TESTIMONY OF DR. ANDREW STEER

PRESIDENT AND CEO, WORLD RESOURCES INSTITUTE

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My name is Andrew Steer, and I am President and CEO of the World Resources Institute. The World Resources Institute is a non-profit, non-partisan research institution that goes beyond research to provide practical solutions to the world's most urgent environment and development challenges. We work in partnership with scientists, businesses, governments, and non-governmental organizations in more than seventy countries to provide information, tools and analysis to address problems like food and energy security, water management, urbanization, and climate change. Our focus is on how to grow the economy, while protecting it for our grandchildren.

My testimony has three main themes. First, the United States can achieve a low-carbon future and provide global leadership by harnessing key drivers of economic growth. Second, the U.S. has set an ambitious but achievable emissions reduction target for 2025 in its Intended Nationally Determined Contribution. Third, the leadership the U.S. is demonstrating at home is paying significant dividends, helping to spur greater action by all countries around the world, both developed and developing.

First, a growing body of evidence shows that economic growth is not in conflict with efforts to reduce emissions of greenhouse gases. The Global Commission on the Economy and Climate, which delivered a landmark report in 2014, *Better Growth, Better Climate: The New Climate Economy Report*, has shown that the perceived choice between growth and climate action is a false dilemma.[1] New evidence is demonstrating that smart climate policies promote economic efficiency, drive technological advances, provide policy predictability for investors, generate huge economic co-benefits, and reduce the negative impact on growth of climate change itself.

The United States has tackled many environmental problems over the past 50 years, and the historical record is clear: environmental protection is compatible with economic growth, and environmental policies have delivered huge benefits to Americans. Furthermore, recent experience at the state and national levels demonstrates that well-designed policies can reduce greenhouse gas emissions while providing overall net public benefits, for example, through improved public health, as well as direct financial benefits to businesses and consumers.

The solutions typically lie in improved efficiency in resource use, smarter city growth, more efficient development of rural areas, cleaner fuels, and new technologies and processes – and these solutions often create net economic benefits. For example, we know that increased efficiency pays off. With strengthened fuel efficiency standards, drivers will save on average a net $3,400 to $5,000 over the life

of light-duty vehicles built in 2025 compared with those made in 2016. Federal appliance efficiency standards put into place over the past twenty-five years resulted in $370 billion in cumulative utility bill savings. States with energy efficiency targets and programs in place are saving customers at least $2 for every $1 invested.[2]

Other countries also recognize the benefits of acting on climate change. In the lead-up to the Paris climate summit, more than 180 countries have put forward national climate action plans (known as Intended Nationally Determined Contributions, or INDCs) that both address climate change and can generate better growth for their economies.[3]

Businesses have recognized the economic value of action. More than eighty major global companies, including eighteen U.S. companies – including Dell, Coca-Cola, General Mills, and Procter & Gamble – have committed to setting emissions reductions targets in line with science.[4] And recognizing the global nature of their operations, more than 80 U.S. companies – including Alcoa, Bank of America, Cargill, Coca-Cola, General Motors, Microsoft, PepsiCo, UPS, and Walmart – recently signed a pledge in support of a strong international agreement and committed to significant actions in their own supply chains.[5] Six major U.S. banks and investors also recently signed a statement supporting strong international action in order to set clear expectations and market signals.[6] Around 435 businesses worldwide already use an internal carbon price to guide investment decisions. For a number of major oil companies – including Shell, BP, Exxon-Mobil, and ConocoPhillips – the internal carbon price is typically around $40/t CO2.[7]

Taking action is essential because no nation is immune to the impacts of climate change and no nation can meet the challenge alone. Every nation needs to work together, take ambitious action, and do its share. The United States has always provided leadership when the world faces big challenges, and climate change should be no exception. That leadership can ensure a livable planet for ourselves and future generations.

With global GHG emissions still on the rise, delaying action on climate change will only result in climate-change-related events becoming more frequent and severe, leading to mounting costs and harm to businesses, consumers, and public health. The new EPA report, *Climate Change in the United States: Benefits of Global Action*,[8] estimates billions of dollars of avoided damages in the U.S. that would result from global efforts to reduce greenhouse gas emissions, ranging from reduced damage to agriculture, forestry, and fisheries, to reductions in coastal and inland flooding, to fewer heat-driven increases in electricity bills.

If nations fail to combat climate change together, the U.S. will suffer billions of dollars of damages to agriculture, forestry, and fisheries, and to coastal and inland flooding, along with heat-driven increases in electricity bills, just to cite some of the impacts. A recent report from the CNA Military Advisory Board – composed of retired high-ranking military officers – also highlighted the increased threats to national security from the effects of climate change.[9] It is thus in our national interest to act at home so that we can work with other countries to achieve a universal international agreement where all countries act and where the most severe impacts in the U.S. can be avoided.

Second, the U.S. has set an ambitious but achievable emissions reduction target for 2025 in its INDC. WRI research finds that the United States can meet this target using existing federal laws combined with actions by the states. The United States can accelerate recent market and technology trends in renewable energy, energy efficiency, alternative vehicles, and many other areas to reduce emissions 26–28 percent below 2005 levels by 2025. However, U.S. and global efforts to combat climate change cannot stop in 2025. Even deeper greenhouse gas (GHG) emission reductions will be needed in the decades ahead to avoid the worst impacts of climate change. In the meantime, however, the Administration is taking sensible steps to encourage recent market and technology trends that move us toward a low-carbon future. These measures would be even more effective if complemented by measures that only Congress can take.

The United States can achieve the INDC target in concert with economic growth. Over the next decade, the proposed Clean Power Plan will play a key role in meeting the INDC target. Damage to health from air pollution in the United States is estimated to amount to as much as 4% of GDP per year on average.[10] From a benefit-cost perspective, EPA estimates that just the air pollution co-benefits of the Clean Power Plan are worth $25-$62 billion, far more than the estimated $7-9 billion in compliance costs.[11] Adding in global climate benefits increases total benefits to $55-$93 billion.

Third, the leadership the U.S. is demonstrating at home is paying significant dividends, helping to spur greater action by all countries around the world, both developed and developing. The national climate plans (INDCs) that countries have submitted for the 2015 climate agreement represent action by a wide diversity of countries. Of the 183 countries that have submitted national plans, 142 of them are developing countries.[12] The historic Joint Announcement on Climate Change by the United States and China last year, along with the recent Joint Presidential Statement, also demonstrate the tremendous shift in action by countries around the world.[13]

The national climate plans will deliver significant reductions in emissions. Analyses of the INDCs come to the conclusion that the implementation of INDCs would contribute to significant reductions of global GHG emissions compared to business as usual (approximately 3-8 gigatons of greenhouse gas emissions reduced in 2030). The International Energy Agency's Energy and Climate Change Report estimates that the path set by the INDCs would be consistent with an average global temperature increase of around 2.7 degrees Celsius (4.8 Fahrenheit) by 2100,[14] compared to an almost 4 degrees Celsius temperature increase given business as usual (BAU) policies.[15]

Moreover, the agreement that will be reached between all countries at the climate summit in Paris will be a major step forward in meeting U.S. objectives on climate change internationally. The agreement will be universal and applicable to all, will ensure transparency, and will be durable and effective. Building on and implementing the United Nations Framework Convention on Climate Change (UNFCCC), which was ratified by the Senate in 1992 by voice vote, the agreement will mark a critical step forward by involving action to reduce emissions by all countries, both developed and developing. Its structure, based on nationally-determined plans, has enabled broad-based participation and buy-in from all countries and sets a new pathway for international action.

The agreement will also include vital provisions on transparency and accountability to provide assurance that all countries are following through in meeting their targets. The agreement must also be durable, able to accommodate countries' evolving development and economic circumstances and ensure that all countries continue to move forward in a regular and timely way toward a commonly understood objective. Finally, it must be an effective agreement, driving the finance and investment needed for low-carbon climate resilient pathways from an array of countries and actors, including the private sector, while also meeting the need to address the serious impacts experienced by all countries, and especially the most vulnerable.

The action that countries around the world are taking, along with the international framework to support that broad-based action, should be viewed as a significant success for the United States and its leadership role. Meeting the global challenge of climate requires global solutions, including actions by all. The world is now on the cusp of an international climate agreement that will concretize that vision.

My testimony is organized as follows: Section I discusses why the United States can take meaningful climate actions while growing the economy overall and why U.S. leadership on climate change is essential. Section II reviews technology and market trends in some key sectors and demonstrates how accelerating these trends can reduce carbon emissions while generating positive economic impacts. Section III presents an overview of WRI analysis showing how the United States can meet or exceed its INDC target with a portfolio of policies across key sectors. Section IV describes the national climate plans prepared by many countries and the benefits for the United States of the 2015 international agreement. Section V offers some concluding comments on climate policy.

I. Climate Protection and Economic Growth

A growing body of evidence had found that economic growth and action on climate change can now be achieved together. According to the New Climate Economy Report, the scale of investment over the next 15 years means we now have a huge opportunity to create better growth and reduce the risk of climate change. Around US$90 trillion globally will be invested in cities, land use and energy infrastructure between now and 2030.[16] Choosing to invest that money in a low-carbon way will bring multiple economic benefits and reduce the negative economic impacts of climate change.

Climate-smart policies promote economic efficiency, an area where the US has always been a global leader. These policies involve more efficient use of energy and natural resources, putting a price on greenhouse gas emissions, and removal of subsidies to fossil-fuels.

Efforts to reduce greenhouse gas emissions have already proven to be a win for local economies and jobs in the northeast United States. The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by nine New England and Mid-Atlantic states to cap and reduce emissions from the power sector. Economic growth in the nine RGGI states has been higher than in the rest of the states, at the same time as they have reduced their emissions by 18% compared to 4% in other states. The RGGI contributed a net benefit of $1.3 billion to these member economies in 2012-2014 alone, generating 14,200 new job years. All nine participating US states showed net job additions.[17]

Climate-smart policies also drive technological advances. They involve policies to support the research, development and deployment of new technologies. The growth of wind and solar power has consistently outstripped projections from the International Energy Agency.[18] The IEA's 2007 projections for renewables in 2030 have already been met.[19] Even Greenpeace underestimated how much solar would grow.[20] The US is a world leader in developing and deploying the technologies that drive tomorrow's prosperity.

In the coming years, the global clean energy market will expand dramatically, and it represents a significant opportunity for U.S. economic growth. The cost of LED lights has dropped 90% since 2008, large-scale solar by 60%, and wind and battery prices declined by over 40%. And with decreasing costs has come greater deployment. Since 2008, we've gone from 400,000 LED lightbulbs to more than 78 million installed, wind energy production has tripled, and solar has increased more than twenty-fold.[21]

It is imperative that the United States continues to lead on clean energy innovation. On Monday in Paris, President Obama announced how this will happen. The president, along with a wide range of other top global leaders, announced "Mission Innovation," an initiative by 20 countries to double their respective clean energy research and development investment over five years to address global climate change, provide affordable clean energy to consumers, and create additional commercial opportunities in clean energy.[22] Mission Innovation parallels a private sector effort, spearheaded by Bill Gates, which includes a coalition of over 28 significant private capital investors from 10 countries, and will be called the Breakthrough Energy Coalition.[23] The combination of public and private sector investment will ensure that large scale penetration of clean energy technologies.

Clean energy technologies will deliver hundreds of thousands of new jobs and deliver huge economic co-benefits in the United States. The U.S. solar industry is creating jobs twenty times faster than the overall economy.[24] There are already more solar workers than coal miners in the United States. A clean energy future could create on average 550,000 net jobs per year in the United States between now and 2050, according to a study from Synapse Energy.[25] Another new economic analysis from NextGen Climate America found that a clean energy economy will create more than 1 million additional jobs by 2030, increase U.S. GDP by $145 billion, increase household disposable income by $350-$400, and save families $5.3 billion on energy bills.[26]

Energy efficiency, another powerful way to reduce emissions, can also unlock savings for U.S. citizens. Investment in energy efficiency could boost global cumulative economic output by US$18 trillion by 2035, according to the New Climate Economy.[27] The United States' Energy Star program has already lowered household utility bills by an estimated US$360 billion since 1992.[28]

While total policy certainty can never be guaranteed, it is always important for policy-makers to look at ways of making policy more credible and predictable. Climate-smart policies can provide a credible and predictable policy environment, which investors from the US and around the world crave. A price on the emissions of greenhouse gases, research and development funding, feed-in-tariffs, and tax credits: these policies give private investors the confidence needed to invest in, and deliver, greater economic efficiency and innovation, which will drive the productivity of all forms of capital and growth.

Many of the pessimistic economic models cited by opponents of climate action have serious shortcomings, as described in the 2014 report of the Global Commission on the Economy and Climate (*Better Growth, Better Climate*):

> The view that there is a rigid trade-off between low-carbon policy and growth is partly due to a misconception in many model-based assessments that economies are static, unchanging, and perfectly efficient…. Indeed, once market inefficiencies and the multiple benefits of reducing greenhouse gases, including the potential health benefits of reduced air pollution, are taken into consideration, the perceived net economic costs are reduced or eliminated.[29]

Our country has tackled many environmental problems over the past 50 years. We have achieved major reductions in air and water pollution. We have reduced our exposure to toxics, and cleaned up and redeveloped industrial "brownfield" sites in our cities. In concert with other nations, we have taken steps to repair damage to the ozone layer. At every step along this road to protection of the environment and public health, opponents have raised the specter of excessive cost and economic disaster. Some opponents of President's emission reduction targets and the Clean Power Plan are raising this specter again now. However, the historical record is clear: environmental protection is compatible with economic growth, and U.S. environmental policies have delivered huge benefits to Americans. In 2010, The Office of Management and Budget reviewed 20 years of major Federal regulations (1999-2009) for which agencies estimated and monetized both benefits and costs, and found aggregate annual benefits of $128-$616 billion, while annual costs were estimated at $43-$55 billion. Research also shows that the actual cost of environmental regulations frequently ends up being less than *ex ante* predictions by industry, and even the EPA.[30]

The movement toward a low-carbon economy is already being demonstrated throughout the United States. Already between 2005 and 2012, greenhouse gas emissions dropped by 8 percent while real GDP grew by 8 percent.[31] Projections from the U.S. Energy Information Administration (EIA) estimate that the intensity of energy use in the economy will continue to decline through 2040, even in the absence of new policies. With reduced energy intensity in manufacturing, more efficient appliances and buildings, and more fuel-efficient vehicles coming to market, the overall economy is becoming more energy efficient. EIA projects that GDP will grow at an average 2.4 percent per year through 2040, while energy use will grow at only 0.4 percent per year.

Businesses have recognized the economic value of action. More than eighty major global companies, including eighteen U.S. companies – including Dell, Coca-Cola, General Mills, and Procter & Gamble – have committed to setting emissions reductions targets in line with science.[32] More than 80 U.S. companies – including Alcoa, Bank of America, Cargill, General Motors, Microsoft, PepsiCo, UPS, and Walmart – recently signed a pledge in support of a strong international agreement and committed to significant actions in their own supply chains.[33] Six major U.S. banks and investors also recently signed a statement supporting strong international action in order to set clear expectations and market signals.[34] 435 businesses worldwide already use an internal carbon price to guide investment decisions. For a number of major oil companies – including Shell, BP, Exxon-Mobil, and ConocoPhillips – the internal carbon price is typically around $40/t CO2.[35]

In the context of meeting the U.S. INDC target, the proposed Clean Power Plan will play a key role. The Energy Information Administration projects the macroeconomic impacts of the proposed plan to be very small: approximately a 0.12% decrease in GDP in 2030, which can be considered "background noise" in the context of a steadily growing $24 trillion economy. Employment impacts are essentially zero.[36] From a benefit-cost perspective, EPA estimates that the air pollution co-benefits alone are worth $25-$62 billion, far more than the estimated $7-9 billion in compliance costs.[37] Adding in global climate benefits increases total benefits to $55-$93 billion.

To get the full economic picture, one must also assess the cost of the impacts of climate change. Failure to reduce emissions will increase economic, social, and environmental risks for the United States and all nations.[38] With global GHG emissions still on the rise,[39] delaying action on climate change will only result in climate-change-related events becoming more frequent and severe, leading to mounting costs and harm to businesses, consumers, and public health. Climate smart policies reduce these negative impacts on growth.

We are becoming more aware than ever of the true costs of a high carbon economy in the United States. Inaction on climate change could reduce the United States' per capita GDP up to 36% by the end of the century, according to a new estimate from leading researchers in *Nature*.[40] Damage to health from poor air quality, much of which is associated with burning fossil fuels, is valued at about 4% of GDP, according to the New Climate Economy.[41] Urban sprawl is immensely expensive, raising the costs of infrastructure and service delivery up to 40% and costing the United States around $1 trillion per year.[42] Subsidies and tax breaks for the production of oil, coal, and gas cost U.S. federal and state governments approximately $20.5 billion annually, distorting investment and consumption choices.[43]

The new EPA report, *Climate Change in the United States: Benefits of Global Action*,[44] estimates billions of dollars of avoided damages in the U.S. that would result from global efforts to reduce greenhouse gas emissions, ranging from reduced damage to agriculture, forestry, and fisheries, to reductions in coastal and inland flooding, to fewer heat-driven increases in electricity bills. We are already experiencing the effects of climate change. Last year the world experienced the hottest year on record in 2014.[45] Fourteen of the fifteen hottest years on record have occurred since 2000.[46] In the United States, some regions are experiencing a higher frequency of flooding, heavier precipitation events, and more frequent heat waves and wildfires.[47]

Extreme weather events are expensive. Between 1980 and 2014, the United States experienced 178 extreme weather and climate events that cost at least $1 billion each with total damages of more than $1 trillion.[48] The frequency and severity of these types of events have increased over the same period, with four of the six years with the most billion dollar disasters on record in the United States have occurred since 2010. Hurricane Sandy cost New York City $67 billion, with power outages, subway tunnel flooding and other problems persisting well after the storm.[49] A similar increase in these costly events is happening around the world. [50,51] While many factors contribute to the cost of these events, such as growing population density and increased development in vulnerable areas more prone to extreme events, increasing global temperatures and climate variability are making certain types of these costly events more frequent and severe.

According to Risky Business, if we continue on our current emissions path without significant adaptation, by the end of the century some states in the Southeast, lower Great Plains, and Midwest risk up to a 50% to 70% loss in average annual crop yields (corn, soy, cotton, and wheat), absent agricultural adaptation.[52]

The true costs of a continuing with a high-carbon economic growth model in the United States are much higher than previously realized, and they are rising as concentrations of greenhouse gases in the atmosphere increase year on year. The true job killer is inaction on climate change – not the solutions we need to stop it.

Moreover, a recent report from the CNA Military Advisory Board – composed of 16 retired three- and four-star military officers – highlighted the increased threats posed to national security by the effects of climate change, including massive population displacement, conflicts due to food and water scarcity, and health catastrophes.[53] These are not only security threats, but also present substantial potential costs to our military and humanitarian relief agencies.

U.S. leadership is critical to the success of the global efforts necessary to avoid billions of dollars in damaging costs to our country. That leadership is paying off as countries have submitted their INDCs and as we move toward an agreement in the international climate negotiations that culminate in Paris.

II. Technology Trends and Emission Reduction Potential in Key Sectors

Many of the key drivers of economic growth—including more efficient use of energy and natural resources, smart infrastructure investments, and technological innovation—can also drive the transition to a low-carbon future.[54] Early efforts to address conventional air and water pollution often relied on end-of-smokestack or end-of-pipe controls. However, in the case of carbon pollution, the solutions typically lie in improved efficiency in energy use, cleaner fuels, and new technologies and processes. Though upfront investments are often needed, these solutions often create net economic benefits rather than costs. The United States can bring the same spirit of competition, ingenuity, and innovation to the climate challenge that it has brought to solving other problems, or it can be left behind as other countries develop the solutions and capture the markets for the fuels, technologies, and processes that reduce emissions.

Opportunities for cost-effective emission reductions are arising across many sectors of the economy. For instance, the capital costs of wind and solar photovoltaic systems continue a rapid downward trend.[55] For example, Texas has seen wind generation multiply 12-fold since 2002, and solar generation in the state has more than doubled since 2011.[56] Over 102,000 people are directly employed in renewable energy sectors in Texas, with thousands more working in businesses linked to renewable energy. Well-crafted energy efficiency programs are lowering utility bills and reducing energy demand, which indirectly reduces GHG emissions.[57] Increased production of low-cost shale gas, while raising concerns about methane emissions and other environmental impacts, has spurred fuel switching away from coal in power generation, reducing carbon dioxide (CO_2) emissions.[58] Technological progress on many fronts

promises to create further opportunities, from creating climate-friendly refrigerants to breakthroughs in electric and fuel cell vehicles.[59]

Nevertheless, market barriers still exist, hindering investment and implementation of strategies needed to transition the United States toward a prosperous low-carbon economy. These barriers take many forms and cut across many sectors. For example:

- Split incentives - The natural gas sector is not very well vertically integrated – many independent companies work along the supply chain without ever taking ownership of the natural gas itself. For this reason, the incentives to invest in control technologies to reduce methane emissions are often poorly aligned.
- Ownership transfer issues - In the residential sector, homeowners may not invest in energy efficient products or home upgrades, thinking they may move before reaping the cost savings.
- Network effects - Widespread penetration of alternative vehicles depends on availability of charging stations, but investment in charging stations may be limited while relatively few alternative vehicles are on the road.[60]

Overcoming these barriers will require targeted policies and measures, including GHG and efficiency standards, more research and development to stimulate innovation, and policies to stimulate market demand for new technologies.[61] The sections below explore opportunities in some key sectors.

A. Producing Cleaner Electricity

The U.S. power sector has already started to transition to a lower-carbon future.[62] In 2013, carbon dioxide (CO_2) emissions were 15 percent below 2005 levels because of a shift in fuel mix and slower demand growth. Coal's role appears to be diminishing while natural gas and zero-carbon alternatives are on the rise. The economics of all generation sources are shifting and if these trends continue, deep greenhouse gas reductions are possible from the power sector, with some parts of the country possibly achieving net savings. In many cases, the public health benefits outweigh the costs of replacing older, inefficient, and heavily polluting generation with newer, more efficient, cleaner generation.

The recent decline in the carbon intensity of the power sector has been caused in large part by the low price of natural gas.[63] Because of lower prices, gas-fired generation has surged and coal fired generation has declined. New coal plants accounted for only 5 percent of the new capacity built since 2000.[64] This trend could accelerate as many existing coal plants struggle to compete with electricity from natural gas and renewable energy sources and if more protective public health standards are put in place. Existing natural gas plants certainly have the capacity to increase output. In 2014, the fleet of combined-cycle natural gas plants ran at only about 48 percent capacity[65]—well below their design capacity of 85 percent. Less coal generation would bring not only reductions in CO_2 emissions, but also would likely bring reductions in a variety of harmful pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury.

Despite its reputation as a clean fuel, natural gas production, processing, transmission, and distribution still leak methane emissions while its combustion results in substantial CO_2 emissions, presenting long-

term challenges for the fuel, in absence of adoption of technologies that reduce methane leaks and cost-effective carbon capture and storage technology. However, natural gas is still essential in reducing power sector emissions. Replacing all existing coal generation with combined-cycle gas generation could reduce power-sector CO_2 emissions by 44 percent below 2012 levels.[66] In addition, as variable generation from resources such as wind and solar increases, grid operators will look to flexible resources such as natural gas to help ensure grid reliability. As a result, natural gas could play an important role even in an aggressive greenhouse gas abatement scenario.

Renewable generation has been on the rise in recent years, and evidence suggests that it could play an even more significant role in the future. Generation from renewable resources accounted for 12.5 percent of total generation in 2013 – nearly half of which came from non-hydropower sources.[67] Renewables represented 85% of the increase in power generation in 2014.[68] Wind and solar outcompete new coal generation in many markets, and are competitive with low-cost natural gas generation in a few markets. As a result, increased renewable energy generation has the potential to save American ratepayers tens of billions of dollars per year over the current mix of electric power options, according to studies by Synapse Energy Economics and the National Renewable Energy Laboratory.[69] These cost savings are illustrated by some recent actions at the state level:

- The Grand River Dam Authority, Oklahoma's state-owned utility, purchased 100MW of wind energy that is estimated to "save its customers about $50 million over the project's lifetime".[70]
- DTE Energy in Michigan announced that it would be lowering customers' electricity rates by 6.5 percent in 2014, citing low-cost wind energy (aided by technology improvements and tax credits) as a major factor.[71]
- Austin Energy in Texas finalized a power purchase agreement for 150 megawatts of solar energy, with a price just under 5 cents per kilowatt hour (estimated at 7 cents per kilowatt hour before federal tax credits).[72] By comparison, the company estimates that new natural-gas-fired generation would have cost 7 cents per kilowatt hour, coal would have cost 10 cents, and nuclear 13 cents.
- MidAmerican Energy in Iowa recently announced that it will invest $1.9 billion in new wind power, bringing wind generation up to 39 percent of their generation portfolio.[73] The company estimates that this will save $10 million annually when all the turbines are completed. This work will create 460 construction jobs, 48 permanent jobs, and generate more than $360 million in new property tax revenue.

While the variability of renewable generation creates some challenges for grid balancing authorities, renewables have considerable room to expand on the grid. Several studies have shown that existing grids across the country can handle about 35 percent generation from variable renewable resources with minimal cost.[74] This is partly because of improvements in renewable energy forecasting and sub-hourly supply scheduling, as well as recent increases in transmission infrastructure.[75,76] Utilities may also see the value in using renewable energy (with zero fuel costs) as a hedge against the uncertainty surrounding future coal and natural gas prices.[77]

Over the longer term, however, as renewable penetration continues to increase with expected declines in equipment costs, the United States would benefit from expanded transmission[78] and increased system flexibility. This could be done, for example, through increased grid storage, distributed generation sources, and demand response.[79]

Nuclear power provides zero-carbon baseload generation. In 2013, it produced 20 percent of total U.S. electric generation[80] and as of mid-2014, three new nuclear plants were under construction, the first new plants since 1996.[81] However, several nuclear reactors closed in 2013[82] and some analysis suggests that some other plants are struggling to remain viable because of cheap natural gas, low renewable energy prices, lower demand for electricity, and rising costs for nuclear fuel, operations, and maintenance (particularly the smaller, older, standalone units).[83] Continued retirements could prompt an increase in fossil baseload generation and lead to an overall increase in CO_2 emissions from the power sector. Even if these pressures do not force nuclear capacity to retire prematurely, the nation will eventually need to replace some of these units as they reach the end of their useful lives. Well-designed policies that value low-carbon generation could help improve the economics of the existing fleet, and could spur the construction of new nuclear units, particularly if increasing international development of nuclear plants leads to reductions in construction costs. Any expansion, however, will likely depend on solving the challenges of public concerns about nuclear safety and long-term waste storage.

EPA's Clean Power Plan (CPP), finalized in August 2015, will build on and accelerate many of these positive trends noted above by establishing CO_2 emissions standards for existing power plants under section 111(d) of the Clean Air Act. These standards incentivize the use of lower carbon sources of electricity generation, like natural gas, renewables, and nuclear, as well as incentivize programs that reduce the overall demand for electricity. EPA projects that the CPP will reduce power sector CO_2 emissions by about 28-29 percent below 2005 levels by 2025 and by 32 percent by 2030.[84] The CPP also offers huge health benefits at four to nine times the amount of compliance costs. In total, the standards are expected to result in $32 to $54 billion in health benefits and global climate benefits per year by 2030, far outweighing the costs of $5.1 to $8.4 billion.

Given current technology trends in renewable power, these estimates may actually be overly conservative, and deeper reductions may be possible at a net public benefit. For example, when examining deep emission reductions in the power sector (approximately 61 percent below 2005 levels in 2030), the Union of Concerned Scientists found that on an annualized basis, benefits to Americans from reduced SO_2 and NOx emissions alone would total $56 billion in 2025, growing to $69 billion in 2030 (equal to 5 and 10 times the annual compliance cost to the power sector).[85] And studies have also shown that a more rapid decarbonization of the power sector in the post-2020 time period is technically possible as well as legally defensible.[86]

B. Reducing Electricity Consumption

The U.S. economy is becoming more efficient as a result of development and deployment of new technologies supported by state and federal policies. This success is largely due to the fact that smart investments in efficiency save money. Federal appliance standards implemented since 2009 alone are expected to save consumers nearly $450 billion because of lower electricity bills through 2030. [87,88,89]

State efficiency portfolios regularly save customers over $2 for every $1 invested, and in some cases up to $5.[90] And efficiency has been the cheapest resource option available to utilities for decades, with levelized costs one-half to one-third the cost of new electricity generation options. [91,92] Harnessing efficiency as a resource leads to high-quality jobs in manufacturing, installation of efficient appliances, home energy auditing, and more. In part due to the expansion of efficiency programs, energy consumption is expected to grow at less than 0.5% per year on average through 2040 even as GDP grows by nearly 2.5% per year.[93] But even greater opportunities to capture efficiency and associated savings can be captured by scaling up successful programs and implementing new initiatives.

The discussion below focuses specifically on homes and commercial buildings (with efficiency opportunities in transportation and industry discussed later). In buildings, electricity demand growth has fallen from about 8 percent per year in the early 1970s to about 1 percent per year today.[94] This is in part due to a robust and growing portfolio of both regulatory and voluntary energy efficiency initiatives including:

- ***Appliance and equipment standards, labeling, and research and development***
  Customers have saved over $370 billion (net) as a result of lower utility bills from 1987 through 2012 as a result of federal appliance and equipment standards that set minimum energy efficiency levels for more than 50 products commonly used in homes and businesses.[95] This success has been achieved in part because major appliances—including refrigerators, dishwashers and clothes washers—have become 50 to 80 percent more energy efficient over the past two decades. Appliance and equipment standards are complemented by other federal and state initiatives, including research and development, partnerships with industry, competitions (e.g., L-prize and ENERGY STAR awards), voluntary labeling programs (e.g., ENERGY STAR and the Federal Trade Commission's Energy Guide), and rebates and incentives for efficient appliances. Together, these programs can drive innovation and commercialization of products that are more efficient than the minimum required by standards, as has been demonstrated in many product areas including lighting, water heaters, and clothes dryers.[96] The Institute for Electric Innovation projects that pushing forward on new federal appliance and efficiency standards could reduce total electricity use by 6–10 percent below projections in 2035.[97]

- ***State energy efficiency savings targets***
  Twenty-four states currently have mandatory electricity savings targets that require utilities and third-party administrators to offer energy-saving programs to their customers.[98] Most state targets require incremental electricity savings of 1 percent of projected electricity sales or more each year once programs are fully ramped up, with a few requiring savings in excess of 2 percent per year. Scaling up state energy efficiency savings targets so that each state achieves savings of 2 percent annually would reduce electricity consumption in the range of 400–500 terawatt hours in 2035 (9–11 percent of total projected electricity sales),[99] and save customers tens of billions of dollars in the process.

- ***State building energy codes***

Building codes help ensure that new construction and buildings undergoing major renovations and repairs meet minimum efficiency standards. According to the DOE, codes adopted between 1992 and 2012 have saved approximately 2 quads in cumulative total energy savings, about 20 percent of the total energy directly consumed by homes each year. The codes are expected to net more than $40 billion in energy cost savings over the lifetime of the buildings constructed during this time period.[100] To date, many states have adopted the 2007–09 codes for commercial and residential buildings. However, only about one-quarter of states have adopted the most up-to-date codes for residential and commercial buildings. The new codes reduce building energy use by 20 and 25 percent, respectively, compared with the 2007–09 standards—leaving the door open for greater savings by other states.[101]

The continued emergence of new technologies—enabled by partnerships between federal agencies, manufacturers, and businesses—will create ongoing opportunities for savings. For example, DOE recently reached an with agreement manufacturers and efficiency advocates on the terms of an updated efficiency standard for commercial rooftop air conditioners that will net $50 billion in utility bill savings for businesses over 30 years.[102,103]

DOE is also working with industry to advance adoption of next-generation intelligent energy information systems and controls that provide whole-building, web-accessible data in real time. These systems allow facility managers to identify wasted energy, with the potential of cutting building electricity use by as much as 30 percent.[74] Whole-building retrofits with the latest technologies have been shown to reduce building energy use in the range of 30 to 50 percent or greater, in some cases.[104] And the jobs needed to perform retrofits—including assessment, installation and maintenance of efficient appliances and systems—can't be sent overseas.

But opportunities to cut energy use and utility bills still exist. Studies suggest that electricity demand could be reduced 14 to 30 percent below projected levels over the next two decades, creating hundreds of billions of dollars in net savings for consumers while significantly reducing U.S. greenhouse gas emissions.[105] These opportunities remain because of the persistence of a number of market barriers to investment in efficient technologies. For example, building owners frequently have little incentive to invest in efficiency if they do not pay the energy bills and therefore do not experience the financial benefits, another example of the "split incentives" problem noted earlier. Building occupants may not expect to capture the full lifetime benefits of an investment, thus creating "ownership transfer" issues**.** This is because residential energy efficiency measures have an average payback period of about 7 years, whereas about 40 percent of homeowners will have moved within that duration of time. Other market barriers, including capital constraints and lack of knowledge of the lifecycle costs and benefits of products, can also prevent the implementation of cost-effective efficiency measures. The United States can harness more of this potential and continue to save money for consumers and businesses in the near to medium term by scaling up existing programs and implementing new policies.

The EPA has an important role to play by making sure that the Clean Power Plan takes into account all cost-effective energy efficiency potential when developing state-specific standards. This would encourage more widespread deployment of state efficiency programs, leading to greater demand

reductions and savings for consumers. The U.S. Department of Energy (DOE) and EPA also should continue to scale up their existing programs, which are already delivering benefits many times greater than their costs. This includes continuing to strengthen existing appliance standards (for example, for residential boilers, commercial unit heaters); setting appliance standards for equipment not currently covered (for example, for ovens, commercial ventilation equipment, general service lamps); increasing funding for research, development, and deployment of efficient technologies and processes; expanding partnerships with businesses and industry (for example, DOE's Better Buildings Challenge); and expanding efficiency labeling programs (for example, ENERGY STAR). New and strengthened appliance standards and less energy-intensive manufacturing together with the Clean Power Plan could lead to total electricity demand reductions of at least 9–10 percent below projected levels in 2025 and 11–13 percent in 2030.

These policies should include or be complemented by other state, federal, and local actions including: (1) updates to building codes and improvements to their enforcement, (2) measures to promote retrofits of existing buildings, and (3) expanded access to low-cost finance for efficiency projects.

C. Cleaner & More Fuel Efficient Transportation

The U.S. transportation sector is becoming less carbon intensive due in large part to the most recent federal GHG emission and fuel economy standards covering light-duty cars and trucks (model year 2012–25). A declining growth rate in vehicle miles traveled (VMT) by passenger vehicles also has contributed to declining emissions from light-duty vehicles over the past decade. Looking ahead, existing and proposed standards for medium- and heavy-duty vehicles and the development of CO2 standards for aircraft will continue to increase the efficiency of the U.S. transport system, leading to even more fuel savings for households and businesses.

1. Passenger Vehicles

The Administration started to take bold action in this sector in 2010 when EPA and DOT established GHG and fuel economy standards for MY 2012-2016 passenger vehicles, and again in 2012 when these standards were expanded again to roughly double the fuel economy of model year 2025 vehicles. In response to these rules, car manufacturers have been utilizing advanced technologies to increase the fuel economy of their fleets- the number of sport utility vehicle models with a fuel economy of at least 25 miles per gallon (mpg) has doubled over the last five years, while the number of car models with a fuel economy of at least 40 mpg has increased sevenfold.[106] Analysis shows that, because of this technology advancement, car manufacturers are actually outperforming the current standards and are on track to meet the model year 2025 standards.[107] As new vehicles become more efficient, they will also save consumers money, improve air quality, and increase energy security by lowering oil demand. Once fully implemented, owners are expected to save on average $3,400 to $5,000 (net) over the life of their vehicle, compared with model year 2016 vehicles. The automobile industry may even be on the brink of an even greater transition. Advances in electric vehicle battery technology, along with the anticipated roll out of fuel cell vehicles in the 2015–17 could transform automobile industry. Battery prices have fallen by more than 40 percent since 2010. Some industry analysts are predicting that by the

early 2020s, long-distance electric vehicles will be cost-competitive with internal-combustion-engine vehicles, thanks to fuel price savings, even without federal incentives.[108]

2. Transportation and Land Use

Transportation policies can also reduce passenger vehicle travel demand, thus lowering fuel use and emissions from vehicles. Passenger vehicle travel demand is already growing more slowly now than in the past decades, from an average growth rate of 3 percent per year from the 1970s to mid-2000s to 0.9 percent per year between 2004 and 2012 (measured in vehicle miles traveled).[109] Multiple factors are likely in play in this slowdown: the economic recession, changing demographics, high costs of driving (including rising fuel prices until late 2014), changing consumer preferences, as well as policy initiatives. It is uncertain whether these trends will continue or whether travel demand growth will rebound due to continued recovery from the recession, population growth, changes in oil prices (such as the rapid declines that occurred in late 2014), or other factors.

State and local policies should aim to provide more safe, reliable transit options for citizens, for instance through compact development patterns coupled with improved public transportation and routes for walking and biking. DOT, EPA, DOE, the U.S. Department of Housing and Urban Development, and other federal agencies can encourage and support these efforts in a number of ways, including increased funding for public transit infrastructure, implementation of performance criteria for funding that incentivizes compact development and related strategies, research and development, tax policies that promote infill development (such as renewal of the Federal Brownfield Tax Incentive), and technical assistance.[110]

3. Medium- and Heavy-Duty Trucks

The medium- and heavy-duty truck sector also presents opportunities to reduce emissions while saving fuel costs. Current medium- and heavy-duty vehicle GHG and fuel consumption standards are estimated to result in $49 billion in net benefits to society (from fuel savings, CO_2 reductions, reduced air pollution, improved energy security due to decreases in the impacts of oil price shocks, and other benefits) over the lifetime of model year 2014–18 vehicles.[111] On June 19th, EPA and DOT proposed a second round of standards for the post-2018 time frame that would increase the fuel efficiency of medium-and heavy-duty vehicles up to 40 percent by 2027 compared to 2010 levels.[112] This level of fuel savings can be achieved using technologies that are currently available—such as tractor and trailer aerodynamic enhancements, hybridization and electric drive, and weight reduction, among others—that are estimated to have an average payback period of less than two years.[113] EPA should finalize the second round of standards in a timely manner and take the full potential of these cost-effective technologies into account.

4. Aviation

The United States has also taken steps to address GHG emissions from airplanes through its emission reduction plan for aviation.[114] The Federal Aviation Administration has initiatives in place to improve fuel efficiency through operations, including establishing direct routes and reducing delays, under its Next Generation Air Transport Systems program.[115] And on June 10th, EPA took the first steps toward setting a

carbon dioxide emissions standard for commercial airplane engines. In anticipation of an international aircraft CO_2 emissions standard, expected from the International Civil Aviation Organization in 2016, EPA released an advanced notice of proposed rulemaking establishing the groundwork and seeking public input on relevant issues like timing and stringency.[116] It's not yet clear what the international standards will deliver, but studies show that there's significant room for improvement in aircraft fuel efficiency, in the range of 20-30 percent or greater in the 2025-30 timeframe through use of improved engines, lower weight and reduced drag.[117] EPA should set standards that take full advantage of these technologies, aiming to improve the fuel efficiency of new aircraft in the range of 2-3 percent annually. FAA should also continue to expand its initiatives to enhance the management of air travel.

D. Cleaner Industry

Industry is a broad category that includes a wider range of economic activities than the residential, commercial, and transport sectors. The energy and emissions intensiveness of industrial activity varies among manufacturing, construction, agriculture, energy transformation, mining, and forestry subsectors.[118] Total U.S. industrial sector emissions peaked at 1.9 billion metric tons of CO_2 in 1979 and have intermittently declined since the late 1990s. Between 2010 and 2014, real U.S. industrial sector value-added grew by 7 percent while total industrial sector energy-related carbon dioxide emissions dropped by one percent.[119] Emissions reductions have been driven by a combination of efficiency improvements, cleaner energy use, changing product mix, and additional combined-heat-and-power (CHP) utilization.[120] While the U.S. industrial sector has become more efficient, studies suggest that it can move forward at an even faster pace, reducing energy consumption by 15 to 32 percent below 2025 forecast values.[121] In 2014, total U.S. industrial sector emissions amounted to 1.5 billion metric tons CO_2, which covered 27 percent of total U.S. energy-related CO_2 emissions.[122]

The industrial sector presents a large challenge and opportunity for moving the United States to a prosperous low-carbon economy. The Administration's commitment to reduce U.S. emissions can improve industrial competitiveness by catalyzing innovation and investment. U.S. firms can leverage low-cost clean energy and efficiency improvements to expand production and market share.[123] Given that the vast majority of U.S. emissions increases to 2040 are expected to come from industry and manufacturing sector growth,[124] this sector has a unique opportunity to benefit from forward-thinking policies and new investments. Recent studies have clearly demonstrated the positive economic, employment, and competitiveness benefits of investing in U.S. industrial energy efficiency. In 2012 Congress passed the American Energy Manufacturing Technical Corrections Act, which mandated that the Secretary of Energy should produce a report on the deployment of industrial energy efficiency in the United States. One high-level finding of the report, which was published in June, was that a $5 billion Federal matching industrial energy efficiency grant program implemented over a 10-year period would help support up to 9,700 to 11,200 jobs per year for the life of the program and help manufacturers save $3.3 to $3.6 billion per year in energy costs by Year 5 of the grant program, and $6.7 to $7.1 billion per year by Year 10 of the grant program.[125] The Administration's Climate Action Plan and international commitments offer a framework for re-invigorating U.S. industry in a low-carbon economy.

Within the industrial end use of energy, energy efficiency improvements (including technical improvements, material efficiency, and waste reduction) and fuel-switching are the primary levers for industrial sector emissions reduction, in addition to reductions from combined heat and power usage. Industrial sector demand, as reflected in the value of shipments, is expected to grow by more than a third between 2015 and 2030.[126] This growth creates opportunities for investments in efficiency and for well-designed policy interventions.

Industrial energy efficiency is inhibited by persistent barriers, including financing (such as intra-company competition for capital, corporate tax structures that allow companies to treat energy expenditures as tax offsets, split incentives, and energy price trends), regulation (monopolistic utility business models and cost-recovery mechanisms, exclusion of efficiency from energy resource planning), and informational barriers (ignorance of incentives and risks, unavailable energy use data, and lack of technical expertise).[127] Industrial sector demand growth combine with barriers to energy efficiency improvements to create a range of opportunities and challenges that will influence the absolute level of total U.S. GHG emissions.

A 2010 National Academy of Sciences study estimated a cost-effective energy efficiency improvement potential of 14 to 22 percent for the U.S. industrial sector by 2020.[128] Numerous state and federal policies have been enacted to accelerate industrial sector efficiency improvements. These include regulations for equipment via emission performance standards under Boiler Maximum Achievable Control Technology (MACT); EPA's New Source Performance Standards; market and rate design that helps to reduce industry sector GHG emissions by promoting clean distributed generation; tax credits, exemptions and/or deductions; technical assistance from federal government agencies such as DOE's Better Buildings, Better Plants Program;[129] and research grants such as Advanced Research Projects Agency-Energy[130] and DOE's Advanced Manufacturing Office[131] programs.

Reducing industrial sector GHG emissions below current levels will require additional investment and policy action. Government can combine ambitious minimum performance standards for sources, along with voluntary benchmarking and labeling programs to encourage further industrial efficiency improvements.

E. Improved Production, Processing and Transmission of Natural Gas

Methane is the primary component of natural gas, and is therefore a valuable commodity.[132] It is also a potent greenhouse gas, with at least 34 times the global warming power of carbon dioxide.[133] Emissions of methane and other air pollutants occur throughout the natural gas life cycle, creating unnecessary waste along with damage to the local environment and the global climate. [134] Without additional policies, methane emissions from natural gas systems are expected to grow 4.5 percent by 2018, and to continue to grow slowly over the coming decades.[135] But the right policies will encourage investment in cost-effective technologies and best practices that companies can use to reduce waste, save money, and cut harmful emissions of methane and other pollutants.[136]

Dozens of proven technologies that minimize leaks and vents of methane are currently available and deployed across the United States. However, their use remains uneven largely because of market

barriers that impair the ability of drillers and other service providers to capture the increased revenue by changing equipment and practices. In addition to the "split incentives" noted above, these barriers include:

- ***Imperfect Information:*** Because emissions measurement technology is still expensive and not widely used, many companies do not have a complete picture of how much methane they are emitting, and from which sources. Most companies, therefore, are not aware how much money they can save by investing in technologies that reduce methane emissions.

- ***Opportunity Costs:*** Investing capital or engineering capacity in equipment to reduce or eliminate natural gas leaks represents an opportunity cost for owners and operators of natural gas systems as investments in projects that reduce wasted natural gas compete with other potential investments, primarily the drilling of new production wells or other measures to increase natural gas production. Even though most emissions-control technologies pay for themselves in three years or less, that may not compare favorably to other investment opportunities.

While some companies active throughout the natural gas supply chain—from production through distribution— have already recognized the economic advantages of investing in technologies that reduce methane emissions, many have not. Voluntary measures reduce about 20 percent of methane emissions from natural gas systems, according to EPA.[137] But existing voluntary measures merely skim the surface of available, cost-effective emissions reduction opportunities, according to recent studies from the Natural Resources Defense Council (NRDC) and ICF Consulting.[138] This suggests the states and the federal government have ample opportunity to implement additional standards requiring reductions in methane emissions to overcome these barriers.

EPA's 2012 standards to reduce emissions of hazardous air pollutants, and volatile organic compounds are expected to significantly reduce methane emissions, saving the industry approximately $10 million per year in 2015 because the value of the avoided emissions of natural gas is greater than the cost of equipment to capture it (annual savings are estimated at $330 million versus $320 million in compliance costs). Importantly, these savings do not consider the benefit of reducing methane emissions and conventional air pollutants. EPA estimates that the standards will reduce emissions of volatile organic compounds by 172,000 metric tons in 2015 alone.[139] Some studies have found that the health benefits due to improved air quality could be as high as $2,640 per metric ton of volatile organic compounds nationwide, with even higher benefits in some localities.[140]

EPA rulemakings have taken the first steps by indirectly reducing methane emissions in this sector, and recently proposed methane standards for new and modified oil and gas infrastructure[141] are an important step in the right direction, but much remains to be done. One recent study estimated that 40 percent of emissions from onshore gas development can be eliminated at an average cost of a penny per thousand cubic feet.[142] EPA should propose and finalize standards on both new *and* existing natural gas systems by 2017, and phase in implementation through 2020, to reduce methane leakage by 67 percent below business-as-usual projections. This can be achieved using existing technologies, many of which pay for themselves in three years or less.

F. Reducing Emissions of High Global Warming Potential Gases

HFCs are used primarily for refrigeration, air conditioning, and the production of insulating foams. HFC emissions have been increasing because they are a replacement of ozone-depleting substances (chlorofluorocarbons and hydrochlorofluorocarbons) under the Montreal Protocol and Clean Air Act. Unfortunately, some HFCs have very high global warming potential (GWP). Fortunately, alternatives with low GWPs are increasingly available. Several companies have begun to use these alternatives, with many saving money and energy while they reduce GHG emissions.[143] For example:

- Coca-Cola uses CO_2 in 1 million HFC-free coolers and aims to purchase only CO_2-based equipment by 2015.[144] Because of its transition to CO_2-based technology for new equipment, Coca-Cola has improved its cooling equipment energy efficiency by 40 percent since 2000, and reduced its direct greenhouse gas emissions by 75 percent.[145]
- Coolers introduced by PepsiCo, Red Bull, Heineken, and Ben & Jerry's are based on hydrocarbons including propane (R-290) or isobutane (R-600a). These companies combined have more than 600,000 units in use today and have seen energy efficiency improvements from 10 to 20 percent or even greater.[146]
- Fifteen car companies, including General Motors, Ford, and Chrysler, are moving forward with HFO-1234yf,[147] a new low-GWP refrigerant for personal vehicle air conditioners that has a GWP 99.9 percent lower than the HFC it replaces.[148] An estimated 1 million cars on the road worldwide already use this low-GWP refrigerant.[149] This number is expected to grow to nearly 3 million by the end of 2014.[150]

However, some low-GWP replacements have relatively high upfront costs, require the replacement of old equipment, or require equipment redesign.[151] Thus, there is little reason to believe that the U.S. market will rapidly move to these alternatives without new rules or other incentives.

The United States (with Canada and Mexico) has advocated for the past several years for an amendment to the Montreal Protocol that would phase down the use of HFCs globally. Agreement was finally reached in early November at the 27th Meeting of the Parties to the Montreal Protocol to negotiate the terms of this amendment. These negotiations will be conducted during 2016 through a series of additional meetings, with the HFC amendment to be adopted in November 2016.[152] However, to help reduce the use of HFCs domestically pending this amendment, EPA has started to implement measures that address high-GWP HFC use in personal vehicles and in pickups, vans, and combination tractors.[153] In February 2015, EPA finalized rules through the Significant New Alternatives Program (SNAP) program to approve low-GWP alternatives[154] and in July 2015, EPA finalized rules to move some higher-GWP HFCs out of the market for various applications.[155] In October 2015, EPA proposed a rule that will help capture, reclaim and recycle more HFCs from existing equipment to reduce the amount of new HFCs produced.[156]

Opportunities exist to make HFC reductions beyond those finalized by EPA to date. While a global phasedown, through the Montreal Protocol, would be much more effective than a few individual countries taking action alone, EPA can continue using the SNAP program to jump start the removal of

high-GWP HFCs from the market when low-GWP alternatives become available. However, it will be important for EPA to ensure that new alternatives are both safe and efficient.

III. How the United States Can Reach Its INDC Target

As demonstrated in the previous sections, opportunities are emerging across the economy in multiple sectors to harness fuels, technologies, and processes in moving toward a low-carbon economy. The actions taken to date by the Obama Administration under the Climate Action Plan seize many of those opportunities and set an important foundation for meeting its target of reducing emissions 26–28 percent below 2005 levels by 2025, as outlined in its Intended Nationally Determined Contribution (INDC).

In May 2015, WRI published *Delivering on the U.S. Climate Commitment: A 10-Point Plan Toward A Low-Carbon Future.* This study demonstrates that the United States can meet, and even exceed, its INDC target with a broad policy portfolio using existing federal laws combined with actions by states. This would include expanding and strengthening some current and proposed policies and standards and taking actions on emission sources that are not yet addressed. Since we completed our analysis, the Administration has already started to move on some of the additional actions we identified as necessary for the US to meet its INDC target, including taking steps toward improving the efficiency of medium- and heavy-duty trucks, aircraft, and rooftop air conditioning units.

Figure 1 presents emissions projections for three low-carbon pathways that could reduce U.S. emissions by 26–30 percent below 2005 levels by 2025 and 34–38 percent by 2030. *Delivering on the U.S. Climate Commitment* outlines specific steps federal agencies and state governments can take to achieve these reductions, recognizing that other pathways could reach those targets as well by applying different policy portfolios. Notably, our pathways do not include steps to reduce emissions and increase sequestration from the agriculture and forestry sectors. However, in April 2015, the Administration announced an initiative titled *Building Blocks for Climate Smart Agriculture & Forestry*.[157] USDA expects this comprehensive set of voluntary programs and initiatives to reduce net emissions and enhance carbon sequestration by over 120 million metric tons of CO2 equivalent per year by 2025. The opportunities in agriculture and forestry reinforce the notion that there are multiple pathways to achieve the U.S. INDC target.

Figure 1. Net U.S. Greenhouse Emissions: Reference Case and Low-Carbon Pathways Using Existing

Federal Authorities and Additional State Action

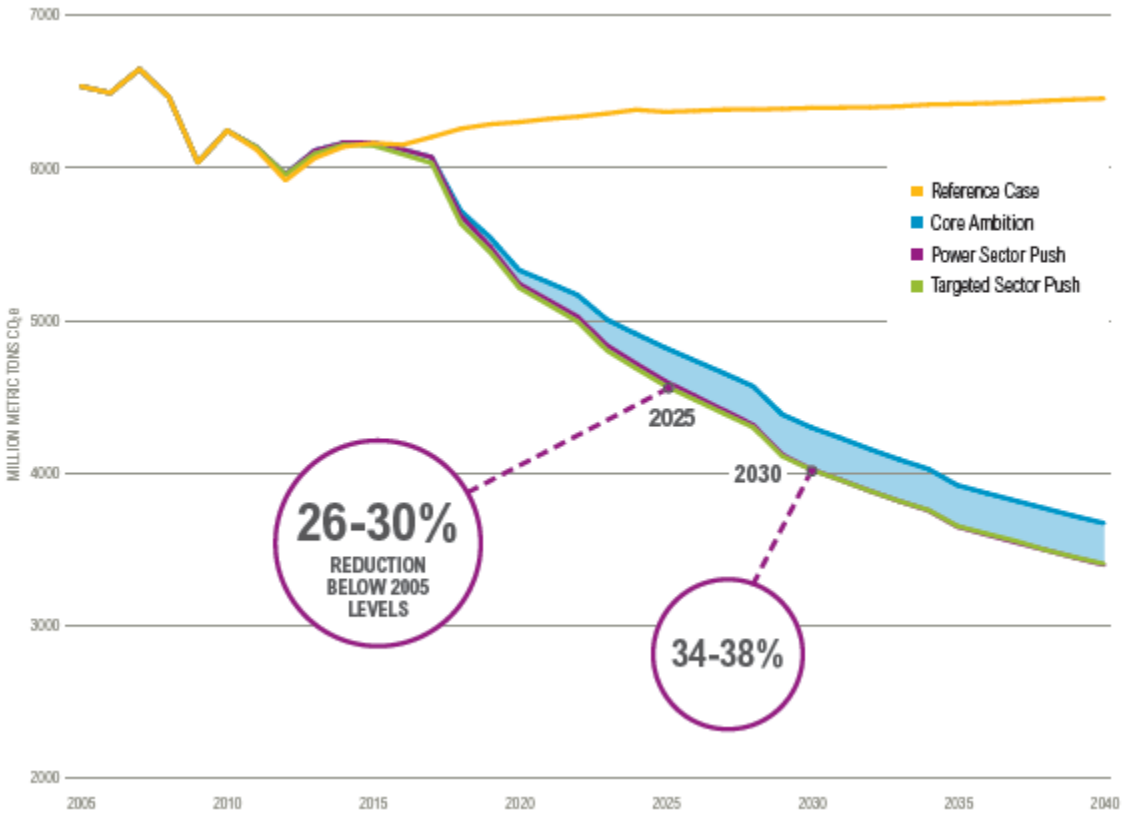

Figure 1 depicts net GHG emissions under three low-carbon pathways we modeled in our analysis that could be pursued using existing federal laws and additional state action. The "Core Ambition" pathway reflects the EPA's Clean Power Plan (CPP), in addition to emission abatement opportunities across other sectors of the economy. (The modeling is based on the CPP as proposed, however, the reductions projected in 2025for the final rule are nearly the same.) "Power Sector Push" builds on Core Ambition by assuming that states and utilities go beyond the CPP to take advantage of cost-effective energy efficiency resources and continued decreases in renewable energy costs. "Targeted Sector Push" assumes that the CPP, but pushes the envelope in a few key areas outside the power sector to achieve economy-wide reductions similar to "Power Sector Push". Both of these pathways were designed to achieve very similar levels of emission reductions, illustrating alternative ways to go beyond a 26 percent reduction across the economy, either through increased action in the power sector or outside the power sector. The shaded area between the pathways indicates that reductions anywhere in this range are possible given mixtures of policies that blend these three pathways. The full report contains all the details and assumptions underlying these pathways and the Reference Case projection, and the modeling approaches used.

IV. International Action

A. Intended Nationally Determined Contributions (INDCs) and National Climate Actions

The leadership shown by the United States has paid substantial dividends internationally. In the lead-up to the Paris climate summit and the 2015 international climate agreement, we have witnessed an unprecedented level of commitment to climate action by a wide array of countries, both developing and developed. As of November 30, 2015, 183 countries, including all major economies, have submitted national climate plans for the 2015 climate agreement.[158] These plans, known as Intended Nationally Determined Contributions (INDCs), are from countries representing more than 95 percent of global greenhouse gas (GHG) emissions.[159] This unprecedented effort indicates countries' increased seriousness in addressing climate change.[160]

The recently released UNFCCC INDC synthesis report finds that these INDCs represent a much greater breadth of countries than those submitted in 2010,[161] when only 100 countries submitted plans in association with the Copenhagen Accord and the Cancun Agreement.[162] We are also witnessing an extraordinary effort from developing countries in the lead up to the Paris negotiations. In 2010, only 33 developing nations announced a national climate plan.[163] As of November 30, 2015, 142 developing countries – including 46 least developed countries – have submitted an INDC, through which they outline their plans to mitigate emissions and adapt to a changing climate. Only two least developed countries (LDCs) have yet to submit an INDC.[164]

The effect of these plans on climate policies will be considerable. Of the plans submitted, those from at least 123INDCs include a greenhouse gas emissions target, usually expressed as a percent reduction by a certain year. By contrast, of the countries with pledges adopted for 2020 targets in association with the Copenhagen Accord and the Cancun Agreement, only 61 included greenhouse gas emissions targets, less than half of those with such targets in the current INDCs.[165]

Countries are also using their INDCs to outline significant policies and actions that support the deployment of clean energy and help countries adapt to the effects of climate change. In the plans submitted, more than 100 INDCs include plans to scale up clean energy between 2020 and 2030, as they look for ways to limit greenhouse gas emissions while sustaining economic growth, boosting energy security and providing energy access to the billions of people who lack it now.[166] More than half of these plans include specific targets for increasing renewable energy supply.[167]

In addition to addressing mitigation, the plans from at least 135 INDCs include adaptation,[168] describing activities and goals in vulnerable sectors like water, agriculture and human health. Most countries clearly identify existing gaps, barriers and needs associated with adapting to their local climate change impacts, which begins to outline a roadmap for global efforts to build capacity, develop and share technology, and scale up adaptation finance.[169]

As a whole, INDCs not only address climate change, but also address domestic goals such as sustainable economic growth and poverty reduction. Importantly, the INDCs signal a new phase of climate policy, in which climate action is strongly rooted in domestic policies and national development and economic agendas and aligned with country priorities.[170]

1. Developing Countries' Plans and Actions

The climate actions of major developing countries are particularly worth noting. Last year's U.S.-China Joint Announcement on Climate Change was an historic agreement that included unprecedented actions by China. China committed to reach a peak in its carbon dioxide emissions around 2030 and make best efforts to peak earlier, and to increase the non-fossil fuel share of its energy use to around 20 percent by 2030.[171] China's INDC, submitted in June 2015 for the Paris climate agreement, formalized these targets and also set additional targets to reduce the carbon intensity (carbon emitted per unit of GDP) of its economy by 60 to 65 percent from 2005 levels by 2030 and to increase its forest stock by around 4.5 billion cubic meters.[172] In addition to national targets, eleven cities and provinces from across China committed to reach a peak in their carbon emissions before the national goal to peak around 2030.[173] This group comprises a quarter of China's urban carbon emissions, roughly equivalent to the total annual carbon emissions of Japan or Brazil.[174]

China has made significant progress in decoupling emissions from economic growth in recent years and is on track to exceed the carbon intensity and energy intensity targets in its 12th Five Year Plan.[175] These are key steps to achieving China's commitment to reduce its carbon intensity by 40 to 45 percent from 2005 levels by 2020.[176]

China's 2030 targets are in line with even stronger efforts. A 2014 study by MIT and China's Tsinghua University found that a scenario with emissions leveling off between 2025 and 2035 and slowly declining after that involves stronger measures well beyond current policies, including a rising price on carbon.[177] Stronger steps will also be needed to achieve the non-fossil target. China will need to install 800-1,000 gigawatts (GW) of non-fossil fuel electricity generation capacity to achieve its 2030 non-fossil energy target, greater than its current coal-fired capacity and almost the total current electricity generation capacity of the United States.[178]

Expert projections[179] of a peak in China's carbon emissions and an increased share of non-fossil energy are supported by several major building blocks: scaling up non-fossil energy, limiting coal use,[180] improving energy efficiency, placing a price on carbon, and rebalancing the economy from heavy industry toward services.[181] China is already taking significant action in each of these areas.

China led the world with nearly a third of global investment in renewable energy in 2014,[182] is the world leader in installed wind power capacity,[183] and has set targets to roughly double its 2014 wind capacity to 200 gigawatts and more than triple its 2014 solar capacity to 100 gigawatts by 2020.[184] China has banned new coal plants in three key industrial regions[185] and many provinces have targets to reduce

coal use.[186] China has been strengthening and expanding policies to increase energy efficiency across its economy, including targets for the efficiency of coal plants,[187] energy-saving targets for industrial enterprises,[188] building energy codes,[189] and fuel economy standards.[190] President Xi Jinping recently announced that in 2017 China will launch a national emissions trading system,[191] which has the potential to be a powerful instrument to reduce emissions over time.[192] Finally, China is seeking to shift away from its old growth model driven by investment in energy-intensive industry toward a new model driven by consumption, services, and advanced manufacturing,[193] which should have an emissions reduction benefit.[194]

China is working on including additional steps in its upcoming 13th Five Year Plan, to be released early next year.[195] Signs of a recent decline in China's coal use[196] and other trends have led some experts to predict that China's coal use may have already reached its structural peak (controlling for cyclical factors)[197] and that China's emissions will likely peak before 2030, consistent with the government's stated aim to make best efforts to peak early.[198]

Other major developing countries have also taken important steps forward. In its INDC, Brazil has set a target of reducing emissions by 37 percent below 2005 levels by 2025,[199] becoming the first major developing country to commit to an absolute reduction of emissions from a base year. Brazil also plans to increase the share of renewables (other than hydropower) in the power supply to at least 23 percent by 2030. This will increase Brazil's renewable electrical capacity (excluding hydropower) by an estimated 48 gigawatts, more than quadrupling 2012 levels.[200] The country also has set a target to achieve zero illegal deforestation by 2030 in the Brazilian Amazon. Over the past decade, the rate of deforestation in the Brazilian Amazon has already dropped by 70 percent compared with the previous decade, keeping 3.2 billion metric tons of carbon dioxide (CO_2) emissions out of the atmosphere.[201] This is equivalent to taking all U.S cars off the road for three years.[202]

India has set goals to substantially increase its renewable energy capacity to 175 gigawatts by 2020, including increasing its solar capacity to 100 gigawatts—a twentyfold increase from current levels of 4 gigawatts—and increasing its wind power capacity to 60 gigawatts.[203] The solar target is more than half the total global installed capacity of 181 gigawatts of solar energy in 2014.[204] In its INDC, India builds on this targets by committing to increase its non-fossil fuel power sector capacity to 40 percent by 2030. India's INDC also commits to reducing the greenhouse gas intensity of its economy (greenhouse gases per unit of GDP) by 33-35% below 2005 levels by 2030. India will also create an additional carbon sink of 2.5 to 3 billion tons of carbon dioxide through additional tree cover.[205]

Additional major developing countries have submitted INDCs that indicate a peak date for the absolute level of emissions. Mexico was the first developing country to release its INDC and plans to reduce its greenhouse gas emissions by 22 percent and its black carbon (soot) by 51 percent by 2030 relative to BAU levels.[206] The INDC indicates that the policy is expected to lead to a peak in emissions by 2026. South Africa joins China and Mexico in stating intended peaking years for emissions. South Africa's INDC provides a target to peak national greenhouse gas emissions between 2020 and 2025 and decline in absolute terms beginning no later than 2035.

2. Effect of INDCs on Global Temperature

Several recent studies have shown that the INDCs submitted will make a significant difference in reducing global emissions in comparison to current policy trajectories. All of the studies find that the INDCs collectively reduce global emissions relative to the current trajectory, though additional effort will be needed to limit the global temperature increase to a rise of less than 2 degrees Celsius (3.6 degrees F) above pre-industrial temperatures, the globally agreed goal for limiting climate change.[207]

The International Energy Agency's Energy and Climate Change Report[208] concludes that full implementation of INDCs would contribute to 4-8 gigatons ($GtCO_2e$) of greenhouse gas emissions reductions by 2030. The report estimates that the path set by the INDCs would be consistent with an average global temperature increase of around 2.7 degrees Celsius by 2100. That contrasts with the Agency's projections of an almost 4 degrees Celsius temperature increase by 2100 given business as usual (BAU) policies.[209]

The Synthesis Report of the INDCs conducted by the UNFCCC estimates that the implementation of INDCs would result in emissions in 2025 that are 2.8 gigatons (and up to 5.5 gigatons) of greenhouse gas emissions ($GtCO_2e$) lower than current policy trajectories and emissions in 2030 that are 3.6 gigatons (and up to 7.5 gigatons) lower. The synthesis report does not present the effect of INDCs on global temperature.[210]

The reports come to a similar conclusion that the implementation of INDCs would contribute to significant reductions of global greenhouse gas emissions (approximately 3-8 $GtCO_2e$ in 2030). Although the collective reductions of the INDC emissions targets are not yet sufficient to achieve the 2 degrees Celsius goal, progress has already been made. The INDCs represent approximately one third of the emissions reductions needed to meet the 2 degrees Celsius goal relative to current trajectories, and half of the reductions needed relative to the business as usual policies in place in 2010.[211] While more needs to be done in the coming years, the INDCs are an important first step in transitioning to a low-carbon economy and limiting global temperature increase. This will assist in avoiding some of the most costly impacts in the United States and in other countries.

Further action beyond the INDCs is in our economic interest, according to the New Climate Economy, in its 2015 report, *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. It identified actions in 10 key areas that can drive economic growth and development and achieve as much as 96% of the greenhouse gas emissions reductions needed by 2030 to keep global warming under 2°C.[212] These include investing in low-carbon cities, which could save urban areas around US$17 trillion globally by 2050 and reduce emissions by 3.7 Gt CO_2e and investing in energy efficiency measures, which could boost cumulative global economic output by US$18 trillion by 2035.

B. International Agreement

The leadership role played by the United States has helped to catalyze not only broad-based action by other countries, but also the momentum toward an international agreement that achieves a key set of aims for the United States.

First, and most important, the agreement is applicable to all countries. The Paris agreement will build on and implement the existing United Nations Framework Convention on Climate Change (UNFCCC), which was ratified by the Senate in 1992, and will mark a critical step forward by involving action to reduce emissions by all countries, both developed and developing.

The universality of the agreement is exactly what the United States has been seeking for many years in the international climate negotiations and should be viewed as a major success. It will be an agreement with a structure that removes previous question marks about action by China and other countries and puts in place clear pathways for action by all countries. This shift to a universal system is also the result of a process in the negotiations to generate national climate plans, the INDCs, at the national level in accordance with their national circumstances.[213] This sets a strong foundation for countries to achieve what they have set out in their INDCs.

Second, the Paris agreement is a critical opportunity to enhance the existing system of transparency and accountability to enable greater clarity and enhance trust about whether and how countries are fulfilling their INDCs. Following the UNFCCC Conference of Parties (COP) in Copenhagen in 2009 and the Conference of Parties in Cancun in 2010, all countries are required to track and report their emissions through a system referred to as Measurement, Reporting and Verification (MRV), with some differences for developed and developing countries in timelines and exact reporting requirements.[214] The Paris agreement can strengthen this system and ensure that developed and developing converge to the same MRV requirements over time (including through the use of capacity building support for developing countries to implement the requirements).

A robust system of transparency is very much in line with the values of openness and accountability that are so fundamental and deeply imbedded in the United States. It is essential to making sure that other countries are carrying out what they have said they will do. The MRV system also offers an opportunity to identify challenges that developing countries with limited capabilities may be facing and to work with them to address those barriers.

Third, it is vital that the Paris agreement is durable, designed not only for circumstances as they exist in 2015, but also for years to come. In part, the agreement must be flexible enough to accommodate evolving national circumstances, particularly as countries' capabilities continue to grow. Beyond that, the agreement must also ensure that all countries continue moving forward over time, regularly returning to review, revisit and update their national climate plans. This is essential to making this agreement universal over the long-term, ensuring that countries across the board continue to move forward in a regular and timely way, while also providing an opportunity to consider whether countries are doing their part to take adequate action. Establishing a long-term global goal for action to reduce

emissions can also help to ensure that all countries, not just some, are expected to move toward a common objective over time.

Fourth, the Paris agreement is an opportunity to effectively expand the scope of finance and investment needed to meet this challenge, bringing many new actors into the mix. Public funding remains essential, particularly to address the serious impacts of climate change on the poorest countries. But the substantial investment needed to shift our economies to low-carbon and climate resilient pathways also requires mobilizing and shifting the broader private sector financing that is so necessary to making progress.

Moreover, developing countries with greater capabilities are increasingly stepping up to play a meaningful role in climate finance. Chinese President Xi's recent commitment in the Joint Presidential Statement with President Obama that China would provide more than $3 billion in climate finance was a game changer.[215] Some developing countries have also now contributed to the Green Climate Fund, a central international funding mechanism.[216] The Paris agreement can reflect this shift and the key role of finance from developing countries that are ready to provide it.

Acting together with these other countries and private sectors investors, U.S. engagement to mobilize climate finance is a sensible investment. Especially by enabling vulnerable countries to build resilience to changing weather patterns, sea level rise, and extreme weather events, international climate change investments can help counter security threats that otherwise would have to be confronted with more costly interventions. The impacts of climate change must also be addressed to avoid undermining or reversing development gains in poor countries, especially those in vulnerable regions like Sub-Saharan Africa. An assessment by the World Bank illustrates how climate change increasingly threatens health and livelihoods of vulnerable populations, magnifying existing challenges to poverty alleviation.[217]

And, fifth, the Paris agreement can help catalyze action to address the impacts of climate change that are already being felt, especially in the most vulnerable and poorest countries. This is a challenge that affects us all – whether it is increased water scarcity and drought, vulnerable coastal areas facing sea-level rise, or growing risks to agricultural productivity. All countries need to work together to address these challenges, and the Paris agreement is a critical opportunity to catalyze collective action to build resilience to climate impacts. The United States has always stood with and supported the most vulnerable and poorest countries in tackling their challenges and should continue to do so today.

Meanwhile, there is more that will happen in Paris beyond the bounds of the international agreement itself. A major platform for actors other than national governments – including businesses and cities and states – will highlight the many actions and initiatives that are already underway to advance a low-carbon and climate resilient economy. Effective action on climate change cannot rest only on the actions of governments or agreements among them – it will depend on everyone playing a part.

V. Conclusion

The United States has the opportunity in the coming years to lay the foundation for a path to economic growth that delivers significant climate benefits. The key drivers of economic growth—including more

efficient use of energy and natural resources, smart infrastructure investments, and technological innovation—can also lead to a low-carbon future. By bringing a spirit of competition, ingenuity, and innovation to the climate challenge, the United States can be a leader in delivering the improvements in energy efficiency, the cleaner fuels, and the new technologies and processes that can lower emissions and create net economic benefits. With more than 50 years' experience in addressing environmental problems, the United States has demonstrated that environmental protection is compatible with economic growth, and environmental policies have delivered huge benefits to Americans.

The U.S. emissions reduction target of reducing emissions by 26 to 28 percent below 2005 levels by 2025 is both ambitious and achievable. Use of existing federal laws combined with actions by the states can help accelerate recent market and technology trends in renewable energy, energy efficiency, alternative vehicles, and many other areas in order to meet or beat that target.

It is very much in the national interest of the United States to play a leading role in addressing climate change. All nations will need to take ambitious action and do their share, since no nation is immune to the impacts of climate change and no nation can meet the challenge alone. U.S. leadership has already paid substantial dividends as we witness the wide variety of countries coming forward with their national climate plans and as we see the development of an international climate agreement that is universal, transparent, durable and effective.

The United States has always provided leadership when the world faces big challenges, and by acting at home, we can work with other countries to achieve an effective international agreement in which all countries act.

Thank you for the opportunity to testify before the Committee, and I look forward to answering any questions.

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[76] According to DOE, "more than 2,300 circuit miles of new transmission additions were constructed per year, with an additional 18,700 circuit miles planned over the next five years. By comparison, transmission was being constructed at a rate of about 1,000 circuit miles per year as recently as five years ago" Ryan Wiser and Mark Bolinger, "2012 Wind Technologies Market Report," U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, accessible at http://emp.lbl.gov/sites/all/files/lbnl-6356e.pdf, Bird et al., "Integrating Variable Renewable Energy: Challenges and Solutions."
[77] R. Wiser and M.Bolinger. "2013 Wind Technologies Market Report." Lawrence Berkeley National Laboratory. Accessible at: <http://emp.lbl.gov/sites/all/files/2013_Wind_Technologies_Market_Report_Final3.pdf>.
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[79] For more information, see M. M. Hand, S. Baldwin, E. DeMeo, J. M. Reilly, T. Mai, D. Arent, G. Porro, M. Meshek, D. Sandor (eds.), *Renewable Electricity Futures Study*, 4 vols. NREL/TP-6A20-52409, Golden, CO: National Renewable Energy Laboratory, accessible at http://www.nrel.gov/analysis/re_futures/.
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[82] According to EIA, four nuclear units closed in 2013 with additional closures announced for 2014, including Entergy's Vermont Yankee plant. U.S. Energy Information Administration, 2014, "Table 8.1: Nuclear Energy Overview," *Monthly Energy Review*, June 2014, accessible at http://www.eia.gov/totalenergy/data/monthly/pdf/sec8_3.pdf;
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[85] Union of Concerned Scientists. 2014. *Climate Game Changer*. Accessible at: <www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/Carbon-Standards-Analysis-Union-of-Concerned-Scientists.pdf>.
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standard and efficiency standard, or an "all cost-effective" energy policy, and are sufficiently funded to meet these targets. For more details, see http://aceee.org/sites/default/files/publications/researchreports/u1403.pdf.

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http://energy.gov/sites/prod/files/2014/02/f8/eveverywhere_blueprint.pdf). At this price point, along with other concomitant advancements, DOE expects long-range (280 miles) electric vehicles to be cost-competitive with internal combustion engines (on a levelized total cost of ownership basis over five years). DOE notes that shorter-range electric vehicles and plug-in hybrids would likely become cost-competitive before this price point for long-range electric vehicle batteries is met. Tesla Motors recently announced plans to build facilities by 2017 to produce large electric vehicle batteries that are 30 percent cheaper than today's batteries (around $190 per kilowatt hour, assuming current reported prices, see Chapter 3 for additional discussion).

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[117] U.S. Environmental Protection Agency, 2010, EPA Analysis of the Transportation Sector, http://www.epa.gov/oms/climate/GHGtransportation-analysis03-18-2010.pdf.

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[119] See real (2009) value-added data at http://www.bea.gov/industry/gdpbyind_data.htm; emissions data from http://www.eia.gov/totalenergy/data/monthly/pdf/sec12_7.pdf.

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[122] These emissions numbers include both direct emissions and indirect emissions attributable to electricity use. U.S. Energy Information Administration. "Table 12.4 Carbon Dioxide Emissions From Energy Consumption: Industrial Sector." *Electricity Power Monthly*. Accessible at: <http://www.eia.gov/totalenergy/data/monthly/>.
[123] For more information on emerging digital manufacturing technologies, see McKinsey's recent analysis at http://www.mckinsey.com/insights/manufacturing/manufacturings_next_act.
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[129] http://energy.gov/eere/amo/advanced-manufacturing-office
[130] http://arpa-e.energy.gov/
[131] http://energy.gov/eere/amo/advanced-manufacturing-office
[132] Methane is the primary component of natural gas, but gas also has significant concentrations of volatile organic compounds–many of which are precursors to ground-level ozone formation. Hazardous air pollutants are present in unprocessed natural gas. For more information, see R. Lattanzio, "Air Quality Issues in Natural Gas Systems," Congressional Research Service, March 2013, accessible at http://www.civil.northwestern.edu/docs/Tight-Shale-Gas-2013/Air-Quality-Issues-Natural-Gas-Ratner-2013.pdf.
[133] According to the latest estimates from the Intergovernmental Panel on Climate Change, because it is a powerful but short-lived greenhouse gas, methane traps 34 times as much heat in the atmosphere as CO_2 over 100 years, and 86 times as much over 20 years. See G. Myhre and D.Shindell, "Anthropogenic and Natural Radiative Forcing," in *Climate Change 20013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge, UK: Cambridge University Press, accessible at http://www.climatechange2013.org/images/report/WG1AR5_Chapter08_FINAL.pdf.
[134] Here, "natural gas systems" refers to the production of natural gas from natural gas wells, as well as the processing, transmission, and distribution of that gas. Natural gas produced at oil wells is not included. Similarly, the end use of natural gas – for electricity generation, transportation, residential heating, or other purposes – is not included.
[135] ICF International, 2014, "Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries," March, Fairfax, VA, accessible at http://www.edf.org/sites/default/files/methane_cost_curve_report.pdf.
[136] For more information on these technologies and practices, see Obeiter, M. and C. Weber. 2015. "Reducing Methane Emissions From Natural Gas Development: Strategies for State-Level Policymakers." Working Paper. Washington, DC: World Resources Institute. Accessible at: www.wri.org/publication/reducing-methane-emissions.
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