

The Promise of the Smart Grid: Goals, Policies, and Measurement Must Support Sustainability Benefits

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Acknowledgments

Thanks to Don Clevenger of Oncor, and to David Lamont and Richard Sedano of Vermont's Regulatory Assistance Program, for their useful information. Also, thanks to John Howat and Janine Migden-Ostrander for their review and feedback on this paper. The author also would like to acknowledge the contributions of the following individuals in drafting, reviewing, and helping prepare this issue brief: Ralph Cavanagh, Brandi Colander, Danielle Davidian, Jennifer Freeman, Philip Henderson, Kit Kennedy, and Jennifer Sass.

About NRDC

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Developing the smart grid is about leveraging information technology to improve the production and distribution of electricity. At every level of the power system—from power plants to transmission lines to office buildings and homes—smart grid technology uses information and produces information for others to use. This data may be utilized automatically in the system, or it may be used by grid operators and consumers to help save resources and to keep the system working smoothly.

Billions of dollars will be spent on upgrading the electrical grid in the United States in coming years. New equipment that can produce and respond to data will provide many potential benefits, including reduced waste, improved resilience and reliability in the system, and greater ability to use renewable energy sources. In order to achieve the clean energy and conservation benefits of smart grid technology, programs need to be designed specifically with clean energy and conservation goals in mind.

The Natural Resources Defense Council (NRDC) believes that well-designed programs, careful implementation, and alignment of metrics with environmental goals, in addition to consumer education, are key to realizing the clean energy benefits of the smart grid. By transforming the way we produce, distribute, and use electricity, the smart grid presents a unique opportunity for a cost-effective transition to a more sustainable energy future.

WHAT DOES A SMART GRID DO?

A smart grid produces and reacts to information in order to create a better electrical system. Smart grid technologies include switches, sensors, software, meters, and a host of other components that now enable two-way communication across the power system. These technologies can be located anywhere on the grid, from power plants to transformers, and power lines to consumers' homes. Using information provided by the technologies, the smart grid can help conserve energy, facilitate the integration of renewable energy sources, and make the grid more resilient, responsive, and reliable.

Communication between electricity customers, utilities, and the grid:

- Allows operators to better manage distribution, electricity use, and repairs based on real-time data
- Allows the grid to use more diversified, distributed, and variable energy sources such as rooftop solar installations and wind farms
- Enables grid operators to detect outages in real-time, so that restoration of service can occur more rapidly and the scope of outages can be reduced
- Empowers consumers with pricing information so they can choose to use electricity at off-peak times at discounted rates, and lower their bills
- Lets customers use demand side management to reduce their electricity use during periods of peak demand, and so avoids the need to build more generating capacity

Smart Grid Improves Service in Vermont and Texas

On a Sunday in August 2011, Hurricane Irene barreled through Vermont. One-third of Vermont Electric Cooperative customers were left without power. With the help of its smart grid technology, including sensors and meters, the Cooperative was able to pinpoint where outages had occurred so utilities could send repair crews straight to problem areas. Before, the utility would not have been aware of an outage unless it was reported by a customer, but with the help of smart grid technology, power to Vermont Electric Cooperative customers was restored by Tuesday, two days after the storm hit.

Meanwhile, in Texas, the Dallas-based utility Oncor found that after deploying smart grid technologies, “20 percent of the time we respond to customer outages before or without ever receiving a customer call,” on days without a storm.^a Without having to wait for customers to come home from work and report outages, Oncor reports that its workers’ time is being used more efficiently. The new technology helped the utility solve 19 percent of outage calls remotely by identifying problems like tripped breakers on the customer’s end, saving millions of miles of unnecessary service trips. In addition, the technology revealed hundreds of small, intermittent problems that Oncor was able to repair before they led to an extended outage.

^a Memorandum to Ralph Cavanagh, NRDC, from Don Clevenger, senior vice president, External Affairs, Oncor Electric Delivery (July 31, 2012).



By providing accurate real-time information, the **Vermont Electric Cooperative’s** smart grid technology helped the utility to restore electricity quickly to customers after the destruction caused by Hurricane Irene.

Photo credit: FEMA Photo Library

BENEFITS OF THE SMART GRID

The smart grid can give us cleaner air, better health, lower electricity bills, and reduced carbon dioxide (CO₂) emissions in the atmosphere. NRDC is particularly interested in supporting the smart grid’s potential to deliver large-scale clean energy and conservation benefits, such as the following:

■ Encouraging energy efficiency

One benefit of the smart grid is to help larger buildings use energy where it is needed, and curb waste through actions such as turning off lights and other equipment on nights and weekends when the buildings are closed, or by adjusting fans to cool only occupied areas as revealed by sensors. The information provided by the smart grid’s meters and sensors can also be used in designing programs to drive consumer behavior to use energy during off-peak hours, reducing peak demand so that less power generation is needed to meet overall demand.

Another potential benefit of the smart grid is to increase energy efficiency on the utility system by reducing line losses. Using smart grid technologies, energy loss can be reduced by optimizing energy flows in the distribution grid, based on real time feedback from sensors throughout the system. The smart grid also makes analysis more efficient: as the technologies produce a continuous supply of information, it is easier and less expensive to frequently evaluate and analyze whether policies and programs are working well to drive efficiency.

■ Reducing carbon dioxide and other harmful emissions

The smart grid can reduce CO₂ emissions primarily by helping customers use less electricity, and in some cases by shifting demand away from peak periods, reducing the need for utilities to bring extra power plants on line that emit CO₂ and other pollutants. However, merely shifting demand without reducing it will not necessarily cut power plant emissions. In addition, the smart grid can increase the flexibility of the grid, allowing it to integrate a greater amount of variable resources like solar and wind power, which can reduce the need for energy from fossil fuels.¹ Studies indicate that increasing the use of renewable energy could account for up to 60 percent of the CO₂ pollution reduction potential of the smart grid (figure 1).

■ **Enabling greater use of plug-in vehicles**

The smart grid can further reduce emissions and oil dependence by enabling the widespread use of plug-in electric vehicles. These vehicles will not only reduce the need for oil; they can also lower costs for both utilities and consumers if charging is done during off-peak hours. Dynamic pricing programs can provide incentives for charging at night. These benefits build on each other—electric vehicles’ emission reduction benefits are maximized if the electricity they use during off-peak hours is produced using renewable energy sources.²

■ **Lowering costs for both consumers and utilities**

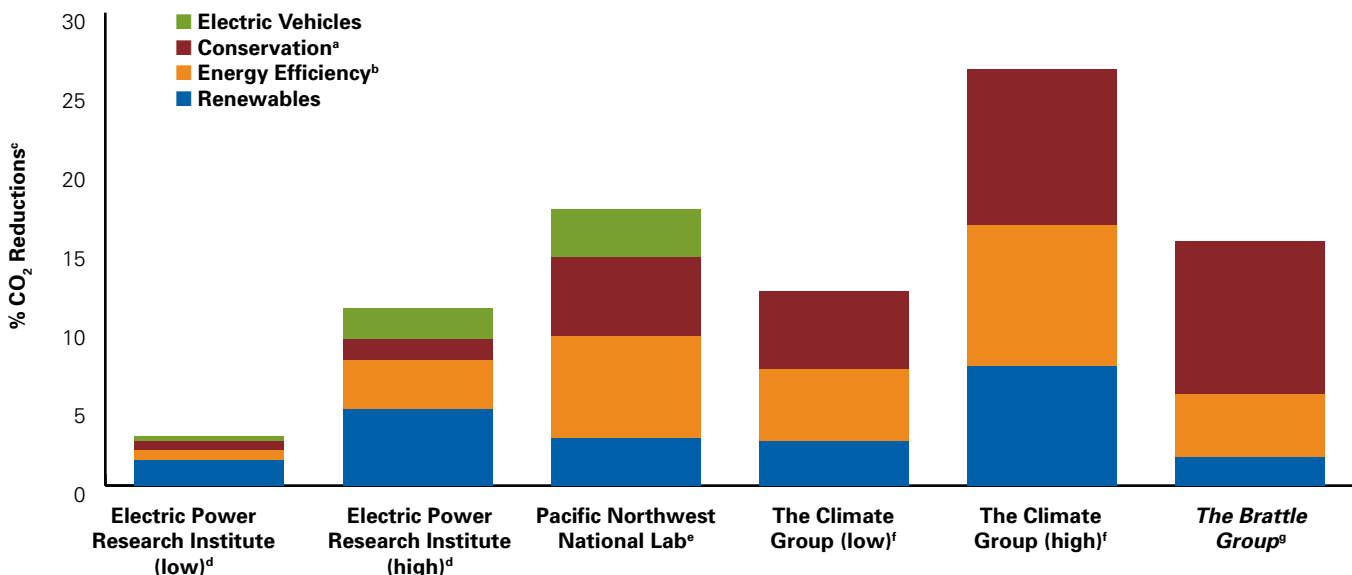
By avoiding construction of new power plants, and creating demand side management programs coupled with strong consumer education, the smart grid can help both consumers and utilities to hold down costs. For instance, utilities could contract with consumers to permit the utility to shift electricity use away from peak hours, such as by using remote access to pre-cool buildings or to adjust air conditioning systems on the hottest days in the summer

to avoid spikes in electricity demand. Dynamic pricing structures help inform consumers and empower them to pursue cost saving measures that both reduce peak demand and help the utility cost effectively manage fluctuations in demand.

As these examples show, smart grid technologies do not produce savings by themselves, but rather are enabling technologies. They are tools that enable grid operators to shift demand, integrate renewable energy sources, and accelerate plug-in electric vehicle adoption.

Consumer participation is key to fostering the smart grid’s success and its benefits. Education will be an important part of any smart grid program, as will program designs that benefit consumers as well as utilities. Underscoring the need for consumer education, a 2011 poll of Americans’ perceptions of energy conservation showed that while a majority describe themselves as knowledgeable about energy issues, and many are already taking actions to conserve energy at home, more than half are unfamiliar with the term “smart grid.”³

Figure 1: Potential Carbon Dioxide (CO₂) Emissions Reductions from the Smart Grid: A Comparison of Estimates from Four Sources



a In home display direct feedback and consumption impacts of load shifting.
 b Reduced line losses, conservation voltage reduction, advanced voltage control, measurement and verification of efficiency programs, and accelerated efficiency deployment.
 c Reductions in power sector emissions measured relative to DOE/EIA 2030 Reference Case except ICT study where reductions are based on 2020 Reference Case.
 d Electric Power Research Institute (EPRI), *The Green Grid: Energy Savings and Carbon Emissions Reductions Enabled by a Smart Grid*, 2008, 1016905.
 e Pacific Northwest National Lab (PNNL), *The Smart Grid: An Estimation of the Energy and CO₂ Benefits*, PNNL-19112, 2010, Richland, WA.
 f The Climate Group, *Smart2020 Enabling the Low Carbon Economy in the Information Age*, 2008.
 g Ryan Hledik, *The Brattle Group*, "How Green is the Smart Grid?" *The Electricity Journal* 22(3) 2009:29-41.

The U.S. Department of Energy (DOE) and the Smart Grid

After the passage of the Energy Independence and Security Act of 2007, support for the smart grid became federal policy. The government's smart grid initiative was augmented in 2009 with \$4.5 billion in grants and loans to support smart grid development, distributed in part through the DOE's Smart Grid Investment Grant program. The DOE identified the following as "the major performance features of a smart grid":^a

- Self-healing from power disturbance events
- Enabling active participation by consumers in demand response
- Operating resiliently against physical and cyber attack
- Providing power quality for 21st century needs
- Accommodating all generation and storage options
- Enabling new products, services, and markets
- Optimizing assets and operating efficiently

^aU.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, Smart Grid information page, <http://energy.gov/oe/technologydevelopment/smart-grid>

DEFINING SUCCESS: ALIGNING METRICS WITH DESIRED OUTCOMES

Smart grid programs are typically evaluated on the basis of how they affect peak electricity demand, without regard to the source of the power. These metrics can fail to capture other benefits, especially reduced CO₂ emissions. NRDC proposes that in addition to measuring effects on peak load, smart grid programs should be judged by whether they lower CO₂ emissions. Using a metric related to CO₂ would emphasize the smart grid's ability to accept more renewable energy installations and facilitate a shift to cleaner sources of power generation.

Typical metrics judge a smart grid program a success if consumers shift their laundry, electric car-charging, ice-making, and other energy-intensive tasks to times when demand for energy is relatively low, so utilities can avoid building new power plants. Although the reduction of peak electricity demand can delay the need for new power plants and make inefficient plants run less often, it could also result in trading, say, peak-hour electricity from natural gas for off-peak electricity from dirtier coal plants, thereby increasing net pollution. To avoid this kind of outcome, including CO₂ reduction in smart grid metrics makes sense.

Smart grid technologies can be powerful enablers of important environmental benefits, but simply rolling out technologies, such as online interfaces that allow people to clearly see how much energy each appliance or system is using, will not ensure that these benefits are realized. Rolling out technologies should not, therefore, be judged as a major metric for success. A better metric is evidence that consumers are using the new technology to change behavior and lower peak demand, combined with evidence that the shift is enabling use of renewable energy sources leading to reduced CO₂ emissions.

Careful smart grid program design and implementation is needed not only to leverage the environmental benefits of smart grid technologies, but also to direct capital toward solutions that benefit the environment. To accurately gauge the success of smart grid technologies, programs should be measured on the basis of direct benchmarks such as electricity consumption, grid flexibility, variable resource capacity value, and electric power carbon intensity.



Workers install a smart switch on the grid in Chattanooga, TN. This smart grid technology can detect outages remotely, and isolate damaged spots so that repairs can be made quickly.

Photo courtesy U.S. Department of Energy and the Electric Power Board of Chattanooga, TN.

ADDRESSING PRIVACY CONCERNS

Smart meter implementation in some states has drawn questions from customers related to privacy protections for usage data. Customers have voiced three types of concerns that could be described as generally relating to “privacy.” One concern is about data security, or ensuring that utilities implementing any smart grid technology or data systems protect customer usage information from unauthorized access. NRDC believes that data security must be a primary concern for utilities, and we continue to work to assure that utilities achieve this goal, such as by using modern encryption methods whenever customer usage data is transmitted.

A second concern is about utilities themselves using customer usage data. Utilities have long had the ability to track information from individual meters, and use it to manage transmission, production, and planning to meet future demand. Utilities today are subject to a range of local and state regulations on what they may do with customer information. Smart meters give utilities more meter information, which may permit an additional level of insight into customer behavior. Some have asked whether additional controls on what the utility might do with the information are needed. NRDC expects utilities to employ usage information to operate core utility functions properly, as they do today, including supporting efficiency programs. At the same time, utilities should not be permitted to use the information inappropriately.

A third privacy concern involves information sharing. Utilities today are subject to local and state laws and regulations that restrict sharing of customer information without customer permission. The advent of smart meters collecting more detailed information has prompted both a call for greater clarity in the prohibition on sharing without consent and a call for utilities to give customers greater capability to access their meter information. This would allow the customer to use it or share it with service providers, such as to enable a contractor to estimate potential savings from installing a better air conditioner.

NRDC supports efforts to ensure that consumers have strong privacy protections for their usage information.⁴ In addition, NRDC believes that strong public education programs must be a component of any smart grid implementation to reduce consumers’ concerns about how utilities collect and use data from better meters.

IMPORTANT SMART GRID POLICY CONSIDERATIONS

The smart grid can lower costs for consumers and utilities, facilitate efficiency, and smooth the transition away from fossil fuels toward clean, renewable energy. NRDC encourages utilities and regulators to actively continue to support and develop the smart grid with carefully designed programs and efficient implementation in a cost-effective manner. NRDC recommends the following important policy considerations:⁵

- **Smart grid programs should be carefully designed** to align performance measures with desired outcomes that can be verified through performance-based measures such as cost effective integration of renewables, reduction in electricity use, and lower CO₂ emissions.
- **Technologies built into smart grid standards should be based on open standards** and be as technology-neutral as possible so system upgrades can develop smoothly, using the best technology at any given time and avoiding commitment to outdated technology.
- **Consumer education should be a high priority, fully funded component** of smart grid programs. Energy efficiency benefits should be clearly and actively reported to consumers, through education programs and transparent information, to motivate consumers to understand and actively participate in behavior that reduces peak demand.
- **Utilities’ smart grid enhancements should be integrated with their energy efficiency and renewable energy programs and targets.** Too often these obviously complementary efforts and crucial utility functions are managed independently; instead, utilities should look for opportunities to explore and maximize synergies.
- **Investments in smart grid technologies should be verifiable and transparent,** and utilities should be held accountable for adhering to the cost estimates and delivering the benefits they promise as a result of such investments. Cost reductions should be netted against the amount that the utilities seek to collect from consumers. Smart grid programs should not over-emphasize cost savings in the short term, such as by mandating lowest-cost technology, but should invest in technology that will ensure success over the long term.

- **The smart grid should not in any way reduce consumer protections.** Consideration should be given to increasing consumer protections where necessary. Pricing programs that encourage consumers to use electricity at off-peak hours, such as *dynamic* or *time-of-use* pricing, should be optional rather than mandatory.
- **The smart grid should protect consumers against unauthorized sharing of their meter information,** while giving them the ability to access and use meter data to take advantage of new products and services that may use meter data. At the same time, utilities must be able to use information to manage demand, achieve efficiency, increase reliability, and improve performance of the grid. When evaluating or implementing smart meter proposals, regulators should look to achieve these goals with attention to information security.

By using information-age technology to transform the way energy is produced, distributed, and consumed, smart grid technology can help with an affordable transition to a sustainable energy future.

For more information, please contact Ralph Cavanagh at rcavanagh@nrdc.org.

Endnotes

- 1 International Energy Agency, *Energy Technology Perspectives 2012*, Chapter 6: Flexible Energy Systems.
- 2 Electric Power Research Institute, Natural Resources Defense Council, and Charles Clark Group, *Environmental Assessment of Plug-In Hybrid Electric Vehicles Volume 1: Nationwide Greenhouse Gas Emissions*, <http://mydocs.epri.com/docs/public/000000000001015325.pdf>.
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- 4 National Consumer Law Center, National Association of State Utility Consumer Advocates, Consumers Union, and Public Citizen, "Need for Essential Consumer Protections: Smart Metering Proposals and the Move to Time-Based Pricing," <http://energy.gov/oe/downloads/need-essential-consumer-protections-smart-metering-proposals-and-move-time-based-0> (accessed June 21, 2012).
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