Enlisting distributed energy devices to balance the power grid

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PNNL and its partners are developing a unique way to balance the increasingly complex power grid: an incentive-based coordination and control system for distributed energy devices such as rooftop solar panels, batteries and electric vehicles.

The electric grid has to balance power supply and demand nearly in real-time, requiring power plants to be adjusted on a second-by-second basis. This instantaneous balance is made significantly more complex by renewable energy such as wind and solar, which add more uncertainty and variability.

A new research project is proposing a unique solution to this growing problem: employing the millions of distributed energy resources that already exist, such as solar panels on rooftops and heating and cooling systems in buildings. The new approach uses these resources to balance the power grid, increase reliability and decrease carbon emissions. This incentive-based coordination and control system for distributed energy resources is also expected to make the grid more efficient, sustainable and resilient.

The $4 million project was one of 12 new projects announced Friday by DOE's Advanced Research Projects Agency-Energy, or ARPA-E. The Department of Energy's Pacific Northwest National Laboratory is leading the project.

"Our new approach to balancing the power grid offers a great deal of flexibility and the potential to increase system reliability," said PNNL engineer Karan Kalsi, who is leading the project. "It would give the future power grid the ability to quickly take on and shed power, which would also enable us to incorporate more intermittent renewable energy into the nation's power mix."

PNNL's project team includes United Technologies Research Center, GE's Grid Solutions (formerly Alstom Grid), Southern California Edison, PJM Interconnection and California Independent System Operator (also known as CaISO).

Better, bigger

This new approach will be far more advanced than existing efforts to coordinate distributed energy resources. Most methods being considered today focus on just one type of resource, only offer one grid-balancing service and ignore local system requirements. The PNNL-led team is incorporating many different resources and grid-balancing services in its system, while also ensuring local power reliability is maintained.

To test the system, more than 100 actual distributed energy devices - including heating and cooling systems at commercial and residential buildings, inverters for utility-owned solar panels and residential water heaters - will be managed with the new system. And to evaluate the system on a larger scale, more than 100,000 simulated devices will also be managed through several grid modeling tools that PNNL is combining for the project.

How it will work

The new method will involve asking companies, citizens and others to voluntarily enroll their distributed resources, which include batteries, smart appliances, electric cars, solar panels and heating & cooling systems. Owners of participating resources would be offered incentives - which could include a contract, a payment, a coupon or something else - to encourage them to enroll their devices.

Sensors and controls would be installed on enrolled resources to detect and alter their operations as needed, but within limits set by device owners. The sensors would allow resources to communicate through a cooperative decision-making platform, where information about the power needs of the grid and individual distributed resources are exchanged.

High-speed local controls will be used to operate the devices. The system's computational framework can estimate distributed resource needs and only has to occasionally communicate incentives to encourage the devices to alter their energy consumption.

A new organization called a distribution reliability coordinator would then evaluate the flexibility of various distributed resources to simultaneously provide the following three grid services:

- frequency response - very fast-acting (within milliseconds) emergency response to major events, such as a power plant failure
- regulation - responding within seconds to maintain balance between power supply and demand
- ramping - buffering rapid changes in power demand

ARPA-E awarded the project a total of about $2.7 million, approximately $1.4 million of which will go to PNNL. An additional $1.3 million of the project's expenses will be covered by cost sharing from project partners.

More information: arpa-e.energy.gov/sites/defaul … ect_Descriptions.pdf

Provided by Pacific Northwest National Laboratory

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