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

WHAT A SMART GRID MEANS TO OUR NATION'S FUTURE.

A smarter electric grid works to strengthen our nation's economy, environment, security and independence.

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 policymaker.

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

THE SMART GRID: *WELCOME TO OUR GENERATION'S SPACE PROGRAM.*

When people are asked to name the most significant engineering achievement of the 20th century, a typical response is America winning the race to the moon. An understandable answer, but incorrect. Ironically, it was the first man on the moon, Neil Armstrong, who announced the award winner: Our nation's electric grid.

America's trillion-dollar grid has fueled our nation's prosperity almost since the days of Edison. It continues to keep our lights on, our businesses productive and our citizens comfortable. And it responds to our split-second demands 99.97% of the time.[2] However, it is ill-equipped on several fronts to meet our collective future. Consider the grid's declining reliability factor, recognized as long as a decade ago. The second half of the 1990s saw 41% more outages affecting 50,000 or more consumers than in the first half of the decade. It remains victim to outages and interruptions that not only inconvenience but compromise the safety of all Americans, at a cost of $150 billion annually – or $500 for each one of us.[3]

Compounding the challenges to the grid going forward:

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, investment totaling approximately $1.5 trillion will be required over the next 20 years to pay for the infrastructure alone.

Nationwide, demand for electricity is expected to grow 30% by 2030.[4]

Electricity prices are forecast to increase 50% over the next 7 years.[5]

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.

In 2007, the last year statistics were available, power plants in the United States emitted 2,500 million metric tons of carbon dioxide; total CO_2 emissions nationwide were 6,022 million metric tons, 75.9 million more than in 2006.[6]

DIMENSIONS OF A NATION BUILDER

The electric grid's approximate dimensions are indeed impressive: 1 million megawatts of generating capacity, 200,000 miles of high voltage transmission lines and 5.5 million miles of distribution lines.[1]

"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.

CLEARLY, THE GRID'S FUTURE CAN'T BE LIKE ITS PAST. AND THEREIN IS OUR OPPORTUNITY

Like the telecom and Internet revolutions that preceded it, technology holds the key to the Smart Grid and its benefits. The Smart Grid and the technologies embodied within it are an essential set of investments that will help bring our electric grid into the 21st century using megabytes of data to move megawatts of electricity more efficiently, reliably and affordably. In the process, our nation's electric system will move from a centralized, producer-controlled network to a less centralized, more consumer-interactive, more environmentally responsive model.

Far more than "smart meters," a fully functioning Smart Grid will feature sensors throughout the transmission and distribution grid to collect data; real-time two-way communications to move that data between utilities and consumers, and the computing power necessary to make that intelligence actionable and transactive.

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, we must address them all more or less simultaneously. As an organizing principle and enabling engine, only the Smart Grid will deliver all of these benefits as part of a unified plan by bringing the tools, techniques and technologies that enabled the Internet to utilities, the grid and consumers at large.

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.

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 ultimate goals that together define a Smart Grid.

THE POWER THAT RESIDES WITH YOU

To be sure, creating a Smart Grid faces fiscal, regulatory and cultural hurdles. Absent political will, these hurdles get even higher. However, federal and state legislators can have an enormous impact on the speed and effectiveness of Smart Grid deployment. Amid necessarily conflicting stakeholder agendas, congressional and state action on climate and energy issues can provide much needed impetus for investment in and adoption of the Smart Grid.

In the following pages, you'll learn what policymakers need to know about the current state of the smarter grid; the benefits it makes possible, including its potential for job creation; the steps being taken by various stakeholders toward its adoption; and how it can keep our systems secure in the face of attack.

At the outset of the telecommunications revolution, few could envision how technologies born then would ultimately transform and enrich our lives. Similarly, the journey that is the Smart Grid promises to deliver advancements and benefits that no one can now predict.

As a policymaker, one of the architects of our nation's vision, it is your job to see that future and guide America toward it.

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.

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 for Smart Grid adoption is fundamental, lasting and real.

• Over 20 years, $46 billion to $117 billion could be saved in the avoided cost of construction of power plants, transmission lines and substations.[7]

• Increasing energy efficiency, renewable energy and distributed generation could save an estimated $36 billion annually by 2025.[8]

• Distributed generation can significantly reduce transmission-congestion costs, currently estimated at $4.8 billion annually.[9]

• Smart appliances costing $600 million can provide as much reserve capacity to the grid as power plants worth $6 billion.[10]

Financial benefits of this magnitude flow through to all stakeholders.

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 a complex ecosystem.

It is a fitting characterization.

When viewed relative to "the grid we have now," transformation to this modernized 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 the need for additional power generation. With consumers' involvement, utilities will be able to help balance supply and demand and ensure reliability. A smarter grid enables residential customers to have the same type of opportunities in this regard as commercial and industrial customers.

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, resulting in maximizing 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) – small, widely dispersed plants, generally in close proximity to energy loads*
- *Renewable energy – wind, solar, etc.*
- *Energy storage – in essence, giant "batteries" and "capacitors"*
- *Demand response (DR) – decreasing demand instead of increasing supply in response to peak loads*
- *Plug-in hybrid electric vehicles (PHEVs)*

Today, there is the opportunity for far more grid-connected distributed generation. With an increasingly smarter grid, distributed energy resources are 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.

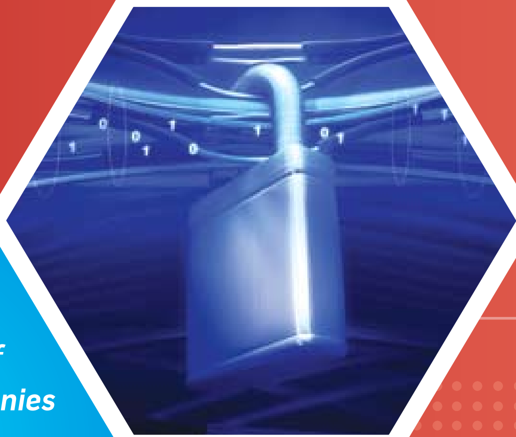
It is a fact of modern life that our economy grows relentlessly more digital by the minute. Check out your nearest server farm, brokerage operation or high-definition television. According to the Electric Power Research Institute (EPRI), by 2011, fully 16% of our nation's electric load will require digital-quality 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 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 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.

Benefit: Operating resiliently against attack and natural disaster.

Today's grid is far too susceptible to disruption by means of both natural disasters and physical and cyber attacks. The Smart Grid will address critical security issues from the outset, making security a requirement for all of its elements.



As far back as 2002, 70% of energy and power companies experienced some kind of severe cyber attack to computing or energy management systems.

SMART GRID SECURITY: **SAFETY BUILT IN.**

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 other individuals 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 changes 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 makes security 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. Resilience will be built into each element of the system, and the overall system designed to deter, detect, respond and recover from man-made disruptions as well as those from hurricanes and earthquakes. Planning for man-made threats will consider multiple points of potential failure.

According to DOE, this approach could apply risk management methods to prioritize the allocation of resources for security, including research and development. Particular goals of security programs would include:

- *Identifying critical sites and systems*
- *Protecting selected sites using surveillance and barriers against physical attack*
- *Protecting systems against cyber attack using information denial (masking)*

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).

- *Dispersing sites that are high-value targets*
- *Tolerating disruption*
- *Integrating distributed-energy sources and using automated distribution to speed recovery from attack*

KEYS TO RESISTING ATTACK

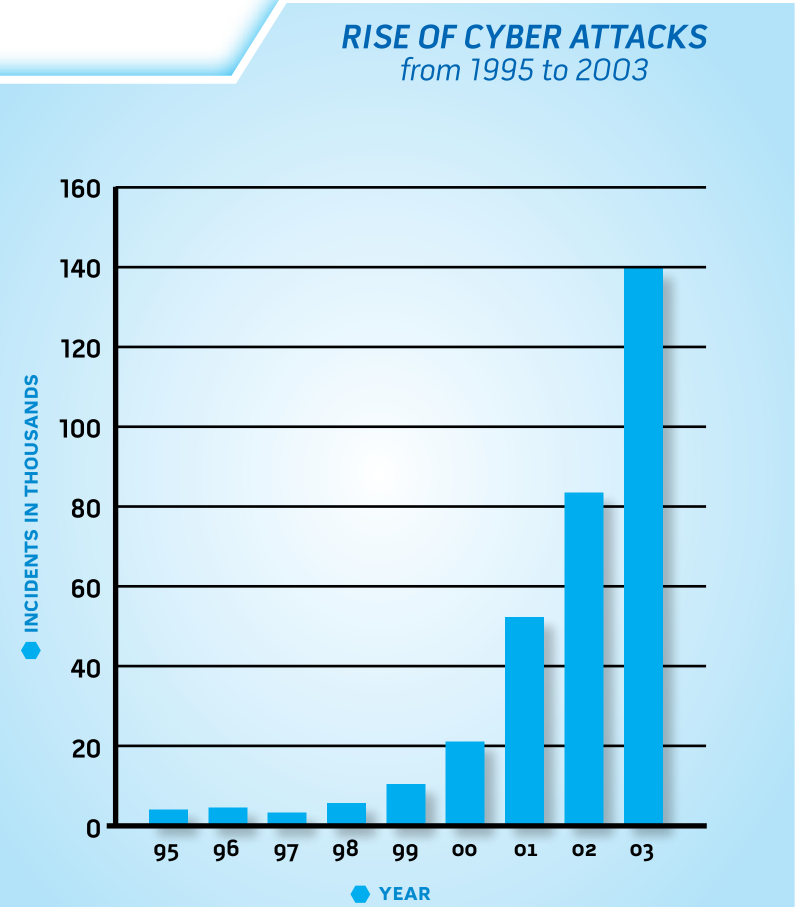
The Smart Grid must be designed – at the component level – to reduce the:

- ***Threat** of attack by concealing, dispersing, eliminating or reducing single-point failures*
- ***Vulnerability** of the grid to attack by protecting key assets from physical and cyber attack*
- ***Consequences** of a successful attack by focusing resources on recovery*

To succeed at this task, the Smart Grid's "system requirements" rely upon greater and more sophisticated levels of automation to provide wide-area monitoring, remote system control and predictive tools to deal with impending disruptions before they happen. In addition, the system must be capable of enabling "islanding" (the autonomous operation of selected grid elements) and ensuring that added equipment and control systems do not create additional opportunities for attack.

THE VALUE OF A SYSTEMS APPROACH TO GRID SECURITY

A systems approach involving government and industry encourages balanced investment that ensures costs for security requirements will be allocated across the Smart Grid. Federal, state and local policies and regulations should be developed to allow utilities and others in the electricity industry to recoup reasonable costs for security upgrades that are part of the overall system design.



An escalating problem. *Cyber attacks continue to proliferate against energy and power companies in the United States.*

A systems approach to electric power security will identify key vulnerabilities, assess the likelihood of threats and determine consequences of an attack.

KEY TECHNOLOGIES *of the Smart Grid*

MODERN KEY TECHNOLOGIES	SECURITY SOLUTIONS
Integrated Communications for Real-time Information & Control	*• Use communication for prediction and decision support • Wide-area secure communications instead of internet monitoring • Monitor and respond to threat conditions instantaneously*
Sensing & Measurement	*• Remote monitoring that detects problems anywhere in the grid • Events detected in time to respond*
Advanced Components & DER	*• Tolerant and resilient devices • Fewer critical points of failure • Distributed, autonomous resources*
Advanced Control Methods	*• Islanding to isolate vulnerable areas of the grid • Automated network "agents" for dynamic reconfiguring • Self-healing with preventive or corrective actions in real-time*
Improved Interfaces & Decision Support	*• Operator training for response to attacks • System recommendations for best response • Simplification of operator interaction with the system*

The impact of Smart Grid projects could result in the creation of approximately 280,000 new positions.

THE SMART GRID EFFECT: **REVITALIZING OUR NATION'S WORKFORCE AND ECONOMY.**

Both near- and long-term, creating the Smart Grid brings with it significant benefits with respect to America's overall employment picture and economic well-being. Welcome news indeed in a challenging economy.

A recent study by KEMA, a member of the GridWise Alliance, projects that a potential federal investment of $16 billion in the Smart Grid would act as a catalyst in driving associated Smart Grid projects worth $64 billion, due to cost sharing and other factors. The impact of these projects could result in the direct creation of approximately 280,000 new positions. More than 150,000 of these, KEMA maintains, could be created by the end of 2009. The study goes on to say that "nearly 140,000 new direct jobs would persist beyond the Smart Grid deployment as permanent, on-going high-value positions."

A GRID OPEN TO OPPORTUNITY ENABLES OUR ECONOMY

Now more than ever, our nation's economy depends on reliable energy. As noted, Smart Grid technologies can dramatically reduce total fuel consumption—and thereby potentially reduce fuel prices for all consumers. In addition, a smarter grid creates new markets as private industry develops energy-efficient and intelligent appliances, smart meters, new sensing and communications capabilities and passenger vehicles.

More specifically, with advanced components and widespread communication supporting market operations and providing full visibility of data to all, a smarter grid will encourage new market participants, enabling a variety of new load management, distributed generation, energy-storage and demand-response options and opportunities. These contributions are reinforcing the Smart Grid's economic advantages by allowing demand to act as a supply resource – recently deferring some large capital investments in power

THE TIME IS NOW

Under the American Recovery and Reinvestment Act of 2009 (ARRA), $4.5 billion have already been disbursed toward hundreds of Smart Grid projects.

A smarter grid creates new markets as private industry develops energy-efficient and intelligent appliances, smart meters, new sensing and communications capabilities and passenger vehicles.

TOTAL SMART GRID JOBS
Created and Transitioned

CATEGORY	DEPLOYMENT PERIOD (2009 TO 2012)	STEADY STATE PERIOD (2013 TO 2018)	COMMENTS
Direct Utility Smart Grid	*48,300*	*5,800*	*Direct utility jobs created by Smart Grid programs*
Transitioned Utility Jobs	*-11,400*	*-32,000*	*Utility positions (e.g. meter reading) transitioned to other roles*
Contractors	*19,000*	*2,000*	*External installation & service providers*
Direct Utility Suppliers	*117,700*	*90,000*	*Smart Grid equipment suppliers (e.g., metering)*
Indirect Utility Supply Chain	*79,300*	*22,500*	*Suppliers to direct utility suppliers*
New Utility / ESCO Jobs	*25,700*	*51,400*	*New jobs from new Smart Grid business models*
Total Jobs Created	***278,600***	***139,700***	***Total new jobs at end of each period***

As the owners of the energy infrastructure, utilities have a particular stake in retaining a skilled workforce as Smart Grid adoption progresses. KEMA's Smart Grid Workforce Study indicates that far more jobs will be created than lost.

plants, substations and transmission and distribution lines. As a result, tens of billions of dollars will be saved over a 20-year period, according to the Pacific Northwest National Laboratory. By increasing the grid's robustness and efficiency, options such as these will work to reduce peak prices and demand, leading to cost savings and downward pressure on rates for all stakeholders.

SMART GRID "ROI"

For an investment of this size, our nation's return on the Smart Grid will begin to be realized relatively quickly. Consider these estimates:

The EPRI *Electricity Sector Framework for the Future* estimates $1.8 trillion in annual additive revenue by 2020 with a substantially more efficient and reliable grid.

The Galvin Electricity Initiative holds that Smart Grid technologies could reduce power disturbance costs to the U.S. economy by $49 billion per year.

Also among its findings: "Widespread deployment of technology that allows consumers to easily control their power consumption could add $5 billion to $7 billion per year back into the U.S. economy by 2015, and $15 billion to $20 billion per year by 2020." Assuming a 10% penetration, distributed generation technologies and smart, interactive storage capacity for residential and small commercial applications could add another $10 billion per year by 2020.

MAKING THE CASE: DOE SMART GRID DEMONSTRATION PROJECTS

DOE's many ongoing demonstration projects, such as the one currently proceeding in Fort Collins, CO, are designed to create, collect and evaluate real-life data in a systems context to support cost-benefits analysis, business-case development and technology validation.

The city and its city-owned Fort Collins Utility support a wide variety of clean energy initiatives, including the establishment of a Zero Energy District within the city (known as FortZED).

This demonstration project will integrate a wide range of renewables and demand response within utility operations. It seeks to transform the electrical distribution system by developing an integrated system of mixed distributed resources to increase the penetration of renewables – such as wind and solar – while delivering improved efficiency and reliability. To realize the potential of a "zero energy district," the project involves a mix of nearly 30 distributed generation, renewable energy and demand-response resources across five customer locations for an aggregated capacity of more than 3.5 MW. By increasing the use of renewables and distributed energy resources for supplying power during peak load periods, the project seeks to achieve a 20%-30% peak-load reduction on multiple distribution feeders.

THE SMART GRID JOBS BANK

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

The solar industry can create an estimated 440,000 gross jobs and $325 billion in economic development over the next eight years.[12]

An investment of $10 billion in 25-year solar power purchase agreements could produce 4,000 MW of energy and create 350,000 jobs.[13]

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.[14] This is widely attributable to the length and depth of the worldwide recession and just as widely expected to be an anomaly. Most agree that 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 persistent customer 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.

From a behavioral perspective, there is measurable energy savings when consumers participate, approximately 6% in the residential sector.[15] Awareness on the part of consumers to manage peak load by virtue of a feedback mechanism may incite greater attention to consumption patterns and results in savings.

ENABLING CARBON SAVINGS

The full exploitation of renewable energy sources such as wind and 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.

CAP & TRADE & SMART GRID

As you know, 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.

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) to lower the cost of integrating wind into the system and optimize penetration of renewables into the grid.

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 initial penetrations of PV solar, placing excess power back onto the grid may also pose problems. Smart Grid control systems can help the grid rise to this challenge.

A SMARTER GRID IS A GREENER GRID

It has been estimated that the Smart Grid could reduce carbon dioxide emissions by up to 25%.[16]

The use of wind as 20% of the U.S. power supply could save 4 trillion gallons of water typically used in electricity generation between now and 2030, savings all the more significant due to increasing stress on our nation's water supply.[17]

To learn more about incentives for energy efficiency and renewable energy on a state-by-state basis, visit dsireusa.org, DOE's official website for tracking such incentives.

For more detailed information on the Smart Grid and our environment, see "The Smart Grid: An Estimation of the Energy and CO_2 Benefit", published by PNNL, August 2009.

STATES TAKING ACTION:

32 states and the District of Columbia have developed and adopted renewable portfolio standards, which require a pre-determined amount of a state's energy portfolio (up to 20%) to come exclusively from renewable sources by as early as 2013.

STATE	AMOUNT	YEAR	RPS ADMINISTRATOR
Arizona	*15%*	*2025*	*Arizona Corporation Commission*
California	*33%*	*2030*	*California Energy Commission*
Colorado	*20%*	*2020*	*Colorado Public Utilities Commission*
Connecticut	*23%*	*2020*	*Department of Public Utility Control*
District of Columbia	*20%*	*2020*	*DC Public Service Commission*
Delaware	*20%*	*2019*	*Delaware Energy Office*
Hawaii	*20%*	*2020*	*Hawaii Strategic Industries Division*
Iowa	*105 MW*	*–*	*Iowa Utilities Board*
Illinois	*25%*	*2025*	*Illinois Department of Commerce*
Massachusetts	*15%*	*2020*	*Massachusetts Division of Energy Resources*
Maryland	*20%*	*2022*	*Maryland Public Service Commission*
Maine	*40%*	*2017*	*Maine Public Utilities Commission*
Michigan	*10%*	*2015*	*Michigan Public Service Commission*
Minnesota	*25%*	*2025*	*Minnesota Department of Commerce*
Missouri	*15%*	*2021*	*Missouri Public Service Commission*
Montana	*15%*	*2015*	*Montana Public Service Commission*
New Hampshire	*23.8%*	*2025*	*New Hampshire Office of Energy and Planning*
New Jersey	*22.5%*	*2021*	*New Jersey Board of Public Utilities*
New Mexico	*20%*	*2020*	*New Mexico Public Regulation Commission*
Nevada	*20%*	*2015*	*Public Utilities Commission of Nevada*
New York	*24%*	*2013*	*New York Public Service Commission*
North Carolina	*12.5%*	*2021*	*North Carolina Utilities Commission*
*North Dakota**	*10%*	*2015*	*North Dakota Public Service Commission*
Oregon	*25%*	*2025*	*Oregon Energy Office*
Pennsylvania	*8%*	*2020*	*Pennsylvania Public Utility Commission*
Rhode Island	*16%*	*2019*	*Rhode Island Public Utilities Commission*
*South Dakota**	*10%*	*2015*	*South Dakota Public Utility Commission*
Texas	*5,880 MW*	*2015*	*Public Utility Commission of Texas*
*Utah**	*20%*	*2025*	*Utah Department of Environmental Quality*
*Vermont**	*10%*	*2013*	*Vermont Department of Public Service*
*Virginia**	*12%*	*2022*	*Virginia Department of Mines, Minerals, and Energy*
Washington	*15%*	*2020*	*Washington Secretary of State*
Wisconsin	*10%*	*2015*	*Public Service Commission of Wisconsin*

*Five states, North Dakota, South Dakota, Utah, Virginia, & Vermont, have set voluntary goals for adopting renewable energy instead of portfolio standards with binding targets.

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 be plugged in to a standard household electrical outlet to recharge their batteries. Currently capable of travelling up to 40 miles in electric-only mode, the majority of PEVs operating on battery power could meet the daily needs of most drivers, according to the Edison Electric Institute (EEI). Compared to 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 to 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.[19]

On average, PHEVs will produce just one-third of the greenhouse gases (GHGs) emitted by traditional, 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. They could reduce national oil consumption by as much as four million barrels per day in 2050 according to that same EPRI/NRDC study.

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

A MAJOR "OIL CHANGE"

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%.[18]

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

off-peak. Charging PEVs on-peak would only further stress the grid.

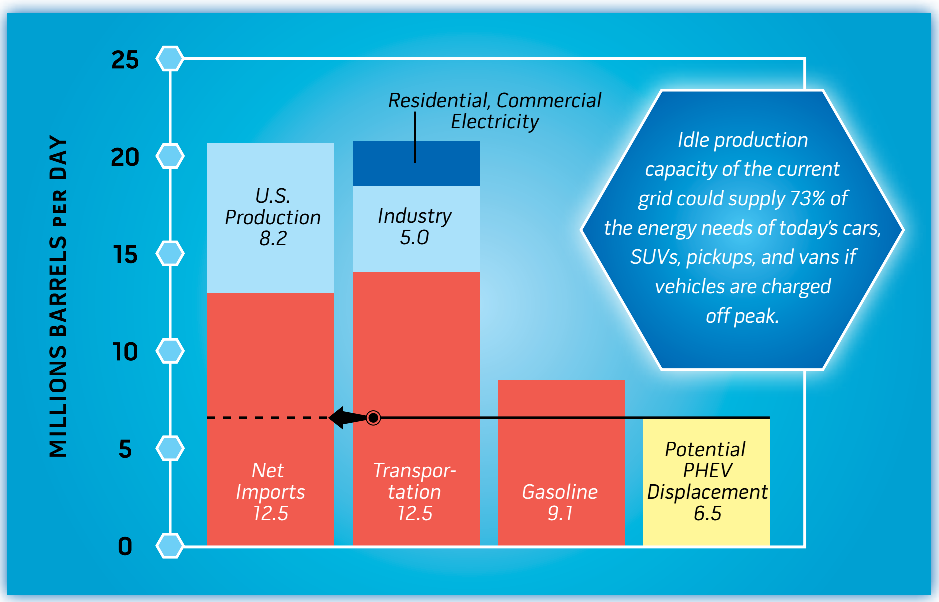
In terms of carbon emissions, the nation's vehicles produce roughly the same carbon emissions as the nation's coal-based power plants. By moving their emissions from millions of tailpipes to far fewer smokestacks, the Smart Grid could dramatically reduce the size and complexity of the industry's ongoing "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 PHEV deployment will cut GHG emissions including CO_2. In the process, it will work toward improving the general health of the United States as well as lessening our dependence on foreign oil.

ATTENTION FOREIGN OIL SHOPPERS...

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

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



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

STAKEHOLDER WATCH/ REGULATORS: **FERC, NARUC & THE SMART GRID CLEARINGHOUSE.**

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

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.

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

- *Accommodating all generation and storage options*
- *Enabling informed participation by customers*
- *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 to form the FERC/

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.

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 Smart Grid Clearinghouse as an additional tool for Smart Grid stakeholders to use in advancing 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:

- *State and Federal Policymakers*
- *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*

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.

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.

The Maturity Model creates a roadmap of activities, investments and best practices with the Smart Grid as its vision.

STAKEHOLDER WATCH/ UTILITIES: ***THE SMART GRID MATURITY MODEL.***

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 and policymakers alike 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. Those 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 creating a smarter grid.

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, like 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	DESCRIPTION	RESULT
ONE: Exploring and Initiating	*Contemplating Smart Grid transformation. May have vision but no strategy yet. Exploring options. Evaluating business cases, technologies. Might have elements already deployed.*	Vision
TWO: Functional Investing	*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.*	Strategy
THREE: Integrating Cross Functional	*Smart Grid spreads. Operational linkages established between two or more functional areas. Management ensures decisions span functional interests, resulting in cross-functional benefits.*	Systemization
FOUR: Optimizing Enterprise Wide	*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.*	Transformation
FIVE: Innovating Next Wave of Improvements	*New business, operational, environmental and societal opportunities present themselves, and the capability exists to take advantage of them.*	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

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

A 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.

BOLD STEPS

Congress has already taken bold steps by passing EISA 2007 and ARRA 2009, each containing key Smart Grid policies and federal funding to get things done. Across the country, many states, cities and towns are following suit.

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 and efficient – 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 will 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 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.

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

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.[20] A true measure of customer acceptance – many didn't want the project to end.

Cities, towns and utilities all over the country are following these leaders by launching efforts to create a smarter grid in their own backyards.

(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 smart grids. 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.

In terms of reaching worthy societal and economic goals and ensuring our nation's security, seldom has opportunity knocked quite so loud or insistently.

NEXT STEPS: ***TOGETHER TOWARD A SMARTER GRID.***

Our electrical grid is at a crossroads, and it is up to policymakers across the nation to chart the path forward.

If we do nothing, environmental studies show that 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.[21]

If we commit to the Smart Grid, the same studies show that utilities, through implementation of energy efficiency programs and use of renewable energy sources, could not only displace that growth, but actually have the opportunity to reduce the carbon output to below 1,000 million tons of carbon by 2030.

If we do not bring together stakeholders with leadership from policymakers, we are choosing to stay the course with our current grid in a world of increasingly diminishing resources.

If we enable consumers to become part of the solution via Smart Grid two-way communication, they will be able to take action to lessen strains on the grid, exercise their environmental stewardship, save money – or all three.

If we do nothing, renewable sources of energy like wind and solar remain marginal at best.

If we integrate them within the Smart Grid and reinforce them with energy storage solutions, they can genuinely help our states reach their renewable-portfolio standards goals.

Finally, if we approach issues of reliability, affordability, energy independence and grid security piecemeal, piecemeal solutions are all we will get. Only the organizing principle of the Smart Grid enables us to approach this matrix of complex issues all at once.

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.

AS A POLICYMAKER, YOU ARE IN A UNIQUE POSITION

Alone among Smart Grid stakeholders, you are charged with securing our nation's prosperity, security and future. Transforming the Smart Grid into reality requires the vision and political will that only you can bring to it. It is your job to bring clarity to the Smart Grid and the issues surrounding it.

Fortunately, you are not without a roadmap in this regard. 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 the provision of electricity.

As a Smart Grid champion, you must see to it that the public is made well aware of Smart Grid benefits. You must work to facilitate, whenever you can, the rapid collaboration and consensus-building required for large-scale Smart Grid implementation. You should support a public-awareness campaign, Smart Grid demonstration projects, and advocating for an interoperable framework for grid technologies. In terms of reaching worthy societal and economic goals and ensuring our nation's security, seldom has opportunity knocked quite so loud or insistently.

The time to build the Smart Grid is now.

TODAY's GRID. AND TOMORROW's.

Today's Grid	Smart Grid
Consumers are uninformed and non-participative with power system	*Informed, involved, and active consumers; demand response and distributed energy resources*
Dominated by central generation; many obstacles exist for distributed energy resources interconnection	*Many distributed energy resources with plug-and-play convenience; focus on renewables*
Limited wholesale markets, not well integrated; limited opportunities for consumers	*Mature, well-integrated wholesale markets, growth of new electricity markets for consumers*
Focus on outages; slow response to power quality issues	*Power quality is a priority with a variety of quality/price options; rapid resolution of issues*
Little integration of operational data with asset management; business process silos	*Greatly expanded data acquisition of grid parameters; focus on prevention, minimizing impact to consumers*
Responds to prevent further damage; focus is on protecting assets following fault	*Automatically detects and responds to problems; focus on prevention, minimizing impact to consumer*
Vulnerable to malicious acts of terror and natural disasters	*Resilient to attack and natural disasters with rapid restoration capabilities*

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.

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*

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www.smartgrid.gov

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