Current Concerns

We are on the verge of a new era in electricity generation and consumption.

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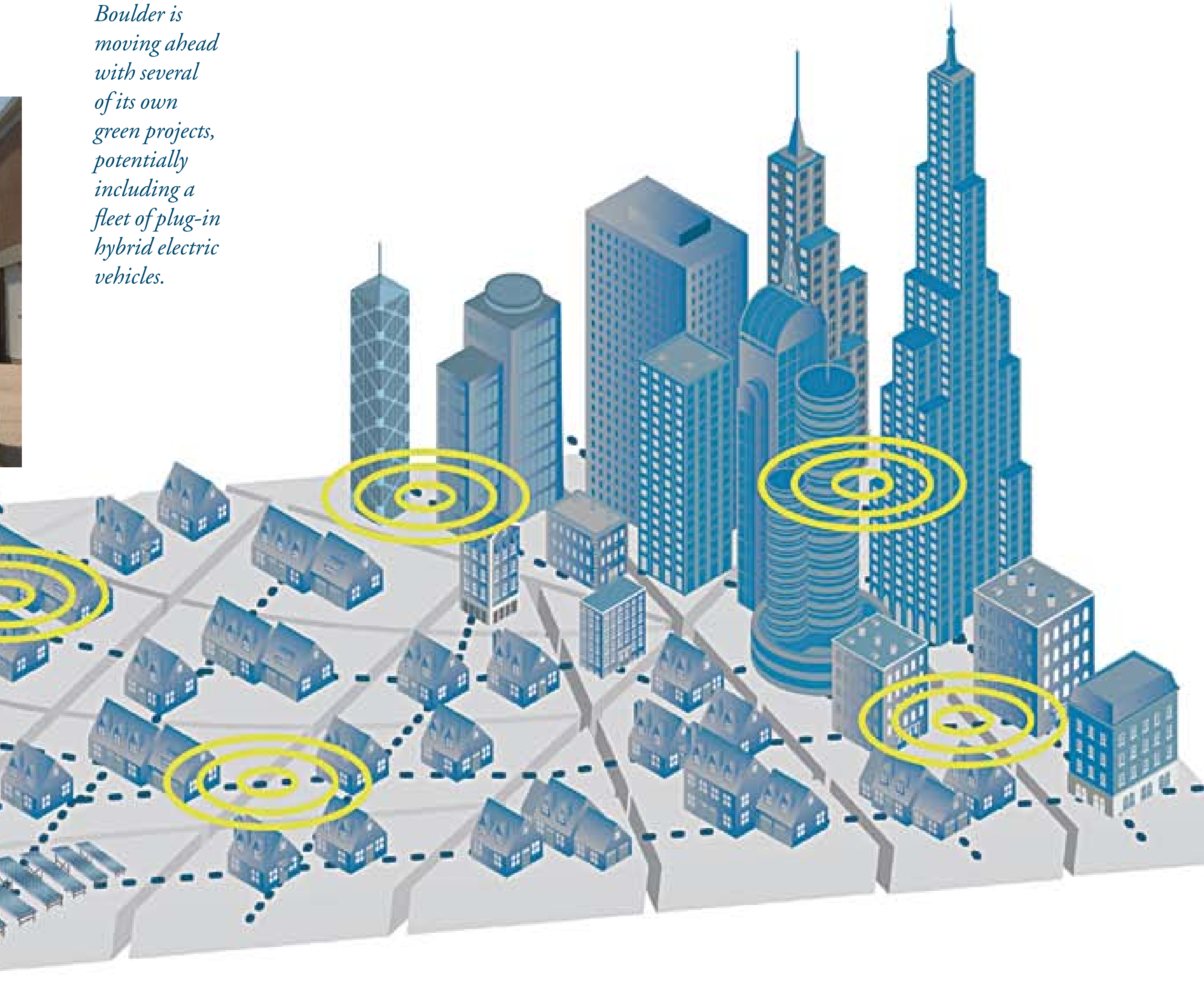

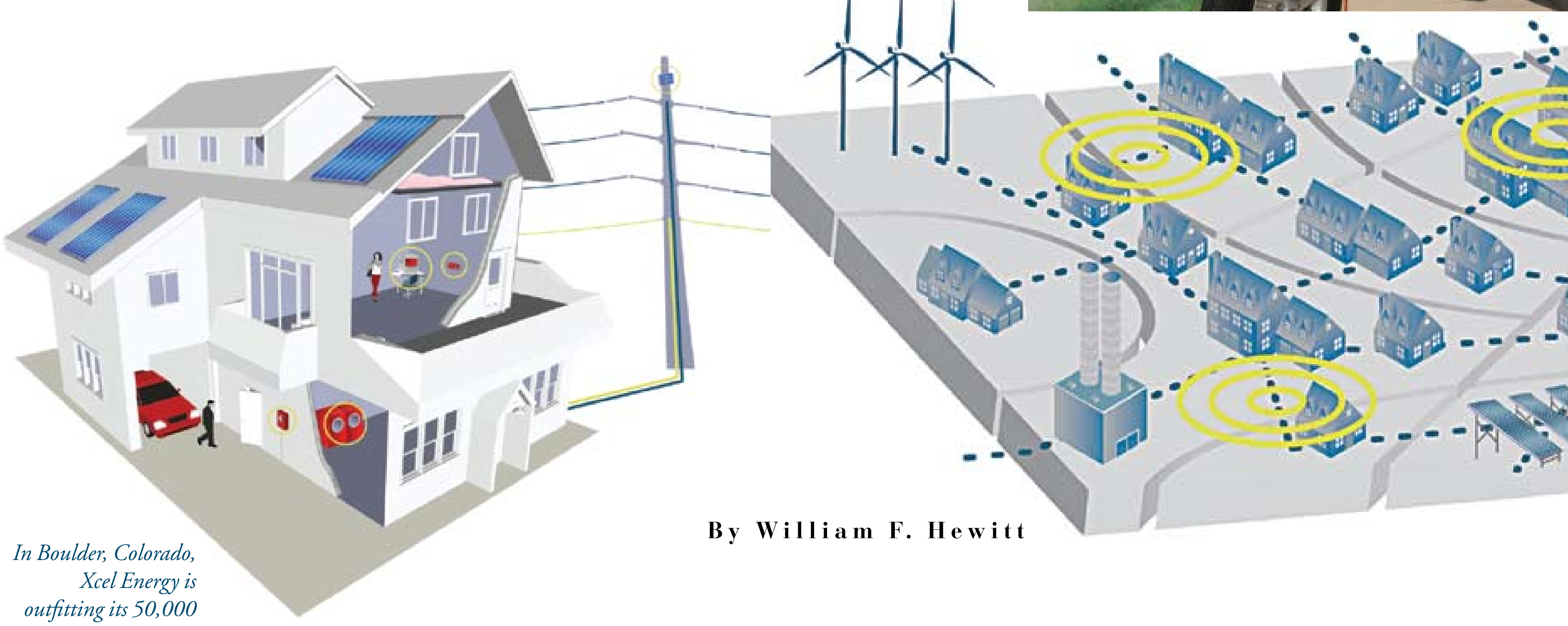

Art this spread courtesy Xcel Energy

In Boulder, Colorado, Xcel Energy is outfitting its 50,000 customers with the components needed for a SmartGridCity system. Key to the system are smart meters—allowing automated meter reading—and more precise power flows.

By William F. Hewitt

Electricity is poised to get cleaner, cheaper, more easily managed, more reliable, and more secure. In the U.S. and elsewhere, we are entering the age of the "smart grid."

Some of the major components already exist: central generating stations powered by coal, natural gas, nuclear power, or water; nearly 160,000 miles of high-voltage transmission lines; and hundreds of thousands of miles more of lower voltage distribution lines. But beyond these familiar elements of the old system new ones are looming: massive wind farms sprouting up in the Great Plains from Minnesota to Texas; cogeneration plants supplying both heat and electricity with more than double the efficiency of central power stations; green buildings with remarkably low power demand, many deploying on-site power from solar photovoltaic arrays; and demand-response systems that help utilities manage peak loads.

Also on the horizon are geothermal, tidal, wave, and concentrated solar power plants; digital metering, wireless sensors, and other devices to measure and moderate energy use; high-speed communication linkups and computers to connect these diverse elements; and sophisticated software to manage it all.

The smart grid is being researched, tested, and rolled out now. Several other names are associated with it, including the energy internet, the connected electronet, the modern grid, and IntelliGrid. Regardless, various players are working on the same concept: a deeply interconnected electrical power grid that enables both suppliers and consumers of electricity to communicate, manage power, ease stresses, and, in many ways, to make our energy consumption cleaner and less costly. To physically implement the smart grid, much of the existing infrastructure will be used, but hardware like meters will be replaced, and upgrades to substations, transmission lines, and other infrastructure need to happen. That could cost as little as $600 billion or as much as $1 trillion, depending on whom you ask.

Completely plugged in

In Boulder, Colorado, the smart grid has already arrived. Xcel Energy—the regional power company—and its industry partners are working with the city to put in place all the components necessary to tie 100 percent of Boulder's 50,000 residential, commercial, light industrial, and institutional consumers into the new SmartGridCity system. Xcel calls this "an important milestone in a nationwide industry effort to modernize the aging power grid."

Smart meters will allow two-way communication between the customer and the utility, enabling automated meter reading and a more detailed history of energy use. Some 90 percent of the two-way communication will use broadband over power lines, while the rest will be done wirelessly.

Distribution infrastructure is also being upgraded to enable system monitoring and automation to regulate power flow much more efficiently. Operators will be able to manage demand more quickly and easily, and the utility will be able to do better analysis because of the quality and depth of information it will have. Similarly, customers will have web-enabled access to information and analysis, and they will be able to control their use. An Xcel video describes the new system as a "neural net" allowing "multidirectional conversations" among users, generators, and distributors of electricity.

Some of Boulder's recent initiatives helped make it a lab for the smart grid. In 2002, the city council decided to reduce the city's carbon footprint. A year later, it began exploring the possibility of a municipal utility to foster energy efficiency and the use of renewables. Xcel, Boulder's principal supplier of energy, wanted to keep Boulder in its service area *and* help it achieve its goals.

"We wanted renewables, conservation, efficiency, reliability, and rate stabilization to support our economic vitality," says Kara Mertz, assistant to the city manager and the point person for Boulder's smart grid. "The smart grid demonstration would help us achieve these objectives without incurring the risk of creating our own utility."

Boulder is moving ahead with several of its own projects to exploit the smart grid's potential. Twenty city facilities are being audited with an eye to optimizing energy management, including using renewables for on-site generation. The city is also looking into a large-scale renewable project. Meanwhile, Boulder residents and businesses are taking advantage of federal tax credits and rebates from Xcel to install solar collectors.

In addition, the city wants to develop a fleet of plug-in hybrid electric vehicles (PHEVs), a natural complement to the smart grid. Xcel is even outfitting a smart home for the chancellor of the University of Colorado. "We have the kind of businesses and residents who will accept the fits and starts of technology innovation," says Mertz.

The modern meter

In Indiana, Duke Energy wants to roll out 800,000 smart meters over the next five years. These meters will allow the utility's customers to participate in a number of energy-saving programs, thus enabling Duke to reduce voltage. That lower demand increases reliability by reducing stress at peak times—peak power is much more expensive for the utility. The total energy savings could be enough to power 40,000 households. After Indiana, Duke will expand the program to the other states it serves—North Carolina, South Carolina, Ohio, and Kentucky—ultimately offering smart meters to all of its four million customers.

After Hurricane Ike devastated coastal areas of Texas this September, it roared into the Ohio Valley, knocking out power for well over a million customers, many of whom are in Duke's service areas. One of the principal rationales for the smart grid is that it will make utilities more reliable by automating the rerouting of power to impacted areas, thus letting them respond more quickly to power outages.

Todd Arnold, Duke's senior vice president for the smart grid and customer assistance, is one of those who call the smart grid an "energy internet." Aside from the enhanced system reliability and ability to foster conservation, the smart grid will make the uptake of distributed energy resources, or distributed generation, easier.

"Net metering" is integral to these efforts because it allows customers with smart meters to sell the power they've generated on-site back to the utility. When they need power, the same customers take it from the grid. Duke is working with the state of North Carolina to develop siting criteria and zoning regulations to help get these sorts of resources up and running.

Arnold also says the smart grid is great at amassing data. This will be very important in load forecasting and resource planning. The smart grid is "just as much about more data and control as it's about new wires," he says.

Grid unlocked

Working behind the scenes, the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability is sponsoring an effort called the "Modern Grid Strategy." Steve Pullins, president of the Horizon Energy Group—a firm based in Bloomington, Illinois, with public and private clients in the energy industry—leads the team creating that strategy. The goal, as Pullins explains it, is "formatting an actionable plan to modernizing the grid—with intelligence."

According to the DOE, the U.S. has 960 gigawatts of electrical generating capacity connected to the grid, but we only use, on average, 440 on any given day. We have to draw on extra power during peak times. The regulatory requirement for reserve capacity margin—how much extra power you must have available during peak times—runs from about 15 to 22 percent. In other words, our total capacity is more than double what we need—a highly inefficient and costly situation. Pullins calls the reliance on massive overcapacity a "bad habit" and says the smart grid offers users more options so they can break that habit.

One of the principal reasons why we're operating this way is because our grid architecture works in one direction: generation to transmission to distribution. If our grid allowed a two-way flow, things would be different. We could not only manage demand more efficiently, but we could use the massive amount of backup power that is currently in place.

According to Pullins, 78 percent of all businesses in the U.S. have backup power—to the tune of 220 gigawatts daily. Add that to the 440 GW in average use and you get far more than you need to meet peak demand. In other words, bring that idle 220 GW of backup power online to meet peak needs and you offset expensive peak generating plants. In the end, as Pullins describes it, you "wouldn't have to replace retiring generating plants." You obviate the need for more transmission, distribution, and generation assets. You can build less infrastructure.

In a business-as-usual scenario, the electric power industry estimates the need to spend about $1 trillion in the next 20 years in the U.S. The Electric Power Research Institute and others, however, estimate that with the full deployment of smart grid technology that figure would drop to $600 billion. Pullins cites studies in four states that confirm the possibility of these savings.

Ready to invest

Last April, DOE announced $50 million in funding for nine demonstration projects for Renewable and Distributed Systems Integration technologies. There were many more proposals than expected, showing that the industry and its partners were willing to commit at least $500 million of their own funds for these projects. The industry, according to Pullins, is "ready to invest."

One of these RDSI projects involves Consolidated Edison, serving downstate New York. Con Ed is working with Verizon, the telephone giant, to bring some idle backup capacity into play during peak hours. Verizon has massive two-megawatt diesel generators, and part of the project is to evaluate the effectiveness of using these when needed. Beyond this, the RDSI demonstration will attempt to "integrate new hardware, software, and administrative protocols to create a virtual power plant that can safely distribute third party customer power into Con Edison's network system."

Arthur Kressner, Con Ed's director of research and development for power supply, is looking beyond even this peak load project. He sees the various key components of transmission, distributed generation, storage, load management, efficiency, and renewables as integrated into a "connected electronet." Con Ed has one of the most reliable systems in the country, performing at a level seven times above the national average, according to an independent rating group.

Kressner notes that sophisticated modeling, sensors, and information technology have made this reliability possible, and that the coming smart grid revolution will further deepen the security and reliability of utilities nationwide.

What is driving the move to a modernized grid infrastructure? One important factor, as we've seen, is the need for greater reliability. Developed economies—and their underlying information technology—increasingly rely on electricity. That's one of the reasons why the heaviest hitters in the industry, companies like Dell, HP, Microsoft, Google, and Intel, formed the Climate Savers Computing Initiative in 2007. The aim is to save $5.5 billion in energy costs and reduce greenhouse gases by 54 million tons a year by 2010. Managing power is of paramount concern to these companies.

There is also a great deal of business to be done in helping to build out the smart grid. IBM, Accenture, and scores of other large and mid-sized information technology companies are developing smart grid applications.

Below: a thermostat that is part of a smart metering system. Bottom: images from the U.S. entry to the International Competition for Sustainable Urban Designs.

Xcel Energy

The specter of global climate change is another reason to modernize the grid. Businesses, states, cities, and slowly, the federal government, are seeing what many environmentalists have seen for a long time: Our energy use has to change not only to mitigate global warming, but also to avoid the economic impacts. The British *Stern Review on the Economics of Climate Change*, published in 2006, estimated that damage from climate change could approach that of the Great Depression or World War II.

Smart infrastructure

Jesse Berst, the executive editor of *SmartGridNews.com*, calls the world's exploding demand for electricity an "accidental addiction"—an unintended consequence of forces like population growth and computerization.

Berst predicts that the winners of the 21st century will be those with reliable and green energy. The "cornerstone of the infrastructure will be the smart grid," he said in an interview. He calls the whole framework of renewables, energy efficiency, storage, demand response, microgrids, green building, and even surface transportation tied to the grid the "global smart infrastructure."

"Microgrid" refers to the small community networks that generate, store, and distribute their own energy. Sometimes they sell excess energy to the utility grid and draw from it when necessary. Microgrids, Berst points out, are being built by large institutions, military bases among them, and are proposed in places like Stamford, Connecticut. The Connecticut state legislature has looked at this concept, as has the U.S. Conference of Mayors. Working with Pareto Energy, the mayors organization is looking at creating "energy independence districts."

This sort of approach also furthers one of the desirable outcomes pinpointed by the Modern Grid Strategy: building less infrastructure. Berst says that planners are going to be seeing much more of this drive to local self-reliance.

The U.S. Conference of Mayors has also formally endorsed the goals of the GridWise Alliance, a consortium of public and private stakeholders and the U.S. Department of Energy.

The city of Chula Vista, in San Diego County, California, is serving as a demonstration site for much of the innovative GridWise technology that is being proposed. The National Energy Center for Sustainable Communities is a public-private partnership that will steer the Chula Vista initiative and monitor and measure what happens there.

Doug Newman, the director of the NECSC and a planner by training, emphasizes the need for research that will help meet the challenges of creating sustainable communities. How do people shop, move, and use energy at home, work, and school? When you have the answers to these sorts of questions, you can optimize design, says Newman. He is working with the British Petroleum Urban Energy Systems project at the Imperial College London to develop urban energy modeling tools.

As more and more consumers and communities call for distributed generation, renewables, and other sustainable energy choices, it will be incumbent on planners to know about all the many available choices and developments in the field. As Ingrid Kelley, chair of APA's Environment, Natural Resources, and Energy Division, notes, "All sustainability issues have an energy component." Kelley is a project manager at the Energy Center of Wisconsin, where she is involved in "integrating energy strategies into community smart growth planning."

With the coming of the smart grid, the chances are good that more planners will have similar jobs in the future.

Bill Hewitt is a writer specializing in sustainability issues. He blogs on climate change for the Foreign Policy Association and is the principal of Hewitt Communications.

Resources

From APA. For more on distributed energy, see "With the Power at Hand," July 2006. The APA Policy Guide on Energy is at www.planning.org/policyguides/energy.htm.

Online. The Smart Grid Newsletter can be found at www.smartgridnews.com. DOE's Office of Electricity Delivery and Energy Reliability: www.oe.energy.gov/smartgrid.htm. GridWise Alliance: www.gridwise.org. National Energy Center for Sustainable Communities: www.necsc.us. National Energy Technology Laboratory's Modern Grid Strategy: www.netl.doe.gov/moderngrid. Xcel Energy and Boulder's Smart Grid initiative: http://birdcam.xcelenergy.com/sgc/news/index.html.

In print. *Energy in America: A Tour of Our Fossil Fuel Culture and Beyond*, by Ingrid Kelley, is available from the University Press of New England at www.upne.com.

Art this row: National Energy Center for Sustainable Communities

Proposed energy-efficient home of the future.

Resource management center (left); future business district (below).