# Energy Efficiency, Clean Power and the Smart Grid

## Opportunities and Barriers to Implementing Cost-Effective Solutions That Can Save Consumers Money, Reduce Greenhouse Gas Emissions and Improve Our Health

White Paper

Global Green USA

# TABLE OF CONTENTS

# FOREWORD

Since 1994, Global Green has consistently worked to promote energy conservation and clean power generation. Reduced and smarter energy consumption directly benefits consumers by reducing energy bills, creating new jobs, and reducing our need for new fossil fuel power plants. As the single largest contributor of greenhouse gas emissions in the United States, energy production poses a significant challenge in combating climate change, but also provides a meaningful opportunity.[i] Given that the operation and maintenance of our nation's buildings account for 40% of all energy use, increased energy efficiency has been a central focus of Global Green's efforts.[ii]

Global Green has advocated for green building policies and provided direct technical assistance to projects, which has resulted in the greening of $20 billion worth of school and affordable housing new construction in California, New Orleans, and across the country, and led to significant reductions in these buildings' electricity costs and greenhouse gas emissions.

In addition to economic and environmental benefits, green affordable housing, schools, and communities improve the lives and health of people. Green homes are less toxic to inhabitants; and, studies of green schools reveal numerous benefits, including reduced rates of asthma and other respiratory disease, as well as improved student test scores.

While energy efficient new construction constitutes an important component of creating greener cities, the low-hanging fruit of energy efficiency is found in existing buildings. Increased energy efficiency directly benefits all consumers by **shrinking energy bills, creating new jobs, and reducing our need for new power plants**. In addition, if we can further reduce energy use and increase the reliability of the electric grid through better visibility, transparency, and integrated distributed renewable generation, like solar and wind, we also reduce the need for peaker plants, typically the dirtiest of all power sources since they operate only during peak periods of demand.

Unfortunately, insufficient financing, uninformed building owners, and a lack of appropriate incentives represent just some of the market barriers to more investment in energy efficiency. To address these barriers, Global Green has championed green building, solar, and energy efficiency policies at the local, state, and federal levels. Sponsored by Global Green and signed into law on October 11, 2009, California Assembly Bill 758 mandates increased energy efficiency in existing buildings and marks a major step forward in reducing energy production and consumption.[iii]

The design and implementation of this law will ultimately help set the stage for innovation and strategy development to increase the efficiency of our country's entire stock of buildings. Moving forward, our nation needs a combination of dynamic programs to not only radically reduce our carbon footprint, but also allow citizens to play a direct role in successfully combating climate change.

Unfortunately, our shockingly "dumb" electrical grid poses another challenge to sound energy policy. Our current primary power delivery system, the electric grid, lacks the intelligence and adaptability of most other modern ubiquitous systems, such as the Internet and our telecommunications system.

A "smart grid," by providing consumers with the ability to see, in real-time, the costs attached to their energy consumption, can foster a more efficient use of resources, reduce peak demand, and provide a cleaner, more reliable, and affordable electricity product.

This report highlights the need for integrated strategies in reducing energy use, increased distributed renewable energy generation, and a more intelligent electrical grid and explores the role of the “smart grid” in developing a more sustainable, energy efficient future.

# EXECUTIVE SUMMARY

With contemporary society increasingly addicted to energy, energy efficiency provides the cleanest and cheapest power resource and allows us to lock in savings through tightened building and appliance standards. A strategy that prioritizes energy efficient buildings, distributed renewable energy, e.g., solar PV, and the deployment of the smart grid offers the greatest opportunity to achieve economic and environmental gains in the built environment sector in the U.S.

While the Information Technology (IT) revolution in the last quarter century provided a wide range of new technologies that have helped advance telecommunications, industry, the Internet, ecommerce, book reading, movie watching, and much more, it largely bypassed the utility sector.

Using IT gains to "smarten" the electric grid, in combination with energy efficiency efforts and distributed renewable energy generation, will allow once passive ratepayer/customers to become proactive partners in creating affordable answers to today's energy challenges. Electric utilities have traditionally been in the pilot seat controlling decision-making about clean energy and smart grid deployments. By allowing consumers to "co-pilot" our energy future, the collective cost of a new energy paradigm can be reduced, an important concern in today's struggling economy. Greater access to energy efficiency, the integration of clean distributed energy technologies, and a smarter grid will allow consumers to more easily and effectively monitor and control their energy use, reduce and manage their peak demand for energy, lower their utility bills, and slash their greenhouse gas emissions that fuel climate change.

**A smarter grid affords one of the strongest opportunities to transform and make more efficient our entire energy system—from our everyday appliances, to our buildings, and to the larger grid itself. A smarter grid will enable both customers and host utilities to realize the full potential of energy efficiency investments and the integration of renewable energy resources, particularly, distributed generation technologies.**

A comprehensive and well-designed clean energy strategy can revolutionize the way our nation consumes, produces, and manages our energy resources. We must emphasize that the success of any clean energy program—efficiency, renewable distributed generation, or smart grid—depends upon the active partnership of all stakeholders. The rollout of a program must fully engage residents, businesses and local governments. A clean energy strategy must ensure an open and democratic process, providing all stakeholders meaningful opportunities to participate, to unlock value, and to innovate. Ultimately, clean energy strategies and the smart grid aspire to create a completely new, redefined, and restructured electricity sector that can better serve all stakeholders, including disadvantaged communities and the utilities themselves.

Global Green's recommendations, included below, target both utility and public policy decision makers and aim to guide future investments in energy efficiency, distributed renewable generation, and smart grid deployments. Finding synergy among and leveraging the investments in these three sectors—combined with advances in renewable energy, energy storage, and other technological innovations—will boost the efficiency of today's power delivery system.

Our recommendations are guided by our own experience as developers and technical advisors on green building projects, including the construction of the two first fully solar-powered affordable housing projects in the country (Solara and Los Vecinos), and informed by a review of two compelling case studies on differing approaches to the smart grid in Oklahoma and California.

Global Green's Initial Recommendations for Leveraging and Integrating Current and Future Investments in Energy Efficiency, Distributed Clean Power, and the Smart Grid include:

Recommendation #1

## EFFICIENCY RULES!

### Make Our Nation's Existing Buildings Energy Efficient

Energy Efficiency is critical to saving money, creating jobs, and reducing $CO_2$ emissions that cause climate change. Buildings must be the first target of energy savings strategies given their enormous contribution to greenhouse gas emissions. Existing buildings present the greatest opportunity to increase energy efficiency (new buildings account for less than 1.5% of the overall building stock), but various challenges and market barriers have stymied progress. Allowing the owners of these buildings to access and monitor their energy use, in real-time, will support increased energy efficiency. The innovations and solutions to address market barriers discovered through the implementation of California's AB 758, which mandates increased energy efficiency in existing buildings, will help inform energy efficiency programs and strategies throughout the nation.

Recommendation #2

## IT'S THE ECONOMY, STUPID!

### Enable Utilities to Profit from Energy Efficiency and Conservation

Currently, the more electricity utilities sell, the more money they make, which does not incentivize them to promote energy efficiency or conservation. However, if the link between revenues and sales volume is broken, this challenge can be effectively addressed. For example, California implemented "decoupling," a business model that encourages efficiency by rewarding utilities when they sell less energy. Information and incentives for utility customers via the smart grid will only enhance this approach.

Recommendation #3

## GETTING ALL "A"s IN ENERGY USE

### Make Real-time Pricing Options and Information About Energy Usage Available to Enable Consumers to Make Better Choices

A nimble, yet robust, approach to deploying and managing the smart grid, efficiency, and renewables is critical to success. The smart grid is more than just smart meters—it encompasses the connection of smarter devices to the grid by deploying an open standards based network that can integrate options, which can be tailored to meet the distinct needs of a variety of customers while providing real-time information on electricity use (e.g., how much electricity a consumer is using), price (e.g., how much electricity costs a consumer at different times of day, particularly during peak demand when prices are higher), and generation (e.g., how much electricity a solar PV system is producing and how much the customer is being paid). Business models, such as "virtual power plants" and "microgrids," should also be encouraged to allow for a more decentralized and democratic energy system to flourish; and, all hardware and software technologies that adhere to industry standards should be permitted to "plug and play" into all grids.

Recommendation #4

## HELP CONSUMERS BECOME CITIZENS AGAIN

### Empower Energy Consumers Through Education and Outreach About Energy Efficiency, the Smart Grid, and Distributed Renewables as Key Ingredients to Reducing Energy Consumption and Greenhouse Gas Emissions

When consumers can track real-time energy consumption and access cost data, they can decrease their energy consumption approximately 10 to 15% and make investments in energy efficiency and renewable energy systems, e.g., solar PV. The public deserves access to information on the economic and environmental benefits of the smart grid, smart meters, and integrated energy strategies to reduce energy use and produce clean energy. Two states provide meaningful examples. While Oklahoma has not been known as a leader on fighting climate change, Oklahoma Gas & Electric (OG&E) is a leader in innovation. Through partnerships with policy makers and their customers, the integration of wind power, and energy efficiency gains from increased visibility into energy consumption, OG&E anticipates eliminating the need for two fossil fuel peaker plants by 2020. Through an extensive outreach campaign that included town hall meetings, face-to-face conversations, and 24-hour advance notice of electrical prices, OG&E implemented and operated a successful pilot smart grid project. California has a long history of educating the public about energy efficiency and conservation; and, a range of programs, public funding, and legislation support the state's commitment to these issues. Successful energy efficiency, smart grid, and distributed renewable generation programs depend upon an informed consumer base.

Recommendation #5

## MAKING IT ALL WORK TOGETHER

### Incorporate Clean Energy, Energy Efficiency and the Smart Grid into Long Term Utility Planning

If utilities prioritize investments in the smart grid, clean distributed energy, and energy efficiency programs as part of a comprehensive, funded plan, these individual investments are more likely to yield significant results. The Integrated Resource Plan (IRP) process serves as a valuable method for this type of planning. In addition, developing long-term (10-year) incentives for solar and other distributed renewables will help support market development by inspiring confidence in investors and industry players. The California Solar Initiative is a successful, first-of-its-kind 10-year solar incentive program, which sets the tone for other programs around the country. Also in California, Pacific Gas & Electric has been a leader in supporting innovative conservation and energy efficiency policies, like net metering. These types of programs and incentives are critical to and should be a part of any utility long term planning process.

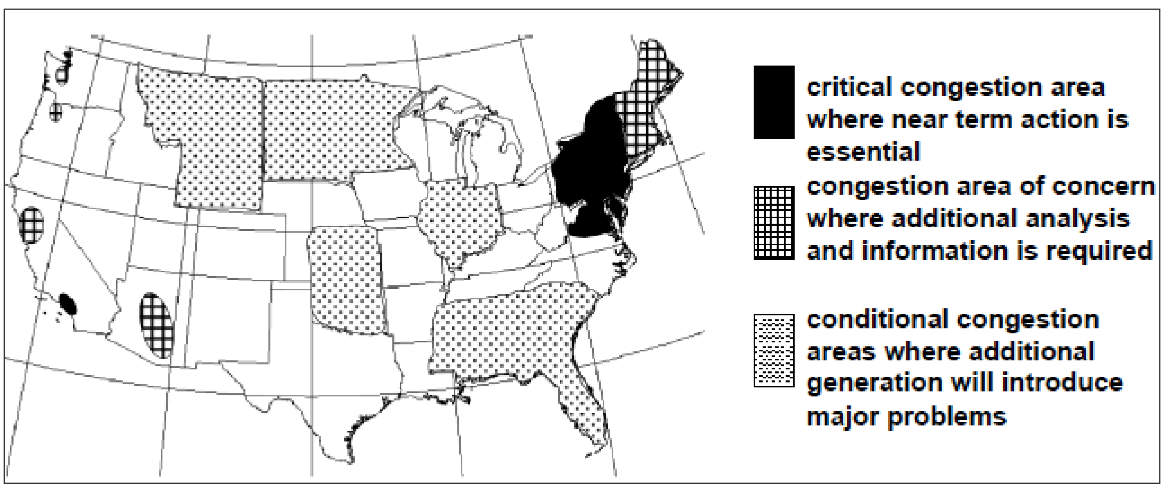
# I. THE INEFFICIENT STATUS QUO MORE & THE ROLE OF ENERGY EFFICIENCY

The expansion of our current electricity grid to serve the vast majority of Americans was once described by the U.S. National Academy of Engineers as "the greatest engineering achievement of the 20th century."[iv] "Yet today, in the early 21st century, the [electricity infrastructure] of the United States … is woefully inadequate" for meeting the economic, environmental, and reliability needs of today's consumers.[v]

Though "the electric power grid … was installed at the same time as the telephone system,… it has [never faced] the same impetus to transform itself into something [more efficient] from a rival system like the Internet."[vi] Until recently, the electric power grid essentially stood still as the world around it underwent radical technological transformations. As a result, it is extremely "vulnerable to terrorist threats, natural disasters, [such as earthquakes or hurricanes], and [simple] human error,"[vii] such as the massive grid outage in the Eastern US and Midwest during 2003.

Moreover, the electric grid is aging and deteriorating; and, it lacks the intelligence of most other modern ubiquitous systems, such as telecommunications, upon which we rely daily.[viii] The last major overhaul of our power grid occurred during the presidency of Franklin D. Roosevelt and his "New Deal" in the first half of the last century. Many of our buildings are equally as old, further highlighting the inefficiency of our current power delivery and consumption patterns.

**FIGURE 1: AREAS OF GRID CONGESTION IN THE U.S.**




*Source: Department of Energy*

At the same time that our grid infrastructure direly needs an upgrade, our buildings and inside appliances waste an enormous amount of energy. The inefficiency of our buildings, our appliances, and today's power grid clearly demonstrates the inadequacy of the status quo.

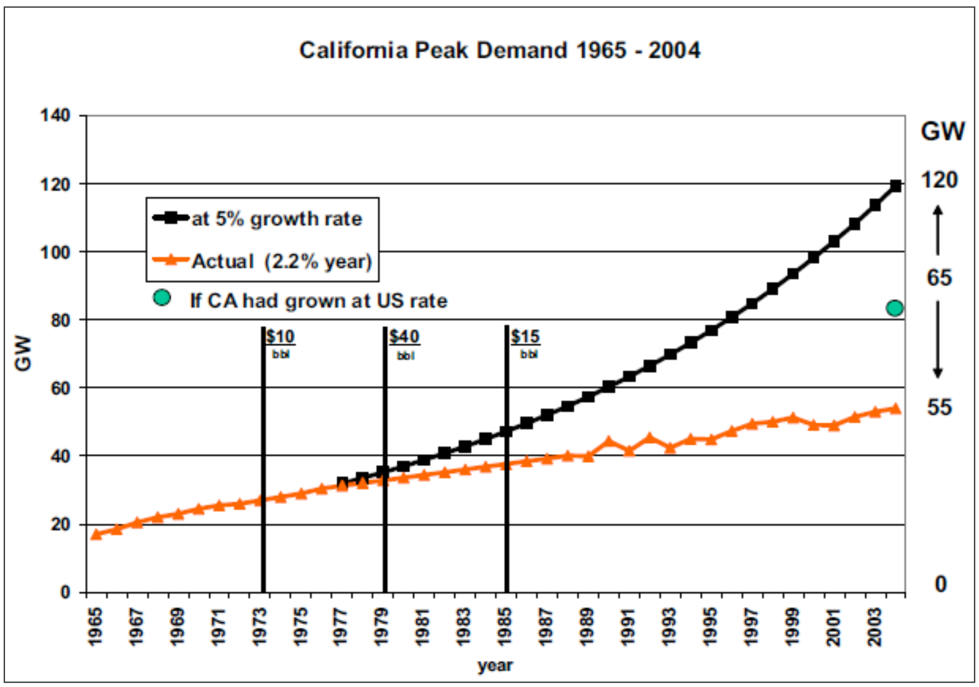
## TAPPING OUR CHEAPEST AND CLEANEST POWER SOURCES FIRST

Residential and commercial buildings are America's largest energy and electricity-consuming sector, and buildings are the largest single source of America's $CO_2$ emissions, at 38 percent.[ix] To win the fight against global climate change, we must look to our homes, offices, factories, and churches—all of our buildings. Because homes and other buildings represent 40 percent of total

U.S. energy consumption—73 percent of its electricity—this segment of our economy will reap the most rewards for our investment.[x] Energy efficiency is the lowest cost source of power—with no trade-offs or environmental concerns.

Minimum energy efficiency standards for our appliances and buildings are powerful tools to achieve energy efficiency. A smart grid can attain deeper savings by helping us better manage our use of these more efficient appliances and make our buildings more responsive to demands being placed on the overall grid, shifting our remaining power usage to times of greater supply and lower costs.

**FIGURE 2: HOW CALIFORNIA'S STANDARDS SAVED ENERGY**




*Source: Art Rosenfeld*

In California, energy standards were first pioneered in 1976 for appliances and then in 1978 for buildings. These statewide standards helped stablize energy usage and reduce the need to build the equivalent of more than 20 gigawatts (GW) of power plant capacity, which would have been needed if California's energy consumption had followed national trends. If power consumption had followed a 5 percent growth rate, as some experts had expected, the savings total 65 GW, an amount of power supply typically provided by more than 30 nuclear reactors the size of Diablo Canyon in San Luis Obispo.

The largest contributor to these energy efficiency savings was the implementation of the so-called "Title 24" standards. These standards, updated every three years to reflect the latest advances in energy efficiency "best practices," apply to new construction. However, according to the California Energy Commission, "more than half of California's 13 million residential units and over 40 percent of the commercial buildings were built before 1978."[xi]

AB 758, a new state law, now requires the California Energy Commission to develop and implement a comprehensive program to achieve energy savings in the existing building stock (all building types) that falls significantly below current Title 24 building standards. Based on analysis by the California Energy Commission, if cost-effective energy efficiency measures were applied to existing buildings, there would be a savings of 9 percent of statewide electricity consumption, 11 percent of peak demand, and 5 percent of natural gas consumption; it would be the equivalent of taking 3 million cars off the road for one year.[xii]

## MAKING NEW CONSTRUCTION MORE EFFICIENT: THE FEDERAL 30 PERCENT SOLUTION

California cannot solve the nation's climate change challenge alone. The concept of tighter building standards that can lock in long-term savings needs to be applied across the nation. Despite America's heavy dependence on imported fossil fuels and skyrocketing power prices, there have only been modest energy efficiency increases in the International Energy Conservation Code (IECC), the nation's only nationally recognized model energy code. Increasing the minimum energy efficiency standards of the model code is the easiest and most effective way to decrease our greenhouse gas emissions and our energy consumption, while saving money. A smart grid can then shift our remaining power consumption to periods when prices are low or when excess power is available.

In 2010, the IECC increased efficiency requirements by 30 percent.[xiii] This is the largest increase in federal energy efficiency standards since 1975, and was declared a historic victory by the Department of Energy, environmental groups, low-income housing groups, and many others.[xiv] In the residential building sector, improved energy efficiency will be achieved through methods like better sealing, improved efficiency of windows and skylights, increased insulation in ceilings and walls, tighter duct sealing and more.

Recommendation #1

### EFFICIENCY RULES!

**Make Our Nation's Existing Buildings Energy Efficient**

Energy Efficiency is critical to saving money, creating jobs, and reducing CO2 emissions that cause climate change. Buildings must be the first target of energy savings strategies given their enormous contribution to greenhouse gas emissions. Existing buildings present the greatest opportunity to increase energy efficiency (new buildings account for less than 1.5% of the overall building stock), but various challenges and market barriers have stymied progress. Allowing the owners of these buildings to access and monitor their energy use, in real-time, will support increased energy efficiency. The innovations and solutions to address market barriers discovered through the implementation of California's AB 758, which mandates increased energy efficiency in existing buildings, will help inform energy efficiency programs and strategies throughout the nation.

Increasing energy efficiency in new buildings is the low hanging fruit of the energy efficiency movement. Investment in capital intensive solar PV systems or smart grid technologies does not make sense if our buildings continue to leak copious amounts of energy due to outdated technologies and wasteful practices. Energy efficiency serves as the foundation of any effort to improve the environmental and economic performance of the power grid. From there, technologies such as demand response, small wind turbines, or hydrogen fuel cells can add diversity and agility to our power supply, making it more nimble, more resilient and more affordable.

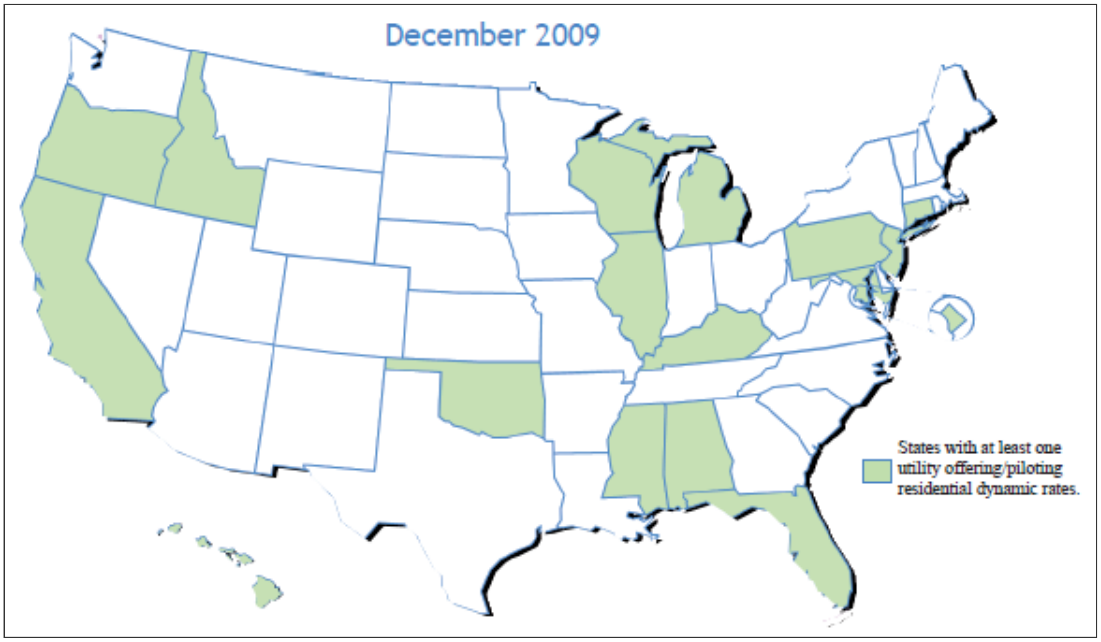
## BUILDING UPON STANDARDS WITH A SMARTER GRID

While energy efficiency standards form a solid foundation upon which we can build a more sustainable energy economy, these reductions do not obviate the need to modernize the electric grid. Our aging grid infrastructure, combined with a still steady rise in domestic electricity consumption to heat, cool, light, and power our buildings due to still surging population growth, contributes significant levels of the greenhouse gas emissions that fuel global climate change. Other pollutants from fossil fuel combustion pollute our air and our waterways.

Most home owners, building owners, and tenants find calculating the energy consumption of their buildings and spaces much more difficult than calculating the energy consumption of their vehicles (measured by every tank of gas). Fortunately, the solutions to this problem already exist. Yet until utilities, entrepreneurs, policymakers, *and* customers are fully engaged in implementing these solutions, the necessary changes required to bring our grid delivery system into the 21st century will not be successfully enacted.

One promising development is the number of utility programs that offer differentiated rates based on when consumers use the most electricity. These rates, often referred to as "real-time pricing" or "time-of-use" rates, reflect—in real-time—the dynamics of shifting power costs throughout the day. Generally, prices are lowest at night, when there is the least demand, and highest in late afternoons and early evenings, when people come home from work or air conditioners are turned on due to late afternoon heat. The map below shows states where investor-owned utilities offer these types of rate schedules.

**FIGURE 3: STATES WITH IOU REAL-TIME PRICING RATE PROGRAMS**




*Source: Department of Energy/Edison Electric Institute*

Other programs that help make our electricity system more efficient are policy vehicles, such as renewable portfolio standards, "utility revenue de-coupling," "system benefits charges" (also commonly referred to as "public goods charges"), net metering, and feed-in tariffs. Below are brief descriptions of these critical policy tools that can help optimize our power supply system to become more sustainable and efficient, especially when working in tandem with a smarter grid:

- Utility Revenue De-Coupling: Launched in California in 1983, this policy rewards utilities for selling less electricity, not more, by breaking the link between utility revenues and sales volume. The revenue of utilities on an annual basis is held constant by state regulators. The policy can be applied to both natural gas and electricity.

- System Benefits Charges: Most utilities in the U.S. impose a small surcharge on every customer's power bill to help fund development of renewable resources, programs for low-income electric customers, and research and development of new energy saving technologies. Without some funding mechanism to preserve these desirable features of the current electric utility system, these "system benefits" or "public goods" may have disappeared under utility restructuring efforts. A system benefits charge appears to be the best way to fund these services under today's energy market conditions.

- Renewable Portfolio Standards (RPS): Utility companies are starting to promote all forms of renewable energy generation in an effort to meet the renewable portfolio standards (RPS) adopted by 29 states.[xv] While designed primarily to add large scale renewable projects that are the most cost effective resource additions, some states include set-asides for distributed generation, primarily solar PV. Efforts to pass a federal RPS, also referred to as a Renewable Electricity Standard (RES) are ongoing.

> Recommendation #2
>
> **IT'S THE ECONOMY, STUPID**
> **Enable Utilities to Profit from Energy Efficiency and Conservation**
>
> Currently, the more electricity utilities sell, the more money they make, which does not incentivize them to promote energy efficiency or conservation. However, if the link between revenues and sales volume is broken, this challenge can be effectively addressed. For example, California implemented "decoupling," a business model that encourages efficiency by rewarding utilities when they sell less energy. Information and incentives for utility customers via the smart grid will only enhance this approach.

- Net Metering: This is a policy that allows customers who generate their own power through solar, wind, fuel cells and some biogas facilities to receive "credit" from the utility for any power they produce in excess of what they use. The rates and rules vary depending on state laws and utility policies. Currently net metering is offered in 43 states.

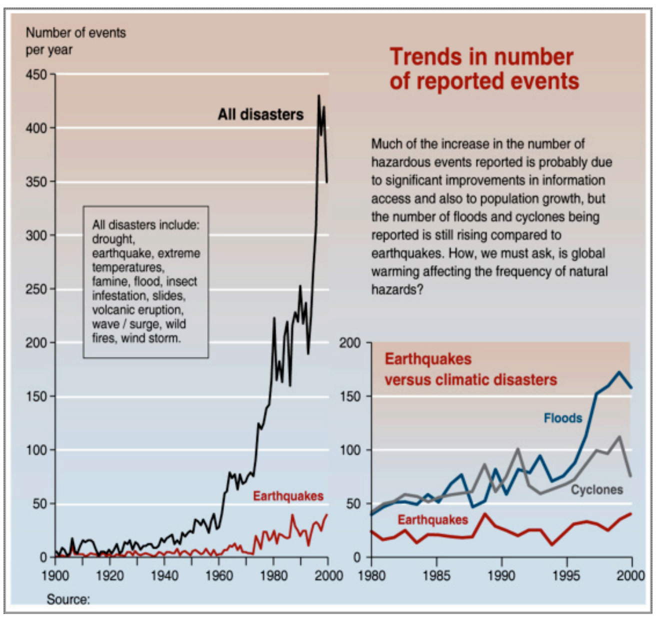
- Feed-In Tariffs: A feed-in tariff is a long-term power purchase contract that guarantees grid access and establishes a rate at which the local utility will purchase power from the private generator. There are a number of utilities, municipal power agencies and electric cooperatives that offer feed-in-tariffs to their customers; terms vary depending on the needs of the utility. The U.S. currently has no national feed-in tariff.

## ASSESSING THE BIG PICTURE: OUR CURRENT ELECTRICITY INFRASTRUCTURE

Notably, "[w]ith over $600 billion in assets, the nation's electric utilities are twice as large as the telecommunications industry, and almost 30 percent larger than the [declining U.S.] auto industry. Roughly 70 percent of [utility] assets [in the United States today] are power plants, most of them built in the mid-1960s," that run on coal and nuclear fuels while "[o]nly 10 percent of utility assets are in transmission facilities," which will need to be expanded if America is going to diversify utility supply portfolios with cleaner sources, such as remote wind farms. [xvi] "The remaining 20 percent of utility assets are in the poles and wires of utility distribution systems that connect power directly to [retail consumers]."[xvii] It is this last category of assets that is the current focus of concern—and corresponding smart grid innovations. Utilities lack data about the actual power consumption of its customers in this part of the grid. For example, grid operators do not know when an individual homeowner's solar photovoltaic installation is off or on. There is simply no available data at this level of utility service. And it is here where most power outages originate, and then, upon occasion, cascade up to the transmission level of electric service with a rolling blackout.

The fundamental architecture of today's electricity grid—based on the idea of a top-down system predicated on unidirectional energy flows—is now obsolete. The present antiquated "dumb" electric grid costs US consumers $140 billion annually due to inefficiency. A recent study by the Electric Power Research Institute (EPRI) estimates that redesigning and rebuilding the utility grid will require more than a decade of steep costs: "$13 billion a year for 10 years—65 percent more than the industry is currently investing annually."[xviii]

**FIGURE 4: NATURAL DISASTER TRENDS CHALLENGE TODAY'S "DUMB" GRID**




*Source: CRED*

The stakes could not be higher, given a wide variety of energy security threats, including an accelerating trend in natural disasters. Add to the challenges of weather the ever-present terrorist threat and other human forms of attack, and it becomes clear why the electric grid is a natural target, considering modern society's heavy dependence upon electricity. As our motor vehicles increasingly switch from gasoline to electricity in order to reduce the carbon footprint of our mobility, our susceptibility to grid outages only becomes more acute.

The architecture of the existing centralized and radial transmission system grid is the antithesis of distributed energy networks made possible by the Internet-based smart grid. According to Michael

Hordeski, "We now have the diverse tools and technologies necessary to force a revolution in energy production that mimics, to a large extent, the evolution in scale and efficiency found in the telecommunications and computer industries."[xix] Solar photovoltaics—which convert sunlight directly into electricity—allow consumers to not only reduce reliance upon the larger grid for power, but generate clean electricity on-site—without any air pollution. These newer technologies[, which also] include … fuel cells and wind turbines … are the equivalent to wireless cell phones and portable laptops that replaced traditional grid-connected [phones and huge mainframe] computers," respectively.[xx]

Recommendation #3

**GETTING ALL A'S IN ENERGY USE**
**Real-time Pricing Options and Information about Energy Usage should be Made Available to Consumers to Enable Customers to Make Better Choices**

A nimble, yet robust, approach to deploying and managing the smart grid, efficiency, and renewables is critical to success. The smart grid is more than just smart meters—it encompasses the connection of smarter devices to the grid by deploying an open standards based network that can integrate options, which can be tailored to meet the distinct needs of a variety of customers while providing real-time information on electricity use (e.g., how much electricity a consumer is using), price (e.g., how much electricity costs a consumer at different times of day, particularly during peak demand when prices are higher), and generation (e.g., how much electricity a solar PV system is producing and how much the customer is being paid). Business models, such as "virtual power plants" and "microgrids," should also be encouraged to allow for a more decentralized and democratic energy system to flourish; and, all hardware and software technologies that adhere to industry standards should be permitted to "plug and play" into all grids.

Our electricity grid is an artifact dramatically out of sync with today's information sharing technologies. Over the last decade, sensors have been developed that can track changing conditions instantaneously and then be linked up with affordable communication technologies, offering a new way to micro-manage our energy consumption. Virtually every piece of electrical equipment changed from analog to digital control, rendering the old ways of managing electricity inherently wasteful.

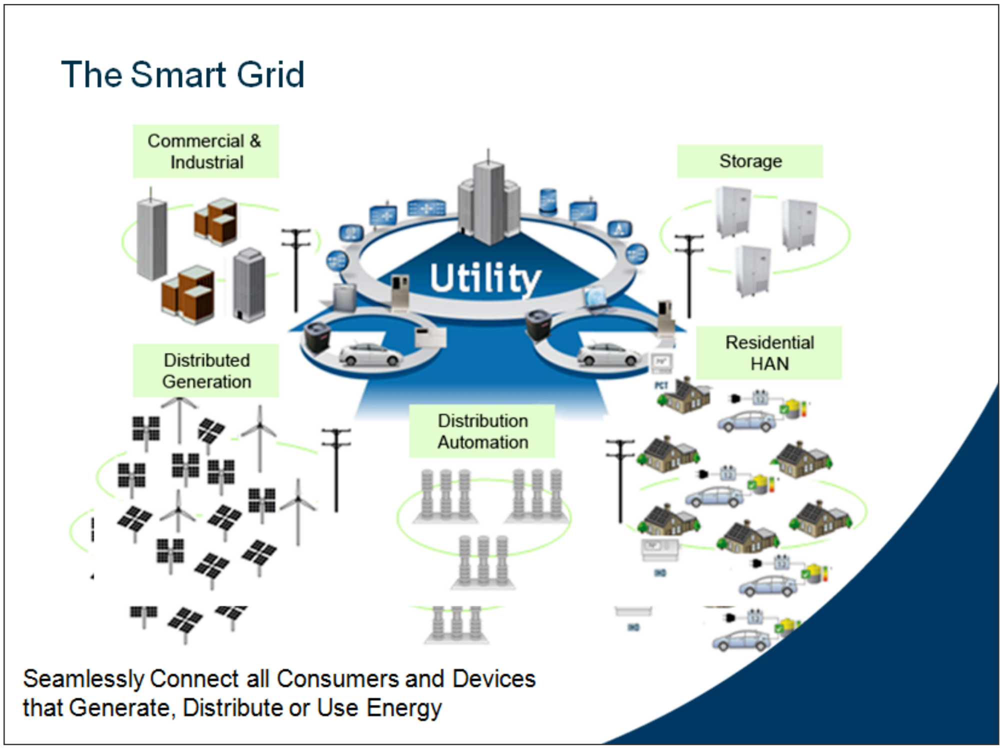
Today, American consumers have the potential to achieve significant reductions in energy bills, electricity demand, and greenhouse gas emissions with improved access to information about their power use. In order to realize these benefits, however, consumers will need to tap timely, useful information regarding the amount of electricity they consume, its price, and the sources from which that electricity is derived. The most important step in this evolving smart grid is to make efforts to save energy and reduce our overall long-term energy costs extremely easy, while assuaging concerns about data sharing, privacy, and public health.

## II. THE SMART GRID AND YOUR NEW ENERGY REALITY

Our power use generally follows a fairly predictable usage pattern. Lights, televisions, small appliances, and personal electronics are powered on and off manually. Larger appliances, such as refrigerators, freezers and water heaters, all operate according to the edicts of internal sensors and feedback loops that most of us seldom consider. Climate control—whether heating or cooling—is regulated by programmed scheduling, manual control, sensor feedback, or some combination of all three.

Each of these scenarios shares one thing in common: nearly complete information opacity on the part of both the electric utility provider and the consumer.[xxi] Consumers or business owners can flip a light switch, turn on a computer, open the fridge, or turn on the TV and be confident their meter readings will go up—but with no ability to trace consumption back to each of these activities or devices. This information gap constrains both retail power customers and utilities. From the perspective of the utility, no demand data flows back to them from the customer.

**FIGURE 5: DEPICTION OF SMART GRID ENERGY LANDSCAPE**




From the perspective of the power consumer, the lack of granular usage information makes adjustment of consumption behavior challenging, if not impossible. Some power needs likely rank higher than others, e.g. refrigeration likely trumps television; but, consumers cannot track the exact costs of one appliance or power need versus another. The consumer must perform either an appliance-by-appliance census, or a series of controlled experiments, changing a single variable (for example, reducing the thermostat set point by several degrees) and observing the resulting change in their monthly power bill. This requires a tremendous investment of time by the consumer. Consumers could speed up this process by placing meters on each major appliance, but such meters remain comparatively costly. Furthermore, even this type of auditing often produces inaccurate results.[xxii] In the example given, savings based on the reduction in the temperature set point of a thermostat could be traced to a change in external temperature, rather than the adjustment of the thermostat.

## GIVING MORE POWER TO THE PEOPLE

The antidote to this power consumption information vacuum is the creation of an intelligent grid that, even at the household or factory level, provides real-time analysis of all the power draws in a building. This information can even be presented to the consumer in dollars and cents, as a portion of their monthly bill, and as email alerts. Pacific Gas & Electric (PG&E) already provides these sorts of proactive alerts, sending automated warnings to users who have subscribed to the alerts system.[xxiii] These alerts warn power customers when they are about to cross into a high-price consumption tier, affording customers a chance to throttle back on power usage.[xxiv] Another possible service would be an automated alert system informing customers when an unusual increase in consumption is detected (e.g., from a dryer clogged with lint, failing air conditioner, or simply an ajar door to a climate controlled area).

This increased visibility not only allows power customers to better reduce waste and lower bills, but also allows utilities to offer incentives for reducing electricity at times of peak demand or to provide more competitive pricing for certain consumption activities during particular times.[xxv] "Flattening" the demand peaks and valleys of total grid consumption allows for more efficient use of fuel resources, and saves everyone involved money. With a smart grid, customers can engage in the practice of "demand response," automated systems that shrink energy usage of appliances, as well as heating and cooling systems, during times of peak demand.

The concept of demand response is not exactly the same as energy efficiency. One may still be using the same overall amount of energy when engaged in demand response programs, but by shifting the time of energy usage, one can contribute to the more intelligent management of energy resources. For example, one study by Brattle found that dynamic pricing programs could shave 2.6 percent of our overall power consumption across all types of customers.[xxvi] Though valuable, these programs are not substitutes for the energy efficiency standards that lock in long-term savings in our buildings.

Recommendation #4

**HELP CONSUMERS BECOME CITIZENS AGAIN**

**Empower Energy Consumers Through Education and Outreach About Energy Efficiency, the Smart Grid, and Distributed Renewables as Key Ingredients to Reducing Energy Consumption and Greenhouse Gas Emissions**

When consumers can track real-time energy consumption and access cost data, they can decrease their energy consumption approximately 10 to 15% and make investments in energy efficiency and renewable energy systems, e.g., solar PV. The public deserves access to information on the economic and environmental benefits of the smart grid, smart meters, and integrated energy strategies to reduce energy use and produce clean energy. Two states provide meaningful examples. While Oklahoma has not been known as a leader on fighting climate change, Oklahoma Gas & Electric (OG&E) is a leader in innovation. Through partnerships with policy makers and their customers, the integration of wind power, and energy efficiency gains from increased visibility into energy consumption, OG&E anticipates eliminating the need for two fossil fuel peaker plants by 2020. Through an extensive outreach campaign that included town hall meetings, face-to-face conversations, and 24-hour advance notice of electrical prices, OG&E implemented and operated a successful pilot smart grid project. California has a long history of educating the public about energy efficiency and conservation; and, a range of programs, public funding, and legislation support the state's commitment to these issues. Successful energy efficiency, smart grid, and distributed renewable generation programs depend upon an informed consumer base.

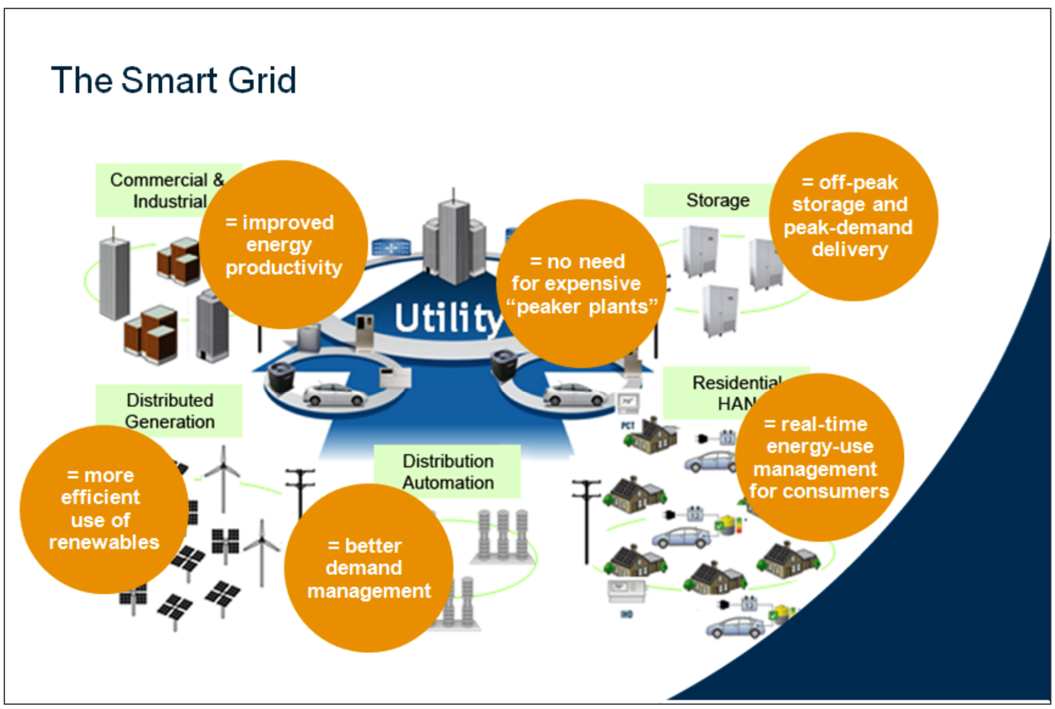
## TEACHING AN OLD GRID NEW TRICKS

We must improve the existing grid to better meet ever-growing power demands while more effectively shaping our consumption to intelligently do more with less. For the most part, utilities have focused on an important first step: the installation of "smart meters." The American Recovery and Reinvestment Act (ARRA) provided over $4 billion in funding for new smart grid technologies, approximately half of which funded underwriting the installation of these smart meters.[xxvii] These investments by the federal government were typically matched with investments by the private sector, primarily utilities.[xxviii]

In the U.S., smart meters are typically wireless systems (like today's cell phone and much of our Internet service) that eliminate the need for random and infrequent meter reading to determine monthly utility bills—and, "[a]s of September 2011, around 27 million smart meters had been installed in the U.S., [according to an estimate by] the Institute for Electric Efficiency. Based on planned deployments and proposals, the IEE estimates that by 2015 approximately 65 million smart meters will be deployed, representing 54% of U.S. households."[xxix] These devices broadcast real-time consumption data back to the utility over a secure data network. Ultimately, these smart meters should allow utilities to roll out more sophisticated demand-management programs to households and businesses.

(In Europe, many smart meter roll-outs have not involved wireless communications, but rather fiber optics, addressing some customers' health concerns related to radiation emitting from wireless devices. The science is unclear at this point. The smart grid is not really just about wireless signals, but rather about harnessing the power of real-time data on energy usage to boost efficiency.)

**FIGURE 7: NET BENEFITS FROM THE SMART GRID**




A number of technology companies are experimenting with integrated demand management approaches that build a more comprehensive smart grid system. The approaches include automated thermostats that can be controlled over an Internet connection and flat-panel whole-house and whole-facility demand management systems that will allow users to dial-up or dial-down power to specific sockets or appliances.

A recent Pacific Northwest National Laboratory study provided homeowners with dynamic pricing and smart grid technologies to monitor and adjust the energy consumption in their homes; and, "[t]he average household reduced its annual electric bill by just 10 percent. Nevertheless, if widely deployed, this approach could reduce peak [demand] on utility grids up to 15 percent annually—which equals more than 100 gigawatts (GW), [offsetting] the need to build 100 large coal-fired power plants over the next twenty years in the United States alone. This could save up to $200 billion in capital expenditures on new plant and grid investments, and take the equivalent of 30 million [motor vehicles] off the road."[xxx]

### LINKING OUR HOMES AND CARS TO BECOME PART OF THE SOLUTION

Further down the line lies a smart grid that allows utilities to rely on power sources emanating from residential and industrial customers as a mechanism to manage spikes in demand. Part of the business plan of "Better Place," the electric car charging company, is the expectation that the batteries of parked plug-in electric hybrid cars could be used to store power from on-site solar PV or small wind systems. These batteries could buffer the grid, allowing more of us to generate our own clean electricity. In this way, each of our homes can help be part of the solution, reducing energy use through efficiency and shifting of demand when power is cheaper and readily available, and then allowing on-site power to charge up cars that then can also provide services back to the grid (see illustration on next page). This sort of innovation at the distribution level of service alleviates the problem of shoe-horning the intermittent power production of tiny solar and wind generators into a power grid originally designed for always-available power sources such as coal, the source of 50 percent of the U.S. electricity supply and among the most polluting options available.

A smarter grid can set the stage for the decentralization and "democratization" of energy. Improvements to metering and grid design will allow for the transfer of surplus energy from homes and business back into the grid, for consumption by others. This type of distributed power generation allows for enormous regional autonomy, with individual consumers no longer solely beholden to remote central power stations or a grid that may be unreliable.

Typically, on-site renewable power generation is intermittent, making power reselling critical to the economic viability of small-scale solar or wind technologies. At certain times of the day (or season) the amount of power generated by these sustainable resources will be more than what is needed at any particular point in time. If this surplus can be channeled back into the larger grid—or perhaps to nearby neighbors—power generation from these green sources can supplant a far larger portion of demand than if restricted to the individual customer level.

## III. TWO SMART GRID CASE STUDIES

### OKLAHOMA

In 2008, OG&E Electric Services, a utility serving 765,000 customers in Oklahoma and western Arkansas, launched the Positive Energy® Smart Grid, a program to deploy smart grid technology to attempt to reduce consumer power usage in pilot households by 10 to 15 percent. This smaller program was part of what the utility hoped could become a broad demand response project that would eliminate the need to build two new power plants by 2020 that were projected to be required to maintain grid stability. In total, OG&E hoped to slice 160 megawatts off peak demand for electric power. OG&E partnered with a vendor that provided end-to-end smart grid solutions, including network technology, smart meter infrastructure, and consumer interactivity technology.

## The Initial Project

In the summer of 2008, OG&E launched an initial deployment of the smart grid solution to 6,600 customers in northwest Oklahoma City, a region selected due to its high volume of service calls. The effort included wireless smart meters enabled to continuously broadcast data via an advanced network infrastructure. This provided OG&E near real-time information on customer habits, as well as on outages. For 25 of those residential customers, energy management web-based portals were also installed to allow both OG&E and its customers to gain real-time feedback on power consumption. This pilot project ran for three months.

As part of the project, OG&E also installed remotely controlled thermostats in residences and businesses in the pilot project. These thermostats included an intuitive interface providing different cooling options. One option allowed users to "pre-cool" their homes during mid-afternoon off-peak hours. The thermostat was considered crucial because 35 percent of power in Oklahoma is sucked up by central air conditioners. In addition to access to the personalized Web portal and the thermostats, customers also received an integrated handheld device (IHD) for home energy reading information. The IHD, a wireless device the size of a cell phone, could be magnetically affixed to a refrigerator, file cabinet, or any other metal surface. It had only six buttons to allow users to easily scroll through screens and menus to view data on current electricity use (in dollars and cents—and kilowatt hours—on a daily, weekly and monthly basis) and information on the current price of energy.

A survey of participants taken after the pilot found "that 100 percent were more aware of their energy consumption and pricing." With this knowledge, pilot study participants cut their energy use during peak hours of 2 p.m. to 7 p.m. sufficiently to produce an average bill reduction of 10 percent to 13 percent per month. According to the vendor, real-time feedback about home energy use and the fluctuating cost of that energy prompted users to shift some tasks such as clothes drying and closing blinds. It also increased the use of ceiling fans and prompted consumers to consider the use of timers on some devices to shift to lower-priced time periods.

## From Pilot to General Deployment

The program was judged to be a success after several months. OG&E, with permission from the Oklahoma City Commission and regulatory bodies, decided to move forward with a broader deployment. To prepare for the broad Positive Energy deployment, OG&E undertook an extensive outreach campaign to inform participants of the benefits of the project and to educate broader communities where OG&E anticipated rolling out the Positive Energy program in the future.

OG&E customer support personnel received extensive training to inform them about the technology and empower them to better answer a wide variety of anticipated questions from consumers. OG&E organized numerous "town hall" meetings where OG&E project managers were available to answer general and specific questions about the Positive Energy program. In addition, OG&E notified customers of the Positive Energy program through door hangers, bill inserts, emails, advertising campaigns, and other direct and advertising mechanisms.

OG&E technicians and representatives also undertook extensive face-to-face communications efforts with individual customers to personalize its outreach. OG&E informed consumers about new pricing programs that would allow consumers to make proactive choices to reduce power consumption and save money. For example, one pricing program, received positively by customers, provided 24-hour advance notice of electrical prices, allowing consumers to adjust behavior in advance and plan their days to take advantage of better pricing.

OG&E has rolled out the program to roughly 42,000 more households and is on track for deployment to the majority of its customer base.[xxxi] The well-planned nature of the rollout combined with extensive public education has allowed OG&E to effectively manage public concerns and answer questions before wide deployment. Unlike other smart grid and smart meter programs in California or other parts of the country, the OG&E program met with little public resistance and was largely embraced by the community.[xxxii] OG&E was not forced to make expensive communications adjustments or to perform damage control; and, municipal authorities have not lodged objections to the program. OG&E plans to include additional enhancements, such as an iPhone application to allow customers to see electrical usage and pricing information on their phones.

The keys to the successful smart grid deployment by OG&E included the following:

- A tightly-controlled, well-designed pilot project to test the program for efficacy and public education, then a broader deployment undertaken in controlled stages,
- Extensive public education efforts that involved multiple interventions through multiple media, including considerable face-to-face communications,
- Multiple feedback mechanisms, including personalized Web portals, IHDs, and other systems to allow consumers to easily track real-time electrical usage and pricing information, and
- Feedback delivered at point of usage—not only on the Internet. but also on IHDs.

## CALIFORNIA

Pacific Gas and Electric (PG&E) is the largest utility in California and one of the largest utilities in the United States. PG&E has aggressively pursued green energy initiatives and, in the early 2000s, began to plan a smart meter rollout that would ultimately cover the utility's entire customer base. This move towards demand management via smart meters was met with strong resistance by many PG&E customers and communities served by the utility. The resistance has been so dramatic that roughly two dozen local government bodies in Central and Northern California have expressed strong objections and angry customers have even launched protests and blockades of installation vehicles in an effort to halt smart meter rollouts.[xxxiii] PG&E didn't adequately provide outreach and education to its customers. The company also didn't put in place technology that would give the customers immediate transparency on smart meter operations. As a result, customers' trust in PG&E eroded and efforts to leverage the smart meter installed base for true customer-driven demand management was damaged further.

### Initial Advanced Meter Infrastructure Project Deployment

After receiving approval for an extensive Advanced Meter Infrastructure (AMI) Project from the California Public Utilities Commission (CPUC), PG&E began planning technology integration and testing equipment. The utility began to deploy smart meters in Northern and Central California in 2007. The AMI Project entailed not only upgrading customers' metering capabilities, but also upgrading or constructing communications networks sufficient to monitor 5.1 million electric meters and 4.2 million gas meters located within PG&E's territory.[xxxiv] The program also created specifications for the appropriate software and IT infrastructure to leverage the information gathered from smart meters to improve PG&E's demand response efforts.

By the fall of 2009, over 600 Smart Meter consumer complaints alleging "unexpectedly high" bills and inaccurate recordings of electric usage had accumulated at the CPUC.[xxxv] Over 90 percent of these complaints originated from PG&E's service area. State legislators inquired about the issue; and, in response, the CPUC hired The Structure Group to complete an independent investigation as to the efficacy and accuracy of PG&E's smart meter system. Meanwhile, local objections continued to build even while PG&E continued installing smart meter systems at a rate of 176,000 per month.[xxxvi]

In some cases, local governments voted to enact moratoriums on further smart meter installations or even outright bans on smart meters in those communities. The municipalities ranged from staunchly environmental and Democratic communities, such as Mill Valley and Fairfax in Marin County, to more conservative enclaves in the San Joaquin Valley. So vehement were protests that opponents blockaded the entrance to the vehicle yard of one of the companies contracted by PG&E to carry out the installations.[xxxvii]

Opponents' objections to smart meters run the gamut from invasion of privacy, to health concerns related to wireless device emissions, and to perceptions that smart meter installs resulted in markedly higher electrical bills. In public appearances, PG&E executives admitted the smart meter program had been badly handled.[xxxviii] That smart meters could stir up such controversy in a diverse array of communities spanning the entire political spectrum indicates that PG&E's smart meter deployment could have been greatly improved.

## Elements Lacking in Initial Effort

The Structure Group's review of smart meter installations and the performance of the system and individual meters validated PG&E's assertions that the meters are, for the most part, functioning correctly and accurately measuring power usage. Nonetheless, PG&E's rollout of smart meters clearly lacked critical elements required for public acceptance, most notably, a well thought-out communications and education plan. PG&E's critical mistakes include:

- **Limited Public Education Campaign**
  PG&E pursued a wide-spread public education campaign through traditional media and through notices included in paper or electronic customer bills. Unfortunately, these efforts lacked reach and depth. Customers complained that notification via utility bills, email, or traditional mail was not helpful because many people do not bother to read these types of communications. Likewise, consumers complained that they did not realize public notices and advertisements taken out by PG&E would impact them directly. This contrasts markedly with other successful smart meter installation efforts where utilities called town hall-style meetings, went door-to-door, and made extraordinary efforts to maximize human interaction with customers to augment communication and recognition. For example, as part of its efforts to roll out a municipal Wi-Fi network in San Francisco, Google enacted a number of well-attended town hall meetings and made its officials and outreach professionals easily available for public inquiries.

- **Lack of Sufficient Notice of Smart Meter Installation**
  PG&E failed to provide customers with sufficient notice of the exact dates and times that smart meters would be installed. Many customers did not even realize smart meters had been installed on their properties. PG&E employees or contractors did leave notes on doors and did knock to alert customers before performing installations, but installations usually

occurred during daytime hours when most customers were at work or in school. That PG&E employees or contractors had performed installations without specifically receiving customer approval fostered deep suspicions and engendered a sense of invasion of privacy.

- Insufficient Customer Service Capacity
  PG&E initially did not provide a dedicated customer service number for smart meter queries from customers. This resulted in confusion over where to obtain information about smart meters and made it difficult for customers to reach the appropriate PG&E staff. PG&E also did not hire sufficient numbers of additional customer service personnel required to field customer queries in a timely fashion. PG&E later added 165 new customer service personnel.

- Poor Explanation of Benefits of Smart Meters
  PG&E failed to provide customers with any tangible benefit from smart meter installations. PG&E did not call or otherwise attempt to actively contact customers to explain potential benefits of the smart meter system. While these benefits were communicated on the company's website and in bill inserts, the general public felt this was not sufficient. This failing was critical. Software or Internet sites that would allow customers to see activity on their smart meters, study readings, and gain real-time or near real-time feedback on electrical usage were not initially highlighted and few customers availed themselves of this opportunity. Making sure that customers could actually see and track how their own behavioral changes impacted power consumption would likely have avoided some objections about electric cost increases attributed to smart meters. In general, this failure to educate and engage customers represented a lost opportunity to lay a foundation for improved customer awareness, empowerment, and education on the simple behavioral changes required for effective bottoms-up demand management.

As of November 2011, PG&E had installed over 8.5 million smart meters.[xxxix] The company has enhanced its outreach and education efforts in various ways: adding walk-in centers for customers to air concerns, adding customer service representatives for phone conversations, engaging in education outreach at large public venues such as the California Academy of Sciences, and instituting customer feedback panels. Many communities continue to object. Smart meter bans are still a hotly debated topic. Some of these communities would likely never have been in favor of the smart meter program. PG&E learned the hard way the price of failing to build an appropriate communications plan for such a major endeavor. The revelation in November 2010 that the top manager of its smart meter program was eavesdropping on customer groups opposed to its smart grid roll-outs using the alias "Ralph" was yet another blow to the utility's reputation.[xl] The executive was forced to resign.[xli]

## IV. VIRTUAL POWER PLANTS AND MICROGRIDS: BUILDING BLOCKS OF THE SMART GRID

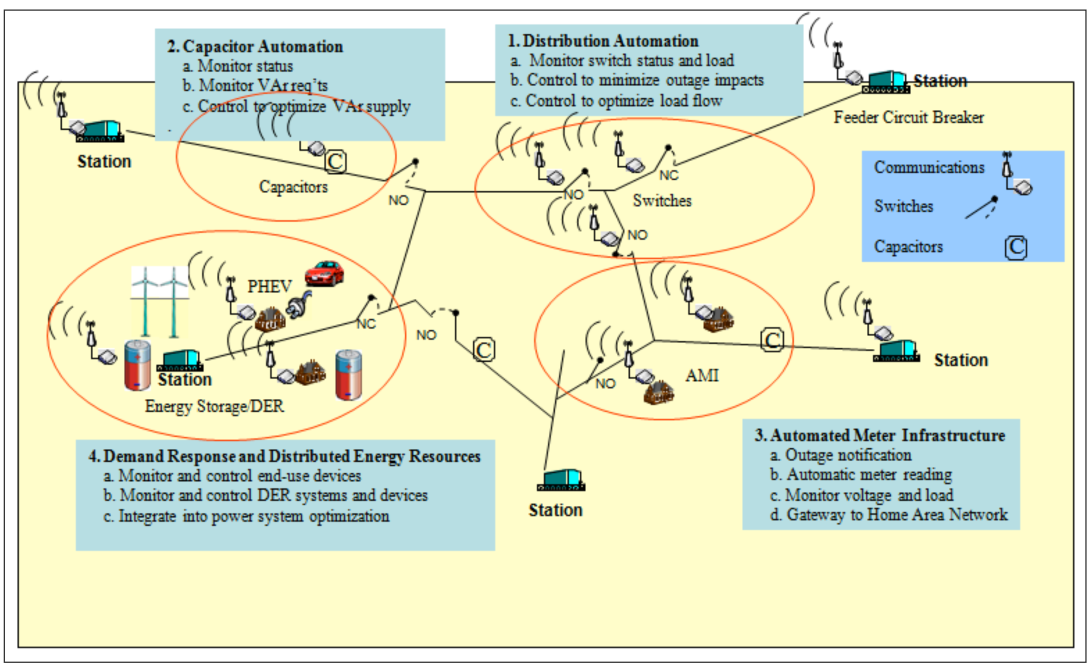
Smart meter rollouts by utilities are just one aspect of the smart grid. This section describes other building blocks of a more intelligent electricity distribution system, highlighting how a more responsive management of our energy future can engage entire communities and a diverse set of technologies to develop a more efficient energy economy.

## VPPS: USING AN "INTERNET OF ENERGY"

The first of these building blocks is a new model … based on the intriguing term of a "virtual power plant" (VPP)—a term sometimes used interchangeably with "microgrids,"which is described later in this section. "VPPs rely upon software systems to remotely and automatically dispatch [power generation sources, demand response, or storage] resources in a single, secure web-connected system. In short, VPPs represent an 'Internet of Energy,' tapping existing grid networks to tailor electricity supply and demand services for any customer, maximizing value for both end-user and distribution utility through software innovations."[xlii]

In Europe, a VPP typically refers to aggregating supply side resources, most often a diverse pool of renewable resources, to look like a typical 24/7 power plant to a grid operator. One such Research & Development project in Germany—deemed a "Regenerative Combined Power Plant"—was awarded the German Climate Protection Prize for 2009.[xliii] A mixture of 36 solar, wind, biomass, hydroelectric and combined heat & power plants were operated as if they were one giant facility, proving that, at least theoretically, all of Germany could operate solely on renewable energy. In the U.S., a VPP may not involve generation sources at all. Instead, these VPPs tap utility demand response programs as resources that, when aggregated together, can mimic characteristics of a traditional power plant. These VPPs can help a utility meet peak demand, the need for energy, or small increments of instantaneous power—sometimes only lasting seconds—to keep the grid functioning harmoniously.

**FIGURE 8: DIAGRAM DISPLAYING VPP VERSATILITY**




*Source: American Electric Power*

The diagram from American Electric Power highlights the variety of resources that can be tapped to "construct" a VPP. These resources include key elements of a smart grid, including automated meter infrastructure, demand response, distributed energy resources, distribution line automation, and utility substation capacitor automation.

Moreover, "[w]ithout any large-scale fundamental infrastructure upgrades, VPPs can stretch supplies from existing power generators and utility demand reduction programs, delivering greater value to the customer (lower costs, new revenue streams) while also creating benefits to the host distribution utility (avoidance of capital investments in grid infrastructure or seldom used power plants reserved only for periods of peak demand). When compared to the fossil central station power plants that dominate electricity markets worldwide, one of the primary advantages of VPPs is they can react quickly to changing customer load conditions, are dynamic and deliver value in real time."[xliv]

Ultimately, "[t]he beauty of the VPP is that it can optimize the entire system and deliver much greater value, without the need for large capital investments in infrastructure and corresponding long lead times for implementation. Customer-owned generation sources, utility designed demand response, and [real-time] pricing programs—and even plug-in electric vehicles—[all become] eligible candidates to help utilities solve grid balancing challenges."[xlv] In short, the VPP meshes the unique characteristics of all of these potential resources into a "virtual" facility that can be organized by program type, supply-side resource category, or location on the distribution network. VPPs are really geared to helping utilities cope with the smart grid by aggregating a meaningful number of solar PV installations, small wind turbines, or residential customers with "smart" appliances to reap the rewards of economies of scale in a whole new way. "Instead of building bigger and bigger physical power plants, software and other controls enable utilities to aggregate resources on a short-term basis according to proximity, cost, environmental performance, and/or other criteria."[xlvi] A VPP is not limited by geography and a static set of resources, like the typical microgrid. "With its emphasis on smart meters, real-time pricing, and demand response, the smart grid is [actually] a necessary prerequisite for VPPs… VPPs are [likely] a natural evolution of the smart grid."[xlvii]

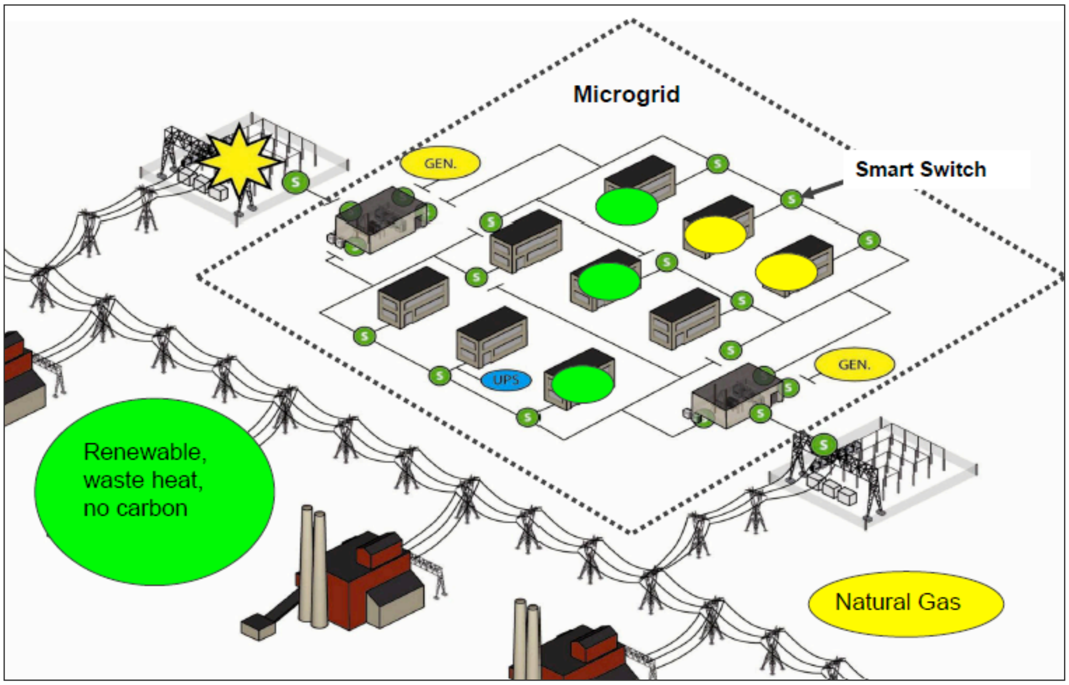
## MICROGRIDS: BUILDING THE SMART GRID FROM THE BOTTOM UP

Another building block, the "microgrid," "can be summed up as follows: *an integrated energy system consisting of distributed energy resources serving multiple electrical [customers or devices and] operating as a single, autonomous grid either in parallel to—or 'islanded' from—the existing utility power grid*."[xlviii]

A "microgrid" is really just a small-scale version of the electricity grid that the vast majority of electricity consumers rely on for power service today—only smarter and more self-sufficient. Like today's power grid, microgrids include generation facilities, distribution lines, and voltage regulators. They can be networked with one another and the central grid in order to boost capacity, efficiency, and reliability—or can function as autonomous islands of power.

But in other ways, microgrids are quite different. The much smaller scale translates into far less line losses, less energy lost during long-distance transmission, and greater efficiency because electricity is generated closer to the customers who need it. Line losses can add up to 10, or even 15, percent of the power originally generated—a level of inefficiency for which all customers pay. Microgrids can lessen demand on the utility transmission infrastructure, thereby increasing the system's capacity to serve other customers, especially in times of shortages. Instead of using a utility smart grid program to raise the level of homogeneous power quality for all distribution utility customers, microgrids offer the flexibility to add on premium power services to meet a customer's specific needs. Microgrids can be considered one of the ultimate expressions of the smart grid, a contingency framework that is enabled when all else fails.

**FIGURE 9: THE MICROGRID PARADIGM**




*Source: Galvin Electricity Initiative*

Microgrids address our power needs from indigenous resources at the local level, creating islands of self-sufficiency and sustainability. "Perhaps the most compelling feature of a microgrid is its ability to separate and isolate itself—known as "islanding"—from the utility's distribution system during brownouts or blackouts. Under today's grid protocols, all distributed generation, whether renewable or fossil-fueled, must [essentially] shut down during times of power outages," so they do not feed power back to the larger utility grid.[xlix] This fact exasperates those who have invested large sums to generate their own renewable energy. A power outage is "precisely when these on-site sources could offer the greatest value to" themselves, society, and the environment.[l] The most common technology deployed during grid outages are diesel generators, among the dirtiest of all possible power generation technologies.

Instead of relying upon limited and polluting fossil fuels, microgrids, with some level of storage of renewable energy, could instead provide clean power services when the larger grid system has failed consumers, providing emergency services to the neighborhood in times of earthquakes or other natural disasters. For the military, "the value proposition … is security, cyber and physical, since the concept of 'emergency' can be a 24/7 matter. Deploying mobile applications during combat missions can literally mean that microgrids are a matter of life and death when it comes to minimizing reliance on liquid fossil fuels. Still other … microgrids never interact with any larger grid, and are focused on reducing diesel fuel consumption" in poor rural villages in Africa, China, or even remote spots in Canada. [li]

With additional technological advances, engineering, and government standards, these microgrids could also interact with utility smart meters to help boost the overall reliability of the larger grid network—hence, why growing numbers of utilities are embracing microgrids.

Likewise, "[d]eveloping countries that have yet to build out the centralized power plant radial transmission model offer unique near-term market opportunities for microgrids. Typically, these microgrids will initially be at a smaller scale and have a simpler design. … Over the long term, however, the markets in developing countries could become the largest microgrid sector. Why? It is quite feasible that as smaller microgrids become networked with each other, these islanded pockets of power may obviate the need for—or greater reduce the scale of—any central transmission grid."[lii]

# V. CHALLENGES TO SMART GRID & ENERGY EFFICIENCY DEPLOYMENTS: ENCOURAGING CONSUMER ENGAGEMENT AND UTILITY PARTICIPATION

> *The future will be filled with a tension between the forces for change propelled by the Smart Grid and energy efficiency policies on one side and the perception that keeping the current structure may be more reassuring to investors, CEOs, and policy makers on the other. Deregulating more of the industry will be a challenging proposition, caught between technological change that regulators will be severely challenged to keep up with and the memories of deregulatory problems they desperately want to avoid … the solution will be business models and reformed regulation that plug deregulated competition into the right parts of the Smart Grid but preserve regulation and oversight in parts of the system that still need it.*[liii]

These words are those of Peter Fox-Penner, a principal with the Brattle Group consulting firm and author of *Smart Power: Climate Change, the Smart Grid and the Future of Electric Utilities,* a book about the future of "smart" utilities.[liv] The need to reinvent our electric utilities originally led to a wave of restructuring activity in the 1990s,[lv] which in California led to the Enron debacle and the power crises of 2000-2001. A new form of enlightened restructuring is now required to unleash the power of the smart grid.

Fox-Penner notes, "Today, the electric power industry faces challenges far larger than any in its history. A system of nearly one million megawatts, operating mainly on fossil fuels, will require a trillion-dollar retooling in the span of the next several decades."[lvi] Not only must old, polluting, and centralized power plants be replaced by new ones on a massive scale, but new regulatory schemes and industry structures must be worked out, all while ensuring that lights stay on and industrial motors keep humming along. "It is like rebuilding our entire airplane fleet, along with our runways and air traffic control system, while the planes are all up in the air filled with passengers," he writes.[lvii]

Fox-Penner sees two futures for utilities. In one possible future scenario, regulated utilities become ***"smart energy integrators"*** that operate an energy delivery and information network but no longer own power plants or even sell power into the grid. These new utilities keep supply and demand in balance and run smart grid programs enabling customers to shift their electricity usage as prices change during the day, or swap power in and out of the larger utility grid from hybrid vehicles. Customers choose their own private or public power providers as well as energy efficiency service contractors.

Utilities operate under an ***"energy services utility"*** in the other possible scenario. Under this model, utilities still deal directly with customers—unlike the energy integrator—and they continue to operate the grid. They may or may not own power plants. Instead of just selling electricity, however, the utility sells services heat, cooling, or lighting (as Thomas Edison did in the late 19th century), exploiting new technologies to achieve greater and greater efficiency. They boost profits by selling less energy, but better services—the opposite of the old-fashioned profit structure.

In spite of the opportunities enabled by the smart grid and greater energy efficiency, many Americans are unaware of the advantages of both of these necessary solutions to our current environmental and economic challenges. Some utilities have not aggressively engaged their customers or yet moved to deploy smart meters. Others have not tapped the lowest cost resource available—energy efficiency—because their business models reflect a goal to sell more and more kilowatt hours, rather than a focus on providing the best service possible. Increasing transparency and providing real time pricing are key ways to remove barriers to effective deployment of a more energy efficient utility system. Solution providers and utilities must make public education a greater priority to affect change in consumer behavior towards energy. Some basic recommendations on removing these barriers are included below.

## EDUCATE CUSTOMERS

Utilities must considerably transform their relationships with consumers. Utilities have traditionally engaged customers only minimally, with their primary interaction coming in the form of monthly transactions or the rare repair call. However, creating a successful smart grid or energy efficiency program requires a tremendous amount of education and constant interaction with customers at multiple levels over an extended period of time. These types of interactions must start at the earliest stages of a deployment in order to shape customer and community expectations.

These interactions must help a utility proactively identify and address concerns in order to head off potential conflicts that could result in negative messaging and suspicion. Deploying smart grid and energy efficiency programs often seem more complicated than building a far away power plant. In addition, most ratepayers are oblivious to how the status of the grid impacts their lives. Considering that many consumers are already suspicious of utilities, the educational efforts required are far more considerable than many utilities may initially realize. Education efforts must incorporate a range of activities, including door-to-door and town-hall meetings, mailers and door-hanger notes, e-mail campaigns, and advertising in prominent local publications or media outlets. In some instances, utilities may want to conduct outreach through a third party, one which the community views as more trustworthy.

> Recommendation #5
>
> **MAKING IT ALL WORK TOGETHER**
> **Incorporate Clean Energy, Energy Efficiency and the Smart Grid into Long Term Utility Planning**
>
> If utilities prioritize investments in the smart grid, clean distributed energy, and energy efficiency programs as part of a comprehensive, funded plan, these individual investments are more likely to yield significant results. The Integrated Resource Plan (IRP) process serves as a valuable method for this type of planning. In addition, developing long-term (10-year) incentives for solar and other distributed renewables will help support market development by inspiring confidence in investors and industry players. The California Solar Initiative is a successful, first-of-its-kind 10-year solar incentive program, which sets the tone for other programs around the country. Also in California, Pacific Gas & Electric has been a leader in supporting innovative conservation and energy efficiency policies, like net metering. These types of programs and incentives are critical to and should be part of any utility long term planning process.

Regarding the smart grid, utilities have also done an inadequate job of personalizing the benefits to communities by explaining the resulting decrease of emissions from power plants or need to build generally unpopular and unsightly energy generation facilities. (Of course, energy efficiency standards and programs also reduce the need for continued reliance upon polluting power plants.) A smart grid can empower consumers, businesses, and utilities to help solve our energy challenges locally, without shipping pollution to other states or countries by importing dirty coal. By making these sorts of connections more explicit—without seeming entirely self-serving—a utility can convey not only the power reduction and cost benefits of a super efficient grid system, but also the less tangible, but equally important, community benefits of such a system. Likewise in communities where resistance to smart meters is strongest, utilities may want to develop smart grid alternatives to assuage fears about health issues. In Europe, smart grids do not rely on wireless smart meters. Microgrids, particularly those based on DC configurations, offer a smart grid alternative to traditional smart meter deployments, which can then hook into larger traditional smart grid deployments. Making these sorts of technology alternatives available would help drive greater adoption and, more importantly, secure customer and community trust.

## CONTINUE LONG TERM EDUCATION EFFORTS

Even after the launch of a smart grid program, it is critical that education efforts continue because reliance on an Internet portal alone as a means to drive consumer behavior is fraught with uncertainties, namely from increasing competition for consumers' time and attention. Successful smart grid rollouts will ensure multiple points of interaction for consumer education and customer engagement. Various means include, for example, deployment of integrated handheld devices, personalized Internet energy management portals, and email and text message notifications of power consumption trends. Having an IHD providing power consumption feedback mounted on a refrigerator—a key crossroads in any house or business—likely encourages interaction with the smart grid program in a way a Web portal may struggle to achieve.

Education about many energy efficiency measures requires less intensive efforts since programs often focus on the one-time adoption of certain improvements. In the case of minimum energy efficiency standards, education efforts focus more on how the additional costs of insulation, better windows, or more efficient appliance represent a long-term investment in power savings. Utilities will need to support efficiency standards with new incentive programs to accelerate deployment on a timely basis.

## HIGHLIGHT MODEL PROGRAMS AT SCHOOLS AND AFFORDABLE HOUSING PROJECTS

Utilities would be wise to link their smart grid roll-outs to popular energy efficiency initiatives at schools and affordable housing developments. Fostering such partnerships generates good will and energy savings. The significant public investments in smart infrastructure can also deliver benefits to taxpayers by helping to green our schools and affordable housing projects.

Building greener buildings is a key strategy to lower emissions and create more affordable solutions to global climate change by capitalizing on energy efficiency—the cleanest and cheapest source of energy. Since many families spend the bulk of their lives in homes and schools, greening these buildings also helps to foster a safer and healthier community.

Schools can also serve as institutions to help educate and demonstrate sustainable energy practices, including teaching the next generation about how energy efficiency upgrades work synergistically with the demand responsive nature of a smart grid. Already, many solar PV and wind turbines have been installed at educational institutions throughout the country to serve as education tools and living laboratories of sustainable practices. Environmental progress must not be limited to wealthy institutions and residents, but must also take hold from the bottom-up, in affordable housing complexes and in our schools. See the Appendix for more information about Global Green's efforts on developing green schools and green affordable housing units.

## ALTER CONSUMER BEHAVIOR THROUGH PROPER INCENTIVES AND TRANSPARENCY

In regions of the country where power costs are relatively low, current approaches to smart grid engagement or education on the importance of energy efficiency upgrades may not be sufficient. Customers are unlikely to make what may seem to them drastic behavior changes—or previously unnecessary investments in time and money—to create greener buildings in order to save a few dollars on their electrical bills each month. Utilities and other vendors may need to either more aggressively reward customers who practice effective demand management or make it far simpler for customers to control their electric usage. Likewise, enabling consumers to see prices in real-time or, even better, prices for the next day, provides powerful incentives that could drive participation up and energy use down.

**FIGURE 10: BENEFITS OF THE SMART GRID WITH PROPER ENGAGEMENT WITH CUSTOMERS**

| Benefit | Description |
|---|---|
| **Increase program effectiveness** | By leveraging detailed energy usage information, managers of efficiency programs can micro-target the homes that would benefit the most from such programs, boosting the average energy savings rates for these programs. |
| **Encourage consumer investment** | Inspire additional efficiency investments by helping consumers measure the benefits of their own investments and behavior changes and make comparisons with neighbors, friends, and others in the community. |
| **Increase job growth** | Increased spending on energy efficiency will create jobs for providers of energy efficiency products and services. |
| **Reduce program costs** | Using web and e-mail channels to micro-target efficiency programs to the homes that need them most will reduce the cost of delivering programs, products and services to consumers, allowing more dollars to be directed at driving broader efficiency adoption. |
| **Improve measurement and verification** | Smart meter data enables immediate measurement of efficiency improvements, which helps regulators better target their efficiency and incentive programs, measure the results of these programs, and design more effective ones. |

*Source: Silver Spring Networks*

Energy price and usage notifications become even more useful when utilities give consumers tools that allow them to remotely, or in a more automated manner, manage power consumption. Providing customers the ability to adjust thermostats on heating and air conditioning systems, to turn up the temperature several degrees on a refrigerator, to shut off a hot-water heater, or to simply shrink reliance on the largest sources of power consumption is not yet widely available. Whole-home energy management systems, however, are emerging as viable technologies. By using these types of products, utilities could easily create more innovative incentive structures. If meshed with strong energy efficiency standards and home energy management systems, the smart grid will gain support since they will provide clear financial savings.

Finally, utilities will likely attain better outcomes when they can not only provide incentives, but also provide detailed recommendations based on usage data from smart meters. Research by Pacific Northwest National Laboratory suggests energy use "feedback tends to be most effective when it:

- is based on actual usage data
- is provided on a frequent basis (daily is better than weekly, etc.)
- involves goal setting and choice
- is provided over a year or more
- [provides] specific behavioral recommendations regarding appliance[ use]
- [offers] normative or historical comparisons."[lviii]

For regulators, this type of data could be used to design consumer and industry incentive programs and to decide what sorts of economic incentives are most appropriate. If shown the connection between consumption behaviors and energy usage, consumers are far more likely to reduce demand. Beyond these recommendations, the utilities should strive to create an ecosystem of service providers and product companies that can help customers reduce power consumption and realize significant energy savings. This ecosystem would create green jobs and would also shift the position of the utility from exercising its monopoly to fostering a real marketplace, representing a marked transformation that could alleviate trust issues and also drive community support by creating jobs and spreading the wealth.

## ENGAGE IN A SOCIAL MEDIA STRATEGY

Consumer behavior has shifted to high levels of engagement through social media. These forms of media, such as Facebook and Twitter, drove record participation in the 2008 presidential election. Utilities should learn to leverage social tools effectively to not only communicate information, but also to build community and foster engagement. A user who manages to reduce power demand by 10 percent might be allowed to unlock a badge that gives them discounts at a local restaurant, for example. That user could then share the badge with friends, encouraging them to take similar action. The rise of so-called "game mechanics" has made it easy to provide both monetary and intrinsically non-monetary reward structures to drive any sort of behavior. As mentioned previously, several startups are already building game platforms designed to drive green behaviors. The power of games and community to drive customer behaviors—particularly when combined with granular control capabilities—could give smart grid adoption efforts a tremendous boost.

# APPENDIX: GREEN SCHOOLS & AFFORDABLE HOUSING PROJECTS

## GREEN SCHOOLS

Just as green homes are necessary to provide healthy, comfortable, and efficient living, green schools are crucial to ensure a safe and healthy learning environment for children—while both contribute to our collective efforts to address global climate change. Green schools lessen the impact of building construction on the environment and set an example for future generations that environmental quality is essential to our long-term well being. Moreover, green schools provide benefits in several key student and teacher performance areas. For example, green schools:

- Protect Student and Teacher Health - Schools designed with attention to proper ventilation, material selection, acoustical quality, and other indoor environmental factors can expect improved student and teacher health and higher classroom attendance;
- Improve Student Performance - Attention to site planning and adequate daylighting has been shown to heighten student performance on exams by as much as 25 percent;
- Lower Operating Costs - Operating costs for energy and water can be reduced by 20 percent to 40 percent, allowing more money to be used for teacher salaries, textbooks and computers; and,
- Provide a Unique Educational Opportunity - When advanced technology and design are made visible, school buildings can become teaching tools and important features of science, math, and environmental curriculum.

## GREEN LOW-INCOME HOUSING

Utility costs for low-income families can be up to 25 percent of expenses after rent or mortgage payments compared to just 5 percent of net income for middle-class families. The second leading cause of foreclosures for low-income homeowners is unanticipated utility bills. Reducing energy consumption affords the most fundamental way new policies and programs can aid disadvantaged citizens, particularly during the current economic recession.

Green affordable housing directly benefits individuals and families in need by reducing energy bills and creating healthier living environments. Combined, green building and affordable housing can have a huge impact on families that live in low-income housing. Low-income residents would be able to lower their utility bills even further with advances like the Smart Grid.

Our extensive experience with and dedication to greening low-income housing allows Global Green to understand the importance of new energy efficient technology and to identify successful strategies in this unique sector, which experiences its own particular challenges in becoming more energy efficient.

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