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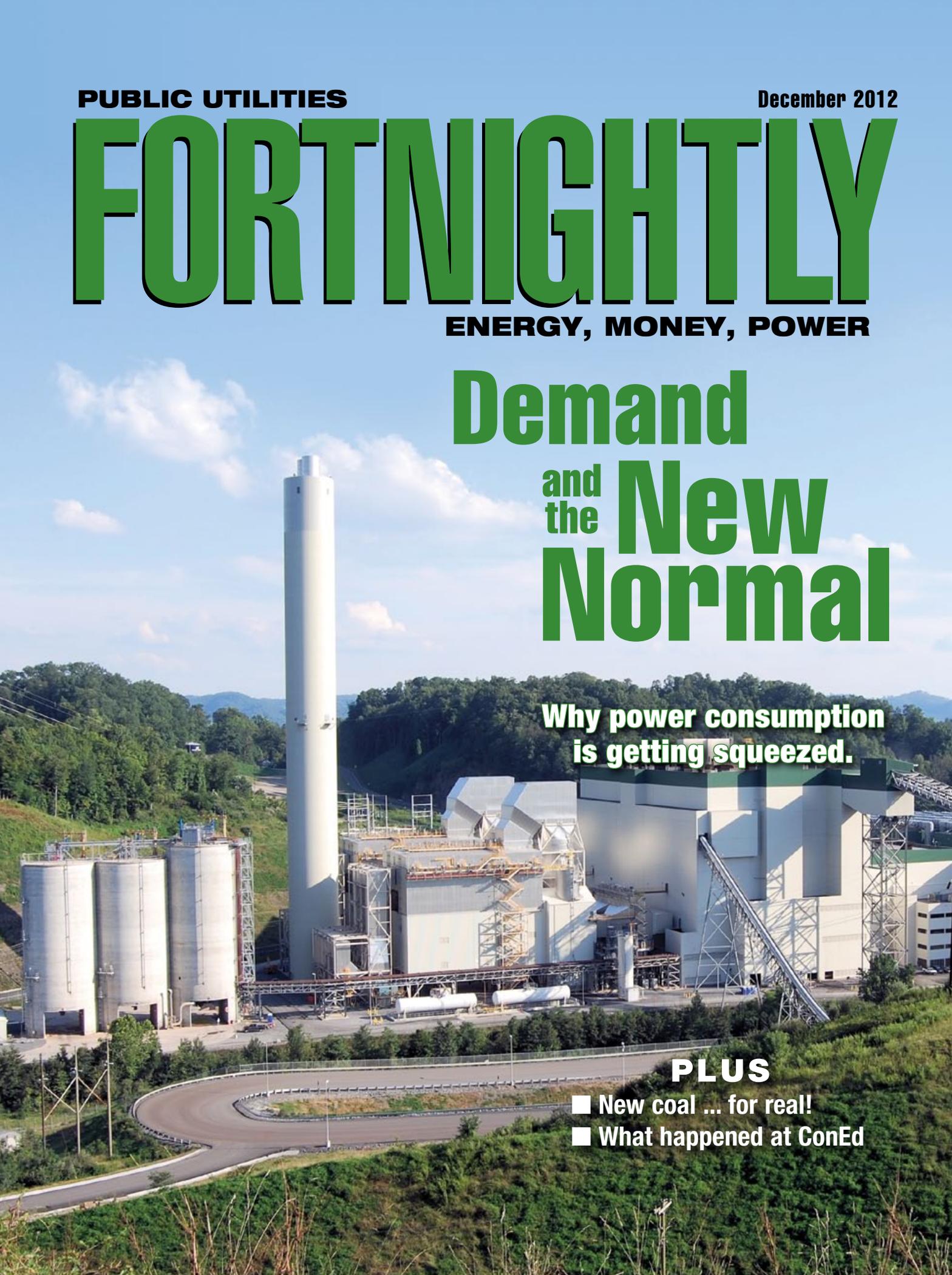
ENERGY, MONEY, POWER

Demand and the New Normal

**Why power consumption
is getting squeezed.**

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Demand Growth and the New Normal

Five forces are putting the squeeze
on electricity consumption.

BY AHMAD FARUQUI AND ERIC SHULTZ



demand for electricity has plummeted since the onset of the recession in December 2007. And while the recession ended 18 months later, the slowdown in growth has persisted. It's tempting to attribute the slowdown in growth to the recession, but that would be wrong.

The distribution of electricity sales growth—two-decade intervals—presented in Figure 1 shows that demand growth has been declining since 1950, from an average annual electricity sales growth rate of 9.86 percent during the '50s to an average annual growth rate of 0.85 percent in the first decade of the 21st century. To some extent, a slowdown in population growth since 2009 might be blamed for a slowdown in demand growth. However, after rising in the 1990s from around 11,000 kWh to 12,000 kWh, per-capita consumption has flattened off. On an aggregate basis, according to the U.S. Energy Information Administration, total delivered electricity use in the all sectors is predicted to increase at an annual growth rate of 0.7 percent per year from 2010 through the year 2035.

The agency also expects electricity consumption per U.S. household to decline in this time frame. The commercial sector will lead growth through 2035, mirroring the de-industrialization of the economy. As shown in Figure 2, cumulative growth will come in at 18 percent in the residential sector, 28 percent in the commercial sector, and 2 percent in the industrial sector. Long-term forecasts of peak demand growth are also on a downward trajectory. In the last decade, according to the North American Electric Reliability Council (NERC), the projected growth in summer peak demand has declined each year, from 1.79 percent in 2002 to 1.23 percent in 2011. After the recession in 2008, we experienced the biggest absolute decrease in growth, from 1.5 percent in 2009 to 1.23 percent in 2008. But the recession isn't the only main force behind this decrease in growth. Five primary forces are creating the new normal: the weak economy; demand-side management; codes and standards; distributed generation; and fuel switching all play major roles. In addition, there are secondary forces such as other energy efficiency policies—*i.e.*, state-specific energy efficiency portfolio standards; and natural competition between manufacturers, which further boosts energy efficiency of products. Such forces dampen demand growth as well.

A Weak Economy

While the 2008 and 2009 economic recession was met with an expected drop in electricity demand, the subsequent tepid recovery has been paired with a slow growth in demand. Electricity demand is specifically tied to economic recovery, as the “pace and shape” of economic recovery will dramatically influence electricity demand. As stated in NERC's 2011 Long-Term Reliability Assessment:

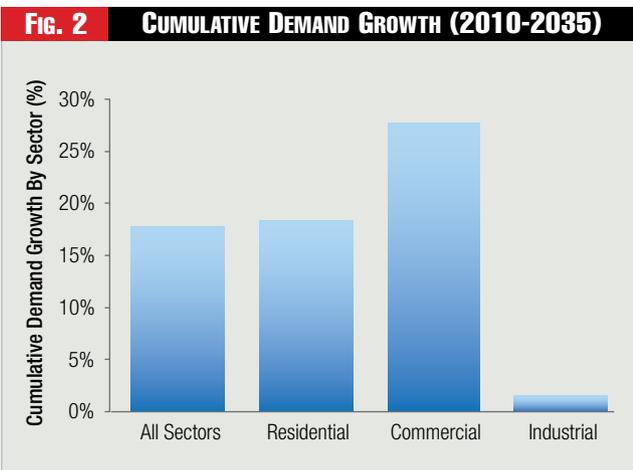
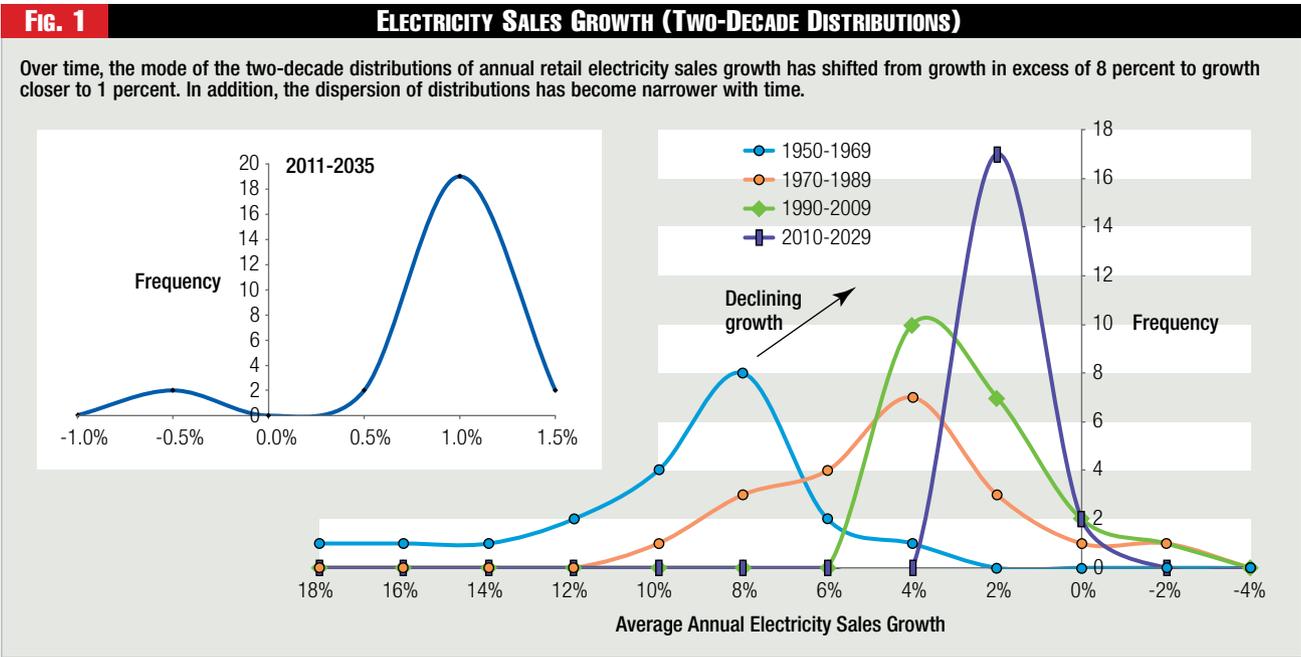
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Demand growth has been slowing since 1950, from nearly 10 percent a year during the '50s to less than 1 percent today.

Largely unpredictable economic conditions resulted in a degree of uncertainty in the 2009 and 2010 demand forecasts not typically seen in periods of more stable economic activity. It is vital that the electric industry maintain flexible options for increasing its resource supply in order to respond effectively to rapid, upward changes in forecast electricity requirements and any unforeseen resource development issues.”

Some of the recessionary impacts might be permanent. In an effort to cut operational costs to maximize profits, businesses have relocated offshore. Some industrial facilities have closed completely. Right now, people are unemployed, underemployed, or underpaid, thus reducing electric consumption and the purchase of electricity-consuming appliances. The tepid recovery has led to a new psychology of frugality and pessimism about the prospects for the U.S. economy. Such a decrease in consumer confidence, a major driver for consumption, has led to the inevitable drag on consumer spending. Demand forecasters find that even after they put actual economic growth rates in their models and analyze past results, they're still over-estimating demand; consumer demand curves apparently have shifted inwards as consumers engage in belt-tightening. Considerable uncertainty remains over the global and national economy, which will continue to weigh down on demand growth. The recently issued report by the International Monetary Fund (IMF) estimates the U.S. risk of recession in 2013 at 15 percent, and warns that, “U.S. legislators must soon remove the threat of the fiscal cliff and raise the debt ceiling. If they fail to do so, the U.S. economy could fall back into recession.”

“With greater uncertainty in future electricity use attributed to the recent economic recessions, continuously updating demand forecasts are essential to the planning process. Furthermore, the pace and shape of economic recovery will dramatically influence demand growth across North America in the next 10 years.



Source: U.S. Energy Information Administration, Annual Energy Outlook 2012 with Projections to 2035, June 2012

55,000 MW, or 4.5 percent of the on-peak resource portfolio. Other estimates are even more optimistic about DSM. In 2010 The Brattle Group polled 50 experts to get their forecasts of demand response and electric energy efficiency savings. The survey indicated that demand response is expected to reduce peak demand by between 7.5 and 15 percent by the year 2020. Dynamic pricing is rolling out, spurred on by pilots and rapid smart meter deployment. California leads the charge, where two major utilities—San Diego Gas & Electric (SDGE) and Southern California Edison (SCE)—currently have approximately 3.8 million customers on critical peak rebate (CPR) or peak time rebate (PTR) rates. Under these programs, utilities specify “peak event” days on which customers are paid a rebate for electricity saved during the designated peak period.

Demand-Side Management

The increased penetration of demand-side management (DSM) throughout the United States has put downward pressure on demand growth. DSM programs and technologies enable consumers to reduce peak demand and electric energy consumption by providing customers with incentives to buy more energy efficient technologies and to shift demand from peak hours—where the power grid is stressed due to high demand—to off-peak hours. Such peak hours occur during periods of hot weather, for example, when customers crank up air conditioning units. DSM programs often encourage this shift in demand through monetary savings in the form of peak time rebates or other dynamic pricing schemes. These pricing schemes set electric prices highest during peak hours where demand is highest, and prices lowest during off-peak hours where demand is lower.

All areas in NERC’s forecast are expecting increases in DSM over the next 10 years. In 2021, DSM is projected to reach

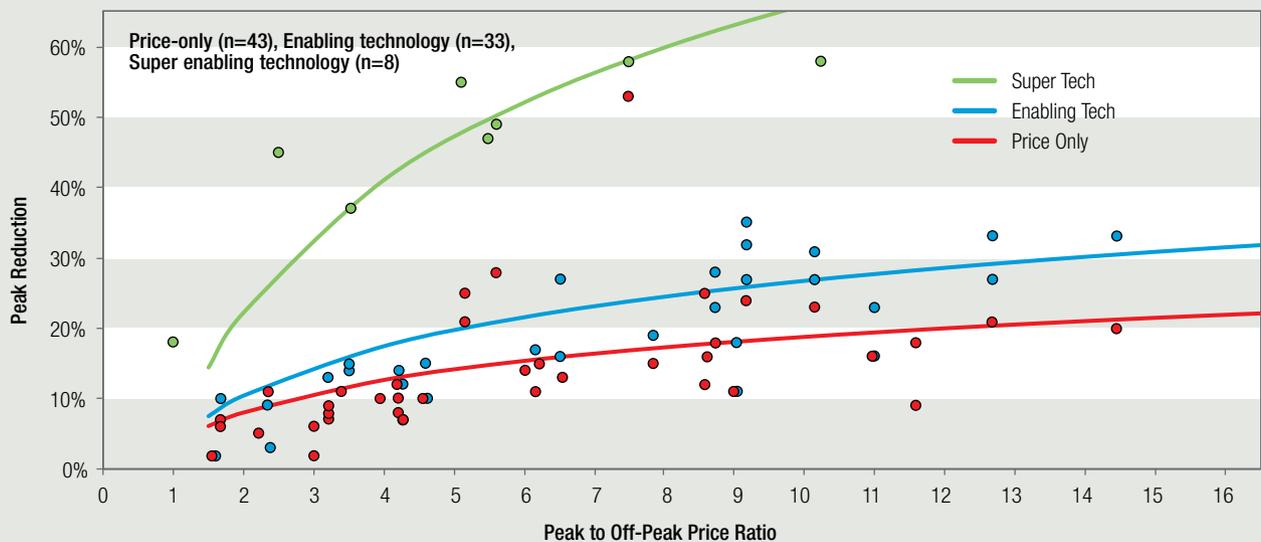
The results of similar programs around the world are illustrated by data from dynamic and time-of-use pricing pilots. Figure 3 plots the arc of price responsiveness—*e.g.*, demand response as a function of the ratio of peak to off-peak prices. The amount of demand response rises with the price ratio, but at a decreasing rate. When the data are regressed, about half of the variation in demand response can be explained by variations in the price ratio. This result is remarkable because the programs differ in many factors, from regional climate to marketing approach. (See Ahmad Faruqui and Jenny Palmer, “[The Discovery of Price Responsiveness – A Survey of Experiments Involving Dynamic Pricing of Electricity](#),” *EDI Quarterly*, April 2012.)

The model also shows that enabling technologies—such as in-home displays, energy orbs and programmable and communicating thermostats—further increase the amount of demand response.

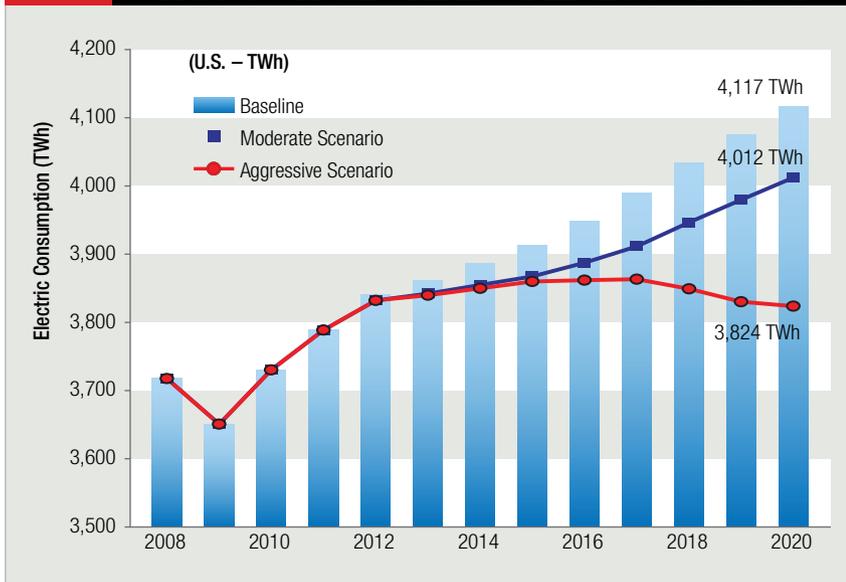
Environmental concerns have come to the forefront, making

FIG. 3**ARC OF PRICE RESPONSIVENESS**

Data from 74 dynamic pricing experiments of electricity spanning three continents reveal that the amount of customer demand response rises with the price ratio, but at a decreasing rate. If dynamic pricing schemes are coupled with enabling technologies such as in-home displays and programmable and communicating thermostats, this demand response can increase to greater levels.



Source: Ahmad Faruqi and Jerry Palmer, "The Discovery of Price Responsiveness - A Survey of Experiments Involving Dynamic Pricing of Electricity," ETO Quarterly, April 2012.

FIG. 4 **IMPACT OF CODES AND STANDARDS ON ELECTRICITY CONSUMPTION**

Source: Institute for Electric Efficiency, "Assessment of Electricity Savings Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes (2010-2020)," Prepared by Global Energy Partners and IEE, December 2009.

lighting systems that use incandescent lights with high-efficiency compact fluorescent (CFL) or light emitting diode (LED) systems.

Moreover, efficiency has become an important sales tool for all manner of products. Televisions are getting more energy efficient, and laptop computers and tablets continue gaining greater market share over power-hungry desktop PCs, further reducing energy consumption per capita. Businesses are looking to buy high efficiency heating, ventilation, and air conditioning (HVAC) systems while industrial facilities are looking to more efficient electric motors and those equipped with adjustable speed drives. So even as electrification of the economy

demand-side management programs ever more important to consumers. A new generation of consumers is emerging—and for this generation, conservation isn't just a personal virtue. Web portals and social media are raising the consumers' energy consciousness, and increasingly they understand that DSM reduces electricity use, and therefore cuts emissions. As a result, about 7 million households in North America are saving 1.4 billion kWh of electricity per year due to home energy reports that compare their monthly usage with their peer groups' usage. And more consumers now are looking to buy high efficiency air-conditioning systems and refrigerators, while replacing old

continues, it's doing so in an increasingly efficient way—further constraining the demand growth curve.

Codes and Standards

Utilities and customers aren't the only groups responding to these concerns. The federal government has imposed codes and standards that promote energy efficiency in appliances and buildings. Additionally, several states have passed laws either requiring or promoting energy efficiency. Rapidly expanding innovation in appliances and building technologies, spurred on by state legislation and mandates, has significantly reduced energy

Fig. 5

EFFICIENCY GAINS OF ENERGY STAR QUALIFIED MODELS

SOURCE: ENERGY STAR

Product	Efficiency Gains
Refrigerators	60 percent improvement in energy efficiency since ES program was introduced 20 years ago; current certified refrigerators use 15 percent less energy than non-certified models.
Televisions	ES certified televisions are on average, over 20 percent more efficient than conventional models.
Lighting	ES qualified commercial light fixtures use approximately 75 percent less energy than incandescent lighting.
Computers	As set by the July 2009 Specification, an ES qualified computer will use between 30 percent and 65 percent less energy, depending on how it is used.
Conventional Battery Chargers	Use 30 percent less energy than conventional models.
Displays	ES displays, such as computer monitors and digital picture frames, are on average 20 percent more efficient than standard options.
Digital-to-Analog Converter Boxes	Since ES specification on Jan. 31, 2007, energy use cut by more than 70 percent compared to products available in the worldwide marketplace.
Vending Machines	Since ES specification, new models have reduced energy consumption by more than 50 percent.
Clothes Washing Machines	Use 70 percent less energy than a standard washer 20 years ago; certified clothes washers use 20 percent less energy than non-certified washer.
Room Air Conditioners	Use 10 percent less energy than conventional models.

consumption in buildings. California, the Pacific Northwest, and most states in the Northeast are leading the country in this regard. These areas are subject to major strains on the grid during peak demand hours, and regulators are using building efficiency standards as tools for helping grid operators balance electric demand and supply. As seen in Figure 4, new codes and standards could dramatically decrease baseline energy consumption. In fact, the EIA attributes declining per capita residential electricity sales to new federal lighting standards in the Energy Independence and Security Act (EISA) of 2007, which took effect on Jan. 1, 2012. The act stipulates that general-service lamps providing 310 to 2,600 lumens of light are required to consume 30 percent less energy than typical incandescent bulbs, and compact fluorescent

and LED lamps replace low-efficiency incandescent lamps. As a result of these standards, the EIA estimates that delivered energy used for lighting per household will fall by 827 kWh per year by 2035, a 47 percent decrease from the 2010 level.

Programs such as ENERGY STAR and the Leadership in Energy and Environmental Design (LEED) that promote energy efficiency are gaining more traction and support (see Figure 5). ENERGY STAR is a government testing and labeling program that promotes energy efficiency products for the home and businesses. Through increased efficiency, products such as refrigerators and computers can reduce emissions and save money through the use of less electricity.

Like ENERGY STAR, LEED has improved public awareness by providing a framework for green building design, construction, operation, and maintenance. LEED uses a point-based system (0 to 100) to give building projects scores for satisfying these criteria. Building projects awarded a score of 80 points and above are given the highest certification—Platinum. The other certification levels, in descending rank, are Gold, Silver, and Certified. LEED has made designing buildings with energy efficiency in mind an attractive option for businesses to both save operating costs and to look good in the public eye. LEED certification has even been shown to increase the market value of properties, pushing many businesses and building designers

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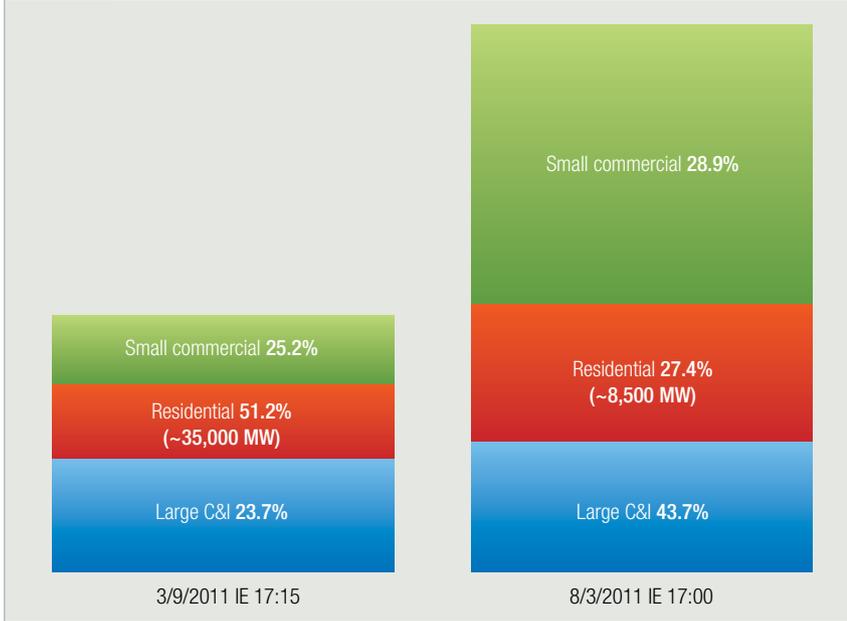
—NERC

to keep energy conservation and efficiency in mind when constructing or renovating buildings. The U.S. Green Building Council estimates that LEED certification increases a building’s value by 10.9 percent for new construction projects and 6.8 percent for existing sites.

Distributed Generation

Distributed generation with net metering could further reduce electricity demand significantly in the coming years. Distributed generation (DG), such as rooftop solar photovoltaic (PV)

panels and microturbines, is producing a growing share of the overall electricity supply. While that share remains tiny today, the Energy Information Administration predicts significant increases in distributed generation, especially when complemented with investment tax credits and other policies, and particularly among commercial and small industrial end users. The EIA projects that both solar PV and microturbine electric generation additions between 2010 and 2035 will outpace the growth in conventional natural gas-fired cogeneration, wind, and fuel cells.

FIG. 6**ERCOT LOADS IN TEXAS (3/9/11 AND 8/3/11)**

Source: Texas Water Conservation Association, "ERCOT Overview," March 19, 2012.

A key policy variable involves net metering, which enables distributed generation to expand. In 2003, there were less than 7,000 customers in the United States on net metering. By 2030, this number is expected to reach 156,000—mainly fueled by a rapid expansion of net metering in California, which will account for roughly half of this number. In California, the state’s 5 percent cap on net-metered customers is predicted to be reached by 2015. Nevertheless, 156,000 customers would amount to only 0.1 percent of total electricity sales in the United States.

Growth in distributed generation depends primarily on four factors: the retail cost of electricity; the cost of on-site generation; net metering regulations; and storms and outages. While the retail cost of electricity has been increasing, the cost of on-site generation has decreased, making DG a more attractive option for customers. Most notably, the average price for solar panels continues to fall, decreasing overall by 97.2 percent from \$30 per watt in 1975 to \$0.84 per watt in 2012.

Net metering regulations vary by state, because each state’s generation mix is different, and so are such policies as renewable energy portfolio standards. But in general, major storms are becoming more frequent, often resulting in outages—sometimes with extended consequences, such as those in the wake of Superstorm Sandy in the fall of 2012. Estimates for U.S.-wide customer cost of power outages range from \$20 billion to \$150 billion per year.

The 2003 U.S. blackout in the Northeast alone resulted in \$7 billion to \$10 billion in economic losses. In an August 2012 report, the Congressional Research Service stated that “data from various studies lead to cost estimates from storm-related outages to the U.S. economy at between \$20 billion and \$55 billion annually. Data also suggest the trend of outages from

weather-related events is increasing.”

Generating power on-site through the use of reciprocating engines, PV, or wind turbines provides consumers an opportunity to hedge the cost of power outages. With distributed generation, net-zero energy homes can become a reality. In Austin, Texas, the Zero Energy Capable Homes program seeks to have all new single-family homes be net-zero energy capable by 2015. The largest community of net-zero homes in the United States is rising in West Village at UC Davis in California. The California Energy Commission has called for all new residential construction to be zero net energy by 2020 and for all new commercial construction to be zero net energy by 2030. However, policy makers and utility executives are

still grappling with the question of who will pay for the grid if all of this comes to pass.

Fuel Switching

The final primary factor explaining the projected decreased growth in U.S. electricity demand is fuel switching. Due to technological innovations in hydraulic fracturing, the United States has a glut of natural gas. This outward shift in natural gas supply has been met with an expected plummet in gas

Generating power on-site through the use of reciprocating engines, PV, or wind turbines provides a hedge against power outages.

prices, making natural gas an even more attractive option for heating; consequently, more customers might switch away from electricity to natural gas for heating in the near future. According to the EIA, “Henry Hub spot prices for natural gas rise by 2.1 percent per year from 2010 through 2035 in the Reference case, to an annual average of \$7.37 per million Btu (2010 dollars) in 2035.” The average electricity price to all users, in 2010 dollars, would rise from \$28.68 to \$29.56, an increase of 0.1 percent. However, when accounting for greenhouse gas standards in the future that might introduce carbon taxes, electricity prices could increase by 25 percent and 33 percent relative to EIA’s base-case scenario in the GHG15 and GHG25 cases respectively.

In addition, technological innovation could spur more fuel switching from electricity to natural gas. Oak Ridge National

Laboratory has developed gas-fired heat pumps, which could supply both heating and cooling. The expansion of combined heat and power (CHP) systems also will reduce the demand for electricity for heating purposes. Many industrial facilities now can satisfy their electricity and thermal needs using one fuel source. Instead of purchasing electricity for heating purposes, these facilities serve heating needs with waste heat that previously was released into the environment.

Variables and Regional Factors

Apart from the five primary factors affecting demand growth, a host of other forces are putting upward or downward pressure on electricity demand. The list is extensive: energy efficiency policies such as state-specific energy efficiency portfolio standards; natural competition between manufacturers, leading to improvements in energy efficiency of products; disruptive end-use technologies such as home automation, green buttons, and smart phones.

Of course, some factors could drive demand growth higher in the coming years. The digitalization of life at home and in the workplace has increased the need for electricity to power new appliances and technologies. And plug-in electric vehicles, while saving customers substantial gasoline costs, will bring a major increase in electricity use. Also, increasing home sizes result in more energy consumption, just as aging baby-boomers are spending more time at home. Plus, the United States population increasingly is migrating to warmer states, leading to increased demand for space cooling.

Across the country, there is considerable variation in demand growth and in the reasons why this growth has slowed down. An informal survey of utility forecasters helped to identify some of these regional differences.

In California, new home construction has collapsed in the wake of the recession, reducing forecasts for electricity demand. Manufacturers are resorting to self-generation and microturbines, cutting their share of electricity demand from 33 percent to 10 percent. Meanwhile, advanced metering has rolled out and dynamic pricing is following suit.

EV adoption, meanwhile, might moderate California's falling electricity demand. NRG Energy is funding the installation of electric car charging stations across the state. Because one of the main barriers to electric vehicle expansion is the lack of an electric charging infrastructure, such a move might enable an increase in the penetration of plug-in electric vehicles in the vehicle market.

In the Pacific Northwest, industrial self-generation is rising, old industries are shutting down, and new industries, such as server farms, aren't creating many jobs. In the Midwest, weather-adjusted use per household has dropped in the third quarter for the past two years. New England has seen both energy efficiency and demand response bid into forward capacity markets. New York's housing construction has slowed down, possibly due to delayed

family formation. In PJM, FERC approved price-responsive demand in the RTO's tariff and operating agreements, allowing the rollout of advanced metering on a system-wide basis. More than 2 million customers will be on dynamic pricing in the next few years. In the Southwest, the recession hit hard and the housing market collapsed. Declining population growth there also might lead to decreased demand growth. In the Tennessee Valley, consumers are responding to the buzz about efficiency by taking actions to save money and conserve.

And then there's Texas, where the mass market is primed for demand response. Perhaps nothing better illustrates the potential for demand response in Texas than comparing two Wednesday evenings in different seasons of the year. Figure 6 shows the ERCOT loads in Texas for Weds., March 9, 2011 and Weds., Aug. 3, 2011. On March 9 at 5:15 p.m., when the temperature in Dallas was 64 degrees F, the ERCOT load was 31,262 MW.

And then there's Texas, where the mass market is primed for demand response.

Residential demand was approximately 8,500 MW, contributing to 27.4 percent of total demand. At 5:00 p.m. on the summer evening of August 3, the ERCOT load more than doubled that of March 9 at 68,416 MW. The temperature in Dallas at the

time was 109 degrees F, prompting many customers to pump up air conditioning units. The residential class contributed 51.2 percent of demand (35,000 MW), about four times the amount it contributed on March 9.

As DSM expands in the coming decades, the gap in electric demand in Dallas and other hot areas across the country should narrow.

Redefining 'Normal'

When all is said and done, the drop in electricity demand growth seems to be permanent, not transitory. It would be a mistake to attribute this drop solely to the recession and assume that it will go away once normal economic activity resumes. As seen in Figure 1, the drop is consistent with the historical trend of demand growth. The new normal might be demand growth at about half of the pre-recession value, in the 0.7 percent to 0.9 percent annual range.

For utilities and regulators, survival in this sub 1-percent growth world calls for new thinking, such as initiatives in many states to decouple a utility's earnings from its sales volume. As Peter Fox-Penner argues in *Smart Power*, utilities should consider becoming smart wires companies or integrated energy service companies. However, for this all to happen, enlightened regulators will have to rewrite the rules of the game—in a way that works both for utilities and their ever-changing customers. ■