WHITE PAPER

SILVERSPRING NETWORKS

How Silver Spring Networks and the Smart Grid can Jump Start Energy Efficiency

Executive Summary

Energy efficiency has become an increasingly urgent policy matter due to several factors. Demand for electricity continues to grow at a time when supply is increasingly constrained as a result of greenhouse gas emissions concerns. Energy independence has become a critical national security item. Small increases in energy efficiency are estimated to create noticeable increases in GDP. And the development and deployment of new clean/green technologies have tremendous potential for creating high-quality jobs and increasing exports.

Smart grid infrastructures being built across the globe offer an unprecedented opportunity to improve the effectiveness of energy efficiency programs and drive adoption of efficiency-oriented products and services.

Research shows that consumers reduce their energy consumption when provided with ongoing data about their actual energy usage along with customized efficiency recommendations, such as turning off lights, replacing inefficient appliances and weatherizing their home. Until recently, utilities have had no cost-effective way to collect the detailed energy usage data needed at the household level to provide accurate, personalized efficiency recommendations to large numbers of consumers.

Smart grid deployments and the availability of energy web portals such as Silver Spring Networks' CustomerIQ portal are changing that reality. Today, utilities can collect timely energy consumption data and use web-based advisory software to deliver highly targeted efficiency recommendations to the millions of U.S. households already equipped with smart meters. Studies and Silver Spring's own real-world experience indicate that the Advanced Metering and two-way communication capabilities of a smart grid, coupled with web-based energy portal software, can be used to deliver the type of tailored efficiency information that prompts consumers to action.

Combining detailed usage data from smart meters with web-based portal software can:

- Accelerate investment in energy efficiency by educating consumers about their energy usage and automatically providing customized recommendations for reducing consumption.
- Create jobs for providers of energy efficiency products and services.
- Enable regulators to precisely target efficiency/incentive programs and measure their results.
- Reduce the cost of delivering energy efficiency by creating an ecosystem that matches consumers with relevant products and service providers.

A smart grid-enabled energy efficiency solution is the most cost-effective way to deliver targeted efficiency programs to consumers at scale.

Silver Spring, with its Smart Energy Platform that includes the CustomerIQ portal, can help governments and utilities reduce energy consumption and achieve greater energy independence, lower carbon emissions and ramp up jobs in the nascent residential and commercial energy efficiency markets.

The Power of Efficiency

Rising global demand for energy and concerns about national security, GDP growth, global warming and greenhouse gas emissions are driving government efforts to increase energy efficiency. Economic incentives alone are compelling: one report estimates that a comprehensive national focus on energy efficiency could yield energy savings of $1.2 trillion off an investment of $520 billion ("Unlocking Energy Efficiency in the U.S. Economy," McKinsey Global Energy and Materials, July 2009). How to boost efficiency is no mystery: Research shows that consumers reduce their energy consumption when provided with ongoing data about their actual energy usage along with specific recommendations for how to reduce consumption.

To date, utilities have had no cost-effective way to collect detailed energy usage data at the household level that can be used to provide accurate, personalized efficiency recommendations to large numbers of consumers. However, studies and Silver Spring Networks' own real-world experience indicate that the Advanced Metering and two-way communication capabilities of a smart grid can be coupled with web-based advisory or portal software to deliver tailored feedback to consumers.

Given the steady pace of smart grid deployments and the millions of U.S. households already equipped with smart meters, the opportunity exists to combine these technologies with portal software to accelerate consumer participation in energy efficiency. Specifically, leveraging smart grid and Internet technologies can:

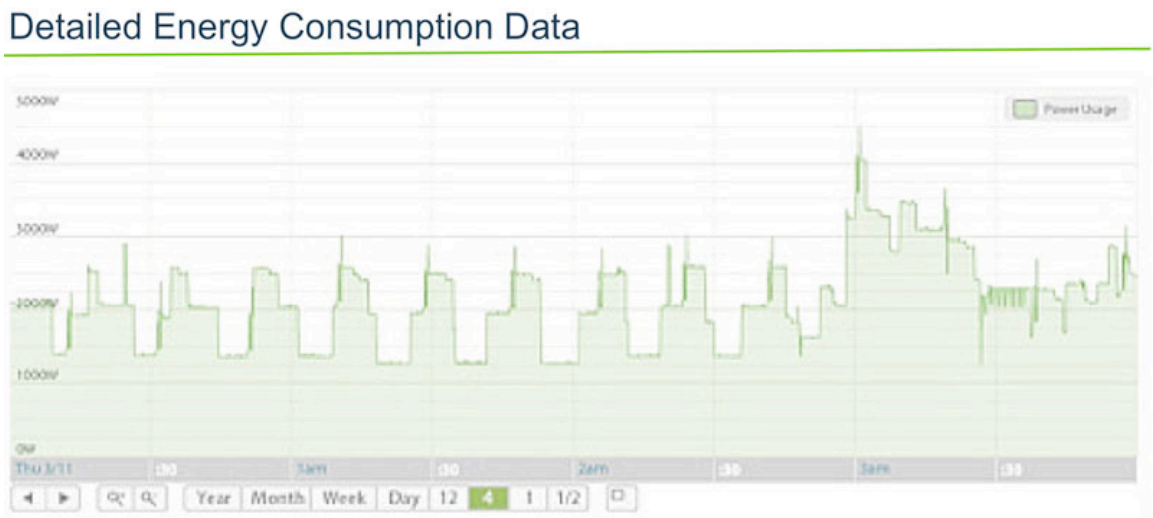
- Increase participation in and effectiveness of energy efficiency programs by educating consumers about their actual energy usage and specific steps they can take to reduce consumption.
- Inspire additional efficiency investments by helping consumers measure the benefits of their own actions, and compare these actions with neighbors, friends and others in the community.
- Create jobs for providers of energy efficiency products and services.

- Help regulators better target their efficiency and incentive programs, measure the results of these programs and design more effective ones.
- Reduce the cost of providing energy efficiency products and services so that consumers continue to invest in efficiency even after the end of stimulus programs designed to catalyze the market.

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.

The Challenge: You Can't Manage What You Can't Measure

Currently consumers lack the information they need to make smart decisions about reducing household energy usage. Monthly utility bills provide only coarse data with little detail. For example, using standard techniques for analyzing monthly billing data, it's impossible to estimate the air conditioning load in a particular home or to compare operating older refrigerators to newer, more efficient models. Without detailed information about their specific energy usage, consumers don't know which efficiency investments or even simple behavior changes will yield the greatest energy savings.



The more granular the data about energy consumption, the easier time consumers have mapping their behavior to changes in energy usage. This graph depicts consumption data in five-minute intervals.

In addition, utilities have had no cost-effective way to provide accurate, personalized efficiency recommendations to large numbers of consumers. Most efficiency programs today leave it up to the individual consumer to sort through program options and figure out what makes sense for them. This decision is nearly impossible for most people to make, so they don't participate in programs.

Currently, for consumers to get a better picture of their energy footprint and specific ways they can conserve, an energy auditor needs to visit a household. Yet even the results of such audits are limited because it's very difficult for energy auditors to precisely assess electricity usage. While they can count the number of light bulbs installed and determine the age of appliances and even look over a year's worth of electricity bills, for example, they cannot determine how a particular household uses their lights and appliances without detailed usage data from a smart meter. In-home energy audits often result in "best guess" estimates of energy savings and payback periods because auditors base their calculations on aggregate data, not a deep understanding of a given consumer's daily usage patterns and specific utility rates.

In addition, such audits are expensive and time consuming to conduct. As a result, only a few hundred such audits might occur in a given area over the course of a year, whereas tens of thousands of such audits are needed in the near term for utilities to meet mandated energy efficiency targets.

Some utilities and third parties have implemented primitive mechanisms that provide consumers with energy usage information and recommendations based on monthly usage data (e.g., via inserts in monthly paper bills or simplistic web interfaces). Such recommendations are hampered by a lack of detail; as a result, they are often incorrect and can leave consumers frustrated if they don't achieve the energy savings they were promised.

Finally, even when consumers do change their behavior and/or make efficiency investments, they have no easy way to verify whether their actions had the intended effect. Nor can utilities or regulators track the performance of those investments on either an individual or aggregate basis. Without the information they need to determine whether they save money after purchasing a new heating system or installing a solar water heater, consumers lack the incentive to continue investing in efficiency or to share their efficiency success stories with friends, family and neighbors.

The challenge to boosting and subsequently measuring energy efficiency is in collecting detailed usage data for individual households and communicating efficiency recommendations to consumers. Some type of device for capturing energy consumption data must be installed for each household along with a communication network, which can be costly and labor intensive to deploy. However, by leveraging the data collection and communications capabilities of existing smart meters and smart grid deployments and coupling these systems with web-based advisory or portal software, managers of energy efficiency programs and energy providers can reach large numbers of consumers with detailed data and individually targeted programs and recommendations.

The Smart Grid as Efficiency Catalyst

Consumers change their energy consumption behavior in response to frequent, specific feedback. In its 2010 report "The Smart Grid: An Estimation of the Energy and CO_2 Benefits," the Pacific Northwest National Laboratory (PNNL) examined a number of studies regarding the effect of feedback mechanisms on consumer energy usage. The organization found that feedback is most effective when it is based on actual usage data and provided on a frequent basis; for example, daily reports work better than weekly ones. Consumers should also receive the feedback over a long period – a year or more is recommended. In addition, the feedback should also involve goal setting and choice, offer specific behavioral recommendations regarding appliances and provide normative or historical comparisons.

Feedback on energy use should:
Be based on actual usage data
Be provided in near real time or at least very frequently (daily vs. weekly)
Involve goal setting and choice
Be provided over a year or longer
Provide specific behavioral recommendations for appliance use
Offer normative or historical comparisons

Source: Pacific Northwest National Laboratory report

PNNL also cites studies indicating that "the smart grid capabilities offered by AMI and two-way communications networks […] provide an effective way of engaging the consumer and providing tailored feedback." This level of feedback is possible because smart meters can collect a rich set of data on individual household energy usage that was never before available.

In addition, the PNNL report notes the two-way communications provided by a smart grid Advanced Metering network is required to deliver feedback in near real time, which is key to changing behavior. Inserts included with monthly bills "do not provide the timeliness or frequency characteristics of effective feedback," the PNNL authors state, and so do little to change consumers' energy habits.

When detailed meter data is coupled with interactive web-based advisory applications and tools, consumers can get detailed usage information as well as automated recommendations of specific actions to take.

Example recommendations can include:

- Modify their behavior by turning off lights, adjusting thermostats, setting pool pump timers appropriately and taking other modest actions.
- Repair or replace inefficient heating and air conditioning systems, seal ducts and otherwise address systemic inefficiencies in the home
- Upgrade to newer, more efficient appliances, pool pumps and other energy-consuming devices.
- Insulate, weather strip and otherwise weatherize their "building envelope."
- Install renewable energy systems such as solar water heaters, solar photovoltaic panels and other alternative energy devices.

When smart meter data is analyzed and channeled to consumers via web-based portals or personalized energy information displays, households have reduced their energy consumption from 5 to 20 percent, according to studies such as the cited PNNL report. These results are corroborated by Silver Spring Networks' own real-world projects with several utilities and diverse consumer groups. For additional value, data from a smart grid can be used to verify energy savings and CO_2 emission reductions.

Since smart grid systems are integrated into a utility's billing system, very precise measurement and verification are available. In addition, the data provided by smart meters enables utilities and efficiency program managers to precisely target high usage homes or homes with clear inefficiencies, which increases the average energy efficiency gain of the whole population. The smart grid's ability to interface to thermostats and automatically control heating and air conditioning systems also offers tremendous potential for energy savings.

Creating an Energy Efficiency Ecosystem

Smart grid and Internet technologies can be used to support all the stakeholders involved in boosting consumer energy efficiency, including the state and federal agencies that set efficiency targets and design incentive programs; utility companies and the plethora of product and service providers, from energy auditors to weatherization specialists, solar installers, and even retailers selling "Energy Star" rated appliances. The smart meter's ability to collect detailed usage data, coupled with the two-way communications and robust analytics that smart grid providers supply, makes it possible to automatically identify which consumers would benefit from efficiency programs and what types of programs should be targeted to them.

Using a self-service interface for advisory software lets utilities and efficiency providers reach large numbers of consumers with targeted recommendations at minimal cost. At the same time, consumers can be matched easily with providers of the products and services they need most, eliminating much of the transactional cost in the current energy efficiency marketplace. Having access to detailed usage data provides a range of benefits to both operators of efficiency programs and the providers of efficiency products and services (see table).

Benefits of detailed usage data	
For operators of efficiency programs	*For providers of efficiency products and services*
Automatically identify customers who are good candidates for specific energy efficiency and demand response opportunities	Automatically target households with the greatest potential for energy reduction
Analyze the effectiveness of programs and investments	Conduct online energy audits and automatically generate initial recommendations
Fine tune programs based on measurement and verification of their impact	Reduce the cost of sales by pre-screening potential customers based on their actual energy needs and goals
	Accelerate sales cycles
	Reduce the ratio of on-site visits to closed deals

In addition, leveraging the communication capabilities of the smart grid in conjunction with the Internet allows for the emergence of an online “efficiency ecosystem,” whereby product and service providers as well as utilities can interact with consumers and consumers can interact with each other, to promote effective energy efficiency solutions.

An online efficiency ecosystem can:

- Help program managers and efficiency providers publicize benefits and experiences of early adopters to encourage broader consumer participation and investment.
- Enable consumers to easily find providers in their area.
- Help consumers drive participation and investment by sharing success stories, reviewing products and providers, making recommendations and referrals and interacting with other consumers through various social media.

The combination of smart grid and Internet technologies, including web-based advisory software or portals, allows for a rich exchange of information that supports an online efficiency ecosystem. As a result, consumers can share their experience of insulating their house, buying an energy-efficient refrigerator or working with a particular solar installer. Providers of products and services benefit from the ability to reach prospects and cut sales costs, which helps ensure a vibrant supplier community and translates to lower costs to consumers.

What it Takes to Jump Start Energy Efficiency

A smart grid and web-based portal are key components in jump starting energy efficiency. However, additional tools and capabilities are needed to create a vibrant, fully functioning efficiency ecosystem. State and federal agencies, utilities and other parties looking to accelerate consumer adoption of energy efficiency behaviors, products and services need a smart grid-based efficiency solution that can micro-target consumers as well as address the requirements of all the stakeholders of the efficiency ecosystem.

A smart grid-enabled, targeted energy efficiency solution needs to:

Scale

- Scale to millions of endpoints/households as well as thousands of program administrators, product and service providers, etc.
- Have sufficient bandwidth to accommodate meter data volume and transmission frequency.
- Collect detailed usage data from households at 15-minute or more frequent intervals.

Provide end-to-end integration

- Integrate with devices in the home, such as thermostats.
- Integrate with utility back-end systems and third-party software systems.
- Include a web-based energy efficiency software platform that can be deployed as a standalone web site or integrated with the utility or third-party web site.

Offer tools for all stakeholders

- Provide consumers with detailed energy usage information along with automated efficiency recommendations based on their actual usage and utility rates.
- Give consumers tools to analyze the effectiveness of their efficiency investments and behavior changes.
- Support social networking to help consumers share their success stories, review providers and otherwise drive consumer participation and investment.
- Automatically generate printed reports to reach non-Internet enabled consumers.
- Provide tools that help administrators of federal, state and utility-run efficiency programs target their programs appropriately and analyze program effectiveness.

Support standards and privacy mechanisms

- Have an open architecture capable of supporting emerging standards as these are finalized.
- Have the ability to collect individual meter data anonymously and maintain consumer privacy as well as to aggregate data.
- Provide mechanisms so that consumers can give providers of efficiency products and services access to their energy usage information while protecting their privacy.

Be economical and readily deployable

- Require zero investment from consumers to get started.
- Cost effectively deliver to utilities all the functionality of a smart grid-enabled solution.
- Be available for governments or utilities to deploy in the very near future.

Addressing all of these requirements is challenging but quite feasible in the short term. Silver Spring's utility customers have already deployed more than a million smart meters. The company has also delivered CustomerIQ, a robust customer portal, as well as other tools needed by utilities, regulators and managers of efficiency programs. Like the Internet itself, which has expanded exponentially since its inception, smart grid-enabled efficiency solutions will expand in scope and functionality as the technology matures and everyone learns from consumers' experiences. But Silver Spring has the foundation pieces in place to begin delivering significant efficiency gains right away.

How Silver Spring Networks Can Accelerate Efficiency Adoption

A pioneer in delivering smart grid solutions, Silver Spring can help jump start consumer adoption of energy efficiency programs, products and services. The Silver Spring Smart Energy Platform, including the CustomerIQ energy web portal, enables utilities to reach millions of households with efficiency messages and programs such as the Home Star and Building Star weatherization and efficiency programs.

In addition, Silver Spring's expertise at complex integration and track record of implementing highly scalable solutions enables it to help utilities deliver targeted efficiency programs to consumers at scale quickly. It supports the extended efficiency ecosystem.

Silver Spring has made a significant investments in its Smart Energy Platform over the last five years, creating a highly customizable solution. The Silver Spring platform consists of standards-based network infrastructure, including smart meters; software to support utility operations and a robust consumer web portal and smart grid services. For example, the Silver Spring UtilityIQ application suite includes advanced metering, DA management, outage detection and network management applications. It also supports standard web services for integration into a utility's back-office applications. The Silver Spring CustomerIQ web portal, formerly known as Greenbox, gives consumers timely consumption and pricing information and lets them easily participate in energy efficiency programs such as demand response.

Silver Spring delivers against the broad range of requirements needed in a smart grid-enabled, targeted energy efficiency solution, including:

Scale

- Silver Spring's highly scalable solution already supports millions of households
- The Silver Spring high-bandwidth network is designed to transmit and manage large amounts of data
- The company has experience analyzing and abstracting detailed meter data and
- The ability to deliver targeted efficiency programs to consumers at scale quickly

End-to-end integration

- Silver Spring has expertise at complex integration
- The Silver Spring Smart Energy Platform supports standard web services for integration into a utility's back-office applications and is highly customizable
- The company has experience integrating smart meters with devices in the home, including thermostats, and strong support for the ZigBee protocol for the Home Area Network (HAN)

Tools for all stakeholders

- The CustomerIQ customer-facing self-service web portal provides consumption and pricing information and presents targeted, actionable information and real-time feedback
- The UtilityIQ application suite for the utility back office includes a range of smart grid modules
- The software's support for social networking and other mechanisms facilitates the pairing of consumers with efficiency experts, retailers, contractors and utility customer service departments
- Its tools give utilities the flexibility to deliver recommendations through printed reports, the web and/or partner engagement

Support standards and privacy mechanisms

- Support for standards such as ZigBee enables Silver Spring to support the extended efficiency ecosystem
- Support for authenticated access, authorization controls and encrypted communications ensure data privacy

Economical and readily deployable

- The Silver Spring Smart Energy Platform can deliver detailed energy consumption and comparison information inexpensively via the CustomerIQ web portal

A smart grid-enabled energy efficiency solution is the most cost-effective way to deliver targeted efficiency programs to consumers at scale. Silver Spring Networks has the technology and experience needed to help utilities improve energy efficiency dramatically in the short term.

Achieving Greater Energy Efficiency

Smart grid deployments offer an unprecedented opportunity for federal and local governments to reach millions of households with efficiency messages and programs such as the Home Star and Building Star weatherization programs. By combining the data collection capabilities of smart meters, the communications network built into the smart grid and portal software, governmental agencies and utilities can deliver targeted efficiency information to consumers at scale quickly and support the extended efficiency ecosystem.

As research shows, consumers will adopt efficiency behaviors and programs when they have frequent access to their electricity usage data and good analysis that turns that data into actionable information. Leveraging smart grid and Internet technologies makes it easy to begin educating consumers about their usage patterns; to provide a targeted list of efficiency recommendations and programs based on consumption patterns and to support social networking and other mechanisms for pairing consumers with efficiency experts, retailers, contractors and utility customer service departments.

The Silver Spring Smart Energy Platform, with its CustomerIQ energy web portal, enables utilities to quickly and efficiently reach millions of homes and businesses and help jump start energy efficiency programs such as Home Star and Building Star weatherization. By making it easy for consumers to embrace energy efficiency, Silver Spring's smart grid and portal technologies enable utilities, governments and other stakeholders to more rapidly achieve their efficiency goals, including reducing dependence on foreign energy sources, boosting employment and overall GDP and cutting greenhouse gases. The tools are here – the time to act is now.

About Silver Spring Networks

Silver Spring Networks is a leading smart grid networking platform technology and solutions provider. We have connected over 10 million homes and businesses throughout the world with the goal of achieving greater energy efficiency for the planet. Our innovative products enable utilities to gain efficiencies, integrate renewable energy sources and empower customers to monitor and manage energy consumption. Silver Spring Networks' clients include Baltimore Gas & Electric, CitiPower & Powercor, Florida Power & Light, Jemena Electricity Networks Limited, Pacific Gas & Electric and Pepco Holdings, Inc. among others. For more information please visit **www.silverspringnet.com**.