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Reducing Demand, Promoting Efficiency Key to Defusing Electric Rate Increases

America's electric power system is facing its greatest challenge of recent decades. Demand for electricity continues to increase even as existing infrastructure ages, and the construction of new generation, transmission and distribution facilities grows in difficulty and cost. Fuel prices for natural gas and coal are predicted to remain volatile. New state and federal policies mandating renewable or alternative energy sources will require significant investments, the costs of which will be borne by end users of electric power.

Additional challenges exist for those states that opted to deregulate. As part of the deregulation process, many imposed rate caps and rate freezes which have held back rate increases for electricity customers even as fuel prices and other costs have risen. In states where the caps have been lifted, electricity rates have climbed, raising concerns about similar price spikes in other states.

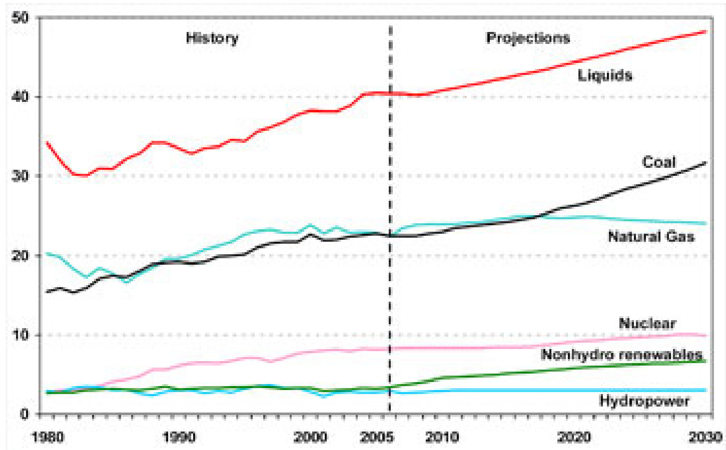
Addressing these challenges demands proactive policies targeted at increasing the efficiency with which we use electric power. Some of these strategies include:

- Reducing total and peak demand through real-time pricing, more demand-reduction/demand-curtailment programs offered by utilities and installation of advanced metering technologies;
- Investment in energy-efficient practices, equipment and technologies; and
- Development of distributed electric generation systems.

These policies not only reduce customers' bills, but they also have long-term benefits. Decreasing electricity consumption enhances the reliability of the grid by lessening strain on transmission and distribution infrastructure; lowers the volume of harmful emissions from power plants; and reduces the need for new facilities.

Many states have begun to implement new policies in response to these challenges. While their policies are unique to their respective situations, they have broad applicability regardless of location. We assess the benefits and costs of those policies as strategies for reducing demand and permitting local generation. Our recommendations focus on actions at the local and state levels that can help ameliorate the effects of rapidly rising energy prices and address the environmental impacts of energy consumption.

Figure 1: Delivered Energy Consumption by Sector 1980-2030 (quadrillion Btu)
Source: U.S. Energy Information Administration (EIA)



The Energy Information Administration's (EIA) Annual Energy Outlook 2008 projects continuation of the decades-long increase in energy consumption across the residential, commercial and industrial sectors. With the slowdown of the U.S. economy, EIA lowered 2007 projections of average growth in electricity consumption from 1.5 % to 1.3% per year. The annual growth rate across all sectors was 2.3% in the 1990s. Even so, EIA still anticipates Americans will use 10.7-billion kilowatthours(kWh)/day this year, a jump in consumption of 1.16-billion kWh/day from 2000 electrical use. That total demand is about eight times the daily electricity consumption of the African continent, about one-quarter of total world electricity consumption and equivalent to the amount of electricity needed to power 5 billion plasma television sets during an average day.

Figure 2: Seasonal Peak Demand
Source: PJM Interconnection

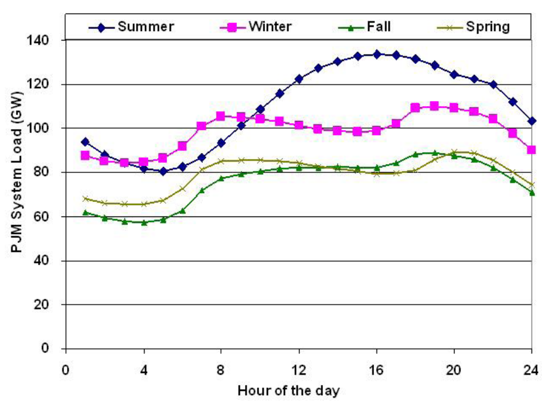


Figure 2 shows a typical seasonal demand pattern for PJM Interconnection, which manages the electricity grid for much of the Mid-Atlantic, including Pennsylvania, and parts of the Midwest. To meet peak demand, utilities must dispatch generators—known as "peakers"—which are highly inefficient, more expensive to operate and more likely to have high emissions of greenhouse gases. Peaking generation represents 15 percent of the total capacity in PJM, but this capacity is used only 1.1% of the time. Lowering peak demand by even a few percentage points would reduce the need to use these plants and would lead to savings.

Reining in Electricity Consumption Through Reducing Total and Peak Demand

Policies requiring a 5% reduction in electricity consumption across all sectors would be a first step. This would help offset anticipated price hikes caused by increasing fuel prices, investments needed to meet new federal regulations on emissions and the costs of adding electricity produced by alternative energy sources to utility offerings. Policies that encourage reducing peak demand include adopting real-time pricing, encouraging utilities to offer more and better demand-response/demand curtailment programs, and promoting advanced metering technologies.

What is real-time pricing?

One policy shown to be effective in lowering consumption is calculating bills based on real-time pricing of electricity generation rather than on an average price. Currently, most electric customers pay a rate calculated by averaging the cost of generation over all hours in a day and over many days. But the cost of generating electricity varies with demand. During periods of peak demand, such as heat waves, utility companies must add generation to meet demand. While the generating units added to meet this peak demand—called "peakers"—can be turned on and off quickly, they typically have much higher operating costs than the more efficient units which provide electricity on an ongoing basis.

But under the current pricing structure, customers don't know when "peakers" are added or when their electricity usage costs more. As a result, they have no incentive to reduce their power consumption or shift consumption to off-peak times. Real-time pricing makes explicit the impact of consumption, allowing the consumer to avoid times of high demand and high cost.[1] Studies show that only a modest number of customers need to participate for real-time pricing to be effective in reducing prices for all customers.[2]

Industrial and commercial customers that are able to shed load or reduce their electric requirements by shutting off equipment likely have been offered rates based on real-time pricing. But residential customers also can benefit from real-time pricing as evidenced by a year-long project involving 112 Washington homeowners and sponsored by the U.S. Department of Energy's Pacific Northwest National Laboratory.[3] Those homeowners received new meters, software that allowed them to monitor real-time prices, and new water heaters[4] and dryers, both of which could be turned down or off by the monitoring software. Armed with the ability to check their electric usage and the price for electricity, the homeowners changed their consumption behavior, reducing their electric bills by an average of 10 percent. Rob Pratt, manager of the Department of Energy's GridWise Program which sponsored the project, said if the systems were commercially available, homeowners would have recouped their investment through the savings from lower electricity bills within four years.

Managing electricity demand through real-time pricing reduces the frequency of peak-demand occurrences. Another long-term benefit: Reducing demand also decreases the need for construction of any new type of power plant.

What are demand-response/demand-curtailment programs?

Many utilities offer demand-response/demand-curtailment programs as a way for customers to reduce electricity consumption. In these programs, customers contract with their utilities to suspend or interrupt electric service during times when prices skyrocket or when the grid is strained. In return, the customer may receive a lower rate, a monthly credit or even a payment from the utility generally in excess of the cost of the electricity which would have been consumed. Large commercial and industrial customers often take advantage of these interruptible or demand-curtailment programs.

These programs vary from state to state and even from utility to utility, reflecting the different power needs of each region and the varying emphasis placed on these policies by different states and utilities. Utilities in some states, for instance, have reduced demand only a fraction of a percent.[6] Other states, such as California and Vermont, have pursued reduction and curtailment policies quite aggressively. In 2005, the California Public Utilities Commission, for instance, set an ambitious target of reducing annual system-peak demand for the state's three largest investor-owned utilities by 3% in 2005; 4% in 2006; and 5% in 2007. [7] While some reduction occurred as the result of these targets—per-person electricity use has remained relatively stable in California while increasing in many other states[8]—this first-time effort focused attention on the need to reduce peak demand. The state currently is setting new goals.

What are time-of-day/time-of-use programs?

Sections 1252(a) and 1252(f) of the Energy Policy Act of 2005 mandate that all utilities offer another demand-reduction program often referred to as time-of-day or time-of-use plans. These rate plans feature different electricity prices based on the time of day or season. Electricity used during peak-demand hours in the afternoon, for example, is more expensive than electricity used at night. High prices during peak periods encourage customers to reduce overall demand and to shift some of their electricity consumption from peak to off-peak hours. Customers with these contracts can save money because they are charged less non-program participants during off-peak periods. Time-of-day contracts require special metering technology which allows the utility to see when each customer is using electricity. Some states require that, as a first step towards demand reduction, utilities offer time-of-day plans to large customers using 500 kW or higher during peak demand times.

Demand-response/demand-curtailment contracts benefit industrial customers but also could be advantageous to other types of customers who are able to decrease their electricity demand by turning down or off non-critical equipment, changing settings on HVAC equipment, dimming lights or initiating backup generation. In addition, smaller electricity customers could join together in "power pools" to create large entities for demand reduction. This would make for more cost-effective contracts for both an electric utility and for customers.

What are advanced metering technologies?

Advanced metering technologies offer another opportunity to reduce demand. These include "next generation" automated meters, advanced software and commuications technology, all of which enable customers to control their appliances from pool pumps to air conditioners in response to real-time prices and conditions. In these systems, customers can "see" their electricity consumption on in-home devices and over the Internet and can lower thermostats or turn off appliances at home or remotely when electricity rates are high.

Interest in these technologies is considerable. In summer 2007, NSTAR Electric & Gas, which serves 1.4 million customers in eastern and central Massachusetts, offered selected residential customers a power-monitoring device at 20 percent of its retail price.[9] The device provided information about real-time electricity use and hourly cost and transmitted that information to a wireless display. More than 3,000 customers took advantage of NSTAR's offer.

Texas utilities also are evaluating advanced metering technologies. As part of a state bill passed in 2005, they are determining requirements for advanced metering systems in pilot projects across the state.[10] Those utilities also are assessing how to recover the up-front costs to implement such systems—costs that are substantial and will be borne by customers through new surcharges. But the benefits also are expected to be significant: reduced demand, reduced pollution and increased reliability of electric networks.

California's three investor-owned utilities have already begun installing "smart" meters in homes and businesses with roll-out projected to be completed by 2011. In a filing with that state's public utilities commission, Southern California Edison (SCE) estimated the cost of deploying about 5.3 million meters at $1.967 billion with the benefits estimated at $2.076 billion.[11] Furthermore, SCE anticipates operational savings will cover 63% of the costs.

Studies confirm that customers change their behavior and reduce electricity consumption when provided with rate and usage information. While deployment of advanced metering projects across all sectors will require substantial investment, pilot projects point to short-term gains in changing customers' energy habits and long-term benefits in improving power plants' operational efficiencies.

Promoting Energy-Efficiency Policies with Public, Private Investment

What is meant by energy efficiency?

Energy-efficiency policies have been shown to be the most effective and least costly means of reducing electricity consumption and protecting the environment. These practices and programs focus on lowering energy use by upgrading building codes and by investing in more efficient lighting, water-heating equipment, and heating and cooling systems and processes. Energy-efficiency policies involve homeowners and farm operators, businesses and industries as well as schools and government agencies. Estimates are that energy-efficiency improvements alone can reduce by 20 percent the amount of electricity Americans are projected to consum in 2030.[12]

A recent report by the American Council for an Energy-Efficient Economy shows the effectiveness of energy-efficiency policies. The dozens of programs profiled by ACEEE have collectively reduced consumption by more than 2,400 GW of electricity.[13] In doing so, they have saved customers hundreds of thousands of dollars. In some states, these award-winning programs are administered by the utilities. In others, government agencies or public-private partnerships have administrative oversight.

ACEEE also recently outlined energy-efficiency policies for Maryland after two of the state's utilities proposed rate hikes of between 13% and 72% following deregulation of the industry.[14] These policies are estimated to cut electricity bills by a net of $860 million by 2015 and to have a return of $4 in lower bills for every $1 invested.[15] The policies, which include more stringent building energy codes and expanded demand-reduction programs by utilities, also have a goal of reducing per capita consumption by 15% by 2015.

Such savings in electric demand come with a price. Estimates are that an energy-efficiency policy with a goal of a 5% reduction in electricity use by Pennsylvania customers, for instance, would cost between $400 million and $800 million annually.[16] But the benefits from lower market prices and less intensive use of peak-demand generation would be about $1.9 billion.

The U.S. Department of Energy provides states with funding for energy-efficiency programs through its Weatherization Assistance Program which is targeted to the elderly and low-income families. Each state administers this program focused primarily on retrofitting homes and apartment buildings. The energy-efficiency measures range from adding new insulation and windows to purchasing new appliances.

Like many states, Pennsylvania has its own additional program—Low Income Usage Reduction Program (LIURP)—aimed at reducing payment delinquencies and energy demand of low-income individuals.[17] Utilities recoup the cost of these programs either by folding it into their base rates or by adding a "universal service charge" to residential customers' bills. The state Public Utilities Commission (PUC) requires utilities to document the number of eligible participants and annual expenditures on their programs. In filings with the PUC for 2006, for instance, Metropolitan Edison and Pennsylvania Electric Company (Penelec)—subsidiaries of FirstEnergy Corporation—reported spending about $3.7 million for energy savings of 2.2 million kWh or a little less than 0.008 % of the two utilities' total sales.[18]

How are energy-efficiency programs funded?

States with energy-efficiency policies typically have adopted a system or public benefits charge to pay for the programs. How these charges are calculated may differ from state to state. Some states use a per kW charge, others a per kWh charge, and still others a flat percentage of the electricity bill.

Electricity customers in Vermont, for instance, have reduced their electricity consumption by 5.4 percent since 2000 when the state legislature created Efficiency Vermont to provide energy-efficiency services such as energy audits or reviews, evaluations of energy-efficient equipment and processes, and coordination of purchase programs. Efficiency Vermont is funded by an "Energy Efficiency Charge" based on a customer's total or peak demand. This year, that charge will generate almost $31 million to be used on Efficiency Vermont programs. According to the most recent audit in 2005 of Efficiency Vermont, the return on investment (ROI) for each dollar spent in the commercial and industrial sectors is $1.97; the ROI in the residential sector, $1.51.[19]

In July 2007, Wisconsin changed its energy-efficiency policy by establishing a new funding mechanism for the state's programs. Utilities now pay 1.2 percent of electricity and natural gas revenues—a rate calculated on a three-year average—to the Statewide Energy Efficiency and Renewables Administration. These funds support the state's Focus on Energy programs which are administered by the non-profit Wisconsin Energy Conservation Corporation (WECC). This year, WECC will have about $63 million to spend on residential and business projects as well as on renewable-energy projects. About half of this year's total—around $30 million—will go to financial incentives such as cash rebates and low-interest loans to help homeowners and businesses purchase and install more energy-efficient equipment and technologies. The remainder of the fund goes to providing technical assistance and consulting services, education and training programs and marketing. According to the program's 2006 annual report, "the cost of the conserved energy is $0.03/kWh—considerably less than the cost to generate that energy" and more than 931 million kWh have been saved annually since 2000.[20]

In Massachusetts, all energy-efficiency programs are funded through a $0.0025 per kW assessment—a “Demand Side Management Charge”—paid by all electricity users whether residential, commercial or industrial customers.[21] That charge raises about $125 million to $130 million annually which the utilities are required by law to spend on energy-efficiency programs. Those programs are reviewed to ensure they meet statewide energy-efficiency goals. Programs can include energy audits or reviews to identify potential energy savings, engineering plans to determine cost and savings strategies and financial incentives to help with capital costs of energy-efficiency investments. The utility National Grid, for instance, underwrote the purchase of new lighting for Fall River Public Schools at a cost of $720,000. An additional benefit: The school system’s electricity bill dropped about $115,000 a year because it had reduced demand by 1.2 million kWh, according to the district’s director of administrative and environmental services.

In an approach similar to Wisconsin’s, Minnesota’s electric utilities were required to spend 1.5% of gross operating revenues—2% for Xcel Energy, the state’s largest utility—on “measures or programs, that target consumer behavior, equipment, processes, or devices” to reduce energy consumption.[22] In 2007, Minnesota revised its legislation to require utilities to *save* 1.5%—2% for Xcel Energy—of their gross annual retail energy sales of kWh based on a three-year average which takes weather conditions into consideration. The goal of the new legislation is greater levels of energy efficiency. Utilities recover the costs of their programs through surcharges on rate payers.

Policies Needed to Support New Models for Electricity Generation

While real-time pricing, demand-reduction programs and investment in energy-efficiency policies can be effective in reducing peak and total demand, action also is needed to address the nation’s aging electric power infrastructure. Decades-old power plants and associated transmission lines have passed their presumed life and need to be replaced to ensure a continued supply of power. The cost for new transmission lines alone has been estimated in the billions of dollars, according to experts.[23] In addition to financial constraints, construction of new generating facilities and lines faces battles over environmental concerns and siting. As states debate whether and where to build new plants, consideration also should be given to developing new models of electricity generation.

What are microgrids?

One potential means of adding capacity across the grid without building large plants is through decentralized or on-site generation technologies. One of the more promising of these distributed-generation technologies is the microgrid. Unlike single-user distributed generation units, microgrids serve multiple users located in close proximity to each other. These can include large office complexes, industrial parks and even residential neighborhoods. Currently, many states effectively prohibit the construction of microgrids as legislation has given utilities exclusive rights to selling power within their jurisdictions. Removing this legislative barrier is a first step in exploring this alternative model of generation.

Microgrids have several advantages. Because they can generate power separate from the grid, microgrids insulate their customers from the havoc caused by regional blackouts or fluctuations in power quality. This capability is particularly important for customers—such as data centers, government units, research facilities and hospitals—whose operations require dependable and high-quality electricity around the clock.

Microgrids' location near the end users enables another benefit—namely, they are better able to use the heat generated in the conversion of fuel to electricity. Estimates are that only about 40% of energy inputs at regional generation facilities—or macrogrids—actually produce electricity, with the other 60% lost in the transmission systems or vented into the atmosphere.[24] Because the microgrid's customers are near the plant's location, this waste heat can be captured and used to power heating and cooling equipment. Combined Heat and Power systems—also known as CHP or cogeneration— have been estimated to have efficiencies as high as 85%.[25] The efficiency of the separate systems is estimated at 45%.

One final advantage: Microgrids have the potential to inject excess production into the electric grid, thereby supplementing supplies during peak times. Policies need to be structured so that microgrids could take advantage of provisions in the Energy Policy Act of 2005 that allow for "net metering," or the sale or delivery of electricity generated through a single-user system to a utility. To encourage this alternative generation model, net metering policies need to compensate microgrids based on the hourly location-based market price for any power sold to the grid and charge microgrids the hourly market price for any power bought from the grid. Similar policies could apply to other distributed energy resources.

While microgrids exist in other countries, no commercial microgrids are currently in operation in the United States because of legislative barriers. Nonetheless, several test projects are underway in Ohio and Texas,[26] and according to the U.S. Conference of Mayors, about two dozen cities are considering microgrid development projects.[27] Two Connecticut cities—Stamford and Ansonia—are the farthest along in owning and operating microgrid systems to be located in specially designated energy districts. In June 2007, the Connecticut legislature approved legislation permitting the creation of these districts within any municipality, effectively clearing the way for this new model of generation. Proponents of micrgrids expect that these systems will not only provide reliable and stable power but will do so at costs below those of the local utility companies.[27]

While Connecticut's projects will be located in areas with a concentration of end users, Texas has been exploring microgrids as a means of providing electricity to colonias—Spanish for neighborhoods—along the Texas/Mexico border which currently have no service. One, designed by the Texas Engineering Experiment Station (TEES), is operational and providing electricity to about 20 homes, said Dean Schneider, manager for energy and environmental sustainability at TEES. Costing about $75,000, the system combines a small generator fueled by biodiesel or ethanol and includes solar panels and battery storage of 40 kWh. It produces electricity at a cost of about 25 cents a kWh—more than what Texas utilities charge which Schneider said averages between 13 cents and 18 cents a kWh. Even with that higher cost, Schneider said the microgrid not only offers residents of rural areas an option but also is a viable supplier of power in emergency response situations, temporary construction sites or military bases which need to be energy independent.

Researchers caution that microgrids may not cut electricity prices across all customers in all locales. Models indicate they will be most effective in places with high energy prices or low natural gas prices.[28] Similarly, the savings may only accrue over a project lifetime, so microgrid customers must balance short-term costs over long-term gains on increased reliability. As electricity rates go up, however, microgrids offer some customers opportunities for savings.

Planning Now for the Future

Reining in demand and pursuing energy efficiency are not options. They are necessities—and they provide a cost-effective and immediate means of addressing volatile fuel prices, the nation's aging electric power infrastructure and the worldwide problem of accumulating carbon dioxide emissions. As demonstrated in states with policies which promote individual involvement in energy management, ordinary citizens can and do manage their energy consumption wisely in their homes and businesses when they have access to proven technologies and programs.

Proactive policies implemented now will stabilize customers' energy bills in the near term. But these policies also have significant long-term benefits in reducing the need for new energy generation. The notion that reducing energy consumption will be harmful to people or to the economy is a myth as the benefits of lower electricity consumption can be enjoyed without major lifestyle changes or sacrificies in quality of life.

While individual policies must be tailored to meet each state's unique circumstances, an unprecedented opportunity exists for individuals, organizations, government agencies and industry to determine now their energy future.

End Notes

1 The incremental price of electricity during peak demand in PJM Interconnection which manages the electricity grid for much of the Mid-Atlantic can reach $1/kWh—about 10 times what customers currently pay. Most customers, however, are charged far less during peak periods. See http://wpweb2.tepper.cmu.edu/ceic/papers/Competitive_Energy_Options_for_Pennsylvania.htm; accessed 01/16/08. One of the authors of this brief (Blumsack) was a participant in this study.

2 See http://wpweb2.tepper.cmu.edu/ceic/papers/Competitive_Energy_Options_for_Pennsylvania.htm; accessed 01/16/08. Commercial and industrial users in Pennsylvania, for instance, account for 64% of electricity demand but only comprise 10% of the state's electric meters. Any reduction in demand by these customers would reduce the need for peaking generators, thereby benefiting all consumers in the system.

3 See http://www.pnl.gov/topstory.asp?id=285; accessed 02/13/08.

4 Water heaters typically represent between 9 and 10% of a residential customer's electricity use.

5 A recent study estimates that real-time pricing, in conjunction with a tax on carbon dioxide emissions, would raise the price of electricity generated by fossil fuels and could reduce demand by 3% to 5% with even greater reductions possible during peak periods. This would not only reduce electricity prices but would also decrease emissions by between 10% and 18 % without any investments in new technologies. For more information on the study, see http://pubs.acs.org/cgi-bin/asap.cgi/esthag/asap/pdf/es071749d.pdf.

6 In a 2007 filing with the Pennsylvania Public Utilities Commission, the state's largest utility—PPL Electric Utilities Corp.—reported that peak demand was reduced in 2006 by 246.6 MW for a savings of 2.6 million kWh through its Interruptible Service-Economic Provisions tariff schedule.That savings represents about 3.3 percent of its 2006 summer peak demand but only about .06 percent of PPL's total kWh sales. In its filing, Duquesne Light Company reported that the amount of demand curtailed by residential and commercial customers in its "Direct Load Control Program" was not "significant." See www.puc.state.pa.us/general/publications_reports/pdf/epo_2007.pdf; accessed 03/03/08.

7 See http://docs.cpuc.ca.gov/word_pdf/final_decision/44881.pdf; accessed 03/09/08.

8 Because California's population continues to increase, overall electricity consumption has increased. See http://www.cpuc.ca.gov/NR/rdonlyres/58adcd6a-7fe6-4b32-8c70-7c85cb31e-be7/0/2008_eap_update.pdf; accessed 03/09/08.

9 See http://www.nstaronline.com/ss3/nstar_news/press_releases/2007/blueline.asp; accessed 03/03/08.

10 See http://www.puc.state.tx.us/electric/projects/34610/34610.cfm; accessed 02/26/08.

11 See http://www3.sce.com/sscc/law/dis/dbattach1e.nsf/0/99BF82FE823A65A388257329007E02A0/$FILE/A.07-07-XXX+SCE+AMI+Phase+III+Application.pdf.

12 See http://www.aceee.org/conf/04ss/rnemeta.pdf; accessed 03/24/08.

13 See http://www.aceee.org/pubs/u081.pdf; accessed 02/11/08.

14 These estimates are based on data from Maryland's PUC before the termination of rate caps with the results of the default supply auction. See "Office of Staff Counsel - Report/Observations on the Standard Offer Service Bidding Process and Results for the 2006-2007 supply year. Case No. 8908" at http://webapp.psc.state.md.us/Intranet/CaseNum/CaseAction.cfm?RequestTimeout=500

15 See http://aceee.org/pubs/e082.htm; accessed 03/24/08.

16 See http://wpweb2.tepper.cmu.edu/ceic/papers/Competitive_Energy_Options_for_Pennsylvania.htm; accessed 01/16/08.

17 See http://liheap.ncat.org/stcodes/pawa.htm; accessesd 02/25/08.

18 See http://www.puc.state.pa.us/General/publications_reports/pdf/EPO_2007.pdf; accessed 02/26/08.

19 See http://www.state.vt.us/psb/EEU/OversightActivities/EEUOversightActivities.htm#Cost-effectiveness%20audit; accessed 02/15/08.

20 See http://www.focusonenergy.com/files/Document_Management_System/DOA/D_AD_RPTE-FY06AnnualReport.pdf; accessed 02/18/08.

21 See http://www.mass.gov/legis/laws/mgl/25-19.htm; accessed 02/22/08.

22 See https://www.revisor.leg.state.mn.us/statutes/?id=216B.241; accessed 03/11/08.

23 Roseman, E., "Getting Necessary Transmission Built: The Value of Reliability and Lost Load," *21st Century T&D*, 1:3, pp. 24-25.

24 See http://www.lbl.gov/Science-Articles/Archive/EETD-microgrids.html; accessed 01/24/08.

25 See http://www.aceee.org/energy/chp.htm; accessed 03/21/08.

26 See http://www.gradingandexcavation.com/de_0709_backing.html; accessed 03/21/08.

27 See http://www.usmayors.org/uscm/us_mayor_newspaper/documents/07_30_07/pg8_Ansonia.asp and http://www.usmayors.org/uscm/US_Mayor_newspaper/documents/02_06_06/Pareto.asp; accessed 03/12/08.

28 See www.localpowernow.com/how.htm (accessed 03/21/08) for information about Pareto Energy, Ltd.,which is working with both Connecticut cities.

29See King, D. and G. Morgan, "Customer-Focused Assessment of Electric Power Microgrids," *Journal of Energy Engineering*, Sept. 2007. At the Pennsylvania State University is a joint project of the Penn State Institutes of Energy and the Environment and the Social Science Research Institute. The Center supports a lecture series, policy relevant research, and produces a series of public policy communications including Penn State Policy Notes and policy briefs.

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