Connected and Sustainable Energy

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by the Cisco Internet Business Solutions Group

Overview

Energy, especially electricity, drives the world economy. It lights our homes, powers our factories, runs our technology, and could soon fuel our vehicles. Electric power, however, is facing major challenges. Demand for electricity will likely exceed available supply over the next 25 years. Electricity creates more greenhouse gases than any other source, including transportation, manufacturing, and agriculture. Aged equipment used to produce and distribute electricity suffers from years of underinvestment. The result is an inefficient electricity generation and distribution system that converts only one-third of the total energy it consumes into useful electricity.[1] That equals 1.5 billion metric tons of CO2 emissions wasted during the production and delivery of electricity in the United States each year—equal to 250 million automobiles[2]—not to mention the subsequent waste in how we consume electricity once it reaches our homes, offices, schools, and factories.

Recognizing these inefficiencies, the energy community is starting to marry information and communications technology (ICT) with renewable energy to improve how electric power is generated, delivered, and consumed. Technology allows the electric grid to become "smart." Near-real-time information enables utilities to manage the entire electricity grid as an integrated system—actively sensing and responding to changes in power demand, supply, costs, and emissions across the grid. Also, better information lets consumers manage their own energy use more effectively. As former U.S. Vice President Al Gore has pointed out, "Just as a robust information economy was triggered by the introduction of the Internet, a dynamic, new, renewable energy economy can be stimulated by the development of an electranet or Smart Grid."[3] The main principles of a Smart Grid include:

- **Demand Management:** Reducing electricity consumption in homes, offices, and factories. Demand Management includes:
  - *Demand Response:* During emergency periods of peak energy usage, utility companies send electronic messages to alert consumers about reducing their energy consumption by turning off (or turning down) unessential appliances.
  - *Smart Meters and Variable Pricing:* In many areas, electricity prices rise and fall based on demand at that moment. "Smart meters" let consumers shift energy consumption from high-priced periods to low-priced periods (load shifting and shedding).

1. Annual Energy Review, 2006, Page 221 (page 2 of Section 8), "41 quadrillion BTUs of raw energy are consumed to generate 13 quadrillion BTUs of usable electricity," Energy Information Administration, U.S. Department of Energy (http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8.pdf)
2. The average car (in terms of fuel economy) driven the average number of miles per year (15,000) produces approximately 13,000 pounds of CO2 annually (http://www.weathervane.rff.org/solutionsandactions/United_States/Federal_Approach/Combating_Global_Warming_One_Car_at_a_Time.cfm).
3. Al Gore speech at NYU Law School, September 2006 (http://thinkprogress.org/gore-nyu)

- *Smart Buildings with Smart Appliances:* Traditional, stand-alone building control systems are now converging onto a common ICT infrastructure that allows appliances (heating, ventilation, air conditioning, lighting, and so forth) to “talk” to each other, coordinating their actions and reducing waste.
- *Energy Dashboards:* Online energy dashboards provide real-time visibility into energy usage while suggesting ways to reduce consumption.

- **Distributed Energy Generation:** Encouraging homes and businesses to install their own renewable energy sources. Distributed Energy Generation includes:
  - *“Microgeneration”:* Some homes and offices generate their own electricity locally using small equipment (wind generators, photovoltaics, fossil-fuel generators with heat reclamation). Many of these devices are now as affordable as energy from utilities, and produce 50 percent less greenhouse gases.
  - *Storage and Hybrid Electric Vehicles:* Owners of plug-in hybrid electric vehicles (PHEVs) can buy energy when it is inexpensive, store it in batteries, and sell it back to the grid when the price goes up. PHEV drivers hope to arbitrage the cost of power, while utilities see fleets of PHEVs supplying power to reduce peaks in demand.
- **Supply-side Efficiency:** Using IT to improve control of the electric distribution grid. Supply-side Efficiency includes:
  - *Grid Monitoring and Control:* Utilities are installing sensors to monitor and control the grid in near real time to detect faults earlier and provide time to prevent blackouts.
  - *Grid Security and Surveillance:* Utilities are installing surveillance sensors to monitor and secure unmanned, remote equipment that is vulnerable to terrorism.

Connected Urban Development Perspective

Worldwide demand for electric energy is estimated to rise 82 percent by 2030[4]. Unless revolutionary new fuels are developed, this demand will primarily be met by building many new coal and natural gas electricity generation plants. Not surprisingly, world carbon dioxide emissions are estimated to rise 59 percent by 2030[5] as a result.

Building a technology-enabled electricity grid can help offset some of this increase in energy usage and CO2 emissions, while improving reliability. For example, such a grid would have the ability to:

- Reduce peaks in power usage by automatically turning down appliances in homes and offices

4. International Energy Outlook, 2007, Energy Information Administration, U.S. Department of Energy, Figure 6, “World net electricity generation grows by 85 percent in the IEO2007 reference case, from 16,424 billion kilowatt-hours in 2004 to 22,289 billion kilowatt-hours in 2015 and 30,364 billion kilowatt-hours in 2030” (http://www.eia.doe.gov/oiaf/ieo/highlights.html)
5. International Energy Outlook, 2007, Energy Information Administration, U.S. Department of Energy, Figure 6, “World carbon dioxide emissions continue to increase steadily in the IEO2007 reference case, from 26.9 billion metric tons in 2004 to 33.9 billion metric tons in 2015 and 42.9 billion metric tons in 2030, an increase of 59 percent over the projection period” (http://www.eia.doe.gov/oiaf/ieo/highlights.html)

- Decrease waste by providing instant feedback on how much energy is being consumed
- Encourage home and business owners to install their own renewable sources of energy
- Encourage manufacturers to produce "smart" appliances to reduce energy use
- Delay construction of new electricity generation and transmission infrastructure

From a city's perspective, this cuts annual costs to operate city-owned facilities, reduces energy costs to attract and retain private industry, decreases residents' energy costs, and lowers overall greenhouse gas emissions and related health costs.

Many of the technologies needed to create a smart electric grid are already available today. Forward-looking utilities across Europe and the United States are already offering Demand Response technologies to help millions of customers reduce their energy usage.

Discussion Points

1. How can utilities, developers, technology providers, and city governments work together to promote adoption of Smart Grid concepts?
2. What can be done to accelerate needed standards-setting for Smart Grid technologies?
3. What is the right balance between incentives and regulation to drive Smart Grid adoption?
4. What role can governments play in encouraging microgeneration investments on the part of consumers, and acceptance of microgenerated electricity by utilities?

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