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Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)

Stuttgart site:
Industriestr. 6, 70565 Stuttgart

Driving the Energy Transition with Big Data

ZSW develops smart method to map energy flows in the electrical grid

Scientists from the Centre for Solar Energy and Hydrogen Research in Baden-Württemberg (ZSW) are looking to use improved, self-learning algorithms to get a more detailed picture of energy flows in the electrical grid. A major research project was launched to this end in February 2017. These algorithms will serve to more accurately forecast consumers' needs and the amount of electricity generated from renewables. Satellite data will also be used to improve feed-in forecasts. The results of the researchers' efforts are to be tested and refined in power companies' grids.

Renewables feature prominently in Germany's power grid, so a comprehensive view of energy flows is needed to ensure power is delivered cost-effectively and as reliably as ever. Energy service providers' new business models require precise forecasts of energy flows through to the distribution grids, as do the operators of smart grids.

As part of a four-year project that goes by the name of *C/sells*, ZSW researchers are striving to chart current and future energy flows with unprecedented precision. The objective is to optimize the technical and business operations of power grids with very high solar penetration in 46 sample regions and neighborhoods (cells) in southern Germany. The transmission grid operators TransnetBW and TenneT, distribution grid operators, municipal utilities, energy and software service providers, and research institutes are all on board. The Federal Ministry for Economic Affairs and Energy is funding C/sells with some €50 million as part of an initiative called Smart Energy Showcase – A Digital Agenda for the Energy Transition (SINTEG). The project's overall budget runs to around €100 million and involves 42 partners.

A lot left to learn about energy flows

Supply and demand—that is, power in-feed and consumption—must always be balanced in the power grid. This is easy to do given a central feed from a power plant park, where the power supply is simply adjusted on the fly to match consumption. However, striking the right balance is far more difficult with increasingly decentralized feeds from fluctuating solar and wind power sources. This requires a high-resolution picture that captures all the details of local energy flows.

Today's forecasts for power feeds into the grid are not mapped in sufficient detail and are too inaccurate under certain weather conditions.

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On top of that, households and smaller businesses' consumption is merely estimated using standard load profiles. Consumer behavior has changed in recent years, so these estimates no longer accurately reflect the reality of the situation.

There is also a new player in the energy arena—the prosumer that not only generates electricity but also consumes it. There are now around 800,000 prosumers in southern Germany alone, and accurate predictions of their behavior are needed. As feed-in and consumption forecasts improve, power companies will have to draw on fewer fossil fuels to sustain the power supply. This drives down macroeconomic costs and contributes to more stable grid operations.

Smart methods to optimize energy systems

Now Big Data is making inroads into the power supply chain with researchers applying smart, new methods to map the electrical grid's energy flows in greater detail. ZSW is using high-performance computer platforms based on graphics card clusters to develop state-of-the-art methods aimed to gain deeper insight into regional sections and local cells of the grid and to better forecast future conditions and energy flows.

"These new methods analyze vast amounts of complex information and are designed to process a variety of data sourced from power plants, environmental monitors, measurements and satellites," says Dr. Jann Binder, who heads up the Photovoltaics: Modules Systems Applications department at ZSW. They sift through this mountain of data to independently filter out crucial properties for forecasting. These are key factors that influence green power plants' expected electricity yields and consumers' demand for electricity. These methods are also called self-learning algorithms for their ability to act autonomously. Binder adds, "The goal is to deliver data in a form and level of quality beyond that of commercially available products."

Research project in the south of the Republic

The C/sells research project involves actors and grids in Bavaria, Baden-Württemberg and Hessen. This region has the highest solar penetration in Germany, a multi-layered grid structure with over 400 distribution grid operators, and a combination of industrialized conurbations and sparsely populated rural regions. And it is located centrally in the European grid network.

The Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (Centre for Solar Energy and Hydrogen Research Baden-Württemberg, ZSW) is one of the leading institutes for applied research in the areas of photovoltaics, renewable fuels, battery technology, fuel cells and energy system analysis. There are currently around 230 scientists, engineers and technicians employed at ZSW's three locations in Stuttgart, Ulm and Widderstall. In addition, there are 90 research and student assistants.

C/sells

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Self-learning algorithms are to predict the power grid's energy flows with greater precision.

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