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*NRDC's Fifth Annual Energy Report*

# AMERICA'S CLEAN ENERGY REVOLUTION


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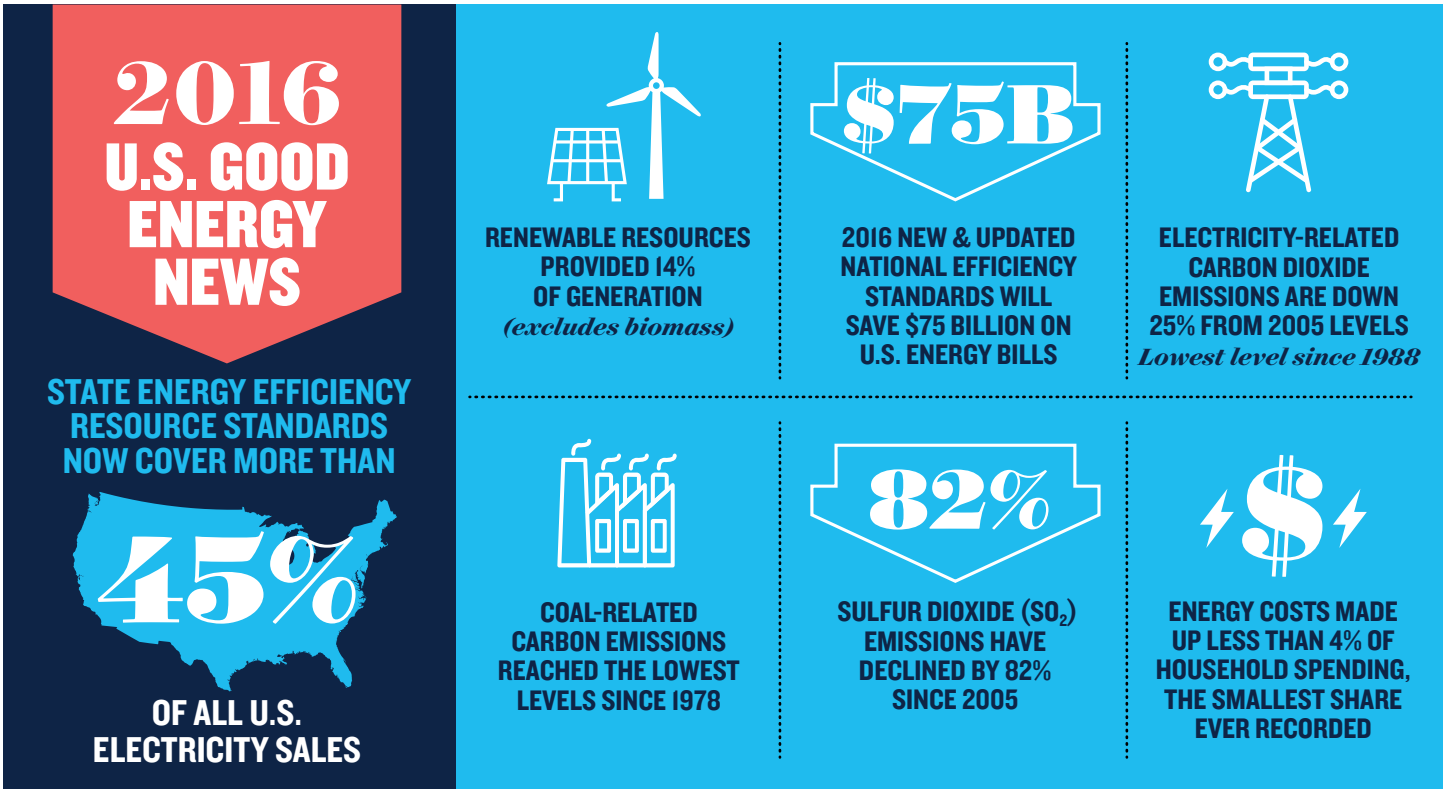
# *Fifth Annual Energy Report*

Dozens of clean energy records have been shattered across the United States in the last year and a half. Solar energy is growing at an unprecedented rate and the first U.S. offshore wind farm now provides clean electricity off the coast of Rhode Island. Grid operators and utilities are implementing new techniques and grid improvements that allow us to integrate more clean energy into America's electricity system without compromising reliability. At the same time, states and utilities have increased their energy efficiency investments, reducing energy waste and energy costs across the U.S. economy. Taken together, the United States is slashing climate-changing and other harmful pollutants *even as national energy spending hits record lows*. Cities, states, and businesses recognize the economic advantages of clean energy and have taken the lead on U.S. climate action and must continue to do so. It is clear that a low-carbon future is more affordable and achievable than ever. The last year and a half has proved that, despite some new political headwinds, ever-improving economics can propel the clean energy transition in the years to come.



The good news is we don't have to choose between the environment and a booming economy. Clean energy not only reduces pollution harmful to public health and our environment, it is also one of the fast-growing areas for U.S. jobs and contributes billions to the U.S. economy annually.[1] Energy efficiency and renewable energy are already the cheapest sources of new energy in the United States over the life of the investment.[2] Building new wind and solar farms is even expected to be cheaper than running existing coal and gas plants within the next decade.[3] Clean energy (from energy efficiency improvements and renewable resource additions) already employs almost 3 million Americans.[4,5] That is more than twice the number of jobs in the U.S. fossil extraction and production industries.[6]

Energy efficiency supports the bulk of clean energy employment in America today, providing permanent, well-paying jobs in the design, manufacturing, construction, and installation of energy-efficient buildings and appliances. In addition, energy efficiency plays a crucial role in keeping U.S. manufacturing and other industries competitive in a global market—reducing energy waste, lowering the costs of domestic production, and making our facilities some of the most efficient in the world. The U.S. Department of Energy (DOE) estimated in 2016 that with more aggressive, but feasible, investments in energy efficiency, industry could save up to an additional 7.5 quads of energy annually by 2030—about 35 percent of all power used by industry in 2016, or about the total amount of energy used by 50 million Americans in a year.[7,8] These electricity savings would be worth almost $30 billion annually (using 2016 average electric prices for industry).[9]

The energy intensity of the U.S. economy (energy consumption per real dollar of GDP) has fallen about 60 percent since 1973.[10] With the growth of clean, zero-carbon energy like solar and wind, the carbon intensity of the U.S. economy (energy-related carbon emissions per real dollar of GDP) has seen even greater declines, with reductions of 65 percent since 1973 and 28 percent in just the past 15 years. Some states have done even better: North Dakota, for instance, has reduced the carbon intensity of its economy by 45 percent since 2000.[11,12]

## ENERGY POLICY REVISIONS AND RECISSIONS

NRDC's *Fifth Annual Energy Report* comes after a hectic year of both significant progress and massive setbacks. Our last energy report was released following the historic Paris accord, the first international agreement calling for the entire global community to keep the increase in global warming to well below 2 degrees Celsius. However, in June 2017, President Trump announced his intention to withdraw the United States from the global agreement.[13] The new administration also began the process of rolling back many Obama-era environmental and energy rules, like the Clean Power Plan (CPP) to limit power plant pollution, and proposed massive funding cuts to leading-edge energy research programs at the DOE.[14] Ironically, however, the electricity sector is already well ahead of schedule in achieving the emissions reductions envisioned by the Clean Power Plan, having made more than three-fourths of the mandated reductions 14 years before the 2030 deadline.[15]

In open defiance of the Trump administration, cities and states across the country have pledged to press ahead on clean energy and climate action. More than 350 U.S. mayors and governors representing more than 110 million Americans and half of all U.S. carbon emissions have recommitted to the goals of the Paris accord.[16] These cities and states have begun taking significant steps to increase clean energy development, promote clean energy jobs, reduce energy waste, and shrink the carbon footprints of their own facilities and of the broader community. Separately, more than 180 colleges and universities and 900 businesses have pledged to follow the goals of the Paris accord.[17] NRDC recently released a report detailing how America can achieve an 80 percent reduction in greenhouse gases by 2050, which is in line with holding global warming well below 2 degrees Celsius. State and local action on renewable energy, energy efficiency programs and standards, and improved urban planning can play an important role, especially in the next few years, in keeping the U.S. on track to meet our climate goals.[18]

The period covered by this report saw a surge of clean energy policy developments at the state level, from carbon markets and emissions reduction policies to renewable energy incentives and development. The expansion of new state and regional carbon markets had slowed in recent years as Congress and the Environmental Protection Agency (EPA) considered federal carbon regulation. With those efforts now in limbo, there is a renewed effort to both strengthen existing state carbon policies and expand them to new states. California's landmark cap-and-trade program was upheld by the courts and then extended through 2030 this year.[19] The state is now pursuing strategies to achieve an economy-wide 40 percent reduction in emissions below 1990 levels. The nine-state Regional Greenhouse Gas Initiative (RGGI) is also on track to strengthen and extend its own carbon markets through 2030.[20] In addition, the governors of Colorado and Virginia have established state caps on carbon pollution and other climate pollutants.[21]

Most state efforts around renewable energy standards in the past five years have been attempts to weaken or repeal those standards. Yet, in 2016 and 2017 there were more than two pieces of legislation to strengthen renewable portfolio standards (RPS) for every proposal to weaken them. None of the efforts to weaken renewable policies have been successful since the beginning of 2016, but seven states did pass major positive reforms. Oregon and New York both raised the minimum renewable energy content of their electricity mix to 50 percent, by 2040 and 2030, respectively.[22] Rhode Island increased its RPS to almost

40 percent by 2035, Maryland opted for 25 percent by 2020, and Massachusetts added new energy storage and offshore wind targets to its standard.[23] Illinois and Michigan passed comprehensive clean energy reform statutes at the end of 2016.[24]

## GREENHOUSE GASES AND OTHER POLLUTANTS

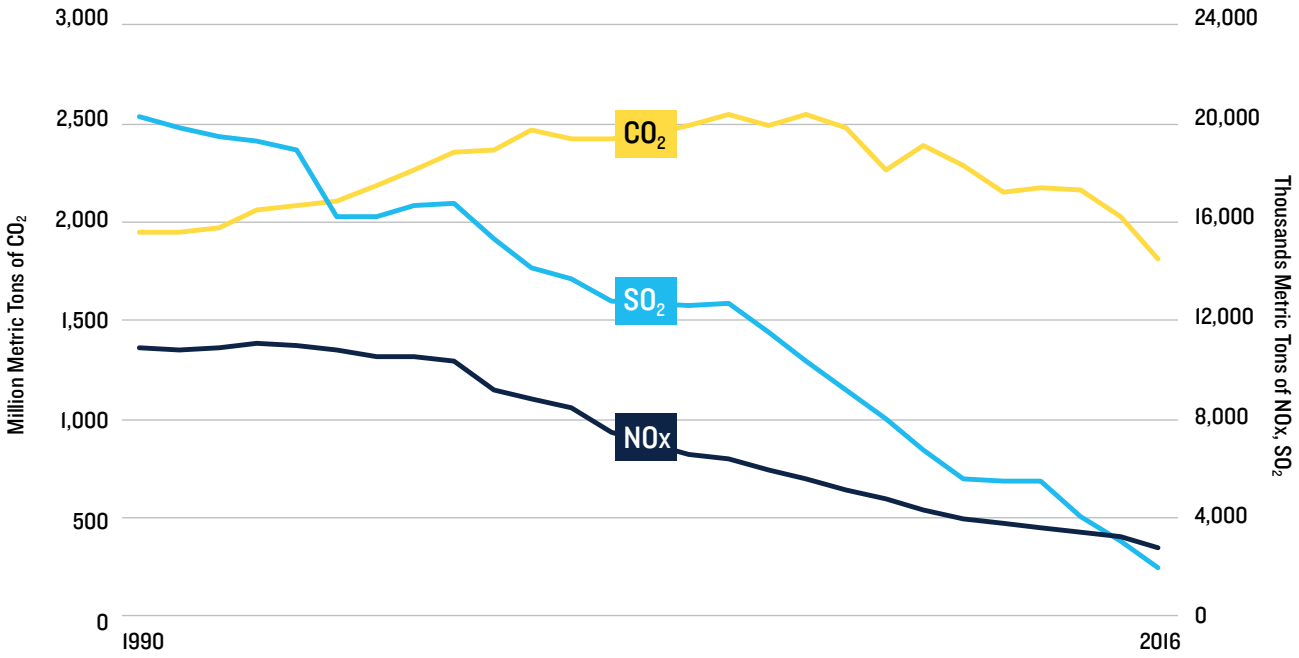
Carbon dioxide ($CO_2$) accounts for the majority of climate-harming U.S. greenhouse gas (GHG) emissions, with methane, nitrous oxide, and fluorinated gases as the next-largest contributors (in $CO_2$-equivalent terms) to U.S. GHG emissions.[25] U.S. energy-related $CO_2$ emissions in 2016 were down 14 percent from 2005 levels (Figure 1).[26] This is the lowest level since 1992 and a significant drop in climate-changing pollution. However, much more progress is urgently needed. While state action can reduce U.S. GHG emissions and help keep the United States on track toward meeting our Paris commitments, federal regulation is vital to achieving U.S. commitments for 2025 and beyond.

The year 2016 was a watershed because the electric power sector's carbon emissions dropped below those of the transportation sector for the first time in at least 40 years.[27] And this trend is holding—the U.S. Energy Information Administration (EIA) forecasts that transportation will remain the largest source of carbon pollution through 2040.[28] Transportation emissions increased by 2 percent year-over-year in 2016, making it the only sector to see an increase in carbon pollution between 2015 and 2016. The increase in transportation $CO_2$ emissions is primarily due to sustained low oil prices, which have resulted in some increases in vehicle use and miles traveled (although total U.S. petroleum consumption is only 3 percent higher than it was in 1973).[29]

Meanwhile, electric power plant carbon emissions declined dramatically, due to a combination of lower oil and natural gas prices, increased wind and solar power availability, and coal plant retirements. Coal power continued to see reductions in market share in the face of cheaper natural gas, solar, and wind power; emissions from coal-fired power plants were 40 percent lower in 2016 than in 2005 and the lowest in 35 years.[30] In total, electric power emissions have declined by 25 percent since 2005 levels, with 2016 annual emissions reaching the lowest level since 1988.[31]

The reduction in coal power has also resulted in dramatic drops in other air pollutants harmful to human health, such as nitrogen oxides ($NO_X$) and sulfur dioxide ($SO_2$). $NO_X$ is a key component of smog and acid rain and can cause respiratory issues, especially in the young and elderly, as well as worsen asthma and allergies. Like $NO_X$, $SO_2$ is a precursor to fine particulate matter, which can result in respiratory issues, asthma attacks, and even premature mortality. Between 2005 and 2016, $SO_2$ emissions from the electric power sector declined by nearly 85 percent, while $NO_X$ emissions declined by more than 56 percent (Figure 1).[32] These reductions have been achieved through a combination of air pollution control equipment driven by the EPA and state clean air rules, lower natural gas prices, and coal plant retirements.

**FIGURE I: ANNUAL CARBON DIOXIDE, SULFUR DIOXIDE, AND NITROGEN OXIDES EMISSIONS FROM U.S. POWER SECTOR FROM 1990 TO 2016**



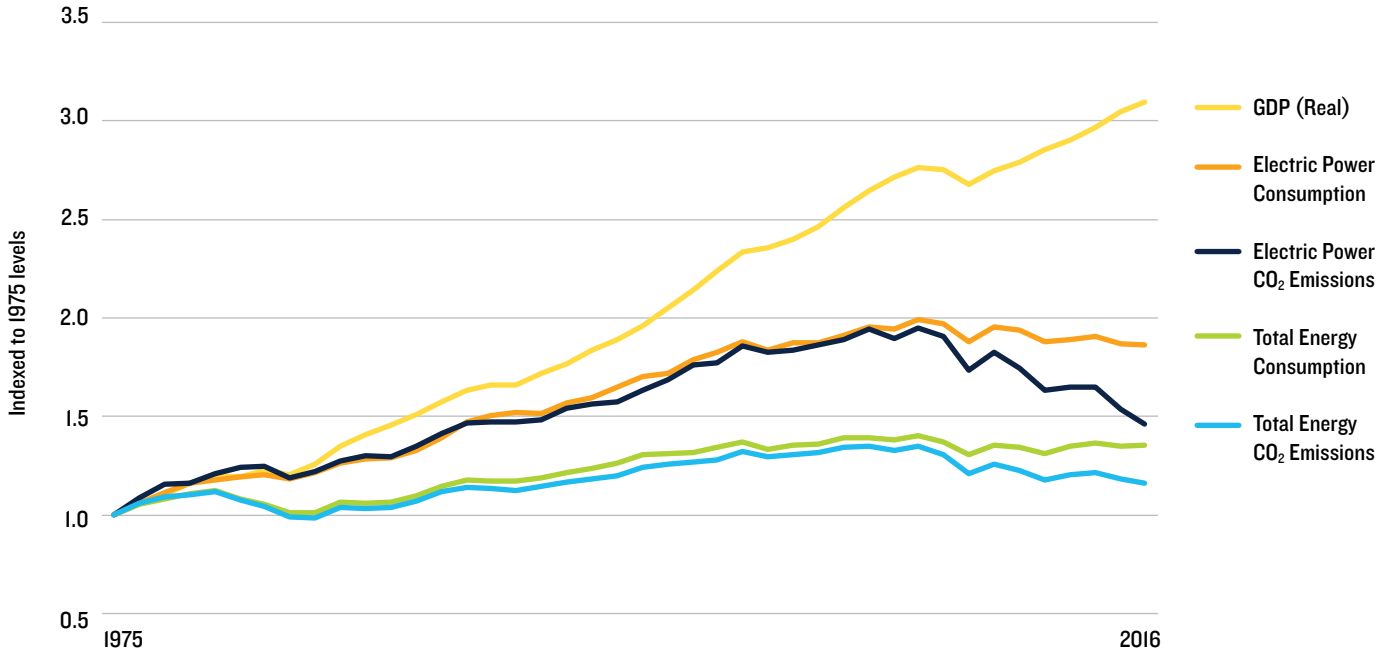
## ENERGY EFFICIENCY

The U.S. economy grew by 17 percent between 2005 and 2016 while carbon dioxide emissions fell by 14 percent and energy use remained flat.[33,34] (See Figure 2.) This is in large part due to energy efficiency. Smarter energy use is the most productive and cost-effective way to meet our energy needs. By using energy in our homes and businesses more efficiently, we can reduce the amount that must be generated and supplied, thus avoiding the need to build more power plants. This saves homeowners and businesses tens of billions of dollars annually on their utility bills, prevents a significant amount of carbon emissions, and provides local job opportunities in the construction and installation of energy efficient buildings and appliances.

And there are still significant opportunities for states and consumers to cut energy waste. A July 2017 American Council for an Energy-Efficient Economy (ACEEE) report found that the adoption of 21 state-level appliance standards across the country could provide $113 billion in savings for consumers and businesses over 15 years.[35] These standards, which would apply to products that are not covered by the federal energy efficiency standards program, would save 590 million megawatt-hours (MWh) of electricity, enough to power 50 million U.S. homes for a year, and save an additional 1.6 quads of natural gas, which could meet the heating needs of half of all Americans for a year.[36] Every state should adopt these energy- and cost-saving standards. For the many other appliances and products that are already covered by the federal program, however, federal efficiency standards take precedence, and continued progress to improve these national standards is critical. The new administration has delayed several such standards, which were developed with input from industry and other groups.[37] Efficiency benefits everyone, and policymakers should continue to pursue new and strengthened standards at all levels of government.

States also are making progress on building energy codes, benchmarking policies, and green financing. In 2016, Connecticut, Massachusetts, New York, Ohio, Tennessee, and Utah adopted stricter residential and commercial building energy codes. These codes will save residents billions of dollars over the next few decades by ensuring that all new homes are appropriately insulated, safe, and follow smart building design.[38] In addition, almost 10 percent of commercial office space is now subject to local or state benchmarking requirements.[39] These policies direct owners to publicly provide information on the energy consumption—and relative efficiency—of their large buildings. Such reporting provides businesses and consumers with critical information on the expected energy costs of office space and allows owners to understand how their buildings stack up against others. Even without official energy-saving policies, building owners are voluntarily investing in constructing or improving the efficiency of their office spaces. More than 6 percent of all building space in the United States is now ENERGY STAR®-certified, which means these buildings have proved they are among the most efficient of their kind in the country.[40] Not only do these certified buildings experience large energy cost savings, their owners see rent premiums, higher occupancy rates, higher tenant satisfaction, and increased retail value.[41]

**FIGURE 2: GROWTH IN ENERGY, ELECTRICITY, EMISSIONS, AND GDP IN THE UNITED STATES BETWEEN 1975 AND 2016**



Meanwhile, states and utilities are exploring alternative business models that encourage energy efficiency and demand-side (customer-side) energy technologies like rooftop solar panels. This includes rate-adjustment mechanisms like revenue decoupling, which uses barely noticeable upward and downward tweaks in retail utility rates to break the otherwise powerful linkage between utilities' financial health and fluctuations in their electricity and natural gas sales. Under this approach, any variation in revenue (over or under) pre-approved levels is returned or charged, respectively, to customers in the next year. If electricity sales are higher than expected (e.g., due to very hot or cold weather, greater economic or customer growth), any excess revenue will be returned to customers via a bill credit. Likewise, if there are fewer sales than expected (e.g., greater energy efficiency, mild weather), the utility can apply an additional, often capped, charge to recover prudent costs, like the costs of maintaining and operating power plants, poles, and wires, and providing billing and customer service. This helps remove the disincentive for utilities to support energy-saving programs, since a utility will no longer lose out on cost recovery when it helps customers control their energy consumption and reduce energy waste.

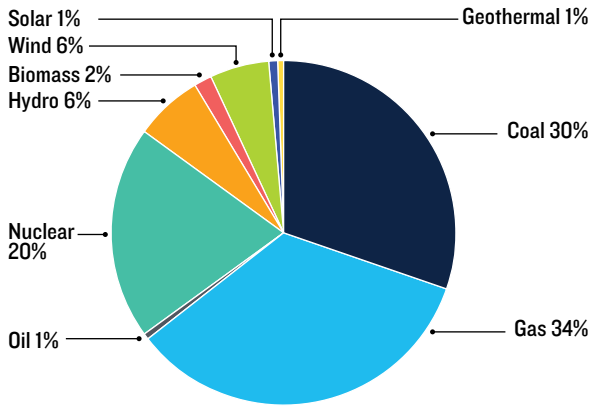
Colorado, Illinois, and Washington authorized decoupling for one or more electric utilities in the past year.[42] The nation's largest publicly owned utility, the Los Angeles Department of Water and Power (LADWP), also renewed its existing decoupling mechanism last year.[43] As of June 2017, 16 states and Washington, D.C., have at least one decoupled electric utility, representing 36 electric utilities who serve more than 37 percent of all customers of investor-owned electric utilities.[44] In total, 29 states and Washington, D.C., have decoupling for gas and/or electric utilities, covering 92 gas and electric utilities.[45]

States and utilities are also unlocking new efficiency opportunities, achieving and sustaining previously unheard-of levels of energy savings. Utility spending on energy efficiency programs remains the largest and fastest-growing source of spending in this segment, accounting for 59 percent of U.S. investment in energy efficiency through formal frameworks (e.g., Property Assessed Clean Energy financing and energy service companies).[46] In total, U.S. natural gas and electric utilities spent $7.4 billion on energy efficiency in 2015.[47] This is a 17 percent increase over the past five years (adjusted for inflation).[48] Of this, $750 million went to help low-income households make their homes more energy efficient.[49]

In addition, utility spending is set to increase with the passage of multiple new and improved energy efficiency resource standards, policies that require utilities to achieve a specified level of customer energy savings every year. At the beginning of 2016, Massachusetts set an ambitious energy efficiency target: 2.93 percent annual savings for 2016 to 2018; this means reported energy savings must be equal to or more than 2.93 percent of total annual electricity sales in the state.[50] For comparison, the average state achieved only 0.67 percent savings in 2015.[51] Not only did Massachusetts utilities exceed the target in 2016, but they did so at a lower cost than budgeted, achieving 3.3 percent annual savings statewide while using only 90 percent of the funding set aside for energy efficiency programs.[52] Meanwhile, in August 2016 New Hampshire established its first energy efficiency resource standard (EERS), which is set to achieve 1 percent annual savings in 2019 and 1.3 percent in 2020. And the Arkansas EERS was extended through 2019 after a review of the program showed significant energy savings, overall customer and utility cost savings, and lower rates due to energy efficiency investments.[53]

This momentum continued into 2017 as Colorado passed new legislation extending its utility energy efficiency programs for another 10 years. Maryland also passed legislation to extend its program, emPOWER, which is expected to save residents 130 million MWh of electricity over the next decade (around $1.5 billion in utility bill savings) and create 68,000 new jobs.[54]

**FIGURE 3: U.S. ELECTRICITY GENERATION BY SOURCE IN 2016[55]**




Note: Numbers are rounded

## RENEWABLE ENERGY

The current growth in renewable energy is not an aberration but a lasting paradigm shift in the U.S. electric sector. Renewable energy grew to 14 percent of total U.S. electricity sales in 2016, with wind and solar amounting to 8 percent and hydropower and geothermal accounting for the other 6 percent. (See Figure 3.) In March 2017 and again in April, for the first time in U.S. history, wind and solar energy made up more than 10 percent of all electric power.[56] And as the costs of these technologies continue to fall, clean energy will only grow. Newest forecasts estimate that renewables (including hydropower) will

represent almost half of total electricity generation in North America in 2040, due to the favorable economics of clean energy, growing flexible demand and storage options, and the improved ability of regional grids to integrate these variable-output resources.[57]

As of the end of 2016, wind became the largest source of renewable capacity in the United States, beating out hydropower for the top spot.[58] More than 8.9 gigawatts (GW) of onshore wind capacity was added to the U.S. grid in 2016, enough to power 3.2 million homes.[59] (Energy capacity refers to the maximum possible energy a power plant can produce at any given time.) And with the extension of the federal renewable energy tax credits at the end of 2015, onshore wind is expected to continue to enjoy significant growth in the next few years.[60]

America's first offshore wind farm, Block Island, also began operation in December 2016, producing power off Rhode Island. The federal Bureau of Ocean Energy Management is working to designate new ocean areas for offshore wind development and grant leases for their development. At the state level, Massachusetts, New York, Maryland, and Virginia are all moving forward on plans to support the development of offshore wind farms in the next few years (See Figure 4).[61]

But the even bigger story of 2016 was solar energy. More than 14 GW of solar capacity was added—almost double the record-breaking new amount in 2015.[62] This momentum should continue as the costs of solar energy continue to fall. Annual solar installations (large- and small-scale) are expected to rise to 15 GW of capacity by 2019 and to surpass 20 GW a year by 2021.[63]

While state energy mandates have driven much renewable growth historically, the economics of clean energy and corporate interests will likely be the dominant factors over the next few years. Solar panel prices have seen an 80 percent decrease in less than a decade. At the same time, the average wind power purchase agreement (PPA), which is a long-term contract for a certain portion of energy from a power plant at an agreed-upon price, has fallen from $70 per MWh in 2009 to $20 per MWh in 2015, according to the DOE.[64] And even as the federal renewable energy tax credits phase out over the next five years, analysts expect wind and solar to become the cheapest form of new power nationwide by 2023, with new solar even outcompeting existing fossil generation by 2027.[65]

A few policy shifts could have implications for the economics of these resources. There is some uncertainty about the continued growth of wind once the production tax credit (PTC) sunsets in the early 2020s.[66] In addition, the International Trade Commission is considering a petition from two solar manufacturers seeking a 40-cent-per-watt duty on imported solar cells and a 78-cent-per-watt floor price for solar modules, which are the building blocks of

**FIGURE 4: MAP OF OFFSHORE WIND LEASE AREAS IN U.S. ATLANTIC**


solar panels. Most U.S. panels use imported modules, and if a new duty is placed on them, solar prices could rise significantly compared with current expectations.[67]

Corporations and utilities made waves in 2016, signing 20-year power purchase agreement contracts for solar energy at prices as low as 3 cents per kilowatt-hour (KWh), which is close to current wholesale power prices. Not only are these renewable contracts as cheap as market

power today, but they provide businesses and utilities with the knowledge that their power prices will stay this low for the next 20 years. In contrast, the average wholesale market price can be volatile, rising and falling quickly in response to gas and coal prices. (For example, average wholesale power prices in the eastern U.S. were $30 per MWh [3 cents per KWh] higher in 2014 than in 2016.) And wholesale price increases are ultimately borne by consumers.[68] New waves were made this year when Tucson Power signed a 20-year contract for solar power and battery storage for less than 4.5 cents per KWh, a record low price for this type of project.[69] This solar and storage combined project will allow the utility to store the low-cost solar energy that it purchases and use it to meet customer energy needs even when the sun is not shining.

The favorable economics of renewable energy are increasingly obvious in the United States. Iowa currently gets 37.8 percent of its electric capacity from wind, which ranks it first among the states for the proportion of wind power in its energy mix.[70] North Dakota and Kansas are second and third, with 37.4 percent and 31.9 percent, respectively.[71] By 2020 these states will be even more wind-heavy. MidAmerican, Iowa's main utility, expects to get more than 85 percent of its energy from wind by 2019 and 90 percent by 2021. MidAmerican predicts this will save enough money that it will not need to raise utility rates before 2030. Kansas Gov. Sam Brownback has called for 50 percent of the electricity in his state to come from wind by late 2018 or early 2019, and the state's main utility, Westar, expects to be 32 percent wind-powered by the end of this year. And in July 2017, General Electric and Invenergy announced plans for the largest wind farm ever built in the United States: a 2,000-MW facility in Oklahoma. A plant this size could power more than 800,000 homes annually, enough to serve almost one-quarter of the state's population.[72]

While it commands a smaller portion of the U.S. energy mix currently, solar is gaining market share, especially in the Southwest and Southeast. It accounts for 14.2 percent of Nevada's capacity mix today, the highest of any state, followed by California at 13.8 percent and Utah at 9.5 percent.[73] California has already proved that solar energy can be reliably integrated and handled. In late May, the California grid operator reached a new peak renewable generation record. During the early afternoon, the state met 67.2 percent of total energy demand with non-hydro renewables—mostly solar—and more than 80 percent with renewables when including hydro resources.[74] Elsewhere, grid operators across the nation, from Texas to Colorado to the entire Plains region, have all been able to meet more than 50 percent of all energy demand with wind alone at certain times, a feat thought impossible just a few years ago.[75]

## NEW PLAYERS: EVS AND BATTERIES

Decades of research & development and innovation funding have helped transform solar and wind energy into the mainstream and economical technologies they are today. And battery technologies are poised to be the next to make it big. Technological innovation has already spurred dramatic declines in the price of energy storage batteries and electric vehicles (EVs). Prices for the lithium-ion batteries typically used in EVs have fallen by more than 70 percent since 2010, due to process improvements from increased experience with these technologies and improved economies of scale.[76] In addition, as electric vehicles gain a foothold in the market, consumers now have more clean electric vehicle options. In fact, 55 models of EVs were available at the end of 2016, almost 20 percent more than in 2015.[77] Analysts expect even greater customer interest and options in the near future. Tesla already has sparked huge investor interest and a substantial waiting list for its first lower-cost, "mass market" electric car, the Model 3, which began rolling off the assembly line in the summer of 2017.

Bloomberg New Energy Finance estimates that 25 percent of all U.S. cars will be electric by 2040.[78] Supporting policies—like EV rebates, innovative electric rate plans for EV owners, and increased investment in electric vehicle charging infrastructure across the nation—could drive even greater EV adoption in America.

Carmakers have plans to make even larger investments in this clean car sector. Volvo Cars has pledged that all the models it introduces from 2019 onward will be either hybrids or powered solely by electric batteries.[79] Ford expects to introduce its first battery-powered SUV by 2020, and Tesla is set to unveil a fully electric freight truck in the fall of 2017 (something considered unfeasible merely four years ago). This will only fuel the diversity and growth of the EV market in the future.

Technological innovation is also likely to continue to reduce costs and improve the performance of electric vehicles and standalone batteries. Toyota announced that within the next five years it could be producing "solid state" batteries for electric vehicles that would be fully charged in less than three minutes.[80] These advances not only can address consumer concerns about range and charging time, they can catalyze the growth of battery storage by translating the improvements in vehicle batteries to large-scale batteries to store and distribute electricity on the grid. As variable renewable generation becomes a bigger source of power in the United States, the grid can see huge benefits from storage.[81] Big, long-term energy storage can address monthly or yearly variations in sun and wind power. But the grid also will need fast, responsive, short-term power storage to smooth out variations across seconds, minutes, and hours. This is known as "voltage regulation" and "frequency response," which are crucial and valuable grid services that maintain the reliability and resiliency of our

electricity system.[82] Currently, these grid services are filled by quick-start natural gas resources, but battery storage can be a zero-carbon alternative.

## NATURAL GAS

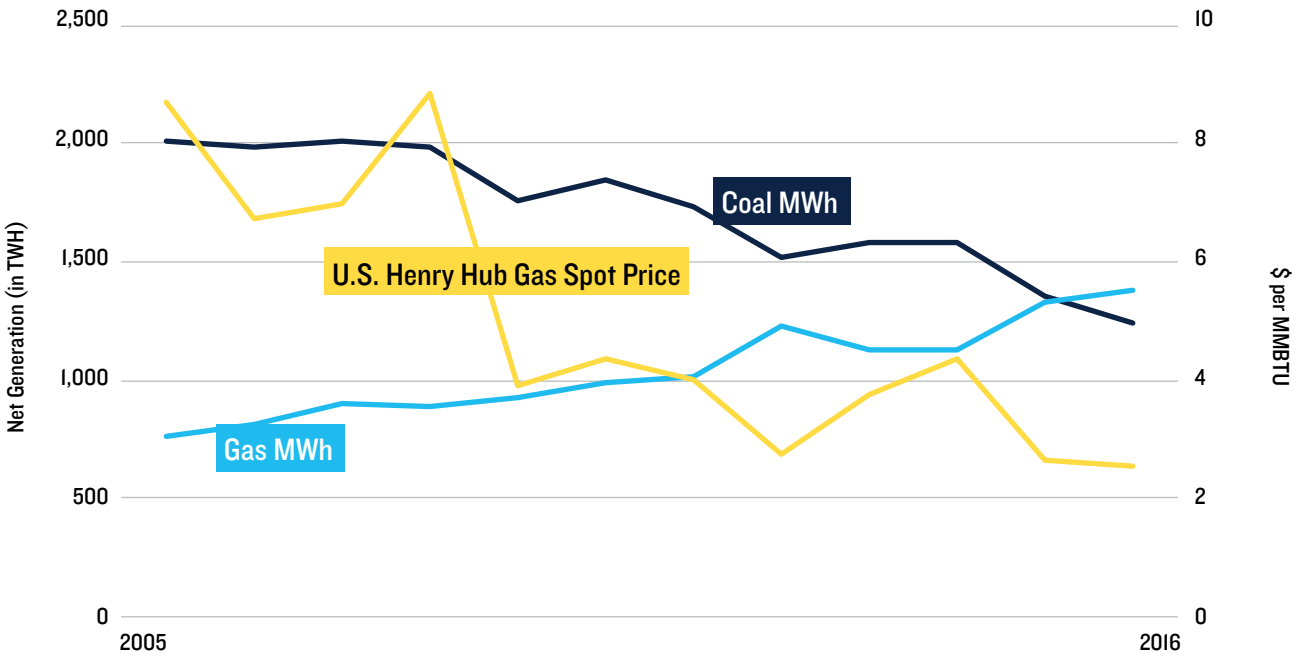
For the first time, natural gas has become the largest source of electric power in the United States. In 2016, 34 percent of all electric power came from gas-fired power plants and 30 percent came from coal-fired plants. The overall power mix is substantially more diverse now than at the turn of the century, when coal accounted for more than half of all generation and wind and solar were barely present. This shift is being driven by a combination of factors, including increased domestic natural gas production, low gas prices, environmental regulations, and an aging coal fleet.

The United States is the world's largest natural gas producer, having surpassed Russia in 2009, and is on track to be a net exporter of natural gas in 2017.[83,84] Even as U.S. gas production increased, the United States had remained a net importer of natural gas since 1958, because easy access to Canadian gas sources via pipelines and growing energy needs kept U.S. natural gas demand higher than domestic production could support.[85] The EIA now forecasts that the nation's status as a net exporter will continue to grow over the next two years as U.S. gas demand remains flat, imports from Canada decline, U.S. exports to Mexico increase, and liquefied natural gas (LNG) export capabilities grow. The United States now exports an average of 4 billion cubic feet of gas to Mexico a day, a fourfold increase since 2010.[86] As Mexico looks to build its natural gas power capacity, the United States has the potential to export even more gas to Mexico if there are no new trade restrictions between the two nations.

Increased domestic production of natural gas has been driven by hydraulic fracturing technologies that have uncovered new gas sources. This technique, which injects fluids at high pressure into deeply buried fossil fuel reservoirs, has reduced America's dependence on foreign oil and helped keep natural gas prices relatively low. But it also harms our communities and the environment. It can and has contaminated air and drinking water, ruined landscapes, caused earthquakes, harmed human health, and contributed to climate change.[87]

The massive shift in the U.S. energy landscape from America being an importer of natural gas to a net exporter has had ripple effects across the entire energy system. Dozens of coal plants have closed in the past five years under the pressure of lower cost natural gas generation, renewable energy, and energy efficiency. Additional coal plants have been converted to run on natural gas. Outside the power sector, industry and freight transportation have also started transitioning away from coal and petroleum, respectively, to natural gas as the domestic supply continues to grow and prices remain low. In fact, natural gas prices reached new lows in 2016, declining to an average of $2.52 per million British thermal units (MMBtu).[88] This is a quarter of the cost of gas in 2008, as shown in Figure 5.

**FIGURE 5: U.S. COAL AND GAS ELECTRIC GENERATION BETWEEN 2005 AND 2016 (LEFT AXIS) AND THE PRICE OF NATURAL GAS (RIGHT AXIS)**




The Henry Hub Gas Price is the price of natural gas delivered to Henry Hub, Louisiana. It is the main U.S. benchmark price for natural gas.

## OIL

Annual U.S. oil consumption in 2016 was 10 percent below that of 2005, which was the highest in the nation's history, and only 3 percent higher than in 1973, the year of the first OPEC embargo, despite the U.S. economy tripling in size since then.[89] However, oil use has increased modestly for the past four years, due mainly to increased vehicle miles traveled and consumers' revived interest in SUVs and light trucks, spurred by low gasoline prices. Continued strengthening of clean car and fuel economy standards remains critical for achieving oil consumption reductions.

However, these federal standards are under review by the new administration. Fuel standards for cars, SUVs, and light trucks were projected to nearly double automobile fuel efficiency from 2010 levels by 2025 and to cut oil imports by a third. In August 2016, the EPA and the U.S. Department of Transportation also finalized new fuel economy standards for medium- and heavy-duty trucks—including new large pickups, tractor-trailers, buses, and delivery vans. These standards would reduce fuel use by up to 25 percent by 2027 and save owners about $170 billion in fuel costs over the life of vehicles sold under the program.[90] Despite these projected savings, the administration has indicated it wants to reverse these planned advancements.

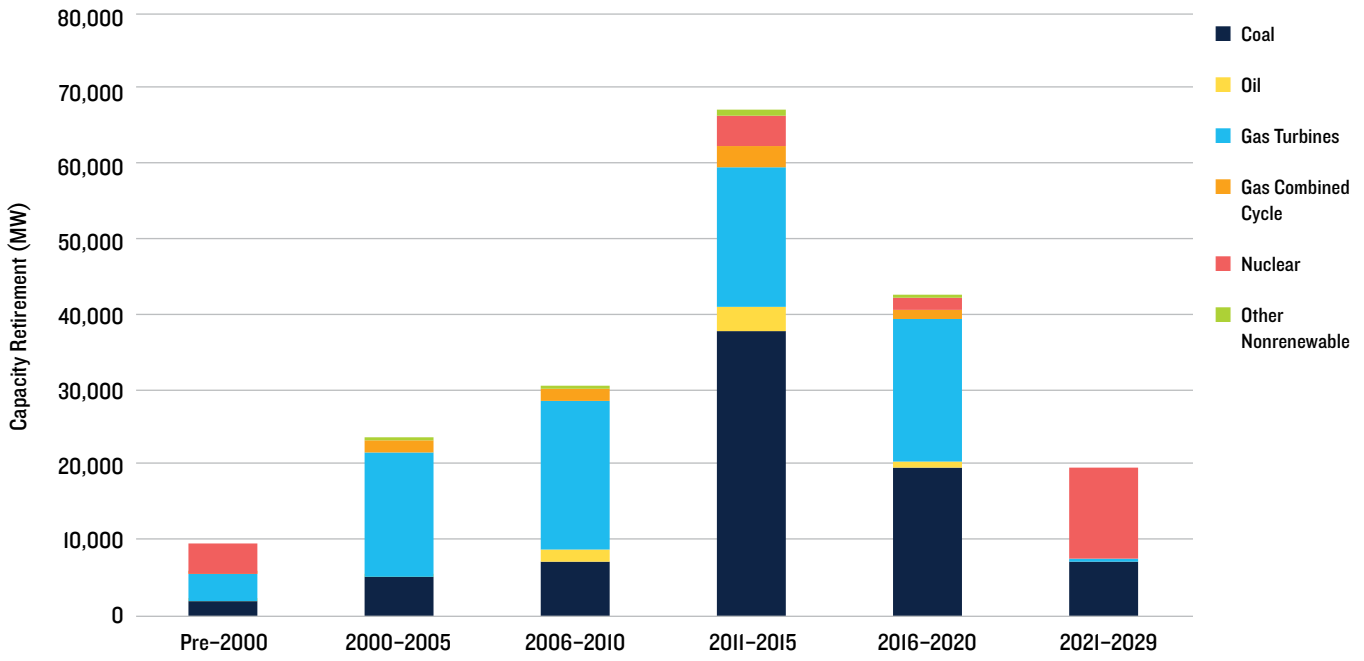
Meanwhile, the new administration has pledged to approve a number of oil pipelines, including Keystone XL, which the Obama administration rejected in November 2015.[91] Keystone XL and other announced pipelines, if built, will increase greenhouse gas emissions, disrupt sensitive wildlife habitat, and threaten to pollute water sources in America's heartland.

## NUCLEAR ENERGY

Low wholesale power prices and growing maintenance costs have put increased pressure on America's aging nuclear fleet, resulting in a number of retirement announcements that captured significant attention from state and federal policymakers over the past year. Regulators and other stakeholders are working to avoid abrupt nuclear facility closures, which could result in carbon emission increases from replacement generation. They are aiming instead for retirements with sufficient lead time to ensure that power is reliably replaced with zero-carbon energy resources and that workers and communities are protected from negative economic impacts. Over the past year, three states moved forward on plans to avoid abrupt closures.

California's last remaining nuclear power plant, the Diablo Canyon facility in San Luis Obispo, is owned by Pacific Gas & Electric. In a novel agreement between local groups, PG&E, labor unions, and environmental groups (including NRDC), the parties devised a plan for the phasing-out of Diablo Canyon's two nuclear reactors without any increase in greenhouse gas emissions. Their Joint Proposal calls for retiring Diablo Canyon by 2025 and replacing its power with lower-cost, zero-carbon options led by additional

**FIGURE 6: POWER PLANT RETIREMENTS BY FUEL SOURCE FROM 1975 TO 2030 (IN MEGAWATTS OF CAPACITY)**




Retirements for 2017 through 2029 reflect only plant retirements already announced, and are not a projection of total retirements in future years.

energy efficiency and renewable energy resources. The Joint Proposal also includes significant labor and community protections, such as provisions for worker retention and retraining, and compensation for severance and community impacts.[92]

New York and Illinois took a different approach, promising nuclear plants long-term electricity payments that at least initially exceed the value of their power in wholesale markets, while also increasing renewable energy, energy efficiency, and storage. Both states' nuclear payment structures were upheld by courts in the summer of 2017, although these decisions are being appealed.[93]

## COAL

There is no doubt that America is decreasing its reliance on coal-fired generation. The share of electricity generated from coal fell from 52 percent in 2000 to 30 percent in 2016, reflecting market shifts to natural gas and non-hydro renewable energy and driven in part by strengthened air pollution standards.[94] Until 2008, coal generation outproduced natural gas, wind, and solar energy combined by a factor of 2; however, in 2016, natural gas was the largest single source of electricity, and natural gas, wind, and solar together represented 42 percent of all electricity generated.[95]

U.S. coal consumption and emissions saw large year-over-year declines, with total 2016 coal-related emissions falling to the lowest level since 1978. Around 45 GW of coal capacity has retired in the past five years (see Figure 6), and additional retirements have been announced.[96] The last coal power plants in Massachusetts and New Jersey closed on July 1, 2017, and more states are expected to go coal-free by 2020.[97] Electric utility companies are planning to retire more coal generation over the next decade or two due to economic and environmental factors. These utilities cover all regions of the United States, from DTE in Michigan to Public Service of New Mexico to the entire Pacific Coast and Northeast. And they expect to replace much of this fossil capacity with new renewable energy.

## HOW CONSUMERS BENEFIT

The massive decline in natural gas prices over the past decade, as well as increased renewable energy and efficiency, have helped Americans lower their energy costs. In fact, for the first time since 1960, the average U.S. household spent less than 4 percent of its income on all energy—including gasoline and electricity spending—despite the much larger number of electronic gadgets and appliances we now use.[98] The average U.S. household spends just $3.95 a day for electricity—down from $4.02 in 2015.[99] The price of electricity has been growing at a much slower rate than that of all consumer goods, which means the real price of electricity paid by America's households is actually significantly lower than it was a year ago.[100] And consumer spending on electricity is still falling. In January 2017, electricity costs were only 1.27 percent of all consumer expenses, the lowest ever recorded by the U.S. Department of Commerce. The previous record, 1.29 percent, was set just two months earlier.[101] In fact, over the last 35 years, energy spending as a share of U.S. GDP has declined by over 50 percent.[102]

Not only have energy costs, as a portion of household income and our economy, hit record lows, but the United States has greatly outpaced expectations for a clean, efficient energy system. The United States has blown past the Department of Energy's predictions from 10 years ago (see box below). For example, total U.S. solar capacity is 46 times higher and wind capacity has seen an almost fivefold increase from expectations. Carbon dioxide emissions were 1.6 billion tons below the DOE's forecast, which is more than the annual pollution from powering and heating America's homes in 2016. In addition, energy consumption across the U.S. economy was 19 quads less than predicted, saving as much energy as we consume from renewable, biomass, and nuclear sources every year.

The ongoing transition from dirty fossil fuels to cleaner and more efficient power resources has been a win for consumers, the environment, and the economy. It's no wonder that policymakers, educators, and business leaders across the country are doubling down on clean energy and climate action. This will only enhance American economic prosperity, national security, and our standing on the world stage and in the global market.

**THE U.S. DEPARTMENT OF ENERGY'S 2006 PREDICTION VS. AMERICA'S 2016 ENERGY LANDSCAPE[103]**

| DOE IN 2006 PREDICTED THE U.S. IN 10 YEARS WOULD | WHAT HAPPENED IN 2016? | THE DIFFERENCE? |
|---|---|---|
| Emit 6.79 billion tons of $CO_2$ | Emitted 5.17 billion tons | **25% less** |
| Consume 115.6 quads of total energy | Consumed 96.5 quads | **17% less** |
| Generate 2,235 TWh of coal power | Generated 1,240 TWh | **45% less** |
| Generate 769 TWh of natural gas power | Generated 1,380 TWh | **80% more** |
| Generate 58 TWh of wind & solar power | Generated 280 TWh | **380% more** |
| Have 0.8 GW of installed solar | Had 39.3 GW of installed solar | **4,500% more** |
| Have 17.8 GW of installed wind | Had 82 GW of installed wind | **350% more** |

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