Center for American Progress

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A Clean Energy Action Plan for the United States

By Luke H. Bassett, Myriam Alexander-Kearns, and Jerusalem Demsas

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Introduction and summary

After years of concerted effort to advance climate and clean energy policies, the United States has started on the path to a low-carbon economy. Several developments have fundamentally shifted the nation's energy outlook: falling technology costs; forward-leaning policies enacted by federal, state, local, and tribal governments; investments in new infrastructure; advances in energy efficiency and renewable energy research and development; and a newly minted international agreement to tackle climate change. The projected trajectory of U.S. greenhouse gas emissions has flattened, demonstrating to the United States and the world that pollution can be cut in the context of economic growth. To achieve a low-carbon economy, however, the United States must stay on this pathway for decades to come, something that can be assured only through continued effort.

The next president and Congress must build on this foundational set of policies and capitalize on the available suite of clean energy technologies. Investments made in energy infrastructure today will have carbon consequences tomorrow. If care is not taken to foster low-carbon options, support them financially, and remove barriers to their deployment, future policymakers might have even bigger challenges than they do now. These considerations call for a policymaking strategy that continues to advance the United States on the path toward deep emissions reductions by midcentury. The political and business case for deploying energy efficiency and renewable energy technologies has gained traction across the country.[1]

This report proposes policy recommendations that promote the three elements of decarbonization—energy efficiency, low-carbon electricity generation, and the electrification of end uses—and that address their integration, financing, and implementation at the federal level.[2] It examines specific policy actions that a new administration and Congress can take in the short term to expedite deployment of renewable energy and energy efficiency technologies. This is just one part of an overall climate mitigation strategy U.S. leaders will need to employ to meet the nation's long-term carbon pollution reduction targets.

By instituting these recommendations, the next president and Congress will accelerate the transformation of the electric power sector into the low-carbon engine of the U.S. economy. Because the deployment and integration of energy efficiency and renewable energy technologies in electricity generation and end uses create the foundation for further carbon emissions reductions in other sectors, the electric power sector is a crucial area in which policymaking can guide current momentum forward.[3]

Indeed, the risks posed by inaction on climate change have never been clearer, and the momentum to act has never been greater. These factors provide the next president and Congress with advantages no previous U.S. government has had: a clear need to act, bolstered by international agreement and demonstrated tools for successful action. But the next president and Congress will also face unprecedented pressures. With a proven scientific need for more ambitious pollution reductions, strengthening but still emerging clean energy supply chains, and greater domestic action necessary to lead the international community, U.S. policy leaders will need to act quickly and decisively. The next president and Congress should consider the recommendations in this report to champion a Clean Energy Action Plan that utilizes federal authorities and funding while encouraging states to act constructively and ambitiously. By moving forward with such a plan, the next president and Congress can transform current clean energy trends into realized pathways toward a low-carbon economy in the United States.

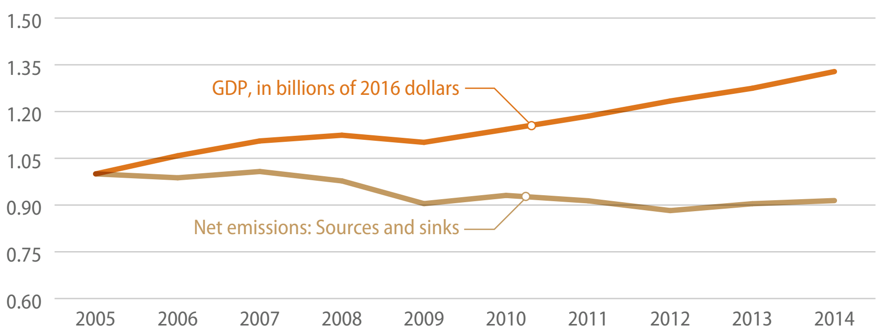
Building on eight years of clean energy growth

Over the past eight years, the United States has made significant progress in addressing climate change. Domestic greenhouse gas emissions trends have declined while the U.S. economy has grown.[4] (see Figure 1) The costs of renewable energy and energy efficiency technologies—such as wind turbines, solar photovoltaic, or PV, systems, LED bulbs, and electric vehicle, or EV, batteries—have fallen, and deployment rates for those technologies have risen.[5] Global investment in energy efficiency and renewable energy technologies has continued to grow in the face of low fossil fuel prices, with 2015 claiming a record $285.9 billion in investment, up 5 percent from 2014.[6] Public concern for climate change has also grown, with 38 percent of Americans perceiving that global warming is currently harming people in the United States, up 6 percentage points in the past year.[7] These metrics are among many that indicate that decades of scientific research, policymaking, and investments in the low-carbon economy and the fight against climate change are shifting the course for the better.

FIGURE 1

The U.S. economy has grown while carbon emissions have fallen

U.S. greenhouse gas emissions and GDP from 2005 to 2014,
by million metric tons carbon dioxide equivalent and billion dollars



Sources: U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks:* 1990-2014 (2016), available at https://www3.epa.gov/climatechange/ghgemissions/usinventoryreport.html; Bureau of Economic Analysis, Current Dollar and 'Real' Gross Domestic Product (U.S. Department of Commerce, 2016), available at http://bea.gov/national/xls/gdplev.xls.

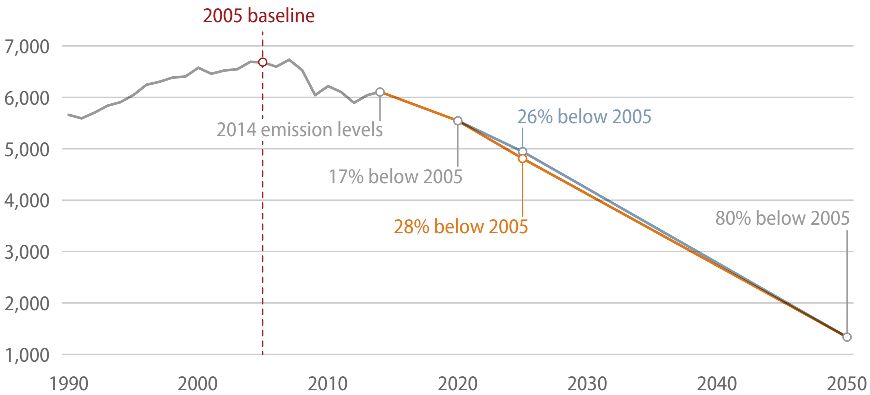
The effects of a changing climate have also appeared with increasing frequency and intensity, at times in devastating ways.[8] In 2015 alone, 10 U.S. weather and climate events exceeded $1 billion in losses, and the trend of record-breaking global high temperatures has continued.[9] The body of science about the changing climate and its potential effects on society and ecosystems continues to grow, and consensus among the scientific community regarding its human causes has solidified.[10]

Against this backdrop of increasing risks, public concern, and scientific clarity, President Barack Obama has taken strong actions to tackle climate change: He instituted a broad set of executive actions in his Climate Action Plan, invested more than $90 billion in clean energy and related technologies through the American Recovery and Reinvestment Act of 2009, introduced the first-ever standards for carbon pollution from existing power plants, and worked with other world leaders to forge the Paris Agreement.[11] These actions have charted a new path toward the Paris Agreement commitments to keep the global average temperature from increasing more than 2 degrees Celsius, including President Obama's emissions reduction targets of 17 percent by 2020 and 26 percent to 28 percent by 2025 below 2005 levels.[12]

FIGURE 2

Emissions milestones on the U.S. pathway to deep decarbonization

U.S. historic and projected greenhouse gas emissions from 1990 to 2050, by million metric tons carbon dioxide equivalent



Sources: U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks:* 1990-2014 (2016), available at https://www3.epa.gov/climatechange/ghgemissions/usinventoryreport.html; United Nations Framework Convention on Climate Change, "Cover Note INDC and Accompanying Information," available at http://www4.unfccc.int/submissions/INDC/Published Documents/United States of America/1/U.S. Cover Note INDC and Accompanying Information.pdf (last accessed July 2016).

At the end of President Obama's second term, some of the key initiatives in the Climate Action Plan will require further action. The U.S. Environmental Protection Agency's, or EPA's, Clean Power Plan will remain in the courts, and the next president will have to act to bring the 2020 and 2025 international goals to fruition.[13] At the same time, if every nation meets their pledges under the Paris Agreement, global warming will still exceed the agreed-upon goal of 2 degrees Celsius.[14] Therefore, the next president will need to continue efforts begun under the Obama administration and take additional actions in order to reduce emissions further beyond 2025.[15] (see Figure 2)

Shaping a strategy for the next four years that seizes current opportunities

Clean energy and emissions trends over the past eight years indicate that the United States has moved onto a low-carbon pathway, but these trends illustrate only the beginning of the journey. Despite record growth in renewable energy, for example, it makes up only about 10 percent of overall U.S. electricity generation capacity.[16] The next four years will shape whether and how the nation continues on its low-carbon pathway.

Taking pathways to a low-carbon economy

The U.S. energy system is made up of a continent-spanning network of diverse energy resources, infrastructure, and end-use technologies that, together, currently rely on burning fossil fuels.[17] Several energy system scenarios—developed by a range of nonprofit organizations, research universities, government research agencies, and international agencies—illustrate the roles that different technologies could play in reaching long-term U.S. emissions reduction goals. They also depict the mix of technologies needed, from greatly increased renewable energy generation to investment in carbon capture and sequestration and/or nuclear energy. Each scenario's technology mix indicates the technological, economic, and policy tradeoffs that any particular pathway entails. More importantly, the commonalities of these scenarios point to the need for bold and immediate improvement of energy efficiency and the deployment of renewable energy technologies at aggressive rates, similar to those seen in the past build-out of the existing global energy system.[18]

Decision-makers should use these decarbonization pathways as tools to weigh the long-term benefits and risks of investment and policy decisions—particularly the risk of paying for new infrastructure, which commits to a certain level of emissions for years to come.[19] The options within these pathways may enable more flexibility as continued research, development, and demonstration projects, or RD&D,

further lower the costs of key technologies. They may also yield more adaptive regional policy responses.[20] Additionally, building a low-carbon economy requires recognizing the energy system benefits, costs, and interdependencies beyond the power sector—including transportation and industrial emissions, water and land use, and the application of information and communication technologies.[21] Factoring long-term thinking and decarbonization goals into decision-making across sectors is paramount.

Investing in energy efficiency and renewable energy

Each part of the U.S. energy system has benefited from public and private investment and federal, state, local, and tribal policymaking at various stages. Federal investment in RD&D has advanced energy efficiency and renewable energy technologies for several decades.[22] More recently, the U.S. Department of Energy, or DOE, and other federal agencies have addressed finance gaps in pilot and demonstration projects and encouraged technology deployment through procurement, grants, challenges, and other resources.[23] These investments have yielded increasingly cost-competitive commercial products such as onshore wind turbines and solar PV systems, among others. However, financial, policy, technical, and consumer barriers may continue to hinder deployment.[24] Frequently with energy technologies, the high capital costs and longer times required to innovate or see return on investments lower investors' risk tolerance. As a result, the different phases of RD&D and commercialization attract very different investor types—from government-supported basic research to private-sector-backed loans or equity for more proven technologies entering the market.[25]

Similarly, RD&D and deployment stages call for different policy interventions, a factor further complicated by differences among jurisdictions governing the energy system. The deployment costs for these technologies often include so-called soft costs such as permitting, construction, installation, or other costs that inhibit or slow down decision-making, business development, or other aspects of turning on energy efficiency or renewable energy installations.[26] The next president and Congress will have a role in supporting policy interventions and government investments that connect these stages and deploy energy efficiency and renewable energy technologies more quickly and with greater rates of adoption.[27] Fortunately, recent gains made in RD&D, technology cost reduction, policy implementation, and political consensus provide the next president and Congress a strong foundation for action.

Investing in clean energy as existing infrastructure is retired

In recent years, the costs of several energy efficiency and renewable energy technologies have become competitive with conventional technologies in many U.S. markets. According to the DOE, onshore wind generation; utility-scale and distributed solar PV generation; LEDs; and EV batteries have all experienced dramatic cost declines. In each case, direct RD&D investments and loan guarantees, policy incentives such as tax credits, and policy goals such as renewable portfolio standards have attracted industries and consumers to install these alternatives.[28]

New records for low renewable energy prices are appearing more and more frequently. In 2015, for example, Nevada utility NV Energy signed a record-low $0.0387 per kilowatt-hour rate for electricity generated by a First Solar utility-scale solar PV installation. This is down nearly 72 percent from the utility's 2014 average electricity purchase rate.[29] The increasingly competitive prices for renewable energy technologies and the electricity they generate represent encouraging shifts in the U.S. electric power sector.

In the coming decade, utilities, investors, and policymakers will have important opportunities to replace components of the U.S. electric power sector as they age and are retired. In the past century, coal-burning power plants constructed more than 35 years ago made up the majority of U.S. fossil fuel power capacity, but due to the dramatic decline in natural gas prices in the past decade, that trend has shifted to building new natural gas-fired capacity.[30] As utilities, regulators, and others plan for systemic changes to infrastructure investment, operation, and integration over the next several years, the falling costs of renewable generation and the increasing importance of energy efficiency will provide attractive alternatives to new fossil fuel generation. Indeed, over the past five-year period, more renewable energy generation—wind and solar together—has been deployed than new natural gas-fired generation.[31]

Energy infrastructure turnover

Unlike infrastructure constructed largely by public investment—such as interstate highways—energy infrastructure is often deployed through private investment, spurred by regulatory clarity and encouraged by government incentives. Sufficient private capital is available to deploy the next generation of energy infrastructure as long as there are clear signals that the nation will, from a policy standpoint, stay on a low-carbon pathway. The importance of these policy signals and incentives cannot be overstated.

Despite the encouraging signs of falling costs, barriers to clean energy deployment remain, including the relatively long lifetime of energy infrastructure—a sizable time constraint given the considerably shorter timeframe needed to decarbonize the economy. This requires careful consideration of new infrastructure's committed emissions, or the estimated cumulative carbon emissions from energy infrastructure over the course of its lifetime.[32] The lifetimes of infrastructure—from power plants to houses or office buildings—will likely turn over only once between now and 2050. (see Table 1) Thus, each new investment and policy decision must consider the committed emissions of new energy infrastructure.

TABLE 1

Turnover rates for electricity technologies

Estimated lifespan, by years

Generation infrastructure	Estimated lifespan
Coal	40
Natural gas combined cycle	20
Nuclear	40
Wind	20
Rooftop solar PV	20
Utility-scale solar PV	30
Geothermal	25
End-use infrastructure	
Residential buildings	70
Large office buildings	65
Central forced-air furnaces	25
Central air conditioners	21
Gas water heaters	14
Electric water heaters	22
Clothes dryers	20
Refrigerators	26
Passenger cars and light trucks	11.4
Incandescent light bulbs	0.23
Compact fluorescent light, or CFL, bulbs	1.14
LEDs	5.71

Sources: Authors' data on coal, natural gas combined cycle, nuclear, wind, rooftop solar PV, utility scale solar PV, geothermal from Lazard, "Lazard's Levelized Cost of Energy Analysis—Version 9.0" (2015), available at https://www.lazard.com/media/2390/lazards-levelized-cost-of-energy-analysis-90.pdf; data on residential buildings from U.S. Department of Energy, *Windows and Building Envelope Research and Development: Roadmap for Emerging Technologies* (2014), available at http://energy.gov/sites/prod/files/2014/02/f8/BTO_windows_and_envelope_report_3.pdf; Data on large office buildings from Energy Information Administration, *Commercial Demand Module* (U.S. Department of Energy, 2015), available at http://www.eia.gov/forecasts/aeo/assumptions/pdf/commercial.pdf; Data on central forced-air furnaces, central air conditioners, gas water heaters, electric water heaters, clothes dryers, and refrigerators from Energy Information Administration,"Residential Demand Module" (U.S. Department of Energy, 2015), available at http://www.eia.gov/forecasts/aeo/assumptions/pdf/residential.pdf; Data on passenger cars and light trucks from U.S. Department of Transportation, "Table 1-26: Average Age of Automobiles and Trucks in Operation in the United States," available at http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_26.html_mfd (last accessed August 2016); Data on lighting from U.S. Department of Energy, *Lifetime of White LEDs* (2009),available at https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/lifetime_white_leds.pdf.

Cementing the health benefits and business opportunities that clean energy provides

The move toward a lower-carbon electricity sector provides significant health and economic benefits for American families and businesses. Expanding clean electricity generation will protect the country from the worsening effects of climate change and air pollution—which disproportionately affect children, elders, low-income communities, and individuals with heart disease or lung disease.[33] Increased asthma attacks are just one of the projected health effects of climate change.[34] The EPA estimates that its Clean Power Plan will prevent 90,000 asthma attacks in children and avoid 1,500 to 3,600 premature deaths in 2030 by lowering emissions from existing fossil fuel generation.[35]

Growth in the clean energy sector is also creating jobs. In the second quarter of 2015, nearly 1.9 million Americans worked in jobs directly related to energy efficiency technologies, primarily heating and cooling, lighting, appliances, and other building materials and systems.[36] According to the DOE, in the same quarter, U.S. wind generation firms employed 77,000 people.[37] In 2015—for the third consecutive year—the U.S. solar industry grew more than 20 percent, increasing to nearly 209,000 workers.[38] The DOE also reports that, in 2015, the U.S. solar industry employed significant numbers of women, at 24 percent; minorities, at 26 percent; and veterans, at 8 percent. Storage and smart grid technology firms in the United States employed approximately 40,000 workers in the second quarter of 2015.[39] Whether in whole numbers, trends, or broken down by demographic, clean energy jobs are a vital and growing part of the U.S. economy.

Policy recommendations for the next administration and Congress

The next president and Congress should seize current opportunities for energy efficiency and renewable energy growth and the health and economic benefits they deliver by launching a Clean Energy Action Plan. This plan should build on current climate policies and successful investments by incorporating energy efficiency into planning and policymaking as a step to achieve cost savings for all Americans; increasing deployment of energy efficiency and renewable energy technologies, especially in states with currently low adoption rates; strengthening efforts to integrate these new technologies into the U.S. energy system; and creating incentives for electrification. The plan also points to the need to consider and implement solutions for financing to aid the deployment of energy efficiency and renewable energy technologies, as well as to strengthen leadership and coordination from the White House and federal government to achieve these goals.

Strengthening energy efficiency as a foundation for action

The Clean Energy Action Plan should strive to increase the nation's energy efficiency across the board. Increasing energy efficiency enables households, businesses, and industries to use less energy from products such as furnaces and light bulbs while obtaining the same services such as space heating or lighting; in doing so, efficiency can reduce consumers' electricity bills and cut carbon emissions. Current energy use in residential and commercial buildings makes up more than 38 percent of all U.S. energy use and related carbon emissions, with the majority of that energy going to space conditioning, lighting, water heating, and refrigeration.[40] On a national scale, such improvements add up greatly—as evidenced in the 58 percent growth of U.S. energy productivity, defined as economic output per unit of energy, from 1990 to 2015.[41] The nonprofit American Council for an Energy-Efficient Economy, or ACEEE, estimates that efficiency was responsible for 60 percent of this energy productivity increase from 1980 to 2014 , saving approximately $2,500 per person in 2014.[42] Because of its contribution to economic growth and energy savings for all Americans, energy efficiency should be a central piece of the low-carbon agenda of the next president and Congress.

Appliance efficiency standards and building codes have proven critically important to boosting energy efficiency for American families and businesses. Appliance efficiency standards cover individual product categories as diverse as commercial refrigeration units, electric motors, and fluorescent lamps, while model building energy codes set minimum standards and incorporate more comprehensively the best construction practices and technologies for homes and businesses.[43] By saving American families and businesses money and decreasing carbon emissions, both programs make a strong argument for their continuation and strengthening in the next four years.

Appliance standards

Energy efficiency standards issued in recent years will save Americans $540 billion cumulatively through 2030, and the additional standards planned for 2016 will put the United States on track to avoid 3 billion metric tons of carbon emissions over the same time period.[44] Many of these standards—including the largest-ever standard, which covers commercial air conditioners and furnaces and will save businesses $167 billion over its lifetime—result from negotiated rulemaking processes that bring together industry, labor and environmental groups, and DOE experts to reach consensus on the best measures.[45]

A recent report by the ACEEE and the Appliance Standards Awareness Project, or ASAP, projected that under the next president and within existing authority, the DOE can continue this tremendous progress and potentially save the equivalent of 762 terawatt-hours in 2035, or "equal current annual energy consumption of all the homes in Texas and Ohio combined."[46] But the impressive potential cumulative carbon savings outlined in the report—3.5 billion metric tons by 2050—is not inevitable, and achieving these savings will require the next president to champion the appliance efficiency standards program against attempts to stall or weaken it.[47] The ASAP/ACEEE report recommends that the DOE takes several actions to update and improve product testing and analysis; add product categories—including, potentially, televisions and computers; facilitate system savings; and address products connected by information and communication technologies, such as smart controls, thermostats, and other new products.[48] The next president should adopt these actions to expand the appliance efficiency standards program and work with Congress to increase its funding and provide more tools for enforcement and compliance efforts, including a greater ability to perform spot testing in the field and increased civil penalties for noncompliance proportional to the products' value.[49]

Additionally, the next president and Congress should address at least two major gaps in the program: the potential for increased energy efficiency from connected devices and the growing proportion of energy use from a diverse range of products often categorized as "other uses" in the residential and commercial sectors.[50] This other use category refers to products—such as heating elements and exterior lights—that individually do not meet the statutory threshold required for the DOE to consider new rulemakings. The U.S. Energy Information Administration, or EIA, projects that its energy use will grow from 19 percent to 28 percent of the residential market and from 35 percent to 48 percent of the commercial market from 2014 to 2050.[51]

The next president should work with Congress to lower the regulatory threshold of energy use for new product determinations from the current threshold of 150 kilowatt-hours per household per year. This metric has limitations for commercial and industrial end uses, and adopting a more adaptable metric would enable the DOE to set energy efficiency standards for a broader array of products that individually are less energy-intensive but together constitute a rising source of energy demand.[52] Congress should also consider enabling performance-based standards, which focus on the time an appliance is used or cover specific aspects of its energy use profile—such as network standby requirements—in order to increase energy efficiency across a broader category of other use appliances and equipment without regulating them individually.[53]

Building energy codes

The success of building energy codes, which set minimum standards for the energy efficiency of residential and commercial buildings, lies with state, local, and tribal governments, which adopt and enforce them. The DOE contributes to model code development for commercial and residential buildings through consultative processes and estimates that codes from both sectors will yield 4 billion metric tons in cumulative carbon emissions savings through 2040.[54] In terms of consumer savings on energy bills, the DOE estimates that 2015 updates to the model residential building code will achieve 32 percent greater savings over the 2006 model code, or an average of $500 in annual savings for homeowners.[55] Building energy codes serve a vital purpose by achieving integrated energy savings for consumers, but the adoption and enforcement of updated codes often lags behind development in related technologies and products.[56] In some cases, states also draft alternative, more aggressive building energy codes that bring more energy efficient building technologies into the market more quickly. For example, Massachusetts adopted and has subsequently updated an opt-in stretch code for municipalities that links buildings to performance standards rather than minimum standards, a more aggressive path for cities to encourage or mandate highly efficient buildings.[57]

The next president should direct and fund the DOE to develop stretch codes alongside the regular base code updating process and to provide states with technical assistance when deciding whether and how to adopt and implement stretch codes. The next president and Congress should also incentivize states to update their existing building energy codes by increasing federal funding for state building code offices and inspectors when states adopt the most recent model codes or enact stretch codes. As of July 2016, the DOE reported that only 14 states had adopted or exceeded either of the two most recent model residential building energy codes. Similarly, only 24 states had adopted or exceeded either of the two most recent model commercial codes.[58] Providing incentives for the adoption and enforcement of the most recent codes will achieve significant energy and carbon emissions savings.

Energy data, connected devices, and cybersecurity risks

The U.S. energy system is one of the most data-rich systems in the global economy; trade flows, commodity prices, electrical properties, and carbon emissions are but a few of the data types it uses, often in real-time monitoring and analysis. The different sectors that make up the energy system are becoming increasingly connected, interdependent, and communicative, and this connectivity underlies the ability of the existing system to integrate more energy efficiency and renewable energy technologies effectively.[59] They are also more dependent on higher-quality and greater quantities of data and face increased threats from physical attacks, extreme weather, and cyber attacks.[60] Enhancing the quality and quantity of energy data available to the government, research institutions, and the public would aid in policymaking, the design and implementation of preventive security measures, achieving market efficiencies, and responding to emergencies quickly and appropriately.

Cybersecurity threats may define the future of the U.S. electricity grid: As new technologies across the transmission and distribution systems enter service, potential vulnerabilities in the operational technologies used to manage the grid, the information technologies that consumers use, and the interaction of these technologies may disrupt service or compromise data. Although cybersecurity extends beyond end-use technologies, addressing such risks is central to the success of connected devices in increasing energy efficiency and distributed generation.

Energy efficiency stands out as a challenging area that would benefit from better data quality and quantity. The evaluation, measurement, and verification, or EM&V, process can be challenging for public officials, energy service companies, or interested consumers due to the quantity, diversity, and quality of available data and the lag time between interventions such as installing insulation and realizing savings on an electric bill.[61] As end-use technologies—from phones to thermostats to vehicles—become more connected, the data they generate and consume is rapidly reshaping how consumers, utilities, and third parties access and control equipment, make or save energy and money, and prevent or respond to cybersecurity threats.[62] The United States' 5.6 million commercial buildings and 120 million households are a significant resource for increasing energy efficiency, managing the electricity system, and growing renewable energy resources, but the interoperability of these buildings depends on setting shared and safe standards that allow innovators to tap into their energy resource potential without exposing businesses and households to cyber risks.[63] In this growing but still nascent sector, it will become increasingly important to develop open interoperability standards that balance energy services with cybersecurity safeguards while concurrently establishing uniform methods of calculating the energy savings they achieve.

By keeping energy efficiency and the reduction of cybersecurity vulnerabilities at the forefront, the next president can address energy data, cybersecurity, and connected device efficiency in an integrated way. First, he or she should direct the Department of Energy, the Department of Homeland Security, and other federal agencies to work with utilities, state regulators, and other stakeholders to set distribution system standards to protect critical infrastructure and encourage the growing market of connected devices. Second, championing the Green Button program—an initiative sponsored by electric utilities that enables customers to access their energy data securely—will make more high-quality energy data available to utility customers. The next presidential administration should work with utilities and third-party energy efficiency and renewable energy service providers to expand the program.[64] Lastly, the next president should request a road map for near-term open standards, platforms, and EM&V methods to optimize energy efficiency and cybersecurity protections that builds on the DOE's existing research on building interoperability in coordination with the DOE's Uniform Methods Project and the White House's Commission on Enhancing National Cybersecurity.[65]

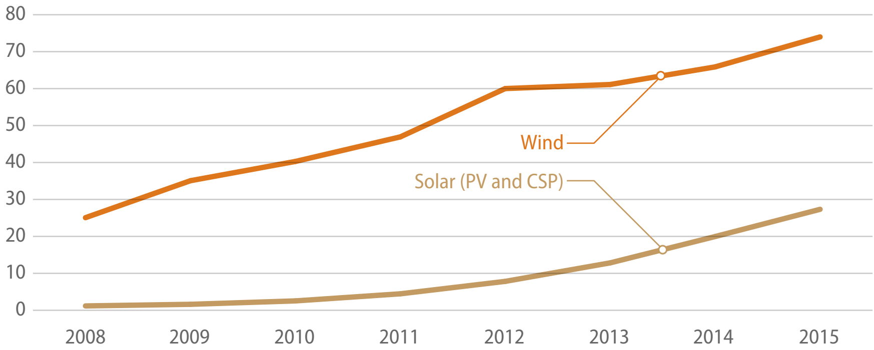
Enabling renewable energy deployment and integration

Renewable generation capacity—both distributed and utility-scale—has grown rapidly but unevenly in the United States, transforming the electricity system and its technical, economic, and environmental character. Between 2008 and 2015, U.S. renewable generation capacity grew at dramatic rates. (see Figure 3) This additional capacity reflects falling technology costs and federal, state, local, and tribal policy incentives, from net energy metering and renewable portfolio standards to federal tax credits. The growth rates for these technologies differ considerably from state to state, however, often reflecting differences among policy and regulatory structures rather than renewable resource potential.[66]

FIGURE 3

Growth of selected U.S. renewable energy technologies

Cumulative generation capacity from 2008 to 2015, in gigawatts



Sources: Data on wind energy from U.S. Department of Energy, *2015 Wind Technologies Market Report* (2015), available at http://energy.gov/eere/wind/downloads/2015-wind-technologies-market-report; Data on solar energy from U.S. Department of Energy, *Utility-Scale Solar 2015: An Empirical Analysis of Project Cost, Performance, and Pricing Trends in the United States* (2016), available at https://emp.lbl.gov/sites/all/files/lbnl-1006037_report.pdf.

After several years of uncertainty regarding extensions, a schedule for the wind production tax credit and solar investment tax credits was enacted in December 2015.[67] It established steps down from initial tax credit amounts to either lower amounts or complete phase-out through 2019 for wind and starting in 2019 for solar.[68] Beyond enhancing market certainty, the extensions are projected to increase renewable energy deployment—in both high and low natural gas price scenarios—and bridge what might otherwise be a slowdown between now and 2022, when the Clean Power Plan comes into force.[69] (see text box)

Regulatory avenues to drive deployment of clean energy and energy efficiency technologies

The Clean Air Act offers federal policymakers an important tool to cut carbon emissions from the electric power and industrial sectors through deployment of renewable energy and energy efficiency technologies.

Section 111 of the Clean Air Act authorizes the EPA to set "standards of performance" for any stationary source category that "causes, or contributes significantly to, air pollution which may reasonably be anticipated to endanger public health or welfare."[70]

Under section 111, the EPA has set carbon pollution limits for new and existing power plants. In August 2015, the EPA finalized the Clean Power Plan, which, when fully implemented, will reduce carbon pollution from the power sector by 32 percent.[71] The EIA predicts that the Clean Power Plan will accelerate clean energy deployment in the United States.[72] On February 9, 2016, the U.S. Supreme Court stayed implementation of the Clean Power Plan pending further judicial review.[73] Assuming the plan is implemented, the EPA could use its authority under section 111 to review and, if appropriate, strengthen the carbon pollution limits to reflect advancements in the best system of emissions reduction.[74]

Section 111 also gives the EPA the authority to set performance standards for greenhouse gases from other industrial source categories, such as petroleum refineries and industrial, commercial, and institutional boilers. Energy efficiency would likely form the core of these standards to minimize energy use and, therefore, emissions.

Unlike the industry-specific approach of section 111, section 115 of the Clean Air Act offers an economy-wide approach. Section 115 authorizes the EPA to require states to reduce emissions that contribute to the endangerment of health or welfare in other countries, if those countries provide reciprocity to the United States.[75] The EPA would set an overall carbon pollution budget for each state but offer them the flexibility to decide where and how to achieve the reductions, such as renewable energy requirements, energy efficiency standards, or even a statewide carbon pricing program.

With some overarching federal policy drivers in place, the renewable energy market has great potential, but several actions are needed to promote the installation and integration of these new, low-carbon resources into the electricity system. From accounting for their costs and benefits in reasonable electric rates to balancing new power sources with storage, the integration of renewable energy will reduce emissions and provide additional economic and system benefits.

Electric rates and valuation

State, local, and tribal policies and programs complement federal policies by offering additional incentives—such as tax credits—or setting other requirements for low-carbon energy generation, as in the case of renewable portfolio standards.[76] The diversity of regulations and policies governing the electricity system reflects its planning, construction, and management design under the Federal Power Act of 1935, which created separate federal and state jurisdictions. The federal government, through the Federal Energy Regulatory Commission, or FERC, regulates wholesale sales and interstate transmission, and each state public utility commission, or PUC, regulates retail sales of electricity and transmission within its borders.[77] This diverse regulatory and policy landscape has fostered an equally diverse set of electric utilities—from investor-owned utilities to federal power marketing administrations to rural cooperatives, among others.[78]

In this context, state PUCs regulate retail electric rates and approve electric utilities' rate cases, or legal proceedings before PUCs in which utilities propose and argue for changes to the price they charge customers for electricity. The electricity system's rapid and significant changes are forcing PUCs to adapt their roles as new generation, distribution, and end-use technologies enter the market and transform the customer demands and the ability of utilities to meet policy goals and recuperate investments.[79] In setting regulations and determining rate cases, PUCs have an ever-growing set of costs and benefits to consider: traditional accounting for utilities' capital expenditures on power plants and transmission and distribution infrastructure; the value of services provided by the grid and distributed resources, such as energy storage; and how to capture and quantify the societal and environmental benefits of renewable generation. These include, for example, electricity generated on customer rooftops rather than at a centralized power station.[80] Valuing these costs and benefits accurately can inform electric rate-setting and promote clean energy growth, or it can halt that growth entirely.[81] For example, a utility may justify a rate increase proposal to build centralized fossil fuel generation by only comparing traditional costs such as construction and operations without analyzing the additional benefits that distributed renewable generation provides, such as avoided costs for pollution control equipment.[82]

Although the discussion of retail electricity rates and many other aspects of energy policy occurs at the state level, the federal government can play an important role by providing or facilitating technical assistance to state PUCs and other decision-makers.[83] Much of this technical assistance, often performed in partnership with the DOE's National Laboratories, focuses on policy analysis and support through national membership groups; direct education of officials, including PUC staff; and funding of projects designed to advance state, local, or tribal energy policies.[84]

Given the DOE's expertise in analyzing the climate, health, and economic benefits of clean energy, more emphasis should be placed on making its work directly available to states. In recent years, technical experts at the DOE and National Laboratories have been invited to provide expert analysis to inform PUCs' decisions, and third parties have often cited DOE-supported analysis in their own comments and testimony.[85] Drawing on the DOE's and National Laboratories' expertise and analytical capabilities would provide objective insight into the many issues that PUCs contemplate, including retail rate design. The next president should charge the DOE with developing a team of technical experts—in partnership with relevant national groups such as the National Association of Regulatory Utility Commissioners—to support states, particularly state PUCs and other officials, as they request technical expertise to inform considerations of incorporating clean energy into their resource mix, including energy efficiency and distributed energy resources.

Infrastructure for renewable energy deployment

Recent news celebrated the construction of the first offshore wind farm in U.S. waters, a 30-megawatt, five-turbine operation near Block Island, Rhode Island.[86] The developer's use of a Norwegian vessel, supported by an American vessel, to install the turbines illustrates one challenge common to renewable energy deployment across different technologies: Non-energy infrastructure that enables the installation or operation of energy infrastructure, such as roads or ports, often inhibits access to energy resources, slows the installation of energy infrastructure, or does not exist.[87] The potential for growth in the offshore wind market is staggering: The DOE estimates 22 gigawatts of capacity in 2030 and 86 gigawatts by 2050. Yet the enabling infrastructure for offshore installations currently relies on foreign vessels.[88] Some U.S. shipbuilding industry facilities are able to build ships similar to those used for offshore wind turbine installation, having delivered more than 50 offshore service vessels in 2014.[89] Through its Federal Ship Financing Program, the U.S. Maritime Administration currently allocates $42 million for loan guarantees for advanced shipbuilding.[90]

The 2015 "Quadrennial Energy Review" identified similar constraints on shared infrastructure, including weight limits for roads and highways over which heavy installation equipment or renewable energy components such as turbine nacelles or blades travel. It recommended a DOE-led assessment of current routes and their capacity to accommodate relevant heavy or oversized shipments.[91] The next president should charge the DOE to work in partnership with other federal agencies, including the U.S. Department of Transportation, to go further by identifying key regions for renewable generation development, analyzing the transportation infrastructure needed to move heavy or oversized freight through those regions, and setting new standards for relevant infrastructure. The next president and Congress should then increase funding for needed projects to encourage the development of shared or enabling infrastructure, including the Maritime Administration's Federal Ship Financing Program.

Transmission

Renewable generation resources—particularly high-quality onshore and offshore wind, hydroelectric, and solar resources—are located in North American regions at a distance from demand centers and thus require the construction and interconnection of high voltage transmission lines. The 2015 "Quadrennial Energy Review" projected increased transmission investments to address aging infrastructure and system congestion and to connect these renewable resources with demand centers.[92] Projections by the National Renewable Energy Laboratory indicate that the high penetrations of wind needed to increase low-carbon generation in the eastern United States would require transmission construction or result in curtailment of wind projects.[93] Permitting, siting, and financing transmission projects have presented challenges to linking these resources.

The recent passage of the Fixing America's Surface Transportation Act established a unified dashboard through which federal agencies report performance schedules—varying by scope and project type but held to standardized deadlines—in order to increase transparency, create common metrics, track environmental review and stakeholder input, and expedite review processes.[94] The new dashboard represents President Obama's latest move to prioritize infrastructure development and remove bureaucratic barriers where appropriate; another pending action includes the finalization of rules regarding a pre-application process aligning federal authorizations across several agencies for electric transmission lines.[95] Once finalized, these new features will aid the development of transmission lines bringing renewable energy from high-quality resource areas to demand centers. The long-term development of transmission projects—which command significant lead time due to siting and regulatory processes, especially when multiple states are involved—will require the next president to increase funding for federal agency infrastructure review officers in order to keep agencies on track under the new performance standards.

The next president and Congress should create incentives for transmission infrastructure projects by adding qualified transmission projects to the investment tax credit scheme under section 48 of the Internal Revenue Code.[96] The investment tax credit was initially established by the Energy Policy Act of 2005 in order to incentivize the production of solar technology.[97] The investment tax credit gives a direct tax rebate of a certain percentage of an investment for qualifying assets. These assets are optimal for projects that require a large upfront investment, and many companies prefer them because they can be sold for cash value to institutional investors.[98] A transmission investment tax credit would aid investment in infrastructure, as it has done for solar, which is projected to double in capacity from 2016 to 2020 due to the recent solar investment tax credit extension.[99]

Setting project qualifications above a voltage level and/or limiting the investment tax credit to direct current lines would further promote transmission projects related to renewable energy development.

Collaboration with North American neighbors

Energy trade in North America reached $65 billion between the United States and Mexico in 2012 and $140 billion between the United States and Canada in 2013, reflecting increasing energy system integration across both borders.[100] Cross-border electricity trade between the United States and Canada is nearly as old as the grid itself, dating to an interconnection near Niagara Falls in 1901. Since that time, total average daily electricity trade between the United States and its bordering neighbors has grown to upwards of 218 gigawatt-hours per day—enough to power 20,000 homes daily.[101] These trade activities aid each country by promoting access to clean energy resources—from Canadian hydropower to Mexican wind—while also enhancing grid reliability in times of need.[102]

In recent years, the United States, Canada, and Mexico have each been advancing climate and clean energy policies across North America. While President Obama continues to advance his domestic climate agenda, the Canadian premiers have begun to develop a pan-Canadian plan to accelerate emissions reductions, and Mexico has implemented its Energy Transition Law to drive clean energy development.[103] In addition, collaboration among the three nations has grown tremendously, as seen in the U.S.-Canada Joint Statement on Climate, Energy, and Arctic Leadership released in March 2016; the North American Leaders' Summit held in June 2016; and the U.S.-Mexico state visit in July 2016. In each of these, climate and energy were a primary pillar of collaboration.[104] It is notable that each country has committed to increase RD&D funding commitments, promote common industrial energy management standards, work jointly on green government activities such as clean energy procurement, and achieve 50 percent clean power generation across the continent by 2025.[105]

The next president should charge relevant federal agencies with work with its counterparts in Canada and Mexico to:

- Implement the commitments of the 2016 North American Leaders' Summit, sustain the trilateral climate and energy engagement, and promote new, stronger commitments in the future
- Harness the benefits of collaborative RD&D through the Mission Innovation initiative and other enterprises
- Complete the North America renewable integration study recommended by the 2015 "Quadrennial Energy Review" and use it to identify, incentivize, and remove barriers to clean energy project development, including cross-border transmission projects, over the next 10 years[106]
- Continue collaborative efforts on energy data collection, scrubbing, and coordination with the goal of informing continent-wide energy modeling in future clean energy studies[107]
- Expand EV integration initiatives to appropriate Canadian and Mexican regions and trade routes
- Identify opportunities to strengthen deployment of energy efficiency and renewable energy technologies through coordination and trade with Canada and Mexico, particularly when considering setting new goals or designing new policies and programs, while promoting similar partnerships at the regional level among states, provinces, cities, and tribes[108]
- Ensure that regulatory and infrastructure investment decisions in North America reflect the need to reduce carbon emissions

Energy storage

Another enabling infrastructure for renewable generation is energy storage. One of the technical obstacles to greater deployment and integration of renewable technologies is their variable and intermittent generation output. Energy storage technologies balance these characteristics by reducing the curtailment of excess generation, meeting peak demand, and assisting power quality regulation.[109] Across the variety of storage technologies—including batteries, pumped hydroelectric storage, flywheels, and other systems—costs are an ongoing barrier to adoption.[110] With continued investment, storage costs are expected to decline. For example, the capital cost of lithium-ion batteries is expected to fall 50 percent from 2015 to 2020.[111]

Many states and utilities are already expanding their use of energy storage. Since 2014, California, Oregon, and Massachusetts have announced storage requirements for their electricity systems. California's storage mandate calls for 1.3 gigawatts of capacity by 2022; in response, one utility—Southern California Edison—purchased more than 250 megawatts of capacity in 2014, five times its quota.[112] While promising, these mandates can only be fulfilled if the regulatory environment for storage is clarified and storage-friendly policies are implemented.

While recent attention has focused on advanced technology for energy storage such as batteries and flywheels, the DOE estimates that there is major potential to develop pumped-storage hydropower, or PSH, resources. A PSH project provides for water to be pumped to elevation when electricity is plentiful and then to be subsequently run through a turbine to generate electricity when needed. While the DOE has modeled as much as 36 gigawatts of additional PSH capacity by 2050 under a combination of technology and finance scenarios,[113] every PSH project would have to be carefully evaluated for environmental consequences, costs, and other effects to determine its appropriateness.

The next president should recommend that Congress expand the investment tax credit to explicitly include energy storage technologies. Because storage technologies do not produce energy, a storage investment tax credit would likely be based on the amount of energy that each unit could store. Similar to the transmission investment tax credit proposal, a storage investment tax credit would attract investors to install storage technologies, driving further integration of renewable generation into the electric grid while also enhancing its reliability.

Additionally, the next president should call for the DOE to complete a study on the carbon benefits of storage. The benefits that energy storage provides to renewable generation have been documented, but a comprehensive assessment of the emissions reduction potential for broader uses of storage is needed.[114] Storage's ancillary services—such as regulating the physical properties of electricity—support electric power transmission and distribution systems, and under FERC Order 890, energy storage and other demand resources must be considered as alternatives to new transmission.[115] When serving as a demand response or outage recovery tool, energy storage often serves as a substitute for fast-response fossil fuel power plants, providing those services at lower costs.[116] Energy storage provides value by avoiding the costs of new infrastructure investments and performing services less expensively than fossil fuel generation, but the broader effect of energy storage on carbon emissions is less understood.

Energy storage currently occupies a gray area in the wholesale and retail electricity markets, potentially classified as either a transmission or generation asset. The multiple services that storage provides make the case for its classification as an asset in more than one category and affect which entities regulate it and how utilities incorporate investment costs into their electric rate structures. To date, the FERC has decided to classify energy storage on a case-by-case basis, as seen in its decision to side with the Midcontinent Independent System Operator in classifying an Indiana battery facility as a generation asset in a 2016 interconnection dispute.[117] In 2016, the FERC issued a formal data request regarding energy storage and wholesale electric markets.[118] The next president should recommend to the FERC that it set clear and flexible standards for the classification of different storage technologies by size and services provided to clarify the regulatory landscape and encourage the deployment of these technologies.

Electric vehicles

EVs are often considered a clean energy or carbon emissions solution due to their potential role in reducing emissions from the transportation sector. As a result, state and federal policymakers have implemented regulatory and tax incentive programs to drive new EV deployment. Between 2011 and 2015, cumulative U.S. sales reached more than 400,000 plug-in vehicles, manufactured by 13 different automakers. As of 2015, approximately 30,000 EV charging stations operate in the United States.[119] When considered in the context of the electric power sector, however, EVs play an additional role as a new source of demand and potentially as a purveyor of grid services.[120] To that end, the DOE and Edison Electric Institute, which represents U.S. investor-owned utilities, launched a utility partnership that includes augmenting the Workplace Charging Challenge and other charging infrastructure deployment programs. This year, the White House also announced several initiatives and partnerships aimed at financing and planning EV charging infrastructure.[121]

Charging availability near economic activity, residences, and commercial or government vehicle fleet parking sites will drive electricity demand growth on the distribution system, providing potential grid services but also posing challenges to the distribution system.[122] When connected to the grid, EVs may provide services such as frequency regulation, demand response and peak reduction, and others, with a broad range of potential value to utilities depending on time of connection and region.[123] Partnerships among the federal government, utilities, automakers, and other stakeholders create benefits by utilizing the technical and policy analysis capabilities of the DOE and National Laboratories to identify and maximize EV benefits to the grid as well as economic benefits for consumers and manufacturers.

Siting charging infrastructure appropriately is key to capturing the potential value of EVs to the grid and drivers simultaneously. Utilities must address the addition of EV charging infrastructure near parking, whether at businesses or parking garages in the daytime or residences at night, by managing new demand and/or new services the EVs may provide.[124] In residential neighborhoods, particularly in urban areas, existing municipal streetlights offer a potential entry point for utilities to connect concentrated populations of EVs with existing infrastructure they often manage or own. Currently, the DOE Better Buildings Outdoor Lighting Accelerator works with local governments, utilities, and other stakeholders to increase LED replacement of the United States' approximately 44 million streetlight fixtures, among other outdoor lighting installations, more than 60 percent of which are owned by utilities.[125] As municipalities move to implement LED streetlight conversion to achieve energy efficiency goals, utilities may consider adding on-street charging infrastructure at streetlight fixtures as a way to circumvent loss of revenue and provide additional distribution grid services. The next president should call on the DOE to work with states, municipalities, utilities, and other stakeholders to install charging infrastructure when retrofitting streetlights with LED bulbs as a combined second phase to its Workplace Charging Challenge and Outdoor Lighting Accelerator.

In July 2016, the Obama administration announced actions that the federal government and private sector will take to increase access to EV charging and promote EV adoption, including by designating a network of EV charging stations as part of zero-emission corridors, strategic locations for alternative fueling stations and related infrastructure along highways or other roadways to improve mobility for vehicles using such technologies.[126] In fall 2016, the White House will convene state and local governments, utilities, automakers, charging companies, and other stakeholders to identify needs for a nationwide network for fast-charging stations, which are high-power chargers that can charge an EV battery in 20 to 30 minutes. The next president should use this needs assessment to identify and implement policy changes, procurement actions, and financing mechanisms to further develop zero-emission vehicle corridors and greater EV adoption. Additionally, to broaden the effects of this endeavor, the next president should charge the DOE and other relevant agencies with following this initial meeting with outreach to government and industry stakeholders in Mexico and Canada to identify cross-border corridors for zero-emission vehicles and charging infrastructure.

Advancing state, local, and tribal energy policies

State, local, and tribal governments significantly shape the energy policies of their respective jurisdictions and, considered together, of the United States as a whole. Their energy resources, policies, and needs are diverse and location-specific, and the policy levers useful to decision-makers at each level vary greatly. Technical assistance, policy solutions, and funding needs differ as well. Because of the historic role of state, local, and tribal governments in energy policy and regulation, the next president and Congress should seek to enlist their constructive engagement in ensuring that the nation remains on a pathway to a low-carbon future. This initiative can take the form of coordinated state, local, and tribal clean energy engagement initiatives, as appropriate to each level, and can bring a focus to the implementation of select recommendations in this report:

Energy efficiency

- Direct the DOE to develop stretch building energy codes and provide technical assistance to states in order to increase their implementation
- Award additional funding to state building code programs when states significantly enhance their building energy efficiency efforts

Renewable energy deployment and integration

- Develop a DOE-led team of experts to support state, local, and tribal decision-makers, including PUCs, with targeted technical assistance on clean energy options
- Work with border states to identify opportunities to strengthen the deployment of energy efficiency and renewable energy technologies through coordination and trade with neighboring Canadian and Mexican counterparts
- Launch an EV charging infrastructure and streetlight retrofit challenge with states, municipalities, utilities, and others to advance grid integration and energy efficiency at the same time

Energy finance

- Work with the federal energy finance director to identify and apply for financing at different federal agencies appropriate for state, local, and tribal stakeholders

Reshaping the federal role in energy

From the 1970s through today, the federal government has reduced its energy use through building and fleet energy efficiency improvements and increased its renewable energy use through onsite installations and power purchasing.[127] By setting—and meeting—benchmarks for energy efficiency, carbon emissions, water use, and other metrics, these efforts have set an example outside the federal government.[128] Even with significant progress toward President Obama's federal energy use and emissions reduction goals, the next president and Congress will need to set an ambitious agenda, communicate it clearly throughout the federal government, and give agencies the tools they need to achieve energy and emissions savings.

Place climate and clean energy at the top of the executive branch agenda

President Obama's commitment to addressing climate change has prioritized the issue throughout the executive branch—securing it as a top agenda item for relevant Cabinet officials, the president's senior adviser, the White House Council on Environmental Quality, the Domestic Policy Council's Energy and Climate Change team, and several other White House offices. This has included elevating it in each year's budget and through public speaking and championing legislative action on climate and clean energy. Each White House office has devoted its resources—whether expertise, skills, budget, or relationships with relevant federal agencies and members of Congress—to this effort. As described in this report, the increasing complexity of energy policymaking requires strong leadership and coordination within the White House, across the executive branch, and in working with Congress. The next president should prioritize climate and clean energy in the structure and staffing of his or her White House policy offices.

Established under the National Environmental Policy Act of 1969, the CEQ exists as an advisory body to the president and as the coordinator of federal interagency environmental policy development and implementation of the act.[129] As a statutorily derived body, CEQ's mission captures the intertwined character of environmental, energy, climate, economic, and social policy deliberation.[130] The expertise, resources, and personnel needed to execute the next president's climate and energy agenda may continue to dwell in several White House offices, but this agenda's urgency and complexity call for improvements to this arrangement.

With that in mind, the next president should combine the Domestic Policy Council's Energy and Climate Change team and other climate, energy, and environmental posts into the CEQ and charge it with an integrative policymaking approach as the White House and interagency lead on climate, clean energy, and environmental issues. The next president should name a senior adviser focusing on climate and clean energy or nominate a high-profile individual as chair of the CEQ, elevating that role to the Cabinet level.

The beginning of a new term is a moment for the president to clarify his or her agenda to the public by reorganizing internal White House structures and processes where possible and appropriate. Centralizing interagency coordination, decision-making, communications with outside stakeholders, and policy formulation on climate, energy, and environmental issues within the CEQ will better strengthen the White House's ability to lead high-priority, cross-cutting issues and clearly communicate the next president's agenda across agencies and to the American people.

Improve federal energy use

Since the 1970s, efforts to reduce federal energy use have gained bipartisan support as a means to save taxpayer dollars, reduce dependence on foreign oil, and demonstrate leadership on sustainability. As the single largest consumer of energy in the United States, the federal government has demonstrated strong leadership on energy efficiency in its buildings and fleets and by developing renewable energy projects to meet its energy needs.[131] In 2015, the EIA announced that federal energy use had reached its lowest point since recordkeeping began in 1975, owing to falling jet fuel use and a 40 percent increase in facility energy efficiency.[132] President Obama signed two executive orders setting and subsequently updating ambitious energy efficiency and renewable energy deployment goals for the next decade, including a goal of 30 percent renewable energy by 2025.[133]

The next president will enter office with well-coordinated interagency efforts underway to achieve these ambitious targets, but opportunities remain to streamline processes in order to achieve or go beyond those goals and to build the foundation for even greater energy savings and carbon emissions reductions. To aid the achievement of near-term goals, the next president should elevate the agenda of federal energy use and sustainability by making his or her Cabinet members accountable for the metrics outlined in current executive orders and, by extension, making it their own priority, thereby setting the stage for even more ambitious targets for energy efficiency, renewable electricity, and other sustainability metrics.

One way to prioritize this agenda includes Cabinet officials naming a full-time chief sustainability officer for their agencies, similar to each agency's chief financial officer or chief information officer. Agencies currently assign energy efficiency and sustainability roles on top of the existing responsibilities of senior officials, rather than dedicating an employee to the core functions performed by energy, water, resilience, land use, and other environmental services.[134] Additionally, the next president should task the federal chief sustainability officer with establishing a policy working group made up of each federal agency's chief sustainability officer and general counsel, or other relevant staff attorneys, in order to standardize guidance for contracting, procurement, and appropriations language across relevant energy efficiency and renewable energy regulations.

The U.S. Department of Defense and military services have forged a path for renewable energy generation on federal lands, providing renewable energy to those facilities and, at times, to their surrounding communities. For example, the U.S. Navy worked with the Western Area Power Administration to sign a power purchase agreement with Sempra U.S. Gas & Power, securing electricity for 14 Navy and Marine Corps installations in California from a 210 megawatt solar PV plant that will also help meet California's renewable portfolio standard goal.[135] Civilian federal agencies are currently limited to 10-year power purchase agreements and to retaining ownership of generation equipment when procuring power through performance contracting; both contract stipulations make it difficult to finance renewable energy installations.[136] The next Congress should pass legislation enabling civilian federal agencies to sign, at a minimum, 20-year power purchase agreements to continue the success illustrated by the Department of Defense. The next president should also direct the Office of Management and Budget to issue guidance enabling the option to purchase generation equipment during or after the term of a performance contract rather than requiring ownership outright.

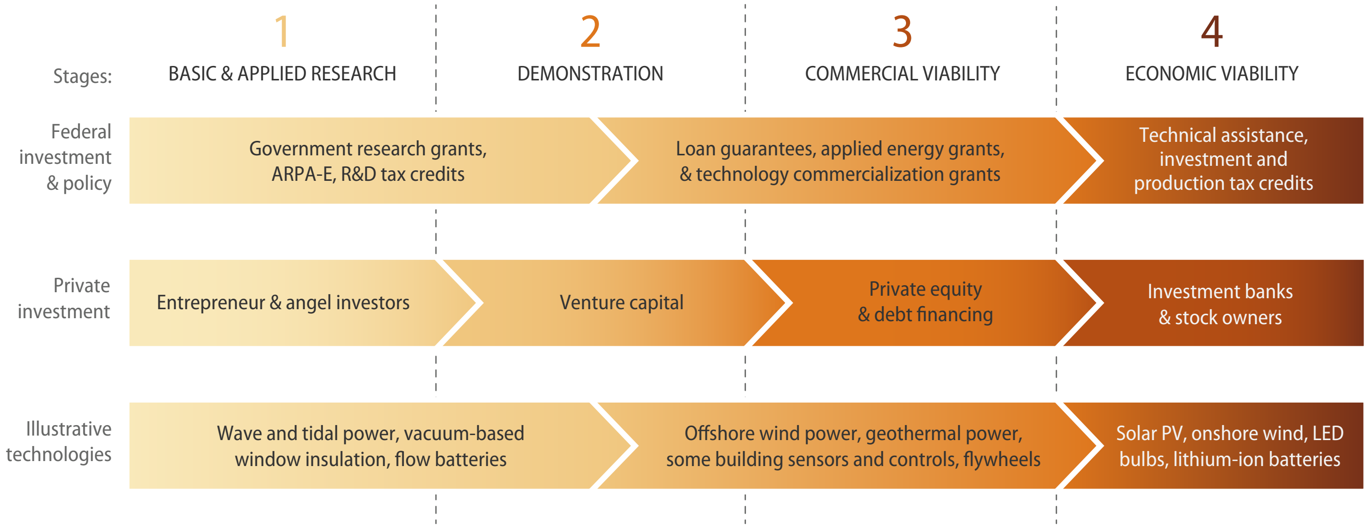
Elevating energy finance

In the past decade, the federal government has sought to overcome financial barriers to energy efficiency and renewable energy deployment across technologies, development stages, business models, and jurisdictions. Building on historic investments in clean energy through the American Recovery and Reinvestment Act of 2009, this federal support has taken several forms: the DOE's Advanced Research Projects Agency-Energy supports companies developing early-stage technologies considered too early for private sector investment; the DOE Loan Programs Office's direct loan and loan guarantee authorities finance demonstration stage technologies; and its applied energy offices help states create markets for deployment through ongoing technical assistance, grants, and research.[137] (see Figure 4) The most significant recent incentives to promote clean energy deployment endeavors came in the 2015 extension of the solar and wind tax credits.[138]

FIGURE 4

The clean energy innovation ecosystem

Public and private sector investment in clean energy technologies and innovation



Sources: U.S. Department of Energy, *Quadrennial Technology Review: An Assessment of Energy Technologies and Research Opportunities* (2015), available at http://energy.gov/under-secretary-science-and-energy/quadrennial-technology-review; L.M. Murphy and P.L. Edwards, "Bridging the Valley of Death: Transitioning from Public to Private Sector Financing" (Golden, CO: National Renewable Energy Laboratory, 2003), available at http://www.nrel.gov/docs/gen/fy03/34036.pdf; Jesse Jenkins and Sara Mansur, "Bridging the Clean Energy Valleys of Death" (Oakland, CA: Breakthrough Institute, 2011), available at http://thebreakthrough.org/blog/Valleys_of_Death.pdf; Philip E. Auerswald and Lewis M. Branscomb, "Valleys of Death and Darwinian Seas: Financing the Invention to Innovation Transition in the United States," Journal of Technology Transfer 28 (3) (2003): 227–239, available at http://link.springer.com/article/10.1023/A:1024980525678.

From an economy-wide perspective, these policies and investments have encouraged the private sector to follow suit, and in 2015, new U.S. investment in renewable energy reached $44 billion, with global investment totaling a record $285.9 billion.[139] Given the current fiscal and political realities in the United States, and in many other countries as well, the federal government is an unlikely source for this level of direct investment. Instead, lowering barriers to private sector financing and unlocking federal government financial incentives at key points in technology development and deployment has become critical.

Kick-start working capital for federal energy financing awardees

Energy efficiency and renewable energy projects funded through the federal government's existing financing mechanisms undergo due diligence processes to better understand and mitigate risks. Upon receiving funding or financing, projects work to meet a schedule of milestones set by the financing agency, but new companies focused on attracting private investment and market adoption often face significant, albeit low-cost, challenges in covering the expenses of business operations or funding for so-called working capital. Working capital costs are one expenditure that companies seek to cover with funds from venture capital investments, but early stage and/or capital intensive energy projects that require longer periods for return on investment do not always attract venture capital interest.[140]

In 2015, Vice President Joseph Biden launched the DOE's Clean Energy Investment Center, a clearinghouse for information on energy finance across federal agencies and a source for technical assistance.[141] Establishing a revolving loan fund for clean energy working capital at the Clean Energy Investment Center would enable young companies to receive small sum loans to cover business operations and other working capital costs outside the bounds of larger loan guarantee, grant, and other federal or private sector assistance. The next president and Congress should create a revolving loan fund able to make loans using existing due diligence processes and award recipients of larger DOE grants or loans additional small loans—up to $500,000—tied to the milestones of the initial grant or loan.

Elevate energy finance within the next administration and new infrastructure bank proposals

Significant existing federal financing mechanisms remain underutilized, untapped, or lack coordination among offices within agencies, across agencies, or with private-sector investors. The Department of Energy has published a catalogue of federal finance programs for clean energy to assist different market segments—from multifamily housing to large manufacturers.[142] The scale of investment needed—both globally and domestically—and the challenges in identifying federal financial mechanisms suited to specific project types and in coordinating across agencies call for elevating the role of clean energy investment.

The Center for American Progress recently proposed a national infrastructure investment authority, calling on Congress to grant it authority to make loans, structure repayment to match infrastructure payback periods and revenues, and group projects as needed.[143] Given the importance of energy infrastructure to meeting climate, economic, and other goals in the national interest, the next president and Congress should make financing energy infrastructure projects a key feature of any infrastructure bank or other investment authority. This also means drawing on existing expertise and tools to maximize the effectiveness of clean energy finance up and down the RD&D and deployment pipeline and to build—and finance—coalitions and regional efforts to support clean energy infrastructure projects that benefit multiple jurisdictions.

The next president should also name a federal energy finance director, elevate that position to the Council on Environmental Quality, and empower that individual to coordinate interagency policymaking and decision-making. The new federal energy finance director would identify new financing opportunities and partnerships and convene stakeholders in the energy and financial industries to pursue clean energy investment goals. Current clean energy finance policy coordination occurs among several Cabinet agencies and White House offices, but no single White House official or office has led coordination among relevant agencies for clean energy project development.

Thinking beyond 2030: Clean energy RD&D and deployment

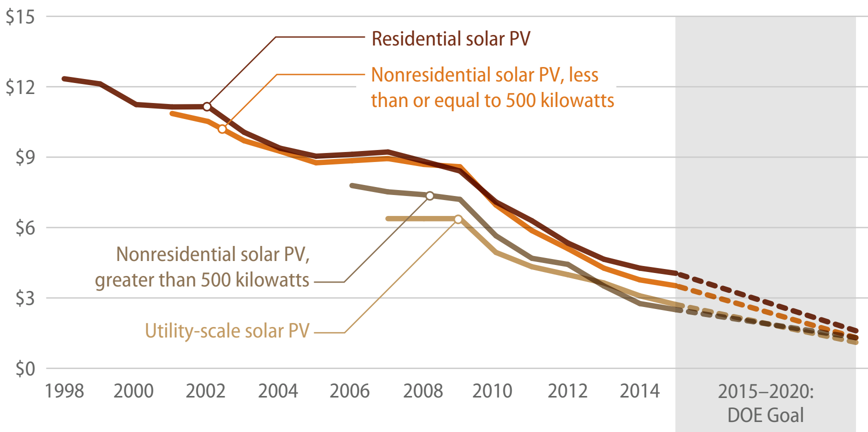
The policies outlined in this report focus on accelerating deployment of energy efficiency and renewable energy technologies to meet current goals and set a path toward decarbonizing the U.S. energy system. Most of the proposals will come to fruition in the next few years, but in the longer term, the United States will need to identify and implement additional measures, new energy technologies, and increased investments in the low-carbon economy. The decarbonization scenarios discussed earlier in this report describe some pathways to those long-term goals, and there remains a clear role for clean energy RD&D going forward: driving down the costs of key energy efficiency, renewable energy, and storage technologies.

The 2015 "Quadrennial Technology Review" provides technology assessments of each major clean energy technology and outlines current and future research goals. In each case, the improvement of a broad range of characteristics—such as design, manufacturing, physical or communications integration with the electric power system, and others—reduces the cost of the technology, enabling it to become more competitive with incumbents.[144] The DOE and National Laboratories RD&D activities result in a steady stream of exciting discoveries across the clean energy landscape, including advances in solar PV materials and more efficient motors.[145] As the federal government's RD&D agency, the DOE also sets and periodically updates cost achievement goals to orient its RD&D efforts and justify budget expenditures.[146] The recent cost reductions in solar PV cell and module manufacturing illustrate the relationship between costs and technical efficiencies and the effects of—and argument for—goal-oriented RD&D funding.[147] The DOE's "Fiscal Year 2017 Budget Request" sets goals for continuing cost declines in several clean energy technologies that extend these recent trends. (see Figure 5)

FIGURE 5

An example of falling costs and federal cost goals

U.S. median installed prices of solar PV systems from 1998 to 2015, by dollars per Watt



Note: Price data availability reflects the appearance of significant capacity in the U.S. market of each technology. For example, the first solar PV project greater than 5 megawatts was intsalled in 2007. Cumulative solar electricity generation capacity was approximately 1.2 gigawatts in 2007, including only 35 megawatts of utility-scale solar PV. (See Figure 4)

Source: Authors' data on residential and nonresidential solar PV from Galen L. Barbose and Naïm R. Darghouth, *Tracking the Sun IX: The Installed Price of Residential and Non-residential Photovolaic Systems in the United States* (U.S. Department of Energy, 2016), available at https://emp.lbl.gov/publications/tracking-sun-ix-installed-price; data on utility-scale solar PV from Mark Bolinger and Joachim Seel, *Utility-Scale Solar 2015: An Empirical Analysis of Project Cost, Performance, and Pricing Trends in the United States* (U.S. Department of Energy, 2016), available at https://emp.lbl.gov/publications/utility-scale-solar-2015-empirical; U.S. Department of Energy, On the Path to Sunshot: Executive Summary (2016), available at http://energy.gov/sites/prod/files/2016/05/f31/OTPSS%20-%20Executive%20Summary-508.pdf.

In 2015, President Obama announced Mission Innovation, an effort to double public sector investment in clean energy RD&D among 20 countries that represent 75 percent of global carbon emissions and more than 80 percent of current investment.[148] He outlined several Mission Innovation items in his fiscal year 2017 budget proposal, and Energy Secretary Ernest Moniz led the first Mission Innovation Ministerial to continue building its international collaborative measures.[149] The next president should support Mission Innovation by proposing additional clean energy RD&D funding in his or her first budget for fiscal year 2018.

That additional funding request should complement current RD&D funding across federal agencies by addressing the most challenging long-term carbon emissions reductions needs and the technologies that show promise in addressing them. As the electric power sector continues to evolve and decarbonize its generation units over time, carbon emissions from the transportation, industrial, and end-use sectors will increase in importance. As an example, the Energy

Information Administration recently indicated that U.S. transportation emissions have overtaken power sector emissions.[150] This recent shift in emissions share indicates the totality of addressing climate change: Reducing emissions in only one sector of the economy will not achieve the goal. Taking into account the differences in technologies, policy approaches, and RD&D agendas used in the industrial and transportation sectors, the next president should increase funding through Mission Innovation to match appropriately the need for innovation and long-term solutions in these sectors.

Conclusion: Summary of recommendations

Strengthening energy efficiency as a foundation for action

Appliance efficiency standards

- Adopt ASAP/ACEEE recommendations to strengthen the DOE's appliance efficiency standards program and increase its funding
- Address the energy efficiency of "other use" technologies by lowering the energy threshold requirements for the DOE to designate new product categories and make that threshold applicable to residential, commercial, and industrial sectors
- Enable the DOE to set performance-based standards for new product categories to allow more flexibility for the DOE and manufacturers to achieve greater energy savings

Building codes

- Direct the DOE to develop stretch building energy codes and provide technical assistance to states in order to increase their implementation
- Fund state building code programs when states significantly enhance their building energy efficiency efforts

Energy data, connected devices, and cybersecurity risks

- Direct relevant federal agencies to develop and set cybersecurity standards for the distribution system that also encourage the growth and energy efficiency of the distributed energy device market
- Champion the Green Button program to provide higher quantity and quality energy data to utility customers and third-party service providers
- Request a road map for interoperability and cybersecurity standards and EM&V methods to optimize building energy efficiency

Enabling renewable energy deployment and integration

Electric rates and valuation

- Develop a DOE-led team of experts to support state decision-makers, including PUCs, with targeted technical assistance on clean energy options

Infrastructure for renewable energy deployment

- Set regionally appropriate standards for shared infrastructure—such as port facilities or highways—to aid the deployment of renewable energy infrastructure
- Increase funding for financing mechanisms that support enabling infrastructure projects relevant to clean energy deployment

Transmission

- Create an investment tax credit for qualified transmission projects

Collaboration with Mexico and Canada

- Foster continued collaboration and ambition among North American leaders on climate change and clean energy
- Strengthen collaborative, cross-border efforts on clean energy RD&D, renewable energy integration, energy data, and clean energy trade

Energy storage

- Create a separate investment tax credit for energy storage technologies
- Direct the DOE to complete a study of the carbon benefits of energy storage
- Recommend to the FERC that it set clear and flexible standards for consideration of energy storage as an asset to the grid

Electric vehicles

- Launch an electric vehicle charging infrastructure and streetlight retrofit challenge with states, municipalities, utilities, and others to advance grid integration and energy efficiency at the same time
- Expand EV integration initiatives to appropriate Canadian and Mexican regions and trade routes

Reshaping the federal role in energy

Climate and clean energy: The top of the agenda

- Make climate and clean energy a priority for the executive branch
- Elevate the role of the Council on Environmental Quality as the lead coordinating body for climate, energy, and environmental issues within the White House and interagency and combine additional related White House offices under the CEQ, where possible
- Name a senior adviser to the president focused on climate and clean energy

Improve federal energy use

- Hold the Cabinet accountable for their agencies' energy use and metrics
- Request that Cabinet officials name a full-time chief sustainability officer
- Charge the CEQ and federal agencies with standardizing guidance for contracting, procurement, and appropriations language interpretation for energy efficiency and renewable energy installations
- Pass legislation authorizing at least 20-year minimum power purchase agreements for civilian agencies to procure clean energy
- Direct the Office of Management and Budget to allow agencies to purchase generation equipment during or after performance contracting terms

Energy finance

- Create a revolving loan fund to assist federal energy financing awardees with their business operation costs and aid them in reaching performance milestones
- Make clean energy infrastructure financing central to any national infrastructure bank proposal
- Name a federal energy finance director to the CEQ to coordinate interagency energy financing policy and assist stakeholders in finding resources across agencies

Thinking beyond 2030: Clean energy RD&D and deployment

- Increase clean energy RD&D funding by supporting Mission Innovation in the first budget proposal
- Match that funding to long-term, low-carbon solutions across the energy sector

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