

2020

# Sustainable Energy in America

FACTBOOK – EXECUTIVE SUMMARY



Growth Sectors of the  
U.S. Energy Economy

# Executive summary (1 of 8)

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Twenty nineteen marked the close of a decade defined in no small part by the rise of sustainable American energy. Over 10 extraordinary years, the U.S. fundamentally overhauled how it produces, delivers, and consumes hydrocarbons, electrons, and heat. In the process, the economy grew more energy efficient, more energy secure, and less carbon intensive. Thanks to associated lower costs, the American consumer has unquestionably been the primary beneficiary.

This marks the eighth year BloombergNEF and the Business Council for Sustainable Energy have partnered to produce the Sustainable Energy in America Factbook. This year's Factbook takes stock of the remarkable changes last decade while focusing specifically on the events of 2019. It includes many of the same data, charts, and facts as in previous editions while addressing some new emerging topics.

## **2010-2019: a decade of profound transformation**

The sectors defined in this report as sustainable – renewables, energy efficiency, natural gas, and advanced transportation – became dominant in the last decade, transforming the generation, delivery, and consumption of U.S. energy. These changes have reverberated not just through every segment of the American economy, but across the globe as well.

### *Production*

- At the wellhead, U.S. oil and natural gas production boomed thanks to decades of research, technological innovation, readily available capital, and entrepreneurship. Today, the U.S. is the world's number one oil and gas producer. From 2010-2019, domestic natural gas production climbed more than 50%. The U.S. went from being a net importer of natural gas in 2010 to being a net exporter as the decade closed.
- The abundance of natural gas resulted in dramatically lower natural gas commodity prices. Those price declines, in turn, made natural gas more competitive for a variety of applications across the economy, particularly power generation, and contributed to significant declines in wholesale electricity prices. Power sector demand for natural gas jumped 60% over the decade and natural gas-fired power generation went from meeting 24% of the nation's needs in 2010 to 38% in 2019. The improving economics of natural gas also hastened the decline of coal-fired power. Coal went from meeting 45% of U.S. demand in 2010 to 23% in 2019.
- Renewables – primarily utility-scale hydro, wind, solar, biomass, geothermal and waste-to-energy – also played a critical role in greening the grid. Generation from these technologies jumped 77% in a decade. Nearly all the new renewable generation came from new utility-scale wind and solar projects, along with rooftop solar systems.
- The results are even more remarkable when considered on a capacity basis. The U.S. has twice the renewable power-generating capacity today compared to a decade ago. Total installed wind has tripled to 108GW. And at 75GW, there is *80 times* more solar capacity online today than at the start of the decade.

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- At first, the build-out of these technologies was spurred by state-level mandates for renewables and federal tax credits. But in the last several years of the decade, projects began winning power-delivery contracts on economic merits alone. In all, almost 150GW of wind and solar was built over 10 years. The U.S. is today second only to China in total installed renewable capacity.
- In the last two years, projects that pair renewables technologies with large-scale batteries have for the first time become economically viable. In particular, “PV+storage” projects have under-bid natural gas-fired plants to win power-delivery contracts in certain states thanks to a 77% drop in the price of typical PV module and an 87% decline in battery pack prices. While the U.S. has made important progress on improving both solar and battery technologies, the drops are largely attributable to sheer economies of scale – specifically, a major manufacturing scale-up in Asia.
- For its part, nuclear generation held largely steady in its overall contribution to the U.S. power grid on a percentage basis, despite a slide in the number of reactors on line. During the second half of the decade, in particular, more nuclear plants became uneconomic and were forced to close or secure state-level subsidies. Still, as of year-end 2019, nuclear accounted for 20% of total U.S. power generation and the majority of zero-emission power produced in the U.S.

## *Delivery*

- The abundance of lower-cost fuels has required larger and smarter delivery networks for hydrocarbons, electrons, heat and other sources of energy. The U.S. natural gas distribution pipeline network grew from 2.09 million miles in 2009 to 2.24 million as of year-end 2018 (the last year for which there is complete data), serving more than 75 million homes and businesses. U.S. midstream natural gas expenditures focusing on natural gas delivery totaled an estimated \$185 billion through 2018. Still, additional pipelines are sought to move natural gas to New England, or out of production zones, and to new liquefied natural gas export terminals.
- To facilitate the delivery of greater volumes of lower-carbon electricity, U.S. utilities have boosted investment to support transmission grid buildout. From 2010 through 2018 (the last year for which complete data is available), investor-owned utilities invested \$170 billion, or \$18.9 billion per year (2018 dollars). Even accounting for inflation, utilities have nearly doubled their annual rate of spend on transmission this decade compared to 2010-2018.

## *Consumption*

- Since 2009, the U.S. has posted 10 consecutive years of economic growth. Remarkably, U.S. energy demand expanded only marginally over that time. The nation’s gross domestic product grew to approximately \$19 trillion in 2019, up about 25% since the start of the decade. Over that same time, total energy use expanded just 6.6%. In five of 10 years of the decade, energy usage actually *shrank* year-on-year.



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- The growth in energy productivity has been supported by a confluence of technology innovation, economies of scale, and policymaking in the energy efficiency sector. The changes are such that the definition of energy efficiency has expanded beyond traditional building and appliance efficiency to include metering and automation. Today, there are over 85 million “smart meters” in U.S. homes and businesses, up from 9.6 million a decade ago. Thirteen states now have smart meter penetration rates exceeding 80% of homes and businesses.
- Costs have dropped sharply for the most modern and efficient household and business equipment. Perhaps the best example is the light-emitting diode (LED) lightbulb. The average price for an “A-type” LED as recently as 2012 was \$37 per thousand lumens produced. By 2017 (the last year for which complete data is available), that had fallen to \$8, according to the Department of Energy. Meanwhile, usage of these bulbs spiked from virtually zero in 2010 to 1.1 billion units as of 2018. Still, penetration of LEDs remains well below 50% in the U.S., suggesting major opportunities still remain to swap out old bulbs to improve efficiency. There have been similar stories in the roll-out of energy-efficient air conditioners, furnaces, freezers, clothes washers, refrigerators, televisions, cable television boxes, and many other devices.
- These energy efficiency breakthroughs have hardly occurred in a vacuum. The federal government promoted best-in-class standards through its Energy Star recognition program and mandated the phase-out of particularly outmoded and inefficient equipment. States have also lent a hand and today 74% of Americans live in a state with a building energy code that promotes energy efficiency. Finally, cities have taken the lead in establishing benchmarking or disclosure policies, which either require building owners to achieve certain levels of energy efficiency or make public their progress on efficiency. Through 2019, 13% of all U.S. building floor space was required to meet an efficiency or disclosure requirement with cities such as New York, Denver, Atlanta, and Los Angeles leading the way.

## *The Empowered Consumer*

- Technological advances and lower costs have handed American consumers unprecedented control over how they consume energy. The control applies not just to how they use power in their businesses and homes but where they source it from. At least 18 regulated utilities now offer “green tariff” programs to facilitate the delivery of renewable power to corporate customers and nine states have taken actions to offer voluntary tariffs for renewable natural gas to homes and businesses. Other corporate customers – including some of the world’s largest tech, manufacturing, and oil companies – have chosen to buy power directly from renewable energy projects. A decade ago “bilateral power-purchase agreements” with renewable project owners were virtually non-existent. As of year-end 2019, U.S. companies had signed contracts with largely wind and solar projects totaling 33.6GW (enough to potentially power nearly 8 million homes).
- Residential customers have broader options to buy clean power as well. Dramatically lower costs have made rooftop solar accessible for the first time to millions of Americans. An average residential PV system cost approximately \$34,000 a decade ago. Today, the average system cost is \$15,000 or less, depending on system size. Output levels have also risen as PV module efficiency has improved.

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- As the decade came to a close, lower-priced batteries and other energy-storage technologies began empowering a small, but growing number of businesses and homeowners with the option to toggle between consuming locally-produced clean electricity or power procured from the grid. “Behind-the-meter” battery systems and thermal energy storage also offer consumers greater resiliency to blackouts and the ability to minimize demand charges during hours of peak consumption.
- American consumers also have a far broader set of choices when it comes to transportation than a decade ago. Ride-hailing and ride-sharing services have removed the need to own a car altogether for some. Those looking to buy or lease can choose from a variety of lower fuel usage vehicles and which fuel they would like to consume – gasoline, diesel, biodiesel, ethanol, or even natural gas or hydrogen – or which drivetrain.
- In 2010, U.S. consumers had virtually zero choices when it came to electric vehicles. Today, 44 pure battery electric models are for sale in North America, along with 35 plug-in hybrid electrics. And manufacturers have promised another 40 BEV/PHEV choices by 2022. Americans purchased or leased 1.4 million battery-electric and plug-in hybrid electric vehicles during the decade with 71,000 charging points available by the end of 2019.
- Perhaps unsurprisingly, more choices have also meant lower prices and lower overall energy bills for consumers of all sorts. U.S. businesses have consistently accessed some of the very lowest wholesale power, natural gas, oil, and other fuel prices (though power prices can vary substantially by U.S. region). Meanwhile, U.S. households are putting less than 4% of their average monthly income on a proportional basis toward energy-related expenditures today, down from 5.1% a decade ago. Lower energy costs have helped make inflation a non-factor in the U.S. economy for a decade.

## *Security, jobs, emissions, and resiliency*

- Plentiful resources and stagnant demand have, by reasonable benchmarks, boosted U.S. energy security. High production has led to oil, gasoline, natural gas and wholesale power price drops and dramatically lower reliance on foreign sources. At the start of the decade, the U.S. was a net importer of approximately 10 million barrels of crude oil and petroleum per day. As 2019 came to a close, that had dropped to nearly zero. Oil and natural gas imports have by no means ceased, but U.S. exports are nearly offsetting them. The build-out of liquefied natural gas (LNG) export hubs is allowing the U.S. to expand trade with allies while countering rivals. Only because the U.S. remains a net importer of electricity (mainly hydro-generated power from Canada) is it not yet a net exporter of energy overall. However, if LNG exports continue to rise, that could change in the next several years.

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- The transformation of U.S. energy – from higher- to lower-carbon generation, from lower- to higher-efficiency delivery and consumption – has had positive impacts on the broader U.S. economy, helping to fuel growth over the decade. The changes have also had more direct economic benefits as well. Since 2010, more than \$390 billion has gone into U.S. clean energy assets at a pace of \$39 billion per year. By comparison, all pre-2010 clean energy investment totaled approximately \$100 billion. In terms of jobs, as of 2018, 3.5 million Americans were working in the energy efficiency, energy storage, renewables, nuclear, and natural gas sectors.
- Finally, the last decade has seen important developments in reducing harmful greenhouse gas emissions. Greenhouse gas emissions from power plants dropped by nearly a quarter and the sector is now the second-biggest emitter, behind transportation. Despite the proliferation of hybrid and electric vehicles, transportation sector emissions rose 5% 2010-2019.
- Overall, U.S. greenhouse gas emissions dipped 4.1% during the decade and as of year-end 2019, U.S. emissions overall were down 12% vs. 2005. While this represents progress, the U.S. is not yet half way towards meeting the pledge made during the Obama administration to cut total greenhouse gas emissions 26-28% from 2005 levels by 2025 as part of the Paris Agreement. While the Trump Administration seeks to leave the Paris Agreement, cities and states representing more than half of the U.S. economy and population have pledged to meet the Paris target.
- As the 2010's wore on, the specter of climate change loomed ever larger with weather and catastrophic natural disasters highlighting the critical need for more resilient systems. Hurricanes Harvey in Texas, Irma and Maria in Puerto Rico, Michael in the Carolinas, floods in the Midwest, the wildfires in California, and other tragedies raised vital questions about how to reinforce or rebuild power grids and other energy infrastructure in an era of more frequent and ferocious climate-related events.
- Away from the headlines, but equally important, was climate change's impact on the U.S. energy system. For example, higher high and lower low temperatures boosted air conditioning and heating demand over the decade. If these trends persist, increased energy consumption can make efforts to reduce energy sector emissions more difficult. Further, disaster related power outages, damage to buildings and infrastructure have led to hundreds of billions of dollars in recovery and rebuilding costs at great expense to communities and taxpayers.

## 2019: a fitting end to the decade

Virtually all the macro trends that have defined the U.S. energy transition over the past decade were also in evidence in 2019. At the highest level, energy productivity – the ratio of GDP growth vs. energy consumption growth – rose 3.3% from 2018. U.S. GDP expanded by 2.3% in 2019 while energy consumption declined 1.0% from the year prior.

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Multiple factors contributed to declining energy use, but less extreme weather conditions compared to the prior year appeared to play an outsized role. The number of “cooling degree days” (CDDs) tracked by the National Weather Service fell substantially from 2018. This lowered demand for air conditioning and reduced stress overall on the U.S. energy delivery system.

## Other major 2019 developments were largely consistent with decadal trends, including the following

- **Natural gas production surged; natural gas prices did not.** Total wellhead natural gas production jumped another 8% from 2018, depressing prices to 2016 levels. Henry Hub natural gas traded below \$3 per MMBtu every month of the year except January.
- **Natural gas consumption grew across the economy, particularly in the power sector.** Natural gas-fired generation rose to account for 38% of all power produced, up from 36% in 2018.
- **The renewable energy build-out continued.** 2019 marked the second-biggest year ever for new non-hydro renewable energy capacity added with 20GW commissioned. Wind and solar again accounted for the majority of new renewables added on a capacity basis.
- **Renewable power generation rose to 760TWh, or 18% of all electricity consumed in the U.S.** That was up from 17% the year prior. 38% of U.S. power was zero-carbon in 2019.
- **Wind surpassed hydro power on a generation basis.** Total wind generation rose to 302TWh in 2019 from 273TWh the year prior. Hydro generation slipped somewhat from 293TWh to 276TWh.
- **Energy storage deployment expanded and solar+storage projects continued to demonstrate their commercial viability.** At least 2.4GW of solar and 870MW of storage in combined solar+storage projects won contracts under tenders held by U.S. utilities.<sup>1</sup> While the use of lithium-ion batteries is growing, pumped hydropower storage still provides 93 percent of U.S. energy storage capacity.
- **Coal’s decline continued.** Power generation from coal slipped to 23% in 2019 from 27% the year prior. 12GW of coal-fired power plants closed in 2019 and the trend is poised to continue as another 14GW have announced they will come off line in the next three years.
- **For the first time, for one month, renewables surpassed coal generation in 2019.** In a potential harbinger, U.S. hydro, wind, solar, biomass, geothermal and waste-to-energy produced more than the country’s fleet of coal-fired power facilities in April 2019.
- **Corporations upped their efforts to secure cleaner power.** A record 14GW of bilateral renewable energy power-purchase agreements were signed. New buyers include major oil companies seeking to reduce emissions associated with the extraction of their fuel.

<sup>1</sup> These values included Hawaiian contracts announced on the last day of December 2018.

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- **Emissions of harmful greenhouse gasses from the power sector fell rapidly.** Thanks to somewhat less extreme weather, power consumption slipped 2.8%. Lower top-line demand coupled with the general move toward a cleaner power matrix caused power sector-related emissions to crater by a rather incredible 7.8%.
- **Total U.S. emissions fell as well.** Taking into account all segments of the economy, U.S. greenhouse gas emissions slid 2.7% in 2019 from the year prior.
- **Sustainable energy sector employment expanded.** Energy efficiency jobs continue to top the list – with 2.3 million jobs across the nation, according to the U.S. Energy Employment report. While solar jobs dropped 4% in 2018, employment in other segments of the new energy economy rose or held relatively steady.
- **Household spending on energy ticked down.** Consumers did not appear to cut their energy usage dramatically year-to-year but lower natural gas and power prices reduced household energy spend.
- **State policymaking efforts ramped up in 2019 in the wake of the 2018 mid-term elections.** Nine states boosted their renewable portfolio standards (RPS). New York sought to establish a new ISO-wide carbon market, above its RGGI commitment. Other states set zero-carbon, energy efficiency and fuel efficiency targets, including Washington, Nevada, and New Mexico.
- **The Trump administration took steps to stall or weaken policies that would have accelerated clean energy deployment.** The U.S. Environmental Protection Agency proposed weakened fuel economy standards for passenger vehicles. The Department of Energy rolled back lightbulb regulations. The Department of Interior delayed issuing a permit for the nation's first major offshore wind farm.
- **But Congress passed – and Trump signed – extensions of clean energy tax breaks and boosted energy RD&D funding.** In December, the U.S. Production Tax Credit benefitting wind, hydropower, biomass, geothermal and waste-to-energy secured extensions while the \$1 per gallon biodiesel tax credit was reinstated retroactively. Funding grew for key research, development and deployment programs at the Department of Energy, including the Office of Energy Efficiency and Renewable Energy and the Advanced Research Projects Agency - Energy (ARPA-E).

## Looking to 2030

Nearly no one a decade ago predicted the magnitude of change that was to come to how the U.S. produces, delivers, and consumes energy. Washington, DC offered limited guidance as the country lacked a cohesive, legislated national energy strategy. And yet a sector that conventional wisdom held would take decades to change was transformed in the virtual blink of an eye. How?



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**Technological advancements** years in the making came to fruition, most notably related to hydraulic fracturing and horizontal drilling for hydrocarbons. A **manufacturing scale-up**, led primarily by Asia-based firms, created economies of scale and drove down prices for PV modules, lithium-ion batteries, LED lightbulbs, and other sustainable energy technologies. A **potent hodgepodge of policies** including the federal economic stimulus law, federal tax credits, the California Solar Initiative, state renewable portfolio standards and state energy efficiency resource standards stimulated market demand. Finally, **an American culture of entrepreneurship supported by billions in investment** created thousands of start-up companies and millions of new jobs.

What will the *Sustainable Energy in America Factbook 2030* have to say about what transpired during the 2020's? Uncertainty abounds, but the lessons of the 2010's are sure to influence the direction of travel. The last decade proved that sustainable energy technologies can as a portfolio deliver safe, reliable, affordable energy services, while meeting evolving consumer needs. The decade also demonstrated that U.S. economic growth and greenhouse gas emissions reduction are not just mutually consistent but mutually *dependent*. These basic principles and others gleaned during these past 10 momentous years will surely dictate what comes next.