Center for American Progress

WIKIPEDIA/AATU LIMATTA

VERSION 1.0

Wired for Progress

Building a National Clean-Energy Smart Grid

Bracken Hendricks February 2009

Center for American Progress

VERSION 1.0

Wired for Progress

Building a National Clean-Energy Smart Grid

Bracken Hendricks February 2009

Contents

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 Oil 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 CO_2 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 biofuels. 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.

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

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.

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.

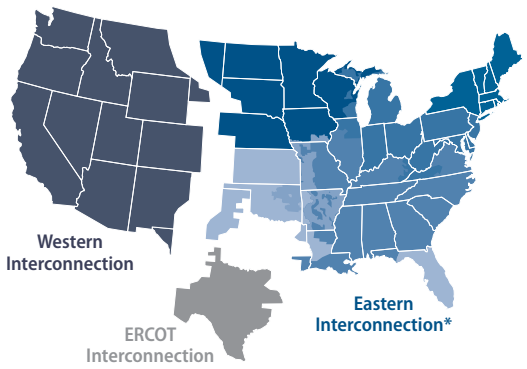
An integrated, IT-enabled, national electrical grid is essential for improving security and reliability, but it is especially critical for bringing higher percentages of renewable electricity into our energy mix due to the variable nature of many of these resources. New information technology like advanced 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.

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

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.

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.

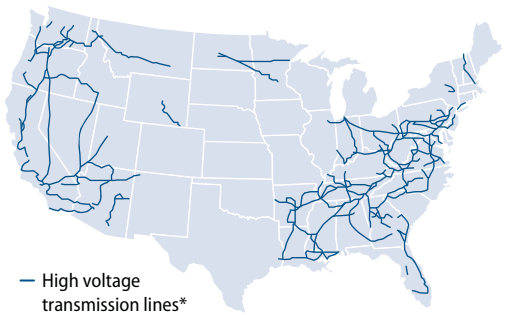
The policy questions we take on here are complex and have been contentious. In matters involving large construction projects such as the building of power plants or transmission lines, there is often controversy. It might involve fundamental questions about the need for a project, or concerns about siting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

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.

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-

sures, 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

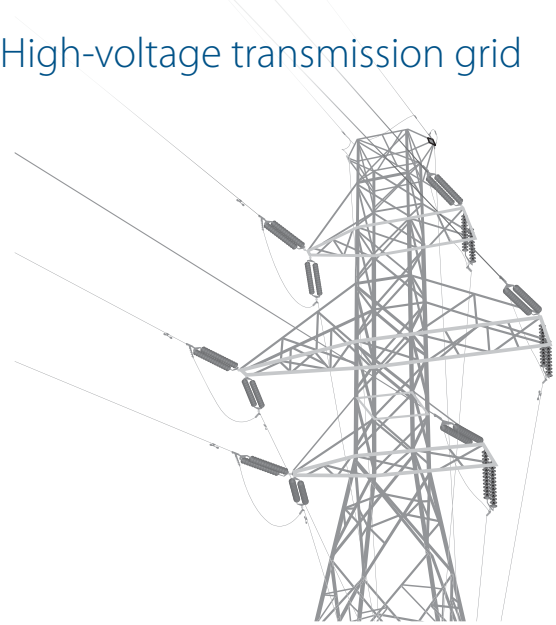
Why it's Smart

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



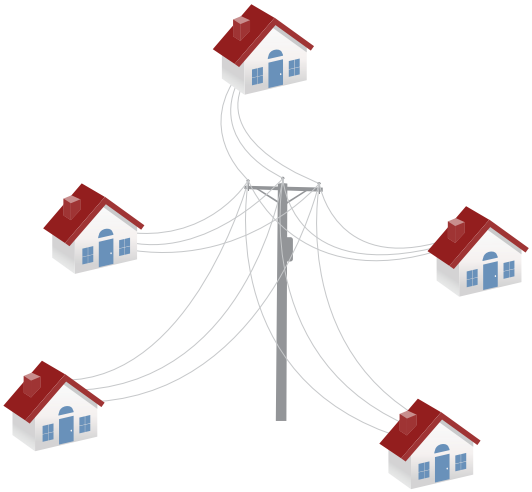
Why it's Smart

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



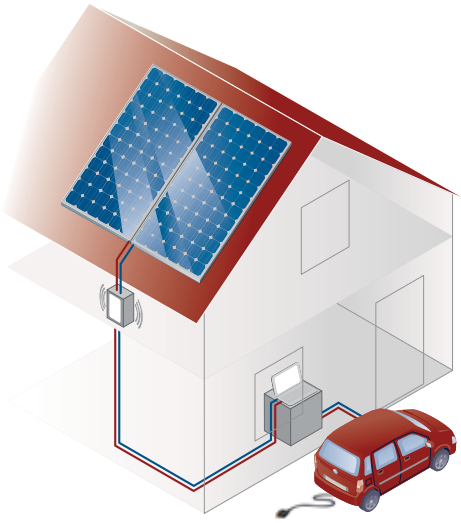
Why it's Smart

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.

The Center for American Progress is a nonpartisan research and educational institute dedicated to promoting a strong, just and free America that ensures opportunity for all. We believe that Americans are bound together by a common commitment to these values and we aspire to ensure that our national policies reflect these values. We work to find progressive and pragmatic solutions to significant domestic and international problems and develop policy proposals that foster a government that is "of the people, by the people, and for the people."

1333 H STREET, NW, 10TH FLOOR, WASHINGTON, DC 20005 • TEL: 202-682-1611 • FAX: 202-682-1867 • WWW.AMERICANPROGRESS.ORG