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Let there be smart power

The electrical grid in the US is old, outmoded and wasteful. All this is to change with a massive government investment

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Plugging in ... a Southern California Edison worker monitors electricity distribution
Photograph: Michael Caulfield/AP

The following correction was printed in the Guardian's Corrections and clarifications column, Friday 22 May 2009:

In the article below we said demand for electricity was expected by 2030 to rise "from 4,100 terawatts a year to 5,400 terawatts". As readers noted, a terawatt is a measure of power, and wrong in this context. We were measuring energy, so we needed to express it as terawatt-hours per year.

For more than 40 years, US utilities have been delivering electricity to industry and homes over an aged, one-way electrical grid. It lacks an automated feedback loop, which means that utility operators aren't aware of power cuts unless a customer calls in the problem. Just imagine how poorly our nervous systems would function without automated responses.

This grid is beginning a much-needed and expensive upgrade so it can obtain the automated brain it needs. But it's a complex transformation that involves other elements besides technology, innovation and money: alterations in political will, industry standards and consumers' use of electricity.

A greater grid

The US demand for electricity is expected to rise by 30% (from 4,100 terawatts a year to 5,400 terawatts a year) by 2030. That's one big reason industry players and some politicians are calling for a more reliable and efficient grid. Add to that electric vehicles and renewable energy from solar and wind - both have the ability to disrupt the delicate balance of supply and demand required for grid operation.

"People think, 'a smart grid is going to immediately lower my energy bill' - it might be true in some cases. The real benefits will be for the greater society with better intelligence on the state of the grid," says Thomas Basso, technology manager at the National Renewable Energy Laboratory in Boulder, Colorado.

With little or no intelligence in today's grid, utility operators face big challenges in balancing loads and monitoring power flows. The bottom line is that lots of electricity is wasted. An IBM study has estimated that if the US grid were 5% more efficient, it would be the equivalent of permanently eliminating the fuel and greenhouse gas emissions from 53m cars.

The good news is US government investment in a smart grid has been increased as part of the American Recovery and Reinvestment Act of 2009 - a multibillion-dollar stimulus package. It allocated 13% (\$104bn) of the total stimulus package to green technology, of which smart grid technology received \$4.5bn. Utilities in North America are also spending a combined \$10bn annually on smart technologies to transform the grid into a digital, self-monitoring and adaptive system.

That's still only a partial down payment on the estimated \$800bn cost. Some of this, however, is expected to be offset by the reduction of annual losses from power cuts and wasted electricity.

There remain several hurdles in making the smart grid a reality, including technical barriers, business practices and regulatory challenges. Among these is the lack of open standards for engineering applications to work in it.

"A lot of the high-level players such as IBM, Intel, Siemens, GE and Westinghouse will be involved in the IEEE [Institute of Electrical and Electronics Engineers] standards efforts," says Basso. A meeting in June will finalise the smart grid interoperability standards. There's also the need for better integration, with sensors, real-time databases and self-healing functions.

"When we look at the challenges in the smart grid area, technology is not the challenge. The really big challenge involves customer behaviour," says Arshad Mansoor, vice-president of the power delivery and utilisation sector at the Electric Power Research Institute, a utility-funded research organisation.

The first big step in making the grid smarter involves the installation of metering systems at homes and businesses. Already, there have been big deployments of smart meters in several US states, with more to come.

Pacific Gas & Electric has installed 2.3m meters in Northern California and plans to have 10m by end of 2011; Southern California Edison has plans to install 5.3m smart meters by 2012, enabling it to reduce energy demand by about 5%, roughly 1,000 megawatts; in Austin, Texas, the so-called Pecan Street Project - which includes Cisco, Dell, GE, IBM, Intel, Microsoft, and Oracle - is in place to create a next-gen grid.

Embracing electricity

"We are at the very beginning of realising how to take advantage of the smart grid," said Dan Reicher, director of climate and energy initiatives at Google.org. Google recently introduced PowerMeter software, which provides consumers with access to detailed home energy data and real-time grid data.

Reicher said it's less likely that customers will be monitoring real-time usage of electricity. Instead, they may sign up for a plan that sets thresholds for prices, so potentially smart appliances such as clothes driers shut off when the limit is reached.

More than 90% of US residential consumers have a flat price for electricity, Mansoor says. He believes people need to embrace varying charges for electricity use in the same way they've embraced mobile phone plans that have different charges at different times.

Venture capitalists in Silicon Valley have also been bullish about the smart grid and made it one of its latest darlings. Some of the prime investment opportunities are in smart meters, sensors and software to help run the systems.

"The challenge for companies is how to get to critical mass," says Andrew Williamson, director of Phisic Ventures in San Francisco. "Utilities are very conservative and used to making 30-year investments. They're not in the business of trying new technologies," he adds.

Over the next 12 to 18 months, there will be more modelling, simulation, and demonstration projects of the smart grid.

However, without a solid set of standards and government policy to support it, the smart grid will not be fully realised as an interoperable system in which meters and appliances can talk to the grid and act more like a nervous system.

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