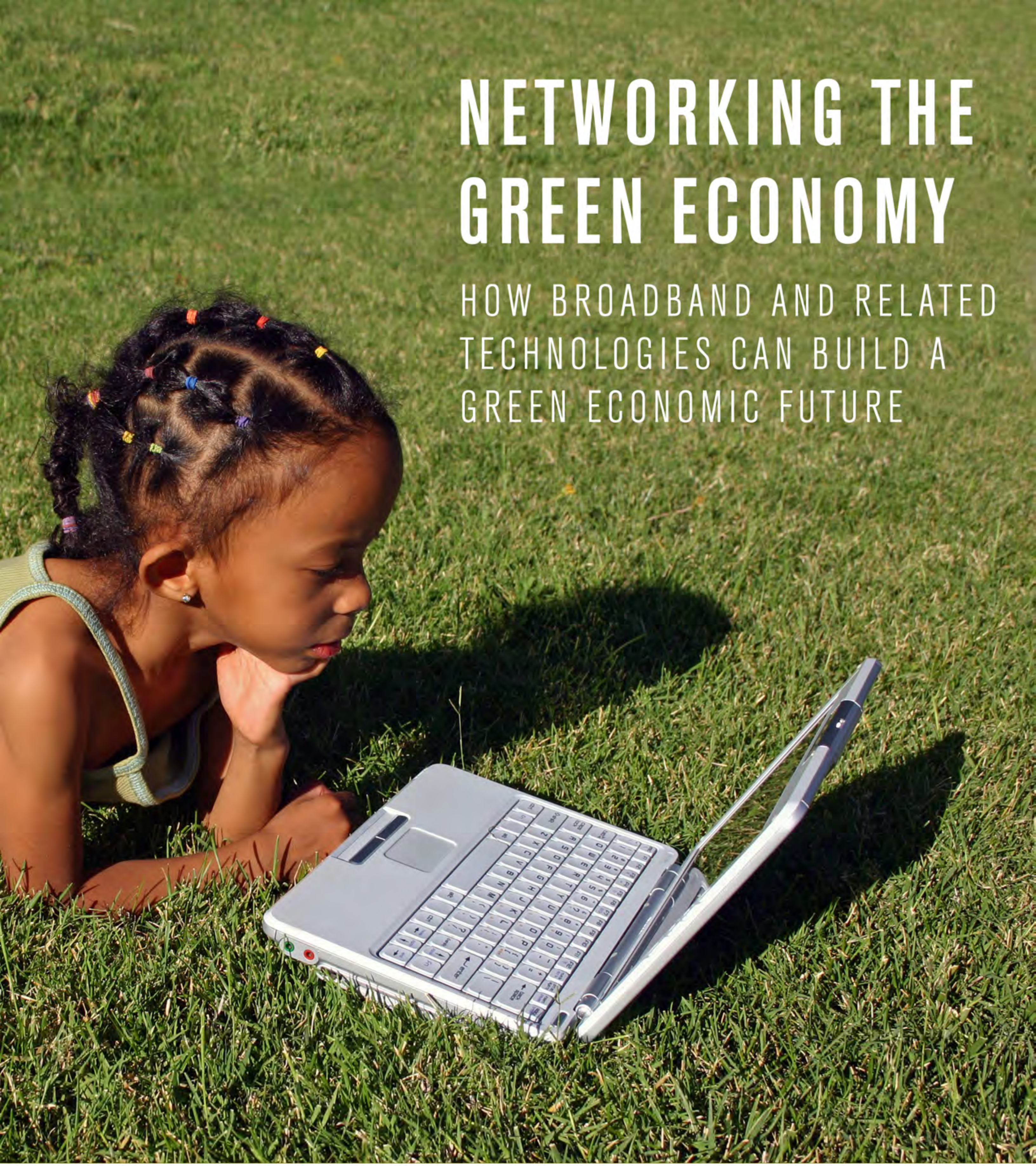
NETWORKING THE GREEN ECONOMY

HOW BROADBAND AND RELATED TECHNOLOGIES CAN BUILD A GREEN ECONOMIC FUTURE



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The Sierra Club is the oldest, largest, and most influential grassroots environmental organization in the United States. It was founded on May 28, 1892 in San Francisco, California by the well-known conservationist and preservationist John Muir, who became its first president. The Sierra Club has hundreds of thousands of members in chapters located throughout the US, and is affiliated with Sierra Club Canada. Its overarching goals are: (1) to explore, enjoy, and protect the wild places of the earth, (2) to practice and promote the responsible use of the earth's ecosystems and resources, (3) to educate and enlist humanity to protect and restore the quality of the natural and human environment, and (4) to use all lawful means to carry out these objectives.
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COMMUNICATIONS WORKERS OF AMERICA

The Communications Workers of America is the union for the Information Age, representing 700,000 workers in communications, media, airlines, manufacturing, and public service. Speed Matters, a project of the Communications Workers of America, promotes affordable high-speed Internet for all Americans.
http://www.cwa-union.org
http://www.speedmatters.org

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Executive Summary- Networking the Green Economy: How Broadband and Related Technologies Can Build a Green Economic Future

Broadband and information communication technologies have the potential of revolutionizing energy management and economic development. With less than five percent of the world's population, the United States accounts for about a quarter of the world's energy consumption. A poor communications infrastructure underlies much of our wasted energy use. In order to reduce energy, new communication technologies can be an important tool to better monitor and more effectively use natural resources. Advanced communications, including a more robust wired and wireless web, will play an essential role in facilitating and integrating these technologies.

Broadband policies, particularly those that support the expansion and implementation of smart grid technologies **have real potential to reduce rising electricity consumption and greenhouse gas emissions**. With coordinated research, support and action from consumers, environmental advocates, labor and federal and state policymakers, broadband and related communications technologies can pave the way for a greener and more robust economy. If implemented effectively, these tools can transform the way people and businesses use technology and, according to some experts, have the potential to reduce carbon dioxide emissions and energy costs in the electricity sector by up to 20 percent by 2020, and, through further investments in the following decade, cut emissions in the electricity sector by 58 percent by 2030. This could also provide potential savings of up to $2 trillion in energy costs and reductions of as much as 53 quadrillion BTUs of energy use over the next two decades.

Information Communication Technologies Are Key to a More Efficient Coordination of Energy Supplies and Distribution: A Smart Grid better manages the distribution and consumption of energy that can facilitate more efficient energy use, integrate various sources of renewable energy into our power system, reduce harmful greenhouse gas emissions, and increase grid reliability.

- Establishing Smart Grids at the transmission level will enable digital controls and high-voltage transmission lines to transport energy from renewable energy source sites to distant primary-use locations with far less energy loss than the current grid model.
- Using communications technologies will integrate distributed energy devices, from solar panels to smart appliances to electric vehicles, into the energy grid and allow monitoring such devices and renewable energy in real time.
- Increasing grid efficiency through real-time monitoring, automation and self-healing capabilities of distribution-level Smart Grid systems can increase grid efficiency, which results in reduced energy generation and reduced energy use. Energy savings equivalent to eliminating greenhouse gas emissions from 53 million cars could be achieved by improving the efficiency of the grid by just five percent.
- By appropriating approximately $11 billion for Smart Grid and grid-related projects in the recent recovery plan, the federal government has taken a small but positive step towards the larger investments needed to modernize the current grid.

Smart Technologies can Reduce Energy Demand in the Home and Office: Installing Smart Meters and connecting home and office appliances to a Smart Grid can offer additional flexibility and opportunities to advance energy efficiency and clean energy goals.

- Using dynamic electricity rates can potentially increase energy and environmental gains as well as economic savings, but it is critical to ensure that consumers benefit from such rate system changes and that other areas of utility regulation remain to encourage other energy conservation programs.
- Instituting Smart Grid technology policies will encourage the creation of sustainable jobs in a transformed utility industry.
- Allowing various building systems to communicate and interact with each other through smart technologies will thereby reduce energy use and buildings' negative impact on the environment.

Broadband can Reduce Travel and Fuel Costs: By reducing air and ground transportation — among the leading sources of pollution — broadband and support applications can reduce the need to travel, decrease gas consumption, and, if implemented correctly, make reductions in greenhouse gas emissions.

- Increased adoption of broadband technology and telehealth practices could decrease travel by allowing doctors to monitor and consult with patients remotely.
- Telehealth technologies could avoid 850,000 transports between emergency departments, resulting in transit cost savings of $537 million a year.
- Teleconferencing and other remote online communication also can reduce the amount of energy used for business and education related travel.

In making the transition to the Smart Grid, Smart Buildings and related technologies, policymakers need to invest for the long-term in ways that benefit consumers, workers, and the broader public interest. The most sustainable technologies will be tied to broadband-based Internet protocols that easily integrate with other digital networks, both wired and wireless.

- To avoid locking consumers into proprietary technologies that may quickly become obsolete, smart meters and other demand-side management tools should use Internet-based broadband technologies, which can also leverage the wireless web and ensure that all parts of the Smart Grid work together.
- The wireless web, phone handsets, and other wireless devices and tools, such as applications on individual PDAs, can empower consumers to better manage their energy use.
- With more than 564,000 people working in the utility industry, policies that support the adoption of Smart Meters and Smart Grids should focus on creating new opportunities and training for front-line utility workers to enable them to be part of the broader information economy.

This Green Economic Future Depends on Large-Scale Adoption of Broadband: To realize the economic, environmental, and societal benefits discussed in this paper, we must commit to ensuring that everyone, regardless of income-level, educational background, geographic location, race, and age has the ability to, and understands the benefits of, being a participant in our digital society.

- As many as 24 million Americans have no access to broadband meeting Federal Communication Commission standards for high-speed broadband, and roughly one-third of U.S. households with access do not subscribe to broadband. Broadband subscription rates are under 50 percent for some groups, including certain minority populations, rural communities, and households with incomes of less than $50,000 per year.
- Therefore, to fully realize a robust green economic future, it will take a firm and long-standing commitment to extend transformative communications technologies to all Americans.

Policy Recommendations for Networking the Green Economy

Basic broadband deployment and inclusion goals: Policymakers should increase access to and adoption of affordable broadband that supports advanced applications and devices in a reliable and consistent fashion. Achieving goals from the National Broadband Plan will be a key component of achieving this greener future. Specifically, policy makers should:

- Promote deployment and adoption of high-capacity wired and wireless broadband to every home, business, and community anchor institution and ensure that it is available to everyone irrespective of income level, age, education, ethnicity or geographical location.
- Promote digital inclusion programs and community technology centers to increase citizens' digital skills and literacy.
- Pool demand to create purchasing efficiencies and support programs that educate individuals on information and broadband supported applications as a means to increase broadband demand.
- Invest in high-speed broadband networks.

Develop programs and policies that support and promote the implementation of Smart Grids and devices. States and the federal government should work to:

- Develop Smart Grid standards and ensure that those standards are transparent, inclusive, and consider states' planning concerns. Encourage accelerated deployment of Smart Grid architecture using existing open standards and protocols, ready to adopt new standards.
- Conduct studies and pilot programs that will supply evidence on the impact of smart technologies on the environment and the cost of energy.
- Adopt a ratemaking policy that allows for a portion of the economic savings produced by deployment of Smart Grid infrastructure and other advanced technology to fund consumer broadband initiatives, energy savings for all consumers, and good jobs in the industry.
- Commit to quality service delivered by career-skilled employees, including work force development and training programs while protecting workers' freedom to form unions. This includes creating good, sustainable green jobs that will enable those employees to develop, manufacture, deploy, and maintain the various elements of Smart Grid infrastructure.

Develop programs to implement Smart Meters and real-time pricing in a manner that protects consumers and strengthens the economy through the promotion of green jobs:

- Ensure that deployed Smart Meters use open Internet standards that are capable of communicating with other Smart Grid components and are not based on proprietary standards likely to become prematurely obsolete and costly for consumers.
- All metering and pricing decisions should require that net energy savings and benefits for individual consumers considerably exceed the costs of deployment to ensure it leads to lower prices for consumers and not just increased profits for utilities.
- Protect broader areas of electricity regulation that promote energy conservation programs funded by utility companies and that protect consumer and workers' rights in the industry during the transition.

Adopt Telehealth Practices in Ways that Decrease Environmental Impact:

- Conduct studies and pilot programs to improve estimates of cost savings and quality care improvements from telehealth initiatives.
- Promote and expand incentives to encourage hospitals, clinics, and other medical facilities to use telehealth technology where reasonable and cost-effective.
- Address privacy, licensing, insurance as well as Medicaid reimbursement procedures and laws that can be barriers to extending the use of telehealth applications.

Introduction

In President Obama's 2011 State of the Union address, he emphasized that investing in American infrastructure is key to "winning the future"— and that an essential component requires investments in high-speed Internet with a central goal "to deploy the next generation of high-speed wireless coverage to 98 percent of all Americans."[1]

This was not a new theme for a President who in his first weekly radio address outlining his economic recovery plan in 2009 emphasized the importance of broadband communications as critical to the economic recovery of our nation. The American Recovery and Reinvestment Act of 2009 (ARRA) included a wide range of technology investments, from broadband and Smart Grid deployment to new technologies that improve the access to health information and care.

While building a green economy is often discussed as a goal distinct from investing in broadband or overcoming the growing digital divide in our society, leveraging new communications technologies can be a critical part of making our energy-hungry economy more sustainable and energy-efficient. As the National Broadband Plan released by the Federal Communication Commission in March 2010 describes, "Broadband can play a major role in the transition to a clean energy economy. America can use these innovations to reduce carbon pollution, improve our energy efficiency and lessen our dependence on foreign oil."[2]

A poor communications infrastructure underlies much of the wasted energy use in our economy. Lack of a high-capacity, interactive communication system linking utilities and electric power systems means utilities continually transmit a significant amount of unused electricity (e.g. electricity wasted through line loss), excessive amounts of electricity (e.g. maintaining unnecessarily high voltage transmit levels), and additional power from plants kept running — so-called "peaker plants" — to meet unexpected surges in demand. Lack of broadband access means patients, especially those that reside in remote areas, are forced to make long-distance car trips for medical care instead of using remote monitoring, and business staff waste jet fuel for travel instead of using teleconferencing for many routine communications.

Smart Buildings, Smart Grids, telehealth, teleconferencing, digital education — all of these critical components of a highly-networked economy — can be tools to leverage energy efficiency, potentially reduce greenhouse gas emissions, and promote good green jobs. In this green energy equation, the deployment and adoption of broadband and other networking technology that supports smart grid infrastructure can help reduce energy usage and achieve our goal of creating a prosperous and green economy.

As we see the explosion of smartphones, tablets and other wireless devices – and their role in spreading both political and economic revolutions across the world – a key goal to achieving this green future will be integrating a robust wireless web into the wired networks powering energy and communication grids. Wireless devices are not just a natural point of control by residential and commercial energy consumers for better managing their energy use. Achieving aggressive energy goals will require significant shifts in behavior by individuals and companies, so wireless social networking will become a key component of allowing early beneficiaries of energy savings to share best practices with neighbors and peers.

However, unless access to robust high-speed broadband, both wired and wireless, is extended to all Americans, the current digital divide could become an energy divide as well, with the poorest and least technologically advanced Americans suffered disproportionately higher energy costs on top of the other inequalities in our economy.   All of this just adds to the urgency of making President Obama's stated goal of universal access to the next generation of high-speed wireless a reality in our economy.

The Environmental Cost of Wasted Energy

The United States uses a lot of energy — nearly a million dollars worth each minute.[3] With less than five percent of the world's population, America currently consumes about one-fourth of the world's energy resources.[4] This vast energy consumption produces greenhouse gas emissions,[5] which are taking their toll on our environment, leading to climate change throughout the world, and threatening the long-term health of our planet.

To foster economic growth without destroying our planet, we need to use energy more efficiently and better integrate alternative energy sources into our power grid. By using applications and devices supported by digital infrastructure, such as broadband and information communication technology, we can help build a green economy. This can stimulate U.S. economic growth and create new jobs, while decreasing our energy consumption and greenhouse gas emissions.

Using Networked Technology to Reduce Emissions and Save Energy

Federal and state leaders, the energy industry, consumer and environmental advocates, and labor unions are increasingly exploring mechanisms to use information technology to remake our power systems. To continue economic growth without devastating our planet through greenhouse gas emissions,[6] we need to consume energy more efficiently, increase the integration of renewable energy sources into our power grid, and replace basic everyday carbon-intensive behaviors with more environmentally friendly and sustainable alternatives. Digital infrastructure and two-way communication technologies such as universal broadband have the potential to revolutionize power planning, from generation to transmission to distribution to use of in-home devices.

This report will detail three broad areas of energy savings from network technology that can help achieve energy savings and environmental goals:

- **Smart Grids** to improve the transmission, management, and distribution of energy in a strategic, efficient, and reliable manner.
- **Smart technologies** that reduce energy use at home or office — including Smart Buildings and other demand-side management tools.
- **Broadband-based services** including telehealth, long-distance business communication, and e-commerce to reduce travel and associated fuel costs.

By transforming the way people and businesses use technology, the United States can leverage additional tools to reduce carbon dioxide emissions and the costs of energy use. Broadband and other network technologies that support the development of smart grid and smart technologies have the potential to reduce greenhouse gas emissions, as much as 20 percent by 2020, according to multiple analyses ranging from the Federal Energy Regulatory Commission (FERC) to McKinsey & Company[7] to the Climate Group, an international organization of business and government members,[8] to the Technological Leadership Institute, [9] which has pioneered research on the Smart Grid.

In addition, over the next twenty years, with the proper technology investments, the Electric Power Research Institute estimates the nation could cut its electricity emission use by up to 58 percent with an estimated dollar savings of up to $2 trillion in lower energy costs and the elimination of 53 quadrillion BTUs of energy use by 2030.[10] That dramatic potential $2 trillion in potential savings for energy users requires dramatic investments in the Smart Grid, on the order of $338 billion to as much as $476 billion in EPRI's estimate. That amounts to a return on investment of more than four dollars for every dollar, which makes these investment costs "modest when compared to the benefits the Smart Grid will yield. On the job creation front, just an additional $50 billion investment in the Smart Grid over five years (i.e., $10 billion per year) can create or retain approximately 239,000 U.S. jobs over a five-year period, according to a report by the Information Technology and Innovation Foundation.[11] These additional jobs include work adding new pipes and wires, upgrading transmission and distribution lines and repairs due to aging and weather, IT services such as integrating, customer equipment installation and a range of subsidiary work needed to support smart grid implementation.

The Smart Grid is not only a tremendous investment to create new tools for energy savings, but is also an investment to assist in cutting the greenhouse gas emission costs to the environment that are threatening to choke the planet.

The Need for a Coordinated Broadband Policy

To achieve the environmental and economic benefits associated with the digital infrastructure, devices, and applications discussed in this paper, the United States needs to strengthen its broadband deployment and adoption.

Unfortunately, as many as 24 million Americans have no access to broadband meeting Federal Communication Commission standards for high-speed broadband,[12] and roughly one-third of U.S. households with access do not subscribe to broadband.[13] According to the Pew Internet & American Life Project, that number is over 50 percent for some groups — such as African Americans and rural residents.[14] Moreover, U.S. broadband networks rank 25th in the world in broadband speeds, behind not only Japan and South Korea, but also Romania.[1] The U.S. needs robust wired and wireless networks so that Americans can realize the full benefits of high-speed broadband connectivity, anywhere and anytime.

To increase broadband access, state and federal governments must commit to supporting build-out of broadband, especially to un-served and under-served areas. Further, there must be a commitment to increasing broadband adoption, especially for populations with low subscription rates, through programs that educate the public on the relevance and importance of broadband, provide digital skills training, and increase the affordability of broadband and related technology. If research uncovers ways to capture the economic savings from using broadband supported applications and devices in

[1] CWA, Speed Matters 2010: Internet Speeds in All 50 States, 2010.

the long-term, part of those savings should be used to fund increased access to and adoption of broadband.

Government needs to continue to expand broadband deployment and develop the technological standards that help coordinate different actors in the energy and communications ecosystem together into a more efficient whole. The National Institute of Standards and Technology (NIST) is leading a Smart Grid Interoperability Panel, which is convening conferences and working groups involving the estimated 600 companies working in the whole Smart Grid ecosystem. [15] Ultimately, product makers have to know that their goods will work with energy distribution systems in the home which in turn need to work with communication and energy distribution systems across the country. [16]

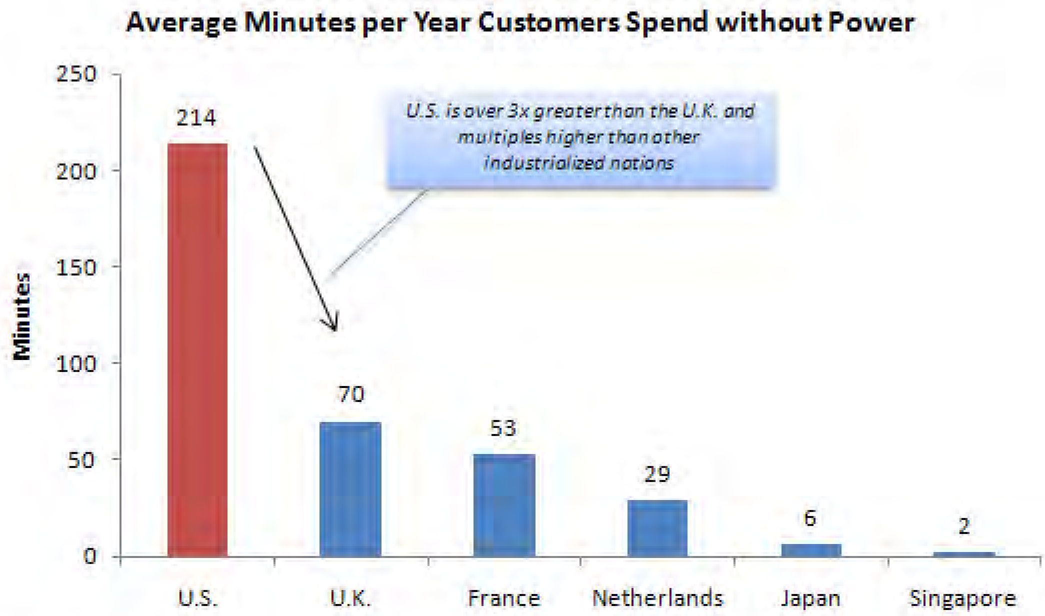
In communications terms, we need to develop the interoperability standards to assure that all systems can communicate with each other and that all Americans have access to the technology in order to take advantage of the potential energy savings possible. Wired and wireless networks need to be seamlessly integrated, with robust options for both integrated in all homes and businesses.

Building a Smart Grid to Reduce the Costs of Distributing Energy

The first step in building a smart grid is rebuilding decaying energy transmission systems around the nation. A lack of investment in grid upgrades and an energy policy that, until recently, focused little on renewable energy sources, has left the United States with an energy grid that is inadequate in terms of capacity, reliability, security,[17] and power quality.[18] Our outdated grid wastes massive amounts of energy during the transmission process and utilities must therefore maintain environmentally destructive power plants that would be unneeded with a more advanced power grid. Since 1982, growth in peak demand for electricity has exceeded transmission growth by almost 25 percent every year, while spending in the industry on research and development is among the lowest in all industries.[19]

The result has been additional costs and an unreliable energy distribution system that is costing consumers billions and hindering our economic growth. Major power outages, including three in the last 10 years, have occurred during the last four decades.[20] These power outages are a result, at least in part, of our unintelligent grid — which has slow response time, poor “situational awareness” and no “automated analytics,”[21] and costs our society billions of dollars. For example, during the summer of 2000 when the Chicago Board of Trade lost power for one hour, approximately $20 trillion worth of trades could not be executed. [22] In aggregate, power outages and disturbances cost the United States between $80 billion and $150 billion annually.[23] Power system disturbances cost an estimated 50 cents for every dollar spent for electricity.[24]

Such losses and disruptions put American consumers and industry at a competitive disadvantage internationally. The average U.S. customer loses power for 214 minutes per year compares to only 70 minutes in the United Kingdom, 53 in France, 29 in the Netherlands, six in Japan, and two minutes per year in Singapore.[25] And it doesn’t take a long disruption to hurt American industry economically. One study found that short interruptions in power of five minutes duration or less caused two-thirds of the economic losses. The economic cost to our international competitiveness is reflected in the fact that commercial firms bear 72 percent of losses, industrial customers 26 percent, and residential users two percent. [26]



Source: Jay Apt, Lester B. Lave, and M. Granger Morgan, "Power Play: A More Reliable U.S. Electric System," *Issues in Science & Technology* (July 1, 2006).

EPRI calculates that modernizing the distribution grid alone could save the U.S economy between $638 billion and $802 billion over 20 years, compared to the $165 billion cost of modernizing the grid.[27] In order to make our grid more efficient and enable the large scale incorporation of multiple renewable energy sources, high-speed and fully integrated two-way communication technologies must be incorporated into the power system.[28] As Bracken Hendricks from the Center for American Progress wrote in a February 2009 report:

> Largely unchanged in generations, we are now using yesterday's technologies to power an increasingly global 21st-century economy… our current electricity grid [is not] capable of capturing the opportunity created by recent advances in information technology; exciting new tools for producing radical gains in energy efficiency, reliability, and security; or the deployment of clean renewable energy at the scale needed to meet the clean-energy demands of a new century.[29]

Building a 21st Century Power Grid

The implementation of a Smart Grid could provide tools to help increase energy efficiency, decrease harmful emissions, provide economic savings, and increase reliability and security. By incorporating best practices from the energy, networking and digital information technology industries, a Smart Grid could optimize grid operations, assist in better incorporation of renewable energy sources, and give utilities and consumers tools like access to increased information in order to help them better control and manage their energy consumption. In fact, the *MIT Technology Review* recently confirmed “without a radically expanded and smarter electrical grid, wind and solar will remain niche power sources.”[30]

Power generation could be decreased by three to five percent by installing a Smart Grid capable of delivering only necessary electricity.[31] Energy savings equivalent to eliminating greenhouse gas emissions from 53 million cars could be achieved by improving the efficiency of the grid by just five percent.[32] Moreover, it is projected that Smart Grid technologies would reduce power disturbance costs to the U.S. economy by $49 billion per year.[33]

In addition, a Smart Grid that extends its communications network to homes and buildings can turn these traditionally large energy users into potential energy producers. Such a grid could allow energy consumers to sell solar-based and other renewable energy back to the power grid,[34] making such investments more economical and further decreasing the dependence on fossil fuel based power plants. For example, a home could be powered by its own solar energy during the day and then the consumer could sell any extra energy produced back to the larger grid, an option called “net metering.[35]

One of the fundamental elements of the Smart Grid is its communication system. As maintained in a testimony before the House Select Committee on Energy Independence and Global Warning, “[a] Smart Grid, in many ways is like an Internet for Electricity, a network of devices that are monitored and managed with real-time communications and computer intelligence.”[36] Communications technology is essential to the functionality of the Smart Grid because it gathers the vast data generated by energy use and transforms this data into information to the consumer and the utility company. As such, the communication that is transmitted must be pervasive, rapid, scalable, secure, and robust at all times, especially during emergency situations.[37]

While some of the specific standards that will support Smart Grids are still under development, it is important to guarantee that investments made in core elements of a new grid will not become obsolete in the foreseeable future. Therefore, the grid communication systems should be capable, among other things, of firmware upgradeability (“over the air” upgradeability) and support low-latency tolerant and high-bandwidth applications and devices.[38]

While much of the political and media focus on grid automation up to this point has been focused on Smart Meters in the home, devices that increase command and control of the grid’s backbone can provide an immediate and long-lasting increase in grid efficiency and savings.[39]

The backbone of a clean energy Smart Grid can be seen as consisting of long-distance energy transmission and power distribution.[40] Approximately 85 percent of the carbon emissions cuts associated with the implementation of a Smart Grid can be attributed to increased incorporation of renewables into the grid and grid optimization, according to the Climate Group’s *SMART 2020* Report.[41]

Managing Long Distance Energy Transmission

Integrating networked communications into the transmission system will help create a grid capable of better response time to large-scale and isolated-system failures, moving renewable energy efficiently over long distances and addressing congestion issues.[42]

Many renewable energy sources in the United States are in isolated areas that are unable to connect effectively with our current outdated power grid.[43] For instance, a Department of Energy study found that it could be possible for 20 percent of the nation's electricity demand to be met by wind sources in 2030.[44] However, one issue hindering wind energy is that a portion of these wind farms are located in remote areas, far from major centers of electricity demand, with little or no access to high voltage transmission lines.[45]

By implementing advanced digital controls and technologies such as syncrophasors — precise grid measurements that indicate grid stress — throughout the transmission system, transmission operators will be able to use long-distance, high-voltage transmission lines to move energy from renewable energy source sites to distant distribution grids located at primary-use locations with far less energy loss than is currently possible.[46]

A Smart Grid could also improve overall grid efficiency and reduce congestion. According to one study, consumers in the eastern U.S. pay $16.5 billion per year in higher electricity prices due to transmission congestion, a problem that would be largely resolved by an upgraded Smart Grid.[47]

Coordinating Power Distribution

Upgrading the old distribution grids with Smart Grid technology will improve distribution-level reliability and efficiency, reduce operating costs, and enable full integration of upcoming renewable and distributed energy sources, which will greatly benefit the environment. In fact, EPRI projects that carbon dioxide emissions could be cut by 25 percent with the implementation of Smart Grid enabled distribution.[48]

Respected organizations (e.g. National Association of Regulatory Utility Commissioners,[49] EPRI,[50] and the Center for American Progress[51]) recognize that significant modernization of distribution systems can produce considerable grid-related efficiency and environmental savings and benefits. System optimization and automation will be enhanced as the Smart Grid is implemented on the distribution system.[52] Authorities also recognize the inherent nexus between the transmission and distribution grids,[53] and they acknowledge the need for Smart Grid deployments at the distribution grid level. As the Center for American Progress has stated:

> The natural complement to a robust interstate transmission network for renewable electricity is an intelligent "Smart Grid" distribution system that delivers electricity right to the plugs in consumers' homes. The Smart Grid integrates digital information technology into regional and local electricity distribution networks, making the grid more reliable, resilient, and secure. The Smart Grid also accommodates distributed generation of renewable power, enables better demand management and energy-efficiency gains by consumers and businesses, and facilitates large-scale deployment of plug-in electric vehicles.[54]

As the above mentioned authorities suggest, modernized distribution systems could also lead to a more reliable and resilient power system overall. For instance, the real-time monitoring, automation, and self-healing capabilities of distribution-level Smart Grid systems will provide for the widespread implementation of microgrids, as well as renewable and individual distributed energy resources like solar panels and plug-in electric vehicles. Incorporating renewable energy resources into our energy distribution system is an essential step to reducing the negative environmental side effects of our energy use.

A distribution-level Smart Grid will enable such resources to interact most efficiently with the bulk power system and also operate independently during decreases in supply levels that result from the intermittent nature of renewable and distributed generation sources or from system disruptions such as line faults. In short, Smart Grid implementation at the distribution level will enable the real-time interaction between the bulk power and distribution systems needed to ensure full optimization of investments in transmission and end-user devices.

Smart Grid improvements should be prioritized in areas that reduce carbon emissions. We need to relieve system congestion that limits renewable resources and lowers carbon resources rapidly. System upgrades, if done without attention to this issue, could actually increase carbon emissions if currently underutilized coal plants increase their operations. Smart Grid improvements should be sequenced such that high-carbon resources are phased out as quickly as possible and replaced with a combination of lower carbon fuels such as solar, wind, and geothermal energy, and lowest-emission combined cycle natural gas technologies.

Smart Grid systems on the distribution level can thereby automate distribution grids, regulate the flow of electricity so as to reduce generation needs, reduce electric delivery costs, and optimize the integration of renewable energy and distributed energy resources, as well as in-home energy management devices. Further, such distribution grid modernization is necessary to maximize the benefits of an advanced electric transmission system, creating a robust, reliable, and secure electric delivery system.

Smart Technologies to Reduce Energy Demand in the Home and Office

If built to connect in real time with a utility and Smart Grid through a high capacity, interactive communications network, Smart Meters, smart appliances and networked homes and offices can become part of a revolutionized power system, which can provide large economic and environmental pay-offs. However, it is imperative that when deploying these technologies, utilities use communications backbone and data management systems in tandem with demand-based technology systems.[55]

Managing Demand to Cut Power Consumption

With the right type of consumer protections and technological metrics in place, Smart Meters and other so-called demand-side management (DSM) tools can help individuals purchase energy more efficiently. Such demand-side management (DSM) could by itself save consumers an estimated $59 billion in societal benefits by 2019, according to one estimate by McKinsey and Company.[56] A Smart Meter system is a component of the Smart Grid designed to help consumers better measure and manage energy usage; its effectiveness depends ultimately on communication systems that are scalable and expandable to accommodate sensors in multiple locations throughout the grid.[57] It is estimated that 65 million Smart Meters will be deployed nationwide by 2020—about half of U.S. homes.[58]

More efficient energy use by customers can yield economic and energy savings, while increasing the quality and reliability – as well as the security – of electric power service to all customers."[59] For example, Smart Meters and dynamic pricing could give consumers the ability to track their own power usage and then provide a financial incentive to alter their energy consumption either by shifting away from periods of peak demand, purchasing more environmentally friendly and energy efficient appliances, or simply decreasing overall energy usage.[60]

So what are the potential savings from using properly designed Smart Meters to reduce energy usage, especially during peak energy (high-cost) periods?

First, there is the direct benefit of lower energy bills for consumers who alter their behavior and either reduce energy consumption overall or reduce consumption during peak periods.[61] Pilot programs and studies have demonstrated that consumers who track their energy use in real time and consequently make simple behavioral changes accordingly can save 5 to 15 percent on their electricity consumption, which amount to savings of $60 to $180 per year per customer.[62]

Second, an overall reduction in peak demand consumption provides indirect benefits to every customer.[63] With lower, steadier demand, in the long term, utilities may not have to invest in or purchase costly new capacity,[64] savings that could benefit consumers who would have to pay reduced energy bills.[65] Dynamic pricing to shift demand can also lead to a more reliable grid and reduce the risk of outages that are often costly to the economy.[66]

Additionally, according to the Department of Energy:

> Demand response may provide environmental benefits by reducing the emissions of generation plants during peak periods. It may also provide overall conservation effects, both directly from demand response load reductions (that are not made up at another time) and indirectly from increased customer awareness of their energy usage and cost.[67]

To give some sense of the benefits of such demand reductions, if just half of American households cut their demand by 10 percent, the CO2 emissions avoided would be equal to taking approximately eight million cars off the road.[68]

Smart Buildings: Networking Homes and Offices for Energy Savings

The incorporation of networked technology into buildings can optimize a building's energy consumption by controlling multiple devices,[69] improve the ability to monitor buildings,[70] give building owners and occupants more information about and control over their energy use[71] and integrate that use into the emerging Smart Grid. Since buildings in the United States account for approximately 39 percent of the nation's total energy use, 72 percent of the electricity consumption and 38 percent of carbon dioxide emissions,[72] smart technology has the potential to increase energy efficiency, cut emissions and free resources for investing in long-term economic growth in this sector.

The Center for American Progress predicts that integrating smart technology into new construction or in the renovation of existing buildings can make them more environmentally friendly, saving the U.S. $20-25 billion and reducing carbon dioxide emissions between 130-190MMT.[73]

In certain circumstances, such as by using specialized software, Smart Buildings can even make their own efficient energy use decisions.[74] Further, Smart Buildings connected to a Smart Grid could automate power-saving methods throughout an entire region.[75] Such digital systems and automated processes can take demand response to a new level where manual controls will give way to smart sensors and automated response systems.[76] For example, a Smart Building could potentially adjust the amount of indoor light being used based on the amount of sunlight coming through a window.[77]

One example of these efforts on a broader scale is a $185.4 million effort by the Chicago's Building Owners and Managers Association to concentrate efforts to make 260 downtown office buildings “virtual generators” through better management of energy use.[78] Charlotte business leaders, working with Duke Energy and Cisco, are collaborating on a similar effort with the goal of reducing energy use in core downtown buildings by 20 percent by 2016.[79]

The net result of these efforts will be more efficient and environmentally-friendly buildings using less energy. This approach not only saves consumers money, but also significantly reduces buildings’ greenhouse gas emissions and carbon footprint.

Making the Transition to the Smart Grid

In making the transition to the Smart Grid, Smart Buildings and related technologies, policymakers need to invest for the long-term in ways that benefit consumers, workers, and the broader public interest. The most sustainable technologies will be tied to broadband-based protocols that easily integrate with other digital networks. Fortunately, there are a number of resources available to policymakers, including parts of the American Recovery and Reinvestment Act, which can assist in this transition.

Using Advanced Technology and Regulations to Protect Consumer and Worker Interests

Any transition to Smart Grids and new energy management technologies should assure that consumers and workers in the industry benefit from the economic savings and growth generated.

While the operational benefits that Smart Meters provide to utilities -- such as facilitating, remote meter monitoring, outage management, remote connect and disconnect,[80] and load forecasting[81] may be more apparent -- Smart Meters and dynamic pricing will benefit consumers only if properly designed and implemented to protect consumer interests. Smart Meters and dynamic pricing that allow individuals to track their energy consumption and provide financial incentives for reduced energy use could result in savings for consumers.[82] Consumer advocates worry that the costs of installing some current versions of Smart Meters could outweigh the savings that households would receive from reducing or shifting their energy usage,[83] especially if those meters become technologically outdated and have to be replaced before any savings offset deployment costs.

In addition, if the cost of electricity is dynamically priced throughout the day, this may not benefit, and could harm, consumers, such as the elderly and the ill, who are not able to alter their energy use.[84] Some consumer advocates also fear that Smart Meter deployment may serve as an excuse for utilities to raise rates.[85] While some studies – usually funded by utilities themselves – show that low-income consumers may shift energy use as easily as upper-income energy users[86], the baseline requirement for any deployment of Smart Meters should be that they do not increase costs for residents, especially low-income users, but instead are deployed only when energy savings can fully cover costs for consumers.

A key to this goal is avoiding deployment of meters based on proprietary standards that don't integrate well with other parts of the smart grid and may rapidly become obsolete.[87] Instead, meters should incorporate high-bandwidth Internet-based protocols and an open architecture that connects the utility grid, the wired network and the wireless web together in a seamless manner. As the New York Public Service Commission argues, a Smart Meter system, or AMI for Advanced Metering Infrastructure, is but one component of a Smart Grid, "[Smart Meter systems] must be designed to meet future requirements of the Smart Grid and particularly must contain communication systems that are scalable and expandable to accommodate sensors in multiple locations throughout the grid."[88]

Policies should also ensure that consumers have access to their meter data in useful forms and that the information is bound by privacy restrictions. Representative Markey (H.R. 4860) and Senator Udall (S. 3487) introduced similar legislation, the Electric Consumer Right to Know Act (e-KNOW Act), which would require utilities to provide energy use data to consumers. Standardizing information protoctols will help both consumers and third-party entities that may help consumers manage that data for them.[89]

States also need to learn from mistakes made during a misconceived process of utility restructuring and, in addition to investing in Smart Meters, maintain other energy efficiency programs that assist consumers in shifting towards less energy use and subsidize such shifts for low-income users. Between 1995 and 1999, driven by flawed attempts at utility restructuring, power companies in North America cut spending on energy-efficiency programs by 42 percent.[90] While many states have restored energy efficiency programs since then, we should learn the lesson from that debacle. Any use of Smart Meters or dynamic pricing must be part of a broader regulated structure that maintains and expands those key energy-efficiency programs, especially for low-income families most in need of their support.

Restoring regulations that protect consumers, as well as protecting the rights of workers in the industry, are also critical pieces to ensuring that consumers derive real benefit from Smart Grid technology. As Peter Bradford, a former chair of the New York Public Service Commission and former president of the National Association of Regulatory Utility Commissioners (NARUC), noted, "[i]f energy policymakers and regulators learn anything from the restructuring experience to date, it should be that cost containment and public benefits should be locked into laws and regulations every bit as firmly as the gains for the energy industries and the larger customers."[91]

With more than 564,000 people working in the utility industry,[92] the adoption of Smart Meters and Smart Grids will likely change the nature of the work for many front-line utility workers and provide new job opportunities. Utility employers and policymakers should ensure that smart grid implementation plans and policies provide utility workers with training and other support necessary to learn the skills to work on new technologies and build careers in new jobs opening up in the smart grid industry. The new opportunities for training and redeployment must first be made available for the present work force; it should not be an avenue to increase outsourcing or evade union representation.

The Obama administration made a good first step in this direction with its dedication of tens of millions of dollars for new “smart grid workforce training and development” programs to leverage similar funding from community colleges and private employers. As Department of Energy Secretary Steven Chu said of the programs: "This is a great opportunity for workers to upgrade their skills and earn more, or for laid off workers from other industries to start fresh in a new and growing field."[93]

Boulder: A Smart Grid Experiment

Boulder, Colorado has been designated as the first “Smart Grid City” in the country that will integrate the first Smart Grid community and host the densest concentration of Smart Grid technologies. The project, currently led by software company Xcel, has invested up to $100 million worth of new technology, partly acquired by the grants provided through ARRA. Approximately 4,600 residential and small business transformers, and nearly 16,000 Smart Meters, are now connected to Smart Grid City.[94] The project has installed new metering systems and converted existing substations into smart substations. Customers of Smart Grid system can also opt to receive in home control devices to automate their energy use. In addition, these grid updates will work to support generators and storage units such as solar panels, battery systems, wind turbines, and hybrid electric vehicles.[95]

The Role of Broadband in the Smart Grid and Smart Technologies

Broadband is a high-speed communications system that can support the most sophisticated Smart Grid technologies available. Smart grid deployment based on Internet standards will not become obsolete in the future – unlike many of proprietary smart meter systems that have been deployed. Each application of a Smart Grid, whether distribution automation, system optimization, Smart Meters, or smart appliances requires some level of bandwidth to transfer the data it is collecting or sending.[96] While currently it may be possible to get by with lower-speed communications, in the long-term, “full broadband capacity is critical for the growth of the Smart Grid,” argues Jesse Berst, a Smart Grid analyst with SmartGridNews.com.[97] While “most of the systems being offered today have enough bandwidth for starter applications including Smart Metering,” Berst argues, “the real power of the Smart Grid is when…every piece of the system is monitored.”[98]

The National Broadband Plan describes in depth how the data needs of a Smart Grid are likely to ramp up rapidly, with both wired and wireless capacity becoming strained without new investments to deepen the infrastructure. Each new system deployed in the information economy has rapidly overwhelmed initial estimates of bandwidth needs so robust wired and wireless broadband systems are critical, since as the National Broadband Plan argues, “the lack of a mission-critical wide-area broadband network capable of meeting the requirements of the Smart Grid threatens to delay its implementation.”[99]

Digital technology must be used to service the communications backbone and consumer demand side of the Smart Grid.[100] The hard reality is that "grid-aware" appliances that, for example, can receive a price signal from the electric grid and respond correspondingly, will only become widespread if they are easy to install and integrate with existing communication networks in the home.[101] There is a broad consensus, particularly coming from the federal government, that broadband is therefore essential to building a Smart Grid infrastructure. Broadband connects all localities to enable nationwide, interoperable communications and control of the electricity system at the same time that it provides high-speed capacity to maintain robust cyber security. Accompanied by integrated broadband, the Smart Grid can facilitate the connection for multiple services and applications.[102]

Broadband providers have begun to unveil plans that coordinate energy use technologies with broadband deployment. Verizon, for example, has announced that it will offer smart electricity metering in connection with FIOS service.[103] AT&T in 2009 announced a partnership to open its wireless network to Smart Meter maker SmartSynch,[104] allowing electric utilities to install Internet-based Smart Grid technology in their covered residential areas."[105] In October 2010, AT&T, Cellular South, Rogers Wireless, Sprint, T-Mobile, Verizon, CTIA and Qualcomm joined together at a Washington, D.C. press conference with Smartsync to advance a shared vision of the wireless web as the Smart Grid communications backbone.[106]

A large percentage of Smart Meters are being installed do work with local home networks to facilitate connections to "smart" devices, such as appliances, HVAC thermostats, hot water heaters, pool pumps, and Electric Vehicle (EV) charging stations that are capable of responding to the signals from the Smart Meter.[107] However, what is also critical is that those local networks integrate seamlessly with the communication networks consumers are already using such as cell phones and other wireless devices.

The Wireless Web and Social Networking in Managing the Smart Grid

Most leaders in the emerging Smart Grid industry recognize that unless they harness the power of the wireless web, and especially the social networking that the wireless web is accelerating, any serious goals for energy reduction are unobtainable. Phones and other wireless devices able to connect to the Smart Grid can serve as a natural interface for consumers seeking to control energy use in their home, especially if any of that management is going to remotely happen.

More importantly, the wireless web will allow consumers to use social networking to compare strategies with neighbors and friends on how to reduce energy use. Arlington, VA-based OPower, has more than 2 million nationwide customers and has developed multiple strategies for combining social media communication methods with Smart Grid technology. It provides energy monitoring services that run on desktop computers and on smart phones. OPower creates a demographic profile based on energy consumption data from its Smart Meters and allows people in similar groups to compare their energy usage against each other and even compete head-to-head to see who can reduce energy consumption the most. As OPower cofounder and CEO Dan Yates argues, the company's research has shown that when people hear from their friends and peers about how to be more energy efficient, the adoption rate of energy saving tools is much higher:

> All you need are a few enthusiasts to create momentum — we've never seen consumers drive action like they have using social media…Online communities are a

> very valuable way to share this information… It allows us to use the information generated by the 5% of very engaged and enthusiastic customers, and share it to benefit the other 95%.[108]

Silver Spring, an OPower rival, has a similar customizable online interface for electric utilities to connect with their customers, and connect customers to each other. The idea is to encourage an almost game-like competition among consumers to "supercharge" the adoption of energy saving strategies.[109]

Like all social networks, the more universal access to broadband and the wireless web becomes among the population, the faster the adoption of the Smart Grid will become. Achieving the most aggressive energy saving goals is inseparable from the goal of achieving universal access to broadband in every home and every phone.

Taking Advantage of Federal Investments in the Smart Grid

The current U.S. grid uses communications systems that are too slow and too localized to support the networked communications required to support an interactive and integrated power grid.[110] In order to update our outmoded power system, federal, state and local leaders need to implement policies that encourage and support the expansion of Smart Grids and their underlying infrastructure and continue incorporating Smart Grid implementation into national policy. The federal government has committed funding just in the past few years to start the expansion of Smart Grid technologies, most recently through funding from the American Reinvestment and Recovery Act (ARRA) for Smart Grid efforts, including demonstration projects and research that amounted to an estimated $11 billion in Smart Grid and grid-related projects. [111] The ARRA, in order to further accelerate Smart Grid deployment, modifies and builds[112] on Title XIII of the Energy Independence and Security Act of 2007,[113] which initially provided financial support for Smart Grid development and demonstration projects."[114]

That funding has helped stimulate and strengthen an ecosystem of firms working in the Smart Grid field. The Greentech Group estimated that $2.75 billion was spent in 2010 on Smart Grid products in the core industry sub-sectors of Advanced Metering, Demand Response, and Distribution Grid Management alone. [115] The coordination of Smart Grid standards by the National Institute of Standards and Technology (NIST) discussed earlier was funded by ARRA funds and tax credits and other funding encouraged many firms to expand their capacity.

The White House laid out the goal of using ARRA funds to equip 700 substations with automated devices to detect and respond to system irregularities help avoid outages and the installation of over 200,000 advanced transformers capable of sensing conditions associated with failures and alerting system operators. This will increase the percentage of transmission systems covered by response sensors from just 12 percent in 2009 to 100 percent by 2013. The combination of Recovery Act funds and private investments promise to add 18 million new Smart Meters to the eight million currently in use. [116]

While cutbacks in the budget at the federal level worry many in the Smart Grid community, the initial ARRA funding has definitely kickstarted a whole industry that will hopefully be able to use the initial economic savings from these initial investments to feed the cycle of investment, savings and reinvestment in upgrading the capacity of the Smart Grid.   As well, the National Broadband Plan has outlined a large number of recommendations for public policy that do not require new government funding but instead drive improvements in government efficiency and help encourage private activity that promotes these national priorities like expanding broadband access and the deployment of the Smart Grid.[117]

Tennessee Valley Authority Case Study by William **Ray**[118]

The Tennessee Valley Authority (TVA) is currently unable to meet their energy demand — they are approximately 2,000 megawatts short of the capacity they need.[119] The area is considering nuclear power as the means to generate the additionally needed units since the outlook for additional coal-fired generation is unclear. Projections put the cost of building new nuclear units around $3,000 and $7,000 per kilowatt. All together, the TVA plans to spend more than $18 billion over the next ten years on new nuclear units.

Broadband can be utilized to give consumers better control over their energy consumption, enable better integration of renewable energy sources and reduce demand during peak periods. In this way, broadband can reduce the need for reserve energy plants and new plant construction.

If the TVA had a high-speed capacity data connection to every home, they could use that connection to control thermostats on heating, air conditioning, water heating, freezers, refrigerators, washing machines, and other household appliances. This type of control mechanism would reduce peak demand by 2-4 kilowatts. Thus, if the money that might be spent on a new nuclear power plant was instead spent on broadband networks for every home and business in the Tennessee Valley, then the improvement in electrical capacity would be double or triple the improvement from building new nuclear power plants. The electrical savings during peak times may decrease enough to actually shut down old coal plants that run just to provide reserve power. Additionally, every home would now have a broadband connection capable of running the most advanced applications.

This broadband connection could be used to reduce other uses of fuel, such as by supporting telehealth and distance learning programs and enabling telecommuting — all of which reduce travel and greenhouse gas emissions.

Using Broadband to Reduce Travel and Fuel Costs

Along with homes and offices, travel is a major consumer of energy. The pollution produced in transportation has a large negative impact on the environment. Broadband and supported advanced technological applications — such as telehealth, long-distance communication services, and online distribution of goods — can reduce the need to travel, decrease gas consumption, and provide more tools to leverage energy efficiency and reduce greenhouse gas emissions by replacing basic everyday carbon-intensive activities with less energy-intensive alternatives.

Telehealth

Travel costs associated with health care delivery are being significantly reduced, particularly for those in remote or underserved areas, due to the integration of technology such as broadband with medical services — commonly referred to as telehealth.[120]

Often highlighted benefits of telehealth include increased access to medical services, improvements in quality of care, patient and doctor convenience, and reducing the cost of the health care system.[121] If implemented effectively, telehealth can decrease the need for, or the distance that patients and health care providers must travel, thereby reducing both negative greenhouse gas emissions and fuel consumption.

- For instance, by using telehealth applications, health professional can monitor and examine (for example with video conferencing) from their homes patients suffering from chronic illness, or requiring routine check-ups to collect basic medical information,[122] potentially reducing the number of trips that have to be taken by patients to medical facilities or by medical professionals to individuals homes.[123] A Veterans Administration study reported a 40 percent cut in emergency room visits and a 63 percent reduction in hospital admissions resulting from its remote home monitoring system.[124]
- Telehealth technologies can also reduce travel between health care facilities. By equipping doctors' offices, clinics, and hospitals with broadband, doctors can share records and data online or send images to each other, facilitating collaboration between medical professionals in different areas and reducing the need, in certain circumstances, for patients to travel for second opinions or to see specialists.[125] One estimate is that telehealth technologies could avoid 850,000 transports between emergency departments, resulting in transit cost savings of $537 million a year.[126]
- According to Jack King, executive director of Northcentral Montana Hospital Association, "with an ongoing shortage of physicians, telehealth will help specialists reduce travel and see more patients."[127] Additionally, when facilities are equipped with broadband, doctors can also attend online trainings and lectures, potentially reducing the need to travel for professional development purposes.

The next frontier for telehealth is the use of mobile medicine to allow a patient's health to be monitored regardless of his or her whereabouts. For example, diabetics can receive continuous insulin delivery based on real-time glucose monitoring sensors that transmit their data to wearable insulin pumps.[128] These advances are in their infancy, but new advances in medicine combined with a robust expansion in the wireless web promise horizons of new mobility for the chronically ill –a significant reduction in energy-wasting travel for monitoring.

However, America's slow broadband speeds are impeding our ability to fully realize all the potential benefits of telehealth. Physicians need to exchange increasingly large files as new technologies such as 3D imaging become more prevalent. Current broadband capacities of health care institutions and remote communication systems are "straining under increasing demand and are unable to support needs likely to emerge in the near future," according to the National Broadband Plan.[129]

While basic information and communications technologies can supply some benefits and savings to the health care system, patients, and the environment, high-capacity broadband in homes across the country is ultimately required to achieve the full life-saving, environmental, and economic benefits of telehealth applications. [130] Especially as advances in mobile monitoring increase, the need for higher-speed broadband and next generation wireless capacity will become a matter of life and death for many patients.

Business and Long-Distance Communication Technology

The emergence of a global economy has increased the need for business travel, in many cases long-distance business travel, that negatively affects the environment. Recent technological advancements, however, such as advanced video-based teleconferencing, have become viable substitutes — where high-speed broadband is available — for certain in-person interactions.[131]

Promoting technology-based innovations in lieu of travel can reduce the current negative impact of business travel on the environment and save an enormous amount of time and money. For instance, video conferencing expends 500 times less energy than a 1000 km [620 mile] business flight."[132] Conducting virtual meetings to replace remote in person interactions could reduce 20-30 MMT of carbon dioxide emissions in 2020" [133] -- providing gross savings of $5-10 billion from reduced spending on fuel for airplanes.[134]

Similarly, teleconferencing is also an essential component to telehealth programs and distance learning programs, expanding opportunities for both patients and students to use their computers as a gateway to higher quality resources that might not be available without wasteful long-distance travel.

Broadband-supported applications can also help reduce everyday travel associated with employment. Telecommuting or flex work, combined with labor protections to prevent unmonitored "electronic sweatshops" from arising, can potentially be a key contributor to a greener economy. Telecommuting creates substantial savings across the economy and the environment, such as helping businesses reduce, or more efficiently use, their office space[135] and allowing employees to save on gas and commuting time. However, it is important to note that a rebound effect may occur where individuals increase other travel or energy use, thus reducing some of the direct benefits of telecommuting. For example, telecommuters often make additional vehicle trips to run errands that could have been done more efficiently during their work commute.[136] Further, telecommuters may increase their personal use of additional energy, such as powering electronic equipment or air conditioning their home when they would have been at work.[137] It is estimated that after considering both the direct benefits and rebound effects,[138] flex work could save $15-30 billion to the U.S. economy and reduce carbon emissions by 50 to 100 MMT.[139]

E-Commerce and Virtual Distribution of Information Goods

The intersection of broadband with commerce leads to energy reductions throughout the economy. Since the inception of the Internet, electronic commerce (e-commerce) has grown exponentially,[140]and retailers, even in rural areas, can reach out to the entire connected world as a potential consumer base.

This new business frontier not only allows businesses to expand their reach, but it can also benefit the environment by reducing negative emissions associated with traditional off-line shopping. For example, e-commerce can reduce the number of car trips consumers take to and from stores to purchase goods, conduct price comparisons, or do product research.[141]

In certain circumstances the Internet has replaced the need for actual physical production or transportation of goods, reducing pollution.[142] A study by the American Consumer Institute Center for Citizen Research found that a reduction in plastics saved from downloading music and videos and the decrease in office paper use due to the proliferation of email and electronic documents could reduce emissions by an estimated 67.2 million tons.[143] Internet businesses, such as iTunes, which allow the downloading of music and videos, not only reduce the use of packaging materials and actual products, but circumvent environmental harms associated with traditional product transport.[144] According to the California Broadband Initiative, if half of today's movie rentals were accessed by video-on-demand, the country could save the equivalent of 200,000 households' annual electricity consumption.[145]

Further, the availability of online media options provides traditionally disenfranchised communities with accessible forums to express themselves, forums that often have lower economic costs than traditional media outlets and produce less environmental harm.[146] "The Internet has the ability to turn retail buildings into Web sites," observes analyst Joseph Romm, "and to turn warehouses into better supply chain software, to dematerialize paper and CD's into electrons, and to turn trucks into fiber optic cables."[147]

Improving the Energy Efficiency of the Broadband Network

One real concern is that broadband networks and online applications powered by massive server farms and devices could themselves become an environmental danger given their own heavy energy needs. The IT industry is responsible for around 2% of the world's carbon emissions and data centers are one of the fastest sources of that problem.[148] However, the Climate Group argues that information and communications technologies should potentially enable energy efficiencies in other sectors that would deliver carbon savings far beyond what it produces itself in 2020.[149]

Further, careful substitution of less efficient information and communication technologies devices with those that are more efficient can help the sector regulate its own energy consumption.[150] For example, in 2008, Dell announced that it had "met its carbon neutral goal"[151] and the Silicon Valley Leadership Group hosted its first Data Center Energy Efficiency (DCEE) Summit on Sun Microsystems' Santa Clara campus.[152] In fact, it is projected that investments in energy efficiency technologies will equal 28% of the total $150 billion global data center infrastructure market by 2015,[153] so the IT industry is already looking to ensure that their own carbon footprint does not significantly counteract gains due to Smart Grid implementation.

Conclusion

It is time that we embrace a 21st century energy strategy. The Recovery Act was a good step towards incorporating broadband and information communication technologies into our national energy reduction and economic growth goals. Utilizing smart technologies that minimize wasted energy and increase efficient energy use, such as Smart Grids, smart devices and Smart Building technology, has the potential to reduce peak energy demand, pollutants, and grid unreliability, while also producing economic savings.

Furthermore, broadband and advanced communication technologies can reduce energy used due to travel**.** Telehealth, long-distance communication programs and e-commerce can all leverage broadband-supported applications to replace basic everyday carbon-intensive activities with more environmentally-friendly alternatives.

However, realizing the green future outlined in this paper will require the implementation of well-designed public policies that not only promote increased use of the high-speed wired and wireless broadband-enabled technologies, but also provide strong consumer and labor protections to assure that households and individuals benefit from their deployment. The United States must better coordinate broadband deployment efforts, address the digital divide, and assure upfront affordability of climate-friendly technologies that will produce savings over the long-term. These efforts will set the United States apart as a global leader in technology investment and energy conservation, and ultimately fuel a robust and competitive green economic future.

Overall, broadband and associated communications technologies can play a critical role in greening the economy by supporting applications and technologies that promote energy efficiencies and creating the possibility of a large drop in energy use intensity.[154]

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coordination across the interfaces between the utility and its customers can have a significant impact on the bulk-power system, particularly as new renewable power and climate policy initiatives introduce the need for more flexibility in the electricity grid, which creates the need for increased reliance on demand response and electricity storage," with such storage ultimately being located on customer premises. The Commission also identifies effective communication and coordination across inter-system interfaces (e.g., transmission and distribution system interfaces) as a priority. The Commission states that "effective communication and coordination occurs when each of the systems understands and can respond to the data provided by the other system, even if the internal workings of each system are quite different," and enabling such inter-system communication is "key to the attainment of renewable power and climate policy goals and can help enable customers to manage their energy usage and cost." Federal Energy Regulatory Commission. *Proposed Policy Statement and Action Plan*. 19 Mar. 2009. Department of Energy. http://www.ferc.gov/news/news-releases/2009/2009-1/03-19-09-E-22-factsheet.pdf.

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address growth, simply adding wires and equipment without intelligence is not a viable option.... Even with the requirement to communicate with all consumers… however the communication systems that the utilities are developing for Smart Meters will not be adequate to support full Smart Grid development. The communications needs associated with the collection of meter data are different from those of grid operations. Additional bandwidth and redundant service will be needed for grid operations because of the quantity of operational data, the speed required to use it and its criticality." Singer, 35.

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