RESEARCH NEWS

Renewable energy

Dynamic energy management using batteries and photovoltaics

One challenge facing the widespread adoption of renewable energies is the fluctuating output of photovoltaic systems — for energy-intensive companies, this means that their distribution networks are rapidly becoming inadequate. Fraunhofer researchers have developed a solution that combines power from renewable sources with electricity from the public grid and uses batteries to compensate for fluctuations. This approach will particularly benefit companies that aim to invest in sustainability with photovoltaics — and reduce their energy costs in the process. A living laboratory, which mimics practical conditions, will give industry customers the opportunity to test components and system solutions. The solution also allows for a more efficient management of e-car charging stations.

Increasingly, industry companies are using energy from renewable sources, such as photovoltaics, in addition to the public power grid. But wind and solar power outputs fluctuate, making energy management a complex task. Batteries are set to play an important role in solving this problem: They serve as buffers and compensate for fluctuations in electrical power. If industrial companies with photovoltaic systems installed on their roofs can successfully combine self-produced electricity generated from photovoltaics with electricity from public grids, they stand to benefit enormously. There is growing demand to do just that, as energy prices are currently rising dramatically. The Fraunhofer Institute for Solar Energy Systems ISE in Freiburg is addressing this need with their Haid-Power project. The Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI — also based in Freiburg — has come on board as a partner.

A comprehensive energy management system

"We are developing a solution that companies in the manufacturing industry can use to combine photovoltaics with battery storage in order to supplement their energy and power needs," explains Felix Stortz, a research scientist in the Applied Storage Systems group at Fraunhofer ISE. As the largest solar research institute in Europe, the institute is bringing a wealth of expertise to the table.

The concept is simple: The software is fed consumption data from all manufacturing machines, as well as data on the status and charging capacity of the batteries that are charged using solar power. "The energy management system can then determine how much power the on-site batteries can supply and how much power must be drawn

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from the public grid," explains Mr. Stortz.

By more effectively exploiting the potential of renewable energies, companies can reduce their CO_2 emissions while saving on electricity costs. Smart energy management also helps avoid the need for major investments, such as installing new power lines.

Energy management with predictive abilities

The intensity of solar radiation can sometimes be predicted days in advance — so the same is true for the output of photovoltaic systems. This information, in combination with readily available data on typical rates of energy consumption for all the manufacturing machines, can enable the software to make predictions. As a result, a company's management team can plan in advance how much energy they can expect from their photovoltaic systems and how much will have to be drawn from the public power grid. In principle, electricity prices could also be considered in this planning process: The batteries could act as a buffer during pricing peaks.

However, this is not to say that the system relies on the forecasts. Current data on the machines' energy consumption flow into the system through smart meters, as does the current status of the batteries. This means the system can react at any time, for example if a machine has to be started up at short notice.

Using load management to prevent consumption peaks

One core component of this solution is its integrated load management. While energy management is the primary tool involved in the overall strategy of producing and consuming energy from various sources, load management serves as a tool for reacting to consumption peaks. For example, if an energy-intensive system, such as a furnace, is put into operation when the charging capacity of the energy storage units is exhausted, then more power must be drawn from the public grid. The load management system can signal this to the energy management system. This then ensures that other controllable machines are throttled or switched off entirely. "It could also be possible to run machines at a later time, when the batteries are charged — provided that the production process allows for this," explains Mr. Stortz.

The Fraunhofer experts used the programming language Python to program the load management solution. This provides complete transparency. The system is under continuous development and runs on industrial PCs using standard interfaces. "It is also entirely possible to implement a system whereby operation takes place on the company's own server and can be controlled via the internet," says Mr. Stortz.

Testing solutions for industry customers in a living lab

In order to establish the optimal conditions for their project and enable further research projects in the future, the Fraunhofer researchers are setting up the Haidhaus development and testing center. This flexible technology platform will use a photovoltaic sys-

tem and modular battery storage as its hardware basis. In addition, the Fraunhofer institutes in Freiburg are working on a living laboratory, where the focus will likewise be on battery technologies. The laboratory will serve as a platform for developing and performing practical tests on components and system solutions. It will also be available to industry customers that want to test and validate their models and systems under real-world operating conditions.

In this way, the living lab will be a platform for developing pioneering energy management concepts that enable both commercial and public power suppliers to accomplish the energy transition. In the e-mobility sector, the principle of intelligent energy management is also considered a key factor for success. For example, if many electric cars need to be charged at the same time on a certain street, the system could prevent load peaks in the distribution network by temporarily throttling the fast-charging function at the charging stations.

The Haid-Power project is funded by the Ministry of Economic Affairs, Labour and Tourism in Baden-Württemberg.

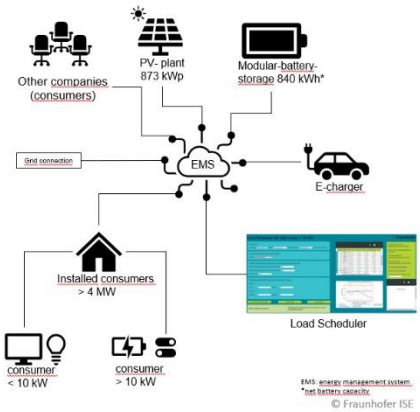

Fig. 1 The Haid Power project's intelligent energy and load management systems regulate energy supply and combine electricity from battery storage with electricity from the public grid.

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Fig. 2 The modular battery storage units in the Haid project are charged using photovoltaics and integrated into the energy management system. The system is able to limit any load peaks that might occur by throttling the batteries' charging capacity.

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