the system. The diagram on the large screen records target values and actual values. This determines how much energy needs to be fed in or withdrawn in order to be able to maintain the current frequency of 50 hertz, which applies right across Europe. At the moment, everything is looking fine, but things can quickly change.

The grid load changes over the day.



"Today we face a market framework for which the established grids are not designed."

Klaus-Wolfgang Tapp,
EnBW Transportnetze AG

Pumped storage – adapted precisely to the power grid

In May 2009, Kopswerk II, one of the world's most modern pumped storage power plants, was inaugurated in the Austrian state of Vorarlberg. The operator, Vorarlberger Illwerke AG, invested around 400 million Euros in this project. Kopswerk II is an extremely efficient power plant which is able to respond to fluctuations in the grid in a matter of seconds. Instead of a conventional pump-turbine, a turbine and a separate pump are allowed for the two operation modes with the motor-generator. The fastest start together with shortest response to the grid can only be assured by a special type of hydraulic coupling between the rotating synchronized motor-generator shaft and the non-rotating pump shaft. Only the use of such a hydraulic torque converter can realize such short switch over times.

Furthermore, all three pumped storage units are designed for a hydraulic short circuit, this means pump and turbine are operated simultaneously. This involves some of the pumped water being processed through the turbine. As a result, the unit is able to pick up the precise quantity of power from the grid currently available.

525 megawatts of peak energy can be fed into the power grid and up to 450 megawatts of unused energy can be absorbed from the grid when pumping.

Pumps, hydraulic converters, spherical valves and butterfly valves were supplied by Voith Hydro.

The Goldisthal pumped storage power plant near German Neuhaus in Thuringia was commissioned from February 2003 to July 2004. With a total capacity of 1,060 megawatts, it is one of the largest in Europe. As at Kopswerk II, Goldisthal can also regulate the output in pumping mode, albeit using a different technique. Of the four units, two are designed for a constant rotational speed with a synchronous motor-generator, while two are designed for a variable rotational speed with twin-fed asynchronous motor-generators.

Kopswerk II in Vorarlberg, Austria.

So, the Goldisthal variable speed machines were the first ones in Europe accommodating a 100 MW regulation band in pump mode. This means that it is possible to control exactly how much power the pumped storage plant takes from the grid. The hydraulic machine was designed and model tested by Voith Hydro.

The Kopswerk II and Goldisthal pumped storage power plants are used primarily to provide regulating power in the primary and secondary range and also as a minute reserve in order to compensate for power fluctuations in the grid.

Energy as a storage mass

In cases such as these, pumped storage plants are connected to the grid. They have several advantages: First of all, they feature very flexible technology, which means they can use and deliver energy quickly. During periods of low load, electrical energy is taken from the grid and used to pump water from the lower to the upper reservoir. The water stored in the upper reservoir is used to generate electrical energy during periods of peak energy demand, feeding it into the grid.

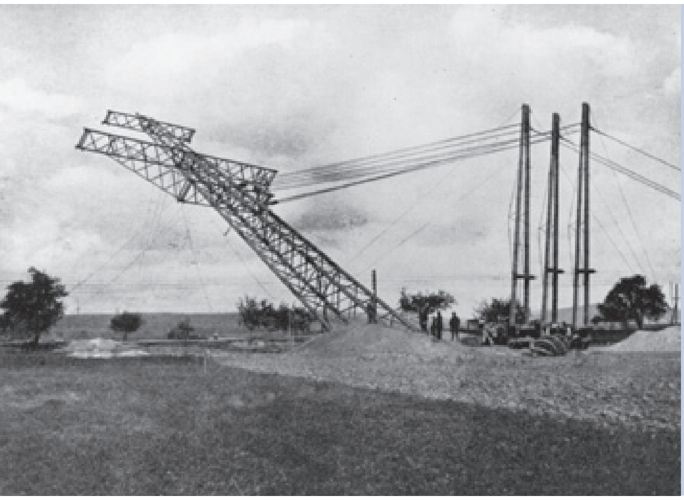
The Austrian Kopswerk II plant, commissioned in May 2009, can deliver 525 megawatts of peak energy to the grid. The German Goldisthal pumped storage plant boasts a total capacity of 1,060 megawatts, thus being one of the largest and most modern facilities in Europe.

The more dynamic the electricity market becomes, the more important large storage facilities will be in future. Many developments are still in their infancy. These include the adiabatic compressed-air reservoirs where the outgoing air drives the generator via a turbine. This system is referred to as adiabatic because the heat that is produced during the storage of the compressed air is recovered and the level of efficiency increased.

Another aspiration for the future is the storage of energy in electric vehicles. When a car is connected to the grid, it absorbs some of the excess energy and thus intercepts the current spikes. This means that the car could be charged at night in order to then release the energy again during the day, when it is parked for a lengthy period of time. This "vehicle-to-grid" concept forms the basis for the idea that lots of small consumers feed in power which is then transported in an upward direction. If practiced on a large scale, this concept will allow more possibilities to integrate renewable energies.

Establishment of congestion management

However, the current capacity problems cannot be solved with visions alone. "Back in 2004 the situation had become so acute that we were in fact worried about the security of supply", recalls Klaus-Wolfgang Tapp. Together with RWE Transportnetz Strom and transmission grid operators from the Netherlands, France, Switzerland and the Austrian state of Vorarlberg, TNG established a coordinated capacity calculation system – the German C – as it is known in the specialist jargon, because it contains the Western borders of Germany which are tightly meshed. At the same time an allocation system of available transmission capacity was introduced. It works on a simple principle: Whoever pays most can transport. Congestion management contains capacity calculation and capacity allocation. The congestion income goes to the transmission grid operators. They are forced to use it to reduce network tariffs and push forward with the further expansion of the grid.



Connecting the Ruhr area with Austria in the 1920s: One of Hugo Stinnes' achievements.

Origin of the European interconnected power grid

220 or 380 kilovolts? Maybe Hugo Stinnes would have voted for the 380 kilovolts option. The higher the voltage, the lower the energy loss. But a 380 kilovolt line was not achievable at the end of the 19th century. This meant that the co-founder of the Rheinisch-Westfälisches Elektrizitätswerk (RWE) had to adopt a different approach.

The Ruhr area, which at the time was the industrial center of Germany, needed power. When Vorarlberger Illwerke AG was founded in 1924, the largest German electricity supplier, RWE, was soon involved also.

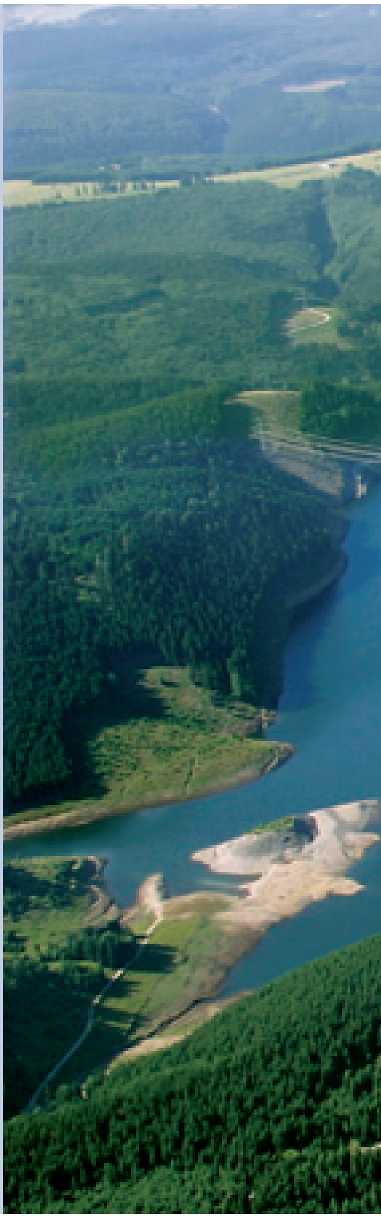
The project was divided. RWE's brown coal plants delivered the base load, while peak loads were covered by Vorarlberg's storage power plants. This constellation resulted in the first 220 kilovolt line in the 1920s. It extended for over 600 kilometers from Vorarlberg to the Ruhr area.

The era of the European interconnected power grid had begun. It was only in the 1950s that it became technically feasible to also transport electricity through 380 kilovolt lines.

Europe is moving closer together as far as electricity is concerned. In December 2008, eleven European transmission grid operators from Poland, the Czech Republic, Germany, Austria, the Netherlands and Switzerland launched an initiative to foster regional European cooperation for system security in the concerned countries and in whole Europe. The involved TSOs (Transmission System Operators) agreed to start up a "TSO System Security Cooperation" with the aim to build up a permanent Security Panel (group of security experts) and a common IT platform for data exchange and performing common security assessments. TSC's main goal is to ensure the overall system security of the European network, an area with 170 million citizens, and is open to the participation of other TSOs.

Stretching the limits in Vorarlberg

Back to everyday life in the main nerve center: "There is a lot going on today", says Bernd Theuner in commenting on his day at work.



Three yellow dots on the large screen indicate a current warning in the Vorarlberg area. This may result in overloads in adjacent power lines and in a worst case scenario there may be a power failure. The monitors flash red. Bernd Theuner picks up the telephone. The engineer still has time to run through various options for solving the problem. His colleague Alexander Wilhelm gets involved. Together they comb through the flood of data coming from the computer. Then they breathe a sigh of relief because the problem has been solved. The yellow dots have disappeared. The situation has calmed down and it is time for a shift change.

Investment in the future

"On some days a year, we are running the grid at its physical and technical limit", said Klaus-Wolfgang Tapp initially, "and this is despite the fact that measures have been taken in recent years to try to do something about it." More and more of the 220 kilovolt power lines are being replaced by the more powerful 380 kilovolt lines. But in order to improve the security and reliability of the grid, 400 kilometers of the maximum-voltage grid will have to be upgraded and 850 kilometers of new power lines will have to be built throughout Germany by 2015.

Goldisthal, Germany.

A global network lights up the dark

Europe

The countries on the European continent are amalgamated in a coordinated system for energy transmission called the UCTE (European Union for the Coordination of Transmission of Electricity). It extends from Portugal to Poland and from western Denmark down to Greece. The transmission grid operators EnBW Transportnetze AG (TNG), Amprion GmbH (former RWE Transportnetz Strom GmbH), Vattenfall Europe Transmission and transpower stromübertragung (formerly E.ON Netz) are responsible for ensuring the security and reliability of the supply in Germany in the four control zones.

In addition to the Western European UCTE, four additional coordinated systems exist in Europe. Nordel supplies Scandinavia, UKTSOA supplies Great Britain, ATSOI supplies Ireland and Northern Ireland and BALTSO supplies the Baltic states. Contact with the European mainland is maintained via direct current bridges because power can only be transmitted using alternating current in undersea cables over a distance of around 70 kilometers.

USA

The power grid in the USA is divided into three sections. The eastern part supplies around two-thirds of the United States and Canada. The western grid caters for the needs of the rest of the territory in the two countries, with the exception of the state of Texas. The power needs of Texas are supplied by the grid operator ERCOT. As in Europe, the grid in the USA is also divided into maximum, high, medium and low-voltage areas. In 2005, the total installed power capacity in the USA and Canada was 950 gigawatts, and in 2008 the amount of power generated in the USA amounted to 4,187.5 terawatt hours. The main source of energy is coal, followed by gas and nuclear power. Hydroelectric power is currently in fourth place. Although other renewable energies have displayed slight growth, they still play a minor role as a source of energy.

China

In 2003, the power grid in China was divided into the state grid and the southern power grid, which in turn are divided into several regional power grids. The Southern Power Grid Corporation answers directly to the central government. A series of long-distance power lines are planned or are already under construction. The aim is to create a grid connecting north and central

China and extending to the east of the country. The project is set to be completed by 2020.

In addition, 15 ultra-high-voltage power lines with a capacity of 800 kilovolts are envisaged. In 2005, the installed power capacity in China was 442 gigawatts, and the amount of power generated was 2,900 terawatt hours. The biggest source of energy is coal, with hydroelectric power in second place.

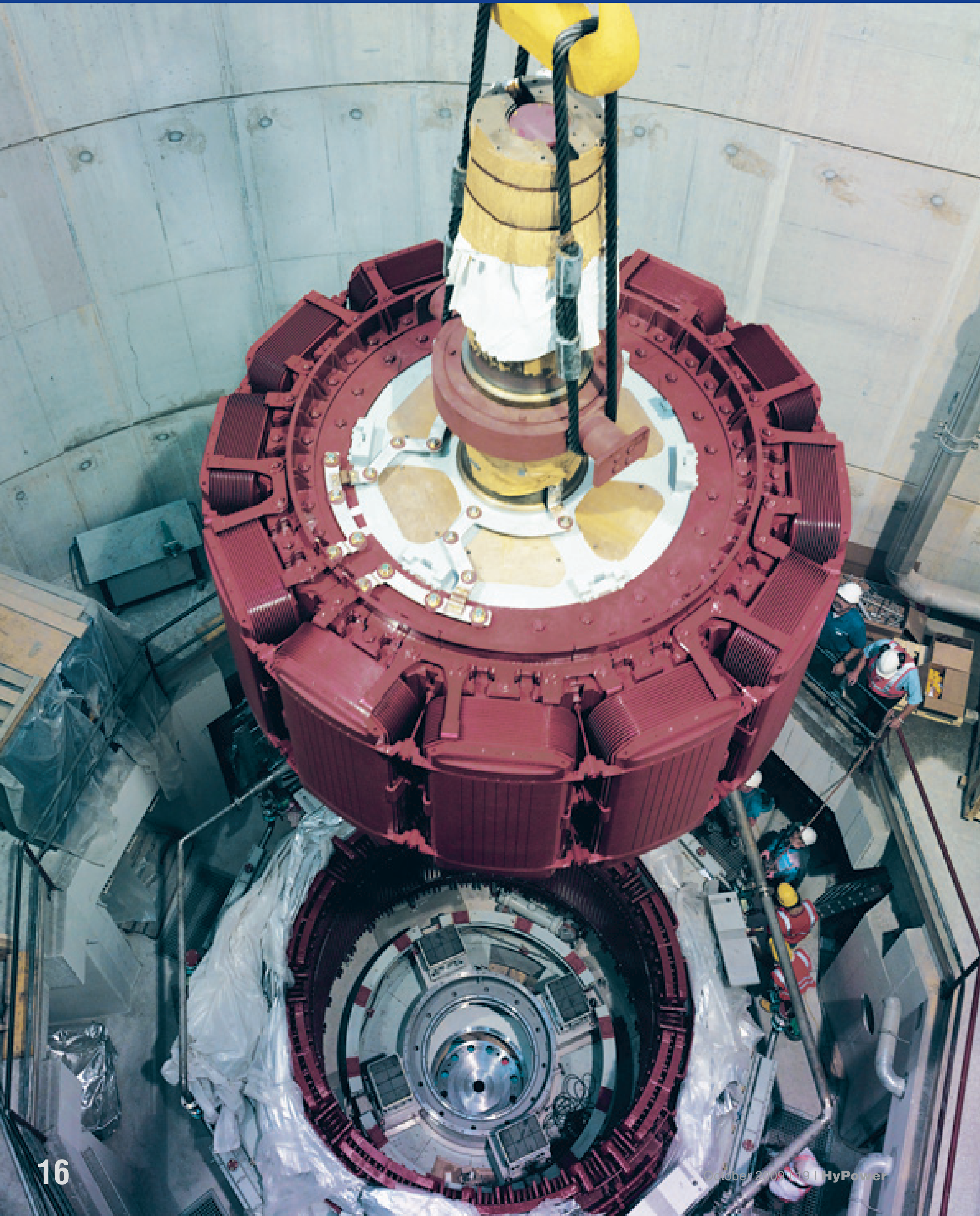
India

Today around 80 percent of the population have access to electricity. However, power outages are common. The government's stated aim is therefore to increase the power capacity by 100,000 megawatts. The maximum-voltage power lines transport the power at 800 kilovolts. In order to guarantee security and reliability of supply, the government is investing heavily in the construction of new power plants. Coal-fired power plants are used predominantly to generate power. Hydroelectric power is in second place. Other renewable energies have only been used to a very small extent since the turn of the millennium. In 2005, the installed power capacity in India was 138 gigawatts, and around 745 terawatt hours were generated.

A study conducted by the German Energy Agency dena calculated that the cost of the grid expansion will be 1.1 billion Euros. But if the plan really is to transport energy trouble-free throughout Europe and to push forward with the expansion of renewable energies, there will probably be no alternative to the further expansion of the power grid.

Load distribution in Germany

The maximum load in Germany is 80,000 megawatts, minimum load currently 40,000 megawatts. The country's current installed wind power is 24,000 megawatts, aiming at a value of 50,000 megawatts by 2020.



Unsymmetrical poles for less CO_2 emissions in large hydro generators

There is a simple way to improve the operational efficiency of a typical large hydro power generator improving both customer benefits and protecting our environment. The idea is to use unsymmetrical instead of symmetrical poles. Simulation results show that an unsymmetrical design leads to a more homogeneous field and lower saturation effects under load conditions reducing stray load losses in the stator winding.

These specific stray load losses are called “longitudinal field losses” because they are caused by a longitudinal field inside the stator slots due to saturation effects in the stator teeth. However, the advantages of the proposed pole design are only measurable under load and not at ordinary no-load/short-circuit test conditions as specified in IEC and IEEE standards.

No reflection of physical reality

It might sound absurd, but large hydro generators are designed and optimized from the loss perspective for no-load and short-circuit situations while the real machines most likely will run under load and very seldom at no-load or short-circuit conditions. The unsymmetrical pole concept for electric machinery is not totally new, but it was never applied for large synchronous hydro generators, because of the inconsistency between usual standards and physical reality.

The basis for testing of unsymmetrical poles are 2D-simulation results as shown in figures 1 and 2 for load conditions.

The high density of the symmetrical pole machine is on the subsiding part of the pole, where the torque is mostly generated. The teeth and pole shoe are strongly saturated on that side of the pole. The field in the saturated teeth is displaced inside the slot and causes eddy current losses – so called “longitudinal field losses” – which can reach up to 20 to 30% of the I^2R-losses inside the stator core length.

These losses additionally heat up the stator winding, which leads to higher ohmic losses. These strong saturations, which cause the longitudinal field losses, only appear under load; they cannot be measured in the no-load and short-circuit runs. Thus they are invisible for standard efficiency measurements.

Avoiding unsymmetrical fields

If the pole shoe is inclined, the maximum air gap on one side will be larger than the air gap on the other side, which will lead to an unsymmetrical air gap reluctance. Since the flux density under load is displaced to the subsiding end of the pole shoe, the combination of both unsymmetrical effects will lead to a more homogeneous field.

Reductions of 30 to 50%

It is not the smooth field which makes the unsymmetrical pole design desirable: The big advantage of this design is the reduction of the losses at load operation. The amount of saved energy depends on the machine design and varies depending on parameters like stator winding slot width, strand width or maximum air gap induction. In general it was observed that the longitudinal field losses can be reduced by 30 to 50%.

Simulations at no-load are totally inverse to the results shown and described above. The field is smooth for symmetrical poles and less homogeneous for the unsymmetrical pole alternative.

Physical reality versus standards – the discrepancy

All major standards for the determination of the losses suggest calorimetric measurements during three different test runs:

1. a mechanical run to determine the windage losses,
2. a short-circuit test to determine the load-dependent losses and
3. a no-load test run to measure the load-independent losses.

The results of these three different test runs are used to calculate the losses under load condition for a certain guaranteed temperature. According to the standards, the only difference between the test runs and load conditions are the temperatures inside the machine.

Focusing on the load-dependent losses V_{SC} it is common to split these losses into ohmic losses V_{ohm} and stray load losses V_{add} sometimes also called additional losses. The ohmic losses can easily be calculated if the temperature during the short circuit test ϑ_{SC} is known:

$$V_{ohm} = R_{\vartheta SC} \cdot I^2 = R_{20°C} \cdot \frac{235+\vartheta}{235+20} \cdot I^2$$

The additional losses according to IEEE are then:

$$V_{add} = V_{SC} - V_{ohm}$$

According to IEEE, these additional losses which are separated at ϑ_{SC} are not dependent on the temperature. The IEC standard uses the guaranteed load temperature instead of the measured short-circuit temperature to split ohmic and additional losses. The sum of ohmic and additional losses is supposed to be constant according to IEC. IEEE says that additional losses are constant and do not depend on the temperature.

Under load:
Magnetic field of a machine with symmetrical poles

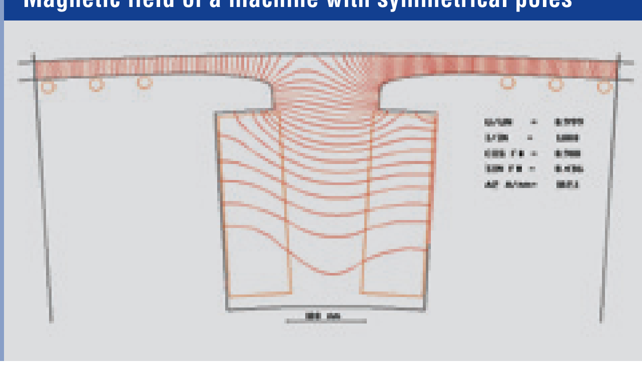


Figure 1: The density of the field lines is higher on one side.

… of a machine with unsymmetrical poles

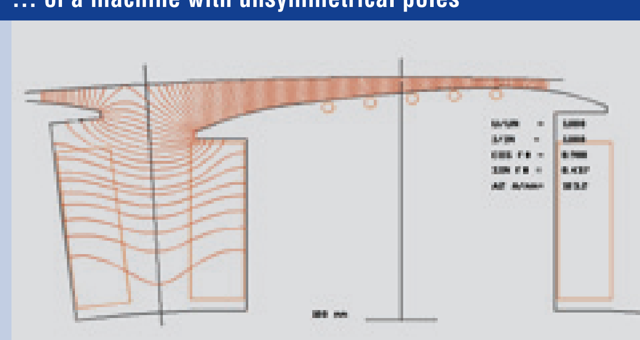


Figure 2: The field is quite smooth on both sides of the pole shoe.

To avoid discussions about what standard is closer to physical reality, efficiency measurements must be made under load conditions. It is, however, even more important to point out that all standards ignore the influence of saturation effects under load operation.

Symmetrical pole designs are optimized for no-load and short-circuit test runs and unsymmetrical poles are designed for load operation. But since the standard efficiency measurements according to IEEE or IEC are performed during no-load and short-circuit, symmetrical pole machines seem to have a better performance.

This leads close to the absurd situation that from the perspective of losses large hydro generators are designed and optimized for no-load and short-circuit while the real machines most likely will run under load and very seldom at no-load or short-circuit.

At no-load

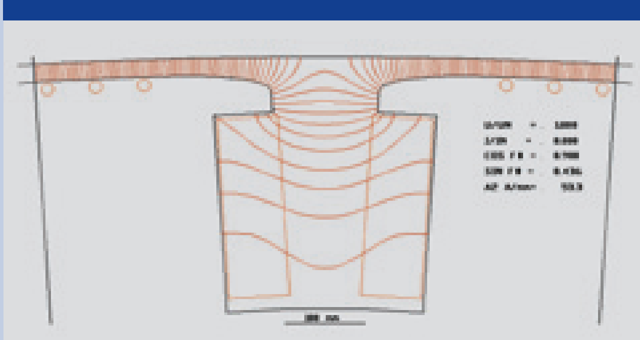


Figure 3: Magnetic field of a machine with symmetrical poles.

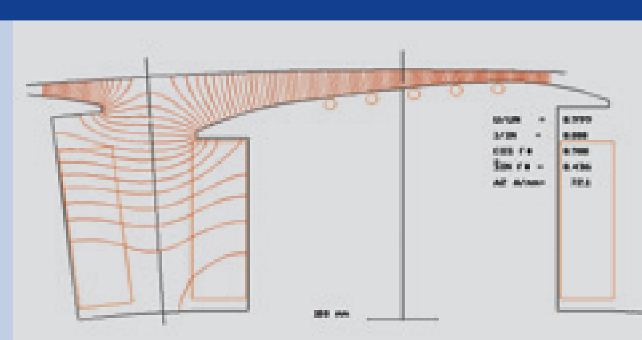


Figure 4: Magnetic field of a machine with unsymmetrical poles.

One test run equals three

To prove the simulation results and to measure the true efficiency of a generator, a calorimetric measurement under full load must be performed to capture all losses that appear under load. If a plant operator only wants to know the efficiency and not the separated losses he can also save time, since only one – instead of three test runs – must be performed during commissioning.

Two examples show how the standards constrain the new design. The first simulated machine (Table 1) has a rated output of 273 MVA, 52 poles and 624 slots. The second machine (Table 2) represents the upper limit of hydro power generators with a rated power of 855.6 MVA, 48 poles and 576 slots. Since ohmic losses of the stator and field winding are basically the same for the symmetrical and unsymmetrical pole design, they are not explicitly mentioned in tables 1 and 2.

Table 1 points out a significant difference between the simulated losses according to IEC and the losses simulated under load condition. Since the longitudinal field losses are not included in the calculation according to IEC, the results are much lower than the results for the simulation under real load conditions.

In fact there is one more field-dependent loss component, but since the influence of unsymmetrical poles on this effect is quite small, it is not discussed here. According to the IEC interpretation of losses, the losses of the symmetrical poles would be 18.3 kW lower. Even according to IEEE, the difference will be in the same magnitude.

Reducing CO_2 emissions

Assuming the calculation results are correct, savings of 190.2 kW are possible under rated load with unsymmetrial pole shoes. With a CO_2 rate of 0.6 kg/kWh (average CO_2 emissions of the power grid mix in Germany) and 8,000 operating hours a year this generator could save 1,522 MWh of energy and 913 tons of CO_2 annually, which equals the annual CO_2 emissions of 570 cars (160 g/km) driving 10,000 kilometers.

Example 2 is even more distinctive. Machines of that size have very high inductions which push the electrical designers to the limit of what is technically feasible. The slots are also quite big. These factors lead to high longitudinal field losses.

The longitudinal field losses reach values comparable to the rated power of small hydro power plants or wind power generators. In that particular case, losses under load can be reduced by 1.1 MW. So one unit could save 5,280 tons of CO_2 per year.

Higher stability at rated load

Another advantage of unsymmetrical poles is higher stability at rated load – referred to the same reactances. For symmetrical poles, the maximum amplitude of the field

Table 1 – Machine 1 (273 MVA)

Calculated losses	Symmetrical poles	Unsymmetrical poles
Electrical losses at no-load	630.3 kW	648.6 kW
Additional losses at short-circuit	366.8 kW	397.8 kW
Longitudinal field losses under load	376.9 kW	245.8 kW
Total calculated losses for load according to IEC at 75 °C	2,885.3 kW	2,903.6 kW
Total calculated losses for load under real load conditions and 75 °C	3,461.0 kW	3,270.8 kW

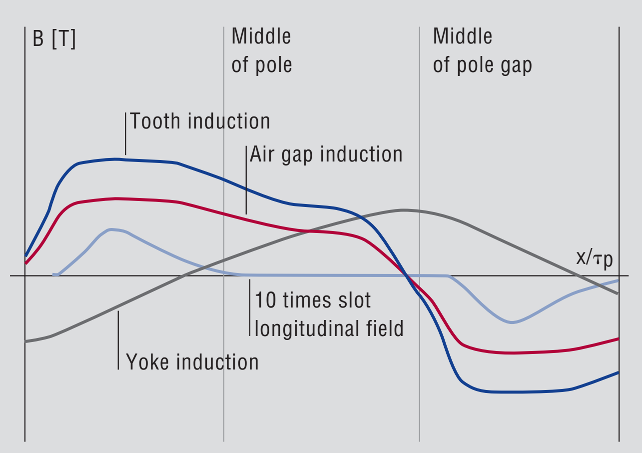


Figure 5: Field curve of symmetrical poles.

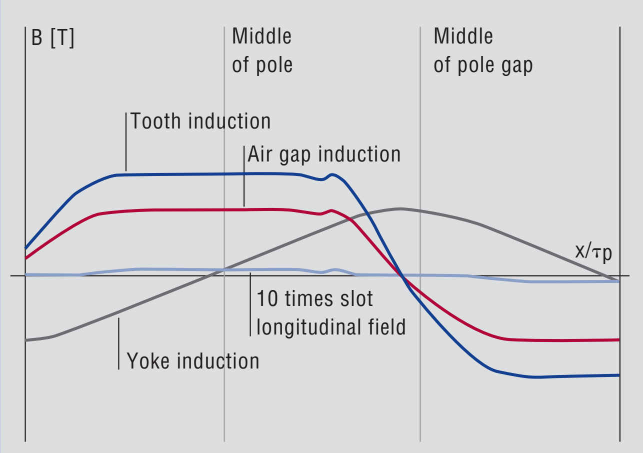


Figure 6: Field curve of unsymmetrical poles.

curve is located in the pole center at no-load, but moves outside the center under rated load. The proposed unsymmetrical pole shape shifts the maximum back to the pole center where the magnetic main axis with the highest stability is located.

The new proposed design for pole shoes of large synchronous hydro generators is to increase the air gap between pole and stator core from one side of the pole to the other. This leads to a more homogeneous flux density as well as less saturation and, as a consequence, to lower losses in the stator winding.

Since the proposed design will only have advantages under rated load, measurements must be done at rated load and not, as described before, at no-load and short-circuit conditions, in accordance with the existing standards. Although standards like IEC and IEEE are essential for the hydro business and are quite good to verify contracted values, they do not always serve non-standard innovations like the proposed unsymmetrical pole shoe design.

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Table 2 – Machine 2 (855.6 MVA)

Calculated losses	Symmetrical poles	Unsymmetrical poles
Electrical losses at no-load	1,930.5 kW	2,006.2 kW
Additional losses at short-circuit	1,093.1 kW	1,093.8 kW
Longitudinal field losses under load	2,099.5 kW	1,146.3 kW
Total simulated losses for load according to IEC at 95 °C	8,495.2 kW	8,568.6 kW
Total simulated losses for load under real load conditions and 95 °C	11,328.0 kW	10,220.0 kW

Flexibility for a diversity of markets

Interview with Martin Andrä, CEO of Voith Hydro GmbH & Co. KG, Heidenheim, Germany

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Mr. Andrä, how do you manage the vast geographical area that your unit serves?

Martin Andrä: In my eyes, we manage this quite well. Of course, it is challenging to serve such a wide range of markets, regions, cultures and customers. But we are well positioned to flexibly adapt to this variety. If you look at Germany or the other Central and Western European markets, we have participated in the upswing of modernization projects and pumped storage revival in one. Not only did deregulation create a grid situation that transcends boundaries throughout Europe today, we also see the implications of low-carbon energy needs from all over Europe grow tremendously.

How does this drive the type of projects or business you are doing?

Well, in the very mature hydro power markets of Europe, we see of course mainly modernization and uprating of existing plants as our core business. However, new pumped storage development is very active due to the need to stabilize the grid as more intermittent renewables like wind or solar come on line. So, the demand for low-carbon electricity generation as well as the development of new renewables help hydro through the demand for energy storage and flexible, quickly available, high volume and emission-free energy in a very fast-acting grid. Automation systems that are to achieve remote control operation for cascades of plants or pure upgrades in our customers' existing plants to state-of-the-art are additional business segments for us.

How are you responding to these changes?

We have built up our manufacturing capacities in Germany – and this is amazing, if you compare this to the downsizing we experienced just five to ten years ago. We have re-established mechanical manufacturing for new runners, rehabilitation of runners and other components, and on top of this, created a new workshop for the manufacture of hydro generators. Our facility mainly supplies equipment to customers in Europe. And we are happy to prove this way that even today there are very good opportunities to provide competitively equipment manufactured in a German location!

Location Info

Voith Hydro GmbH & Co. KG in Heidenheim, Germany, covers a market range that could hardly be more diverse: Western and Central Europe, Africa, India and some South-East Asian markets are covered by the unit's daily business activities for large and small hydro as well as modernization activities. This full-line unit has all engineering, project management and field service capacities in house. It also entertains a state-of-the-art facility in Germany that manufactures all mechanical components for turbines and inlet valves. In addition, new generator pole manufacturing was built up as part of its capabilities' and capacities' portfolio.

What goes beyond this traditional field?

We are a full-liner. Our expertise ranges from single components to the design of total plants and covers the supply of complete electromechanical equipment for hydro power plants including complex automation and control systems. We rely on highly qualified staff in all areas to successfully manage our customers' projects.

We are also constantly working to meet environmental demands in modern hydro power machines: We are for example working on solvent-free paints for turbines through new, carbon fiber-based surface protection to defy erosion and corrosion and extend the life-time of components and entire machines.

Where do you see your unit's specialty?

Our big advantage is our setting within the group. Voith Hydro operates a closely meshed network around the world. Each unit primarily serves its markets and regions and is in close connection with the hydro plant owners and operators in these regions. So, Shanghai serves China and the surrounding markets, São Paulo serves Brazil and Latin America, York, Montreal, and Mississauga serve the North American markets.

Let me point out here, that it has always been a principle in Voith and Voith Hydro to be global not because of low local manufacture or labor cost, but mainly because we value this closeness to the markets and the close relationship with our customers. For us, the relationship counts at least as much as high-end products and quality, which of course, we deliver in our understanding of engineered reliability.

"Renewable energy is the most discussed industry nowadays. How could this not be exciting?"

In this respect, Heidenheim is not only the oldest international location in a more than 140 year old hydro power business, but still the most international unit of all worldwide: Our employees talk to our customers and partners in six languages!

Are there regions where business for you is especially difficult?

Of course, it is not easy to serve Africa these days, or some Asian countries, with financing being required in almost all bids. And I think we can openly say that we do not agree how some hydro power is being developed in these areas with suppliers that do not have to follow the demands of guidelines taking care of environmental and social stakeholder issues, the way we have and want to do it, to get export insurance or to cope with our own environmental standards.

I am not saying that we do not want these guidelines. On the contrary, we are convinced we need them, but it would be better to have them applied for every supplier from every part and in any part of the world.

Are there special issues for the German location?

No, not really. In my mind, we struggle as much with the "race for the best and brightest minds" as other countries. This is one of our

main challenges as a technology leader. As a mature industry, hydro power is often regarded as conservative and, therefore, less exciting than emerging industries.

But this is not at all true: Engineers in this field of renewable energy can work on a variety of challenges that might seem small in their percentage for the efficiency, but large-scale in their effect on the overall performance and output of machines.

One should know that Voith Hydro has participated in the development of the largest machines at their respective times, proving safe operational behavior and reliable, enduring performance. Hydro power's contribution to the global demand for efficient, reliable and safe low-emissions energy generation is incomparable. Solutions driving the increase of performance, reliability, safety and even more environmental friendliness in terms of oil-free, solvent-free, erosion-protective and fish-friendly equipment, cannot be matched by any other large-volume "fuel". Renewable energy is the most discussed industry nowadays. How could this not be exciting?

Also, we often tend to forget that hydro power today has the qualities to meet multi-purpose demands that include flood control, navigation, recreation and grid balance at its best, all from one natural source.

So, what would be your wish at the end of the day?

My strong wish is that the recognition of hydro power and its manifold benefits penetrate in a greater arena of public opinion. Not only technological achievements but also the recognition of the beneficial use of this resource needs to be politically acknowledged again by policy makers worldwide.

We now have the unique opportunity to provide for a sustainable energy mix with a big share of renewable energy coming from hydro power.

So, my wish is that the policy makers provide a framework giving us the opportunity to push hydro power as part of a future-oriented and climate-friendly energy mix.

There is still a lot of potential for hydro power, not only in Europe, but in Africa and other regions of the world, too. And I am convinced it can be developed in an environmentally, socially and economically reasonable way.

Hydro power, large and small, has a lot to contribute to the sustainable energy mix of the future!

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The new power plant will increase San Esteban's capacity by one third in 2012.

Green energy for Spain with new San Esteban II

A new hydro power plant in Spanish Galicia will produce green energy with machines from Heidenheim beginning in 2012. Spanish utility Iberdrola ordered a Francis turbine, a vertical generator and a 32 meter long steel liner for its new San Esteban II hydro power plant.

San Esteban II will be built at the Rio Sil, the left tributary of the Rio Miño. It will be commissioned at the end of 2012 and, with 177 MW, supplement the capacity of the existing hydro power plant San Esteban. The original San Esteban plant was commissioned in 1957 and has a capacity of 265 MW. The new unit for San Esteban II will be installed in a new power house which will be built as cavern inside the mountain. The upper reservoir will be shared by both plants.

With this award, Iberdrola again affirmed their trust in Voith Hydro's technical solutions and capabilities. By 2012 the German unit will also supply four new pump-turbines with an overall capacity of 850 MW for La Muela II.

Iberdrola is one of Spain's largest utilities. With around 8,800 MW, it provides the lion's share of Spain's installed hydro capacity.

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Fit for the next 40 years – Modernization of Sedrun

The Sedrun hydro power plant is located in the immediate vicinity of the headwaters of the Rhine, in the Swiss canton of Graubünden. Its operator is the Kraftwerke Vorderrhein AG, who uses a watershed of around 316 km^2.

The nerve center in the cavern of Sedrun hydro power plant will be totally renovated from 2009 to 2011. It is the most ambitious modernization measure undertaken since the commissioning of the power plant in 1962 and marks approximately the half of the concession period.

With mechanical components and electronic equipment, Voith Hydro will return the plant to long-term, reliable and safe operation. In addition, the control system is being replaced by the process control system HyCon 400 and thus updated to the latest state-of-the-art.

The efficiency is also being optimized through the modernization project. To this purpose, the three machine sets will be equipped with new runners and new inlet nozzles. Over the long term this brings around two percent more efficiency, which may at first glance appear to be little, but it represents a significant economic factor when calculated over a 40 year operation period.

“We are proud to deliver a reliable system which allows the customer to satisfy his concession constantly over the next 40 years”, said Martin Andrä, CEO of the German unit of Voith Hydro, during the acceptance test in Heidenheim.

The refurbishing of the first of three units is well underway and should be completed according to plan by the end of November 2009. The two other units will follow at one year intervals until completion in November 2011, when the power plant will once again provide power to the grid with full and enhanced performance.

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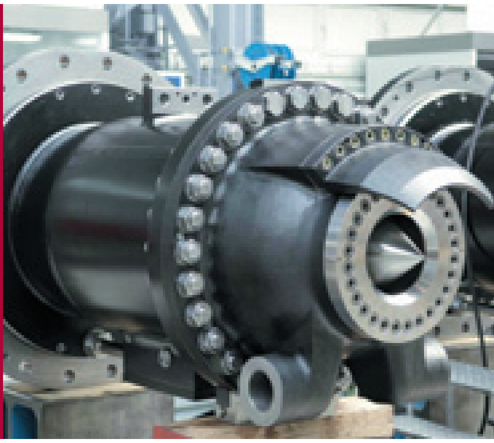
Acceptance test with the Sedrun customer in Heidenheim.



Elaborate erection work underway at Eglisau on the Rhine River

It was late 2006 when Voith Hydro was awarded the contract to deliver the electromechanical equipment for the rehabilitation of the Eglisau hydro power plant. In the meantime, full erection work is underway on the construction site at the River Rhine.

Besides the conversion of the turbine type from the original Francis runner design from almost 100 years ago to a modern Kaplan design, there was another equally important general requirement to meet: Eglisau's status as a historical landmark. The preservation obligations of the plant and its architecture had to be considered very carefully. Much of the plant's technical equipment is still in its original circa 1920 state and will be preserved in its entity.

It did not take long until the Project Management team led by Peter Bührer realized that the gate and door of the old power house would be the bottleneck for the delivery of large components for the rehabilitation project. The door accommodates parts up to 4.5 meters wide, some of the new parts are more than 6.5 meters in diameter – the pit liner for example.

"It was obvious that we had to find another way to get the equipment into the power house", says Peter Bührer: "Our only chance was to go for the slice by slice-option bringing the components in through the windows. Therefore, we now have a truck-mounted crane which lifts the parts from outside upright through the windows." On the inside, a new crane complements the historical one to move the parts to their final position inside the 80 to 90 meter long power house.

By 2012, Voith Hydro Heidenheim will deliver seven 6.7 MW Kaplan turbines, generators and governors as well as the complete control package. "The new turbines even exceed the guaranteed efficiency", explains Peter Bührer.

In its more than 85 years of operation, Eglisau hydro power station produced more than 20 billion kWh of electricity. Using Kaplan turbines instead of the original Francis units increases the flow rate from 385 m^3/s to 500 m^3/s. Thus, annual performance can be raised about a third from 246 to 314.5 GWh. This will be enough electricity to power around 80,000 households.

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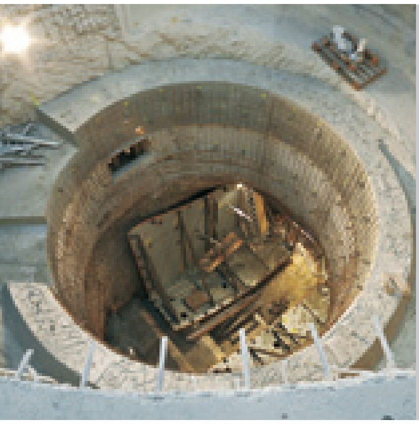


New control technology for Koepchen plant in Herdecke

RWE Power has operated the pumped storage plant at the Hengsteysee (Hengstey Lake) near Dortmund since 1930. The power plant supplies around 130 GWh peak load annually and provides balancing power for safe grid operation. A major overhaul of the power plant was finally planned for 2007.

Voith Hydro delivered the entire control system, including the turbine governor, and replaced the generator poles. The control room was completely redesigned and the existing vibration monitoring system replaced with a modern diagnosis system.

The Koepchen plant is a very important peak load power plant for RWE Power, which is why availability and functionality are top priorities. That is why a decision was reached in favor of the HyCon 400 system, which was specially developed for the requirements of large hydroelectric power plants and particularly of pump turbines. In Koepchen it was implemented fully redundantly.

The challenge of this project was an extremely short period of only four months for the entire overhaul. In addition, a large number of interfaces had to be coordinated because, simultaneously, the upper reservoir was refurbished and the starting converter renewed. Work was also planned for the pump-turbine. This resulted in a record performance for the shortest period of time, and was only possible due to careful planning and very close coordination with the customer.

As a peak load power plant, the machine is subjected to extreme load changes. This makes reliable vibration monitoring and sophisticated diagnostic procedures

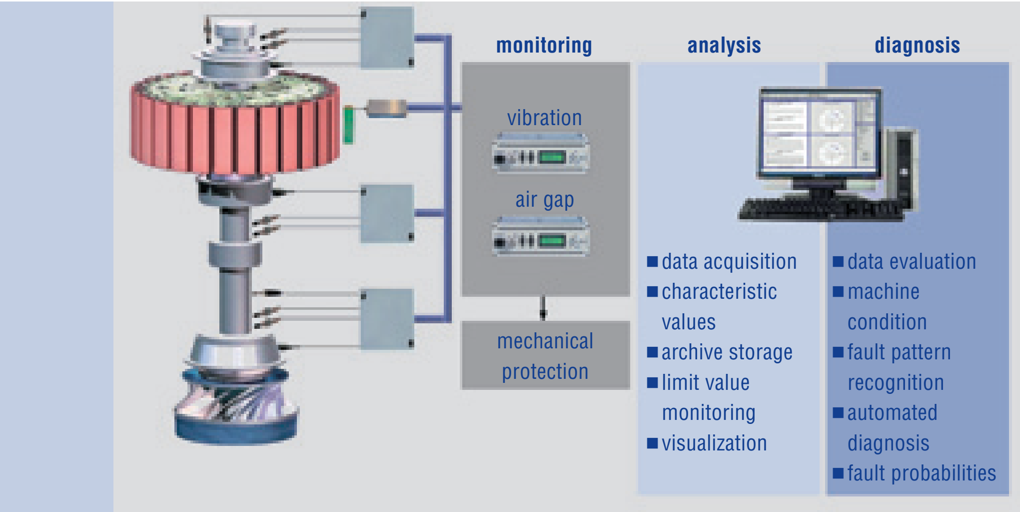
especially important. These are seamlessly integrated into the mechanical protection system and make reliable shutdown in the event of deviating vibration behavior possible.

The limit values set depend upon the type of operation and the operating point of the machine. Sensible monitoring of pump-turbines for which – depending upon the operation mode and the operating point – extreme differences in vibration behavior are perfectly normal, can only be ensured in this way, while at the same time false shutdowns are avoided.

In the Herdecke pumped storage plant, transient operation is now just as consistently monitored as stationary operation. It is now also possible to analyze and diagnose slow and longer term trends in vibration behavior. Especially when a machine is involved whose availability is of the utmost priority, early recognition of arising errors is of particular importance.

The real highlight: The fluctuation experts at Voith Hydro can support and consult with RWE Power from Heidenheim with specially secured remote access. That is already proved itself in the initial operation phase following the overhaul, when the adjustment of a bearing was optimized while vibrations had to be simultaneously reduced. Through the service agreement, the experts from Voith Hydro evaluate the condition of the machinery regularly and can thus recommend necessary maintenance measures.

Patience and experience in analysis is in demand: The characteristic values of the plant in some cases react so sensitively that normal annual fluctuations in the trends are clearly visible and can easily lead to false interpretations.



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Start of assembly during Swedish Midsummer Night

Four truck convoys with special freight arrived in Ligga in northern Sweden on June 23, 2009. They were loaded with 150 tons of cargo, namely the main components for the new turbines with nearly 200 MW.

The Ligga hydro power plant is located about 40 kilometers north of the Arctic Circle and started operation with the first expansion phase between 1951 and 1954. In November 2006, the operator, Vattenfall Vattenkraft, awarded Voith Hydro the contract for the delivery of a new Kaplan runner for the power plant on the river Lule Älv. There were several technological challenges to be managed.

With a rated output of 196 MW, the five-blade Kaplan runner is one of the best performing of its kind and has a diameter of 7.5 meters. In addition, the efficiency of the machine had to be proven by a model test in the Vattenfall research laboratory.

The mounting of the blade pins also required a sophisticated solution: In the interests of environmental protection, they rest on special oil-free elements that eliminate the danger of oil leakage.

The present assembly work also includes the rehabilitation of other turbine components. Together with the assembly partner at site, Vattenfall Service Nordic, the turbine shaft, for example, was also overhauled.

The date is set for the end of October 2009, when the new machine in the Ligga power plant will generate electricity for the first time.

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From August 2010 on, Uglich's unit number two will feed power into the grid again.

Uglich – doubled capacity after rehabilitation

A significant project provided the stage for a significant milestone in Voith Hydro St. Pölten's history: The Austrian unit manufactured the biggest Kaplan runner in its history this summer.

Things got really exciting in the middle of July for the workshop assembly team in St. Pölten. The Kaplan runner for the Uglich hydro power plant was ready for final approval by the customer RusHydro.

At nine meters in diameter and weighing 220 tons, it is the biggest Kaplan runner to be manufactured in St. Pölten so far. And it is among the largest of Voith Hydro's worldwide, too.

Voith Hydro received the award for Uglich in April 2007. The scope of supply included the replacement of unit two's hydraulic machine, the generator and the delivery of automation and balance of plant equipment.

Uglich was the first hydro power station at the Volga-Kama cascade situated in Russia's Jaroslawl region. Its existing turbine has been in service since 1940 and, in the end, could only be operated at a capacity of 35 MW. After the renovation the runner will be able to operate at its full capacity of 70 MW again.

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Voith Hydro in Montenegro

Strenghtened presence in south-eastern Europe

At the opening ceremony in Podgorica.

Voith Hydro this year inaugurated a new office in Podgorica, Montenegro. The opening was attended by both representatives of industry and public administration.

"Voith Hydro is an established full-line supplier for hydro power plant equipment in all major markets in Europe, South America, Asia, Australia and the United States. With our new office in Podgorica we are now present in the region of south-eastern Europe and suitably close to our customers and markets here", said Dr. Leopold Heninger, Board Member of Voith Hydro Austria, during the inauguration ceremony.

The inauguration took place under the patronage of Austria's ambassador Florian Raunig and Montenegro's Minister for Economic Development, Branimir Gvozdenovic.

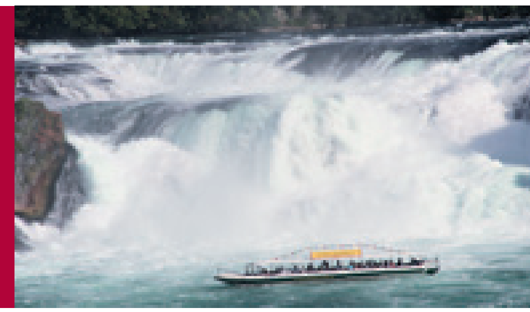
In his speech, the Minister emphasized the importance of the close connection between technical know-how and proximity to customers, now assured with the new office in Podgorica.

In addition to supplying Montenegro, the new Podgorica office will also serve Bosnia-Herzegovina, Serbia, Kosovo, and Macedonia.

This location complements the previous opening of locations in Eastern Europe such as Bucharest, Romania. Here, Voith Hydro had already taken a big step towards presence in south-eastern Europe.

New award at the Rhine Falls

Modernization of a 60 year-old power plant



Rhine Falls at Schaffhausen.

Voith Hydro is upgrading the nearly 60 year-old Neuhausen hydro power plant located next to the Rhine Falls for the Rheinkraftwerke Neuhausen AG. The upgrading contains a new Francis turbine with a diameter of 2.3 meters and the modernization of the related turbine components and control systems. The performance of the hydroelectric power plant will be improved considerably.

The power plant was built between 1948 and 1951 directly next to the largest waterfalls in Europe, the Rhine Falls. A head of 20.7 meters caters an annual production of around 40 GWh. It supplies the community of Neuhausen across the falls with green power. The unit is scheduled to go back online in August 2011.

The shareholders of the Rheinkraftwerk Neuhausen AG are EnAlpin, Axpo AG and the community of Neuhausen.

Richard K. Fisher retired

A passionate hydro advocate for almost 40 years

Richard K. Fisher retired from Voith Hydro after 38 years of service this summer. He was responsible for the Research & Development, Turbine Technology, New Product Development and Technical Marketing Support. He is well-known for being active in the development of hydro turbine modernized designs which are more compatible with environmental considerations than traditional designs.

In the early 1980s, he became active in the development of understanding of how fish pass through turbines and how turbines influence fish, either in their passage, or through affecting their aquatic habitat.

Being the program manager for one of the two U.S. Department of Energy Advanced Hydro Turbine System programs, he and his team led the hydraulic design for modernizing the Bonneville Kaplan turbines, which are the prototypes of a generation of new environmentally friendly turbine designs.

He was also responsible for leading the development of aerating turbines which are used to increase the oxygen content of the water discharged through the turbine for aquatic enhancement downstream of the powerhouse.

His successor is Stuart Coulson who has worked in the hydro power industry for 21 years. He joined Voith Hydro in 2008 as member of the Voith Hydro Engineering Company's International Management Team.

Cooperation with Vienna University

Voith Hydro Austria supports university research

A new cooperation is forged.

The Austrian operating unit of Voith Hydro and the Institute for Thermodynamics and Energy Conversion from the Faculty of Mechanical and Industrial Engineering of the Vienna University of Technology, Austria, will further strengthen their cooperation.

Both parties signed a contract about the funding of two research assistant positions in which basic research on turbines in jointly defined research and development projects will be conducted.

Akköy II – a milestone Pelton project

At an extraordinary head of 1,220 meters, one of the world's highest head Pelton applications will be commissioned by Voith Hydro. It is located in Akköy, in the Black Sea region of Gümüşhane in northeastern Turkey.

Already in 2005, customer Akköy Enerji relied on electromechanical equipment from Voith Hydro and awarded Akköy I, a project with three Francis turbines with a total capacity of 103 MW. Akköy Enerji is a private Turkish investor acting as an independent power producer. All units of Akköy I are now under commercial operation making it the first hydro project of this size in the country's liberalized energy market.

Akköy II will be built adjacent to Akköy I. Although Akköy I and II are located next to each other, they are supplied from different sources.

The three 31 MW Francis units of Akköy I use the water of the Harsit river whereas the Akköy II-plant, equipped with two Pelton units, will be fed by the water of the three rivers Karaovacık, Gelevera and Gavraz.

The waterway is characterized by a system of two dams, a regulator, long tunnels and a penstock to bring the water to the power house. The highly efficient turbines will have a rated capacity of 117 MW each and will rotate at 750 rpm.

The units are scheduled to be commissioned by March and May 2011 respectively.

Akköy I and II are supplied by the same consortium led by Voith Hydro. Voith Hydro's operating unit in St. Pölten, Austria, leads the consortium and is responsible for the design and manufacturing of the generators and turbines as well as for the control and protection system. The Turkish operating unit is responsible for the local manufacture and the assembly of the equipment. Siemens Turkey is the third member of the consortium and provides the electrical balance of plant equipment as well as the unit transformers and the high voltage switchyard.

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Good progress for Brazilian Estreito and Baguari projects

A crucial stage began with the start of the installations for the first runner of Voith Hydro's Estreito project in the beginning of September.

Estreito is considered to be one of Brazil's key hydro projects: It is one of the country's biggest investments in hydro power today and it will operate the largest Kaplan turbines ever manufactured in Brazil. Each of the eight 138.6 MW runners has an impressive diameter of 9.5 meters.

The first unit is scheduled to feed power into the grid for the first time in October 2010. Full operation is planned 14 months later, mid 2011, with one unit going online every two months.

Voith Hydro took a new approach regarding Estreito's stay rings and wicket gates. In order to combine high functionality and competitive costs, the stay rings were subject to several structural analyses investigating the metallic structure's interaction with the concrete under different load regimes. The new design for the wicket gates focuses on the combination of stainless and carbon steel welding with very good results in terms of quality.

For Voith Hydro São Paulo, the project Baguari represents the first bulb machine completely manufactured in Brazil. The first unit is already synchronized to the grid – three months ahead of schedule. And again, the company is working an ambitious schedule for the other three machines to be delivered by the end of January 2010.

"Both Baguari and Estreito belong to the greatest challenges we have faced so far", says Osvaldo San Martin, Chairman of the Board of Mangement of Voith Hydro's Brazilian unit: "But I am confident they will be a great success, too. These projects show: We are able to meet challenges like these, not only in size but also in terms of design and manufacture of innovative machines in demanding time frames."

Both projects are part of PAC, the Growth Acceleration Program of the Brazilian Government.

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Important milestones for Chinese projects

Voith Hydro Shanghai has seen several important milestones for different projects over the last months. It started with La Xi Wa, the largest project on the Yellow River with five units with a total capacity of 4,200 MW.

The La Xi Wa project plays an important role in the Chinese National Hydro Power Development Program. After around four years of design and manufacture, the first two units were successfully synchronized to the grid in April. Units number three and four will follow until November.

With the completed manufacture of the equipment for La Xi Wa another milestone was reached end of August contributing to an early completion of the plant.

Aage Dalsjoe, President of Voith Hydro Shanghai, was happy to see the last unit ready for delivery: "From early 2002 on, we started pursuing this project. The contract was signed in August 2004, and now, five years later, we are here to celebrate the completion of the equipment manufacture. We all know about the challenges of this project with its tight construction and delivery schedule plus long shipping distances. Effective team work over this long period made this possible."

Customer Huanghe Hydropower Development joined the celebration and gave the company high praise also. La Xi Wa is the third project within Voith Hydro Shanghai ranging in the 700 MW capacity level.

Another hydro power plant started operation in late September: Xiaowan on the Langcang River. Voith Hydro delivered three Francis units with an output of 714 MW each. Xiaowan is scheduled to be completed in 2011. Half of its electricity output will be transmitted to Guangdong Province; the rest will be consumed locally.

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Prof. Dr. Fritz Vahrenholt, Chairman of the Board of RWE Innogy, and Dr. Hubert Lienhard, CEO of Voith AG, signed the contract for the joint venture.

A new company for ocean current technology

With the approval of the regulating authorities in Brussels, Voith Hydro and RWE Innogy have created a new company, Voith Hydro Ocean Current Technology, with Voith Hydro holding 80 percent of the shares.

The new company's goal is to enhance technological development, installation and maintenance solutions for ocean current turbines. The total investment guaranteed by both partners over the next few years exceeds over 30 million Euros. This investment clearly shows the conviction of the companies that renewable energies from the oceans will have a considerable share within the energy mix of the future.

"As it always is the case with new technologies, the first thing to do is to make them competitive as quickly as possible. In our opinion, the only way to succeed is through a very close cooperation between the technology developer and the future plant operator in order to consider the needs of all parties. The collaboration with RWE Innogy therefore does not only provide venture capital support but also the required close interaction between the involved parties", explained Dr. Jochen Weilepp, Managing Director of Voith Hydro Ocean Current Technology.

Voith Hydro has been working on ocean current technologies since 2005. Due to the harsh marine environment the company's experts pursue the goal of making the product as robust as possible to reduce servicing needs. The design therefore has no gearbox or rotor blade adjustments. It is especially ecofriendly due to the absence of oil and grease.

The first prototype was manufactured at the company's headquarters in Heidenheim, Germany, and is now on its way to the test site off the South Korean coast. It will be deployed this winter and will be tested thoroughly.

Later, this initial test plant will be part of a large power station project that will generate electricity from ocean currents with a rated power of several hundred megawatts. Further plants in Europe will follow.

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Big steps for hydro power sustainability in 2009

The IHA World Congress on Sustainability in Reykjavik, Iceland, in June impressively showed how the awareness for sustainability in hydro power has grown in the last few years, not only in the industry but also across sector borders. Many players are now involved in the development of a standard that might be applied worldwide to all hydro power planning and implementation.

The conference was an unparalleled networking event for all stakeholders. Views of all kinds in the context of policy, markets and finance were given to a most interested audience.

The draft of the newly developed Hydro Sustainability Assessment Protocol was meanwhile published for a trial phase that is designed to cover all types of projects worldwide, from planning to operation.

Facilitator Helen Locher, Hydropower Sustainability Assessment Forum Coordinator, IHA, David Harrison, Nature Conservancy, and Kirsten Nyman, GTZ.

Panelists addressing the congress.

Ólafur Grímsson, President of Iceland, addressed the crowd at the closing dinner.

Voith Hydro's sustainability workshop in Brazil.

"This was a very encouraging event, which showed the industy's interest at a crucial time in the development of the Protocol. We are looking forward to interacting with many hydropower companies and other interested stakeholders over the next few months in order to make the Protocol a practical, broadly accepted tool", says Dr. Helen Locher, the coordinator of the IHA Hydro Assessment Sustainability Forum (HSAF).

Rollout events in many regions will take place through November 2009.

For further information please contact Helen Locher at hl@hydropower.org.

Internal capacity building at Voith Hydro

Special focus of Voith Hydro and other players in the development of sustainability in hydro power plants lies on the performance measurement against criteria. Capacity and awareness-building are key to successful implementation of standards one day. So, Voith Hydro has implemented intense internal workshops to educate its staff.

In such a workshop in Brazil in April 2009, participants of sales departments of Voith Hydro could learn how to apply sustainability aspects to hydro power stations according to the IHA Sustainability Assessment Protocol.

Aside from the presentation of general definitions of sustainability and its development over the last 30 years in political frameworks and societies around the world, a hands-on exercise let participants experience how to do an assessment of performance and apply ratings with impressive results and findings. Voith Hydro was again helped with the contributions and challenges from the World Wide Fund for Nature (WWF).

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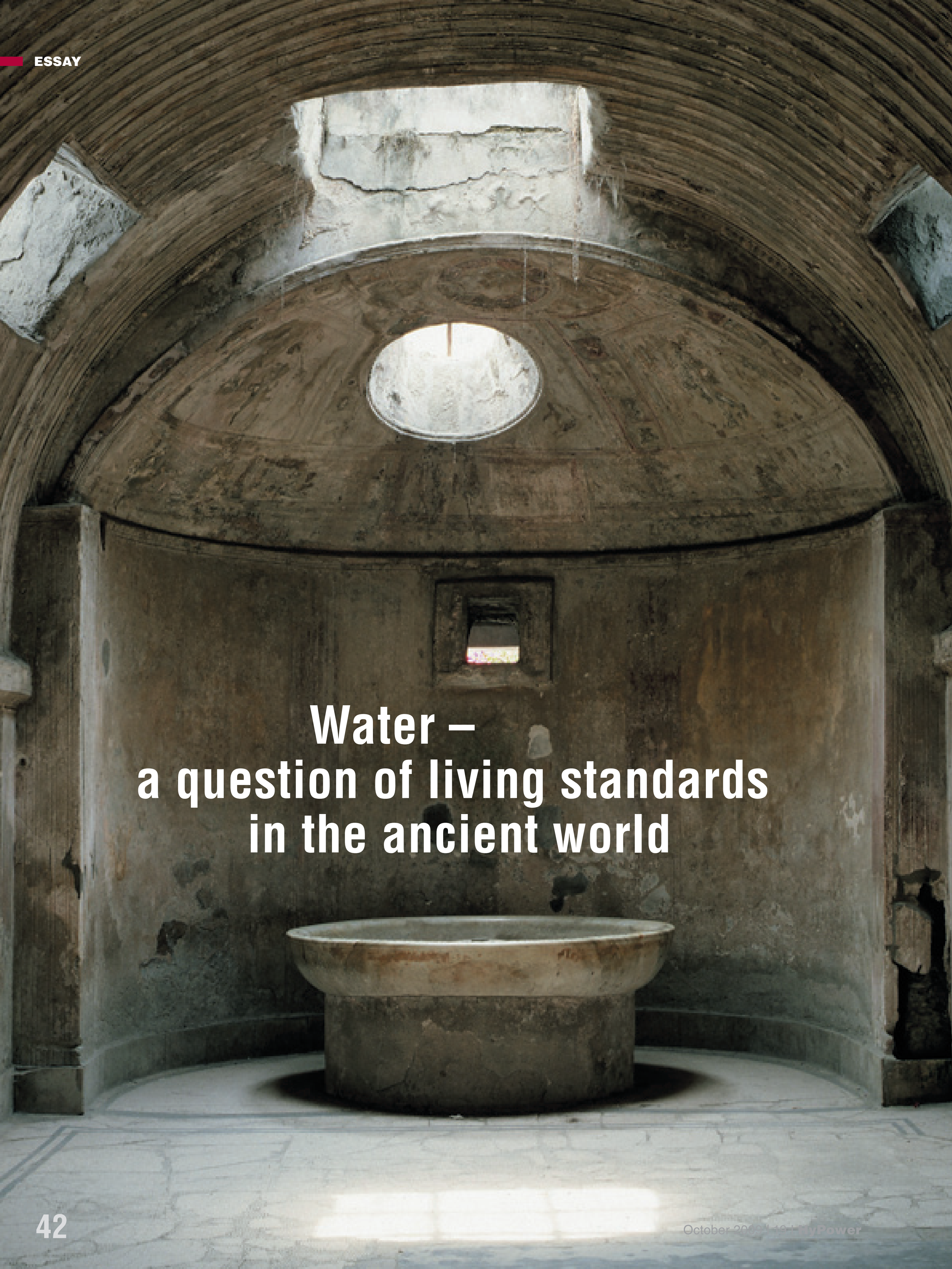


Water – a question of living standards in the ancient world

A sophisticated system supplied ancient Pompeii with water. It involved the interplay of public wells, private fountains and pipelines, as well as technical appliances for the distribution of the water, which was diverted to the city from a great distance.

The eruption of Vesuvius on August 24, 79 A.D. destroyed Pompeii, but at the same time it preserved the city, leaving technical systems for the water supply to a great extent preserved even to the present day.

Pompeii's water supply system was primarily based on the collection and storage of rain water. Above the characteristic roofs of the Italic atrium or peristyle structures (see box on page 45), the captured rain-water flowed into cisterns, which were principally found under every residential building, as well as in or under public buildings and plazas.

Even after the construction of the great distance aqueducts in the 1st century B.C., nearly all cisterns remained in use. This was because, in addition to water storage, people did not want to dispense with the effect that the rain falling into the so-called impluvium (see box on page 45) provided namely the cooling of the central rooms of the house.

Very early on there were wells with a depth of approximately 40 meters. However, because their water was of poor quality, they were completely abandoned and later saw the construction of the long distance aqueduct.

Long distance water supply systems even 2,000 years ago

Two long distance aqueducts ensured the water supply. An older system led from the approximately 30 kilometer distance from Avella to Pompeii. However, the water resources it provided fluctuated greatly depending upon the season. About 50 years later, in the age of Augustus, which is dated from 27 B.C. to 14 A.D., a nearly 100 kilometer long aqueduct system was built, originating from a spring area near the city of Serino and extending to the Bay of Naples. Its main purpose was to supply a fleet, stationed in Misenum by imperator Augustus, with water.

The new system was merged with the existing one to the north of Pompeii. However, Pompeii was only one of many cities to be supplied by this aqueduct.

Water flowing into the impluvium cooled the main rooms of the house (reconstruction).

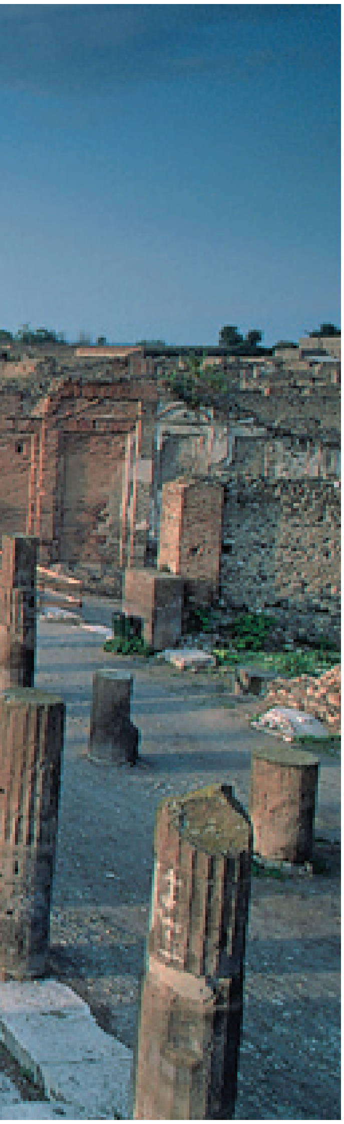
As a consequence, the city was only allowed a contingent of water appropriate for its size. This was considerably less than the peak water volume of Avella, which made the considered management of water resources necessary.

However, there was also one decisive advantage: For the first time, Pompeii now had fresh, cool water throughout the whole year. This, among other things, resulted in a significant increase in the number of hydrotechnology installations in houses and gardens. The inhabitants of Pompeii now afforded themselves a kind of ancient air conditioning: They installed fountains into the impluvia and could thus artificially cause the cooling effect brought about by the evaporation chill as they wished. This cooling effect was previously only present when it rained, which was extremely seldom, especially in summer.

Distribution of water in the city

While Pompeii was still supplied with water exclusively from the Avella system, the water flowed from the aqueduct into a round, shallow and open basin found at a prominent plaza in the city.

A closeable castellum was later built over the basin to prevent misuse of the regulating and



The site of ancient Pompeii overlooked by Vesuvius.

distribution fixtures in the basin, which had been installed in the course of renovations.

These renovations ensured that the water was divided three ways. A weir and regulating plate made of lead distributed the water, precisely dispensed, to three outlet pipes leading to various city districts.

Despite the long distance water supply, the traditional water supply involving the collection and storage of rainwater was maintained. The inhabitants of Pompeii had lived with this system for centuries and it seems apparent that the amount of water was principally adequate.

The quality of life of the residents of Pompeii clearly increased with the constant availability of water through this sophisticated delivery system of aqueducts and resource management: Even at that time, summer in Italy was hot, and anything that could provide cooling was much in demand. ■

Glossary

An **atrium building** has a central room open to the sky, the atrium. Because the light finds its way into the rooms through this opening in the roof, the outside of the house requires no windows.

A shallow water basin, the **impluvium** (Latin: in – into, down from; pluvia – rain), is found in the middle of the atrium. It collects rainwater that falls from the roof and cools the room. The water is collected in a cistern beneath the impluvium.

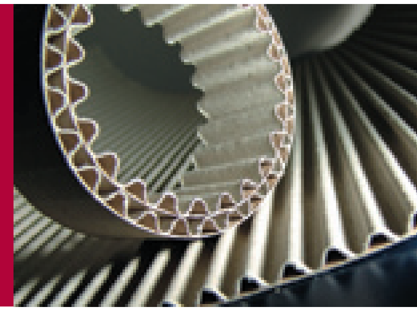
Since 200 years B.C., the Roman atrium house was often expanded by a **peristyle**, an inner courtyard surrounded by pillared walkways (Greek: peri – around; stylos – column). The peristyle is often designed as a flower garden.

Further information

This article is based on an article by Dr. Christoph Ohlig. It appeared first in the magazine "ANTIKE WELT. Zeitschrift für Archäologie und Kulturgeschichte" 2/2009, pages 17 – 24, by publishing house Philipp von Zabern. The magazine is available in German only.

The course of the ancient aqueducts.

Pompeii's water castellum.



Hermes Award for Voith Turbo

Voith WinDrive wins international technology prize

All actors dream to win an Oscar one day, while industrial designers hope to win the Hermes Award. The international technology prize of the Hannover Fair is awarded annually at the world's largest industrial exhibition.

This year, the jury nominated five companies out of over 70 applications. They finally picked Voith Turbo for the "Oscar of Engineers" and awarded the 100,000 Euro-prize to the WinDrive.

The WinDrive was developed in background of a continuously increasing utilization of renewable energy. For power grid operation, the variable rotor speed of wind turbines has to be converted into a constant generator speed.

With the WinDrive, Voith Turbo Wind is the first company to realize the highly dynamic variable transmission in the driveline of a wind turbine without using frequency inverters. "This year's award-winning innovation ensures that there is a fresh wind blowing on the rapidly increasing wind energy market", explained Prof. Dr. Wolfgang Wahlstätter as the jury's motivation to choose Voith Turbo Wind.

In her laudatory speech, Germany's Federal Minister for Education and Research, Dr. Annette Schavan, underlined: "The project comes at the right time and covers the right topic. It is interdisciplinary and highly innovative, while its operation is easy to understand. It aims at a growth market and can already be seen in practical operation.
It thus ideally embodies all of the objectives formulated by the high-tech strategy goals of the Federal Government." ■

Voith Paper

Voith Paper helps paper and board mill Varel to save energy

Between September 2007 and July 2008, Voith Paper rebuilt paper machine 4 of the paper and board mill Varel, Germany, in order to save energy, to enhance operational safety and thus increase the efficiency of the machine.

Today, the success of this rebuild project proves its initiators right. The steam consumption of the machine is reduced by about 10 percent. The operational safety is increased due to a reliable condensate removal. At the same time, the required drive power and the number of sheet breaks declined.

The rebuild comprised the exchange of all 51 steam joints with rotating siphons for new V^{plus} Steam Joints with stationary siphons and the adaptation of the steam and condensate system. The low differential pressure of 0.15 bar reduced the velocity of the steam-condensate mix in the condensate pipe and thus wear in the piping.

The CD moisture profile was also positively influenced.

A special challenge in project management was the narrow time corridor: As part of the rebuild, Voith Paper carried out the complete installation in each case within only 48 and 72 hours respectively.

Initial problems with vibrations were immediately solved. A vibration damper of the siphon was developed in this course – it has meanwhile been registered as a patent by Voith Paper. The payback time of the entire rebuild amounted to less than one year.

Voith Industrial Services

Eastern European Markets: Voith Industrial Services Wind offers optimum customer proximity

The Polish wind energy market has seen excellent growth over the last few years. As a result of this development, service and maintenance requirements have also increased. Germany-based Voith Industrial Services Wind can now rely on a team of local service technicians in Poland.

Employees of Hörmann Serwis Polska – the Polish branch of Hörmann Industrietechnik and fully owned by Voith Industrial Services – for this purpose underwent specialized maintenance and service training. The training comprised theoretical introduction to wind energy, through hands-on training at wind power stations and a second phase of intense on-the-job training.

The Wind business unit of Voith Industrial Services thus extended its specialized service range to the Polish unit by now providing this wide range of services to its local customers. With this addition, service offers cover the entire life cycle of the plant and include assembly, operation, maintenance, modernization, disassembly and reassembly.

Conferences, seminars and symposia

Date	Event / Further information
November 3 - 4, 2009 Ottawa, Canada	**Forum on Hydropower 2009** www.canhydropower.org
November 10 - 12, 2009 Hamburg, Germany	**acqua alta** www.hamburg-messe.de/acquaalta Paper presentation by Voith Hydro
November 16 - 17, 2009 Brussels, Belgium	**EREC** www.erec.org
November 17 - 18, 2009 London, UK	**3rd Tidal Energy Summit** www.tidaltoday.com/ITES/ Paper presentation by Voith Hydro
November 22 - 25, 2009 Recife, Brazil	**XX. SNPTEE** Seminário Nacional de Produção e Transmissão de Energia Elétrica www.xxsnptee.com.br/
March 29 - 30, 2010 Sarawak, Malaysia	**ASIA 2010 – International Conference & Exhibition on Water Resources and Renewable Energy** www.hydropower-dams.com Booth and paper presentation by Voith Hydro
March 24 - 26, 2010 Moscow, Russia	**HydroVision Russia 2010** www.hydroevent.com
June 16 - 19, 2010 Lausanne, Switzerland	**Hidroenergia 2010** www.esha.be/index.php?id=117
July 26 - 30, 2010 Charlotte, USA	**HydroVision 2010** www.hydroevent.com

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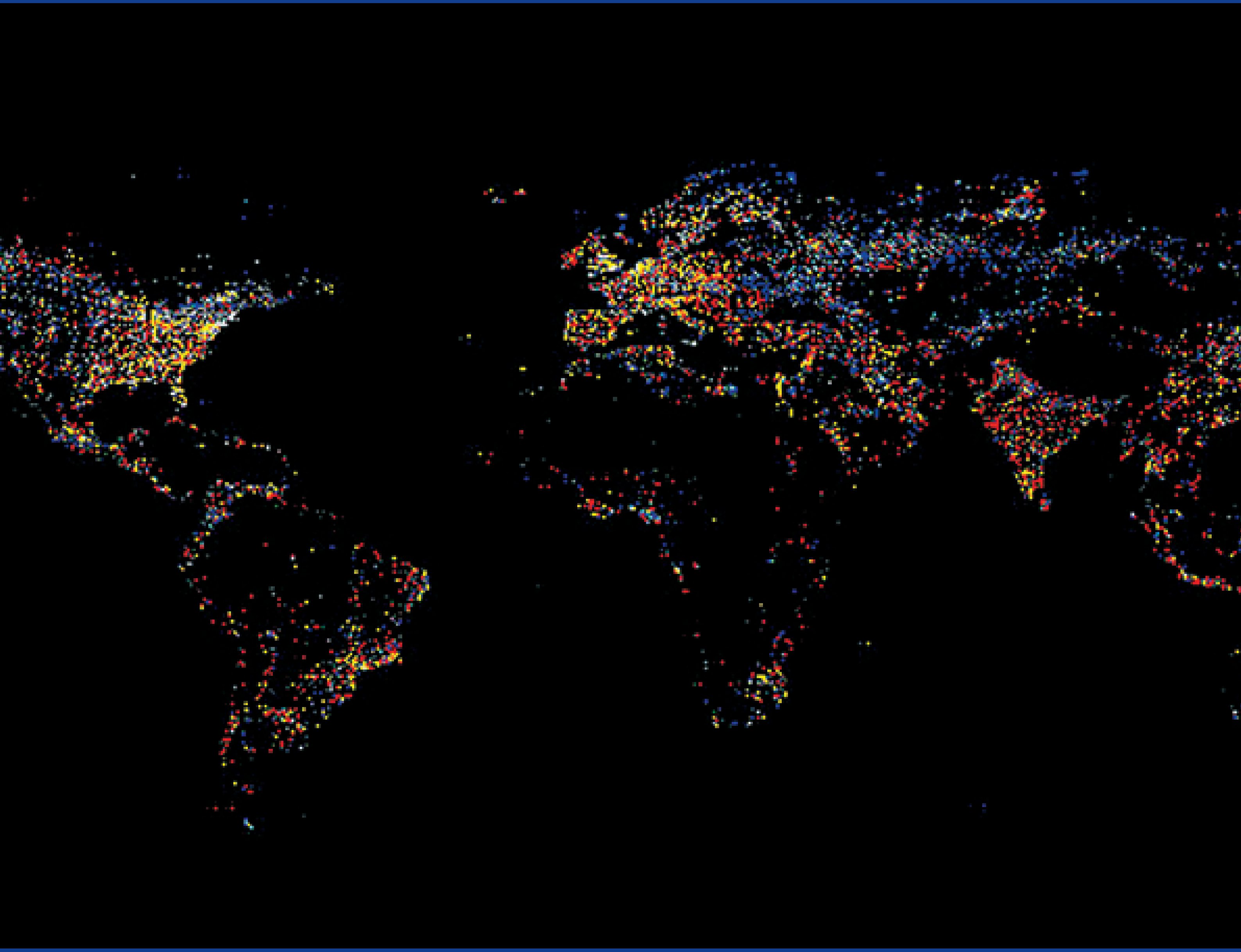

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