How the puzzle fits together

Smart renewable energy: The new energy world can already be recognized in schematic concepts, and the key words that describe it are already well known. A look at the latest developments shows how the pursuits of individual companies intertwine, and fill the concept with life.

Large upheavals generally involve a multiplicity of small changes and experiments before it is really clear how the big picture will look. Today's energy industry is at this stage, a fact reflected in the many facets presented by companies at the Intersolar trade fairs in Munich and San Francisco under the banner of Smart Renewable Energy. Some people make a career of finding the common thread in developments, structuring them, analyzing them and acting on the basis of their hypotheses. Michael Bez is one such person. Bez was the innovation manager at EnBW, a position that evolved into his current job overseeing the virtual power plant at the company, one of Germany's four largest utilities. "Electricity will be the dominant form of energy in the 21st century," he says. Heating and mobility will be electrified.

He is not alone in this view. Sector coupling is coming. More and more people are using heat pumps. Even in comparatively sun-poor Germany, a study by the battery storage manufacturer E3/DC shows that battery storage and a generously dimensioned PV system can cover 75% of total electricity and heating demand with distributed self-supply. The calculation includes the winter months. In warmer regions, air conditioners have always been powered with electricity. There is now little doubt that electric cars will replace their diesel and gas-powered counterparts. And even if some cars are powered by combustible fuels in the future, these fuels will probably be synthetic.

Hardware for new energy

Synthetic fuel too, is a field that is wide open in the new world of energy. "At generation costs of 1.5 to 2 euro cents per kilowatt hour, synthetic hydrocarbons, such as fuels and chemicals, can be introduced to the market competitively," says Christian Breyer. He works on global energy scenarios at the Finnish Lappeenranta University of Technology. Breyer challenges us to think about who should ultimately dominate the hydrocarbon market – a little tip for companies to enter the field. But efficiency improvements are needed in methanization and hydrolysis. Researchers from the Energy Lab 2.0 at the KIT in Karlsruhe, who appeared at the Smart Renewable Energy special exhibition in Munich, are working on the development of better reactors and materials cycles for synthetics, writes Mirco Sieg (p. 126).

There is of room for improvement in hardware. A key trend in this field, and across all industries, is better use of digitalization; SunSniffer wants to revolutionize PV plant operation using big data. It collects data at the module-level, and by evaluating developments over time and comparing PV panels, the technology can trace errors that influence the performance of the plant back to individual modules. Technicians are only dispatched when it is worthwhile, and go directly to the problematic areas of the plant. Tobias Winnemöller, who works in predictive maintenance at E.ON in the wind sector, has similar plans. With his team, he wants to use precise data analysis to predict when components will fail, and use this information to schedule servicing, preferably when there is no wind. He is convinced that his algorithms could also be used for PV plants.

It can also be very smart to combine PV and wind in a single power plant, a concept presented in a panel at the Intersolar conference, and described here by Jonathan Gifford (p.123). This reduces the grid connection capacity and, depending on the location, creates a more balanced generation profile. This is particularly true when the plant is also equipped with battery storage. These efforts are necessary to further reduce the cost of renewables.

"Sector coupling is coming, more and more people use heat pumps"

Photo: Solar Promotion GmbH

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"In the future, there will be 7 million energy assets connected by data"

7 million networked devices

But the master of all disciplines where intelligent systems will dramatically increase, and the one on everyone's lips, is device networking. "All devices will be controllable," says EnBW innovation expert Bez, "Not necessarily because we want that, but simply because that's where things are headed." By way of confirmation, he points to the refrigerators that communicate their own shopping lists. Networked devices, he says, will again revolutionize the energy system. It used to consist of a few large power plants that had to be controlled. Now, there are 1.7 million renewable power plants. In the future, there will be seven million energy-related assets, linked by electricity, mobility, heating and data. "We're transferring knowledge of complex system management to new business models and digital platforms," says Bez.

Christian Breyer believes that this digitalization is necessary, "so that with the lowest possible marginal costs – preferably approaching nil – we can make use of flexibilities in the system."

"Intelligence in the energy system means that in the future we have to control the dumb technology of today," says the founder and managing director of the Energy Brainpool consultancy, Tobias Federico. He is a documented expert on the German energy market. Talking with him, the complexity of this undertaking quickly becomes apparent. "I share the vision that everything with a plug will be connected to the internet," he adds.

This will make toasters, refrigerators and electric cars immediate parts of the balancing group. This is the basis for the physical fulfilment of supply and electricity trading. Every consumer and generator within a balancing group precisely measures how much electricity flows into or out of a particular connection point. Rebalancing has to take place every 15 minutes. The operator of a balancing group has to specify ahead of time how much energy it is likely to purchase or sell, and deviations are paid for after the fact. "That makes optimizing the balancing group price-driven," says Federico. "It would be perfect if we could succeed in managing balance groups to be autonomous in the 15-minute time window."

Technical solutions are already pointing the way to Federico's vision. It begins with IP addresses. The switch from the IPv4 to the IPv6 standard made more numbers available. "That is a prerequisite for connecting every device to the internet," says the expert. It is also a step in the right direction, he says, that chips and controllers have become more powerful. "Every device could have its own trading robot that automatically trades energy, and which it needs to generate a consumption forecast and take into account local availability of renewable energy," he says. There are also start-ups that promote the networking of numerous small devices and automated machine trading.

Communities for greater acceptance

All of this demands intelligence, but technical development has to continue, rather than simply automating the energy system in its current form. The quarter-hourly pace of energy trading also owes a debt to the age of analog. Today, Australia already has a trading frequency of five minutes. Federico thinks we should be aiming at time windows of 30 seconds or less. Lumenaza is active in automated balancing group management. The start-up offers some of the technology Michael Bez needs for his virtual power plant. For instance, in a small town 100 kilometers

east of Stuttgart, EnBW is testing one of the most critical steps in its new world of energy. In Bopfingen, the company is offering regional power. PV plants in the region feed power into a balancing group from which regional consumers can draw electricity. Surpluses are marketed on the electricity exchange, where residual current is procured. The company's "EnBW solar +" is a product that offers a virtual community in a package with PV, storage and intelligent energy management, in which the balancing group is not restricted to the region.

The Lumenaza solution can also control larger consumers and generating facilities to compensate for fluctuations in generation and consumption. The balancing groups are still managed in 15-minute time windows. "Our current goal is 60 seconds; 30 seconds would probably also be doable," says Lumenaza CEO Christian Chudoba. His goal is to ensure that the balancing groups in a region are balanced as well as possible. That cuts down on network expansion. Those who are implementing this approach are driven by idealism. Network surcharges in Germany do not take into account how far the electricity has to travel – there is no financial incentive to use electricity from the region.

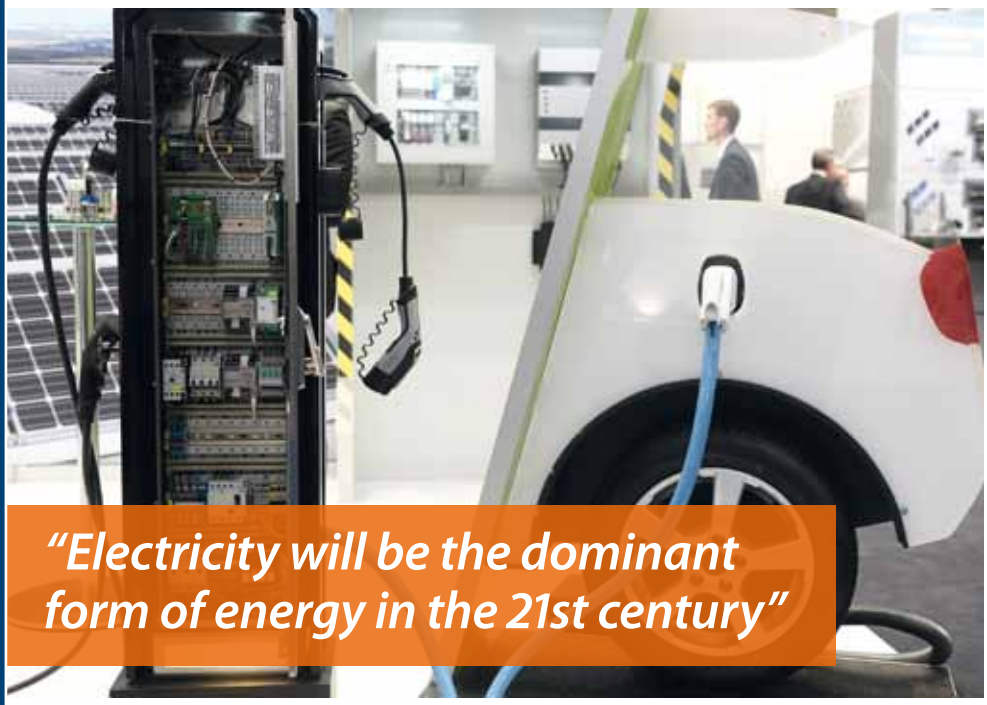

Photo: Solar Promotion GmbH

Apart from this, there is the question of whether such concepts represent progress in the energy transition. "The energy transition is often discussed in purely technical terms," says Chudoba. "It stands or falls on the acceptance of citizens." Lumenaza's approach makes everyone an economic, social and environmental stakeholder. Moreover, regional products are very popular with consumers. With its Community model, storage system manufacturer Sonnen also links the generation and consumption of its customers. It even offers them the opportunity to profit from marketing balancing energy, to stabilize the grid. A bitter debate is raging in Germany over the sustainability of this model.

The discussion demonstrates how this a prime example of how complexity is dumbed-down for consumers. "That's a key point," says Bez. Neither in Bopfingen, nor as part of the Sonnen Community are consumers ever confronted with the energy-market terms "direct marketing" or "balancing group". The term "balancing energy" never appears. For consumers, it is simply a flat rate that is funded through their contribution to stabilizing the power grid.

Four ages of the energy transition

But how do we assess development? Where is it leading? "Bopfingen or EnBW solar + stand for the second of four ages of the energy transition," says Michael Bez. In the first age, large loads and generators, like aluminum plants or wind farms, became controllable and were integrated into the energy market. In the second age, the units became smaller, which we see now in community and regional power projects. In the third age, it is conceivable that regulation will undergo so much change that the flexibility in the distribution network will become useful and thus give rise to new business models. In the fourth age suppliers will become increasingly distributed. That applies to all of the plants connected to the system.

And finally, the buzzword "blockchain" rears its head. This technology is destined to manage such distributed suppliers and consumers. Some years from now, it may be worthwhile to switch on the heating element in the boiler when a neighbor five houses down has a surplus of solar power, saysBez.

EnBW is also developing expertise relating to blockchain-based trading platforms and peer-to-peer concepts. "This will also raise the question of new roles for utility companies." Even large companies like EnBW would no longer be central energy providers, but rather "decentralized energy managers." Michael Bez does not yet see any real need among customers for the blockchain-based trading platform. "There is still no business model that creates something customers are willing to pay for merely through the use of a blockchain," he says.

But for existing business models like that of Lumenaza there may be blockchain applications. "Where we see potential fields of application is with regard to the major cost drivers," says Chudoba, "For example, eliminating traditional metering operations by providing the data via blockchain." He also sees potential in exchange processes.

The startup StromDAO has already developed a blockchain-based business model that looks promising. The company's founders presented it at the Smart Renewable Energy forum in Munich and explain their concept of a so-called hybrid electricity market (p.128).

It is only logical that, with all these developments that integrate renewables increasingly into the energy system and bring them closer to the consumer, Smart Renewable Energy will no longer be part of the Intersolar and the EES, but the other way round. Both of the trade fairs for solar technology and home storage systems will now be under the umbrella of the newly created "The smarter E", which is concerned with the new world of energy as a whole. ◆ Michael Fuhs