Revolution Required:

Meeting Current & Future Energy Challenges

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Climate Solutions is a Northwest-based clean energy economy nonprofit whose mission is to accelerate practical and profitable solutions to global warming by galvanizing leadership, growing investment, and bridging divides. We pioneered the vision and cultivated the political leadership in the Northwest for the proposition that clean energy and broadly shared economic prosperity can go hand-in-hand. For 17 years, we have led successful initiatives to deliver climate and clean energy policies, models, and partnerships that accelerate the transition from fossil fuels to a clean energy economy.

The **Strategic Innovation Team** at Climate Solutions focuses on developing solutions to reduce greenhouse gas emissions and remove carbon pollution from the atmosphere at the scale required to address the climate crisis. We identify the pathways to a low carbon future and create replicable models for emission reduction and carbon storage that provide economic as well as climate benefits, through the following programs:

- **Pathways Project** identifies, analyzes, and publicizes the pathways to transition from a fossil fuel-based economy to a low carbon, clean energy economy, focusing on the technically and economically viable solutions that will move the states of Washington and Oregon off of oil and coal.
- **New Energy Cities** partners with small- and medium-sized communities to achieve significant greenhouse gas reductions by 2030. We are catalyzing replicable models of city-led clean energy innovation by working with communities to set and attain quantifiable carbon reduction targets for buildings, transportation, and energy supply.
- **Sustainable Advanced Fuels** accelerates low carbon alternatives to petroleum fuels in the Northwest. By supporting state clean fuels policies, driving awareness of advanced fuel technologies, and helping to build a viable advanced fuels market, we aim to achieve significant reduction in carbon emissions from transportation fuels.

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Introduction

In the first half of the 21st Century, humankind must radically decrease its reliance on fossil fuel energy and embrace clean energy to limit the Earth's temperature rise to 2 degrees Celsius, meet global energy requirements, and ensure economic prosperity for current and future generations. At Climate Solutions, we view this task as daunting but achievable, as the myriad examples of energy transformation around the globe demonstrate, none more dramatically than in Germany. With the fourth-largest economy in the world and the largest in Europe,[1] Germany leads the world in decarbonization efforts.

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The paper describes Climate Solutions' programmatic focus; offers a brief overview of the history of energy in the United States since 1973, focusing on the impact of shale oil and gas exploration on American energy production and consumption; explores Germany's energy transformation (Energiewende); and reviews some regional renewable energy efforts in the United States, particularly efforts to chart the course to a low carbon future by 2050 in the Pacific Northwest.

"From a terrestrial standpoint, the biggest problem we need to solve on Earth this century is sustainable production and consumption of energy," Tesla founder **Elon Musk** speaking to astrophysicist Neil deGrasse Tyson on StarTalk Radio Show, March 22, 2015.

I. Climate Solutions Programmatic Focus

Climate Solutions is a United States Pacific Northwest-based climate and clean energy nonprofit organization that works to accelerate practical and profitable solutions to global warming by galvanizing leadership, growing investment, and bridging divides. Climate Solutions accepts the scientific consensus that fossil fuel reserves far exceed the carbon budget to which the world must adhere to avoid global warming of more than 2 degrees Celsius[2] and that we must rapidly ramp up a wide range of renewable energy sources along with energy efficiency to replace as much coal, oil, and natural gas as possible by 2050.

Meaningful technical and economic challenges exist with transitioning from fossil to non-fossil energy sources, as Germany is only too aware, but Climate Solutions believes these are manageable with the proper policies in place to encourage the required transition and discourage continued development of, investment in, and burning fossil fuels. The core challenge in the United States is that the oil, coal, and gas industries have a stranglehold on the American political system, which has thwarted progress, particularly at a national level, toward adopting a national carbon emissions reduction target, as well as various climate and clean energy policies that would put the country on the path to significant carbon reduction.

Furthermore, the fossil fuel industries have invested heavily[3] (and successfully) in sowing seeds of doubt that climate change is real and caused by humans, that renewable energy can ever replace fossil fuels, and that capitalism as we know it can survive the transition from fossil to non-fossil fuel energy. This manufactured "debate" about the reality and causes of climate change and the viability of solutions has significantly slowed progress on addressing the United States' carbon emissions, wasting critical time that is needed to quickly reverse dependence on fossil fuels.

In the absence of national climate policies, regional and local elected leaders throughout the United States have stepped up and taken meaningful action to address climate change. The places in North America where we have seen the greatest clean energy innovation are those that have put in place enabling policies, namely California's price and cap on carbon;[4] British Columbia's carbon tax;[5] the Regional Greenhouse Gas Initiative in nine northeastern and mid-Atlantic states;[6] as well as low carbon or clean fuel standards in Oregon,[7] California,[8] and British Columbia.[9] We have also seen progress at the local level in cities, counties, and states that do not have carbon pricing or clean fuel policies in place but have set, and are attempting to attain, meaningful carbon emissions targets and deploy climate and clean energy solutions to reduce their carbon footprints.[10]

Climate Solutions' policy and advocacy staff, in coalition with other nonprofit, labor, business, faith, and social justice organizations are working to put carbon pricing and clean fuel policies in place in Washington and Oregon to create a West Coast bloc of clean energy and climate action.[11] The combined economies of California, Washington, Oregon, and British Columbia rank fifth in the world, so a united West Coast climate action front would make a meaningful contribution to national and international efforts to address climate change.

Climate Solutions' Strategic Innovation program, which focuses on charting the pathways to a low carbon, clean energy economy in the Northwest, works with local leaders to accelerate the solutions that will address global warming and catalyze the transition to a clean energy economy. Our New Energy Cities program has worked with 17 small- and medium-sized communities[12] in Washington, Oregon, Idaho, and Wyoming over the past six years to chart a course for significant greenhouse gas (GHG) reductions by 2030 and create replicable models of low carbon communities. Since 2010, our Sustainable Advanced Fuels program has worked to accelerate the development of sustainable, low-carbon alternatives to petroleum fuels in the Northwest to achieve significant reduction in carbon emissions in the transportation sector.[13]

II. Overview of United States Energy

This section provides an overview of energy in the United States in three time periods: 1973-1986, 2000-2015, and the current state of affairs, with a focus on how shale exploration has impacted fossil as well as renewable fuels.

1973-1997

On October 6, 1973, after Egyptian and Syrian troops attacked Israeli positions in the Israeli-held occupied territories, the United States rallied to support Israel with military supplies, which prompted the Organization of Arab Petroleum Exporting Countries (OAPEC) to launch an oil embargo on October 17, 1973.[14] The price of oil quadrupled to nearly US$12 per barrel ($66.29 in 2015 USD) in one year[15] and for the first time in its history, the United States experienced an energy crisis: in February 1974, the American Automobile Association reported that 20 percent of American gasoline stations had no fuel.

With the memory of this crisis still fresh in the national memory, newly elected President Jimmy Carter made a coherent energy policy one of the cornerstones of his domestic agenda.[16] Describing the oil crisis as "the moral equivalent of war," Carter proposed oil import reductions, energy efficiency measures to insulate 90 percent of American homes, and symbolically installed 32 solar panels on the White House to produce hot water. President Carter also deregulated domestic oil prices, which spurred a significant increase in U.S. oil output and a sharp decrease in oil imports.[17]

The desire to decrease foreign oil dependence, combined with growing environmental awareness, prompted significant support for energy efficiency and solar energy technology at the federal and state level in the 1970s. Fuel economy standards were enacted in 1975, requiring manufacturers to sell more fuel-efficient cars. On May 3, 1978, President Carter announced the transfer of $100 million from nuclear and coal research & development (R & D) into solar R & D in the fiscal year 1979 budget, and directed his administration to prepare an extensive domestic policy review on solar energy.[18] Energy policy came into even sharper relief as the revolution in Iran prompted another oil price shock. Fueled by America's panic, crude oil prices crude oil prices more than doubled, rising from US$14.50 per barrel in 1978 (US$54.83 in 2015 dollars) to US$37 in 1981 (US$100.67 in 2015 dollars).[19]

However, President Ronald Reagan's election in 1980 heralded a prompt reversal of efforts to decrease petroleum reliance and develop renewable energy. President Reagan's first executive order removed price controls on oil and natural gas, leading to soaring oil and gas production, which, along with demand reductions associated with greater energy efficiency, and fuel-switching away from the use of petroleum for power generation, helped bring about a 50 percent decline in the price of oil.[20]

In six years, the Reagan Administration defunded the Department of Energy's renewable energy R & D budgets, discontinued wind and solar technology tax incentives, and symbolically removed the solar panels from the White House when reroofing. By 1986, the United States was recommitted to fossil fuels from foreign suppliers[21] and enjoyed more than a decade of stable or slightly declining oil prices, which allowed it to stop paying close attention to energy issues. In the halcyon days following the end of the Cold War and the long economic boom of the 1990s, the U.S. Senate refused to ratify the 1997 Kyoto Protocol, the first international attempt to commit nations to GHG reduction.

2000-2015

As the millennium dawned in 2000, a growing awareness of the danger that anthropogenic climate change posed to the planet, along with the fear of Peak Oil (the point at which the world would hit the maximum amount of extractable oil)[22], rekindled a public desire to reduce reliance on fossil-generated energy. Energy policy was slow to evolve under the George W. Bush administration, particularly given the influence of Vice-President Dick Cheney, who had close ties to coal, oil, gas, and nuclear industries.

It was not until the inauguration of President Barack Obama in 2009 that momentum shifted to renewables. To stimulate the American economy in the wake of the 2008 economic collapse, Obama proposed the American Recovery and Reinvestment Act of 2009 (ARRA), which authorized a significant economic commitment US$50.9billion) to energy efficiency, renewable energy, smart electric grids, clean transportation, electric vehicles, and advanced battery storage.[23]

However, the Obama Administration has also followed an "all of the above" energy strategy for the United States, encouraging exploration and development of oil, gas, and coal. The economics for natural gas production improved considerably in the 2000's due to both a significant uptick in the price of natural gas, as well as advances in cost-effective horizontal drilling and hydraulic fracturing technologies, or "fracking," which uses water and chemicals to blast oil and gas out of shale rock, making it possible to extract gas and oil from previously inaccessible sites.

Between 2007 and 2013, shale gas production increased from 5 percent to 40 percent of all U.S. natural gas production. The same fracking technology has also created access to deep underground deposits of shale oil, which boosted US oil production from 5 million barrels a day in 2008 to nearly 9 million in 2014.

American shale fields account for about as much petroleum production as the world's entire net growth in oil production since 2008. As a result, the U.S. has joined OPEC as a swing producer in world oil markets, able to ratchet production up or down depending on market conditions, even though in 2014 it was producing just 11 percent of world crude, compared with OPEC's 42 percent. The price of a barrel of oil dropped precipitously from US$100 a barrel in June 2014 to US$45 a barrel six months later. Today, the U.S. produces nearly as much oil as Saudi Arabia (the world's second-largest producer, after Russia) and is poised to overtake the desert kingdom.[24]

Despite its increases in domestic fossil fuel extraction, the U.S. still uses a disproportionate amount of the world's energy. Americans comprise less than 5 percent of the world's population, but consume 18 percent of the world's primary energy, and 21 percent of the world's petroleum, while producing only 15 percent of the world's crude oil.[25]

In 2014, the United States derived approximately 81 percent of its total energy from fossil fuels (35 percent petroleum; 28 percent natural gas; and 18 percent coal) for transport, industry, and

domestic use. Renewable energy comprised 10 percent, while nuclear electric power provided the remaining energy.[26] (See **Appendix A** for charts depicting U.S. energy consumption and production in 2014.)

In 2014 U.S. electricity was generated as follows: 67 percent from fossil fuels (39 percent coal; 27 percent natural gas; and 1 percent petroleum); 19 percent nuclear; 6 percent hydropower; and 7 percent other renewables (biomass 1.7 percent; geothermal 0.4 percent; solar 0.4 percent; and wind 4.4 percent).[27]

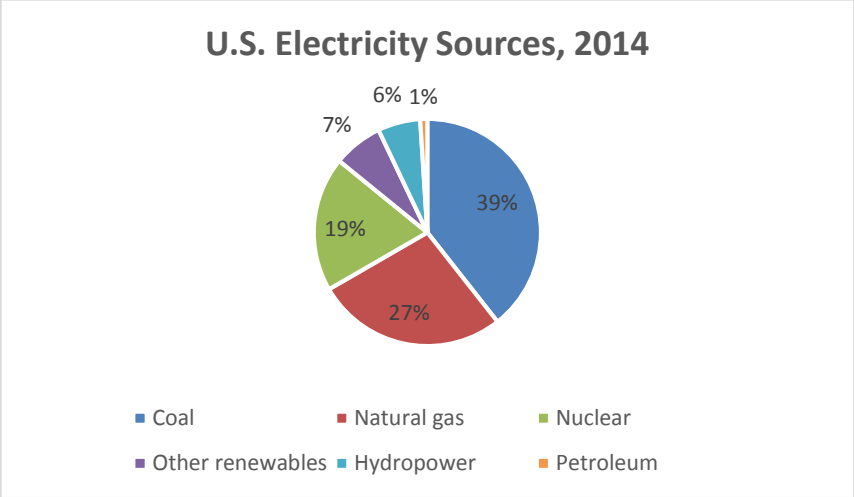

Figure 1: U. S. Energy Information Administration http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3

IMPACT OF SHALE EXPLORATION

Coal has been the biggest loser to abundant inexpensive natural gas. (Natural gas prices at roughly US$2.60 per thousand cubic feet are half what they were last year and 80 percent less than their peak in 2005. [28]) The U.S. Energy Information Administration's Annual Coal Report released on April 23, 2015, reported that:

- For the first time in two decades, U.S. coal production fell below one billion short tons to 984.8 million short tons in 2013, 3.1% lower than 2012;
- U.S. coal mine productive capacity decreased 2.5 percent in 2013;
- The average number of employees in U.S. coal mines fell 10.5 percent; and
- Coal's average sale price dropped 6.8 percent.[29]

Cheap natural gas is also causing challenges for the U.S. renewable energy market. The M.I.T. Energy Initiative estimates the following cost comparisons among natural gas, wind, and solar to produce one megawatt-hour of electricity: $40 for natural gas; $65-70 for water or land-based wind facilities; $130-140 for offshore wind and solar.[30]

Although the falling price of natural gas has eroded the profitability of renewables, technological advances in clean energy have kept it attractive economically. In 2014, the world

experienced an unprecedented boom in renewable energy investment as the cost of solar and wind dropped precipitously. The United Nations Environment Programme (UNEP) and Bloomberg New Energy Finance reported on March 30, 2015 that global renewable energy investments of US$270 billion increased 17 percent in 2014 from 2013: "Brushing aside the challenge of sharply lower crude oil prices, this sudden increase reversed the investment dip of the past two years,"[31] the report observed.

According to the UNEP-BNEF report, 92 percent of all renewable investments were in solar and wind last year. Wind investment set a record, increasing 11 percent to US$99.5 billion, while solar investment rose 29 percent to US$149.6 billion, the second highest figure ever. Record capacity of 49 gigawatts for wind and 46 gigawatts of solar PV were added globally. The costs of solar projects have fallen 59 percent since 2009, while onshore wind farm costs have fallen 11.5 percent, so more renewables are coming online at lower cost. [32] (See **Appendix B** for charts that demonstrate the explosive growth in solar energy jobs, investment in solar and wind, and the increase in solar and wind capacity in the past five years.)

> "In 2011, a record $279 billion in global renewables investments built wind and solar farms that were able to generate 70 gigawatts of renewable energy. Three years later, $270 billion built 95 gigawatts of solar and wind power generation worldwide — more than ever had been built before as costs fell." *Investments in Renewables Herald 'Paradigm' Shift—ClimateCentral*

The U.S. solar sector saw a 21.8 percent increase in solar employment, as 31,000 new jobs were added in 2014, for a total of 174,000 solar workers nationwide.[33] While the cost of wind-generated electricity fell more than 40 percent from 2011 to 2014, [34] the wind industry did not fare as well as solar because the U.S. Congress dithered about whether to extend the Production Tax Credit (PTC)—a federal subsidy of 2.3 cents for each kWh[35] of wind electricity produced. The PTC had been a major driver of wind power in the U.S., which quadrupled between 2007 and 2014, but uncertainty about the PTC caused investments to stall in 2013 and 2014. (See **Appendix C** for a chart that shows how uncertainty about the PTC has wreaked havoc with the wind industry.)

According to the Advanced Energy Economy's 2014 Advanced Energy Market Report, at US$16 billion in 2013, the U.S. is now the third-biggest market for solar PV in the world, and accounts for an estimated 18 percent of global revenue for solar PV, twice its market share from 2011.[36] Solar's market share is still too small to impact the price of other forms of energy, but as BloombergBusiness noted in October 2014, as its capacity expands, "Soon, for the first time, the reverse may also be true: Gas and coal prices will lose their sway over the solar industry."[37]

With the world now adding more capacity for renewable power each year than for coal, oil, and natural gas combined, it would appear that the shift to clean energy is underway, as the following Bloomberg New Energy Finance Report chart depicts:

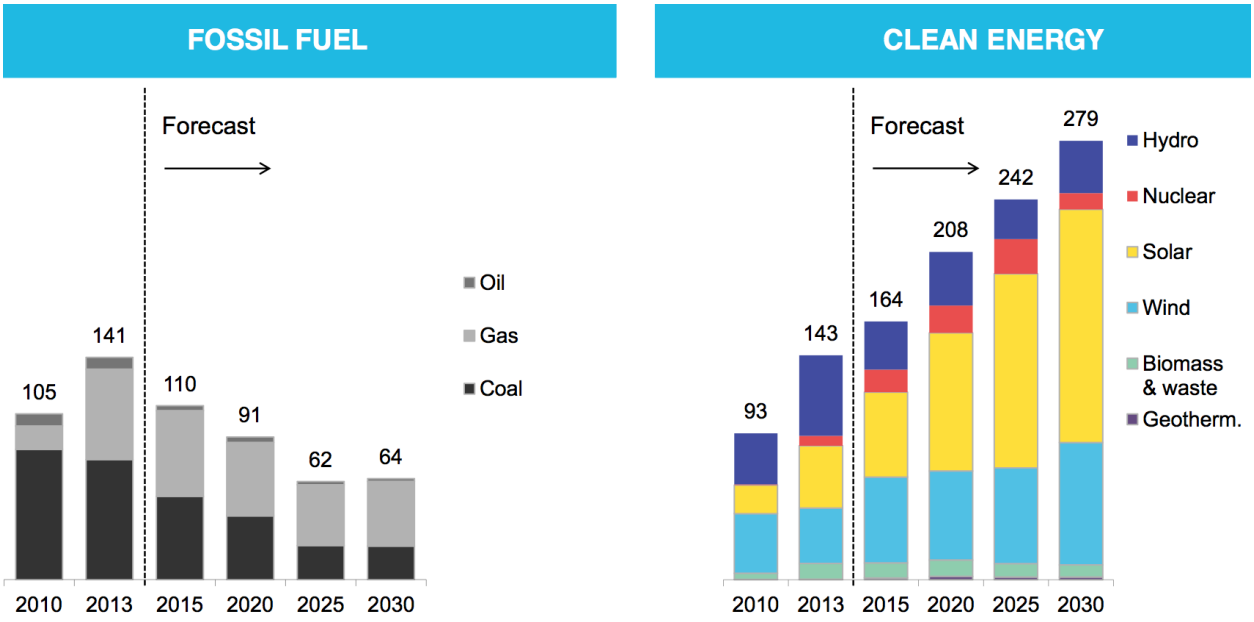

Figure 2. "Fossil Fuels Just Lost the Race against Renewables" Bloomberg, April 14, 2015
http://www.bloomberg.com/news/articles/2015-04-14/fossil-fuels-just-lost-the-race-against-renewables

It is likely that we will look back on 2014 as the turning point when renewable energy was no longer disadvantaged when fossil fuel prices dropped.

III. Germany's Energiewende

The United States has much to learn from Germany's energy transformation plan, *Energiewende*,[38] a model for shifting dependence on nuclear energy and fossil fuels to renewables and energy efficiency while maintaining reliability and economic growth.

In 2010, Germany pledged to achieve the following targets by 2050: greenhouse gas emissions to be reduced by 80-90 percent; renewables to provide 60 percent of power; and electricity efficiency to increase by 50 percent. Additionally, Germany set a goal of one million electric vehicles by 2020 and six million by 2030, along with an increased use of biofuels.[39] The Fukushima nuclear disaster prompted German Chancellor Angela Merkel to order the immediate closure of eight nuclear reactors, accelerating the phase-out of nuclear power.

> "It's pretty amazing what's happening, really," said Gerard Reid, an Irish financier working in Berlin on German energy projects. "The Germans call it a transformation, but to me it's a revolution." *The New York Times, September 14, 2014*

Germany has invested US$140 billion investment in renewable energy paid for through surcharges on electricity bills. A feed-in tariff, which sets a guaranteed premium price for the production of renewable energy fed to the electrical grid, has driven explosive growth in renewable energy. While Germany receives roughly the same amount of sunlight as Alaska (and significantly less than notoriously drizzly Seattle), the country boasts one-third of the world's installed solar capacity[40] and an electric grid that is "10 times

more reliable than those in the U.S., despite higher use of renewables." [41] In 2014, renewables comprised 27 percent of Germany's energy mix, displacing coal to become the number one source of power.

Of greater importance, however, is the fact that Germany appears to have successfully decoupled electricity usage from economic growth. According to Agoura Energiewende, a joint initiative of the Mercator Foundation and the European Climate Foundation, "Power demand fell dramatically in 2014, by around 4 percent – while at the same time the economy grew by around 1.4 percent. That continued the decline in power usage since 2007, while GDP grew simultaneously." [42]

To date, Germany has also demonstrated that a clean grid can also be a reliable grid, having added at least 35 gigawatts of solar and 35 gigawatts of wind (offsetting upwards of 35 coal plants) since 2004.[43]

> "Clearly, installing the equivalent of 100 percent of peak demand as wind and solar capacity does not bring down the grid." Craig Morris, Heinrich Böll Foundation's *Energy Transition* blog, August 25, 2014

Energiewende is also paving the path in challenging traditional utility business models, an inevitable transformation that must take place to shift from centralized thermal power plants to decentralized, multiply sourced energy. Four large electricity suppliers (E.On, RWE, Vattenfall, and EnBW) provided 80 percent share of the conventional power market in 2012 in Germany.[44] But these electricity suppliers own only 5 percent of the renewable energy, and the rapid growth in renewable energy has collapsed the utilities' profits.[45] Germany is in the forefront of utility business model disruption and the U.S. would do well to watch and learn as the country figures out what the new rules will be to maintain a reliable, efficient, economical, and climate-friendly power system.[46]

Germany is a model for the U.S. in demonstrating that an energy transformation is possible and that renewable energy can be added to the grid with reliability maintained, but the U.S. electricity's system is not quite as centralized as Germany's. The top 20 electric utilities serve just one-half of U.S. electricity customers, and many of them operate across state boundaries, subjecting them to different regulatory regimes under the state-level utility commissions that govern utility rates.

In some states, the generation of electricity has been deregulated, and utilities own few generating plants themselves. Utility commissions have also taken very different positions on requiring utilities to encourage their customers to conserve energy, and rewarding the utilities for successful implementation. Finally, in each region of the U.S., an idiosyncratic combination of generating resources and historical cost structures shape the opportunities available to utilities.

Furthermore, the fossil fuel industry maintains a strong grip on the U.S. political system, particularly in Washington, D.C., so despite polls showing by large margins that Americans want renewable energy more than any other source of energy,[47] climate and clean energy advocates

have their hands full turning the tide in the United States and charting a course that would look anything like a Yankee Energiewende.

IV. Climate Action in the United States

In the absence of a coherent national clean energy direction in the United States, a powerful and diverse movement to embrace clean energy is emerging in numerous states and communities. It is also increasingly apparent that customer demand for carbon reduction from individuals as well as corporations is forcing action. As of 2014, 60 percent of Fortune 100 companies and 43 percent of Fortune 500 companies had set carbon reduction or clean energy targets.[48]

This section looks at various drivers for climate action locally and regionally in the United States, starting with policy initiatives—renewable energy and energy efficiency standards, regional carbon pricing systems, and the Clean Power Plan—and ending with a few examples of clean energy innovation at the state and community level in the Northeast, the South, and the Pacific Northwest.

RENEWABLE ENERGY AND ENERGY EFFICIENCY STANDARDS

While Germany has two mandated renewable energy targets for 2020 (40 percent for electricity and 18 percent for overall energy), the United States has no federal renewable mandates. However, 29 states, Washington, D.C., and two territories that between them account for 42 percent of U.S. electricity sales have adopted renewable portfolio standards. These standards mandate that utilities supply a certain fraction of their electricity from qualifying renewable sources, usually in addition to existing large hydro dams. In addition to the states that have renewable portfolio standards, eight additional states have adopted renewable targets.[49] (See **Appendix D** for the status of renewable portfolio standards throughout the United States.)

Similarly, 26 states have energy efficiency resource standards (EERS), policies that set long-term mandatory energy savings targets for utilities. Efficiency programs are making a substantial contribution toward national energy conservation, saving over 20 million MWh in 2012, enough to power nearly 2 million homes for a year. If these states continue to meet their savings targets through 2020, the combined annual electricity savings would be equivalent to 6.2 percent overall electricity sales in the United States in 2020.[50] (See **Appendix E** for the status of energy efficiency resource standards (and goals) throughout the United States.)

Twenty states now supply between 15 percent and 82 percent of their electrical power with renewable resources, including hydroelectricity, and 14 supply between 10 percent and 32 percent of their electrical power from renewable resources, excluding hydroelectricity.[51] [52]

CARBON PRICING IN THE UNITED STATES

Capping and pricing carbon is a critical tool for reducing carbon emissions. Unfortunately, efforts to cap and price carbon emissions nationally have failed to date.[53] However, in the

absence of national carbon pricing, California and nine Northeastern and Mid-Atlantic states have adopted carbon pricing and are leaders in the emerging clean energy economy in the United States.

REGIONAL GREENHOUSE GAS INITIATIVE

The first mandatory cap-and-trade program in the United States to limit CO_2 from the power sector, the Regional Greenhouse Gas Initiative (RGGI), launched in 2005 with a memorandum of understanding (not legislation) among seven Northeastern states—Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont. Maryland, Massachusetts, and Rhode Island joined in 2007, and New Jersey withdrew in 2011.

RGGI's goal is to reduce power sector emissions 45 percent from 2005 levels by 2020. The program covers CO_2 emissions from power plants with at least 25 MW generating capacity, about 23 percent of the participating states' total CO_2 emissions. RGGI requires the plants to obtain an allowance for each ton of CO_2 emitted annually. The mandated power plants can purchase allowances at quarterly auctions, from other generators within the region, or meet their obligations with certified offset projects.[54] In 2014, the cap was reduced by 45 percent and will decline 2.5 percent each year until 2020. (See **Appendix F** for a chart that shows the allowance allocations from 2009-2020 for participating states.)

A minimum of 25 percent of the generated revenues must be used to fund energy efficiency and renewable energy programs. RGGI's first auction of CO_2 emissions allowances was held in 2008. Proceeds from the sale of CO_2 allowances from 2009-2011 (the first control period) were $912 million, which communities put toward with energy efficiency programs, community-based renewable power projects, assistance to low-income customers with electricity bill payments, education and training, and contributions to the general fund. [55] The local economy retained $765 million that would otherwise have been spent on fossil fuel.

A report released in April 2015 analyzing the investment of RGGI proceeds since its inception found that the program has invested over US$1 billion in New England and Mid-Atlantic states, benefiting 3.7 million households and 17,800 businesses with energy efficiency programs (57 percent); GHG abatement (15 percent); renewable energy (13 percent); and direct bill assistance (9 percent). Over the lifetime of these investments more than 48.7 million mmBTU of fossil fuels and 11.5 million MWh of electricity are projected to be saved, and approximately 10 million short tons of carbon pollution will not be released. [56]

Furthermore RGGI's pollution reductions have not come at the cost of the economy. "As a whole, the RGGI states have reduced power sector CO_2 pollution over 40 percent since 2005, while their economies have grown 8 percent, adjusted for inflation."[57]

There are ample examples of how significant the RGGI framework has been in creating a market for clean energy innovation, but we will focus only on Massachusetts here. Drawing on RGGI funds, Massachusetts is able to give six-figure grants to its municipalities to fund clean energy projects. As a direct result of Massachusetts clean energy policies, the state saw six percent

statewide economic growth in the face of a national recession. As New Energy Cities Program Manager Elizabeth Willmott wrote, "The fact that RGGI is a significant source of funding for Massachusetts' community-level work is noteworthy."[58]

The growth in clean energy jobs in Massachusetts tells the story of climate policy success. According to the Massachusetts Clean Energy Center, Massachusetts experienced a 6.7 percent increase in clean energy jobs from 2010 to 2011; an 11.2 percent increase from 2011 to 2012; and a 10.5 percent increase from 2013 to 2014. Clean energy firms have added more than 28,000 clean energy workers since 2010, with 88,372 workers currently employed in 5,985 firms. The industry expects to exceed 6,000 clean energy companies and 100,000 workers by early 2015.[59]

CALIFORNIA'S CLIMATE AND CLEAN ENERGY LEADERSHIP

California's carbon pricing program was signed into law by Gov. Arnold Schwarzenegger in 2006 as part of the state's Global Warming Solutions Act (Assembly Bill 32, or AB 32) and launched in 2013 with a far more ambitious mandate than RGGI: reduce total state emissions to the 1990 level of 427 million metric tons by 2020, including every business in the state that emits 25,000 tons of CO_2 per year (not only the electricity sector, to which RGGI is limited).

As of September 2014, California had sold $2.27 billion of CO_2 allowances—$1.4 billion from the utility pool, the remainder from a state pool. Utilities must spend their proceeds on renewable energy, energy efficiency, or customer rate relief, while state proceeds go into a Greenhouse Gas Reduction Fund.[60] Given that California is the world's eighth largest economy, the program is on track to be the second largest carbon market in the world, coming in behind the European Union's Emissions Trading System, and will cover 85 percent of the state's carbon pollution by 2015.[61]

"California is proving that it is possible to limit, price, and reduce the state's greenhouse gas pollution while spurring continued growth of the state's economy," according to an Environmental Defense Fund analysis of the program's performance in its second year. "Even more encouragingly, some of the fastest economic growth is taking place within the 'green' portion of the economy—defined by jobs and revenues generated from the accelerated adoption of cleaner energy solutions."[62]

A total of $902 million from the proceeds of quarterly auctions of carbon allowances has gone into California's Greenhouse Gas Reduction Fund to invest in projects that achieve greater emission reduction, create jobs, and improve communities. A minimum of 25 percent of the proceeds will benefit disadvantaged communities that are disproportionately affected by climate change and pollution.[63]

California signed a formal agreement with Quebec on January 1, 2014 to allow an exchange of allowances between the two jurisdictions, formally linking the two markets and showing that a greater market can be created by harmonizing different systems.[64] In early April 2015, Ontario Premier Kathleen Wynne pledged to link a cap-and-trade system to Quebec and California,

creating a carbon market of 61 million people, and covering more than 60 percent of Canada's population.[65]

Furthermore, the State of California signed a formal agreement with the National Development and Reform Commission of the People's Republic of China, China's top climate agency, to enhance cooperation through a range of activities, among which is the design and implementation of a municipal emissions trading pilot program.[66]

In his inaugural address on January 5, 2015, California Jerry Brown called for three ambitious 2030 goals: (1) 50 percent electricity sales from renewables; (2) 50 percent reduction in the use of petroleum for cars and trucks; and (3) doubling the rate of energy efficiency in existing buildings.[67] California leads the United States in climate and clean energy innovation, and climate leaders in Washington and Oregon are working hard to create a West Coast bloc of climate leadership, with a suite of compatible clean energy policies stretching from California to British Columbia.

CLEAN POWER PLAN

U.S. electric power plants are the largest source of carbon pollution in the U.S. (roughly one-third of domestic greenhouse gas emissions). On June 3, 2014, the Environmental Protection Agency (EPA) proposed the first-ever limits on carbon pollution from power plants, with the goal of cutting U.S. carbon pollution from electricity generation by 30 percent.[68]

Heralded by some as a "tipping point for the clean energy economy,"[69] the Clean Power Plan will make it difficult for new coal power plants to be built and will encourage retirement of old, dirty coal-fired plants because it will be more economical for utilities to mothball the plants and shift to less carbon-intensive means of power generation. Carbon pollution limits have been crafted for each state individually, depending on its current mix of generation, leaving each state flexibile to design a strategy to meet its limit.

Wind industry proponents and the Department of Energy maintain that implementing the Clean Power Plan will propel significant wind development in the Midwest,[70] while a study by the University of Wyoming released in March 2015 predicted that the state of Wyoming's coal industry and coal-fired power plants could "sink under the weight of the U.S. EPA's proposed Clean Power Plan."[71]

The Clean Power Plan will not proceed without a fight. Much of corporate America is currently sitting on the sidelines or fighting the plan,[72] and Senate Majority Leader Mitch McConnell launched a campaign urging all U.S. state governors to refuse to comply with the rules.[73] However, some governors[74] and some Senate Democrats[75] rebuffed McConnell's entreaty to block the plan and on April 16, 2015, judges skeptically received a legal challenge by the coal industry and coal-friendly states to stop the EPA from drafting the Clean Power Plan's rules.[76]

STATE-LEVEL CLIMATE AND CLEAN ENERGY EFFORTS

Multiple clean energy initiatives are thriving in nearly every state in America. In this sub-section we selected examples from New York, North Carolina, and Washington.

HAWAII

The Hawaii Clean Energy Initiative (HCEI) is the most ambitious clean energy plan in the U.S.: achieving 70 percent clean energy by 2030, with 30 percent coming from energy efficiency and 40% from locally generated renewable energy. These targets are driven by the state's desire for energy security as well as economic prosperity. Hawaii is the most fossil fuel-dependent state in the nation and also has the highest electricity rates in the nation. The HCEI aims to keep an estimated $5.1B in the state instead of spending it imported oil.[77] Hawaii and California are confronting the challenge of renewable energy storage head on.[78]

NEW YORK

Under the leadership of Governor Andrew Cuomo, as well as former New York City Mayor Michael Bloomberg, New York is in the forefront of attempting to create an electric grid that permits customers more control over their energy destiny, as well as one that delivers energy more efficiently and is responsive to distributed renewable energy. On April 24, 2014, the New York State Public Service Commission issued an order requiring that the state utilities determine "how best to prepare for a future in which electric vehicles, rooftop solar panels, and other types of local, on-site power generation are commonplace."[79]

The effort is a recognition that increased energy efficiency, increasingly available solar and wind energy, and onsite power generation (as opposed to centralized power plant generation) are making obsolete the current utility model that encourages utilities to sell ever more electricity, and that utility regulation must be reformed to reflect the new reality.

NORTH CAROLINA

In March 2015 a North Carolina Republican State Representative, Rep. John Szoka, introduced the Energy Freedom Act[80] to permit non-utility renewable energy owners to sell electricity directly to customers as long as they did not generate more than 125% of the customer's annual load. Potential customers would range from military installations, large institutions, corporations and homeowners. The measure has overwhelming support from voters, with over 80 percent favoring passage of the legislation, according to a poll conducted by Conservatives for Clean Energy.[81]

What is particularly interesting about this effort in North Carolina, as well as others, such as a movement to place a ballot initiative to expand solar choices in Florida[82] and a bill that passed in Georgia to allow third-party leasing for solar homes and businesses,[83] is that these are all happening in states where Republicans are in control and have blocked clean energy efforts. The side of conservative U.S. ideology that leans on the free market has spawned these efforts to open markets to renewable energy and to allow for decentralized energy production as an element of personal liberty.

PACIFIC NORTHWEST

On the other side of the country, in the Pacific Northwest, Washington and Oregon enjoy strong climate leadership from their governors on down to many local leaders. The Northwest electricity grid, fed by hydroelectricity, is also much cleaner than elsewhere in the country, so communities start off with an advantage compared to other parts of the country that are either powered by a greater proportion of coal or that are major coal-producing areas.

But the Northwest as a region still draws on coal for 16.7 percent of electricity[84] which is why King County, WA County Executive Dow Constantine and leaders of 13 cities within the county have set as one of several climate goals the removal of coal from the region's electric grid by 2030. Banded together in the King County-Cities Climate Collaboration (K4C), which represents 1.5 million people (75% of King County's population), these local leaders have committed to ambitious carbon emission reduction for the building, power, and transportation sectors.

Cities emit 70 percent of global carbon emissions and King County, which is the most populous county in Washington State and the 13th most populous in the United States, is responsible for nearly 26 percent of Washington State's emissions. Meaningful action at the city and regional level will have a significant impact on the state's carbon footprint. The K4C has committed to reducing its carbon emissions to 50 percent below 2012 levels by 2030, with a cumulative 80 percent reduction by 2050. Climate Solutions' New Energy Cities team is working with these communities to develop and implement aggressive and measurable carbon reduction plans and strategies. (See **Appendix G** for an energy map and carbon wedge analysis, with emission targets by sector, that Climate Solutions' New Energy Cities team has developed for the K4C.)

CARBON NEUTRAL CITIES

A number of U.S. cities are also participating in the Carbon Neutral Cities Alliance (CNCA) through the Urban Sustainability Directors Network, which launched in March 2015. This new collaboration of international cities is committed to sharing best practices to achieving aggressive long-term carbon reduction goals.[85]

The growing movement of cities aiming to achieve carbon neutrality and be powered by 100 percent renewable energy will increasingly apply pressure for the utilities that provide their power to embrace clean technology. On June 17, 2013, the City of Seattle formally adopted its 2013 Climate Action Plan, which calls for carbon neutrality by 2050.[86] In April 2015, Vancouver, BC set its sights on 100% renewable energy—not only for electricity but all for heating, cooling, and transportation by 2050.[1] Fort Collins, CO adopted an accelerated plan of reducing carbon emissions 80% below its 2005 level by 2030 and achieving carbon neutrality by 2050.[872] The municipal utility of Georgetown, TX has already contracted for 150 MW of solar power that will make its electricity supply 100% renewable.[88]

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[1] Stephen Leahy. "Vancouver commits to run on 100% renewable energy" *The Guardian*, April 10, 2015. http://www.theguardian.com/environment/2015/apr/10/vancouver-commits-to-run-on-100-renewable-energy

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Conclusion

While climate policies have been crucially instrumental in stimulating clean energy solutions, and a national commitment to carbon reduction and national carbon pricing would help move the United States faster along the path needed to reduce carbon emissions, it is becoming increasingly obvious that customer demand, local and regional elected leader climate commitment, and corporations looking to green their businesses are enabling the clean energy economy to grow.

The key features of the clean energy future we are trying to hasten include a shift to decentralized and efficient energy delivery systems that rely on renewable energy, not fossil fuel, and that enable individuals to take control of their energy destiny, and a resilient, smart, distributed electricity grid.

To get to where we need to go, we need a major overhaul in the business model for U.S. utilities that run the country's electricity system—a new business model that rewards utilities for performance in efficiency and clean energy technology and not infrastructure investments in capital-intensive, centralized fossil fuel plants that their electric rates must pay back over two to three decades. We must reward customers for reducing energy usage or for investing in renewable energy at their residence or office building and selling the power they generate back to the grid.

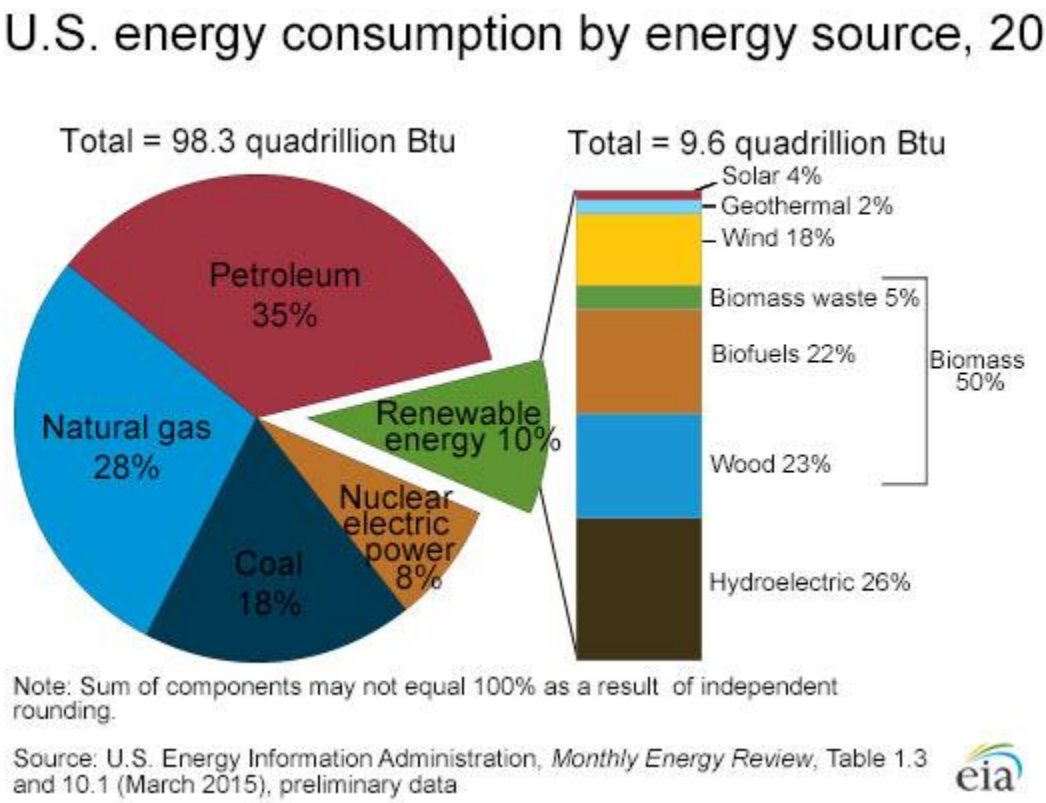
Most crucially, we need a stable, national clean energy policy with adequate levels of investment that does not get implemented and discarded as presidential administrations change hands, or at the whim of an unduly influenced U.S. Congress.

While the United States is far from adopting any action as sweeping as Germany's Energiewende, the extraordinary growth of renewable energy in the face of plentiful oil and gas; the multiplicity of actions across the nation calling for clean energy; and the increasingly broad coalition of leaders and citizens demanding change from the bottom up offer evidence that "[t]he U.S. is on the verge of a revolution in the way we make, move, and use energy."[89]

This is good, because a revolution is required to change our relationship with energy. Let us hope it arrives in time for the United States to do its part to prevent the most damaging impacts of global warming.

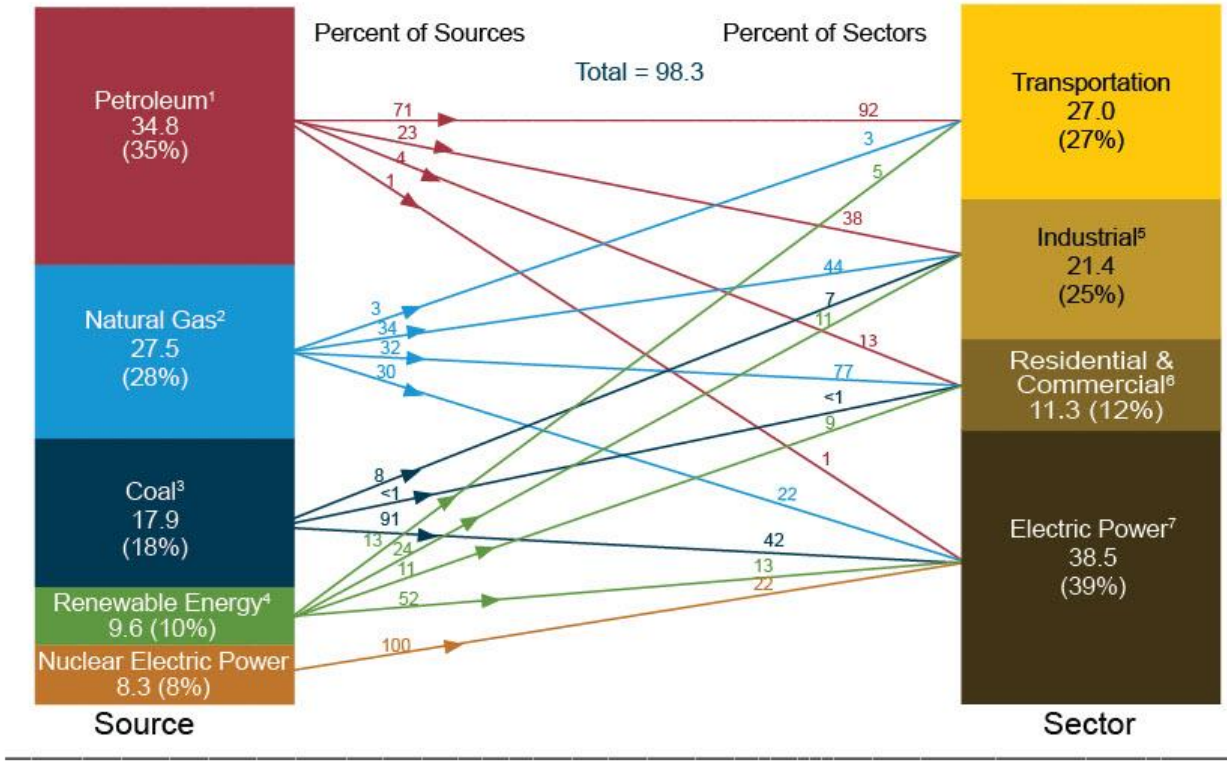
Appendices

Appendix A—U.S. Energy Consumption and Production Charts 2014



Primary Energy Consumption by Source and Sector, 2014

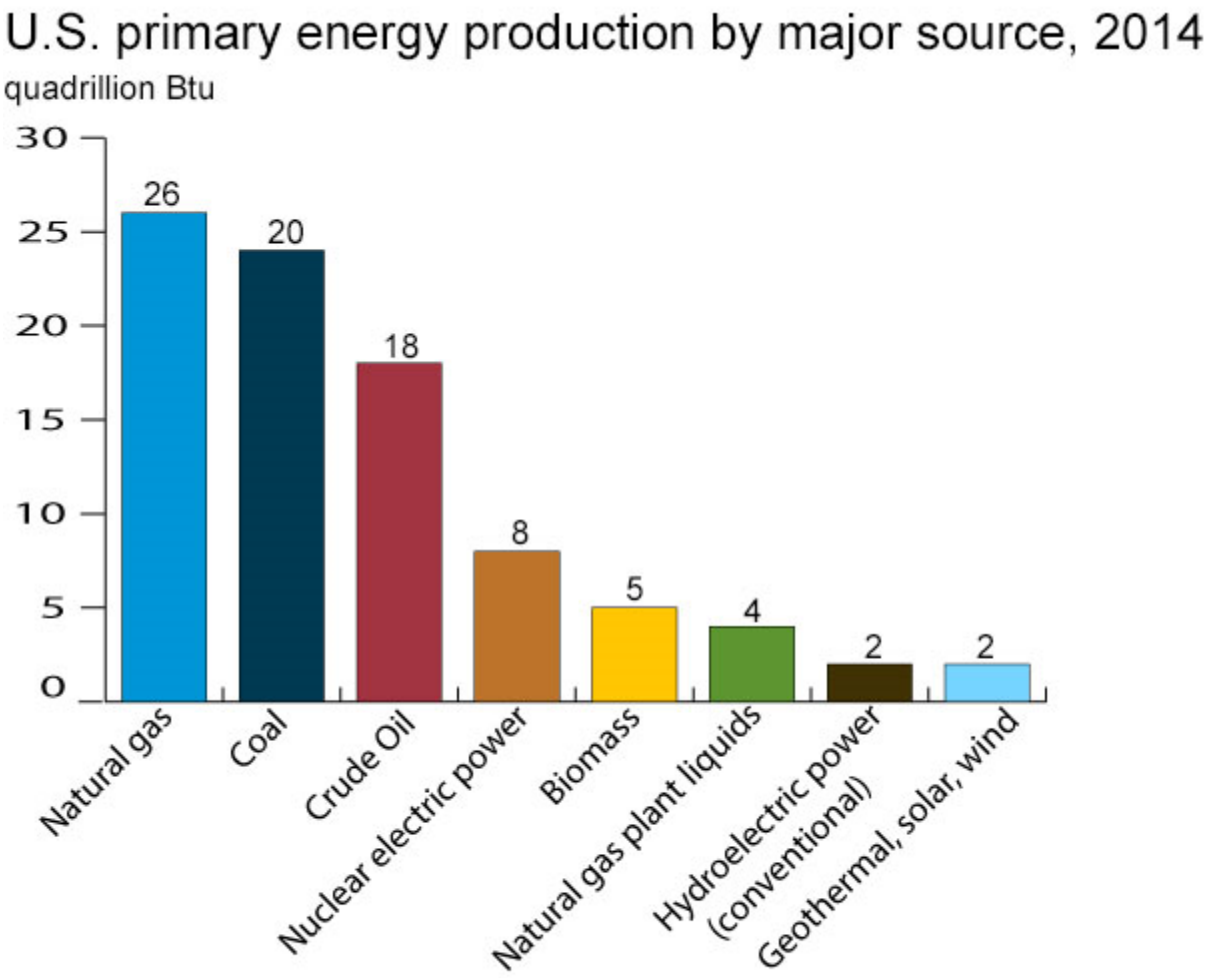
(Quadrillion Btu)



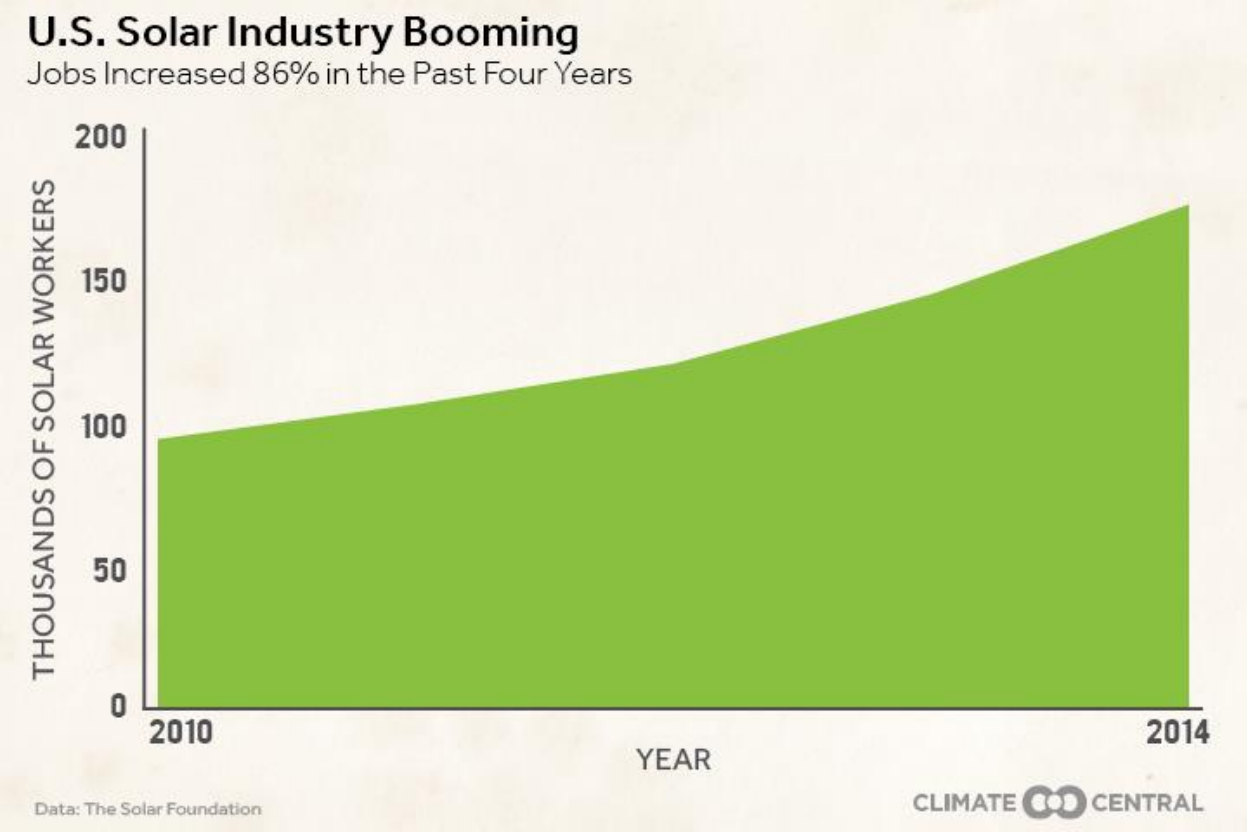
[1] Does not include biofuels that have been blended with petroleum—biofuels are included in "Renewable Energy."
[2] Excludes supplemental gaseous fuels.
[3] Includes less than -0.1 quadrillion Btu of coal coke net imports.
[4] Conventional hydroelectric power, geothermal, solar/photovoltaic, wind, and biomass.
[5] Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
[6] Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
[7] Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public. Includes 0.2 quadrillion Btu of electricity net imports not shown under "Source."

Notes: Primary energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy (for example, coal is used to generate electricity). • Sum of components may not equal total due to independent rounding.

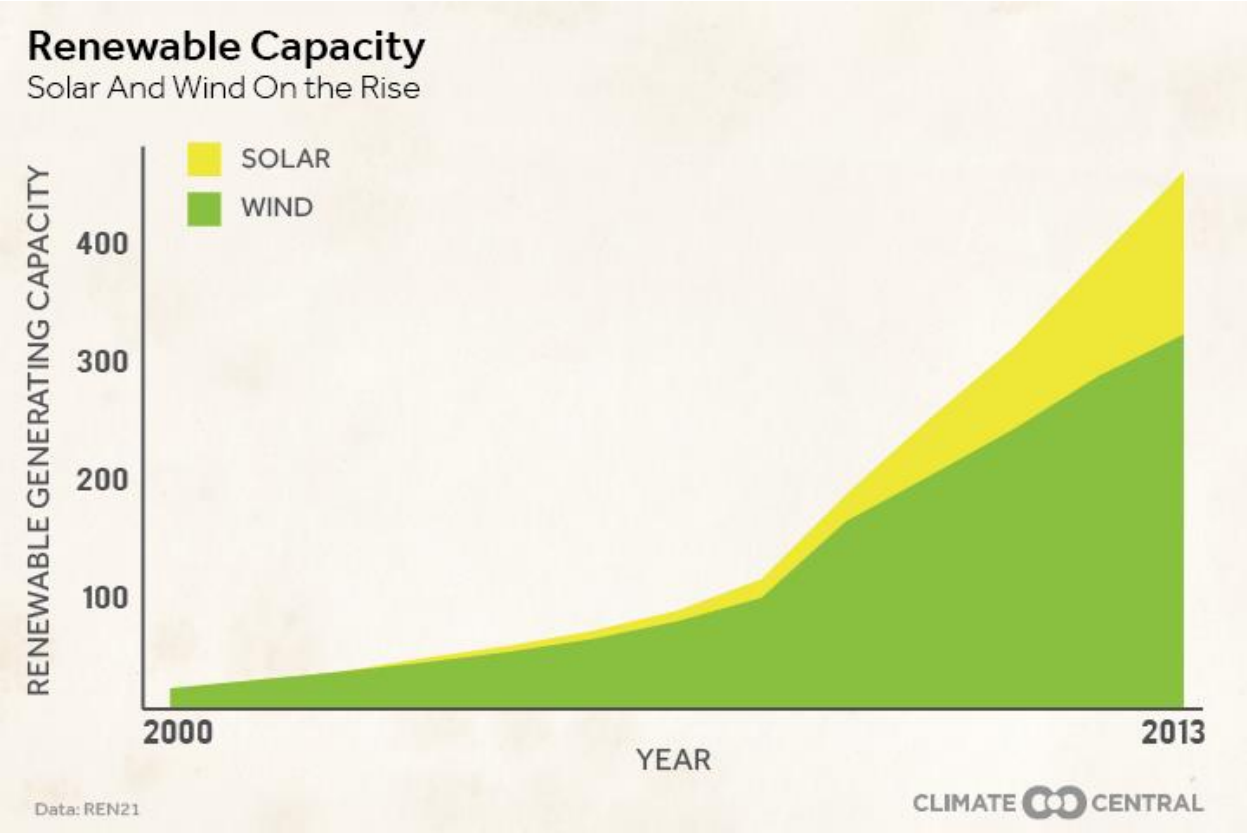
Sources: U.S. Energy Information Administration, Monthly Energy Review (March 2015), Tables 1.3, 2.1-2.6.


U.S. primary energy production by major source, 2014
quadrillion Btu
30
25
20
15
10
5
0
26
20
18
8
5
4
2
2
Natural gas
Coal
Crude Oil
Nuclear electric power
Biomass
Natural gas plant liquids
Hydroelectric power (conventional)
Geothermal, solar, wind
Source: U.S. Energy Information Administration, Monthly Energy Review (March 2015), preliminary data
eia

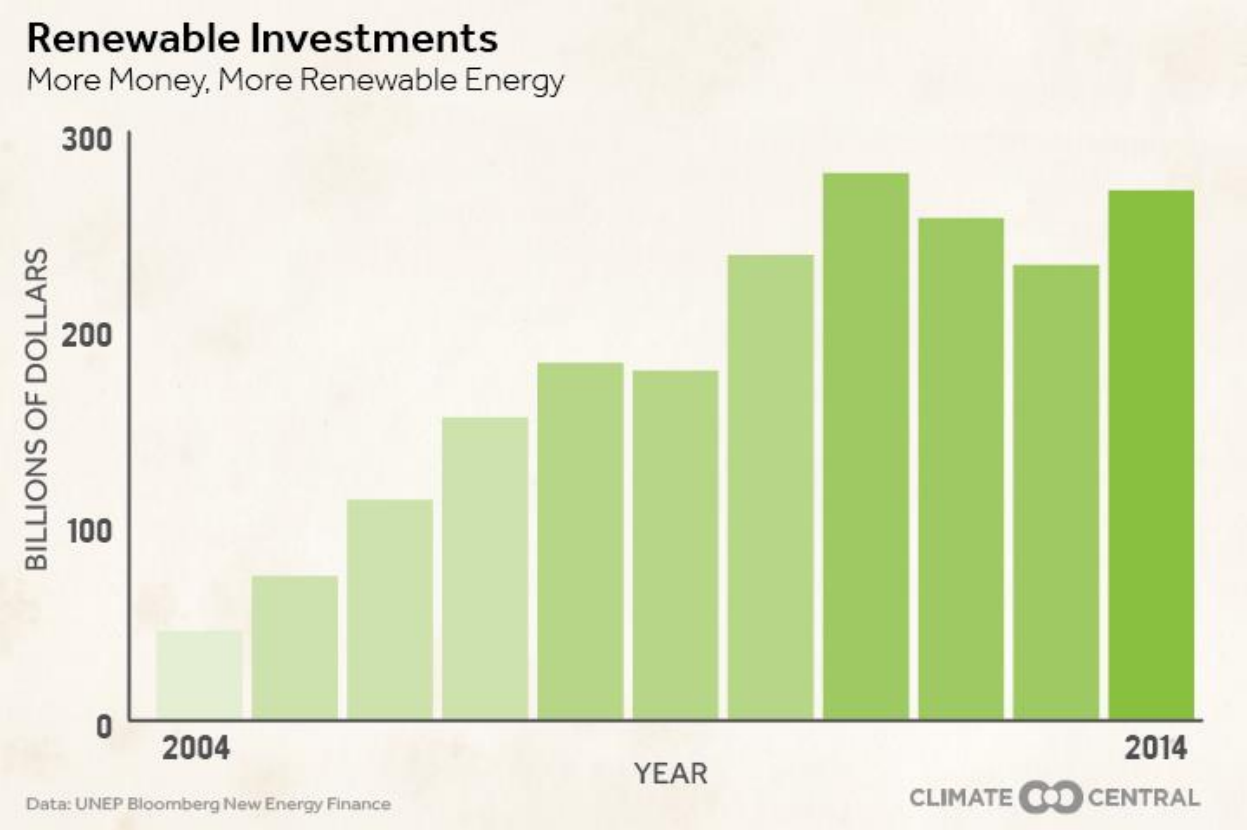
Appendix B—Charts Depicting Explosive Growth of Wind and Solar



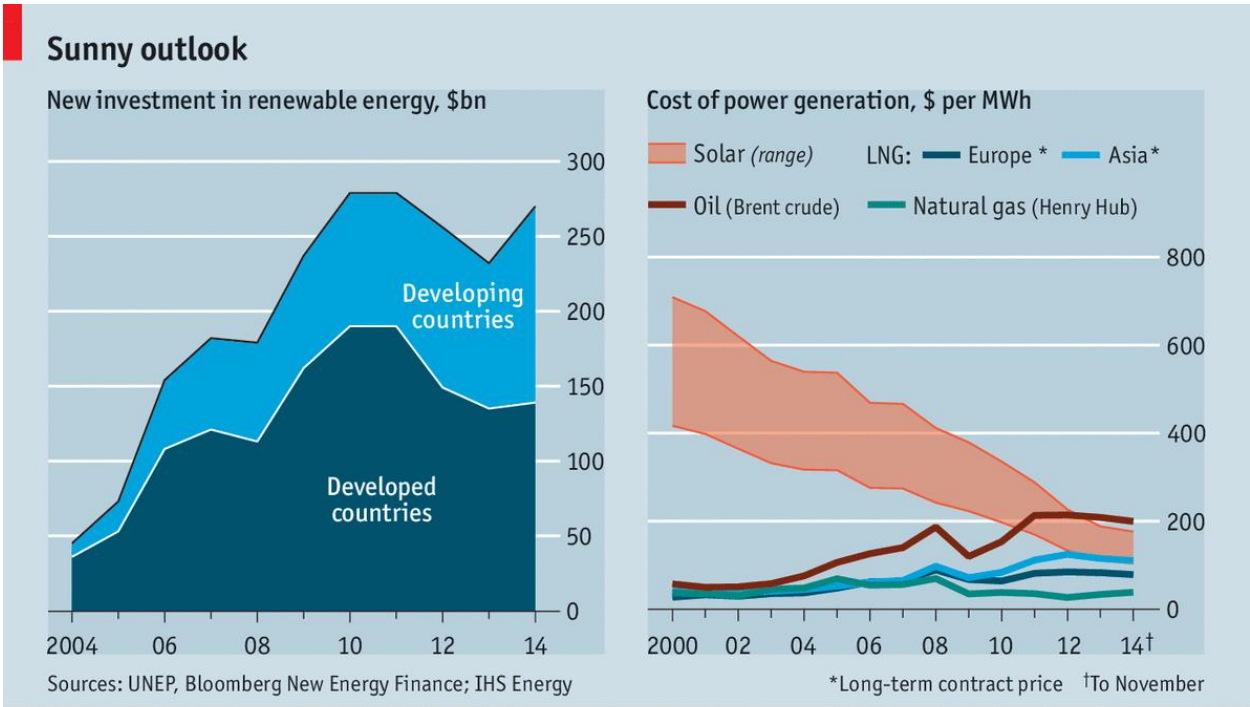
Source: Solar Foundation's National Solar Jobs Census March 2015; employment jumped nearly 22 percent in 2014, adding 31,000 new jobs for a total of 174,000 U.S. solar industry jobs in the U.S. Solar material and installation costs are falling leading to increased installations nationwide.
http://www.climatecentral.org/news/clean-energy-trends-earth-day-18916



Source: 457 gigawatts of solar and wind capacity globally in 2013, up from 17 gigawatts in 2000 REN_{21} data. http://www.climatecentral.org/news/clean-energy-trends-earth-day-18916

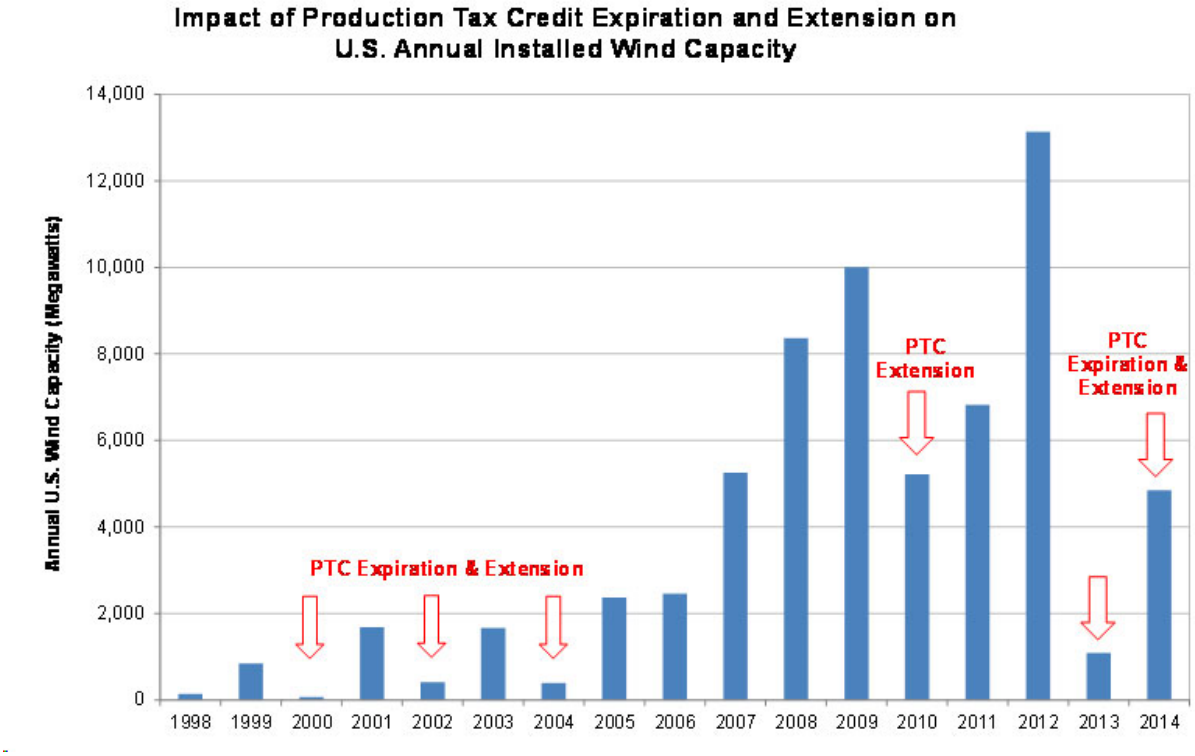


Source: Less money is purchasing more renewable energy. In the case of solar PV, investments fell 22 percent in 2013, but generating capacity rose 32 percent. But investments in renewable energy have risen 600 percent since 2004 (UNEP/BNEF Report). US$270 billion built 95 GW of solar and wind worldwide, a record. In 2011 $279b in global renewable investments built wind and solar that generated 70m GW of RE.
http://www.climatecentral.org/news/clean-energy-trends-earth-day-18916



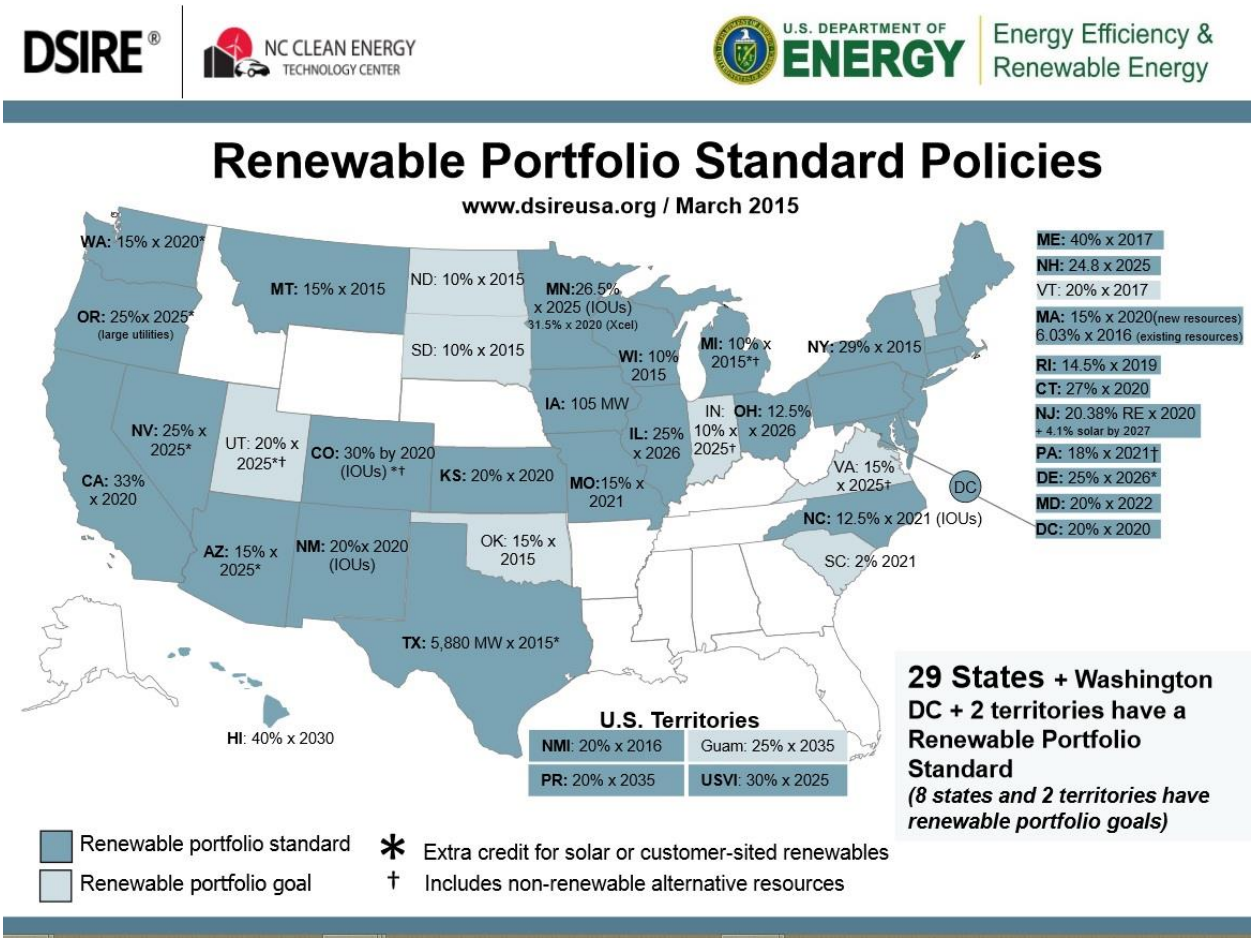
Source: Global investment in renewable energy, chiefly wind and solar power, rose by a sixth in 2014, to $270 billion. This was partly because of subsidies in the rich world, such as America's 30% federal tax credit for solar projects. Under a system known as "net metering," consumers with small solar installations can sell surplus power to the grid at the same price as they pay for power flowing in. But even if the tax credit is cut, as expected, solar electricity could displace 9.7% of American retail electricity sales by 2019, reckons Bernstein, a research firm—over 30 times the share today. http://www.economist.com/news/international/21647975-plummeting-prices-are-boosting-renewables-even-subsidies-fall-not-toy

Appendix C—Impact of Production Tax Credit Expiration and Extension



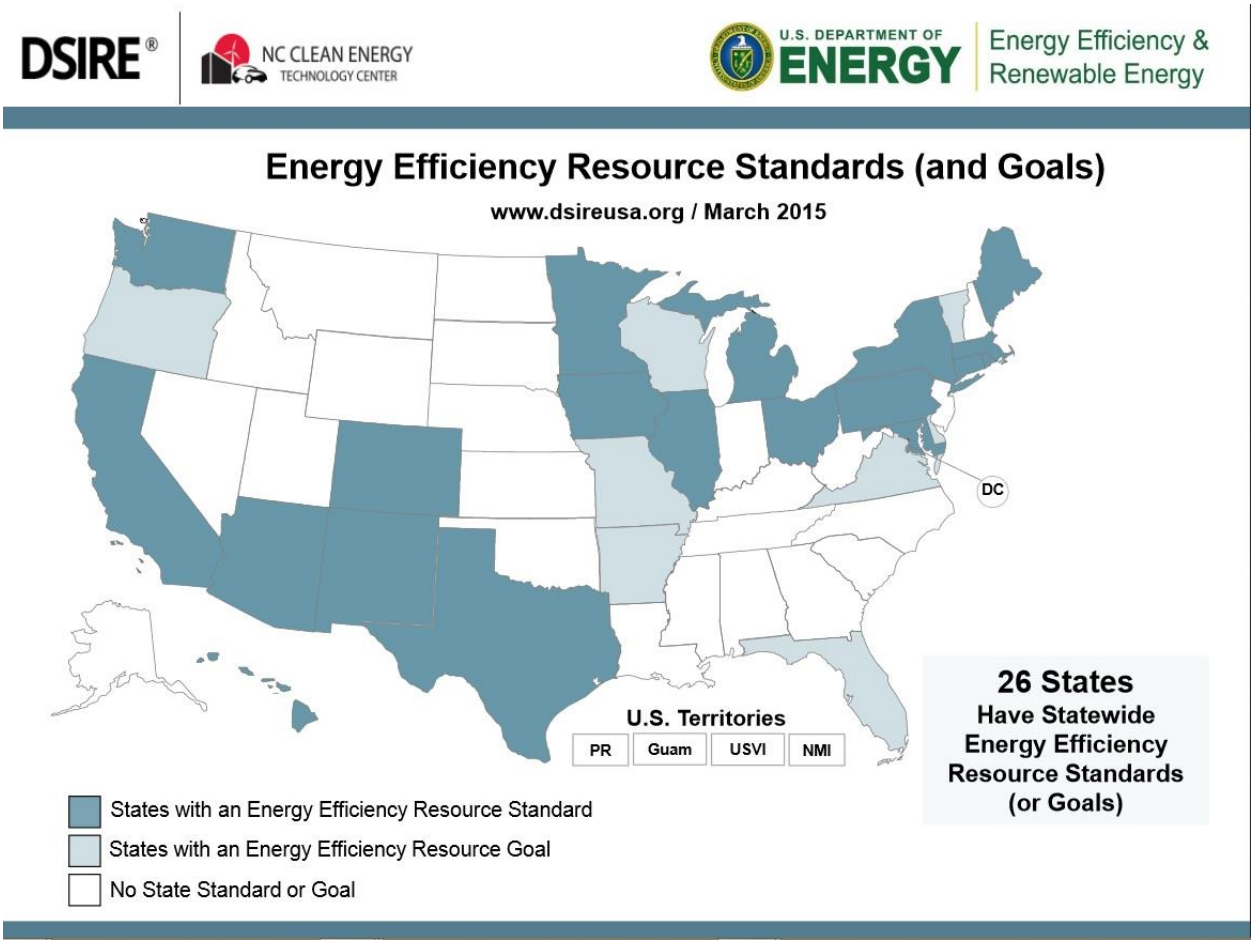
Source: Union of Concerned Scientists Production Tax Credit for Renewable Energy based on data from the Department of Energy 2014 and the American Wind Energy Association (AWEA) 2015. http://www.ucsusa.org/clean_energy/smart-energy-solutions/increase-renewables/production-tax-credit-for.html#.VT1mf5N2A6G

Appendix D—Renewable Portfolio Standard Policies



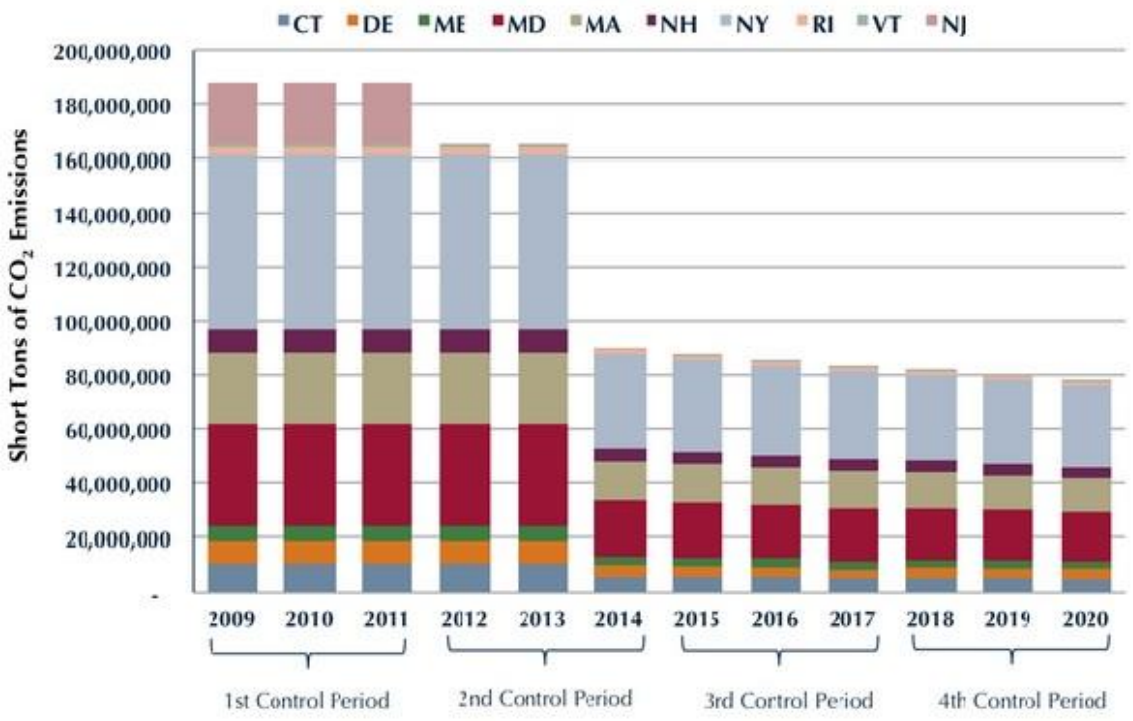
Source: U.S. Department of Energy: Energy Efficiency & Renewable Energy. http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2014/11/Renewable-Portfolio-Standards.pdf

Appendix E—Energy Efficiency Resource Standards (and Goals)



Source: U.S. Department of Energy: Energy Efficiency & Renewable Energy. http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2015/03/Energy-Efficiency-Resource-Standards.pdf

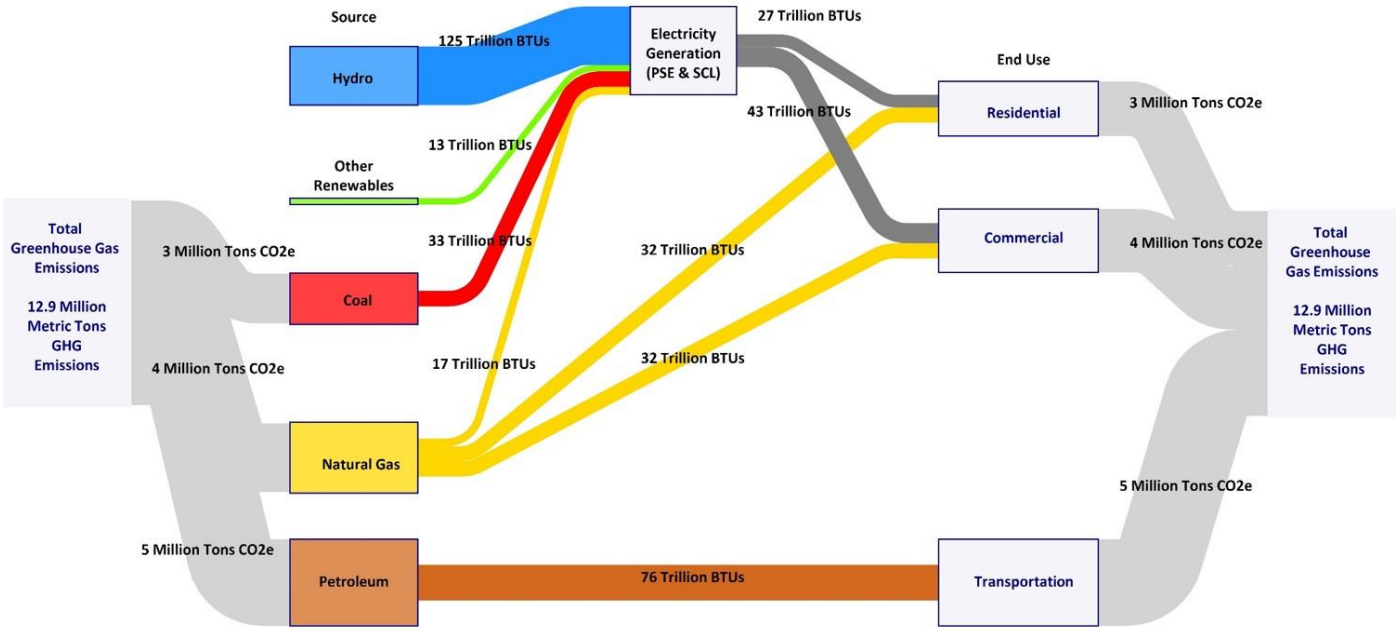
Appendix F—Regional Greenhouse Gas Initiative Allowance Allocation



Source: Center for Climate and Energy Solutions, http://www.c2es.org/us-states-regions/regional-climate-initiatives/rggi; RGGI, Allowance Allocation, http://www.rggi.org/design/overview/allowance-allocation

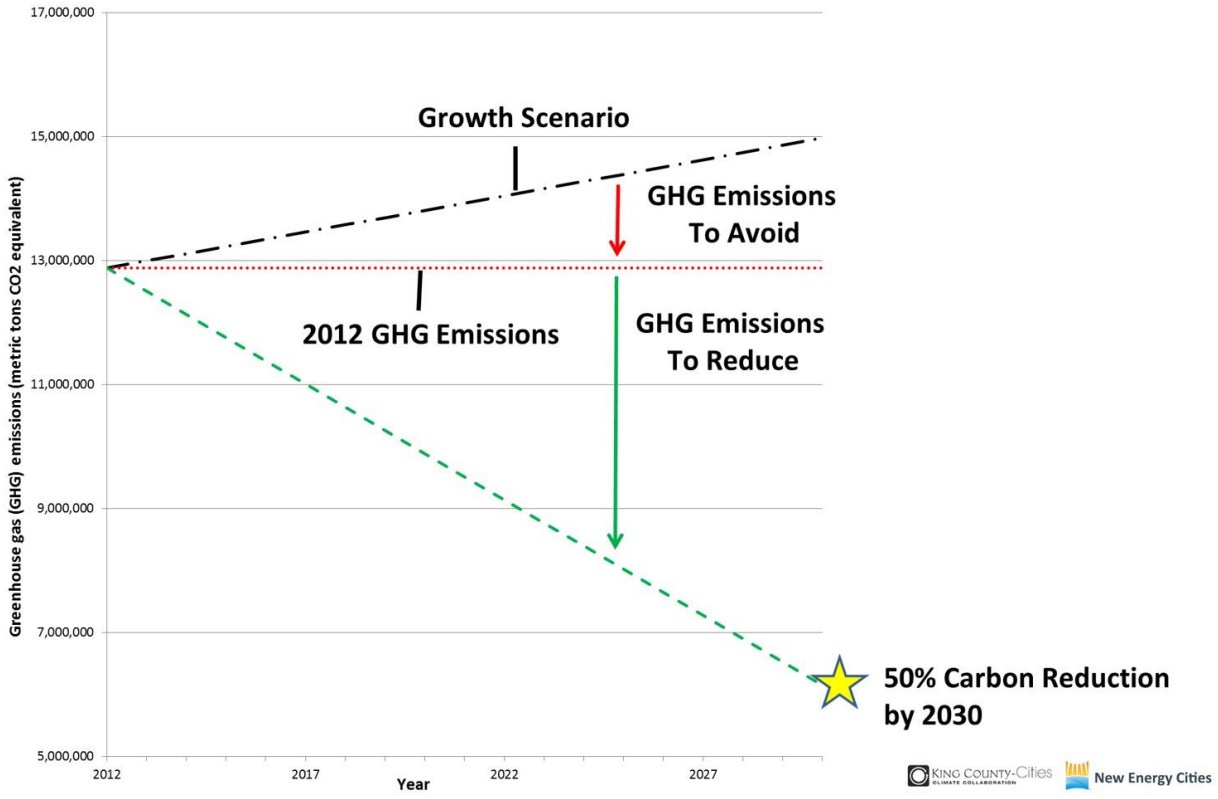
Appendix G—King County Energy Map and Carbon Wedge Analyses

King County 2012 Energy Map



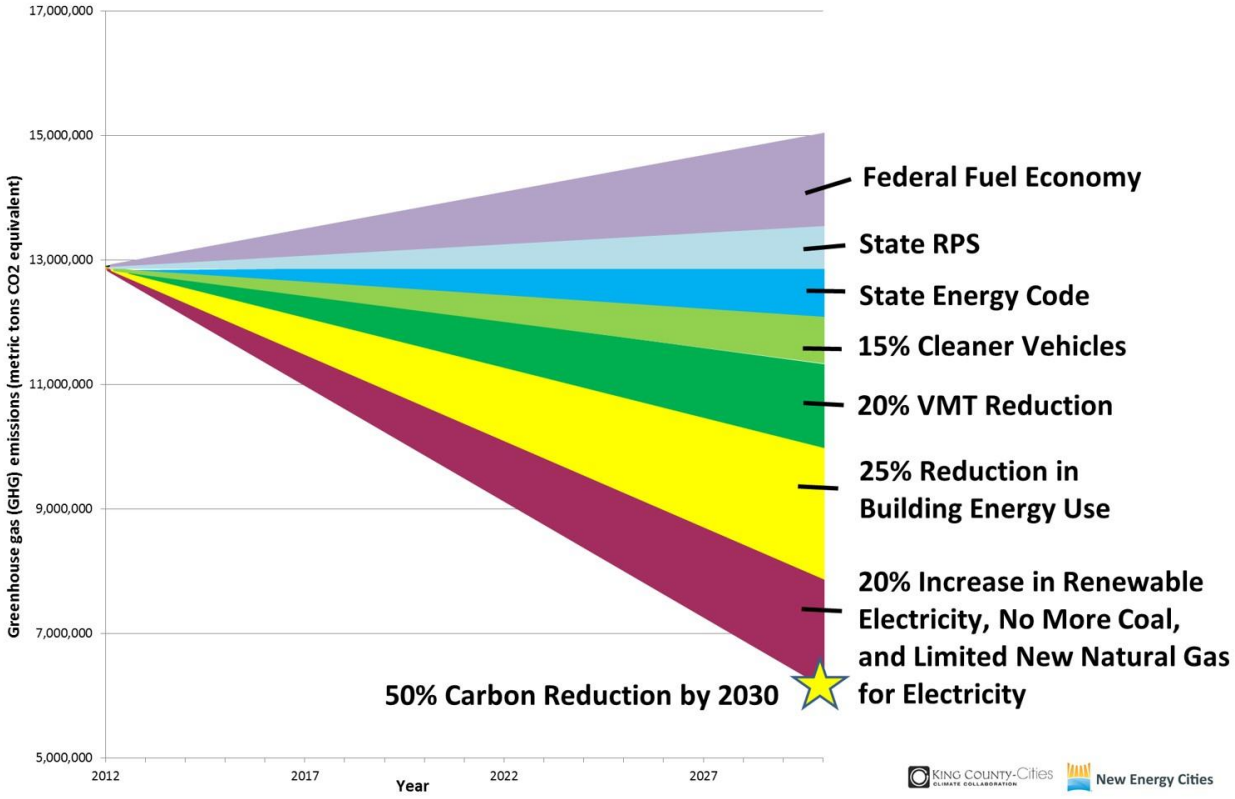
Source: Climate Solutions—Sources and uses of energy for King County depicting the relative contributions of petroleum, natural gas, coal, hydro, and other renewables for sources and their output in the residential, commercial, and transportation sectors. An energy map helps a community quickly see where its carbon emissions are and gives guidance as to where the community should put its energy when crafting its carbon reduction targets. For reference, King County per capita carbon emissions based on New Energy Cities' methodology = 6.4 MT CO_2e.

King County Carbon Wedge Analysis: Emissions to Avoid and to Reduce



Source: Climate Solutions—This graph depicts the reductions necessary for King County, WA to achieve a 50 percent reduction of 2012 GHG emissions by 2030. The black line is a growth scenario "as if" nothing changes and emissions grow on pace with population. The red line represents 2012 emissions. The green line represents a pathway to 50 percent reduction by 2030. The gap between the black and green lines is what needs to be reduced to hit the 50x30 target.

King County Carbon Wedge Analysis: How to Get to 50% Reduction by 2030



Source: Climate Solutions—This graph summarizes the solutions pathways for achieving 50x2030 reduction, on which the King County-Cities Climate Collaboration joint reduction commitments were based. This slide shows that:

- Existing laws are important, but they alone will not achieve the goal
- State, regional, and local levers of change are all essential—and available— to meet 2030 & 2050 goals
- Coordinated local & regional action is needed to achieve ambitious carbon reduction targets

Achieving 50x2030 and 80x2050 is possible, but requires bold, organized action

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