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Wired for Progress

Building a National Clean-Energy Smart Grid

Bracken Hendricks February 2009



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Introduction and summary

The United States stands at a crossroads. The convergence of a deep economic recession, high unemployment, energy insecurity, and a looming climate crisis demands decisive action. Our country is embarking on an economic recovery plan of historic proportions. Investments in our public infrastructure will be made to get the economy *moving*, but we need to make sure we get the economy *moving in the right direction*. Jump-starting economic activity is only the start. The future of our nation's competitive economic advantage and our long-term prosperity rests on the choices we make now—in particular, whether we build a modernized infrastructure for jobs and growth that uses resources wisely, anticipates the coming demand for low-carbon energy, and captures new opportunities for innovation and improved productivity.

Inaction today presents very real and growing costs. To allow a climate crisis to proceed unchecked will directly harm people's lives and the prosperity of the global economy. Global warming presents the threat of lost agricultural productivity, drought and reduced supplies of fresh drinking water, the migration of environmental refugees (creating new global conflicts), and substantial economic damages and lost property for coastal communities. At the same time, our nation's growing reliance on oil is a major national security concern. During the 1973 oil embargo orchestrated by the Organization of Petroleum Exporting Countries, the United States imported less than a third of its oil needs, yet constraints on supply at the time created economic, social, and foreign policy disruptions. Today, we import nearly 70 percent of our oil—at a cost of \$478 billion dollars in 2008 alone—representing a major contribution to our national trade imbalance.

Yet solutions to these mounting crises offer real opportunity as well. Because buildings contribute fully 43 percent of our nation's CO₂ emissions, beating global warming will require that we retrofit millions of homes for energy efficiency, stimulating demand for construction jobs and advanced technology. Reducing oil consumption will require a renewed commitment to the fuel economy of our cars and trucks, but also the electrification of our passenger fleet through plug-in hybrid cars, revival of our automotive industry, and the conversion of long-haul trucks to run on domestic natural gas or advanced bio-fuels. All of these solutions will require new investments in more modern and productive infrastructure and manufacturing capacity—creating stronger communities that rely on the skills of America's workers to build a more efficient and competitive economy.

In short, the answer to our economic, energy security, and environmental crises lies in rebuilding America—creating jobs and laying the foundation for sustainable long-term growth. Today there is plenty to fix. Our country’s entire infrastructure is in disrepair from years of neglect and disinvestment. The American Society of Civil Engineers has given the United States a “D” in infrastructure maintenance, citing more than \$2.2 *trillion* of deferred and neglected investments in our roads, bridges, transit, schools, storm water, and energy systems.¹ This failure to invest over the past several decades threatens U.S. industry, imposes costs on businesses and workers, and causes preventable harm to our communities. While the costs of inaction are staggering, the opportunity to rebuild the foundations of our economy and our public infrastructure is equally inspiring. Reconstruction must become a national priority no less urgent than the Marshall Plan.

Nowhere is this more evident than in our energy system, and particularly our electricity transmission and distribution grid. Largely unchanged in generations, we are now using yesterday’s technologies to power an increasingly global 21st-century economy. Previous waves of investment in electricity infrastructure were essential to building the global economic and industrial leadership that was the hallmark of the U.S. economy in the last century. As local electricity grids evolved into ever larger regional networks to connect vast swaths of the country in a complex grid system, energy became ever cheaper and more reliable.

The results? Large, central-station generating plants used abundant coal reserves to power the steel, auto, and other manufacturing industries that provided steady employment for

“Wired for Progress” Action Plan

A truly national clean-energy smart grid must consist of two distinct components: an interstate transmission “sustainable transmission grid” that will transport clean utility-scale renewable energy long distances to market, and a digital “smart distribution grid” to deliver this electricity efficiently to local consumers. The absence of a national grid that seamlessly integrates these two components is one of the biggest impediments to large-scale deployment of low-carbon electricity.

In this paper we outline a plan to develop such a secure, reliable, interoperable, national, and clean electricity grid to power America’s coming clean energy economy. Our particular policy recommendations focus on the principle bottle necks for building grid projects. These include:

- A framework for collaborative multi-state **planning** to match new grid investments to our resource base

- A stronger proposal for **siting** new transmission projects tied to this plan, giving greater power to the federal government but requiring strong state participation
- Broad-based **cost allocation** to ensure that no single region must bear the cost of a national undertaking
- **Smart-grid investments** and standards to deploy new information technology, controls, and advanced metering infrastructure on the transmission and distribution grid

In addition, major crosscutting issues affecting each of these areas include the need to address **workforce development** and training needs to build and maintain the grid, enhancing the **security and reliability** of the grid through these investments, and strategies to promote **financing** of projects, both public and private, to ensure that these grid enhancements are built efficiently and in a timely manner.

millions in the Midwest. Investments in hydroelectric dams created inexpensive power and brought an aluminum and aerospace industry to the Pacific Northwest. And rural electrification ensured that the benefits of access to reliable and affordable energy brought economic development to every corner of the country as a fundamental principle of American fairness—from remote communities in Appalachia to the rural South, the Great Plains, and the Southwest. Forward-thinking investments in public infrastructure and dependable access to energy have touched every state in America.

Yet, these early-20th-century investments in our electric grid system have not kept pace with today's global economy. Today's grid cannot respond effectively to the most pressing new challenges we now face—from terrorism to global warming to ever-rising demand. Nor is our current electricity grid 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.

That's why it is so important today to reinvigorate our economy by building new generation, transmission, and distribution systems for efficient use of low-carbon electricity. The transformation of our increasingly outmoded electricity infrastructure around the platforms of efficiency, security, reliability, and reduced carbon emissions will boost U.S. innovation and job creation in coming decades. Building a national clean-energy smart grid will create new markets, foster new businesses and business models, put people back to work in construction and manufacturing, and lay the foundation for long-term, sustainable economic growth.

This task will be daunting. As presently configured, the U.S. electric transmission and distribution system faces three major hurdles. First, we face a problem of geography and planning. The current high-voltage transmission grid imposes important constraints on the deployment of new renewable energy such as wind, solar, and geothermal power because it simply does not currently go where many of these renewable energy resources will be developed. Second, congestion and bottlenecks hurt the reliability of the grid overall, and particularly where it is needed to move large volumes of new power from remote generation to major loads.

Third, the monitoring and control technology on both transmission and distribution networks is weak. The lack of smart technology to provide utilities and consumers with better information in real time hurts the security and efficiency of the entire electricity system. The lack of such a modern, smart-grid network slows the spread of new technology such as solar panels on our homes, intelligent appliances to cut our energy bills, or micro-grids to help first responders meet natural disasters.

Although the United States has vast onshore wind resources—more than enough to supply 20 percent of the nation's electricity demand by 2030, according to a recent Department of Energy study—the best of these wind resources are located primarily in remote regions of the country. These areas are generally located far from major centers

Solving today's grid-related challenges will require a national effort to remake the grid with new technology, new investments, and new economic, regulatory, and political arrangements.

of electricity demand and have little or no access to the “backbone” extra- high-voltage transmission lines that would be required in order to transmit power efficiently from these regions to major electricity markets.

A similar problem confronts solar power developers, who have identified sparsely populated areas of the desert Southwest as optimal locations for large-scale solar power stations. Absent major investments in extra-high-voltage transmission lines connecting these areas of the country to major markets, it is unlikely that the United States will be able to fully exploit these renewable energy resources at a scale that can significantly contribute to our national appetite for energy. The development of remote geothermal resources faces similar transmission constraints.

Yet just as fundamental as these current limits to bringing new renewable resources online is the sobering reality that our entire transmission grid infrastructure was developed in a pre-digital era for a completely different set of problems than we currently confront. Today’s grid-related challenges are much more diverse than those of the 20th century, and solving them will require a national effort to remake the grid with new technology, new investments, and new economic, regulatory, and political arrangements in order to improve the reliability, security, and efficiency of the electric grid, and to enhance its environmental performance.

The grid has suffered from systematic underinvestment in recent decades. Increased demand has outpaced investment, and congestion on the grid has grown as well, imposing a mounting burden on the national economy. One study found that transmission congestion currently costs consumers in the eastern United States \$16.5 billion per year in the form of higher electricity prices alone.² Congested transmission lines raise generation costs by limiting the dispatch of low-cost resources—even as they reduce grid operators’ flexibility to deploy low-emission renewable resources. Moreover, a backlog of 300,000 megawatts of wind projects is waiting in line for connection to the grid because of inadequate transmission capacity. Such congestion further limits our future energy diversity and consumer choice.³

A stronger power grid also will be more reliable, significantly reducing the staggering cost of power outages for U.S. consumers and businesses. The 2003 blackout in the Northeast United States and Canada, for example, caused an estimated \$7 billion to \$10 billion in economic losses.⁴ Today, however, we have the tools to improve real-time monitoring and control of the grid with advanced information technology. We can use this IT to better manage energy on the lines, to reduce disruptions, and to respond flexibly to disruptions when they do occur.

These modern smart-grid technologies are not yet widely deployed, yet they have the potential to reduce billions of dollars of costs attributable to power interruptions and fluctuations across the network. The Electric Power Research Institute, for example,

estimates that electricity disruptions cost the economy upward of \$100 billion each year in damages and lost business.⁵ With new investments in technology, these losses are increasingly preventable.

A more robust grid is vitally important as a matter of national security as well. Because transmission investments have not kept pace with increased demands, and advanced smart-grid technologies have not been broadly deployed, the grid is more susceptible not only to costly outages but also to both natural and man-made disasters. New grid investments are justified to make our energy infrastructure more resilient. A more interconnected grid will provide redundancy in the event of a failure in any single location and allow grid operators to respond more flexibly to emerging problems by bringing in generation from other regions.⁶

In addition, security experts increasingly identify cyber-security and direct terrorist threats to the grid as a substantial hazard for the entire U.S. economy, with a few targeted attacks to our existing infrastructure potentially threatening public health, safety, and commerce over vast regions. Hurricane Katrina showed starkly the debilitating consequences that power outages can have not only on citizens' daily lives but also on the welfare and functioning of entire cities, from streetlights to pumping stations to hospitals and refineries. Clearly the security and reliability of our energy supply is a matter of basic public safety. The threat of global warming makes these concerns only more acute.

At the core of our response to these challenges is the humbling realization that the policy and regulatory structure that we have inherited for managing electricity transmission and distribution is not properly designed to meet the growing demands of a changing society. To rise to the current occasion, we must expand the grid to support dramatic increases in the penetration of renewable energy and improve its reliability, efficiency, and security. The status quo is no longer acceptable. But to take rapid and meaningful action will require not only new investment, but also more thoughtful regulatory tools and policy approaches to leverage the potential for large-scale investment into a robust 21st-century electricity transmission and distribution infrastructure that is resilient, clean, efficient, and affordable to consumers.

America has always prospered most when it invests boldly in infrastructure in the face of deep structural problems, “crowding-in” private capital through strategic public investment that opens the floodgates of individual ingenuity and innovation. Time after time—from canals to railroads to rural electrification to interstate highways to modern telecommunications—our nation has been successful at building large-scale infrastructure projects that advance national imperatives vital to our security, technological leadership, and economic growth. Constructing a national clean-energy smart grid is the next great challenge, and it will require similar public commitment, a national sense of purpose, and collective sharing of costs in order to realize far greater public benefits.

A more robust grid
is vitally important
as a matter of
national security.

Rebuilding our electricity infrastructure for today's challenges

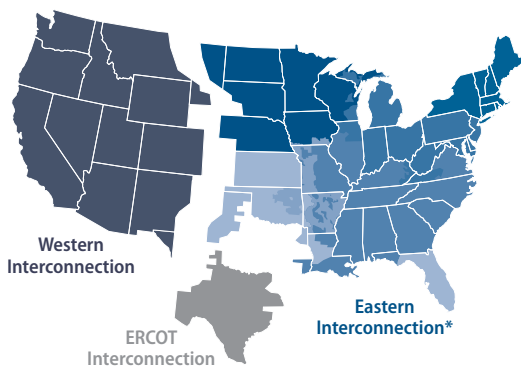
The most high-profile transformation of our nation's electricity system must soon occur in the power generation sector, where policy and investment decisions we make both for the transmission and generation sectors will shape how we power our future as we rein in pollution from aging coal-fired power plants. But at the other end of the grid, where millions of individuals make decisions about how they want to be supplied with power, consumers also must increasingly be able to actively manage their own electricity use, assisted by better information, new controls, green construction, and renewable energy built right into their homes and offices.

Critically, to make any of this possible, key enabling changes must be made in the electricity grid that connects our power plants to each consumer's home. The electric transmission grid comprises both high-capacity and lower-capacity transmission lines that when properly planned and integrated make it possible to move vast amounts of power from remote sources of generation to our population centers. The grid is the essential enabling device that makes a new clean-energy economy possible. The grid allows the electricity system to adapt to unpredictable events and constantly changing circumstances. Only the deployment of a smart grid empowered by advanced information technology can manage these increasingly complex, efficient, and resilient networks.

An integrated, IT-enabled, national electrical grid is essential for improving security and reliability, but it is especially critical for bringing higher percentages of renewable electricity into our energy mix due to the variable nature of many of these resources. New information technology like advanced metering infrastructure is also key to bringing advanced home appliances and end-use technologies on line to capture new efficiencies. While grid investments are not “sexy,” they are necessary preconditions to enable both the generation sector and end-user changes that are needed.

How the grid is managed

Our nation's existing electricity grid is divided into three separate management units or “Interconnections” shown here. Within these divisions, there are many further levels of operation by states, utilities, regions, and different regulatory entities. This fractured system impedes the efficient flow of energy and complicates the introduction of renewable energy resources into our energy mix.



* Shades of blue represent divisions within the Eastern Interconnection.
Source: NERC, 2008 Summer Reliability Assessment, May 2008, page 5.

If a primary national goal is to increase the use of renewable energy from current levels to 20 percent of our total electrical supply—a potential outlined by the Bush administration's own Department of Energy—or even 25 percent, as President Obama has advocated, then we will need new infrastructure designed for the task. This will include substantial new construction of feeder lines to allow new large-scale renewable-energy projects to connect up to the grid. It will also require extra-high-voltage electricity transmission upgrades to the existing grid to permit that power from remote renewable-rich regions to reach consumers.

Similarly, if we want massive numbers of enlightened consumers to make smart choices about how they produce and use electricity, then

they will need access to real-time information on the true costs and impacts of their energy choices and their patterns of consumption. This will require deploying “smart meters” or other technology for managing energy distribution and use both on a smart electric grid and in our homes.

A policy framework for the national clean-energy smart grid

Getting the 21st-century electricity grid that we need will require changes in federal regulatory policy and adoption of new incentives. This paper seeks to lay out a road map for Congress and the Obama administration on key policy changes with respect to the grid that should be considered and adopted. The underlying policy changes to accomplish this vision must include substantial reform of the regulatory structure for planning, siting, and paying for an extra-high-voltage backbone transmission grid and the new transmission lines needed to connect renewable generation to that backbone.

In addition, it will require modernizing distribution networks with information technology to produce an advanced smart grid. Through these policy measures, we can also address economic and national security concerns with policies that create good jobs and improve the resilience of the grid. Specifically, federal policy changes will need to include:

- Planning undertaken on a broad interconnection-wide basis that brings together multiple states in a transparent and participatory process to maximize the use of new renewable resources and optimize the reliability, efficiency, and economics of the entire system, rather than the current fragmented state-by-state, utility-by-utility, or even regional planning approach.
- Certification and siting done on a one-stop basis for new renewable transmission projects so that projects identified in a multi-state clean-energy planning process can receive consolidated review and approval, rather than relying on a system where multiple unconnected permitting agencies (in an uncoordinated process that must cross many jurisdictions) are expected to develop long-distance transmission lines as a new national priority.
- Broad cost sharing to ensure that the expense of new grid investments is shared by all ratepayers, driving down costs and guaranteeing that no single state or region of the country shoulders the burden when everyone gains from the environmental, security, and reliability improvements delivered by a new national clean-energy smart grid.
- Enhanced federal financial support for smart-grid technologies that will improve the capability of utilities to monitor and control this new national grid and give individual consumers the capability to better manage their own energy use. This federal financial support should include expanded incentives for deploying smart-grid technology across

Federal policy changes should include:

- New nationwide planning process
- Efficient certification
- Broad cost sharing
- Enhanced federal support
- Clean energy workforce training

the existing grid, financial and technical assistance for state utility regulators and others overseeing this work, and federal grants to speed regional smart-grid pilot projects that demonstrate the further promise of these tools and expand their capabilities.

- Connecting all of these clean-energy infrastructure investments to standards for job quality, increased training and workforce development, promotion of domestic manufacturing, and other public investments in smart long-term economic development, community reinvestment, and a strong American middle class.

In this paper we present a framework for federal electricity policy reform that will help to drive investment into building a truly national 21st-century electricity delivery infrastructure. This includes both the transmission and distribution of clean energy, as well as installing smart metering and related communications, and new controls throughout the electricity network to empower energy consumers and grid managers at every level with better tools and information. These grid policies will also speed a clean-energy future by allowing more cost-effective implementation of climate and renewable energy policies at the state and federal level.

Sensible design of smart-grid policy will have tremendous benefits in averting global warming, but it need not wait for the details of global-warming legislation to be worked out. The tools that will drive the construction of a national clean-energy smart grid are not dependent on the details of any future policy for climate change or renewable energy, and they can be implemented today without delay.

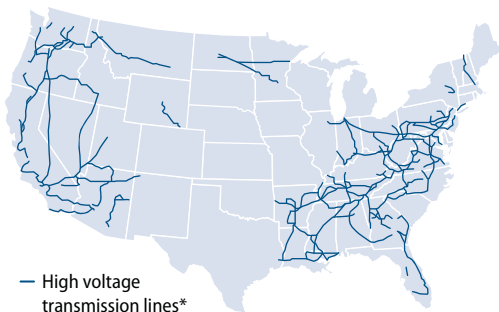
The policy questions we take on here are complex and have been contentious. In matters involving large construction projects such as the building of power plants or transmission lines, there is often controversy. It might involve fundamental questions about the need for a project, or concerns about siting new power lines, or the effect of the new lines on wildlife, the surrounding scenery, or property values.

Or the controversy might instead involve the allocation of costs for such an effort, or perceived infringement on the rights of a property owner, or the prerogatives of a local decision-maker, regulator, or elected official. Questions enough will arise out of these controversies. Why build? Why build this project? Why build this project here? And why should I pay for it? These all have been key questions in past debates over electricity infrastructure.

What's more, the history of litigation on these electricity-grid decisions is long. That's why the objective of this report—along with the dozens of writings and conversations that informed this paper and are

Power lines where renewable energy isn't

Today's high voltage transmission lines do not connect to the regions where wind power, solar power, and geothermal power are most abundant.



* Depicted lines are 500 kV–999 kV and DC.

Source: Platts POWERmap, www.maps.platts.com.

reflected in its appendices—is to find a path forward to change the traditional course of this debate by proposing a broader framework for thinking about the choices before us, and to resolve the trade-offs in new ways that meet the key concerns of many parties. Such a constructive approach is needed to ensure not only that the coordinated national infrastructure our nation needs is built rapidly and effectively, but that it is built with keen sensitivity to the ancillary consequences of the construction.

Central to this effort to broaden the debate is a keen understanding of the clean-electricity “pipeline” of products and services that a new national clean-energy smart grid will enable—new clean-energy vehicles and smart appliances and exceedingly energy-efficient buildings and energy-generating buildings—which in turn will help slow and then reverse global warming. So before presenting our analysis of the problems plaguing our currently fragmented and out-of-date electricity grid, and then our solutions, we must first present a snapshot of what this new clean-electricity pipeline will look like, from source to use.

Building an integrated clean-electricity “pipeline” from source to use

Solving global warming requires major investments in clean energy. A necessarily dramatic reduction in carbon emissions means the United States must deploy clean renewable energy and radically improve energy efficiency at scale across the entire economy. This will require local investments in “smart” digitally enabled electricity distribution systems to integrate new energy resources such as solar panels, energy storage, smart appliances, or plug-in hybrid vehicles. It also will require a robust electricity grid, overcoming the fragmentation and bottlenecks that define the current network and provide inadequate linkages between the tremendous wind potential of the nation’s interior, the solar resources of the Southwest, the geothermal potential of our mountain regions, and the population centers on the coasts and the industrial heartland.

Put simply, a low-carbon economy will rest on the foundation of energy-efficient green buildings powered by wind farms and solar and geothermal power stations, but today we lack the wires to connect these renewable resources with consumers. Exciting technological breakthroughs in clean energy from utility-scale solar, wind, and geothermal energy and the smarter management of traditional energy sources are currently held back by the lack of a supporting infrastructure—and no single business, investor, or community acting alone can make up for this deficit of public policy, planning, and investment.

Interest in bringing new clean technology to market grows apace, yet efforts to upgrade our electrical grid to support these changes are complicated by difficult issues of land use, regulatory authority, and cost recovery. As a result, progress on clean energy lags behind growing public demand for action to build a real and lasting alternative energy solution.

The upshot: We need to modernize our entire energy infrastructure—from the point of generation to the electrical outlets in our homes—with a truly national information-age electrical grid that enables new markets for clean technology. Based on an understanding of the hard choices that have held up development of the electrical grid in the past, we attempt here to outline a way forward that advances the national purpose of building a well-planned clean-energy infrastructure while valuing the important role that local communities will play in guiding that planning and implementation.

A truly national clean-energy smart grid must consist of two distinct components: an interstate transmission “sustainable transmission grid” that will transport clean utility-scale renewable energy long distances to market, and a digital “smart distribution grid” to deliver this electricity efficiently to local consumers. The absence of a national grid that seamlessly integrates these two components is one of the biggest impediments to large-scale deployment of low-carbon electricity.

When the complex issues of transmission and distribution are situated within a larger context, and understood as a key connection in a larger clean-electricity “pipeline,” the public interest in building a robust national electrical grid is clear. Today the grid is a bottleneck in realizing a future where we can move electricity efficiently, reliably, and securely from the source to end user, from a wind farm or solar array to the motor of an efficient “Energy Star” home appliance or the engine of a new electric car. The clean-electricity “pipeline” that will power our low-carbon economy involves a number of distinct parts. These are:

The clean energy pipeline will:

- Produce nationwide renewable electricity
 - Deliver this power on high capacity grids
 - Manage this power with new information technology
 - Allow consumers to contribute energy to the grid
 - Produce new green energy jobs
- Producing renewable electricity at a utility scale to rival large conventional power plants so renewable energy can finally become a major portion of total U.S. energy use, including harnessing the vast wind resources of the Great Plains and coastal regions, the wealth of solar power in the Southwest, and the barely tapped geothermal energy beneath the earth’s surface
 - Constructing an integrated long-distance and high-voltage sustainable transmission grid network designed specifically to serve these new renewable resources to deliver this energy reliably and efficiently to all parts of the country, and especially to population and industrial centers where demand is greatest
 - Developing regional smart grids for high-performance electricity distribution and customer interaction, to upgrade energy infrastructure with information technology that enables management of energy demand, improved conservation, and integration of distributed power generation in our homes, helping use existing power plants more efficiently
 - Transforming consumer energy consumption at the point of use by increasing residential, commercial, and industrial efficiency; by enabling customers to manage their electricity demand more efficiently; and by integrating renewable energy such as solar

panels into their residences, or connecting plug-in electric cars in their homes to store clean energy and reduce dependence on oil

- Connecting clean-energy infrastructure investments to standards for job quality, increased training and workforce development, the promotion of domestic manufacturing, and other public investments in smart long-term economic development, community reinvestment, and a strong American middle class.

When it is fully implemented, this clean-energy pipeline will transform our entire economy. Our new energy mix will include large-scale new renewable power plants, building retrofits, distributed solar power on rooftops, small-scale wind and geothermal power generation, advanced energy storage, sophisticated IT management of energy use, and the electrification of transportation through plug-in hybrid cars that connect, communicate, and support the grid. Consumers will see fewer price spikes due to more diverse sources of energy, which over time will combine with more efficient energy use to drive down family energy bills. Utilities will have greater reliability and a more robust network, and the improved technology will mean that we can build fewer power plants and release less pollution. But the larger plan is dependent on the existence of a new clean-energy smart grid.

Each element in this larger clean-energy pipeline, however, must be guided by a set of policies, regulations, and funding choices that direct planning and development of our electricity infrastructure toward low-carbon sources of energy, and that help build markets for private-sector innovation to drive down costs and accelerate deployment. For instance, policies to lower greenhouse gas emissions and encourage the use of renewable energy will be the engines for transforming the electricity generation sector, while energy-efficiency requirements and new incentives for consumers will drive changes in buildings, cars, and the efficiency of our energy use.

The proposals discussed in this paper focus on making critical changes to the policy framework for our electricity transmission and distribution system. These areas have received relatively little attention from policymakers, yet they are essential for enabling the types of dramatic transformations envisioned for the electricity generation and consumer use. Thus far, transmission and smart-grid infrastructure have not excited policymakers or the public nearly as much as the generation of alternative energy at one end of the energy pipeline and consumers' use of energy-saving appliances and home retrofits at the other.

What's more, the construction of new transmission lines can be a politically contentious issue involving complex regulatory policies and pricing concerns, questions of eminent domain, vexing matters of state vs. federal regulatory authority, financing, rate recovery, and many other potentially intractable policy debates. Similarly, upgrading the electric grid to support digital, smart-grid technologies requires a large up-front investment that is difficult to simply fold into the local rate structure—despite the substantial public benefits that accrue nationally from enabling increased grid reliability, advanced efficiency mea-

Consumers will see fewer price spikes due to more diverse sources of energy, which over time will combine with more efficient energy use to drive down family energy bills.

tures, peak-load management, and vehicle fleet electrification. As a result, while demand for clean-energy services mounts, real progress on the ground is slowed by this bottleneck in both policy change and infrastructure investment.

The policy calculus to implement a national clean-energy smart grid changes, however, when the frame of discussion is expanded to incorporate all of these steps in the pipeline. Building support for this larger national purpose is a political project that can overcome old stalemates, identify creative solutions, and enable new configurations capable of getting the job done. This broader road map for change will allow electricity utilities and consumer advocates, wind companies and union workers, environmentalists and ranch-

Defining our terms

What is the national clean-energy smart grid?

Constructing a national clean-energy smart grid will advance key priorities for our country, including expansion of renewable electricity, enhanced energy efficiency, increased security and reliability for the electricity system, economic benefits and cost savings for ratepayers, and job creation for American workers and businesses. The national clean-energy smart grid consists of an expanded and upgraded interstate transmission grid connected to a modernized utility distribution system that delivers energy and detailed information about the use of that energy to consumers.

Interstate transmission

As a necessary enabler for attaining these key national policy goals, the United States needs to establish a sustainable transmission grid consisting of a well-planned network of long-distance, extra-high-voltage transmission lines to move remote clean-energy resources to power load centers. This transmission network needs to connect renewable energy resources into this extra-high-voltage grid.

Such a grid would enhance reliability, lower power-line losses, and incorporate advanced digital controls and other smart transmission grid technologies, and would be planned specifically to reach from areas with the highest potential for new renewable electricity generation to areas where that energy is most needed. The maps on pages 29 shows where this new extra-high-voltage grid would spread across the United States from regions of our country with the most renewable wind and solar power potential.

Smart-grid electric distribution and the customer interface

The deployment of smart distribution grids will involve integrating new technology into local electricity distribution networks, such as smart time-of-use meters at individual homes and businesses, load controls to help manage the demand that appliances and other end-use equipment place on the grid at key times of day, grid monitoring and control devices to improve the efficiency of electricity distribution within local networks by utility companies, and better tools for information sharing with the end-use consumers of electricity in homes, businesses, and public institutions.

These technologies will advance end-use efficiency and demand response, allowing utility companies to meet spikes in consumer demand by deploying energy efficiency and better management instead of turning on more power plants. They also will enhance customer choice by offering new ways to generate and use energy more efficiently, cutting bills, and better managing resource use. A smart grid also will provide the pricing and control system to flexibly integrate new so-called distributed energy resources close to the point of demand. These distributed energy sources include solar panels, energy storage devices, and increasingly electric vehicles as the batteries in our cars become a repository for clean electricity when we charge them up at night and then feed that power back into the grid when our cars are parked at work or at home during the day, cutting our nation's reliance on oil during daily commutes.

ers, federal and state policymakers to all find common cause. By offering a path to the broad transformation of our entire electrical infrastructure on the foundation of radical gains in efficiency and deployment of non-polluting renewable energy, the outlines of an exciting coalition, and a more effective policy plan, begin to emerge.

Policies to support all the components of the clean-electricity pipeline also must include an emphasis on quality job creation and building a skilled and ready workforce. By focusing smart policy on the transformation of our electricity grid, the nation can ensure that green economic growth is a tide that lifts all boats, offering pathways into the middle class through skills training, better career ladders, and family-supporting wages in the construction trades and in manufacturing within the industries of the future. The clean-energy transformation of the United States is a strategy for broad-based economic re-development in many sectors of the economy and many regions of the country, and it must be crafted as a smart jobs and economic development plan, as well as an urgently needed policy response to global warming and our growing energy insecurity.

While all the components of this pipeline are vital and closely interrelated, in this report we focus specifically on building a national clean-energy smart grid—both transmission infrastructure for renewable energy and improved system reliability, and nationwide deployment of smart-grid distribution technologies—because this is a key barrier to this larger energy system transformation. Likewise, breaking through the logjam and modernizing our electrical transmission system will be a critical accelerant to deploying clean energy at scale, and realizing the creation of new green jobs and economic benefits.

This paper presents a set of policy options and offers a political road map to overcome the historic obstacles that have prevented progress on building a national, information-enabled, and tightly integrated clean-electricity grid. We attempt to outline here the choices that will be faced by policymakers, and highlight a potential policy compromise we think can satisfy the various concerns of a wide group of stakeholders, while producing progressive outcomes that maximize the net social benefit of building a national clean-energy smart grid. This policy proposal must principally be driven by new federal legislation, but it also can be enhanced and supported through executive action, rule making, state and local policies, and smart public investments.

The details of how we reach the political compromises necessary to build a national clean-energy smart grid are as important as the recommendations we make. In the pages that follow, we will first sketch out the challenges to building this new smart grid, then discuss some policy options for overcoming these challenges, and then make our own sets of recommendations about how best to proceed. Our policy suggestions are not exclusive, however, but rather should be viewed as the beginning of a detailed policy discussion that must happen quickly, intelligently, and with purpose in the coming months.

Building a clean energy pipeline

Large-scale renewable generation



Why it's Smart

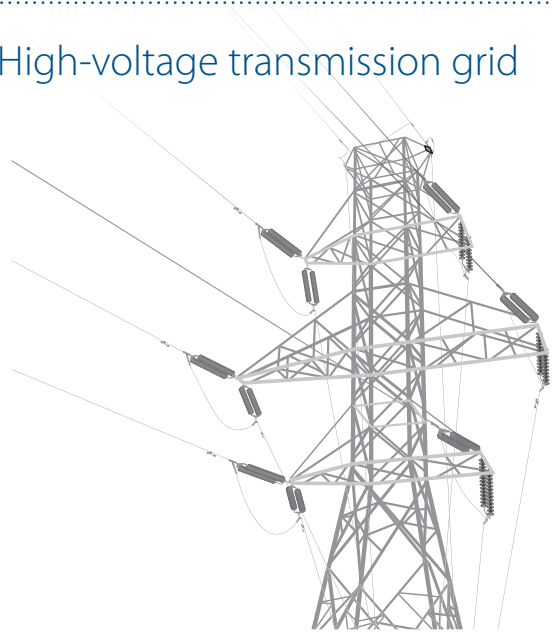


Bringing wind, solar and geothermal resources on line on a large scale creates significant new sources of clean, renewable domestic energy, reducing global warming and making it cheaper and easier to manage greenhouse gas emissions across our entire energy system.

How to implement

- Extend incentives for production and investment in renewable energy plants to make it easier to finance new projects.
- Set standards for renewable electricity production to provide certainty to the market for clean energy.
- Invest in renewable energy manufacturing and construction work to create new, good paying jobs.

High-voltage transmission grid



Why it's Smart

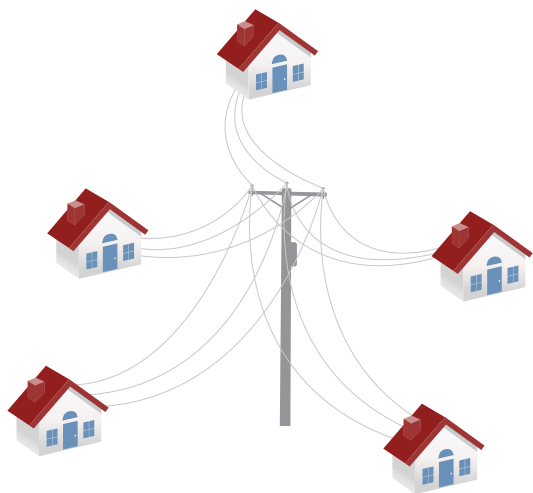


A smart nationwide transmission system will overcome barriers in the current system and include new renewable energy feeder lines to link up distant resources to a high-voltage "backbone" grid.

How to implement

- Plan our grid development to existing resources and create new systems to get many states and entire regions working together to implement a single national electricity system.
- Coordinate multi-state planning backed by stronger federal authority to build the system that states design together quickly, efficiently and transparently.
- Share the cost of these investments broadly among ratepayers and taxpayers nationwide.
- Provide certainty of cost recovery to bring new private investment into the building of these lines.

Regional smart-grid distribution



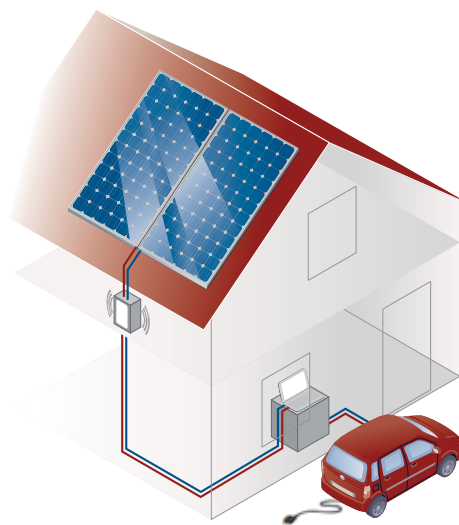
Why it's Smart

A smart grid connects digital IT to the management of the electricity grid, creating new opportunities for innovation, businesses, and the smart use of resources. Smart meters on homes create incentives for conservation and allow for real-time pricing that rewards moving demand away from peak hours.

How to implement

- Public investment to ensure ratepayers in a single region do not carry the full cost of building out the smart grid will help states and regions to get projects off the ground.
- Set standards for building the backbone of infrastructure but leave flexibility for innovation and experimentation by a host of businesses and new technologies.
- Encourage innovation through existing pilot projects, expand the work of regional demonstration projects, collect and share information openly, and then stitch these efforts into a national system.

Home efficiency and generation



Why it's Smart

Each building can generate its own energy, manage its electricity demand more efficiently, and empower consumers and businesses to contribute to our national clean energy supply.

How to implement

- Set standards for stronger home energy efficiency, efficient appliances and power demand management.
- Implement state and federal policies for net metering, real-time pricing, and energy building codes, delinking energy production from the profits that utilities make and protecting consumers.
- Offer new financing tools to support weatherization and energy efficiency retrofits.
- Invest in workforce training programs to meet the growing demand for energy services.

Challenges to building a sustainable transmission grid

In order to craft sensible policy for transformation of the electricity grid, it is important to start with a review of the challenges we currently face. The United States needs a robust, integrated national electricity transmission grid in order to serve the broad public interest in minimizing consumer electricity costs, maximizing power reliability, enhancing grid security, and enabling transformative investments in renewable energy that will be necessary to tackle the challenge of global warming and reduce our dependence on imported energy.

Today's need for a bold national commitment to upgrading and expanding the transmission grid is no less compelling than the national security interests that drove the national commitment to develop the interstate highway system in the middle of the last century. Without new investments in the electrical grid of the same magnitude as that earlier investment in our transportation infrastructure, the U.S. transmission and distribution network will prove inadequate to support our nation's economic, energy security, reliability, and environmental goals.⁷

There is broad recognition, however, that the existing framework for planning and developing electricity transmission infrastructure in the United States is too balkanized to support the development of a robust, integrated national transmission grid. Just as building a truly integrated national interstate transportation system 60 years ago required the overlay of an interstate highway network while preserving the existing pattern of local streets, county roads, state highways, and turnpikes, today a truly coordinated national clean-energy transmission infrastructure will require building up key missing linkages and new long-distance power transmission corridors.

There are six key questions to be asked that can help frame the obstacles facing the construction of a truly national 21st-century clean-energy transmission grid:

- How to improve grid planning?
- How to get new power transmission lines certified and sited?
- Who will build these new lines?
- Who will pay for the new national clean-energy smart grid?
- Who will use this new 21st-century power grid?
- How to ensure the security and reliability of this new grid?

In this section we will consider each of these questions in turn, detailing the problems posed by the question and then offering several different programmatic solutions. In this way we believe we can find common ground with the various stakeholders in the existing grid system and the policymakers and advocacy groups who are looking to build this new national clean-energy smart grid.

How to improve grid planning?

The answer: A new nationwide grid that anticipates future needs.

Current electricity grid-planning processes are too fragmented and decentralized to enable the sort of coordinated and large-scale transmission investments that will be required if America is to promote high levels of renewable energy delivery to the national grid. The policy direction and institutional mechanisms for upgrading technology and dramatically improving reliability, security, and efficiency do not now exist. New and more effective planning for the development of a national clean-energy smart grid should have several key features.

Much larger geographic scope

Ideally, new plans for power transmission that increases clean-energy delivery to consumers will be developed at the scale of the entire interconnection, or the largest area for managing our grid. The nation is currently divided into three interconnections, one east of the Rocky Mountains, one west of the Rockies, and one that covers only the state of Texas. System-wide planning will help to maximize use of available renewable resources and will help ensure integrated planning to improve the efficiency, reliability, and environmental performance of the entire grid system. (See map on page 6.)

Current planning efforts undertaken by utilities, states, Independent System Operators and Regional Transmission Organizations, or ISOs and RTOs, do not have the geographic scope or broad public interest mandate to design the best system to serve our emerging larger national interest in reliable access to clean energy. Decision making at the largest scale possible in planning, if undertaken in a truly transparent and participatory manner, will best enable clean-energy development, increase system benefits, and reduce costs.

Planning to anticipate future needs

The current system for power transmission planning is designed to manage the existing mix of power generation, built around existing central station power plants, and reflecting a patchwork history of how electricity markets and regulation have developed. To anticipate where we need to go, however, and to achieve the Department of Energy's vision of producing 20 percent of electricity from wind resources by 2030,⁸ or President Obama's

target of 25 percent of energy from renewable resources, the nation will require new transmission service linkages to wind-rich and sunny regions where such transmission service is not currently available. This will mean planning and constructing new long-distance extra-high-voltage transmission capacity where existing capacity between renewable energy regions and load centers is inadequate. This also will have the benefit of improving the ability of utilities to manage the grid over larger areas and better balance new intermittent renewable energy resources, which can literally change with the wind.

Programmatic solutions

To effectively tackle this problem, it will be helpful to establish a new multi-state, interconnection-wide planning authority charged with creating plans for generating extra-high-voltage power transmission with the express purpose of enabling large-scale development of renewable energy generation and enhancing the efficiency of the transmission system while better managing for system reliability. This will involve planning new transmission around still-to-be-developed renewable energy resources and identifying needed enhancements to the existing grid to accommodate this new flow of clean energy. The object of this planning process would not be to supplant the existing utility planning processes for meeting current utility needs, but rather to identify those specific national purpose transmission lines and the smaller connecting lines needed to optimize the functioning of the entire interconnection.

In addition, it will be critical to ensure that a coordinated, forward-looking plan for a national system is developed with broad public input and sound analytical basis. The details of the transmission planning process are important, both for public confidence in the outcome and to ensure that the resulting plan builds on existing efforts and addresses the concerns of all stakeholders. For instance, any planning process should be open and transparent. The planning should take into consideration the output of other planning and corridor identification efforts within the power transmission interconnection area. The planning body should have ample funding to support the robust analysis that will be needed.

Planning also should include assessment of the impact that demand management and distributed generation may have on future load growth and system design, along with new utility scale generation. And the planning should result in timely decisions with clearly stated objectives, along with a process for resolving disputes and concerns without the need to resort to expensive and drawn-out adversarial proceedings.

How to get new lines certified and sited?

Like current planning practices, project certification and siting authorities are also currently fractured and not well-organized for the task of coordinating the development of the large-scale transmission projects needed to facilitate dramatic expansions of renewable energy generation. To build a single transmission line can involve separate proceedings in

The answer: New nationwide regulatory structure.

multiple jurisdictions, with the lack of coherent planning potentially adding years of delay to the process while providing little added benefit.

To ensure the United States rapidly builds out a coherent national grid network—designed to maximize efficiency and clean energy—any improved planning processes must be backed by authority to ensure that planned transmission lines are able to obtain the necessary authorizations and certifications to actually be built.

Regulatory authorization to construct new long-distance transmission lines

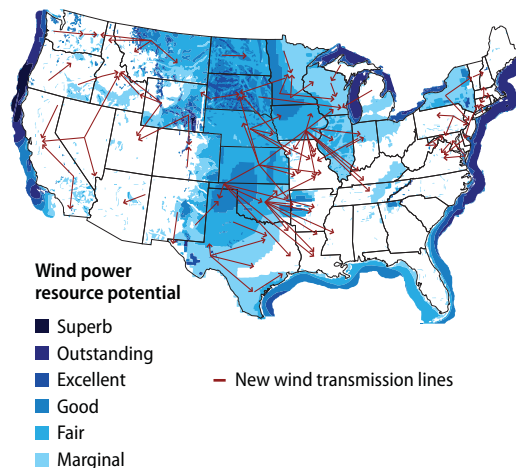
Regulatory authorization to construct new transmission lines under current practice requires numerous state and local approvals that are not coordinated and do not fully recognize larger system-wide state and even national benefits in weighing decisions. Existing practices rely on state authorities and require multiple state actions to build a single multi-state transmission line. Conflicts in a single state, or even with one opponent in a single state, can create a roadblock for an entire multi-state project. Moreover, state certification proceedings may require a public interest determination that is focused solely on the best interests of the particular state—with no provisions for weighing local concerns in the context of broader national public interests that may be very substantial.

A more effective strategy for building a national clean-energy smart grid would respect state and local interests in ensuring appropriate local-scale implementation while also including specific examination about how to ensure that national purposes are also met to ensure the development of a well-functioning clean-energy grid. Providing a more centralized decision-making process with more closely coordinated exercise of regulatory authority and a mechanism for the consideration of broader public interests will be important to ensure that thoughtful plans are implemented.

This stronger siting authority should be exercised only in those projects that are central to advancing the national public interest in clean-energy deployment and broader power grid system reliability, and thus would be linked only to projects outlined in the planning process described above. Further, such a centralized decision-making process will produce good results only if the participation of state and local stakeholders is serious and robust, allowing an authentic voice in shaping the plan and its implementation.

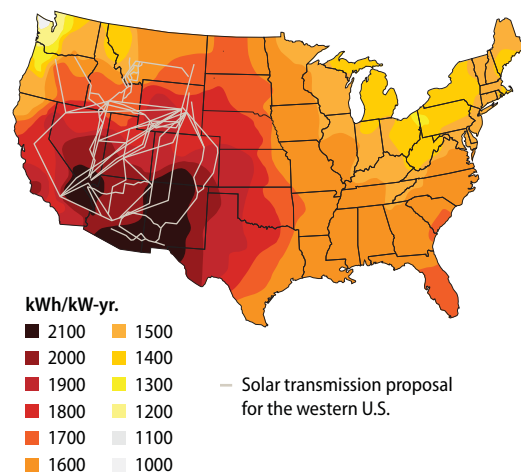
The potential of renewable wind power

Linking our national electricity grid to the best sources of renewable wind power could result in 20 percent of our domestic energy coming from wind farms



The potential of renewable solar power

Linking our national electricity grid to the best sources of renewable solar power could contribute even more domestic renewable energy to our national grid



Source: Wind map—National Renewable Energy Laboratory, POWERmap, powermap.platts.com; DOE, 20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply, page 160.

Solar map—<http://globalwarming.house.gov/tools/2q08materials/files/0157.gif>; WRA Smart Lines Report, 2008, page 2.

A process for obtaining property rights

In order to ensure that critical new clean-energy smart-grid facilities that are identified in the planning process—renewable energy feeder lines and enhancements to the high-voltage backbone grid—are actually built, developers of transmission projects will require a mechanism to obtain needed rights of way. These projects should rely on existing rights of way where possible and engage in collaborative partnership with landowners on siting broadly, but building lines will likely at times require the ability to exercise eminent domain, enabling government authorities to pay fair compensation to private-property owners for the needed land.

The current patchwork of state law concerning eminent domain for electricity facilities is likely inadequate to site the new clean-energy corridors and high-voltage backbone enhancements for renewables. While expanded siting authority would not be appropriate generally for all grid expansions that grid planners might desire, national clean-energy grid projects should be supported with a federal eminent domain authority as long as it flows directly from the authorization of projects that are identified under a comprehensive national clean-energy planning process as outlined above.

Programmatic solutions

As a practical matter, to enable implementation of interconnection-wide clean-energy transmission plans, the project certification and siting authority should be unified under federal law, not governed by multiple and potentially conflicting state laws and rulings. To ensure that this process produces a coherent national infrastructure, the exercise of this authority could be undertaken by federal regulators, or it could be delegated to states acting collectively in an interconnection. In either case, any centralized siting authority must provide for very substantial and meaningful state and local input and should be narrowly targeted only at implementing the purposes of the plan: to accelerate the transition to a clean, domestic, low-carbon economy built on renewables and efficiency.

One key policy choice, however, is whether this project certification and siting authority should be exercised by a federal agency, such as the Federal Energy Regulatory Commission, or by a single multi-state agency, such as an interconnection-wide planning body, or instead be delegated to individual states to exercise in accordance with a strong commitment to realizing a nationally coherent transmission plan. A one-stop regulatory process likely will be needed, whether at the federal level or through a multi-state coordinating body.

The reason: Requiring approvals from multiple jurisdictions with competing local concerns and priorities would threaten to substantially impede the realization of planned transmission upgrades and could compromise the coherence of the overall plan. If broader coordination is supported, then it will be essential that the resulting planning process be designed to be highly inclusive and transparent, giving all stakeholders

involved a real participatory roll, a clear ability to shape the design and implementation of particular lines given local knowledge, and the real ability to shape the outcome.

It is imperative that the final regulatory process be workable in providing timely authorization of clean-energy smart-grid projects identified by the planning body. While a federal agency should be empowered to conduct the certification and siting proceeding, state environmental agencies should have a special status to provide siting-related conditions within that process.

In addition, regardless of who makes the detailed siting and mitigation determinations, the process for evaluating siting proposals must provide for notice of potentially affected parties, opportunity to provide input, and requirements for the project developer to work with landowners and interest groups to site planned projects in a way that minimizes disruption of natural and cultural resources and minimizes impacts on property owners.

Finally, in order to assure that priority lines get built, the federal law authorizing how to certify clean-energy smart-grid projects should carry with it the power, where necessary, to acquire rights of way by eminent domain with just compensation.

Who will build new lines?

Typically, electric utilities, independent transmission developers, and Federal Power Marketing Administrations, or PMAs, will finance these projects, build them, and own the resulting power transmission facilities. At this time—unlike in the construction of new large-scale renewable energy projects such as wind farms, which are having great trouble finding project level finance in the current market downturn—there does not appear to be a shortage of lenders willing to invest in new transmission grid infrastructure, nor a shortage of available capital for financing projects.

Because transmission facilities in most cases are built and owned by the private sector, the development of adequate transmission infrastructure for renewable energy requires access to private-sector financing, and project cash flow that can support that financing. Transmission projects are highly capital-intensive, and neither utilities nor other developers will undertake such investments without reasonable assurance that they will recover their costs and earn at least a reasonable rate of return on their capital investment.

The way that rates are set, and how costs are allowed to be recovered, will have an important impact on whether new lines get built. Transmission service is typically provided on a “cost-of-service” basis. That means the transmitting utility is not permitted to charge market-based or value-based prices for transmission service, but instead receives a rate based on its cost of developing and operating the facilities. As a result, utilities or other transmission developers will demand from regulators that a competitive rate of

The answer: A new regulatory structure will allow public and private sector players to finance and construct the clean energy grid.

return, and perhaps an incentive rate of return, on their capital investment be included in the rates they collect. Moreover, the investor will want to ensure that it does not bear risks associated with lower-than-expected utilization of the facility.

A related and very important potential obstacle to transmission investment is the possible mismatch between which ratepayers must pay for transmission project costs, and which ones enjoy the benefits of the project. Typically, most transmission costs are included in rates paid by local ratepayers—the ratepayers served by the utility that is investing in the transmission—whereas the benefits, in terms of lower energy costs from reduced congestion, greater access to renewable energy, and enhanced reliability, are typically spread over a much larger region. While this issue is addressed by some Regional Transmission Organizations and Independent System Operators, by transmission cost allocation policies, many utilities, utility regulators, and utility ratepayers remain concerned about making and paying for transmission investments that will benefit others.

Even in RTOs and ISOs with cost-allocation mechanisms and benefits analysis, cost-allocation decisions are often protracted and contentious. And regardless, in all cases many of the most broadly shared benefits of a more secure, reliable, and clean-energy system that accrue to the nation as a whole, and the cost of these investments should not be borne alone by a single group of ratepayers in one state or region.

Finally, transmission developers may face added risks associated with whether the capacity on new transmission lines devoted to serving third-party generators can be sold in advance of financing the project to support that financing. New renewable generation developers of projects such as wind farms face a “chicken-and-egg” issue in that they often cannot obtain financing for their new clean-energy generation projects unless they have secured firm transmission rights that guarantee that their power will reach the grid, while transmission developers often face similar hurdles of being unable to finance transmission lines to serve such generators without firm commitments from such customers as new wind farms. A coherent nationally recognized planning process can help organize these private-sector actors, and provide certainty to the market that these projects will get built, and are worthy of offering project-level finance.

Ensuring that needed renewable energy projects get built

Simply because the necessary capacity is identified in a well-coordinated planning process and appropriate regulatory tools are made available to facilitate permitting and siting, there is no guarantee that individual renewable energy projects identified in a plan actually will be developed. These projects will cost money, and a clear structure needs to be in place to ensure that investments can be recovered, in order to get these projects financed, and any additional cost should be shared broadly by ratepayers, not borne by a single group.

Some utility-rate incentive or a larger direct public role in financing also may be justified to ensure that key renewable feeder lines or enhanced grid backbone projects get developed, or that proposed projects are developed with the appropriate capacity to respond to anticipated future transmission needs.

A further question that must be addressed in a comprehensive transmission strategy is timing. Because renewable-energy projects are developed on a quicker timeline than new transmission lines, planning will need to accommodate future demand for the transmission of renewable energy-generated power, and interactions between the construction of power transmission lines and financing future alternative energy power generation will need to be anticipated.

Programmatic solutions

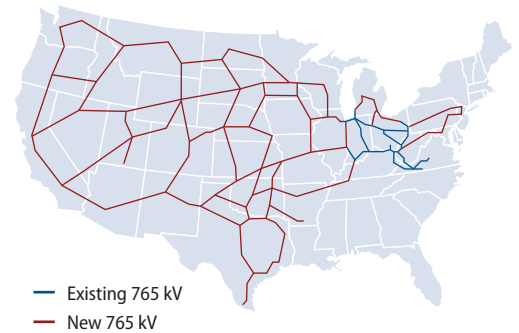
In general, it is expected that private sector developers will be interested in constructing most of the new national clean-energy smart-grid projects identified in any plan. But key policies to ensure that private-sector investment is attracted include appropriate cost-sharing rules (discussed under “Who will pay for it?” below) designed to spread the costs of the projects broadly across all benefiting energy consumers rather than imposing the costs on retail ratepayers in the area of the particular transmission project. Allowance for adequate rates of return within the ratemaking process to incentivize construction also will be important.

If, in certain circumstances or certain geographic regions, these basic rate policies are not sufficient to attract private investment, then other policies could be brought to bear to build out a coherent national clean-energy smart grid, including the infusion of new public resources. Such strategies could include direct public investment in new construction through federal Power Marketing Administrations such as the Western Area Power Administration or the Bonneville Power Administration; increasing the authority of these PMAs to build privately financed projects; and offering a public subsidy for “upsizing” to increase the capacity in privately financed transmission projects.

In each of these cases, the public investment could be justified on the basis of ensuring the full implementation of a national clean-energy smart grid as envisioned in the interconnection-wide planning process. Energy experts including businessman T. Boone Pickens have estimated that the cost of upgrading the transmission grid to support clean renewable energy is likely to be in the range of \$200 billion. This looks like a bargain when contrasted with the nearly \$10 trillion he estimates that this country will send overseas for imported oil in the next 10 years.

New high-voltage transmission lines

The construction of these new high-voltage lines will link new renewable energy resources efficiently and effectively into a nationwide clean energy grid



Source: American Electric Power.

This also compares favorably to another major American infrastructure project, the interstate highway system, which is estimated to have cost \$425 billion in today's dollars, with the federal government paying for 90 percent of the costs over more than 30 years as it was fully built out. As with the highway system, a national clean-energy smart grid will enable an explosion of new economic development opportunities, and will transform the broader economy.

The answer: Ratepayers across the nation will all contribute to the upgrades along with taxpayer dollars. This is a national commitment and the costs should be broadly shared.

Who will pay for the national clean-energy smart grid?

Cost allocation is a key issue that must be resolved in any plan for building an integrated, highly efficient, and increasingly renewable national electrical power infrastructure. Two new types of power lines will be required for such a grid: renewable energy connectors or feeder lines sited to transfer renewable energy from areas of high wind, solar, and geothermal potential to the extra-high-voltage grid, and new extra-high-voltage backbone lines that make the overall system more robust and efficient for long-distance interstate transmission. Improving the environmental characteristics of our electricity supply, diversifying supply, and increasing the efficiency, reliability, and resilience of our grid networks offer strong public benefits to the nation as a whole.

Under typical practices for financing electrical transmission, however, the costs of projects are paid for principally by the ratepayers in the particular area where the project is built. This policy creates a strong disincentive for utilities and their state regulators to invest in transmission that will have broader social benefits that extend beyond their jurisdictional boundaries. Thus, due to our system of cost recovery, as a nation we have underinvested in the backbone electrical grid, relative to the benefits it could provide. Moving forward, the costs of future investments in the national clean-energy smart grid will need to be shared differently, reflecting the broadly dispersed environmental and economic benefits that these projects will generate for our country.

Developing a strategy for broad-based cost recovery

Because the benefits of a national clean-energy smart grid are hard to assign to any single group of customers or region, and because beneficiaries are often remote from the site of new transmission, allocating costs widely across all electricity ratepayers within each electrical interconnection will be the most equitable approach and will minimize the cost burden on any single region or segment of the population. This approach is not now available without legislative change.

Programmatic solutions

While the recently passed recovery package included significant investment in smart grid and transmission construction, with \$4.5 billion and \$6.5 billion in spending

respectively, this was a down payment on a change that will require new legislation. Transmission policy enacted by Congress should provide a new mechanism for cost recovery specifically for use in building national clean-energy smart-grid projects, distributing costs to ratepayers throughout an entire interconnection. Also, payments from taxpayers (as distinct from ratepayers) toward building national clean-energy smart-grid projects will help share the costs still more broadly.

Federal incentives for new renewable energy transmission projects should be strengthened—through accelerated depreciation schedules, increasing Private Activity Bond authority for states, or other federal tax incentives—directly involving taxpayers in the fulfillment of the clean-energy, reliability, and national-security benefits of an updated grid. Smart distribution investments warrant public investment due to their broad public benefits. While in most cases transmission projects will be financed by the private sector, some lines will also need public financing or incentives to ensure they are built.

Who will use the national clean-energy smart grid?

To secure long-term project finance, developers of renewable-energy projects must be able to obtain long-term transmission rights. These transmission rights will need to be made available to renewable energy project developers on a long enough and firm enough basis to provide assurances that their investments will not become stranded assets. Issues of transmission rights are especially acute for financing renewable-energy generation projects because renewable developers often use project financing that is evaluated on the particulars of a project, rather than the balance-sheet financing that many utilities can obtain based on the strength of their overall corporate earnings.

Specific policies could be put in place to offer long-term transmission rights on a priority basis to renewable generation developers. Such policies need to be coordinated with our baseline “open-access” transmission policies so as not to create unintended anticompetitive consequences. Open-access policies were originally developed to prevent integrated utility companies from favoring their own power generation units over independent power producers, but need to be reformed to reflect new environmental concerns. Regulators, for example, could prioritize green projects over polluting ones. Support from environmental advocates and many states and local governments for building new transmission projects will likely be predicated on the public benefits of clean energy, even at higher prices. As a result, it will be important to ensure that the construction of new national clean-energy smart-grid projects is tied closely and verifiably to the development of clean generation resources.

The answer: Clean sources of power need secure access to the new grid to sell clean energy to consumers, and grid expansion should not enable increases in carbon emissions.

Programmatic solutions

New legislation should direct the Federal Energy Regulatory Commission, or FERC, to extend long-term transmission rights to renewable energy generation developers that are

sufficient to support project financed renewable generation projects. While initial prices for this energy may be higher, this should be offset with policies that increase energy efficiency, demand response, and grid innovation to lower consumers' actual bills.

In addition, this legislation could structure a proposed enhanced transmission planning process, to be most useful in support of the development of renewable energy generation. If national clean-energy smart-grid policy is considered in conjunction with a Federal Renewable Electricity Standard or Renewable Portfolio Standard, for example, then the federal government could ensure transmission planning is sufficient to support at least the levels of renewable-energy generation development required by that standard. A Renewable Electricity Standard would set a target for a percentage of all electricity produced in the nation to come from renewable sources. The use of a renewables standard also would offer assurance that new transmission serves the specific purpose of cost effectively bringing new renewable capacity on line.

It is important to consider whether planning the grid for renewable-energy generation development and providing long-term transmission rights to renewable generation developers provides sufficient assurance that the national clean-energy smart-grid projects will directly advance clean-energy goals. Any further possible restrictions or intrusions on current open-access transmission policies should be reviewed carefully, to guard against potential unintended consequences. Yet a strong linkage between new renewable development and power-line construction may be desirable to the public to ensure that clean energy as well as security and reliability purposes are being advanced by these projects.

One way to offer more certainty on the environmental characteristics of power on the national clean-energy smart grid would be to apply a carbon-based emission standard for new generators interconnecting with newly built Sustainable Transmission Grid, or STG, lines. In particular, interconnection to lines developed under any new authorities could be restricted to generation facilities with a carbon-emission rate equal to or better than natural gas power plants to ensure that new transmission investments intended for low-carbon renewable power do not support investments in conventional coal power plant construction instead. This would allow for both new intermittent renewable power, and some siting of new traditional fossil generation where it was required to firm up renewable resources, or even advanced coal with carbon capture, but would broadly ensure that the lines were being built principally to bring new low-carbon energy into the national energy supply.

The answer: A smarter, better-planned, and more robust electricity grid.

How to protect security and reliability

Design criteria that promote the security and reliability of the national grid must be built into any national clean-energy smart-grid policy. Hardening the grid to attack by terrorist groups and using technology to better manage electricity flows and make a more adaptive

and self-healing electricity grid that can respond to both natural and manmade disruptions should be top priorities and a prime justification for additional grid investments.

Issues of security must be addressed within any multi-state planning process and in the technology and design choices made during implementation. In addition, security enhancements may prove to be a public purpose worthy of additional direct federal investment or the creation of federal incentives to promote private investment in this area. The security of the national grid system can be directly enhanced through the implementation of many smart-grid features, through improved monitoring and enhanced management and operations.

Moreover, specific dedicated investments in improving the security and resilience of the grid may be justified, including in places burying lines, or choosing more costly technology than market conditions alone would otherwise indicate. These are considerations that Congress and the Obama administration need to address up front, ensuring that security considerations are included as part of the implementation of any policies to boost the use of more alternative energy in a more efficient smart grid. The smarter, better-planned and more robust electricity grid envisioned in this proposal will in itself offer significant new security and reliability benefits to the overall national energy system.

Challenges for smart-grid distribution

While much of this policy discussion has focused on long-distance transmission needs to bring utility scale renewable energy projects on line, the security, reliability, and efficiency of the grid will be greatly enhanced as well through the use of better technology to improve the intelligence of the grid overall, and particularly distribution networks, extending right to the plugs in consumers' walls. Efforts to deploy smart-grid technology at the electric distribution level include better metering and other strategies to offer real-time information on energy use to consumers, better integration of distributed resources such as rooftop solar panels, or stronger management and control technology on the lines themselves, to show utilities the actual conditions on the electric grid and improve management decisions.

Together, these information technology investments will transform the way we relate to our energy infrastructure, and will offer entirely new services and tools that can greatly improve the efficiency and performance of the entire energy system. But there are key challenges that must be overcome to introduce this smart-grid technology across the current utility grid. Among them:

- Utility decisions about whether to invest in smart-grid distribution or metering upgrades are subject to state regulatory commission oversight and rate review, or in the case of municipal or cooperative utilities, reviews by their governing boards. That means utilities and smart-grid advocates must make the case for smart-grid investments to regulatory overseers based on local returns on these investments, not on the merits of the arguments on a national scale. The result: an incomplete calculation of the public return on investments in smart-grid technology by hundreds of different regulatory agencies with little opportunity to recognize the overarching national benefits to our energy system, and a chronic underinvestment in new technology as a result.
- The up-front costs for smart-grid distribution systems and metering upgrades can be high—tens of billions of dollars nationwide. Utilities may be reluctant to make these investments, and regulators may be reluctant to approve the rate increases necessary to persuade utility companies to do so at a time when consumers and business are struggling with energy costs. To overcome this, some costs might productively be born by the nation as a whole, as was started in the recent economic recovery package, and the \$4.5 billion down payment it made on investments in smart-grid technology.

- The United States has relatively new experience with intensive deployments of smart-grid technology, which means the case studies showing the benefits of these types of investments are not yet fully developed—leading regulators to be more risk-averse about approving such investments as a legitimate expense to add to the rate base. And again, because the assessment of benefits is limited to monetized benefits for customers of one particular utility, larger national, regional, or even system benefits will be under-valued. Additional strategies for a fuller cost-benefit assessment could be productively employed.
- Obtaining the full advantages of demand management and distributed generation that can be enabled by smart-grid technology also may require other supportive rate or regulatory changes at the state level, such as time-of-use pricing, distributed generation interconnection policies, expanded net metering policies to encourage on-site consumer renewable energy generation, and delinking the profit-making incentives of utilities from the volume of their energy sales in order to promote efficiency, and ensuring that consumers see benefits from increasing their efficiency as well.
- In addition, consumer impacts of these measures also must be clarified and protected in policy. For example, real-time pricing can encourage better conservation, but it must be implemented with strong protections for low-income ratepayers to ensure that it does

The potential of the smart grid

The smart grid is not a single technology, but rather a range of exciting new capabilities that merge digital information technology into our electricity distribution and transmission infrastructure, creating a more efficient, resilient, responsive, and “smarter” electricity grid. Better use of real-time information in our energy system will allow utilities to respond to times of high demand by shifting the power load to other times of day, avoiding the need to build new power plants. A smart grid will also empower consumers with new ways to produce and use clean energy in their homes and workplaces, cutting energy bills and reducing pollution. A few of the advances that a smart grid can support include:

Renewable Energy. Integrating renewable energy sources such as rooftop solar panels into homes will allow consumers to easily sell unused clean electricity back into the grid and accommodate electricity storage at home to guarantee secure and reliable access to power.

Energy Efficiency. Enabling consumers to use new smart appliances will help reduce energy consumption at times of high demand as ap-

pliances “talk” to power plants through broadband connections, while smart meters will give them information to help them conserve and real-time pricing options to offer economic benefits for saving energy.

Plug-In Electric Vehicles. Using the batteries in electric cars as power storage units will allow plug-in vehicles to store clean wind energy at night when it is plentiful but demand is low to use on the morning commute. At the office, consumers will be able to sell this “off peak” clean power back to the grid during the day when energy demand is highest (and costs more) by plugging in at a garage, helping stabilize energy loads while turning a profit for motorists.

National Energy Security. Increasing the resilience and efficiency of the whole grid system, using information technology to better manage the power moving across the wires, can help the entire grid network run more cheaply, cleanly, and reliably—from distant wind farms to the plug in your wall. A smart grid will also help the system avoid supply disruptions and recover from physical damage or even cyber attack.

not have unintended social consequences. These equity and consumer protection issues should not be seen as a barrier to pursuing the smart grid, but rather as a key design concern in shaping its implementation.

- A key to making the grid smarter is engaging customers to become a grid resource by enabling new behaviors that shift discretionary load to different times of day to better balance the demands placed on the overall energy system. Consumers also can be given better information to support behavior change that cuts total energy use, and the installation of smart appliances can help make homeowners a part of the solution for better grid management. All of these strategies raise the challenge of educating willing customers on the benefits of moving to time-based pricing and engaging them in the active management of their own energy use in order to reduce their costs or their environmental footprints.

These challenges in turn pose new questions for policymakers to consider as they work through the efforts necessary to overcome investment, regulatory and consumer road-blocks to a truly national and smart clean-energy grid. Specifically, we must ask:

- Who will make the investments?
- How much will the investments cost?
- Do the benefits justify the expenditure?
- Will standards for interconnecting distributed generation, such as solar panels on home rooftops or combined heat-and-power systems, be resolved quickly?
- Will energy efficiency and so-called demand response programs that help tap new consumer behaviors to better manage the grid get widespread acceptance and penetration?
- How can we manage the particular concerns of ratepayers and low-income consumers to ensure that building a smart grid has no unintended consequences?

Above all, though, the key regulatory issues presented by the smart grid involve whether relevant state public utility commissions, or PUCs in regulatory jargon, will permit regulated utilities to recover the cost of their investment through higher utility rates. The existence of significant external public benefits to society beyond the value of cost savings for homeowners or efficiency gains for utilities mean that (like renewable energy transmission projects) the market will underinvest in smart-grid innovations if left to its own. In this section of our report we will attempt to answer the questions posed above in order to find solutions that move the debate beyond the current regulatory parameters.

Cost of smart-grid technologies

The most visible and commonly discussed smart-grid technology—smart meters—cost about \$250 per meter installed.⁹ Smart meters are an important way of bringing new digital information management to our energy infrastructure. They can give both consumers



A new Smart Meter is seen at a home in Elizabethtown, Pa. The homeowner saved money almost every month, up to about 6 percent off his regular electric bill, after volunteering for a PPL Corp. pilot program made possible by a “smart” meter.

and utilities better information about consumption behavior, including real- time information on energy demand, and can be very useful in improving conservation.

But the up-front costs also are considerable. There are approximately 140 million residential and small-business electricity customers in the United States, so the total cost for full deployment of digital smart meters would be approximately \$35 billion. Another \$7 billion or so in additional investment in distribution grid automation—which uses digital technology to manage the distribution of electricity more efficiently on the wires before it reaches customers’ homes— also will be required to upgrade the energy system.

Smart meters, however, are only one strategy for building new information technology into regional electricity distribution networks. Building a smart grid will involve deploying many new information-based monitoring and control systems in a wide variety of transmission, distribution, metering, and end-use applications. A case in point would be encouraging the widespread use of synchrophasors to monitor voltage and current in real time over the grid network. It has been estimated that better use of this sort of real- time information across the entire electrical grid could allow at least a 20 percent improvement in energy efficiency in the United States.

Furthermore, better management would mean fewer outages and reduced costs for businesses and households. The benefits of these smart-grid-related investments also include more effective use of distributed generation and energy efficiency through significant gains

in demand response and better management, load shifting away from peak hours, and other strategies. In short, advanced smart-grid systems can reduce the need for new power plant construction and reduce global-warming emissions substantially.

Utilities and state regulators need a means to better assess these national economic and environmental benefits when they justify the costs of investing in smart-grid technologies, as do individual ratepayers—especially where somewhat higher rates in the near term will be recovered by falling utility costs and dramatically improved reliability in the medium term. Where the benefits are clear for the nation as a whole—through improved system security, reliability, and conservation—there may be a case for taxpayer investment alongside any rate increases that would be required, rather than simply putting the full costs of smart-grid infrastructure directly on utility customers through the rate structure.

The inclusion of \$4.5 billion of new investment in smart-grid deployment in the recent economic recovery bill passed by Congress earlier this month takes a step in this direction, but by no means provides a complete answer to the need for national investment in this technology.

A related regulatory issue is whether utilities will be allowed or directed to make associated changes in rates, customer service, utility operations and operational protocol that will maximize the benefits from the smart-grid investments. These regulatory decisions, such as whether utilities are directed to make time-of-use rates available to all ratepayers to encourage changes in consumption patterns, and whether net metering and interconnection rules support renewable distributed generation, will strongly affect the magnitude of the benefits that can be expected from the smart grid.

Some consumer advocates have expressed concerns about the smart grid in terms of the impact of variable time-of-use rates and the overall rate base from increased technology investment. While smart-grid advocates have strongly encouraged making real-time pricing options available to consumers, standard flat-rate pricing structures and other protections from fluctuating energy bills still would be available to consumers.

In addition, elevating the deployment of the smart grid to a national priority would have the effect of reducing the overall cost to individual consumers, and would avoid some of the price consequences that have given consumer advocates concern. Overall, a more planned and deliberative national strategy can go a very long way to ensuring that the implementation of the smart grid is a strongly positive benefit to U.S. consumers, including low-income households.

Programmatic solutions

One way to resolve these pricing and cost allocation challenges is to provide substantial federal financial support for prompt investments in smart distribution, smart metering and related smart-energy technologies. This support could take the form of investment tax credits or other tax incentives, federal grants, and support from a fund akin to a public benefits fund, such as those that have effectively been used in a majority of states to support public and private investment in energy efficiency, renewable energy, and low-income consumer relief often funded through a very small surcharge on electricity use. Public benefit funds have been used successfully by these states to provide grant or loan funding for everything from wind turbines at community colleges to energy-efficiency retrofits of affordable housing to low-income consumer rate relief to capital access for the retrofit of local manufacturing establishments.

Significant incentives for smart-grid investments have been authorized in recent energy legislation, with an especially important title introduced in the Energy Independence and Security Act of 2007, and proposals for following through on these promised appropriations are included in the American Recovery and Reinvestment Act of 2009.

Congress and the Obama administration also could go further, and link federal financial support for these smart-grid investments on utility adoption, and PUC approval, of rates and other policies that accelerate the realization of the benefits of smart-grid investments for utilities, third parties, and residential and business customers. These policy preconditions could include availability of time-of-use rates, net metering and interconnection standards for renewable distributed energy generation, incentives to consumers, and delinking utility profits from the amount of energy they sell in order to encourage wider adoption of energy efficiency.

While such a connection of federal funding to state policy change would be controversial, it could greatly enhance the economic benefits that came from the conversion to a smart grid, and substantially increase the deployment of distributed renewable energy and clean technology. It also would be possible to promote these broad-based policy changes through an incentive-based system that provided bonus investments for smart-grid technology to those jurisdictions that build the policy as well as analytical capabilities, staffing, and the physical infrastructure to improve the use of information in the management of their energy systems.

Challenges to creating a skilled workforce to build and maintain a national clean-energy smart grid

The need for a well-trained, highly skilled workforce is a critical constraint in implementing a national clean-energy smart grid. Spending tens of billions of dollars on grid-related construction, equipment manufacturing, information technology installation and servicing, and grid operations will directly create large numbers of jobs at a time when job creation is critically needed throughout the economy. In addition, induced demand for renewable energy and efficiency alongside the increased productivity and new product lines and business models that will be unleashed through technological innovation will create still more jobs and growth. Together these drivers ensure that a national clean-energy smart grid will necessitate a significantly increased commitment to training and workforce development.

Realizing the benefits of major grid investment for America's workforce will take planning, investment, and smart policy choices. Creating domestic jobs, and enhancing the quality of wages and benefits for workers in the jobs that are created, is critical to the long-term health of the U.S. economy. While investing in a national smart-grid infrastructure will certainly create jobs and expand industries and innovation, policymakers also must expand training opportunities and help to shape the nature of the jobs that are created by including meaningful standards for job quality. In this section of the report we present some ideas for improving both the number and quality of the good domestic jobs that are created.

Creating good clean-energy jobs

The skills shortage in the power sector is real, and it is widely recognized as a growing concern within the industry. The utility sector faces the demographics of a “graying workforce,” which in many parts of the country means that the average energy sector worker is in his or her early 50s. In addition, the slow rate of transmission construction in recent years, coupled with underinvestment in deploying new technology, means the number of trained workers ready to begin rebuilding transmission and distribution networks is well below the levels needed to support such a bold national commitment.

More broadly, the transformation of power generation through the construction of a new array of clean low-carbon power plants or investing in energy efficiency at the consumer level through the retrofitting of millions of buildings, implementing smart grid technology,

and use of on-site renewable energy, also will require a much larger pool of trained workers than currently exists in the labor market. These jobs will be widely distributed across regions of the country and across sectors of the economy.

The green jobs of a clean-energy economy are in many familiar professions—construction, maintenance and operations, design, and manufacturing. The Center for American Progress and others have shown through economic analysis that such clean-energy investments can create strong economic stimulus resulting in more jobs at better wages than traditional energy investments. In the CAP report “Green Recovery,” for example, University of Massachusetts economist Robert Pollin showed that a \$100 billion dollar investment in an immediate package of spending on renewable energy and efficiency measures would create nearly 2 million jobs.¹⁰ That’s 300,000 more jobs than a stimulus plan relying solely on increasing household consumption, and nearly four times the number of jobs, and three times the number of jobs earning high wages, when compared to investing the same sums of money in conventional energy supplies such as oil and gas.

U.S. capability to manufacture the types of electrical equipment, new technology, and advanced materials needed to undertake these clean-energy projects also represents a significant source of good jobs and economic development. The United States invented the solar photovoltaic cell, yet by failing to develop these industries domestically we have ceded the market for fabrication of advanced solar panels to our European and Asian competitors. Similarly, we invented much of the intellectual property that has built the modern wind turbine, yet the failure to promote the rapid growth of a domestic market for renewable wind energy has meant that the growth of these highly skilled manufacturing businesses has taken place in countries, among them Denmark and Spain, where smart-energy policies drove demand for good jobs in a flourishing wind industry.

Today, the U.S. auto industry faces major challenges. The development of advanced batteries is a technology of increasing strategic importance not only for production of advanced vehicles such as plug-in electric cars, but also for use in energy storage for distributed renewable electricity generation that links solar panels and energy-efficient technology to the design and construction of modern green buildings.

Ensuring that these good jobs, and the resulting economic benefits, are created domestically will require an intentional strategy grounded in proactive policy and incentives. While the absence of U.S. manufacturing capability will not necessarily create a roadblock to getting the projects completed on a timely basis, the economic development and job creation from these clean-energy projects will be multiplied many times over if U.S. companies form the foundation of this new and rapidly growing manufacturing supply chain.

In addition, much like the aerospace industry or defense contracting, some energy technologies should properly be considered critical industries for U.S. strategic interests and our long-term national security as well. The many benefits for the U.S. economy of

U.S. capability to manufacture the types of electrical equipment, new technology, and advanced materials needed to undertake clean-energy projects represents a significant source of good jobs and economic development.

An worker makes adjustments before a section of a wind turbine is put into place at Energy Northwest's Nine Canyon Wind Project. Investing in renewable energy will require a much larger pool of trained workers than currently exists in the labor market.



developing and manufacturing emerging clean technologies—such as advanced batteries for distributed electrical storage on the smart-grid, clean domestic fuels, and a more secure and robust electrical grid—must be recognized as critical to sustaining not only our nation's global competitiveness but also our long-term security as well. Ensuring a strong domestic workforce in emerging next-generation energy technology, and a domestic base of production, is a key public purpose, and retaining these industries in the United States should be a focus of policy.

Investment in a clean-electricity grid can set the foundation for just such a sound national economic development strategy, which places manufacturing and trade at the center of efforts to build a green economy. To truly realize this potential, however, the policies that drive investment in sustainable energy infrastructure must be structured to create good jobs. Such a policy framework should focus on increasing per capita income, building career ladders and training opportunities, expanding domestic supply chains of these new clean-energy technologies and services, protecting the ability to form unions and bargain collectively, and encouraging standards for family-supporting wages and benefits, local hiring, and job quality. In this way, through domestic investment, workforce development, and accountability to high standards, Congress and the Obama administration can ensure that new green jobs mean good jobs for working families.

Programmatic solutions

One way to achieve these goals is to establish a system of federal financial support for technical training and workforce development in the types of skilled trades needed to construct, retrofit, and operate smart-grid infrastructure. Some utilities already have excellent training programs and relationships with their workforces. Many trade unions also offer highly effective apprenticeship programs that provide clear pathways for skill development and credentialing. Union- and employer-based apprenticeship programs have long ensured pathways into skilled crafts for electricians and other building trades.

When new labor demands emerged in the past due to environmental concerns, these programs have quickly responded, developing high-quality training programs to improve the skills of workers in many green workforce areas, from solar panel installation to asbestos removal and the cleanup of polluted sites. As we face a rapidly changing energy economy driven by changes in our energy infrastructure, it is critically important to recognize the power of these existing workforce development programs to expand the training pipeline to rapidly meet the demand for skilled workers.

One clear option for federal jobs policy would be to build on these existing best practices to rapidly increase the clean-energy workforce. Public/private workforce training partnerships with community-based organizations also should be expanded. Any new national program of increased workforce investment should specifically build on the strong precedent established in the Green Jobs Act, which was funded in the recent recovery bill at \$500 million. The Green Jobs Act contains provisions that ensure training programs include participation of both workers and employers, and provides flexibility to involve local community and public interest groups as well, in providing job training and employment services. The linkage to labor-management partnerships and work-based training programs is of particular importance for quality training and access to career ladders in this growing new industry. Smart-grid training policies should be expressly linked to the language in the Green Jobs Act, and the precedent of these existing programs.

It is important, however, not to assume that training and the creation of an expanded and enhanced electricity industry workforce is a concern only for the utility industry. A major non-utility-based smart-grid sector of the economy will service utilities and customers directly, especially through increasing the energy efficiency of our homes and businesses. Indeed, utilities have increasingly looked at new ways to find smart-grid services and functionality, often through contracts with so-called demand response providers, who guarantee a certain number of megawatts of load to be shed when requested. It then becomes the demand-response company's responsibility to assemble these "megawatts" or reductions in energy use from customers, using its own workforce and delivering the demand response when asked. Similarly, distributed generation of renewable energy on site, energy efficiency, and new large-scale renewable energy projects such as wind farms and solar plants all will create jobs at a much faster rate as a result of the changes that will be launched through a strong commitment to smart-grid policies.

To ensure that these workforce development efforts bear fruit, there are several important labor provisions that can be applied to federally supported contracting as we build out a national grid. Clear criteria are extremely helpful in ensuring the integrity of the labor market, the contractors that bid on this work, and the quality of the jobs they create. Standards can be employed in contracts to ensure that public investments create lasting public value, quality economic development, and good wages and benefits. These measures can include requirements for:

Green workforce programs should include:

- Qualified apprenticeship programs
 - Joint labor-management partnerships
 - Employer-based training
 - Good wages and benefits
- Qualified apprenticeship programs with a record of compliance with apprenticeship-hiring provisions to create sustained long-term job creation
 - Joint labor-management partnerships to develop workers' skills
 - Access to health and retirement benefits to provide a secure middle class
 - Employer-based training, including on-the-job training and skill upgrading to create a climate of lifelong learning

In addition, any federal workforce development program in the clean-energy sector must require of participating companies a record of compliance with federal laws, including labor and environmental standards, Occupational Safety and Health Administration standards, and anti-discrimination, anti-harassment, and other regulations to ensure that competition for public funds is based on providing improved value, rather than simply driving down prices by pushing costs onto the public at large.

Compliance by subcontractors to these same performance standards is equally essential to ensure that these best practices spread throughout the economy. A key labor standard covering major public infrastructure investments is the Davis-Bacon Act, which ensures that construction workers and subcontractors are paid the prevailing wages within a local economy. This measure ensures that competition is undertaken on the basis of real efficiency rather than through undercutting wages or benefits.

Another tool to ensure that public investments produce lasting public benefits and broadly shared prosperity involves structured agreements on best practices for hiring and contracting. Such strategies can take a number of forms. So-called first source hiring is a tool frequently used by state and local governments to ensure that small, local, and minority-owned businesses receive due consideration in awarding public contracts. A similar strategy involves negotiating “Community Benefits Agreements” as a part of large public construction projects, which can ensure the creation of positive local economic development through anything from local hiring of construction workers to community-based hiring in ongoing operations, or adherence to high environmental performance standards in construction practices or other designated public protections.

Project Labor Agreements are another tool for creating strong economic development outcomes from such public investments. These agreements involve negotiating labor agreements in advance of awarding contracts to ensure they include provisions for living

wages and benefits in return for no-strike provisions, and no lockout agreements—all of which can ensure projects are completed on time and on budget. Project Labor Agreements could be particularly useful to ensure federal money spent on building a national clean-energy smart grid is deployed wisely and effectively, and that progress is made in building out a new national energy infrastructure rapidly and without delay.

Finally, when major clean energy infrastructure projects receive significant public funding, benefits can be realized not only through the direct economic impact of the initial investment, but also by helping to build stronger domestic manufacturing supply chains for the sourcing of component parts and raw materials, and by driving market transformation through demand for locally sourced raw materials, skilled labor, and advanced technology. In some state economic development programs, this has been explored by offering bonus credits through renewable energy standards or other policies and programs to projects that include local manufactured content or create local employment. Procurement policy can also be used to help spur demand for domestic content in source materials. Such measures must be designed carefully to ensure compliance with international trade laws. They also must avoid sending a signal that America seeks to disadvantage its global partners at a time when all countries around the globe are facing dramatic and interrelated economic challenges.

Framework for a national consensus

Putting together a plan for a bold national transformation that is consistent with federal, state, environmental, consumer, industry, and labor interests

Several key “small p” political issues that must be resolved in any policy to accelerate construction of a more robust national clean-energy smart grid include:

- Determining the respective roles of federal and state governments in the transmission-planning and project-certification process
- Identifying any rules or restrictions that may be needed to ensure that an expanded grid does not have unintended adverse environmental consequences
- Assuring that smart-grid policies advance consumer interests
- Incorporating labor-related policies that maximize the economic benefits of the policies to working families and the U.S. economy

In this section of the report we will consider each of these issues in turn. As we will demonstrate, the seeds of political compromise are not only achievable but significant and sustainable.

Multi-state planning alongside consolidated project certification and siting

In order to effectively expand the transmission grid to support growth of renewable energy penetration to at least 20 percent as outlined by the Bush Department of Energy, and ultimately to realize President Obama’s goal of 25 percent renewable electricity in our generation mix, it likely will be essential for the federal government to take a more proactive role in ensuring that key transmission planning, permitting, and construction are undertaken on a coordinated and timely basis. There are several possible models for such a more active federal role in project approval, including:

- Expansion of the applicability of recently enacted federal authority to provide for “backstop” transmission project authorizations under §216 of the Federal Power Act. This model retains state control of siting in the first instance, but would expand the range of situations in which the federal government could be asked to intervene if the state siting process breaks down.
- Creation of a “one-stop” federal project certification process, using §7 of the Natural Gas Act as a model. This approach would preempt parallel state law requirements, but

could be structured to include robust mandates for involvement of state authorities in planning and siting decision-making. Precedents for giving states a special role in the federal licensing process exist under § 10(j) of the Federal Power Act governing wildlife protection recommendations in hydropower licensing.

- Having the federal government build the needed transmission, expanding on the model of the Tennessee Valley Authority and the Power Marketing Administrations.

Each of these approaches, however, has drawbacks. The Federal Power Act, section 216, process is weak, new, and untested, and the limited experience to date suggests that it may not expedite transmission construction. The Natural Gas Act, section 7, approach may be of concern to the states, which have traditionally held the prerogatives to deal with transmission siting. The federal utility model may be of concern because it would require significant federal appropriations, and could displace private-sector investors willing to fill this need if the regulatory regime is workable.

This paper offers a possible compromise that would accelerate transmission construction through increased federal law authority consistent with the Natural Gas Act model, but clearly recognize the value of preserving a strong and appropriate state role over planning and siting decisions by providing states with the opportunity to take the lead in planning through the development of multi-state regional transmission authorities—and then give states a special role in a consolidated siting process.

In order to promote rapid development of sustainable transmission grid facilities capable of supporting the 20 percent-to-25 percent penetration of renewable energy, this compromise solution would encourage states to form new so-called Multi-State Transmission Authorities, or MTAs, on an interconnection-wide basis stretching across the two main divisions of our national electric grid, roughly east and west of the Rocky Mountains. These MTAs would assume authority for planning the development of an extra-high-voltage backbone system and the renewable-energy feeder lines needed to support much-increased renewable-energy generation throughout the entire region. This integrated planning process would lay out a road map for the development of a seamless and interoperable sustainable transmission grid.

The plan produced and maintained by the Multi-State Transmission Authority would designate new renewable energy feeder lines necessary for bringing new clean energy on line, as well as needed extra-high-voltage (345 KV or above) transmission line projects required to move more renewable energy from remote renewable-rich areas to load centers, known collectively as sustainable transmission grid, or STG, projects.

The MTA would adhere to an aggressive schedule and timeline, and would actively involve state and regional entities in all planning recommendations. Further, the MTA would build off of existing state and regional planning guidance where it exists, rather than recre-

ating this analysis from scratch. In the event that an MTA could not be successfully organized by the states within an interconnection with federal support and facilitation, or if an MTA fails to execute its planning functions in a timely manner, then planning authorities would revert to the federal government via the Federal Energy Regulatory Commission.

Through this compromise, federal law would direct a well-coordinated and robust regional planning process, to advance the national interest in building grid infrastructure for secure and reliable access to low-carbon energy. At the same time, this process would honor the detailed local knowledge and legitimate concerns of states that any planning be undertaken through a responsive and participatory process that allowed significant opportunities for stakeholders to shape implementation.

In addition, because it would provide a focused and centralized opportunity to consider the whole design of the grid network, it would allow advocates for particular interests—whether consumers, industry, or environmental concerns—to weigh in and influence the shape and impacts of the process on a more consistent and ultimately effective basis, rather than tracking multiple, disconnected planning and review processes around the country. Direct regional engagement with communities in the field also would be an important part of the due diligence of the MTA during any planning process.

This MTA approach can build on the strong existing examples and good planning work that has already been accomplished to date in several regions of the country. A good example is the agreement among Western states through their Renewable Energy Zone initiative within the Joint Coordinated System Plan process, which has brought together all the states in the western interconnection to collaboratively plan strategies for promoting renewable-energy deployment, new transmission siting, and the design of a far more integrated and coherent energy system. As envisioned here, such a process could form the foundation for establishing an MTA, allowing the federal government to partner with the states of a region, and delegate planning and siting authority to such a coordinated regional MTA or to the states within it to execute the collaboratively developed regional plan for the interconnection.

The Multi-State Transmission Authority process could further be charged with assessing the role that energy efficiency and distributed generation could play as strategic energy resources—to ensure that long-term electricity planning values the contributions of smart-grid investments, on-site renewable energy production, and energy demand management, on an equal footing with new power generation. Further, these MTAs could be charged with assessing opportunities to upgrade existing transmission lines, and to leverage existing rights-of-way to minimize the local impact of new facility construction determined essential for the national clean-energy smart grid.

Based on a thorough, participatory, and well-supported MTA planning process, a set of needed sustainable transmission grid projects could be identified. This set of projects would produce benefits for the entire regional interconnection, in terms of improved access to renewable generation, enhanced grid and generation efficiency, and improved

reliability and security. In turn, these regional bodies organizing development within each interconnection would build what amounted to a truly national clean-energy smart grid.

For new transmission projects identified as essential for expanded renewable energy generation in the interconnection-wide planning process, federal law would provide for a one-stop certification and siting process as is now done under the Natural Gas Act. Certificates would be issued by FERC, but the MTA-run planning process would establish the basis for determining need for the identified projects. State energy and environmental agencies would have special status in the certificate process to provide local-scale siting restrictions or conditions to be included in the certificate. Should FERC conclude that state-recommended conditions run counter to the national interest in building the national clean-energy grid identified in the plan, then it would be required to work with states to resolve any conflicts.

To support development of the projects specifically required for the sustainable transmission grids as identified in the MTA-generated plan, FERC would be charged with allocating the costs of those projects throughout the interconnection based on load. Broadly sharing the expense of these designated national clean-energy smart-grid investments across all ratepayers in an interconnection would be appropriate and defensible given the enhanced system benefits of a more robust and reliable transmission network, and the strong public purpose of transitioning rapidly to clean renewable energy to cut global-warming emissions.

This approach would ensure that ratepayers in one local area where new transmission investments were deemed necessary to better serve the entire interconnection, and by extension the national interest, would not be asked to pay a disproportionate share of the costs of these grid improvements simply because of their location.

In addition, the federal government could offer loans, loan guarantees, or grants for the incremental costs of “super-sizing” new transmission projects in order to accommodate future renewable energy generation, thereby underwriting the marginal cost of expanded clean-energy grid capacity. Likewise, federal grants, bonding authorities, or tax incentives could be used to encourage rapid technology deployment of the smart grid in regional electricity distribution networks in all regions of the country. Using federal resources to deploy smart-grid enhancements and implement renewable energy and energy efficiency measures—as was begun in the economic recovery package—will offer further benefits to states and regions as a result of this more robust and coordinated national clean-energy smart-grid effort.

Ensuring that the sustainable transmission grid is truly sustainable

Some environmental advocates are concerned that the development of a more robust transmission grid in the name of supporting increased use of renewable energy and improved efficiency could actually result in adverse environmental consequences for wildlife and sen-

Ratepayers in one area where new transmission investments are necessary to better serve the national interest would not be asked to pay a disproportionate share of the costs of these grid improvements simply because of their location.

sitive natural resources due to lack of care in the siting of new facilities. Of equal concern to environmentalists is the possible use of the expanded grid by more polluting generation sources, such as newly constructed coal-fired power plants, which are unable to manage their carbon emissions, or increased utilization of existing fossil fuel power plants in such a way that global warming emissions and other pollution actually increased.

These environmental interests are a key constituency for this type of transformative change, and their concerns must be addressed by any national grid policy. With respect to the siting of new transmission facilities, there must be no weakening or compromising of federal environmental requirements, standards, and safeguards as a result of a new plan to expand the coordination and speed for building a national clean-energy smart grid. This process can be reorganized, however, to speed decisions without biasing science-based results. Moreover, the planning process should take into account ongoing efforts to identify low-impact project corridors on government and private lands, and would allow for more systematic and earlier identification of areas of concern that should be avoided.

In addition, state agencies would maintain a direct and binding influence over siting decisions through their new authority to provide recommended certificate restrictions or conditions on local-scale siting issues in order to mitigate the impacts of any new grid construction. The clear link between these grid investments and renewable energy benefits could further be established in several ways:

First, as a political matter, enactment of new federal powers to drive grid investments could be directly tied to enactment of an aggressive national Renewable Portfolio Standard. This law would set a binding target for a set percentage of all electricity produced in the nation to come from renewable sources for any given year. Such a law would guarantee that a significant portion of new electricity generation development would be from green sources. While it is clearly not essential for transmission policy to be linked to an RPS, if these policies were developed in tandem in the coming Congress, it would provide consumers and advocates with certainty about the level of clean energy penetrating national supplies.

Second, under the sustainable transmission grid process envisioned here, the principal motive for federal planning, siting, and cost allocation provisions is to facilitate renewable generators to get their power to market. The planning process is designed to identify only those renewable feeder lines and extra-high-voltage backbone transmission facilities that would be needed to facilitate the movement of clean energy to load centers, while increasing the security and reliability of the grid. The centrality of this concern in the planning process also offers further protection that acceptable environmental outcomes will be achieved through this policy.

Third, in recognition of the constraint that financing requirements currently place on new renewable generation, this proposed approach would direct FERC to provide renewable generation project developers with long-term transmission rights to support their projects.

The certainty of access to uptake on transmission lines for new renewable projects on this new clean-energy smart-grid infrastructure would be very important in improving access to capital, and ensuring construction of new clean-energy projects.

Fourth, emission-based limitations could be included in this policy, shaping the emissions profile of any generation facilities that would be allowed to interconnect to the new sustainable transition grid facilities. For instance, interconnection to new renewable feeder lines could be limited to new generation facilities with greenhouse gas emission rates no higher than that of a new simple cycle gas-fired generation plant, a likely type of peaking unit that might be installed in parallel with wind generation in order to firm up intermittent production.

Together these policies would ensure strong guarantees that environmental purposes will be advanced as new clean-energy transmission is brought on line. In addition, thoughtful consultation and input to this process on the issue of traditional fossil-fuel power generation and nuclear power plants indicates that as we ramp up clean-energy generation (including carbon capture-and-storage technologies for coal-fired power plants), environmental advocates will share many common goals with utilities and energy developers—suggesting that realistic and clear-eyed compromises can help expedite needed transmission development in a way that is environmentally sound.

In addition, a federal Renewable Portfolio Standard, Renewable Energy Standard and Energy Efficiency Resource Standard, all of which are likely to be included in a comprehensive energy or climate bill along with enhanced research, development, and deployment funding for clean technology, will provide further security that strong standards accompany a renewed commitment to rebuilding our energy infrastructure. Each of these is a significant additional policy tool that can be advanced in parallel to grid modernization efforts to provide stronger assurances of improved environmental performance and the ultimate success of the national clean-energy smart grid.

The impact of smart-grid information technology and demand management on global warming

The emergence of smart-grid technologies and demand response capabilities to better manage consumer use of power has led to a new understanding about the relationship of information technology-based energy management tools in helping reverse climate change. Smart-grid technologies can do this by increasing energy efficiency and the use of renewable energy—the accepted, low-cost cornerstones of climate change mitigation—as well as through more efficient utilization of our existing fleet of fossil fuel power plants, and by helping to support the effective administration of climate-change policy and regulation.

Demand response capabilities dynamically reduce strains on the grid during peak periods but in almost all cases produce a “conservation effect” that lowers overall electricity consumption. That happens because demand for power that is reduced at the peak of use is not replaced in the off-peak period. This total reduction in overall energy use averages around 4 percent, but can range upward of 11 percent.

Moreover, the information feedback and price signals that demand response regulatory policies and enabling technologies provide have also been shown to lead consumers to become more energy-efficient overall in their use of electricity—simply due to the so-called “Prius effect” (named after the fuel-sipping hybrid Prius made by Toyota, which offers real-time readouts of the vehicle’s current fuel economy to the driver) of incorporating information feedbacks into a consumer’s future actions. Thus, the deployment of smart-grid technologies can lead to higher and more sustainable levels of energy efficiency and lower greenhouse gas emissions, as well as consumer cost savings. A smart meter is a green meter in that it can serve as a platform for a new era of greater overall energy efficiency.

Demand response capabilities also can enable greater use of renewable energy. Many renewable energy resources are intermittent. Demand response technologies are specifically designed to manage and reduce demand during peak periods, including via dynamic energy storage in battery banks that can store excess renewable electricity during times of high generation for use at a later time, making it an ideal complement to wind and other intermittent resources and allowing it to help support the increased deployment of renewable energy. These demand response technologies also can serve to meet unexpected needs on the grid when renewable resources that are normally available suddenly become unavailable. This was the case in Texas in March 2008, when an expected contribution from wind suddenly was not available and demand response was dispatched to prevent a large-scale blackout.

Smart-grid technology deployment that works for consumers

A critical element of this proposal is the integration of interstate transmission policy with improved incentives for deployment of smart-grid technology within local and regional energy systems. Just as the new national grid must be designed to maximize the flow of clean renewable energy into the system, so must the overall electricity system be optimized for deploying advanced information technology to improve efficiency, demand response, and integration of distributed renewable electricity generation in homes and businesses. Smart-grid technologies are key enablers for managing demand, improving grid performance, optimizing the delivery of existing and future utility services to customers, and dramatically improving the ability of customers to take advantage of energy efficiency and distributed generation to control their own energy use and better manage their electricity bills.

Because distribution networks are operated locally and regulated at the state level, and because part of the idea of the smart grid is for electricity users to be a dynamic resource

Demand response technologies are designed to manage and reduce demand during peak periods, including via dynamic energy storage in battery banks that can store excess renewable electricity during times of high generation for use at a later time.

to the grid, a separate set of policy actions are necessary to create an end-to-end clean-energy smart grid. As part of any compromise between federal and state authorities in establishing an enhanced federal role driving development of the sustainable transmission grid, the federal government should be accountable to provide substantial financial assistance with the costs of deploying new smart-grid technology, as well as enhanced investment in energy-efficiency retrofits that incorporate demand response technologies and other smart-grid hardware and software.

This federal financing role should include providing tax incentives, bonding authority, and direct federal investments for deployment of a suite of new smart-grid tools, including smart meters and related information-, communications- and control-technology networks. Importantly, this federal support will reduce the costs borne by ratepayers for adoption of these innovations, and will help make ratepayers “whole” with any new energy price impacts that may come from potential climate regulation, and thus help build buy-in from affected interest groups.

Incentives should include federal funding for:

- Smart-grid technology deployment grants to implement technology across the whole grid
- An investment tax credit of 30 percent or more for smart meters and other smart-grid technology
- Accelerated depreciation for smart-grid investments.
- Demonstration projects making concentrated investments in smart metering and advanced distribution technology

In addition, as a separate measure, federal funding for a next generation of home energy efficiency retrofits, distributed renewable energy generation, and adoption of new building energy codes—where the new dynamic smart-grid-enabled options for energy management are incorporated—should be dramatically increased.

Federal financial assistance for implementing smart-grid technology also could be linked to state adoption of best practices in utility regulation that promote an aggressive commitment to energy efficiency, demand response and renewable energy. This can either be done as a requirement attached to federal funding, or through an incentive structure of enhanced public support. These state policies could include: availability of time-of-use rates for customers who choose them, decoupling of utility revenues from their sales, minimum net metering requirements, energy-efficiency performance standards for utilities, and simplified interconnection standards for distributed renewable generation.

Recognizing that state regulators have limited resources to undertake such initiatives, funding and technical assistance should be made available to regulatory bodies and governors to ensure that they have the resources to adequately execute the tasks they will be asked to perform.

The national clean-energy smart grid and good jobs

A national commitment to upgrading the energy infrastructure that drives productivity across our economy will have very significant direct job creation benefits, as America's workers are called upon to do the skilled labor of building, operating, and maintaining an advanced grid, new renewable energy generation, and retrofitting communities for energy efficiency. In addition to stimulating new job creation, a unifying American project to rebuild for a clean-energy economy creates tremendous opportunities for training, not only to improve the skills of workers already in professions with good jobs and wages, but to bring in those who most need the work, through apprenticeship and pre-apprenticeship programs that help reconnect those who have been shut out of the system to good jobs with decent wages.

Lastly, as we bring new demand on line for new construction, advanced manufacturing, and skilled service jobs through out the clean-energy supply chain, we can connect this work to standards for wages, benefits, local hiring, and domestic production that will help turn a green economy into a stronger middle-class economy that broadly shares our newfound prosperity. Connecting these pieces through intentional policy choices will create better employment outcomes and broaden the base of support for clean energy policies moving forward, helping to show workers in today's economy how they can participate in the coming low-carbon economy, bringing the best of their skills and capacities to the task of rebuilding America.

Conclusion

Viewing the national clean-energy smart grid in its entirety—from the generation of new clean renewable energy to more efficient use by consumers in their homes and offices—reveals an incredible potential to design a new strategy that optimizes the benefits of the whole system for the good of the American people. This view is instructive of the opportunity to both get the policy right to protect our global climate, and to at the same time build new political alliances to rebuild our infrastructure to that end.

This examination further reveals the needs and responsibilities of state and federal policymakers and stakeholders to weigh the national issues at stake in this debate and then strike a balance over how to build and maintain this new energy grid. The proposals outlined in this paper seek to strike that balance by establishing a new federally backed legislative policy framework for planning, siting and recovering the costs of sustainable transmission grid facilities while delegating planning responsibilities to new multi-state interconnection-wide authorities.

Our proposal provides federal financial support to states, utilities, and consumers, as the country moves to construct a truly national smart grid. Our proposal would provide substantial support of smart distribution grid investments, as well as financial and technical assistance to state bodies and others, to allow for the speedy consideration and adoption of new smart transmission policies and new technology deployment.

On the environmental front, the proposed compromise seeks to identify those transmission facilities that are needed to support a massive infusion of new renewable energy generation into our national energy supply, and get these projects built efficiently and sensitively to local concerns. The more robust and comprehensive planning process provided in this vision for building a sustainable transmission grid offers a forum for more systematically flagging and protecting sensitive areas, while robustly incorporating efficiency and on-site renewable energy into utility and transmission planning.

A special role for states in recommending siting-related conditions for sustainable transmission grid project approvals would assure sensitivity to local resource protection. Emissions-related interconnection standards also reinforce the clean-energy purposes of these reforms. Substantial federal investment in distribution, metering and end-use smart-grid measures will support important energy efficiency and distributed renewable generation benefits.

Finally, approaching all of these energy policies through the lens of economic recovery and reconstruction, as a form of smart and sustainable economic development, can help realize the very substantial opportunity to create good green jobs today, as we rebuild our energy system. Policies that shape the labor standards, wages, and training opportunities, and that build strong domestic supply chains for new manufactured goods, are a critical component in this strategy for rebuilding our economy to create good jobs and a broadly shared prosperity, on the foundation of clean low-carbon energy.

America stands at a crossroads. Our economy, our environment, and our national security will be profoundly affected by the investment choices we make in coming years. Establishing a powerful national commitment to plan for a clean-energy economy and to build the supporting infrastructure that will be required to reach this goal offers a compelling opportunity to strengthen our economy and ensure the enduring wealth and welfare of future generations. We have faced similar challenges before, and with vision we can now roll up our sleeves and begin again, to rebuild our energy system to create good green jobs, new markets, and strong and healthy communities. This is the promise of a national clean-energy smart grid.

Glossary of terms

Energy Efficiency Resource Standard: EERS is a market-based mechanism to encourage more efficient generation, transmission, and use of electricity and natural gas. An EERS consists of electric and/or gas energy savings targets for utilities, often with flexibility to achieve the target through a market-based trading system. All EERSs include end-user energy saving improvements that are aided and documented by utilities or other program operators. Sometimes distribution system efficiency improvements and combined heat-and-power systems and other high-efficiency distributed generation systems are included as well. EERSs are typically implemented at the state level but can also be implemented over smaller or wider areas.”¹¹

Federal Energy Regulatory Commission: FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to build liquefied natural gas terminals and interstate natural gas pipelines as well as licenses hydropower projects.”¹²

Federal Power Act: This statute provides for regulation of the wholesale sales of electricity and transmission in interstate commerce by the Federal Energy Regulatory Commission.

Power Marketing Administrations: PMAs are an outgrowth of the federal power marketing program that began in the early 1900s when power produced at federal water projects in excess of project needs was sold in order to repay the government’s investment in the projects. PMAs market this power in

such a manner as to encourage the most widespread use at the lowest possible rates to consumers, consistent with sound business principles. Each of the four power marketing administrations [Bonneville, Southeastern, Southwestern, and Western Area] is a distinct and self-contained entity within the Department of Energy, much like a wholly owned subsidiary of a corporation.”¹³

Greenhouse gases: Those gases, such as water vapor, carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, that are transparent to solar (short-wave) radiation but opaque to long-wave (infrared) radiation, thus preventing long-wave radiant energy from leaving Earth’s atmosphere. The net effect is a trapping of absorbed radiation and a tendency to warm the planet’s surface.”¹⁴

Independent System Operators: ISO’s are organizations formed at the recommendation of FERC to coordinate, control, and monitor the operation of the electrical power system usually within a single U.S. state, but sometimes in multiple states. Regional Transmission Operators are similar entities that operate over wider areas, crossing state borders. There are currently eight ISO’s and four RTO’s operating in North America.

Joint Coordinated System Plan: The purpose of the JCSP exploratory study is to identify conceptual transmission overlays that would support two possible futures: a Reference Future and a 20-percent Wind Future. This study investigates the conceptual

overlays to interconnect and deliver the output of projected new generation including existing renewable mandates and up to a higher 20 percent wind penetration level across the Eastern Interconnect.¹⁵

Multi-State Transmission Authorities: MSTAs are agencies that would “assume authority for planning of a high-voltage backbone system and the renewable energy feeder lines needed to support the increased renewable energy generation throughout the entire region.”¹⁶

Natural Gas Act of 1938: This federal statute “gave the Federal Power Commission (subsequently the Federal Energy Regulatory Commission) the authority to set ‘just and reasonable rates’ for the transmission or sale of natural gas in interstate commerce. It also gave FPC the authority to grant certificates allowing construction and operation of facilities used in interstate gas transmission and authorizing the provision of services.”¹⁷

Negawatt: A term coined by Amory Lovins to describe energy saved through conservation and efficiency as an alternative to building new generation and transmission capacity.¹⁸

Regional Transmission Organization: RTOs administer the transmission grid on a regional basis. There are currently seven RTOs in the United States.¹⁹

Renewable Energy: Any energy resource that is naturally regenerated over a short time scale and derived directly from the sun (such as thermal, photochemical, and photoelectric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or

from other natural movements and mechanisms of the environment (such as geothermal and tidal energy). Renewable energy does not include energy resources derived from fossil fuels, waste products from fossil sources, or waste products from inorganic sources.²⁰

Renewable Energy Zones: Areas with high quality, developable renewable resources, [able to support] the development and delivery of electricity generated by renewable energy.²¹

Renewable Portfolio Standard/Renewable Energy Standard: RPS/RES policies require utilities to use renewable energy or renewable energy credits to account for a certain percentage of their retail electricity sales—or a certain amount of generating capacity—within a specified timeframe.²²

Smart Grid: The Modern Grid Strategy project of the National Energy Technology Laboratory has identified the following characteristics or performance features of a smart grid: “Self-healing from power disturbance events; enabling active participation by consumers in demand response; operating resiliently against physical and cyber attack; providing power quality for 21st century needs; accommodating all generation and storage options; enabling new products, services, and markets; optimizing assets and operating efficiently.”²³

Smart Meter: A “smart meter” system is comprised of a digital meter outfitted with a communications link that can measure energy consumption in real time and communicate this data to consumers and the utility in order to better inform demand-side management.²⁴

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