The New Energy Revolution

Disruptive technologies—from micro-grids to solar panels and energy storage—are transforming the electric system.

BY GLEN ANDERSEN

The nation's electricity system is entering a new era. Technology has fueled dramatic strides in efficiency, natural gas extraction, locally generated energy and smart grid technologies. These advances stand to fundamentally alter how policymakers, utilities and energy businesses approach all aspects of the industry, from production and delivery to regulation.

Consumers and businesses have a growing array of choices to help them manage their energy needs. Some are choosing to install rooftop solar panels or combined heat and power units. Others are investing in vastly more efficient building technologies and appliances to lower their monthly utility bills, while the smart grid is enabling them to monitor and optimize their electricity use, an innovation that has huge potential to change the energy landscape.

Energy users are increasingly interested in emissions, sustainability and control over electricity sources, and they're pushing policies to improve efficiency, localized electricity generation and renewable energy. Policymakers are working to ensure access to these new resources and technologies, many of which reduce utility electricity sales and revenues.

Ultimately, the traditional model of the centrally managed and controlled utility, in which its profits are largely based on how much energy it sells, may need to be altered to address the growth of these technologies. "The utility model does need to change to reflect the realities of distributive generation and people wholly or partially leaving the grid (unless they need back-up power)," says Kansas Representative Tom Sloan (R), who serves on two U.S. Department of Energy advisory committees and has been active in grid technology issues.

Representative Tom Sloan (R) Kansas

Do-It-Yourself-Electricity

An overview of some of the developments that are driving the electricity revolution follows.

Energy Efficiency has continued to improve in televisions, refrigerators, air conditioners and other devices. The Energy Information Administration reports that household energy use has fallen for the past three years, and usage in 2013 fell to a level not seen since 2001—a remarkable figure considering the dramatic increase in home computers, large screen TVs, game consoles and other electronics. A 2014 refrigerator will use about half the electricity of a 2001 model, while a new 50-inch LED television consumes just one-quarter the power of a 46-inch LCD from 2008. LED lighting, which uses 75 percent less energy than incandescent, is likely to play a major role in further lowering electricity consumption.

Such technologies are helping business and industry cut operating costs and become more competitive. Efficiency is essential to making distributed resources cost-competitive, since it reduces the size and cost of the power system. Twenty-five states have binding energy efficiency targets for utilities.

Combined Heat and Power (CHP) systems, which create their own heat and electricity, are used in a growing number of industrial buildings because they are reliable and cost effective. Heat produced during electricity generation is usually wasted, but CHP systems capture and use it, resulting in dramatically increased efficiency. CHP systems, which can run on natural gas micro-turbines, fuel cells or other technologies, gained visibility during Hurricane Sandy, when hospitals and other buildings with CHP maintained operations despite extended power outages. Smaller, residential versions are also being introduced.

Most CHP systems use low cost natural gas, which can make them very competitive with utility electricity rates. About 12 percent of U.S. electricity comes from combined heat and power systems, but the potential is much higher—more than half of the electricity produced in Denmark, for example, comes from such systems. States are encouraging CHP with loans, tax incentives and inclusion in energy efficiency or renewable electricity requirements. In North Carolina, CHP qualifies for the energy efficiency portion of its renewable electricity standard, while Texas allows CHP owners to sell electricity at retail rates without regulating them as retail electric utilities.

Solar Panels have been dropping in price for decades due to mass production and growing competition in the global market. Since 2011, costs have plunged 60 percent, increasing the number of U.S. solar installations by 76 percent from 2011 to 2012. This pace continued in the first three quarters of 2013, with solar accounting for a record 20 percent of all new power added to the nation's grid—second only to natural gas. Twenty-nine states require utilities to produce a certain percentage of their power from renewable energy, and 16 have mandates that specifically target solar or distributed generation. Minnesota created its 1.5 percent solar mandate with the passage of HF 956 in May 2013. Representative Will Morgan (DFL), who worked on the bill, feels it will help drive down costs and "position Minnesota as a leader in solar energy production, which will attract jobs to our state and give suburban and urban consumers a personal stake in the fight against climate change." Prices are forecast to continue declining. In Germany, streamlined regulations and economies of scale have helped cut the installed cost of a solar system to about half what it is in the United States.

Representative Will Morgan (DFL) Minnesota

Glen Andersen is director of NCSL's Energy Program.

Energy Storage, which includes batteries, flywheels and other technologies, can benefit both end users and utilities. Storing energy from variable energy sources, such as wind and solar, so it can be used when it is most needed, increases its value and decreases the cost of integration into the power grid. "Storage acts as generation, as well as smoothing the natural 'blips' due to wind speeds changing and clouds passing over the solar collector," says Sloan. Utilities can save money by storing low-cost energy at night for use during the day, when wholesale electricity charges are high. Storage can also reduce the need for expensive transmission upgrades and new power plants.

Storage can reduce local grid instability and could eventually free energy users from the power line. Storage is still too costly to be beneficial for many distributed generation uses, but there may be a time soon when it's installed as routinely as rooftop solar. In 2013, California became the first state to require energy storage. Its public utilities commission has proposed a 1.3 gigawatt energy storage mandate for utilities by 2020. California utilities must integrate a variety of storage technologies, half of which they can own. The other half must be owned by a third party or the customer. Some states also qualify storage for renewable credit. In Kansas, "We already define renewable energy that enters a storage device as being renewable when it is discharged," says Sloan.

Micro-grids, self-sustaining subsystems of the larger electric grid, can serve single residences or universities and large developments. One of the nation's largest is in Co-op City, a housing cooperative of 60,000 people in northeast New York City. Co-op City's CHP system provides all the power and 95 percent of the heating to 35 buildings, shopping centers and schools in the community. Although it is connected to the larger grid system, like most micro-grids, it can operate on its own. The complex chose to generate its own power to save money, but discovered an added benefit during Hurricane Sandy. Co-op City's lights stayed on while surrounding areas went without power.

Federal Actions

The U.S. Department of Energy and the White House have also been working in new energy technology.

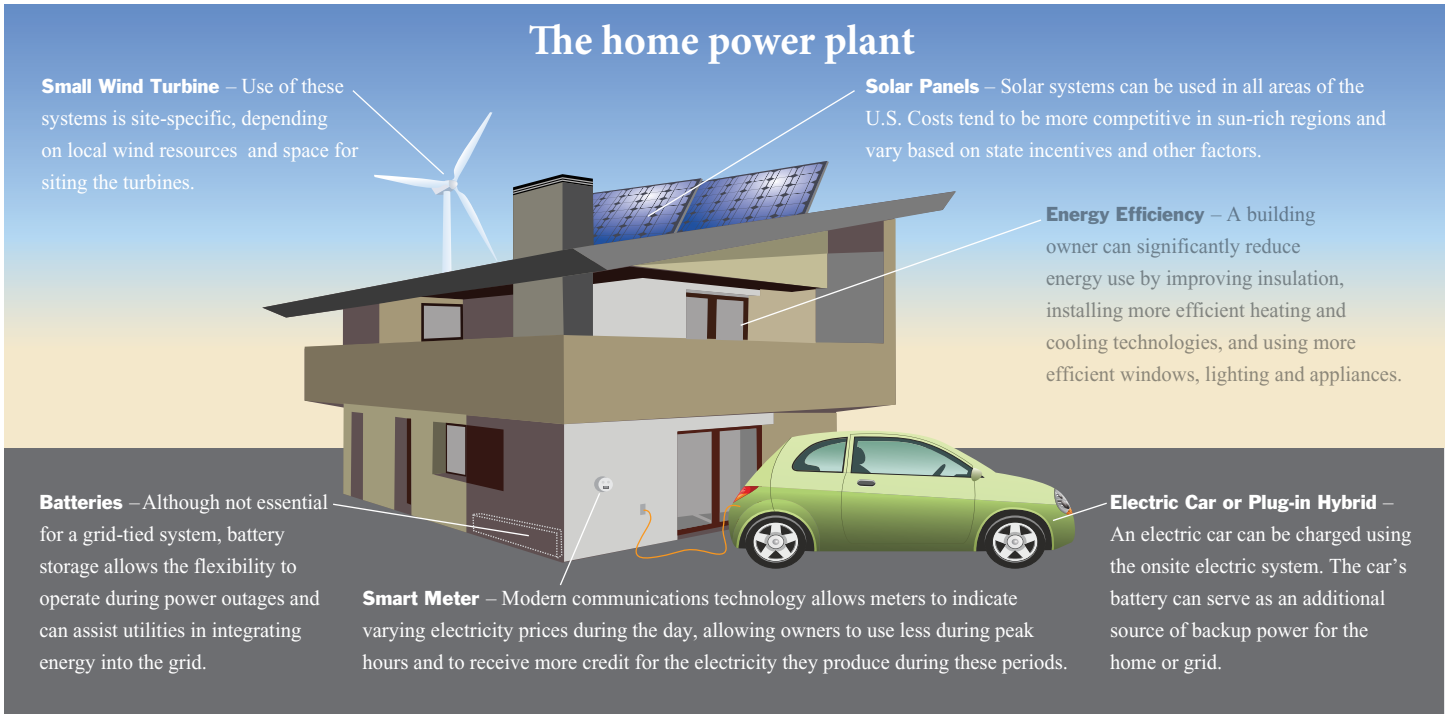
- Since 2009, the U.S. Department of Energy has managed a $7.8 billion grant program to promote smart grid technologies.
- In 2012, the energy department created a $120 million Center for Energy Storage Research, combining the research capabilities of five national laboratories, five universities and four private firms to improve battery performance.
- In 2013, the department set aside $60 million to support innovative solar energy research.
- In August 2013, solar panels were installed on the roof of the White House.
- In August 2013, the energy department proposed rules to improve efficiency standards for commercial refrigeration equipment and walk-in coolers and freezers, and in October released regulations for conserving energy from consumer and residential heating and cooling products.
- In September 2013, the U.S. EPA proposed rules for limiting carbon dioxide emissions from future power plants and will propose regulations for existing plants this June.
- In December 2013, the president directed the federal government to use renewable energy sources for at least 20 percent of the electricity it consumes by 2020.

—Ben Husch

Abundant Natural Gas: Catalyst for Change

Accelerating technological advances and recent developments may result in a seismic change in the electricity market, similar to what began in the telecommunications industry 15 years ago. Few had any idea cell phones would replace the wired telephone, while becoming profoundly more useful and powerful. And just 10 years ago, it was inconceivable the United States would become one of the world's largest producers of natural gas.

The nation's pioneering work in natural gas extraction has opened up vast amounts of previously inaccessible reserves and shaken the electric industry. The country's wealth of natural gas suggests prices may continue



Power Words

Electric Power Grid: The network of power lines, transformers and electrical components that transmit and distribute power from power plants to electricity users.

Smart Grid: An electric grid that uses information and communications technology to deliver electricity more efficiently and reliably, adapting to consumer behavior and integrating new technologies such as energy storage.

Distributed Generation: Power-generating technologies—such as rooftop solar, natural gas micro-turbines and small wind turbines—located at the site where the electricity is consumed.

Micro-Grid: A small version of the larger power grid that distributes locally produced energy and can operate independently. A hospital with a combined heat and power system can operate as a micro-grid, for example.

Decoupling: A state regulatory approach that ends the correlation between a utility's profits and the amount of power it sells. The aim is to decrease the utility's resistance to customer-sited energy efficiency and distributed generation.

to be very competitive for at least the next few decades. Lower capital costs and emissions have made gas an attractive choice, while plans for new coal plants are being cancelled and older plants are retired. Cheap natural gas is also putting the squeeze on nuclear energy.

Less expensive gas also puts pressure on wind and solar, although it has an upside for these technologies, making them cheaper to integrate into the electric grid. New gas plants can be more easily adjusted to follow the electricity production of wind and solar, which can vary depending on the time of year and the weather. Looming EPA carbon standards also favor gas over coal and make distributed generation technologies, which are often highly efficient or have low or no emissions, more attractive. Further, low-cost gas makes it easier for business and industry to make their own electricity with CHP or natural gas generators, possibly at lower cost than buying it from the utility.

Time for a Change?

The regulatory structure in most states often makes utilities focus on the business of selling electricity, giving them little or no incentive to embrace energy efficiency and technologies—such as combined heat and power systems—that reduce their sales. This puts their goals at odds with those of many policy makers, businesses and consumers. Utilities also have substantial infrastructure costs, regardless of energy sales. If recession or increased efficiency reduces sales, utilities must raise rates to cover their fixed costs. "Utilities do have concerns about the impact of distributed generation on their business models. Policymakers should listen to those concerns," says Morgan.

To address the conflicting goals of utilities, lawmakers and customers, some policymakers are exploring ways to move away from the consumption-based regulatory model. A handful of states with strong efficiency and distributed generation policies have broken the link between profit and the amount of energy sold through a policy called "decoupling." This allows utilities to pursue aggressive energy efficiency programs without the fear of losing money due to decreased sales. Some states, such as Massachusetts, also allow utilities a higher rate of return if they meet energy efficiency, renewable energy, reliability or customer service goals. Decoupling allows utilities to focus on investments that keep ratepayer costs low, such as efficiency and demand reduction. But decoupling can shift the risks of weather

and economic downturns to consumers. Fourteen states now have some degree of electricity decoupling in effect.

Other solutions include adjusting rates to compensate utilities when they lose revenue due to efficiency and distributed generation, an approach allowed in 18 states.

One of the challenges of distributed generation is determining the value of the grid system that supports it. Most small energy producers, including CHP and rooftop solar owners, rely on the grid as backup or to transmit the energy to where it's needed, if it is not used on site.

In states such as Arizona and Colorado, utilities are pushing back against state net-metering rules that require utilities to credit owners of rooftop solar for the energy they produce. "The tension on this issue is between making sure customers with distributed generation capacity are compensated for the value of the energy they produce while ensuring they pay their share of the fixed costs utilities have from providing reliable electricity to all customers in their service area," says Morgan. Part of the solar legislation he helped author asks the Minnesota Department of Commerce to work with utilities and the Public Utilities Commission to determine fair compensation for rooftop solar producers.

These may be early signs that distributed technologies pose a threat to utilities under the current utility regulatory model in many states. One day, a good portion of the energy we consume could be produced on-site or within a number of integrated micro-grids, while some users may opt for stand-alone power systems. Just as cell phone technology transformed the communications sector, these developments could turn the centralized energy model upside down.

"This period of transition from a traditional utility to one in which there is two-way communications, customer generation options, and opportunities for third parties to engage in traditional utility-customer interactions will be difficult for all parties, including legislators," says Representative Sloan. "Once technology and customer expectations raise new preferences, it is impossible to go back. The utilities that thrive in the future will be those that can manage their systems and customer desires effectively; the rest will be acquired by the successful utilities or slowly succumb to third-party innovators."