ONE *of* **SIX** SMART GRID **STAKEHOLDER BOOKS**

WHAT THE SMART GRID MEANS TO YOU AND THE PEOPLE YOU REPRESENT.

A smarter grid can work harder and more efficiently to respond to the needs of all consumers, contain costs and enable clean-energy solutions at scale.

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY BY LITOS STRATEGIC COMMUNICATION UNDER CONTRACT NO. DE-AC26-04NT41817, SUBTASK 500.01.02

Your stake as a regulator.

DISCLAIMER

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PREFACE

The U.S. Department of Energy (DOE) is charged under the Energy Independence and Security Act of 2007 (EISA 2007) with modernizing the nation's electricity grid to improve its reliability and efficiency. As part of this effort, DOE is also responsible for increasing awareness of our nation's Smart Grid. Building upon *The Smart Grid: An Introduction*, a DOE-sponsored publication released in 2008 and available online at www.smartgrid.gov, this publication is one in a series of books designed to better acquaint discrete stakeholder groups with the promise and possibilities of the Smart Grid. Stakeholder groups include Utilities, Regulators, Policymakers, Technology Providers, Consumer Advocates and Environmental Groups.

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SECTION **01**

Nationwide, demand for electricity is expected to grow 30% by 2030. Electricity prices are forecast to increase 50% over the next 7 years.

INTRODUCTION: WHAT THE SMART GRID MEANS TO REGULATORS.

Traditionally, you have been the arbiter between those who provide energy and those who use it, ensuring ratepayers affordability, fairness, certainty and reliability and utilities fair return on their investment. As the nation moves toward a smarter grid – as codified in the Energy Independence and Security Act – regulators will get to play an ever more vital role in determining our collective Smart Grid future.

TITLE XIII – SEC. 1301. STATEMENT OF POLICY ON MODERNIZATION OF THE ELECTRICITY GRID

It is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and achieve the goals that together define a Smart Grid.

The Smart Grid represents an opportunity unlike any that you have ever encountered. It will enable you to reconcile the issues before you today with the modernization of an electrical grid necessary for our collective welfare and national prosperity decades or more from now. It will allow you to more finely, equitably and confidently make the necessary trade-offs among classes of ratepayers. It will empower consumers to be able to manage their own energy consumption. And it will add new flexibility in rate design and new visibility into whether or not a new power plant is needed.

Rather than another cost, the Smart Grid represents a potential solution to embrace approaches that have worked in other industries. With grid modernization already taking place on a number of fronts, it simply makes sense to consider these efforts as part of the comprehensive and unified whole that the Smart Grid represents. When viewed in this way, a host of significant societal benefits also emerge.

OUR CURRENT GRID MODEL IS, FOR BOTH GOOD AND ILL, TIED TO THE PAST

Both tireless workhorse and engineering marvel, the grid has sustained our economy, security and way of life for the last century. That's the good news. As you know, it is also based largely on one-way technology that was "state of the art" when Sputnik first orbited the planet and Hula Hoops orbited teenage waistlines. Consider the grid's impending system stressors:

Electricity prices are forecast to increase 50% over the next 7 years.[1]

SMARTER GRID / SMART GRID

Because it is deploying now, yet will only be fully realized over time, it is necessary to split one Smart Grid into two for the purpose of discussion: A smarter grid refers to the current state of the transformation, one in which technologies are being deployed today or in the near future. The Smart Grid is the ultimate vision – the full realization of everything it can be.

Nationwide, demand for electricity is expected to grow 30% by 2030.[2]

Spiraling electricity rates and the cost of carbon (to be fully ascertained through the outcome of proposed cap-and-trade legislation) are combining to reveal the true – i.e., higher – cost of energy.

If we do nothing, U.S. carbon emissions are expected to rise from 1700 million tons of carbon per year today to 2300 million tons of carbon by the year 2030.[3]

The costs of new generation and delivery infrastructure are climbing sharply. According to The Brattle Group – a consulting group that specializes in economics, finance, and regulation – investments totaling approximately $1.5 trillion will be required over the next 20 years to pay for the infrastructure alone. According to the same study, that's 50% lower than it might otherwise be without the Smart Grid.

THE SMART GRID: A WORKING DEFINITION

Defining the Smart Grid is in itself tricky business. Select six stakeholders and you will likely get at least six definitions. According to DOE, it is this: The Smart Grid is the electric delivery network from electrical generation to end-use customer integrated with the latest advances in digital and information technology to improve electric-system reliability, security and efficiency. More broadly, the Smart Grid is the Internet brought to the utility, adding intelligence to revitalize the system rather than reinvent it.

To be sure, there are significant barriers to deployment. Among them is the lack of agreed-upon interoperability standards. Issues relating to proving cost-effectiveness. A compelling business case. Suggestions that vendors are out to "gold plate" the system. And an entire economy suddenly intent upon saving wherever and whenever it can.

But the benefits of Smart Grid implementation as set forth by DOE's Modern Grid Strategy are too fundamental and enduring to ignore. Among these are downward pressure on electricity prices made possible by marketplace efficiencies and consumer involvement; improved reliability and significant outage reduction; increased grid robustness for improved grid security; reduced losses and emissions; the integration of renewable energy; substantial job growth in areas from PV installation to grid-assisting technologies; and the opportunity to revolutionize not only the utility sector, but also the transportation sector through the integration of electric vehicles as generation and storage devices.

THE ELEMENTS OF TITLE XIII

(1) Increased use of digital information and controls technology.

(2) Optimization of grid operations and resources, with full cyber-security.

(3) Deployment and integration of distributed resources and generation, including renewable resources.

(4) Incorporation of demand response, demand-side resources, and energy-efficiency resources.

(5) Deployment of `smart' technologies for metering, communications concerning grid operations and status, and distribution automation.

(6) Integration of `smart' appliances and consumer devices.

(7) Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.

(8) Provision to consumers of timely information and control options.

(9) Development of standards for communication and interoperability of appliances and equipment connected to the electric grid.

(10) The lowering of unreasonable or unnecessary barriers to adoption.

REGULATORS ARE NOT WITHOUT A SMART GRID "ROADMAP"

Consider three "wires businesses"--telecommunications, cable and electricity. Two have become digitized with extraordinary outcomes and dramatically increased efficiencies. Markets have been made, innovation encouraged and a new era of customer choice inaugurated. The potential exists for the same kind of transformation in this third public network to enable new generations of systemwide transmission and distribution technologies, distribution automation and "five nines" (99.999%) reliability.

CONSIDER THIS A PROSPECTUS ON THE POTENTIAL OF OUR PRESENT AND FUTURE GRID

You'll learn about the barriers and opportunities relative to Smart Grid adoption; you'll discover how some regulators have already taken significant steps or put projects in place; you'll see how consensus is being achieved as various stakeholders align behind the need for a Smart Grid, if not exactly agreeing on the steps needed to get there. And you'll gain insight into what extent many consumers and utilities are already on board.

FARSIGHTED FRAMERS: THE SMART GRID OF 1933

Broadly stated, the four objectives of rate-making policy, memorialized in the Regulatory Compact, are to minimize the cost of electricity to consumers; maintain the financial integrity of the utility; minimize future costs; and balance social and environmental concerns.

Clearly, the adoption of the Smart Grid is wholly consistent with these objectives. Yet it is important to recall that the Compact was established when electricity was required strictly for safety and convenience. Later, health and comfort were addressed with the large-scale introduction of air conditioning. And the 1970s ushered in the age of the consumer with the profusion of portable electronics. Next up: Consumers generating energy for sale.

Drastically changing consumer requirements and behavior argue powerfully for a fresh interpretation of the Compact to maximize opportunities for all. It is the Smart Grid that forms the framework for such a future.

For the first time, residential customers will have the same types of demand-response options as many commercial and industrial customers enjoy today.

THE POWER OF INTELLIGENCE: SOCIETAL BENEFITS OF A MODERNIZED GRID.

As numerous studies indicate, the societal case and financial benefits for Smart Grid adoption are fundamental, lasting and real and will flow through to all stakeholders.

- *Over 20 years, $46 billion to $117 billion could be saved in the avoided cost of construction of power plants, transmission lines and substations.[4]*
- *Increasing energy efficiency, renewable energy and distributed generation would save an estimated $36 billion annually by 2025.[5]*
- *Distributed generation can significantly reduce transmission-congestion costs, currently estimated at $4.8 billion annually.[6]*
- *Smart appliances costing $600 million can provide as much reserve capacity to the grid as power plants worth $6 billion.[7]*

Realizing the Smart Grid will require, to greater or lesser degrees, smart sensors and controls, a broadly accepted communications platform, advanced tools for planning and operation and dynamic pricing. It will also require clear standards for interconnection, performance and metrics. Constantly communicating, proactive and virtually self-aware, the Smart Grid has been described as something of an ecosystem.

It is a fitting characterization.

When viewed relative to "the grid we have now," transformation to this smarter grid will give rise to enhancements that promise to positively affect every aspect of electricity generation, delivery and consumption, as most recently detailed by DOE's Modern Grid Strategy and the Electricity Advisory Committee.

HERE'S HOW THE SMART GRID DELIVERS:

Benefit: Enabling active participation by consumers.

A smarter grid gets that way by giving consumers the power to participate and choose. Two-way communication will create a dialog between utilities and consumers enabling consumers to see what electricity they use, when they use it, and how much it costs. For the first time, many will be able to manage their energy costs proactively, whether that means investing in intelligent, energy-saving end-use devices or selling energy back to the utility for revenue or as a means of exercising environmental stewardship.

From the utility perspective, "customer participation" will enable utilities to enlist consumer demand as another resource, offsetting power generation. With consumers' involvement, utilities will be able to help balance supply and demand and ensure reliability by modifying the way they use and purchase electricity. For the first time, residential customers will have the same types of demand-response options as many commercial and industrial customers enjoy today.

"IF YOU ARE CALLING TO REPORT AN OUTAGE..."

It was voted the most significant engineering achievement of the 20th century. Yet some of the people who run it aren't aware it's not working unless the people "left in the dark" tell them.

Benefit: Optimizing asset utilization and efficient operation.

The Smart Grid will be able to exploit proven technologies to optimize the use of its assets – power plants, distribution substations and other critical infrastructure. Such improvements will result in more power flowing through existing assets as well as giving utilities more precise insight into the need for additional power plants. Operational improvements will range from improved load factors to lower system losses. The result: A net reduction in utility costs, and maximization of efficiencies throughout the system.

Benefit: Anticipating and responding to system disturbances.

By performing continuous self-assessments, the Smart Grid will be able to prevent disruptions rather than simply react to them and act faster than operators ever could in resolving fast-moving problems.

Benefit: Accommodating all generation and storage options.

Central to the success of the Smart Grid is the ability to safely and seamlessly accommodate a wide variety of generation, from massive centralized plants to small solar panels and everything in between. "Everything in between" refers to the growing roster of distributed energy resources (DER) which include:

- *Distributed generation (DG)*
- *Renewables*
- *Energy storage*
- *Demand response (DR)*

Opportunities for grid-connected distributed generation are substantial. With the progression of Smart Grid adoption, DER is envisioned to increase rapidly all along the value chain, from suppliers to marketers to customers. The upshot: A grid that is less expensive, more reliable and environmentally friendlier.

Benefit: Providing power quality for the digital economy.

It is a fact of modern life that our economy grows relentlessly more digital by the minute. Check out your nearest server farm, brokerage operation or high-definition television. According to the Electric Power Research Institute (EPRI), by 2011, fully 16% of our nation's electric load will require digital-quality power. And there's no turning back. The Smart Grid will be able to supply varying grades of power quality with a variety of pricing options. It will also detect and correct poor power quality before its effects become significant, dramatically

THE SMART GRID JOBS BANK

Among the Smart Grid's other "leading economic indicators" are these:

Up to 280,000 new jobs can be created directly from the deployment of Smart Grid technologies, in addition to enabling a substantial number of indirect jobs through the deployment of new technologies.[8]

The solar industry can create an estimated 440,000 gross jobs and $325 billion in economic development over the next eight years.[9]

An investment of $10 billion in 25-year solar power purchase agreements could produce 4,000 MW of energy and create 350,000 jobs.[10]

reducing customer losses due to power quality issues (currently estimated at $25 billion per year) and increasing overall quality control of the grid.[11]

Benefit: Enabling new products, services and markets.

In overlaying intelligence across the national grid, Smart Grid principles and technologies support the creation of well-integrated electricity markets compared to the somewhat Balkanized markets of today. The certainty and vibrancy inherent in such markets will attract new market participants – brokers, aggregators and the like – and open the door to new products and services.

at-a-glance

Benefits *of the Smart Grid:*

- *Enabling active participation by consumers*
- *Optimizing asset utilization and efficient operation*
- *Anticipating and responding to system disturbances*
- *Accommodating all generation and storage options*
- *Providing power quality for the digital economy*
- *Enabling new products, services and markets*

To fully capitalize upon grid modernization, elements of the Smart Grid plan must be as thoughtful as the technologies deployed.

RATES & REGULATIONS: **POSSIBLE APPROACHES.**

Currently, the benefits of the Smart Grid are not as apparent to many stakeholders as they could or should be. Like the early days of construction of the interstate highway system, it may be difficult to envision the Smart Grid's ultimate value during its building phase. In fact, perhaps all that certain observers can see when they consider the Smart Grid is disruption of the status quo.

What is abundantly clear is that our costs are rising, our environment is suffering, our energy resources are finite – and we need a plan, disruptive or not. Try to imagine the interstate highway system without one: "Roads to Nowhere," everywhere. Or the Internet without an organizing principle. Millions might have access to e-mail, but millions more would be staring at blank screens.

To fully capitalize upon grid modernization, certain elements of the Smart Grid plan must be as thoughtful as the technologies deployed. Here, we enumerate a number of approaches towards that objective.

DYNAMIC PRICING

The typical electric bill of decades past was undecipherable to many and delivered long after the electricity was. Worse yet, that bill is still being snail-mailed today to far too many consumers of electricity, at a time when existing and emerging technologies make it possible for consumers to see the day-to-day cost of electricity. The capability of Advanced Metering Infrastructure (AMI) to facilitate two-way communication, interval metering and time-based billing make dynamic pricing an option for all classes of utility customers – including lower-income customers.

Dynamic pricing reflects hourly variations in retail power costs, furnishing customers the detail necessary to manage their utility bills in a variety of beneficial ways. Three principal categories of dynamic pricing include:

- *Real-time pricing – rates are based on hourly fluctuations in wholesale markets, which enable consumers to plan their electric use to coincide with low prices.*
- *Peak-time rebate – the traditional blended rate applies, but customers can realize healthy rebates for reducing load during peak periods.*

EFFICIENCY ORGANIZATIONS: AN ALTERNATIVE APPROACH TO RETAIL RATE REFORM

NARUC holds the position that taking utilities out of the efficiency business and having that function played by a State, quasi-State, or private sector entity is a proven alternative to removing disincentives to their promoting efficiency. In fact, numerous examples exist of successful efficiency programs being delivered by non-utility providers. Examples of such organizations include Efficiency Vermont and the New York State Energy Research and Development Authority (NYSERDA).

DECOUPLING DEFINED

According to NARUC, decoupling "is a generic term for a rate adjustment mechanism that separates (decouples) an electric or gas utility's fixed-cost recovery from the amount of electricity or gas it sells. Under decoupling, utilities collect revenues based on the regulatory-determined revenue requirement, most often on a per customer basis. On a periodic basis revenues are 'trued-up' to the predetermined revenue requirement using an automatic rate adjustment."

- *Critical-peak pricing – prices can increase by 500% during peak periods, limited to a small number of hours per year. Customers agreeing to reduce usage in such hours will pay slightly lower rates for the remainder of the year.*

Especially in the prevailing economy, customers may want to avail themselves of as many tools and choices as possible to control their usage and energy bills. According to its adherents, dynamic rates, judiciously structured and applied, stand to benefit every consumer of electricity. Consider a working family out of the house for most of the day with the kids at school. The family's ability to save money by participating in demand-response efforts during the afternoon peak can be very beneficial to them.

With dynamic rates, there are also savings to the system and ratepayers as a whole every time peak demand is reduced because the utility doesn't have to buy expensive power at 2 in the afternoon on July 15 or fire up that expensive peaking plant.

INCENTIVIZING UTILITIES

The pros and cons of retail rate reform with respect to the Smart Grid include a number of hot topics. For example, historically a utility's rate of return has been based on the amount of power it generates and energy it sells. Absent in this model is the incentive for any party to conserve energy, which effectively leaves a utility's incentive to engage in demand response, energy efficiency and distributed generation out of the conversation. One way being proposed to redress this issue is decoupling.

Decoupling lowers a utility's rate of return because that utility is assuming less risk. In fact, since it now has certainty, it lowers the revenue requirements overall that customers otherwise would have to pay. If the utility over-recovers, it refunds the surplus to customers in the same way that if it under-recovered, it would require customers to pay a surcharge. Decoupling also brings a degree of transparency to rate cases among all parties – utilities, regulators and consumer advocates.

Some believe that such an incentive to save energy may make it more likely to subscribe to demand-response, energy-efficiency and distributed-generation programs that haven't "paid off" in the past.

Other stakeholders maintain that decoupling is not the answer, that it guarantees earnings to a utility rather than gives it the opportunity to earn. In response, decoupling advocates argue that it is precisely in removing this risk

DYNAMIC IDAHO

The Idaho Public Utilities Commission is actively gauging the effectiveness of dynamic pricing strategies. The state's time-variant pricing programs include Energy Watch, a simplified critical peak pricing program that rewards customers for reducing demand during summertime "Energy Watch events"; and a Time-of-Day program for customers who shift consumption of electricity from daytime hours to the late evening and weekends. Among the Commission's findings are that customers substantially reduced load during Energy Watch events.

The state is also one of the "early adopters" of decoupling. A three-year pilot has been instituted and is currently deployed by the Idaho Power company. For a map of current decoupling activity by state, visit the website of the Institute of Electric Efficiency (IEE).

or uncertainty that enables utilities to take advantage of saving energy rather than generating even more of it.

NET METERING

Net metering programs serve as an important incentive for consumer investment in distributed energy generation, enabling customers to use generation on their premises to offset their consumption by allowing their electric meters to turn backwards when they generate electricity in excess of their demand. In some states, this offset means that customers receive retail bill credits for the electricity they generate themselves, rather than buy from the system.

THESE APPROACHES ARE NOT SELF-EVIDENT

It will require significant educational outreach to ensure that consumers and utilities alike understand the potential benefits that can be gained from decoupling, dynamic pricing, net metering and similar concepts as they apply to the Smart Grid. DOE is charged with raising their awareness. This book is just one of the many resources you have at your disposal; others are noted in the Resources section.

On approaches like these and others, stakeholders can and will "agree to disagree." However, merely discussing issues such as net metering can result in various constituencies moving beyond conflict to consensus to create forward momentum toward realizing the Smart Grid.

Visit naruc.org for more information.

Visit dsireusa.org to learn more about renewable-energy and energy-efficiency incentives for each state.

HOW NET METERING WORKS IN PENNSYLVANIA

Properly designed regulations & policies like net metering can further the development of the Smart Grid.

In Pennsylvania, investor-owned utilities must offer net metering to residential customers that generate electricity with systems up to 50 kilowatts (kW) in capacity; nonresidential customers with systems up to three megawatts (MW) in capacity; and customers with systems greater than 3 MW but no more than 5 MW who make their systems available to the grid during emergencies. It is available when any portion of the electricity generated is used to offset on-site consumption .

Systems eligible for net metering include those that generate electricity using photovoltaics (PV), solar-thermal energy, wind energy, hydropower, geothermal energy, biomass energy, fuel cells, combined heat and power (CHP), municipal solid waste, waste coal, coal-mine methane, other forms of distributed generation (DG) and certain demand-side management technologies.

Net metering is achieved using a single, bi-directional meter – i.e., two-way communication – that can measure and record the flow of electricity in both directions at the same rate. Net excess generation is carried forward and credited to the customer's next bill at the full retail rate, which includes the generation, transmission and distribution components.

NIST is matching its expertise with DOE's domain expertise to formulate a Smart Grid Roadmap, set to be released by the end of 2009.

STANDARDS & SECURITY: **GETTING TO CERTAINTY.**

Present and future architects of the Smart Grid look for regulatory certainty before they can confidently enter the marketplace with their respective tools and technologies. Meanwhile, many regulators are seeking evidence of mature interoperability and security standards before they can convey such certainty. Historically, in industries from telecommunications to computers, standards follow markets rather than lead them. That said, standards in both areas are evolving with all deliberate speed.

ABOUT NIST

Founded in 1901, NIST is a non-regulatory federal agency whose mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. NIST has created standards for everything from automated teller machines and atomic clocks to mammograms and semiconductors. The agency has been designated within EISA 2007 (Title XIII) to develop the standards framework for Smart Grid technologies.

A status report:

INTEROPERABILITY STANDARDS: NIST AND THE ROADMAP

Many within the regulatory community argue that waiting for standards is the only way to ensure cost-effective interoperability. Others hold that the only standard required is the size of the plug for Smart Grid appliances. Still others maintain that waiting for standards might have retarded the growth of personal computing to the extent that we'd still be playing Pong.

Clearly, there are technologies that can and are being implemented within utilities in anticipation of Smart Grid adoption, among them a wide array of smart sensors. And as long as open technology-neutral standards are observed, private industry is free to develop standards on its own. However, the National Institute of Standards and Technology (NIST) will draw the Interoperability Roadmap. Ultimately, interoperability standards are needed to ensure that software and hardware components from different vendors will work together seamlessly, while cyber security standards will protect the multi-system network against natural or human-caused disruptions.

NIST is matching its expertise with DOE's domain expertise to formulate a Smart Grid Roadmap, set to be released by the end of 2009. At the same time, the GridWise Architecture Council has begun to develop an interoperability maturity model to determine the appropriate process for developing software.

These efforts provide a starting point to bring the stakeholders together to work toward common goals and visions of what the Smart Grid needs to become.

SECURITY: BUILT IN

The grid that we grew up with was never built with today's security in mind. The grid as we know it was engineered, designed and built during a time when "security" referred to the continuing operation of the grid itself rather than determined efforts by terrorists and others to harm it.

Times have certainly changed. Today, the integrity of the grid is itself an issue of national security. At issue are not only attacks *on* the power system, i.e., physical attacks – but also attacks *through* the power system, or cyber attacks. According to the Government Accountability Office (GAO), cyber attacks are increasing at an alarming rate. As far back as 2002, the GAO reports, 70% of energy and power companies experienced some kind of severe cyber attack to computing or energy management systems.

Ironically, recent technological approaches to the grid, including reliance on unprotected telecommunications networks, may be adding to the security problem. In addition, the ease of accessibility to open information sources available via the Internet may also be putting the infrastructure at risk.

A smarter grid, meanwhile, makes security an imperative from the outset. A systems approach to electric power security will identify key vulnerabilities, assess the likelihood of threats and determine consequences of an attack. Planning for man-made threats will consider multiple points of potential failure. Standards are being actively developed here as well.

SECURITY AT THE METER

A collaborative utility task force – the Advanced Metering Infrastructure Security Task Force (AMI-SEC) – is currently partnering with DOE to develop a common set of cybersecurity requirements for advanced metering infrastructure (AMI). Utilities contributing to this effort include American Electric Power, Austin Energy, BC Hydro, Consumers Energy, Dominion, Duke Energy, Exelon, Kansas City Power & Light, Oncor, Pacific Gas & Electric, San Diego Gas & Electric and Southern California Edison. The AMI System Security Requirements document is available online at http://osgug.ucaiug.org/utilisec/amisec.

Simply put, the purpose of the Collaborative is to get a fix on the state of Smart Grid issues, technologies and best practices.

FERC, NARUC & THE SMART GRID CLEARINGHOUSE: **USING THE POWER OF COLLABORATION TO DRAW CLARITY FROM COMPLEXITY.**

DOE-sponsored Smart Grid projects of various sizes and scope are increasingly coming before regulatory commissions in jurisdictions across the country.

In terms of generating enduring benefits to the grid and society, the Smart Grid represents seven defining and beneficial functions:

- *Enabling informed participation by customers*
- *Accommodating all generation and storage options*
- *Enabling new products, services and markets*
- *Providing the power quality for the range of needs in the 21st century*
- *Optimizing asset utilization and operating efficiently*
- *Addressing disturbances through automated prevention, containment and restoration*
- *Operating resiliently against physical and cyber events and natural disasters*

Clearly, these functions are desirable by any standard. Yet reconciling their value with the day-to-day business before the nation's regulators is complex at best. Regulators are hard at work balancing competing priorities; keeping utility service reliable and affordable; "greening" the electricity supply; modernizing transmission; and combating climate change. Where precisely does the Smart Grid "fit" in their busy schedules and what does it mean to the ratepayers they serve?

FERC/NARUC SMART GRID COLLABORATIVE

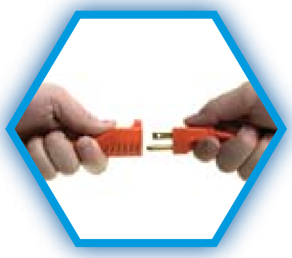
To further their understanding with regard to the range of issues associated with the Smart Grid, federal and state regulatory officials have joined together under DOE sponsorship to form the FERC/NARUC Smart Grid Collaborative, using collaboration to draw clarity from complexity.

The Collaborative brings information to regulators so they can get a better sense of the state of Smart Grid issues, technologies and best practices. At joint meetings, regulators interact with a wide array of subject-matter experts on issues that range from AMI to interoperability standards to appropriate timing for Smart Grid deployments. Additionally, they are apprised of Smart Grid projects already at work. Most recently, at the request of the two organizations, DOE has established the Smart Grid Clearinghouse, a comprehensive website built to house "all things Smart Grid," detail and analyze best practices, and enable regulators to make more informed ratemaking decisions.

THE SMART GRID CLEARINGHOUSE

The Collaborative sees the DOE-sponsored Smart Grid Clearinghouse as an additional tool for Smart Grid stakeholders to advance Smart Grid concept and implementation as well as a venue for many federal and state agencies and public and private sector organizations to assess Smart Grid development and practices. Public and private entities and their representing associations – collectively referred to as the Smart Grid community – can also benefit from Clearinghouse access. These entities could include, but are not limited to:

- *Federal governmental agencies or affiliations (e.g., the U.S. Department of Energy and its Electricity Advisory Committee; the Federal Energy Regulatory Commission, the National Institute of Standards and Technology, and the multi-agency Federal Smart Grid Task Force)*
- *National Association of Regulatory Utility Commissioners; State regulatory bodies (e.g., public utility or energy commissions)*
- *Industry or trade associations (e.g., electric utilities, product and service suppliers, Electric Power Research Institute, Edison Electric Institute, National Rural Electric Cooperative Association, American Public Power Association, GridWise Alliance, National Electrical Manufacturers Association)*
- *End users and many other Smart Grid stakeholders*



TRANSFORMING OUR GRID'S TO-DO LIST INTO A CAN-DO LIST

- *Improving reliability*
- *Managing affordable energy costs*
- *Maximizing energy efficiency*
- *Fully exploiting renewable sources of energy, like wind, solar and geothermal*
- *Shrinking our nation's carbon footprint*
- *Reinforcing our national security*
- *Reducing our dependence on foreign oil*
- *Creating a green-collar workforce numbering in the millions*

Clearly, there is broad consensus around the worthiness of these issues, several of which rise to the level of national priorities. Just as clearly in these challenging times, regulators must address them all more or less simultaneously. As an organizing principle and enabling engine, the Smart Grid can integrate all of these benefits as part of a unified plan.

The Smart Grid Clearinghouse will serve as a repository for public Smart Grid information and direct its users to other pertinent sources or databases for additional public Smart Grid information. The Clearinghouse will become the preeminent resource for stakeholders interested in researching high-level Smart Grid developments and keeping abreast of updates.

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In general, the Clearinghouse will be established and maintained in a timely manner that will make data from Smart Grid demonstration projects and other sources available to the public.

To ensure transparency and maximize "lessons learned," recipients of DOE Smart Grid Investment Grants will be required to report setbacks as well as successes on the site. Accentuating such lessons will speed knowledge transfer, facilitate best practices and hasten the progress of all Smart Grid initiatives.

SMART GRID "FOR THE REST OF US"

Analogous to the Clearinghouse, the Department of Energy will also launch www.smartgrid.gov. Created for a far broader audience – a "typical" American consumer of electricity interested in the country's energy plan but possibly puzzled by its complexity – this site will keep the public informed about DOE's activities in support of the Smart Grid in an easy-to-understand manner. The site will also function as a single point of entry for the general and trade news media, providing a value-added reference point for this key outreach constituency.

Moving forward can't be done without adopting a systems view. Utilities in search of a starting place need look no further than the Smart Grid Maturity Model.

THE SMART GRID MATURITY MODEL: **BECAUSE ONE SIZE DOESN'T FIT ALL.**

No two electricity service providers are alike. Nor are their business plans or investment strategies. As utilities across the country consider investing in a Smart Grid, they're also searching for a reasonable degree of solid footing. Utility executives want to know that making the grid smarter is good business with clear benefits.

In effect, how does a Smart Grid-curious utility "do" the Smart Grid?

Moving forward toward the Smart Grid can't be done without adopting a systems view. Utilities in search of a starting place need look no further than the Smart Grid Maturity Model (SGMM). The Maturity Model creates a roadmap of activities, investments and best practices with the Smart Grid as its vision. Utilities using the model will be able to establish an appropriate development path, communicate strategy and vision, and assess current opportunities. The Maturity Model can also serve as a strategic framework for vendors, regulators and consumers who have or desire a role in Smart Grid transformation.

Maturity models – which enable executives to review the progress a business is making in transforming or altering the way it operates – have an admirable track record of moving entire industries forward. Consider, for example, how they have transformed the software development industry.

During 2007-2009, IBM and seven utilities from four continents developed the Maturity Model and recently donated it to the Carnegie Mellon Software Engineering Institute (SEI). The SEI has developed worldwide de facto standards, such as the Capability Maturity Model Integration (CMMI) for process improvement, and led international efforts to improve network security through its globally recognized Computer Emergency Response Team (CERT) program.

The U.S. Department of Energy is working with the SEI, enabling the Institute to serve as the independent steward of the global SGMM with primary responsibility for its ongoing governance, growth and evolution based upon stakeholder needs, user feedback and market requirements.

SMART GRID MATURITY MODEL
Levels, Descriptions, Results

LEVEL	ONE: Exploring and Initiating	TWO: Functional Investing	THREE: Integrating Cross Functional	FOUR: Optimizing Enterprise Wide	FIVE: Innovating Next Wave of Improvements
DESCRIPTION	*Contemplating Smart Grid transformation. May have vision but no strategy yet. Exploring options. Evaluating business cases, technologies. Might have elements already deployed.*	*Making decisions, at least at a functional level. Business cases in place, investment being made. One or more functional deployments under way with value being realized. Strategy in place.*	*Smart Grid spreads. Operational linkages established between two or more functional areas. Management ensures decisions span functional interests, resulting in cross-functional benefits.*	*Smart Grid functionality and benefits realized. Management and operational systems rely on and take full advantage of observability and integrated control across and between enterprise functions.*	*New business, operational, environmental and societal opportunities present themselves, and the capability exists to take advantage of them.*
RESULT	Vision	Strategy	Systemization	Transformation	Perpetual Innovation

To support widespread adoption and use, the SEI will ensure availability of the model and supporting materials and services for the user community, including a suite of offerings on how to use the tool and "train the trainer" sessions.

It is important to note that the Smart Grid Maturity Model is not a means of comparing one utility with another; rather, the intent is strictly one of self-assessment. The first step for utilities is taking the Smart Grid Maturity Model survey by contacting customer-relations@sei.cmu.edu. The survey offers insights into a utility's current position relative to adoption and development of the business plan necessary to set milestones toward achieving the benefits of the Smart Grid – for both residential and business customers.

PARTICIPATION TO DATE

1. PORTLAND GEN.
2. BC HYDRO
3. EPCOR
4. MANITOBA HYDRO
5. BONNEVILLE POWER
6. SEMPRA
7. SALT RIVER PROJECT
8. COSERVE
9. AUSTIN ENERGY
10. CENTERPOINT
11. ENTERGY
12. EAST MISS. EPA
13. COMED
14. DOMINION VIR.
15. ALLEGHENY POWER
16. PEPCO
17. DUKE
18. AEP
19. HYDRO OTTAWA
20. SCANA CORP.
21. EXELON
22. VELCO
23. FIRST ENERGY

A smarter grid delivers end-use conservation and efficiency thanks to its ability to establish more focused and persistent consumer participation.

SMART GRID & THE ENVIRONMENT: **ENABLING A CLEANER ENERGY FUTURE.**

In 2008, emissions of carbon dioxide from fuel burning in the United States were down 2.8%, the biggest annual drop since the 1980s.[12] This is widely attributable to the length and depth of the worldwide recession and just as widely expected to be an anomaly. Most agree, as the national and global economies improve, carbon emissions will resume their upward trend.

WHY ENERGY EFFICIENCY ALONE HAS ITS LIMITS

Without the Smart Grid, even the boldest energy-efficiency initiatives are not enough. The Census Bureau projects that in 30 years, the United States will be home to 100 million more people, roughly a third more than we have today. Leading organizations like EPRI and others have run the numbers and hold that population growth and a steadily improving economy will more than wipe out the gains from efficiency programs.

Thanks to its ability to establish more focused and pervasive consumer participation, a smarter grid delivers end-use conservation and efficiency. In so doing, it also positively addresses our nation's growing carbon footprint.

Proving that timing is everything, a smarter grid can capture carbon savings from peak load shifting – even if energy is not being saved. When peak load is reduced by means of demand response, many peaking plants – and the carbon they emit – are kept on the sidelines.

ENABLING CARBON SAVINGS

The full exploitation of renewable energy sources such as wind and PV solar is critical to managing our collective carbon footprint. However, when viewed against the limitations of the current grid, both technologies face barriers to full-scale deployment. A smarter grid enables grid operators to see further into the system and allows them the flexibility to better manage the intermittency of renewables. This in turn surmounts a significant barrier, enabling wind and solar to be deployed rapidly – and in larger percentages.

OPTIMIZING WIND

Although possessing myriad attributes, renewables also increase the complexity of operating the grid. A smarter grid enables operators to manage against this complexity.

The Smart Grid can lower the net cost for wind power by regulating fluctuations with demand response. Combining demand response, energy storage and distributed and centralized generation assets can manage these fluctuations (i.e., when the wind doesn't blow)

CAP & TRADE & SMART GRID

- *Congress is working on proposed legislation that would limit greenhouse gas emissions and turn them into a commodity that can be bought and sold (i.e., cap and trade). Accurate accounting of actual carbon footprints made possible by a smarter grid offers solid verification, thereby capturing the value and enhancing the tradability of carbon offsets.*

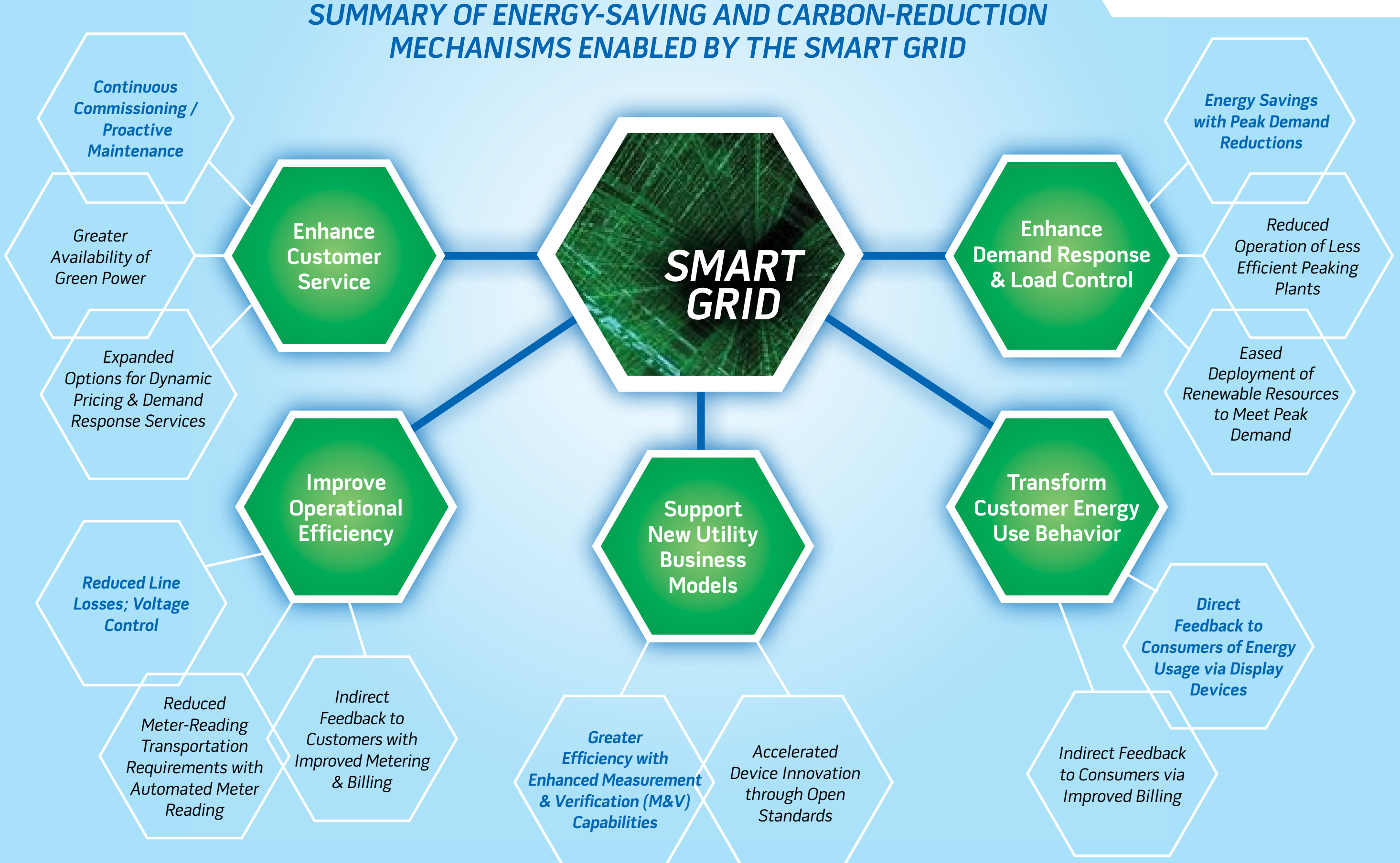
to lower the cost of integrating wind into the system. Overall, the Smart Grid can optimize the penetration of renewables into our nation's electrical system.

A smarter grid can optimize wind resources in conjunction with demand response controls, dealing with the intermittency of such resources by actively managing "holes in the wind."

OPTIMIZING SOLAR

A PV array on every roof would be a welcome sight. However, although existing distribution grids are capable of safely supporting high penetrations of PV solar energy, placing excess power back onto the grid may pose problems. Smart Grid control systems can help the grid rise to this challenge.

SUMMARY OF ENERGY-SAVING AND CARBON-REDUCTION MECHANISMS ENABLED BY THE SMART GRID



As the owners of the infrastructure, utilities and other service providers are keenly aware of their sizable carbon footprints. Recently, in EPRI's Green Grid Whitepaper, the Institute identified ways in which utilities can reduce carbon through the use of Smart Grid approaches and technologies.

SECTION **08**

Widespread adoption of PEVs will cut GHG emissions including CO_2 and significantly reduce our dependence on foreign oil.

THE SMART GRID & ELECTRIC VEHICLES: **DRIVING TOWARD A CLEANER PLANET.**

The Smart Grid's single biggest potential for delivering carbon savings is in providing cost-effective and increasingly clean energy for plug-in electric vehicles (PEVs). Included within this vehicle class are plug-in hybrid electric vehicles (PHEVs), the next generation of hybrids.

Here's how they work. PEVs can actually be plugged in to a standard household electrical outlet to recharge their batteries. Capable of travelling up to 40 miles in electric-only mode, the majority of PEVs operating on battery power would meet the daily needs of most drivers, according to the Edison Electric Institute (EEI). Compared with a current hybrid, a PEV with an electric-only range of 20 miles could reduce fuel use by about one-third according to a report by the American Council for an Energy-Efficient Economy (ACEEE). EPRI estimates that the same PEV could reduce fuel consumption by about 60% compared with non-hybrid vehicles.

Although the vehicles will be producing the savings rather than the Smart Grid, only Smart Grid technologies will allow us to tap their fundamental potential. Consider the following ramifications:

The idle production capacity of today's grid – potential that is not now being used – could supply 73% of the energy needs of today's cars, SUVs, pickup trucks, and vans with existing power plants.[13]

On average, PHEVs will produce just one-third of the greenhouse gases (GHGs) emitted by conventional, gasoline-fueled vehicles – tailpipe to tailpipe. According to a joint study by EPRI and the Natural Resources Defense Council (NRDC), PHEVs have the potential to reduce cumulative U.S. GHG emissions by as much as 10.3 billion tons from 2010 to 2050. PHEVs could reduce national oil consumption by as much as four million barrels of oil per day in 2050 according to that same study.

PHEVs could potentially displace 52% of net oil imports (or 6.7 million barrels per day) and reduce CO_2 emissions by 27%.

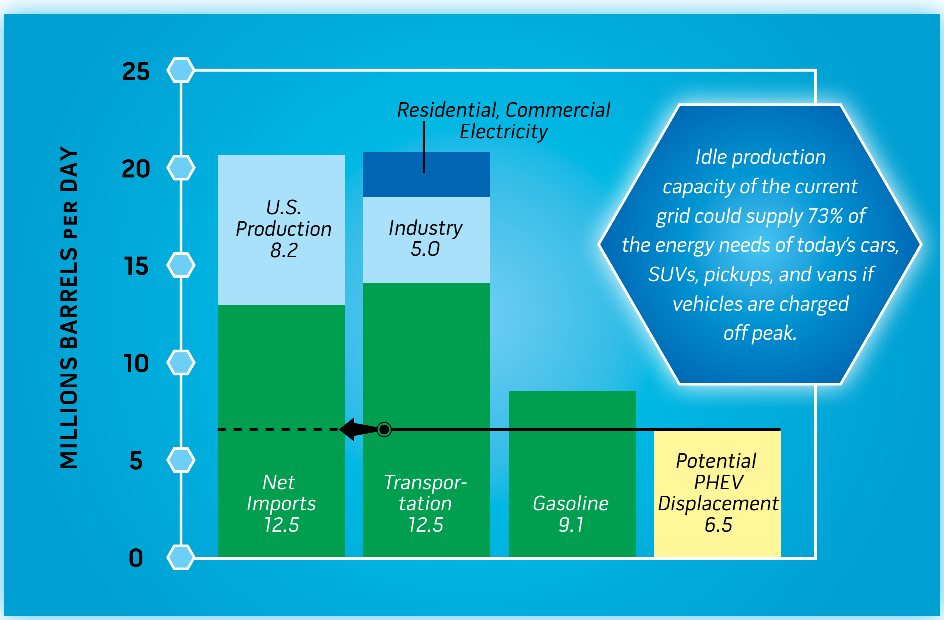
Currently, the United States imports almost 60% of its oil – 70% of which goes directly to the transportation sector. PHEVs could potentially displace 52% of net oil imports (or 6.7 million barrels per day) and reduce CO_2 emissions by 27%.[14]

Furthermore, by enabling the sale of more electricity over the same infrastructure, the Smart Grid has the potential to lower electric rates. These benefits accrue, however, only if these vehicles are charged strictly off-peak. Charging PEVs on-peak would only further stress the grid.

In terms of carbon emissions, the nation's vehicles produce roughly the same carbon emissions as the nation's coal-based power plants. By moving their emissions from millions of tailpipes to far fewer smokestacks, the Smart Grid could dramatically reduce the size and complexity of the industry's ongoing "clean-up detail." That is, rather than wondering how to handle hundreds of millions of four-wheeled emitters, Smart-Grid functionality enables us to shift focus to challenges ranging from carbon management to the use of more renewable sources of electricity.

Widespread adoption of PHEVs will cut GHG emissions including CO_2 and significantly reduce our dependence on foreign oil. The first models are scheduled to roll off assembly lines in 2010.

POTENTIAL IMPACTS OF HIGH PENETRATION OF PLUG-IN HYBRID ELECTRIC VEHICLES ON THE US POWER GRID



ATTENTION FOREIGN OIL SHOPPERS...

- *According to EEI, at 2009 fuel prices, PHEVs will run on the gasoline equivalent of roughly 75 cents per gallon.*

Although some consumers will opt for continued passivity, many more want to be involved in managing how and when they consume energy.

SMARTER GRID IN MOTION: **A PROGRESS REPORT.**

Attempting to gauge the rate of acceptance for a smarter grid reveals a fluid landscape of changing attitudes, successful Smart Grid programs and appliances that think.

ONE LESS $10 MILLION SUBSTATION

DOE is funding several demonstration projects across the country. Among these is the Perfect Power project at the Illinois Institute of Technology (IIT), leveraging advanced technologies to create a replicable and more reliable microgrid. The project's goals: To promote distribution automation, encourage more local and renewable energy generation and electricity usage both on- and off-peak. Prior to embarking on this demonstration project, local utility Exelon had planned on building a third $10 million substation to serve IIT's growing needs. That will no longer be necessary. Not only will this project eliminate the substation's cost, but also the carbon dioxide it would have generated.

PEOPLE

What will the Smart Grid do for consumers? And how much do consumers care?

In addition to making grid operations as a whole more reliable – an extremely worthy goal in itself – the smart grid will empower average energy consumers to a degree unimaginable just a few years ago. Given new awareness, understanding and tools, they'll be able to make choices that save money, enhance personal convenience, improve the environment – or all three.

Until recently, the overwhelming majority of consumers considered energy a passive purchase. According to conventional wisdom, no one really wanted to think about it. And, frankly, why would they want to? Historically, the system never differentiated the true cost of electricity to the consumer, so they've been programmed not to care. Recent research, however, indicates that this perception has changed significantly. Research conducted in 2007 by Energy Insights indicates that consumers are interested in opportunities afforded them by the Smart Grid.

Although some consumers will opt for continued passivity, many more want to be involved in managing how and when they consume energy. Living in a world of seemingly endless customer choice – courtesy of the Internet, telecom and YouTube – consumers have grown impatient with systems characterized by one-way communication and consumption. Research by Energy Insights also reveals that 70% of respondents expressed "high interest" in a unit that keeps them apprised of their energy use as well as dynamic pricing.

Another key trigger for the growth of this consumer class has been growing environmental awareness. A key frustration is that members of this class don't have the tools to make these choices. Once Smart Grid technologies get this information into their hands, customers will enjoy greater levels of

When transmission and distribution sensors are added, 100% of Austin Energy's consumer base will be served by Smart Grid technologies.

satisfaction and service as measured by outage minutes and have the sense that they can control their bills. More broadly, they'll be able to do their part to reduce peak, which gives rise to both environmental and economic benefits.

PLACES

Austin, Texas

Austin Energy, a municipally-owned utility committed to innovation to control costs, thought it was embarking on a modernization project. Instead, it went far beyond that objective, enabling consumer choice through a wide array of programs including demand response/load management, distributed generation and renewable energy programs. Programs such as these enabled the utility to fund investment in new technologies at no extra cost to consumers. Recent deployment included 130,000 smart meters and 70,000 smart thermostats. When transmission and distribution sensors are added, 100% of Austin Energy's consumer base will be served by Smart Grid technologies.

Olympic Peninsula, Washington

One of the first multi-dimensional DOE Smart Grid demonstration projects asked electricity customers to specify a set of simple energy preferences – and then forget about them. In the background, the utility managed energy through smart appliances and thermostats on the customer's behalf, saving customers approximately 10% on average.[15] A true measure of customer acceptance – many didn't want the project to end.

(SMART) THINGS

As for the state of smart appliances, major home-appliance manufacturers are sufficiently convinced of the commercial viability of the Smart Grid.

Whirlpool, the world's largest manufacturer and marketer of major home appliances, has announced that it plans to make all of its electronically controlled appliances Smart Grid compatible by 2015. The company will make all the electronically controlled appliances it produces — everywhere in the world — capable of receiving and responding to signals from the Smart Grid. The company mentioned that its ability to successfully deliver on this commitment in this time frame was dependent on two important public-private partnerships: First, the development by the end of 2010 of an open, global standard for transmitting signals to and receiving signals from a home appliance; and second, appropriate policies that reward consumers, manufacturers and utilities for adding and using these new peak demand reduction capabilities.

GE's smart appliances – or demand-response appliances – include a refrigerator, range, microwave, dishwasher and washer and dryer. Currently running as a pilot program, these appliances receive a signal from the utility company's smart meter which alerts the appliances – and the participants – when peak electrical usage and rates are in effect. In the pilot program, the signal word "eco" comes up on the display screen. The appliances are programmed to avoid energy usage during that time or operate on a lower wattage; however, participants could choose to override the program.

The direction of our nation's energy future rests largely with you.

NEXT STEPS: CHOOSING AMONG AVAILABLE FUTURES.

"What would I possibly do with a computer on my desk?"

Thirty years ago, few of us could imagine an answer. Ten years from now, will we be wondering how we ever made it through the day without our PHEV?

That choice rests largely with you.

As a regulator in the 21st century, your task is a difficult one. You're charged with developing and implementing policy approaches and regulatory tools to minimize impacts on consumers, while assuring system reliability and combating climate change in an economic environment as challenging as most Americans have ever seen. But realizing the myriad benefits of the Smart Grid – economic, environmental, competitive, etc. – is going to require more than rate design based upon the reading of electromechanical meters once a month.

REGULATORS ARE TASKED WITH BASING RULES ON EVIDENCE AND STANDARDS, BUT A CLEAN, RELIABLE AND AFFORDABLE ENERGY FUTURE ARGUES FOR A LONGER-TERM VIEW.

The Smart Grid addresses resource allocation and scarcity with technology. Practically the only certainty in this scenario is that technology is going to change. Rather than focusing on standards, what regulators should consider is the adoption of a uniform – and technology-neutral – set of principles. As regulators craft proposed rulings, the question to ask is "how does this case fit into our principles?"

As in many other areas of the Smart Grid, substantial work has already been accomplished toward such a common framework. In 2006, one of the early work products of the GridWise Architecture Council was the drafting of an Interoperability Constitution. Designed to be ratified by stakeholders, a similar document could be developed by regulators to be ratified by their commissions.

The Smart Grid represents our nation's single best chance to build reliability, affordability and sustainability into the electric system.

THE ROAD FROM HERE

In addressing the potential of the Smart Grid, your efforts will have far-reaching implications for every stakeholder. You will be serving not only ratepayers and society, but also posterity. The immediate challenge now is toward building consensus. As one regulator opined, there is not yet a body of knowledge about the Smart Grid at the lay level.

There's never been a better time to start building one, particularly considering that $4.5 billion in stimulus funds under the American Recovery and Reinvestment Act of 2009 (ARRA) have already been disbursed toward its realization.

And there's this: The efficiencies that Smart Grid technologies begin building in today will grow significantly over a relatively short time. According to EPRI, by modernizing the grid and implementing Smart Grid technology, the United States can save $638 - $802 billion over 20 years, producing an overall benefit to cost ratio of 4:1 to 5:1. Put another way, this means that every dollar spent on the Smart Grid will produce savings of four to five dollars.

Convening a series of public forums attended by stakeholders of every stripe represents momentum toward Smart Grid awareness, acceptance and adoption. Spending time learning more about the Smart Grid – from publications like this one, Smart Grid conferences, organizations such as DOE and the national labs, and even vendors – further focuses that momentum.

The Smart Grid represents our nation's single best chance to build reliability, affordability and sustainability into the electric system. Like the Internet, it will ultimately change the lives of all citizens. Also like the Internet, once a "killer app" like PEVs attains a threshold of visibility, people who don't "have" the Smart Grid will want it.

Getting stakeholders to agree on the path forward ensures that you will be ready for them.

THE CASE FOR A NOVEL BUSINESS CASE

A smarter grid will evolve into the fully integrated Smart Grid over time. Much like every major modernization effort in history, it will face hurdles. Consider the business case for investing in the Smart Grid. Currently, business cases for investing in the Smart Grid processes and technologies are often incomplete when viewed strictly with regard to near-term cost-effectiveness.

Invariably, it is easier to demonstrate the value of the end point than it is to make a sound business case for the intermediate steps to get there. Societal benefits, often necessary to make investments in modern grid principles compelling, are normally not included in utility business cases.

These very societal benefits in terms of incentives and methods for reducing investment risks might stimulate the deployment of modern grid processes and technologies. The future is in your hands to create an infrastructure suitable for the 21st century by making the Smart Grid a reality. It is far more than a line item in a rate case. It is your legacy.

GLOSSARY: SMART GRID TERMS WORTH KNOWING.

ADVANCED METERING INFRASTRUCTURE (AMI): AMI is a term denoting electricity meters that measure and record usage data at a minimum, in hourly intervals, and provide usage data to both consumers and energy companies at least once daily.

CARBON DIOXIDE (CO_2): A colorless, odorless, non-poisonous gas that is a normal part of Earth's atmosphere. Carbon dioxide is a product of fossil-fuel combustion as well as other processes. It is considered a greenhouse gas as it traps heat (infrared energy) radiated by the Earth into the atmosphere and thereby contributes to the potential for global warming. The global warming potential (GWP) of other greenhouse gases is measured in relation to that of carbon dioxide, which by international scientific convention is assigned a value of one (1).

DEMAND RESPONSE: This Demand-Side Management category represents the amount of consumer load reduction at the time of system peak due to utility programs that reduce consumer load during many hours of the year. Examples include utility rebate and shared savings activities for the installation of energy efficient appliances, lighting and electrical machinery, and weatherization materials.

DISTRIBUTED GENERATOR: A generator that is located close to the particular load that it is intended to serve. General, but non-exclusive, characteristics of these generators include: an operating strategy that supports the served load; and interconnection to a distribution or sub-transmission system.

DISTRIBUTION: The delivery of energy to retail customers.

ELECTRIC POWER: The rate at which electric energy is transferred. Electric power is measured by capacity.

ELECTRIC UTILITY: Any entity that generates, transmits, or distributes electricity and recovers the cost of its generation, transmission or distribution assets and operations, either directly or indirectly. Examples of these entities include: investor-owned entities, public power districts, public utility districts, municipalities, rural electric cooperatives, and State and Federal agencies.

ENERGY EFFICIENCY, ELECTRICITY: Refers to programs that are aimed at reducing the energy used by specific end-use devices and systems, typically without affecting the services provided. These programs reduce overall electricity consumption (reported in megawatthours), often without explicit consideration for the timing of program-induced savings. Such savings are generally achieved by substituting technologically more advanced equipment to produce the same level of end-use services (e.g. lighting, heating, motor drive) with less electricity. Examples include high-efficiency appliances, efficient lighting programs, high-efficiency heating, ventilating and air conditioning (HVAC) systems or control modifications, efficient building design, advanced electric motor drives, and heat recovery systems.

FEDERAL ENERGY REGULATORY COMMISSION (FERC): The Federal agency with jurisdiction over interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas pricing, oil pipeline rates, and gas pipeline certification. FERC is an independent regulatory agency within the Department of Energy and is the successor to the Federal Power Commission.

GREENHOUSE GASES (GHGs): Those gases, such as water vapor, carbon dioxide, nitrous oxide, methane, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride, that are transparent to solar (short-wave) radiation but opaque to long-wave (infrared) radiation, thus preventing long-wave radiant energy from leaving Earth's atmosphere. The net effect is a trapping of absorbed radiation and a tendency to warm the planet's surface.

LOAD (ELECTRIC): The amount of electric power delivered or required at any specific point or points on a system. The requirement originates at the energy-consuming equipment of the consumers.

OFF PEAK: Period of relatively low system demand. These periods often occur in daily, weekly, and seasonal patterns; these off-peak periods differ for each individual electric utility.

ON PEAK: Periods of relatively high system demand. These periods often occur in daily, weekly, and seasonal patterns; these on-peak periods differ for each individual electric utility.

OUTAGE: The period during which a generating unit, transmission line, or other facility is out of service.

PEAK DEMAND OR PEAK LOAD: The maximum load during a specified period of time.

PEAKER PLANT OR PEAK LOAD PLANT: A plant usually housing old, low-efficiency steam units, gas turbines, diesels, or pumped-storage hydroelectric equipment normally used during the peak-load periods.

RATEMAKING AUTHORITY: A utility commission's legal authority to fix, modify, approve, or disapprove rates as determined by the powers given the commission by a State or Federal legislature.

RATE OF RETURN: The ratio of net operating income earned by a utility is calculated as a percentage of its rate base.

RATES: The authorized charges per unit or level of consumption for a specified time period for any of the classes of utility services provided to a customer.

RENEWABLE ENERGY RESOURCES: Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include: biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

SOLAR ENERGY: The radiant energy of the sun, which can be converted into other forms of energy, such as heat or electricity.

TIME-OF-DAY PRICING: A special electric rate feature under which the price per kilowatthour depends on the time of day.

TIME-OF-DAY RATE: The rate charged by an electric utility for service to various classes of customers. The rate reflects the different costs of providing the service at different times of the day.

TRANSMISSION (ELECTRIC): The movement or transfer of electric energy over an interconnected group of lines and associated equipment between points of supply and points at which it is transformed for delivery to consumers or is delivered to other electric systems. Transmission is considered to end when the energy is transformed for distribution to the consumer.

WIND ENERGY: Kinetic energy present in wind motion that can be converted to mechanical energy for driving pumps, mills, and electric power generators.

RESOURCES: ***PLACES TO GO TO LEARN MORE.***

DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (DSIRE): *http://www.dsireusa.org*

EDISON ELECTRIC INSTITUTE (EEI): *http://www.eei.org*

ELECTRICITY ADVISORY COMMITTEE (EAC): *http://www.oe.energy.gov/eac.htm*

ENERGY FUTURE COALITION: *http://www.energyfuturecoalition.org*

EPRI INTELLIGRID: *http://intelligrid.epri.com/*

FERC/NARUC COLLABORATIVE: *http://www.naruc.org/ferc/default.cfm?c=3*

GRID WEEK: *http://www.gridweek.com*

GRIDWISE ALLIANCE: *http://www.gridwise.org*

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA): *http://www.nema.org*

NATIONAL ENERGY TECHNOLOGY LABORATORY (NETL): *http://www.netl.doe.gov/*

PACIFIC NORTHWEST NATIONAL LABORATORY (PNNL): *http://www.pnl.gov/*

PNNL GRIDWISE: *http://www.gridwise.pnl.gov/*

SMART GRID: *http://www.oe.energy.gov/smartgrid.htm*

SMART GRID MATURITY MODEL (SGMM): *http://www.sei.cmu.edu/smartgrid*

SMART GRID TASK FORCE: *http://www.oe.energy.gov/smartgrid_taskforce.htm*

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www.smartgrid.gov

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