



VOITH

MAGAZINE FOR HYDRO POWER TECHNOLOGY

HyPower

#20 | SUMMER 2011

FOCUS

Powering the Future

GLOBAL EXPERTISE
Generating Excellence

CASE STUDIES
Full-line Service

TECHNOLOGY
Harnessing the Ocean's Energy

Guangzhou, China

Commissioned in 2000, Guangzhou, in China's Guangdong province, is said to be the world's most powerful pumped storage plant. It has an overall power output of 2,400 MW. Four of its pump-turbine / motor-generator units were supplied by Voith Hydro.

Take a look inside > page 35





A renewed look reflects our renewed vision

Our renewable energy industry is surging with innovation and vigor. Increasing energy demand as well as the urgent request to curb climate change have motivated a whole new generation to reach for better solutions. At Voith Hydro, we have also realigned our perspective in order to help our customers envision and achieve more. As the new editor of HyPower, I will be bringing you stories of these new developments and giving you an up-close view of the challenges and successes. Fittingly, we have given HyPower a fresh new look as well.

In this edition, you will read about how our innovative technology is helping harness the tremendous potential of the world's oceans, and how clients across the world are benefiting from our global generator manufacturing network. You will also gain an insight into how important hydro power – on every scale – is to emerging countries, providing the basis for both economic and social progress. As much as I hope the following pages will inspire you about what's possible, I believe you will be reassured by the 100-plus years' expertise on which our thinking is based. Fresh perspectives combined with expertise is a powerful combination.

I hope you enjoy the read, and we look forward to receiving your feedback on the magazine. Please feel free to contact me at Geraldine.Schroeder@Voith.com.

Best regards,



Geraldine Schroeder, Head of Communications

IMPRINT

Published by:

Voith Hydro Holding GmbH & Co. KG
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In cooperation with:
Burda Creative Group GmbH
Print: Wahl Druck, Aalen, Germany

Paper:

The paper REVIVE 50 white silk contains 50% recycled fiber.

Photographs:

All photos are from Voith Hydro, unless otherwise specified.

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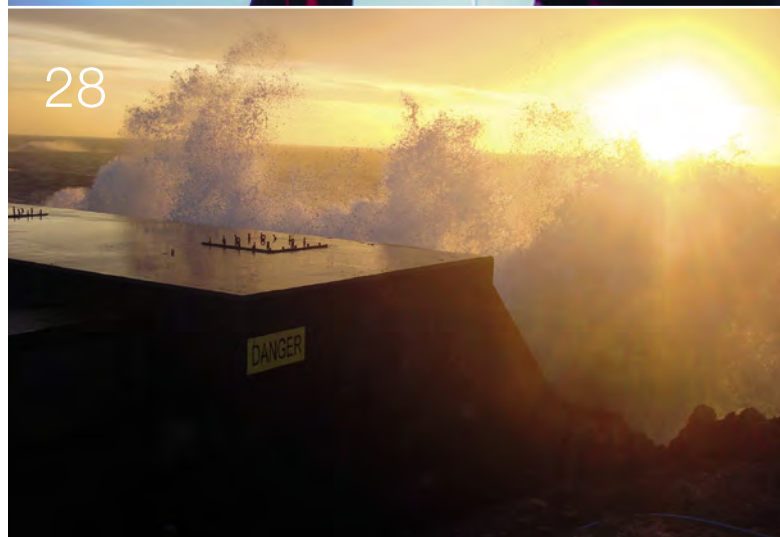
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Agenda setting

The five members of **Voith Hydro's executive board** met recently to assess the state of the energy sector. See why they are realigning their agendas for a greener future.



Green energy

Dr. Roland Münch: Hydro delivers power stably, affordably and on an industrial scale. It has tremendous potential and will form the backbone of the global restructuring of our energy systems.

See interview on page 6 for more



Quality & security

Stefan Schröder: Hydro power is not only a renewable energy source, it is also affordable and sustainable in an economical, ecological and social sense. Economical does not mean cheap, though; we need quality that can be relied on.



Growth potential

Jürgen Sehnbruch: In Europe, hydro power has potential in both large and small hydro as well as in pumped storage. We will be experiencing a renaissance of pumped storage as an important stabilizing medium.



Innovation

Dr. Siegbert Etter: We are in a field that is technologically mature and yet incredibly forward-looking. While we know the traditional hydro plant inside out, Voith Hydro has identified new areas, such as ocean energies, in which we can develop the industry further.



Local know-how

Andreas Endters: Voith Hydro is consistently improving its local footprint across the globe in order to provide its customers with expert presence and first-class facilities.



What role do renewable energies play today?

A crucial one. And, within renewables, hydro power will certainly play a key role worldwide. We are close to seeing a global transformation in our energy systems; fossil fuels are finite and becoming increasingly expensive, and Fukushima has led to a reevaluation of nuclear power in several countries. The concern about global warming and climate change is leading to a rethink in long-term strategy. In addition, power consumption has increased enormously and is continuing to rise, particularly in emerging markets. According to a study by the US Energy Information Administration (EIA), global energy demand will almost double by 2035. We face the challenge of generating large amounts of energy in an environmentally sustainable way.

Why is hydro power more significant than other renewable energies in the long term?

It is both environmentally friendly and economical. Hydro doesn't rely on certain weather conditions, making it unbeatable as a reliable generator of industry-sized amounts of electricity. The efficiency of hydro plants is around 90 percent, making hydro the most effective among the renewables. It is competitive and affordable. What's more, two-thirds of the Earth is covered by water, so water represents the largest source of energy. Hydro is already indispensable, and it will definitely be at the core of the world's renewable energy mix in the future.

INTERVIEW

A positive look forward

As we undergo a global shift in our approach to energy, hydro power looks set to grow in importance, says Voith Hydro CEO, **Dr. Roland Münch**.

“Hydro is already indispensable, and it will definitely be at the core of the world’s renewable energy mix in the future.” Dr. Roland Münch

Why is hydro power so interesting for emerging economies?

A reliable and affordable electricity supply is a prerequisite for economic and social development. For emerging countries, investment in renewable energies will pay off in the long term. It will reduce the dependence on energy imports and fossil fuels. In addition, hydro power will create added value, such as providing new jobs, and ensure sustainable growth.

The construction of the Belo Monte hydro plant in Brazil has received criticism from an environmental perspective. Why is Voith Hydro involved in the project?

Large-scale infrastructure projects, such as those involving hydro power stations, will always have proponents and critics. However, in the case of hydro plants, we believe the advantages clearly outweigh the disadvantages, especially in emerging countries, where the demand for energy is high. Belo Monte will be no different. The project is part of the Brazilian government’s enormously ambitious development program. Once Belo Monte is put into operation in 2019, it will be the third-largest hydro power plant in the world and supply millions of Brazilians with power. It will further help Brazil in maintaining the pace of its economic and social development. Despite its undeniable impact on nature, it is clear that hydro power is among the most environmentally friendly forms of energy in the long term. Also, at Voith, we

are proud to provide cutting-edge technology that minimizes the impact on man and nature in each project.

The Organisation for Economic Co-operation and Development (OECD) plans to tighten environmental regulations for the granting of export credit guarantees. What are your thoughts on this?

As an environmental technology company, we welcome all measures designed to protect the environment. Voith Hydro has been working for years to ensure high standards in the implementation of our projects, and we work closely with environmental and developmental NGOs. For example, we ensure that our employees are regularly trained by the World Wide Fund for Nature (WWF) on environmental sustainability. But, at the same time, we believe in equal rights for all, which is why we are critical of the OECD’s plans. If the testing and decision-making procedures for large projects become more complex, competitors from non-OECD countries stand to benefit. The new requirements would therefore lead to a scenario where the OECD would be involved less and less on major projects. There must be a better solution. It would be more useful to create a framework agreement with the same rules for all key market players.

And what about as regards the focus for Voith Hydro – what are the key markets, then, for the company?

The industry’s focus is on emerging

markets, of course, plus the United States and Canada. But don’t forget Europe! After all, Germany is where we started. With refurbishment and modernization, we could generate up to 16 percent more energy from existing hydro plants by implementing minor changes or additions to the equipment, without having a major impact on the environment. There will be a growing demand for greater energy efficiencies because the wind turbines currently being built need balancing. Pumped storage plants will, and should, be there to stabilize the grid. Overall, we estimate that hydro output in Germany can be increased by up to 30 percent. We must use this potential if we are to succeed in transitioning to renewable energy sources.

What are the biggest challenges we face in the future?

According to studies conducted by the Intergovernmental Panel on Climate Change, 77 percent of energy could be generated from renewable sources by 2050. Our biggest challenge will be to leverage the huge, untapped potential of hydro power from the sea. We are currently the only company actively developing both tidal current and wave power technologies. In terms of both reliability as well as availability, these technologies can now meet commercial standards. In order to make ocean-powered energy accessible, investment in technology for new renewables, such as tidal current turbines and wave power stations, will be necessary. ●



Iceland's Tungnaá River, seen here frozen in a spectacular aerial shot, will help to generate power at the new plant.

Hydro projects ready to flow again in Iceland

ICELAND In its first major infrastructure project since the economic and financial crisis of 2008, Iceland has contracted Voith Hydro to supply the new hydro power plant **Búðarháls** with all its electro-mechanical equipment, excitation systems, turbine governors, mechanical and electrical auxiliary systems. In addition, it will also deliver powerhouse cranes, the machine control system and automation system, as well as handling both erection and commissioning. A distinct focus on optimization of the plant's annual energy output was the major success factor in Voith Hydro's technical solution.

Alongside its technical expertise, Voith Hydro was able to offer hydro power plant operator Landsvirkjun tailored, long-term and attractive financing.

For Búðarháls, Voith Hydro will cooperate with partners and sub-suppliers from Iceland – supporting a high domestic content within the project.

The important new order for Búðarháls continues the long business activity by Voith in Iceland. The first Voith supply to Iceland for the Fjarðarsel power plant took place as early as 1912/1913 and it is the oldest power plant still in operation in Iceland. ●

Voith Fuji Hydro strengthens position on Japanese market

JAPAN Voith Fuji Hydro – a joint venture of Fuji Electric and Voith Hydro – will take over the complete hydro turbine business of the industrial machinery manufacturer **Ebara Corporation**, beginning 1 June 2011.

“For more than 100 years, Japan has been an important market for Voith that we feel strongly committed to, particularly in these difficult times after the tragic events in northeast Japan,” commented President and CEO of Voith Hydro, Dr. Roland Münch. ●

Swiss pumped storage

SWITZERLAND Representing its first major order from French-speaking Switzerland, Voith Hydro will provide Forces Motrices Hongrin-Léman S.A. (FMHL) with two new vertical five-stage pumps coupled to Pelton turbines for its **FMHL+** project in the municipality of Veytaux. To double its current generating capacity of 240 MW to 480 MW, FMHL is constructing a new underground cavern near its existing one, as well as installing two additional pump-turbine groups. By the end of 2014, the pumped storage hydro project will use 420 MW of a total capacity of 480 MW for operations, with 60 MW being kept in reserve. ●

Alden Model Turbine in the Hydraulic Laboratory in York.



Alden Turbine: environmental innovation

UNITED STATES Voith Hydro presented its newest technological developments in a recent conference on environmentally enhanced hydro turbines, hosted by the U.S. Department of Energy and the Electric Power Research Institute in Washington, D.C. In front of a selection of industry experts, the conference offered Voith Hydro the opportunity to show some of its proprietary technologies, including the Aerating Runner for dissolved oxygen enhancement, and the Minimum Gap Runner to enable safe passage for fish.

Also, the new **Alden Turbine** was prominent – a technology expected to produce fish survival rates over 98%. The turbine features a three-bladed Francis-type runner that operates at a slower rotational speed to minimize fish strike. Alden Research Laboratory, developer of the concept, recently collaborated with Voith Hydro to further improve the fish passage characteristics in addition to optimizing turbine performance.

Last year, a scale model was tested in Voith's Hydraulic Laboratory in York, Pennsylvania, with very competitive results; the turbine is now ready to be deployed as the industry's latest environmental innovation. ●

Celebrating milestones

CHINA Voith Hydro and the China Three Gorges Project Corporation recently celebrated a milestone for the **Xi Luo Du** project, located at the border between Sichuan and Yunnan provinces – the delivery of the first turbine runner at the end of June. Voith Hydro supplies the equipment for three 770 MW Francis units at the hydro plant, which is located on the Jinsha River, including generators, turbines and support equipment. After completion in 2015, the Xi Luo Du hydro power plant will have an overall power output of nearly 13.9 GW and will be one of the most powerful in the world.

In a country that is already one of the world's major hydro markets, the Chinese government is laying the groundwork to more than double its already impressive share of renewable energy from hydro power (22 percent) to a total of 380 GW by 2020. Voith has a 100-year tradition in helping China meet its power demands through sustainable energy. ●



From left to right: Chen Guoqing, Vice President Voith Hydro Shanghai; Fan Qixiang, Vice President China Three Gorges Corporation; Martin Andrä, President Voith Hydro Shanghai; Chen Fei, President China Three Gorges Corporation; Tang Xu, Executive Vice President Voith Hydro Shanghai; Zhao Musen, Secretary Xi Luo Du Construction Bureau.

All lit up: Rio de Janeiro glows in the night sky; the success of the Itaipú hydro plant (below) has paved the way for more vital hydro projects in emerging nations.



Powering the future

China, India, Brazil; countries all characterized by rapid economic and social growth. As a source of reliable and renewable electricity, the role of hydro power looks set to play an increasingly vital role in their continued development.

Hydro power may account for around one-fifth of the globe's current electricity supply, yet its potential in the developing world has barely begun to be tapped. Unexploited hydro capacity in developing countries totals nearly four times the capacity currently installed in Europe and North America, and nearly double the installed capacity worldwide. According to the World Bank, the total economically feasible hydro power capacity in emerging economies is more than 1,900 GW, only 30 percent of which has been developed.

Finding environmentally and socially sustainable ways of making use of this vast energy resource has become crucial as emerging economies continue to outpace the developed world in GDP growth.

The Economist predicts that China, which has an estimated 9.5 percent average GDP growth, and India, with 8.2 percent, will be the world's fastest-growing economies between 2011 and 2015. Brazil, where GDP grew by 7.5 percent in 2010, already ranks among the 10 biggest economies on the planet.

Growth at these rates goes hand-in-hand with an insatiable demand for energy, and given volatile energy prices and growing concerns about the environment, more and more developing countries are stepping up their investment in renewable energies to power their future. Hydro power stands out among the renewables for its added-value benefits, including clean drinking water, irrigation and reliable energy reserves. And within this sector, Voith Hydro is a clear leader: a quarter of all electricity generated by hydro plants around the world is produced by the company's turbines and generators, of which Voith has installed more than 40,000 across the globe.

Partner of choice in Brazil

Voith Hydro has participated in some of the world's most ambitious hydro power projects in rapidly developing countries such as Brazil, India and China, and continues to work successfully in these and many other developing areas. The expertise and advanced technologies are helping to provide energy, create jobs, and ensure social, economic and environmental sustainability.

In Brazil, where Voith Hydro has been present for over a century, hydro power accounted for 83.9 percent of the country's electricity production in 2009, and almost half of Brazil's hydro capacity is in plants using Voith equipment.

Located on Brazil's Madeira River, the 3,150 MW Santo Antonio plant, which is set to begin operating in early 2012, is part of the government's growth-acceleration program. ►

“Voith Hydro has a brilliant future in Brazil, where hydro power will remain the best choice for producing energy.”

Antonio Canina, Head of Modernization for Latin American and Brazil

- ▶ “Santo Antonio represents the beginning of a new energy matrix, since the north of Brazil is considered to be the country’s most promising source of electrical energy production,” says Fernando Fernandes, Santo Antonio Project Director for Voith Hydro. “This power plant will also offer a range of other benefits, including supporting the social and economic development of northern Brazil, particularly the Porto Velho region.”

Limiting environmental impact

The technology is making a major contribution to limiting the Santo Antonio project’s environmental impact. “Santo Antonio will employ Voith Hydro’s bulb-type turbines, allowing this project to be a run-of-the-river power plant, and therefore greatly reducing the impact on the Amazon forest and local communities,” Fernandes says. “Santo Antonio’s reservoir covers 271 sq km, which is only slightly more than the natural riverbed at flood stage and is much smaller than what would be required by another turbine type.”

Voith Hydro technology is also crucial to the 11,233 MW Belo Monte project, which will be among the largest hydro power plants in the world when it goes into service in 2019. “Voith Hydro is the responsible party with the consortium for the technical direction of the Belo Monte site, and will supply

generating units, automation and protection systems, and further electrical and mechanical equipment,” explains Nilo Faria, Project Director. The project will create thousands of jobs in a region where employment opportunities are currently limited.

Increased capacity

Further demonstrating its long-term commitment to Brazil, Voith Hydro recently opened a new manufacturing shop in Manaus to complement its plant in São Paulo, which began production almost 50 years ago. The new plant increases the company’s annual manufacturing capacity in Brazil to over one million hours a year.

The Manaus plant specializes in serving the big hydro power projects underway or planned for northern Brazil. “Establishing the plant in Manaus demonstrates Voith’s drive for logistical efficiency and better customer service,” comments Luciano Savieto, Industrial Director at the plant. “Almost all of a turbine’s mechanical parts can be produced here.”

With training programs taught by experts from Voith’s São Paulo facility, the new workshop is also providing benefits for the local labor market in line with the firm’s commitment to training and hiring local human resources. Voith Hydro can now supply complete hydro power plants in Brazil with a national content of over 90 percent and with Brazilian management, engineering and labor.

Established success

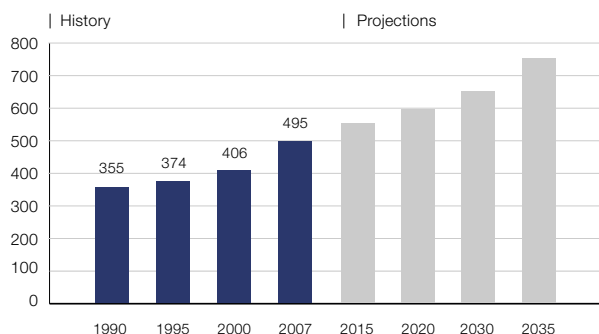
Proof of Voith’s success in bringing high quality and innovation to the Brazilian energy sector is reflected in the venerable Itatinga power plant, which has been operating since 1907 and still generates 80 percent of the energy used by the Santos seaport. Antonio Canina, Head of Modernization for Latin America and Brazil, explains, “Developing the capability and reliability of older power plants is very important in meeting future energy demands, and Voith Hydro will continue to make a key contribution to this effort in Brazil.” He adds, “Voith Hydro has a brilliant future in Brazil, where hydro power will remain the best choice for producing energy.”

Stimulating regional development in India

Voith Hydro is also expanding its role in India’s rapidly evolving energy sector; with around 840 GW of hydro potential, it is ranked seventh in the world in exploitable hydro power. In

Rising rapidly – world marketed energy consumption

1990–2035 / quadrillion British thermal units



Source: EIA, International Energy Statistics database (as of November 2009); projections: EIA, World Energy Projection System Plus (2010)



Working in the foundry of the São Paulo workshop (left); the mighty Amazon river is a valuable source of hydro power (right).

partnership with local player Jaiprakash, Voith Hydro recently supplied the electrical and mechanical equipment for the new 520 MW Omkareshwar plant. “Both partners are committed to making Omkareshwar a long-term success. We will repeat this successful partnership approach for other projects, including Karcham Wangtoo,” explains Werner Kellner, General Project Manager, Voith Hydro Heidenheim.

Omkareshwar, finished in just 48 months, not only serves as a reliable source of power for the Madhya Pradesh region, but also provides irrigation for agriculture, boosts the fishing resources of the Narmada River, and creates significant employment opportunities for locals. “The Omkareshwar plant fosters the region’s industrial, private and agricultural sectors in a balanced way,” says Kellner. “We are deeply committed to accompanying India on its path to an energy mix that is largely based upon hydro power, as well as to implementing environmentally friendly technology and a holistic approach to make sure that our projects benefit the local environment and society.”

Supporting the Chinese boom market

Still very much surfing a wave of rapid transformation and growth, China has become one of Voith Hydro’s key markets in recent years, although the company has been active there for over a century. China’s latest national plan calls for a €550 billion investment in renewables between 2011 and 2016 alone. In addition, the country’s 220 GW of installed

hydro power capacity is expected to rise to 380 GW by 2020 – a clear sign of the potential for further development.

Current focus is the massive Xi Luo Du project, which at just under 13.9 GW will be China’s second-largest hydro power plant when it begins operating in 2015 (see page 9 for more on the project). “Xi Luo Du is crucial for the major west-to-east electricity transmission project and an important move to develop China’s resource-rich western region as well as fostering growth in eastern and central China,” says Martin Andrä, CEO Voith Hydro Shanghai. “In addition to energy generation, the benefits include sediment and flood control as well as improvement in downstream navigation.”

Added value

As this and other projects prove, powering the future, particularly in developing countries, means much more than simply providing electricity access. It requires imagination, innovative technologies, international cooperation and a commitment to protecting natural and human resources over the long term.

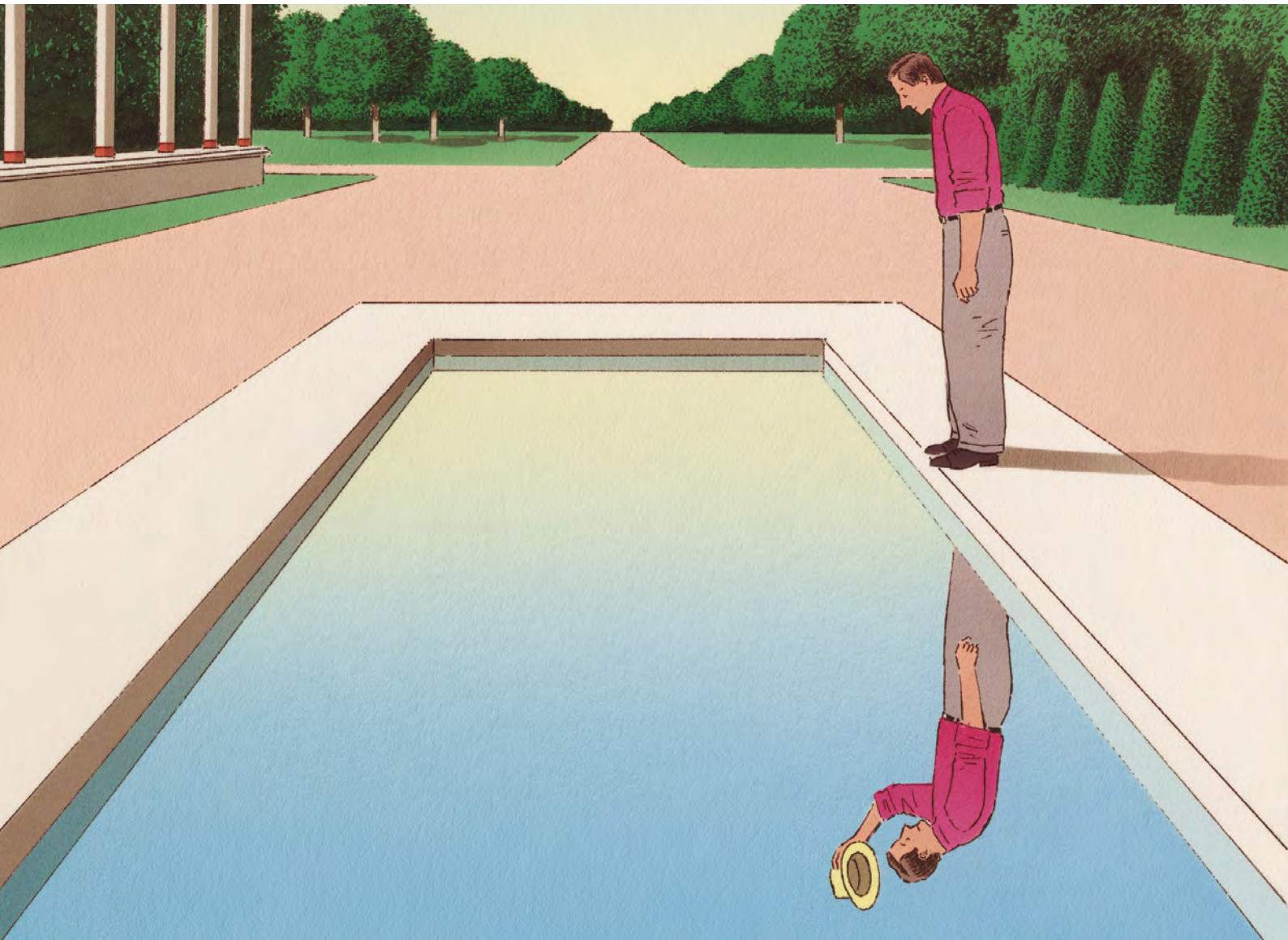
Hydro power comes with risks and challenges, but when developed conscientiously, it provides added value as well as reliable energy to countries most in need. As its work in Brazil, India and China shows, Voith Hydro is ready to help emerging economies satisfy their fast-growing energy needs through sustainable, socially and environmentally responsible hydro power projects. ●

Hydro power: the right renewable for emerging countries

The International Finance Corporation (IFC) – part of the World Bank Group – has helped to launch many private-sector hydro plants in developing countries. We talk to them about the advantages and challenges of hydro power for developing nations.

Tonci Bakovic, a native of Bolivia, is the Energy Specialist for the IFC, dealing with the revenue side of its energy projects all over the world, including its 40 hydro power projects. Bakovic previously served as Dominion Energy's Manager for Business Development in Latin America, and, before that, he worked with Ernst & Young's energy group.

Jorge Villegas, from Colombia, is a specialist in the IFC's Environmental and Social Development Division, where he performs extensive due diligence on the environmental and social impact of IFC projects. He previously worked with the World Bank, the United Nations and the Colombian government.



IFC, a member of the World Bank Group, is the largest global development institution focused on the private sector in developing countries. Its aim is to create opportunity for people to escape poverty and improve their lives by providing financing to help businesses employ more people and supply essential services, by mobilizing capital from others, and by delivering advisory services to ensure sustainable development. IFC's new investments climbed to a record \$18 billion in fiscal year 2010.

> www.ifc.org

Where are the main markets for investments in hydro power?

Bakovic: Around 80 percent of today's feasible hydro power projects in the US and Europe have already been developed. That is not the case for Latin America and Asia. In Africa, almost no hydros have been built, despite the continent's huge resource potential. We need to encourage more hydro power investors to go outside their home regions. Of course, investors have to be able to count on clear rules of the game before they enter a market.

Villegas: Most of the places where we work in Africa mainly require power for peak times. In many cases, a hydro power project in Africa will not require a huge reservoir, and there are plenty of opportunities for smaller projects. If a project does have a large reservoir, it makes sense to focus on a regional market rather than just a local one.

How has investment in hydro power changed over recent years?

Bakovic: Twenty years ago, most investment came from governments. With privatization and reforms, the private sector has become more involved. The IFC has had considerable success with small and medium-sized hydro projects. These plants will last 100 years, and many are on a build-own-transfer basis. Hydro power is an efficient option that, when developed responsibly, will bring power and social benefits to developing countries as well as help to protect the environment. ●

HyPower sat down with **Tonci Bakovic**, IFC Energy Specialist, and **Jorge Villegas**, Specialist at IFC's Environmental and Social Development Division.

What is the rationale behind IFC's support for hydro projects in emerging economies?

Bakovic: Without power, developing regions cannot grow. In fact, in some countries, two percent electricity growth is needed to achieve one percent GDP growth. Of course, we need to balance a need for power with concerns for the environment, and hydro power is a clean, reliable energy source. IFC has been involved in 40 hydro plants with an average capacity of around 100 MW that add up to a total 4,000 MW of energy. These hydros currently displace around 10 million tons of CO₂ emissions every year.

What advantages does hydro electricity have over other renewable energies?

Bakovic: Hydro is currently the most efficient among the renewables. Until researchers achieve a technological breakthrough in solar energy, hydro is the best choice for countries that have adequate hydro resources. Solar and wind plants can cost as much to build as hydro plants, but produce less energy as they have lower plant factors.

As well as bringing power to local residents, what other advantages can hydro projects provide developing countries?

Villegas: Benefits can include better irrigation systems downstream as well as flood control. They can also offer significant cost savings for power, particularly for countries without their own oil and gas reserves. Job creation during the construction phase is another valuable short- to medium-term benefit. In the long term, some countries require project developers to provide

direct benefits to local communities, such as a percentage of revenues. Every developer of a hydro project must minimize the negative impacts and enhance the positive ones.

How is IFC helping contribute toward this aim?

Bakovic: IFC has devised policy and performance standards for the social and environmental sustainability of our projects, and these standards have become the international benchmark. Nearly 70 international commercial banks and financial institutions have adopted the Equator Principles, which are based on IFC environmental and social standards.

Villegas: When a large commercial bank that is a signatory to the Equator Principles finances a power project in an emerging market, it will use IFC standards as a reference. Developers willing to apply these standards will have easier access to financing.

What are some of the challenges that hydro power faces?

Villegas: Location is the key when it comes to minimizing the negative effects of changing a water course. Ideally, companies would identify places with few or no inhabitants and where the project will not require flooding large areas. Companies should also avoid environmentally sensitive places as much as possible.

What about resettlement?

Bakovic: Avoidance of displacement of people and adequate resettlement is a critical issue in hydro developments. IFC pays particular attention to this issue, applying the lessons that we have learned in past hydro projects. This global experience in social and environmental issues is very much valued and appreciated by our clients. So far, our relatively small hydro projects have been located in areas with low populations.

Covering all the bases

Hydro-electric systems are a vital component in the global race to develop more **sustainable and efficient** power supplies. They can also be daunting in their scope and scale, with some taking up to a decade to plan and build. Delivering hydro projects requires commercial acumen, deep technical knowledge as well as skill in managing multiple suppliers, tight timelines and large workforces.

An able full-line supplier must be able to meet an array of needs for clients in a way that consortia or consultancies cannot. Voith Hydro's manufacturing knowledge, its large-scale project management expertise, and its planning, implementation and service skills give it a comprehensive command of the sector; from spare parts supply right up to turnkey project delivery.

"The more information you have, the more support you can offer the client," says Herbert Vergé, Chief Operations Officer for Voith Hydro Germany. "As a full-line supplier, we get much more information from the market than if we were only a manufacturer – for example, knowledge of the impacts between different systems, of how components interact and of how to optimize our own key components. From the client's

perspective, using a turnkey supplier of all services simplifies things considerably, and the time schedule will typically be shorter. Good project management is the key factor in determining timely delivery and completion of a contract in terms of quality and cost."

Voith Hydro's involvement across all aspects of the sector also helps ensure continuous improvement and nurtures innovation. "Full-line service is highly competitive; you are always under pressure in terms of costs and technological development," comments Vergé. "To survive long-term, an organization must constantly look to develop and improve. An effective information flow is vital in helping to refine products and processes as well as provide excellent future solutions." ●

With 15 percent of Portugal's electricity coming from wind power, variable-speed pumped storage units, such as those supplied for Frades II, are vital in helping to stabilize the grid.

CASE STUDY I

Providing stability to the grid

Portugal's plans to revolutionize its electricity grid are well advanced. Increasingly powered by a vast expansion in renewable energy generation – mostly from wind power – the country needs a uniquely responsive grid in order to cope with the problematic surges and dips in power that wind energy poses.

Central to this is a new generation of hydro power systems incorporating technologically advanced variable-speed pumped storage. One of the keystones will be Frades II (formerly Venda Nova III), due for grid connection in 2015. At the heart of this system, Voith Hydro is responsible for the delivery of the electro-mechanical equipment, comprising two reversible pumped storage units, which are the latest in variable-speed technology.

Flexibility and agility

The first variable-speed system in Portugal, and the largest one in the world, the system has two 380 MW power turbines and two asynchronous motor-generators, with a rated capacity of 420 MVA. Voith Hydro will also supply the frequency converters, the control system and the hydraulic steel structures.

“The variable speed capability of the project will give enough flexibility and agility to cope with the fluctuations that are inherent in a grid supplied by a



significant element of wind power,” says Jörg-Peter Albrecht, Head of Global Sales for Voith Hydro Heidenheim.

“Being able to vary the pump speed means you can put energy in or take energy out of the grid. It allows you to be flexible and gives the customer a stable, secure grid.”

Breaking new ground

The project is not without its challenges. Being in compliance with the demanding Portuguese grid code, for example, is a must, says Albrecht. “The requirement is to inject into the grid a certain amount of reactive current with a maximum delay of 30 milliseconds, which means the machine has to react to external impacts instantly and keep the grid frequency stable.”

Voith Hydro's status as a full-line supplier has given the firm the project and technical expertise to enable it to

deploy such a solution effectively and has several advantages for EDP.

“Being a full-line supplier permits you to think about the overall efficiency of the plant. We can shorten lead and execution times, making the project more profitable for the client.”

The experience on Frades II should benefit future clients, believes Albrecht. “Finding cutting-edge answers to technological challenges and providing a range of added benefits goes hand in hand for us.” ●

Frades II

Location: Portugal

Services supplied:

Reversible, variable-speed pumped storage units including pump-turbines, motor-generators, converters, control system and hydraulic steel structures

Timeline:

Grid connection in 2015



Located by the idyllic Loch Ness, Foyers' pumped storage plant is key to Scotland's grid stability. Voith's regular monitoring and maintenance secure its accurate operation.

CASE STUDY 2

Successfully overcoming challenges

Five years into an electrical refurbishment led by Voith Hydro, the 300 MW Foyers pumped storage facility on the southeastern shore of Scotland's Loch Ness has been providing much needed stability to the Scottish grid.

The two 150 MW Francis pump-turbines, from operator Scottish and Southern Energy, play a vital role in stabilizing the grid at 50 Hz; no easy task given the nature of the local grid, which has long transmission lines and a lot of intermittent electricity generated by the region's wind farms.

Such conditions called for a highly responsive, reliable solution when the plant was overhauled. Voith Hydro was tasked with installing a HyCon 400 control system, a digital/mechanical governor and 18 KV switchyard controls – all inside three months.

Challenging conditions

"The Foyers project schedule was very tough," recalls Wolfgang Hörger, Manager for Sales and Marketing in Automation for Voith Hydro Heidenheim. "There were 114 people on site at the same time, which was a challenge. We had to take out 25 tons of old cabling and add completely new cables, sensors and governors. Nevertheless,

we successfully managed both the people and the handling of materials on site in that extremely short time."

The requirements reflect pumped storage plants' operation profile in times of increasing use of renewable energies, which can often mean intermittent energy production. "The unit had to be ready to supply energy to the grid inside a minute and be able to function with 500 mode changes per month, which is a huge requirement in terms of flexibility and reliability. We had to build in full redundancy for the control system and governors so that if one fails another can take over."

Constant monitoring

Voith Hydro also services and maintains the facility, which involves yearly on-site checks. The maintenance contract includes a hotline service, and Voith can monitor the unit performance from Heidenheim, providing preventive checks and field testing, as well as the ability to bring units quickly back into service should problems arise.

"We know the day-to-day behavior of the units, so we are able to identify how best to conduct preventive maintenance," concludes Hörger. "This secures a highly stable service for the operator." ●

Foyers

Location: Scotland

Services supplied:

Electrical refurbishment, control system, governor and switchyard controls, project management and maintenance

Timeline:

Operational since 2009



The Waneta Expansion will build on the success of the existing Waneta Dam.

CASE STUDY 3

Maximizing efficiency

The \$900 million Waneta Expansion, in Canada's British Columbia province, will see Voith Hydro take a leading role in the optimization of a second 335 MW power plant at the Waneta Dam on the Pend d'Oreille River.

One of Voith's key Canadian contracts, the site is located immediately downstream from the Waneta Dam and its existing plant. It will share the existing dam's hydraulic head and generate power from flow that would otherwise be spilled.

Voith Hydro is responsible for supplying the turbine, generator, governor and excitation equipment, including the generator breaker and isolated phase bus. It will also assist with plant optimization and work in close cooperation with the customer SNC-Lavalin, which is the design and build contractor for the plant's future owner Waneta Expansion

Limited Partnership, formed by Fortis BC, Columbia Power Corporation and Columbia Basin Trust. Together, Voith, SNC-Lavalin and civil subcontractor ASL will develop the plant's design in order to achieve the highest efficiency possible, says Lawson Crichton, Western Canada Business Development Manager for Voith Hydro. "In order to successfully deliver a project that meets the expected return on investment, and can be maintained efficiently and safely, it's very important for all involved to have a team that understands this end goal and how best to achieve it."

Proven success

Voith Hydro's extensive track record in delivering large projects, as well as its technical expertise, give it the capability to meet the challenges of the project. "Our standardized process, which is

part of the company's culture and mindset, lays out a detailed roadmap for the implementation team of how to put together a large proposal. It helps ensure that nothing is missed, whether it be safety and environmental factors or details of machine reliability," Crichton explains.

Engineering and construction work for the Waneta Expansion is already underway, and the new facility is expected to go into commercial operation in the spring of 2015. ●

Waneta Expansion

Location: Canada

Services supplied:

Turbine, generator, governor, excitation equipment, powerhouse optimization

Timeline:

Commercial operation in 2015

The generator manufacturing plant in São Paulo is vital for both local and international business.

Generating excellence

Genuine global reach combined with technical expertise are helping Voith Hydro cement its reputation as a leading generator manufacturer.

For nearly a century and a half, the name Voith has been associated with hydro power technology. Voith Hydro has a strong pedigree in design and manufacture of both turbines and generators.

The company’s position as a world leader in full-line hydro power solutions is due, in large part, to a combination of genuine global reach coupled with innovative technical excellence.

As a generator manufacturer, Voith Hydro established a joint venture with Siemens in 2000 and enjoys a reputation for producing the world’s largest and most powerful units. The company has installed generators well above 800 MVA in plants such as Itaipú, in Brazil/Paraguay, Three Gorges, in China, or currently the world’s largest air-cooled units for Guri II, Venezuela, as well as the future record-holding machines at Xi Luo Du. It has also provided variable-speed motor-generators for Portugal’s ongoing Frades II project – the country’s first variable-speed units.

Homogeneous expertise

The heart of the generator business is the Corporate Technology Division in Heidenheim, Germany, which is responsible for the research and development of homogeneous products. Ensuing manufacturing is the responsibility of four large generator manufacturing units, which are located in Heidenheim, Brazil’s São Paulo, Mississauga in Canada and the Chinese city of Shanghai (see map, right).

Each of the longer established facilities has a legacy of specialization, but individual plants are increasingly developing their own expertise. São Paulo still produces all its own components, for example, including all the generator bars used by Voith Hydro worldwide. Mississauga, on the other hand,

now has a global mandate for the supply of Micalastic coils, which replace the Thermalastic resin system it employed there until recently. And, while most Voith Hydro stator windings still come from Brazil, the new Shanghai factory is now producing them for export, as well as its own use.

Quality is paramount

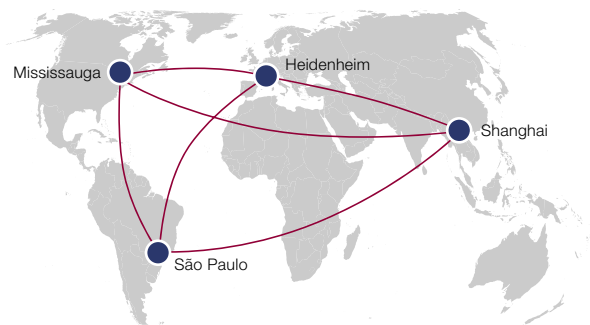
Dr. Udo Erich Wunsch, Voith Hydro’s Head of International Production, emphasizes that “all new equipment and the production technology employed is identical in every facility, no matter where it is located. This results in identical components and identical performance,” he explains.

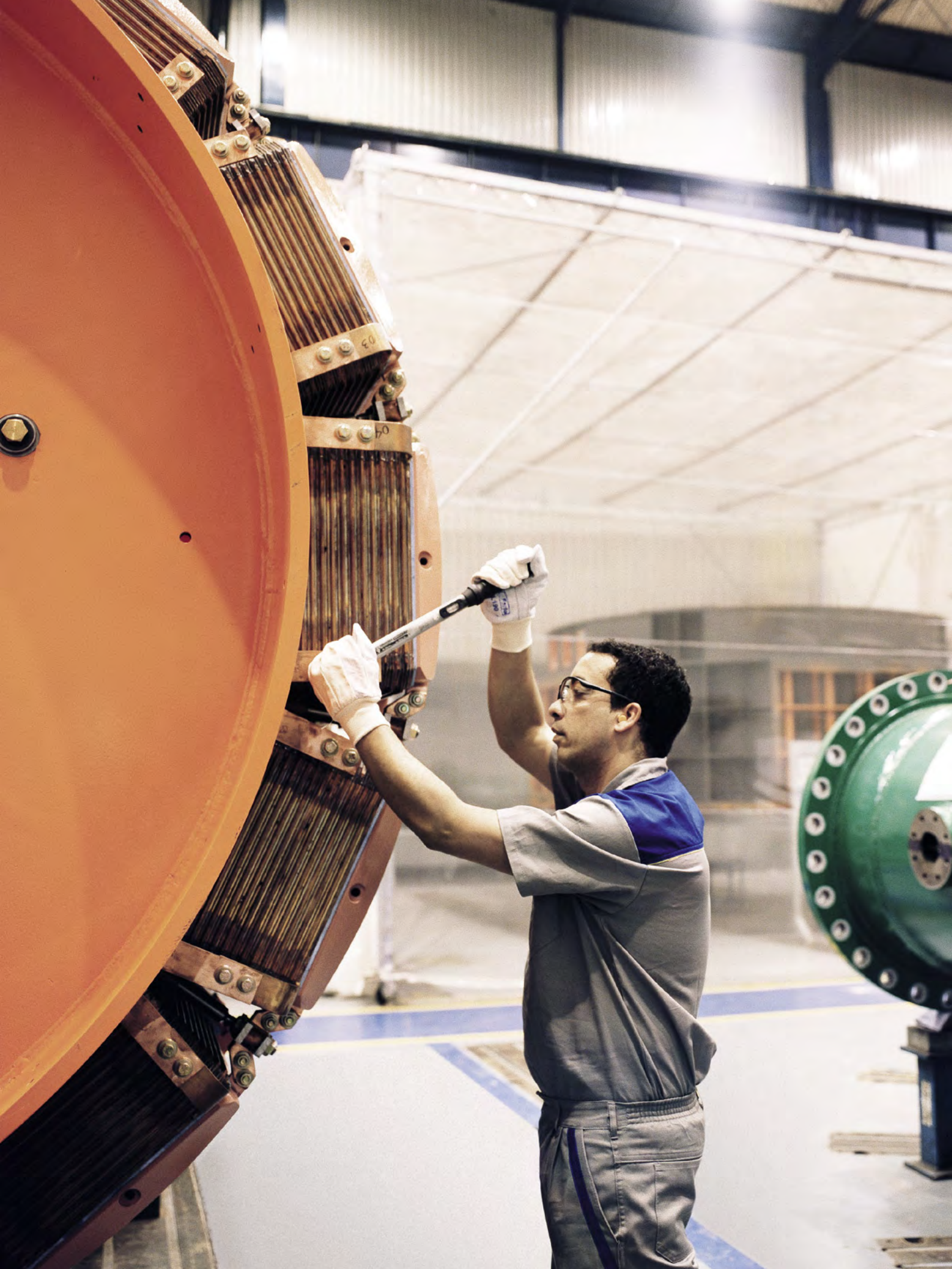
While operational decisions are made locally, Wunsch adds, Voith Hydro retains a complete overview of channel activities worldwide from its headquarters in Germany. The approach is testimony to Voith Hydro’s strategy of putting proximity to local markets first. For Voith Hydro, the client relationship counts every bit as much as high-end products and quality.

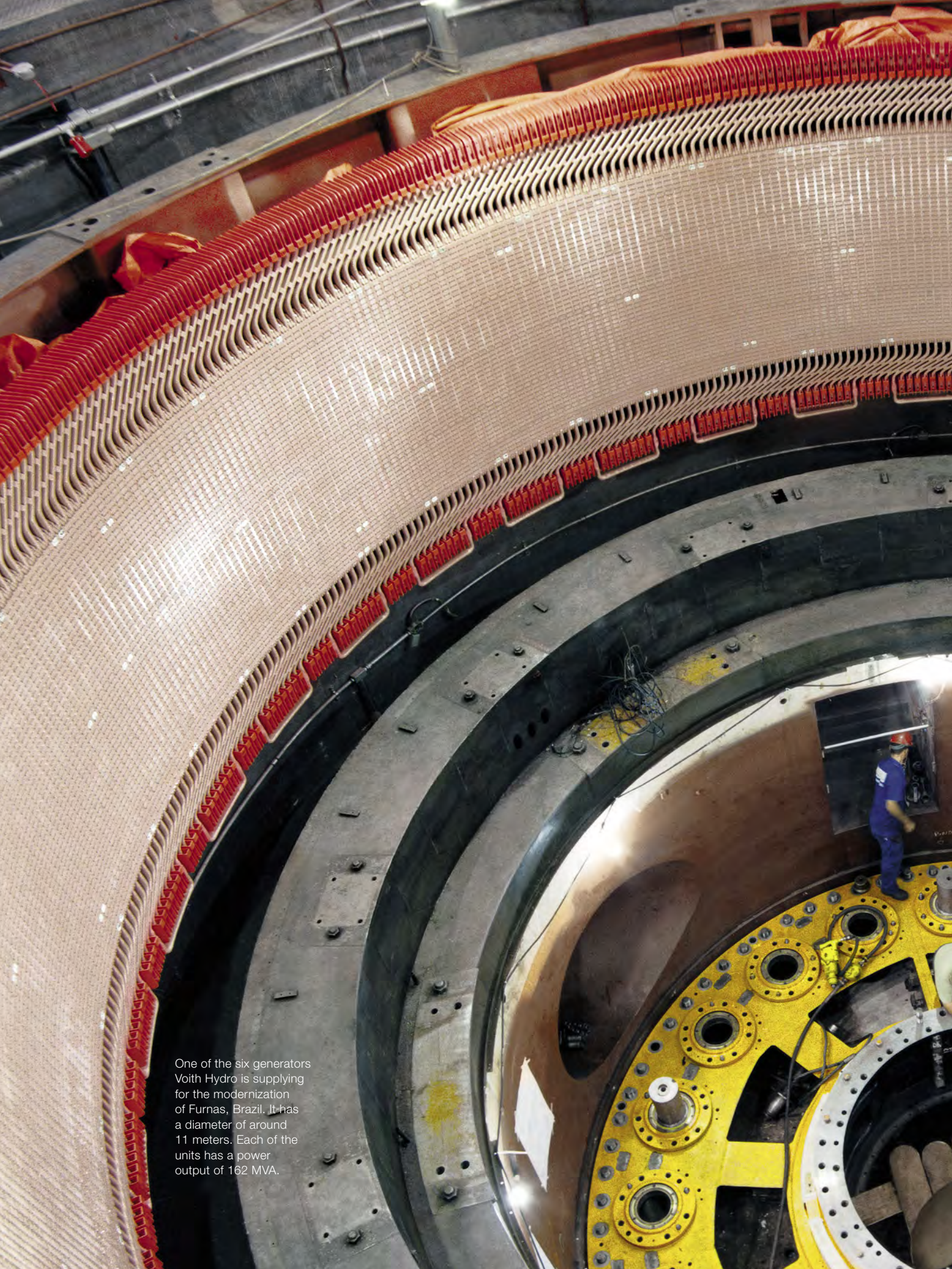
Locating production facilities closer to the primary markets they intend to serve yields significant customer benefits, explains Thomas Hildinger, Voith Hydro’s Head of Generator Engineering. Reducing logistics expenses and ensuring speed of response to customer needs are two extremely important ones, he notes. ▶

Voith Hydro’s four main generator facilities

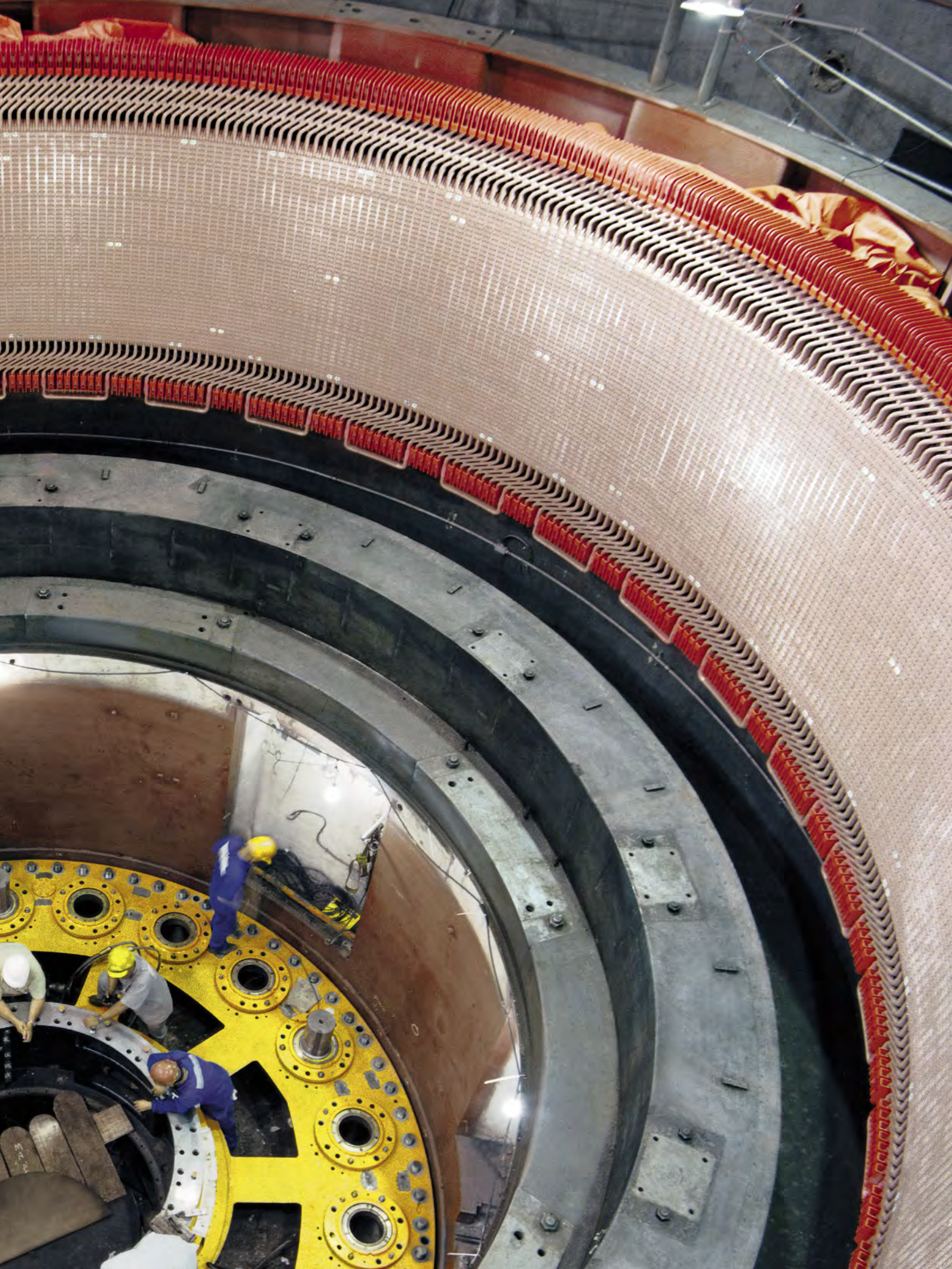
Global network of excellence







One of the six generators Voith Hydro is supplying for the modernization of Furnas, Brazil. It has a diameter of around 11 meters. Each of the units has a power output of 162 MVA.



“The aim is to ensure that at every step along the way good ideas and lessons learned are shared in a well coordinated and efficient manner accross the whole organization.”

Dr. Udo Erich Wunsch

From Shanghai to
Heidenheim, Voith Hydro's
generator manufacturing
network combines
engineering excellence from
around the globe.

► Different opportunities

In some markets the greatest opportunity lies in the provision of new hydro power equipment. This is true with China, for example. However, in long-established, more mature markets, such as the United States and western Europe, modernization of existing plants represents a significant proportion of business, especially in generator manufacturing. Overall, approximately 65 percent of Voith Hydro's production activity worldwide is currently devoted to new installations, and 35 percent to modernization.

The continuing challenge is to extract the most usable energy possible from a given source at the lowest cost. Today's generators consistently achieve efficiencies greater than 98 percent.

Voith Hydro expects to receive its first orders for 1 GW generators in the relatively near future from customers in China and Russia. At this scale, even very small increments in efficiency toward 99 percent can be highly meaningful from the all-important perspective of operator cost per kilowatt. Other technical improvements, such as making generators more compact and more reliable, also bring customer benefits.

Sharing expertise

One of the keys to Voith Hydro's success lies in the extraordinary degree of communication that takes place between both customers and local plants, and between local plants and the Corporate Technology Division.

“The aim,” Wunsch stresses, “is to ensure that at every step along the way good ideas and lessons learned are shared in a well coordinated and efficient manner across the whole organization. There is absolutely no reason why a mistake made in one location should ever be repeated in another, nor why a solution identified in one place should not become rapidly available to every production unit.”

Voith facilitates the necessary communication in a number of ways. There is a constant exchange of people and flow of information between the operating units and the technical team in Germany. A company process standard provides a detailed description of all procedures, including forms and templates, to ensure a standardized approach throughout the organization. Design standards are set by the Voith Hydro

Engineering Company (see pages 26-27 for more), which undertakes a systematic approach to the collection of ideas from group leaders and ensures that designers always have ready access to the latest version of the standards.

William Malus, Chief Operations Officer of Voith Hydro in Mississauga, gives an example of how best practice is identified and shared: “Cycle time is very important to us,” he states. “We put a lot of effort into being first to market and we are doing everything we can to improve cycle time and reduce cost in order to deliver the greatest value possible to our customers.

“To ensure we maintain excellent standards, we are part of a high-performance manufacturing consortium of about 16 companies in southwestern Ontario, Canada,” continues Malus. “We meet once a month to exchange ideas on how to be ‘best in class.’ Of course, these ideas don't stay with us; our steering holding in Heidenheim chairs factory coordination meetings at least twice a year, involving all manufacturing leaders, and these drive a process of continuous improvement.”

Long-term partnerships

Specification of any contract invariably begins with close consultation between the local operating unit and the potential client prior to tendering. “Armed with detailed knowledge of the potential customer's precise requirements, the respective local unit then becomes the client's representative in dealing with Corporate Technology,” explains Marc Jermann, who is Head of Generator Engineering at Voith Hydro's German operating unit.

“We have a very good process, with a design phase and design review, using our knowledge of the customer to negotiate with our colleagues in Corporate Technology in a trusting environment.”

These design principles are valid for all locations. “Every generator built reflects the design philosophy of Voith Hydro, but often the customer is also included directly as a co-designer, bringing their own expertise to the process,” says Thomas Hildinger.

This approach reflects the core values of the Voith brand: innovation, delivering superior reliability and developing fair long-term partnerships with customers. ●



The future is looking bright for Voith Hydro's generator manufacturing plant in Shanghai.

While Voith Hydro's presence in China can be traced back to 1909, the local unit in Shanghai expects a variety of future projects, both in China and internationally. Of particular interest is the Xi Luo Du dam, located on the Jinsha River in China's southwest. Voith Hydro will supply three turbines and generators, including the highest capacity generators it has built to date at 855 MVA.

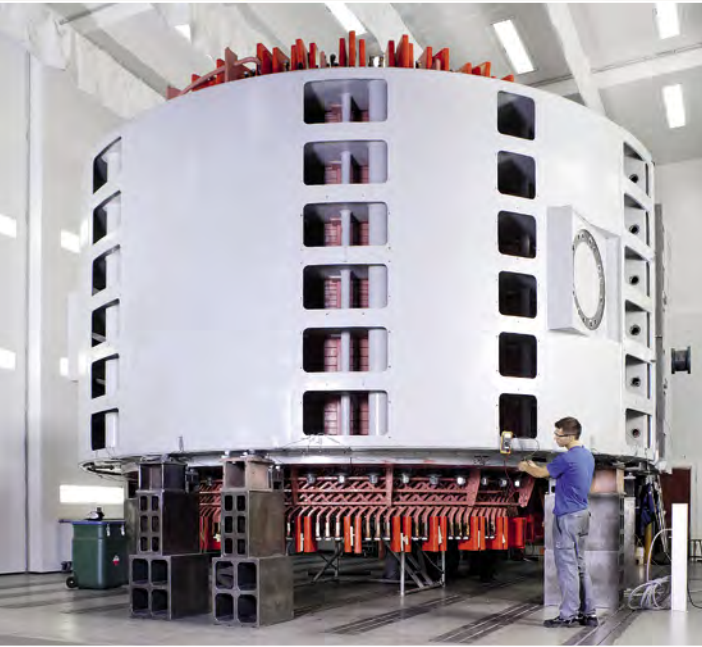
"The Chinese market requests localized turbine and generator solutions," says Voith Hydro Shanghai's CEO Martin Andrä. "It was essential, therefore, that we locate a new generator facility here to bring the company's expertise in generators directly into the Chinese marketplace." The 3,500 sq m workshop is equipped to manufacture generator poles and stator bars as well as the largest generators ever built by Voith Hydro anywhere in the world.

Extraordinary dimensions

In China, the focus for the near future is on large machines: power units of 1,000 MW. Design and manufacturing of big generators such as these require expert know-how as the extremely high voltages and the extraordinary dimensions create new challenges. Voith Hydro is already able to provide the technical solution, emphasizes Martin Andrä: "Our insulation standard for generator coils makes them particularly durable, thus enhancing efficiency."

Strong prospects

Voith sees many opportunities ahead. Growth in Chinese demand for hydro capacity, around six to seven percent a year, is expected to remain strong for the foreseeable future. The current national installed capacity of 220 GW is forecast in the latest national plan to rise to 380 GW by 2020. Significantly, China's aim is to change the balance of energy production over this period from four-fifths coal-fired/one-fifth renewable to approximately two-thirds/one-third, indicating strong perspectives for hydro power. ●





INSIGHT

Fountain of knowledge

For over 100 years, the *Brunnenmühle* – headquarters of the **Voith Hydro Engineering Center** – has been synonymous with state-of-the-art research and development in hydro power. Under the new leadership of Dr. Norbert Riedel, it is well equipped to continue to meet the challenges of the future.

More than 240 engineers work for the Center at its headquarters, in Heidenheim, and its international offices in the United States, Brazil and Sweden. As a center of excellence, the *Brunnenmühle* collects know-how gained by its global operating units, fits the pieces together, and disseminates information back to its regional offices to use for design, problem-solving and optimization.

More than a quality control center, the *Brunnenmühle* is a knowledge hub that unites its international competencies, positioning Voith Hydro as a leader on the global hydro market. “The tremendous advantage of the location is that engineering of the entire power unit – both turbine and generator – is carried out under one roof,” says Dr. Riedel of his new mandate.

Before taking over as Managing Director of the R&D laboratory in 2010, Riedel was Chief Engineering Officer at Voith Hydro in York, Pennsylvania. It’s a homecoming of sorts for the aerospace engineer, whose first position after university was at the *Brunnenmühle*.

Spectrum of expertise

The interdisciplinary expertise found under the Engineering Center’s umbrella makes it possible for the Heidenheim headquarters to offer anything from a complete power unit to storage housing or shaft lines. Whether it’s hydraulic, mechanical, electrical or ventilation engineering, the *Brunnenmühle* has raised the bar, offering expertise in computational fluid dynamics, structural mechanics, strength

Employees at Voith Hydro's Engineering Center tackle complex design challenges with the help of a virtual reality wall.

calculations, coatings and materials research. It also provides a portfolio of competencies that includes expert commissioning support, field service and plant measurement. And having their colleagues in plant engineering located just a stone's throw away is a tremendous catalyst for brainstorming and problem solving.

Local knowledge, global reach

Not all expertise at the Engineering Center is concentrated in Heidenheim, however. In North America, for example, rehabilitation projects such as Bath County, Bonneville and Wanapum have increased demand for York's expertise. Within pre-existing geometries, the York plant is subject to very unique parameters, often requiring its machines to meet the challenges of increasingly enhanced performance. Such projects are approached as a redesign.

However, when an installation is being newly designed, engineers can tap into the collective know-how at the Brunnenmühle or approach another operating unit that has amassed expertise in the new project's singular complexities. "That's why the German-Swiss project at Eglisau was engineered in the United States," says Riedel. "With their help, we were able to increase electrical production from 246 GWh to 314.5 GWh a year. That's enough electricity to supply some 80,000 households."

Optimal processes

"Deciding which of the operating units should be responsible for the design of a specific power unit or even a single component requires making an assessment of the machine's complexity and the operating unit's practical experience," says Dr. Siegbert Etter, Chief Technical Officer at Voith Hydro.

The advantage of having local teams in place is that they have closer contact with the customer and to the project itself. But being part of the day-to-day business has its advantages and disadvantages. By optimizing labor amongst its international offices, the Voith Hydro Engineering Center is able to harness its very fertile network of competencies, thereby ensuring the company's technological superiority.

"For instance, if the lead operating unit has gained experience in only a limited number of designs based on very specific parameters, then the project manager can draw on the Brunnenmühle's wealth of experience and know-how."

For Riedel, integration means bringing the right teams together so that Voith Hydro can provide its customers with the very best results. "The secret is in the mix," he says. "And I am firmly convinced that we have the right one." ●

INTERVIEW

Voith Hydro Engineering Center's new Managing Director **Dr. Norbert Riedel** on coming home and the appeal of the hydro power industry.



What was it like to return to Germany after a five-year stint in the United States?

I enjoyed my years in the United States, but Germany is my home. It is also much easier for me to get out into the great outdoors here than it was in the York area. It's something I really enjoy. The biggest challenge in returning to Germany, however, was importing my American car. Getting it through inspections ... now I know everything there is to know about EU regulations on automobile lighting!

How is it that an aerospace engineer become involved in the hydro power industry?

Hydro power technology is a lot more alluring than one might think. The aviation industry is incredibly regulated. In the hydro power business, the individual engineer can work closely with both cutting-edge technologies and day-to-day business.

How would you summarize your first 100 days?

The Voith Hydro Engineering Center has an incredible team of over 240 highly motivated, highly trained and highly specialized engineers. They bring the kind of intellectual curiosity any good engineer is going to need to come up with the very best solutions, thereby steering the company into the future. ●

TECHNOLOGY

Harnessing the power of the ocean

How Voith Hydro is making **technological breakthroughs** that are helping tap into the oceans' vast reserves of energy.



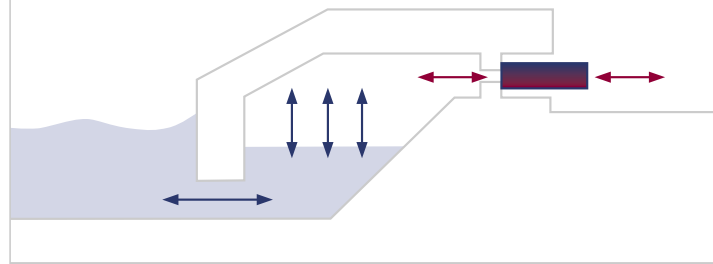
The LIMPET facility (left) has proved a great success. It boasts over 65,000 hours of operation, feeding electricity of industrial scale into the grid.



TOTAL POWER OUTPUT

Wave Power Plant Mutriku, Spain

300 kilowatts



On the remote Scottish island of Islay, you'd be forgiven for not giving a second glance to a modest shoreline concrete structure that looks like a slightly oversized concrete culvert. The eerie sighing and sucking sounds as the waves wash in and out of the structure suggest this is more than just a storm drain, however.

Going commercial

For 10 years, the Land Installed Marine Powered Energy Transformer (LIMPET) has been supplying power to the Scottish grid and testing a wave generation technology that is already leading the world in terms of reliability and robustness.

Now, the technology developed by Voith Hydro Wavegen is fully commercial. Over 1,000 km south, in the Basque seaport of Mutriku, between Bilbao and San Sebastian, a new facility has been integrated into the newly constructed breakwater. Built for client Ente Vasco de la Energía (EVE), it consists of 16 Wells turbines, each 750 mm in diameter, rated at 18.5 kW and capable of generating almost 300 kW in total. The Mutriku plant was officially inaugurated on 8 July this year.

Ahead of the competition

The importance of the event should not be underestimated, says Matthew Seed, Head of Voith Hydro Wavegen. The technology is far ahead of rival wave power alternatives, which are at much earlier stages of development and which have completed a fraction of the hours of testing that the LIMPET has undergone.

"The Islay demonstrator unit has more than 65,000 grid-connected turbine hours; a pretty strong number. None of the other technologies have generated energy for longer than a few weeks and have then been decommissioned or idled," he says.

Such exhaustive and lengthy testing and operation results in very high reliability. The turbine, which uses the action of the waves to push and pull air through turbines, is simple, with one moving part, no gearbox, no contact with water and a wide operating range. "It can be built into breakwaters or new harbor walls, which makes the plant easily accessible," explains Seed. "It also keeps operation and maintenance costs low and resolves the accessibility problem other similar solutions pose."

The design of the unit has been upgraded since the initial installation to improve the aerodynamics of the turbine, the ►

- efficiency of the turbine blades and to cut parasitic losses. The modifications have boosted efficiency by more than 25 percent, adds Seed. “That’s a really big step and is driving down the cost per kilowatt.”

High availability

Availability, the amount of time the device is operational, is an impressive 98 percent (whole year 2010). Such a high number will reassure potential investors in the technology as they will be able to create viable investment models based on demonstrable guarantees. “The availability number is important for investors, and we are confident we can deliver that with the commercial projects.”

The Mutriku project has helped Voith Hydro find ways to reduce costs from the first iteration in Scotland. “We’ve used our experience to engage in value engineering. We decided

“We see these as stepping stones toward larger projects in the order of more than 100 MW – enough to cover the requirements of tens of thousands of households.”

Dr. Jochen Weilepp

to put a large safety margin into the first machines to be sure they would deliver long-term operations in all sea conditions including heavy storms,” Seed explains. “Having learned more about the loads on the units, we’ve now been able to scale some of this safety margin back to save costs. We also expect scale effects to apply. The costs of concrete structures are, to a

large extent, fixed, and being able to distribute the costs over more turbines reduces the cost per kilowatt hour.” Seed believes the technology has the potential to be extended beyond near-shore applications as well. “It could be implemented in floating offshore structures and has the potential for utility scale projects.”

Tidal currents

In addition to the progress made with wave power, Voith is pioneering a second technology – the conversion of kinetic energy contained in tidal flows.

Part of a joint venture formed in 2006 with Korean partner Renetec, the first 110 kW demonstrator unit is now being commissioned. It represents the first important step toward the 200 MW Sea Turtle Tidal Park, currently under development in the Jeollanam-do Province in South Korea. Voith Hydro developed and built the demonstrator unit at its headquarters

in Heidenheim, and while it was transported to Korea in 2009, delays with the installation of a sea cable, beyond the control of Voith, put the installation of the device back to 2011. Despite these setbacks, the unit has now been successfully installed and commissioned.

“The technology is focusing on intrinsic simplicity, and, ideally, no maintenance will be necessary,” explains Dr. Jochen Weilepp, Managing Director of Voith Hydro Ocean Current Technologies. “We needed a turbine concept that could work flexibly with two flow directions, without any adjustment, and we abandoned the idea of dynamic seals for the generator: the water just passes through the generator-water gap. Moreover, we chose a design that allows for seawater lubrication – no oil or grease is needed. First test runs showed brilliant results, which meet all theoretical expectations,” he says positively.

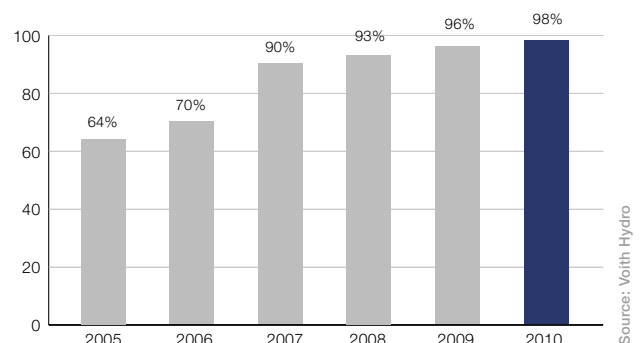
“We will test it for another six months to see how the technologies work. We see these as stepping stones toward larger projects in the order of more than 100 MW – enough to cover the annual power requirements of tens of thousands of households,” Weilepp concludes.

Enormous potential

When the project off the coast of the Jeollanam-do Province is complete at the fully installed 150 MW, it will be the world’s largest tidal current power park. Testing the full-size units intensely represents an essential step toward a full commercialization of the technology. Voith has reserved a

Consistently improving performance levels

Availability of Mutriku test machine

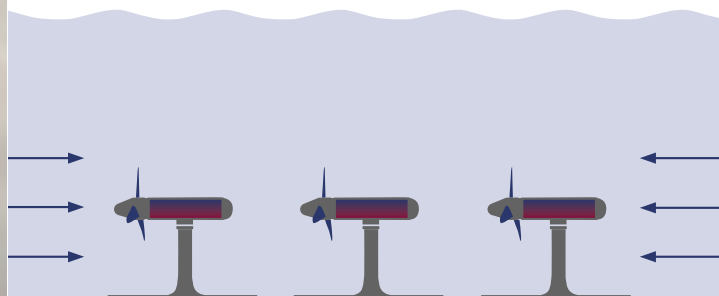




TOTAL POWER OUTPUT (WHEN FINALIZED)

Sea Turtle Tidal Park South Korea

150 megawatts



berth at the European Marine Energy Centre, on the Scottish island of Orkney, and plans to install a 1 MW plant there by the end of 2012. The first fully commercial deployments should happen in 2014-15. An additional aim, says Weilepp, is “to get the cost curves down and to gain the trust of potential investors.” Then, the firm can look at new projects and at extending the reach of the technology.

Although the potential application of tidal current power is smaller globally than that of wave power, owing to the need for specific locations where tidal currents are strong and conditions are suitable, its advantage is high predictability: “You can calculate thousands of years in advance when it will produce electricity,” Dr. Weilepp confirms.

The potential to deploy both of Voith’s technologies – for wave and tidal current power – in countries blessed with the right marine resources is as great as the energy potential of the oceans is enormous. Around 15 percent of the world’s energy demand could be met through the use of wave, tidal or ocean current power, according to the World Energy Council. The UK’s Carbon Trust predicts these resources could supply

around 20 percent of the nation’s energy demand, for instance. But these are still early days for a sector that is at a much earlier stage of development than other forms of renewable energy generation, cautions Dr. Weilepp. “With wave and tidal, the industry is 20-25 years behind wind in terms of development, and we are at least 100-200 GW behind in terms of global installation. Technical convergence is not yet happening in terms of devices, as we are seeing totally different approaches being taken.”

While other challenges remain, not least the need for countries to finance and build the grid infrastructure required to transfer the electricity that is generated, the marine energy sector stands to benefit from some of the synergies and technologies the onshore and offshore wind industries have already developed.

There is little doubt that the will exists to tap the ocean’s vast reserves of energy as part of the global bid to secure sustainable sources of power generation, Dr. Weilepp says. “In time, ocean energy will be as important as wind energy. These are not competing technologies. We need them all.” ●

What does the

Former economist **Jeff Rubin** is the author of the book *Why Your World is About to Get a Whole Lot Smaller: Oil and the End of Globalization*. We talk to him about how rising oil prices will transform the way people live in developed countries and what it means for the future of the energy industry.

Mr. Rubin, please tell us more about your predictions that high oil prices will cause people to move back to the cities and begin to produce and consume locally because transport costs will be prohibitively expensive.

The way that we've organized our economy today is a model based on low oil prices. When prices reach \$200 a barrel, as I predict, people will be forced to understand that distance costs money. The whole idea of having your factory halfway around the world from where you sell goods will quickly become a bad bet. We'll see a major restructuring in society as soon as the prices are too painful to continue avoiding the switch, or as soon as another recession hits. I think that by the end of 2011, we'll have a new world record for the price of oil. The current record is \$147 a barrel. The only thing that stands in the way of \$200-per-barrel oil is another recession.

Tour me through the suburb of tomorrow in a Western country. There are hardly any sidewalks for walking or biking. Mass transit is basically non-existent?

Maybe down the road the suburb you describe simply won't exist anymore. We're going to see increasing urban density as the counterpoint to past suburban sprawl. In time, cities in North America will



“We must re-engineer our lives to adapt to the contours of a much smaller world,” says Rubin.



future hold?

develop a public transit infrastructure like that of cities in western Europe. In addition, places like Canada and the United States are going to have to become a lot more self-sufficient in food. In the world I'm describing, food prices will go up rapidly, maybe even more rapidly than oil prices. And all of a sudden, it's going to be a lot more economically viable to convert that sprawling, now-abandoned suburb back into farmland.

How fast might this happen?

Within the next five years, people may begin to abandon the suburbs. Prices are the messengers of the economy. Prices are going to tell you what to do. When oil is \$200 a barrel, certain things are no longer economically possible and other things – like solar, wind or hydro power – become more economically viable. Living in those far-flung suburbs and having fresh tangerines in the middle of February won't be an option any more. Things will change very, very quickly, and the change will be permanent. We're not going back to a world of cheap oil.

In your book, you discuss positive changes, too. What do you foresee?

I expect to see the return of long-lost manufacturing jobs back to developed economies. We thought that these jobs were gone forever. But you won't have to compete head on with the wages of workers in China and India to keep your factory. For a number of regions, that's a much brighter future. I also expect the revitalization of domestic agriculture – a rebirth of farming. And because production and consumption are going

to be more local, we'll see far greater differentiation in consumer tastes. Call it a renaissance of local and regional culture, if you will. Within the global economy, we just made one product that was sold everywhere in the world. Coffee tasted the same in Tokyo in Frankfurt or in Cincinnati. But local tastes and preferences will come back to the fore. In fact, your major comparative advantage as a producer will

viewed from an economic standpoint. Biomass, solar, wind and hydro power will play a much greater role in the energy supply.

Where is this all heading?

The only answer is conservation. Higher prices must ultimately compel us to use less energy – in cars, in homes and in production. What really makes countries like Denmark green is not so much that

“As all energy prices rise, more money will be invested in alternative energy.”

once again be your proximity to and knowledge of your local customer. That's certainly a different model of doing business than we know today.

Are there any other positive points?

Whether we want to or not, we will have a considerably greener society and a much greener economy. People don't say it, but the best way to reduce emissions is a recession. When the economy is not growing, neither are emissions. And certainly in the world of triple-digit oil prices, the global economy is not going to be growing at four to five percent, particularly global industrial production in smog-emitting places like India and China.

What does this mean for alternative energy?

As all energy prices rise, more money will be invested in alternative energy, which will be increasingly viable as

it gets 20 percent of its power from wind, but rather that power costs 30 cents per kilowatt hour. People in Copenhagen use a fraction of the power that people use in Toronto. When prices accurately reflect the limited supply of energy that we have, people will finally be forced to wean themselves off energy consumption. And, in the process, they may enjoy a simpler, stiller life in cities that are not energy wastelands but hubs of creativity and community. ●



Jeff Rubin is the former chief economist at leading Canadian investment bank CIBC World Markets.

He was one of the first economists to successfully predict the huge rise in oil prices in 2000. Since leaving CIBC in 2009, he has turned his attentions to writing and as well as his recent book, he is also a regular blogger.

> www.jeffrubinssmallerworld.com

Alternating views

“I grew up around the ocean with a concern for the environment.”

Maila Sepri, Resource Analyst, Ocean Current Technologies

“What still excites me is that I can’t say I know everything.”

Otto Kienle, Head of Commissioning Field Service

American **Maila Sepri** is a newcomer to Voith Hydro and is bristling with ideas, while **Otto Kienle** is one of the company’s most experienced and knowledgeable employees. Together, they bring different perspectives to the industry.

Why did you decide to work in hydro power?

I met a Voith representative at a job fair during my graduate studies. I was already studying wave energy as a renewable resource, but hadn’t yet decided to work in hydro power. I really wanted to try working abroad, and I was lucky to find a job related to my studies.

What is your defining impression of the industry?

The challenges we face during construction work in harsh conditions offshore. Tidal energy sites usually lie in locations attacked simultaneously by various extreme conditions. This means operations have to be quick and efficient, but can be expensive. The future of the industry hinges on resolving those challenges effectively.



What particularly excites you about hydro power?

I grew up around the ocean in an area of sensitive environmental habitats, and with a concern for the environment. A professor of mine once pointed out the sense of striving for self-sustainability in power, based on resources available

locally; even comparably small sources of energy can be used to contribute to a sustainable energy balance.

What might be the next big technological advancement?

Any progress to minimize the need for maintenance and installation costs of instruments and structures in remote marine locations will carry large benefits. ●

Why did you decide to work in hydro power?

A friend of mine asked if I was interested in joining Voith because it was very interesting in his department. It wasn’t just design, it was the overall package of the system. It was a very exciting time to join the company because we did the calculations, then the manufacturing, then we tested the equipment and also went out for the commissioning



What is your defining impression of the industry?

My first big job in the office, in the engineering department. 1973 was the time for changing from the mechanical governor to the electronic governor – an analog governor. This was the time I started my career, and I was able to

make this step from mechanical to electronic output. Key was the development of the moving coil – it was a real breakthrough.

What particularly excites you about hydro power?

What still excites me is that I can’t say I know everything. Each day is a new challenge. We have so many different power stations, especially in our business. We have different projects, and each project is different from another. It’s certainly not boring!

What might be the next big technological advancement?

Our target is higher turbine efficiency, though we are near saturation, and higher efficiency for generators. I think the next big step forward is likely to be on the electronic/digital systems side, in automation or sensors. This will be the future. ●



Guangzhou, China Facts

Power	2,400 MW
Turbines	8 x 300 MW pump-turbine units
Construction time	11 years

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Published by:

Voith Hydro Holding GmbH & Co. KG
Alexanderstr. 11
89522 Heidenheim, Germany

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