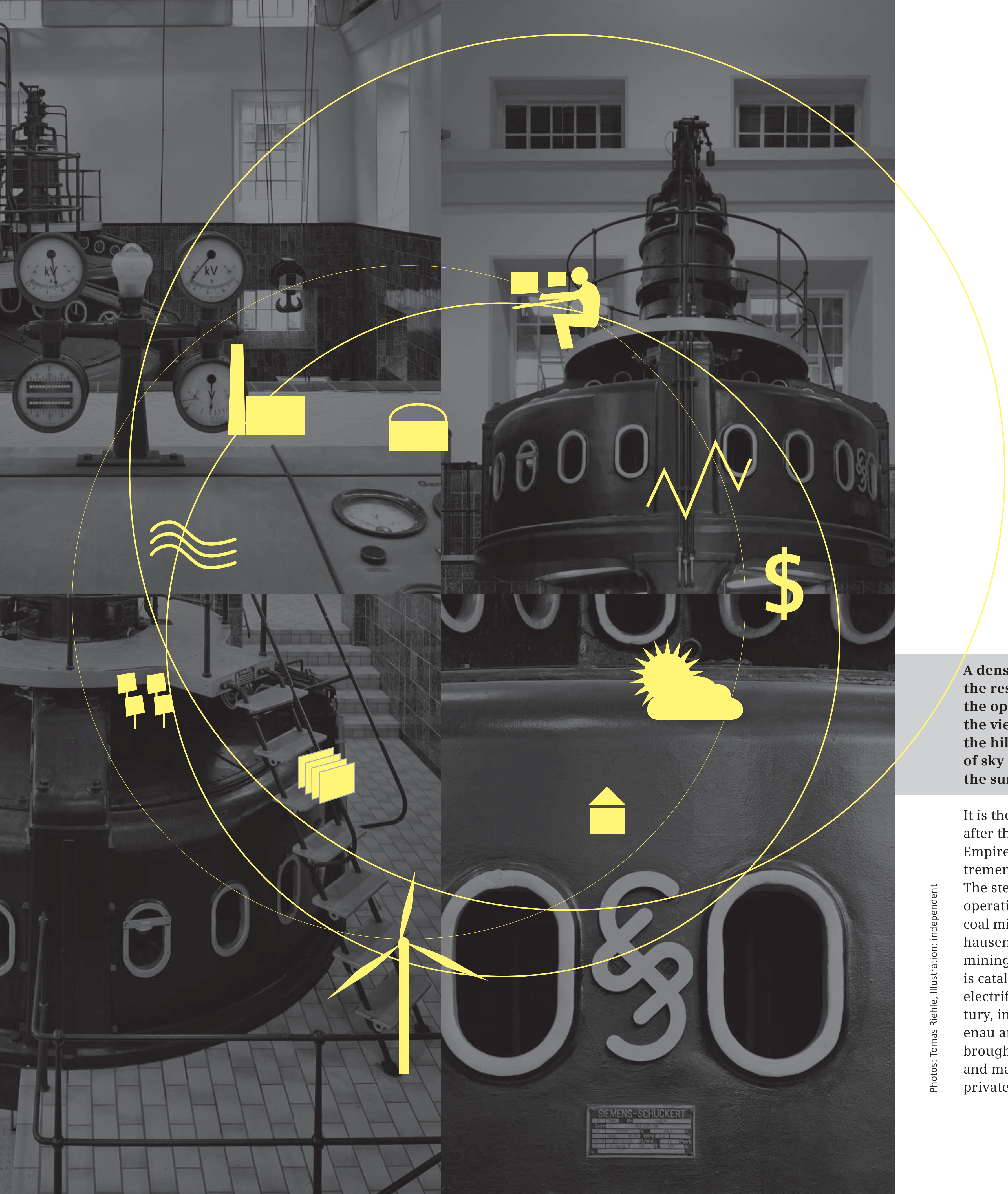


Strength in Numbers: Merging Small Generators as Virtual Power Plants

Vintage hydropower installations are given a new lease on life as state-of-the-art control software joins them into a virtual power plant suitable for the energy markets of the 21st century. Siemens has joined forces with Germany utility RWE and power provider LLK for a pilot project.

By Christopher Findlay

A dense mist covers the surface of the reservoir at daybreak, cloaking the opposite shore and obscuring the view of the sun rising behind the hillside. Only a pale blue patch of sky directly overhead hints at the sunny day to come.

It is the year 1910. Almost 40 years after the proclamation of the German Empire, Germany is in the midst of a tremendous economic growth period. The steelworks of the Ruhr area are operating at full blast, powered by the coal mined in the collieries of Oberhausen, Dortmund and other nearby mining cities. The industrial boom is catalyzed by the rapid advance of electrification; since the late 19th century, innovators such as Emil Rathenau and Werner von Siemens have brought electric lighting, appliances and machinery to businesses and private households alike.

To keep up with increasing demand, construction of new plants is picking up, with hydroelectric power serving as a mainstay of electricity supply. The small power stations and their insular networks mainly supply the immediately surrounding areas. In the side valleys of the Sauerland along the Ruhr catchment basin, a group of entrepreneurs and civil engineers decides to harness the water power of nearby reservoirs, which regulate up- and downstream water levels. Within a few years, small installations such as the run-of-river power station at Niederense with its state-of-the-art Siemens-Schuckert generators, built in 1913, are in operation. But the region is also home to some of the largest projects of the day: the Möhne Dam, completed in the same year, retains a record-breaking 134 million cubic meters of water.

Despite their venerable age, many of the hydroplants operated by LLK are equipped with cutting-edge control software.

Photos: Tomas Riehle, Illustration: independent

The early morning sun burns away the last wisps of fog curling over the quiet reservoir that stretches from the dam back around the bend of the valley. Above the lake, a flock of geese gathers for the long journey southwards.

It is the year 2010. Exactly 20 years after the reunification of Germany, the country is once again experiencing significant economic growth. Most of the Ruhr coal pits have been closed down; climate change and the rising costs of fossil fuel have brought about a change in energy policy. The government subsidizes decentralized power from renewable sources, and integrated grids have brought new models for generating and marketing energy. But visitors to the reservoirs along the Ruhr tributaries might believe they had entered a time warp and gone back a 100 years. The Möhne River still passes through the same Siemens generators at the vintage Niederense station, generating 1.3 MWh per year. Meanwhile, the huge Möhne Dam, destroyed with "bouncing bombs" in a wartime operation made famous by the *Dambusters* movie, has been replaced by a 1950s structure.

“VPPs assist small-scale renewables in the transition to the energy market and provide flexibility and transparency.”

Martin Kramer, RWE Project Manager for Distributed Energy Systems

Clearing Hurdles to Market Access

On the surface, then, little has changed. However, the invisible but powerful new infrastructure to which these old-fashioned turbines are now hooked up is one that the engineers of a century ago would struggle to understand. The small and medium-sized hydropower plants of the Lister- und Lennekraftwerke (LLK) company, some of which are now listed structures regarded as part of Germany's cultural heritage, have been bundled into a virtual power plant (VPP) using the latest management software. In combination, they are treated as a single plant, and acquire the critical mass that allows them to participate in the energy markets as a single larger unit.

"There are a number of obstacles that make it difficult for smaller players to participate in the energy market," explains Martin Kramer, Project Manager for Distributed Energy Systems at RWE. "The specific costs for each plant are simply too high. Also, there are licensing fees to be paid if a plant operator wants to trade on the European Energy Exchange (EEX). And in order to take part in the market for tertiary control reserve, a plant must have a minimum capacity of 15 MW." By linking up the smaller feed-in stations, the operators use synergy effects in sharing loads across the grid and can develop new channels for marketing their energy.

Added to these considerations are the complex administrative efforts: While the power plants in the early days of electrification a century ago were more or less stand-alone structures that provided their energy directly to the consumer, the modern integrated markets require a more intricate procedure. Producers must forecast the amount of energy they will be able to generate over a given period, and conclude their contracts accordingly. Then they must optimize their production by calculating which of the plants in their pool will be able to deliver the agreed amount of energy most economically for that cycle. Based on these considerations, a timetable is generated that ensures the timely delivery. With decentralized renewable energy producers, additional uncertainty arises from environmental factors such as expected wind speeds or hours of insolation per

Built in 1928, the Lenhausen power plant supplies an average 4.9 million kWh per year.

Photo: Tomas Riehle

Virtual Power Plants

The vintage marble control desk faces a pair of Siemens-Schuckert three-phase synchronous alternators.

> "DEMS is a mature, functional technology that can be adapted for other environments and users."
>
> Thomas Werner, Siemens Power Distribution, Smart Grid Applications

day. In order to make the complexity of all these calculations manageable even for smaller operators, RWE has partnered with Siemens to develop the pilot project for a Professional Virtual Power Plant (ProViPP).

Cascade of Innovations

The concept of the VPP is made possible by a cascade of concurrent innovations. Technology for renewable energy generation has matured to the point where not only hydropower, but also solar, wind or biomass energy are forces to be reckoned with. At the same

Photos: Tomas Riehle

Siemens software links the Lenhausen plant and other installations into a single virtual plant.

time, the political and technological requirements are in place for an integrated grid fed by many small producers rather than a limited number of large, monolithic sources. RWE approached LLK, one of its key customers, to ask whether the company would be interested in combining several of its smaller hydropower stations into a virtual plant. Though the same turbines – some of them now approaching their centenary – continue to churn at the heart of each plant, they are now controlled by innovative management software developed by Siemens: the Decentralized Energy Management System (DEMS™). It automatically handles data on expected grid loads and power generation and uses this information to optimize planning and management for each plant. Information is exchanged via a cellular modem linked up to supervisory control and data acquisition (SCADA) software. Siemens has been developing the DEMS control software since 2004, although initial work on the creation of a communication system began in 2001. The system is arranged around a decentralized structure. Its core computing system and server are located near Koblenz, Germany, about 150 kilometers south of the LLK headquarters in Olpe, but the system is serviced by an RWE portfolio manager in another location closer to the company's headquarters. Here, the basic data is managed, and dynamic parameters – including information on expected market and weather developments – are fed into the operating model in real time, with DEMS serving as the hinge between the producing units and the external sources of information.

Nevertheless, the system operates largely autonomously once the basic settings have been entered. As soon as the basic parameters are met, a command is sent through the network. In the remote tranquility of the Sauerland reservoir lakes, sluices are opened as by an invisible hand, and tons of water rush through the turbines, feeding power to the RWE grid.

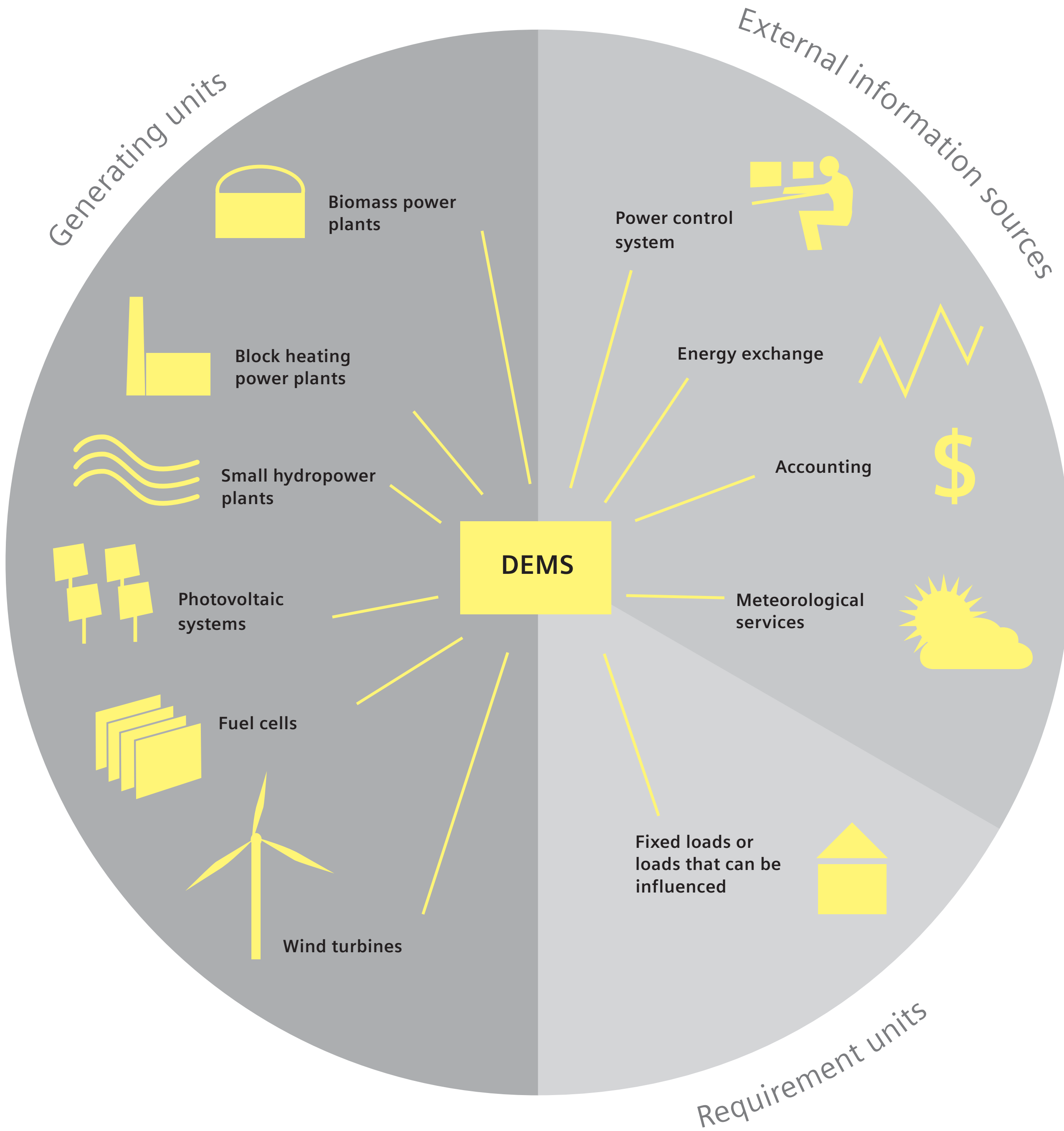
"DEMS is a mature technology," says Thomas Werner. As an engineer at the Siemens Power Distribution, Smart Grid Applications department, he is a product manager for distributed generation management systems. "The system is not only operational as a fully functional control system for the project in Olpe, but is sufficiently advanced to be adapted for other environments and users. All of its functionalities are already available for professional application." Although there are a few smaller competitors in this sector, both Werner and RWE's Martin

Glossary

- **Virtual Power Plant:** A virtual power plant (VPP) consists of multiple smaller decentralized plants (usually producing energy from renewable sources) that are bundled and controlled by centralized steering software. The VPP model allows smaller producers of energy to achieve the critical mass necessary for participation in the energy market.
- **DEMS:** The Decentralized Energy Management System software, developed by Siemens, links power-generating units with key information on market developments, environmental factors, and other data for maximum efficiency and reliability in scheduling the feed-in of energy to the grid.

DEMS as the "Brain" of a Distributed Generator Park

A groundbreaking piece of software for the smart grid of the future: The Decentralized Energy Management System provides a series of interfaces to possible components and participating systems for optimizing energy import, contract management and online optimization. Information is exchanged via a cellular modem linked to SCADA software.



Graphic: independent, Photo: Tomas Riehle

Kramer are confident that DEMS can set new standards as a groundbreaking piece of control software.

Easing the Transition to Deregulated Markets

"From the technical point of view, everything went off without a hitch," says Kramer. But one of the conclusions of the ProViPP project is that a regulated energy market may not be the best setting for market integration of VPPs. Two basic marketing scenarios were considered under ProViPP: straightforward energy trading on the EEX derivatives and spot markets, and marketing flexibility on the exchange for operating reserve. But in Germany's regulated market, operators of renewable energy plants receive generous feed-in tariffs that may act as a disincentive to combining decentralized plants into VPPs, especially in view of the comparatively poor performance of exchange prices during the current financial and economic crisis. However, Kramer sees some political indications that renewables will be introduced to market mechanisms sooner rather than later.

"VPPs can assist small-scale renewables in the transition to the energy market, and they provide flexibility and transparency as far as the supply points are concerned," he states, noting that the concept may even support further expansion of technologies currently fostered by feed-in tariffs. But in addition to easing the entry into a deregulated market, an energy management system such as DEMS can also handle other changes in market models. "Any changes in the external business model could be easily reflected by changing the respective parameters in the software," he says.

Outlook

Although the market forces occasionally prove to be just as volatile and capricious as the forces of nature that power the decentralized plants, both Martin Kramer and Thomas Werner are confident that VPPs will be a seminal technology for the future. One application being discussed is load balancing within networks. While a technically sound concept, the business models for such an application are only now being developed. If distributed renewable energy could not only be marketed more efficiently, but also integrated more directly into the management of grid loads and operating reserve for utilities, it would be another important step toward fine-tuning the overarching concept of the smart grid. In any case, the project managers hope to continue developing the concept on a commercial footing. "We have no doubt that there are sufficient facilities that can be bundled into VPPs," says Kramer. Though they may not be as picturesque as the vintage LLK stations, modern technology can prepare them all for the markets of tomorrow.

__Christopher Findlay__ is a freelance journalist living in Zurich, Switzerland. He writes on science and politics. Before moving to Zurich, where he worked as academic editor for ETH Zurich for many years, he was the Information Officer of the International Solar Energy Society (ISES).

On the exterior, this power station has not changed much since its construction.

Summary

- **Pooling Resources:** Siemens and RWE have jointly developed a pilot project for a Professional Virtual Power Plant (ProViPP), which brings together several small hydro-installations and combines them into a single virtual plant. Using customized control software, the distributed generators can be managed remotely and optimized for participation in the commercial energy exchange. The highly flexible DEMS software can be adapted to other types of power generation or to take new market mechanisms into account.

Further Information

www.rwe.com
www.siemens.com/energy/smartgrid