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2021 Sustainable Energy in America Factbook

The Business Council for Sustainable Energy and BloombergNEF are pleased to announce the release of the 2021 Sustainable Energy in America Factbook**.** For the ninth year in a row, BloombergNEF (BNEF) and the Business Council for Sustainable Energy (BCSE) have produced the *Factbook,* which provides the latest industry information & trends from the energy efficiency, natural gas & renewable energy sectors in the United States.

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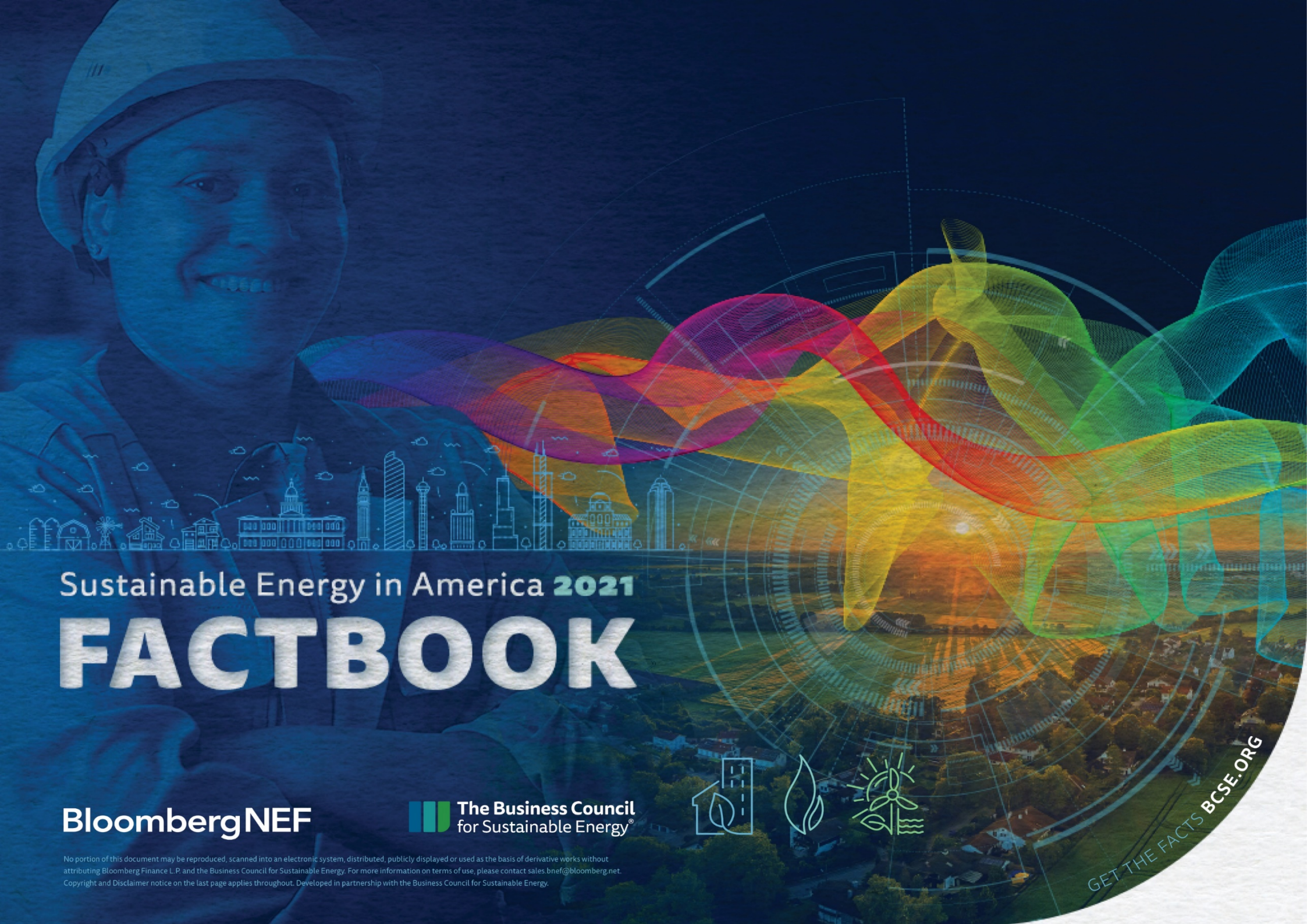

Sustainable Energy in America 2021

FACTBOOK

BloombergNEF

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Overview

The 2021 Sustainable Energy in America Factbook is the ninth in a series documenting the revolution in U.S. energy production, delivery and consumption. This installment documents 2020, a tremendously tumultuous year defined by the spread of a deadly virus, the blossoming of a vital civil-rights movement, massive disruption to the economy and a deeply divisive presidential election.

These macro events provided unique challenges to the sustainable energy sectors. The Covid-19 outbreak temporarily disrupted U.S. wind-turbine manufacturing. Stay-at-home orders kept residential energy efficiency contractors from providing their services and solar systems integrators from marketing services door-to-door. Electric vehicle sales growth was restrained as total vehicle sales plummeted. Most importantly, fundamental demand for energy dropped as the economy slowed. The clean energy sectors furloughed or laid off thousands, primarily in the residential clean energy provider sectors.

While these macro events certainly buffeted the sustainable energy sectors, they hardly derailed overall progress. In fact, in the face of unprecedented obstacles, these sectors demonstrated enormous resilience in 2020. Despite dramatically changed usage patterns, energy productivity continued to rise. A record combined volume of new wind and solar capacity was constructed. Zero-carbon power's share of overall generation hit a new high at 20% as coal-fired generation slipped to its lowest level since before 2005. Energy-related CO2 emissions slipped to their lowest level in at least 3 decades. While much of that decline was due to economic contraction, the shift from to lower-CO2 sources of energy played a critical role.

On the policy front, the year ended on resounding note for the sustainable energy sectors with passage of the Energy Act of 2020 contained in a larger bill to stimulate the U.S. economy and fund the government. The comprehensive legislative package extended key tax credits for renewables, energy efficiency and other clean energy technologies, authorized $19 billion for energy research and development over the coming decade, and allocated grants for electric vehicle charging infrastructure, among other things. The election of President Joseph R. Biden, who pledged to put climate change at the top of his agenda during his 2020 campaign, bolstered hopes for further progress through regulations or legislation in 2021.

The Sustainable Energy in America Factbook provides a detailed look at the state of U.S. energy and the role that new technologies are playing in reshaping the industry. The Factbook is researched and produced by BloombergNEF and commissioned by the Business Council for Sustainable Energy. As always, the goal is to offer simple, accurate benchmarks on the status and contributions of new sustainable energy technologies.

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About the Factbook: What is it, and what's new?

What is it?

- Aims to **augment** existing sources of information on U.S. energy
- Focuses on **renewables, efficiency, natural gas, distributed power and storage** and **sustainable transportation**
- **Fills important data gaps** in certain areas (e.g., clean energy investment flows, contribution of distributed energy)
- Contains data through the end of 2020 wherever possible
- Employs **BloombergNEF data** in most cases, augmented by EIA, FERC, ACEEE, LBNL, and other sources where necessary
- Contains the very **latest information on new energy technology costs**
- Has been graciously underwritten by the **Business Council for Sustainable Energy**
- Is in its **ninth edition** (first published in January 2013)

What's new?

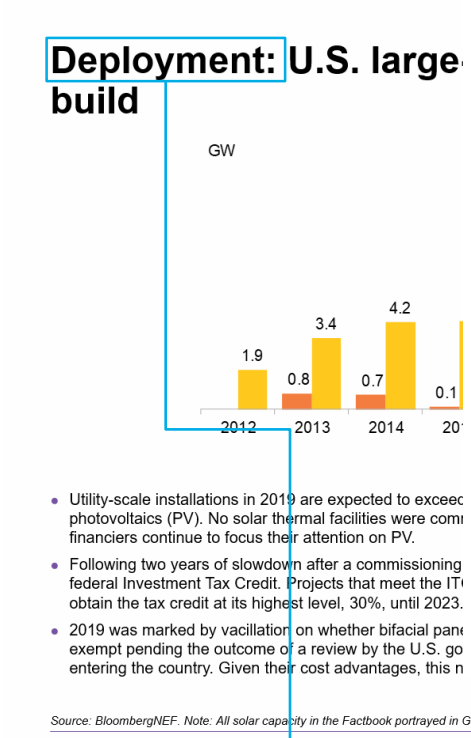
- **New coverage:** This year's report contains both annual and decadal views of and commentary on driving factors in the energy sector. It contains additional content not shown in last year's edition, including data on global stimulus support for decarbonization, U.S. progress towards climate goals, U.S. natural gas-fired power plant build, and hydrogen. It also contains expanded views on midstream energy infrastructure, sub-national climate policy, and energy storage capital costs.
- **Format:** The emphasis of this 2021 edition is to capture the impacts that Covid-19 had in the past year, other new developments, and how both fit into overarching, decadal trends between 2010-2019.

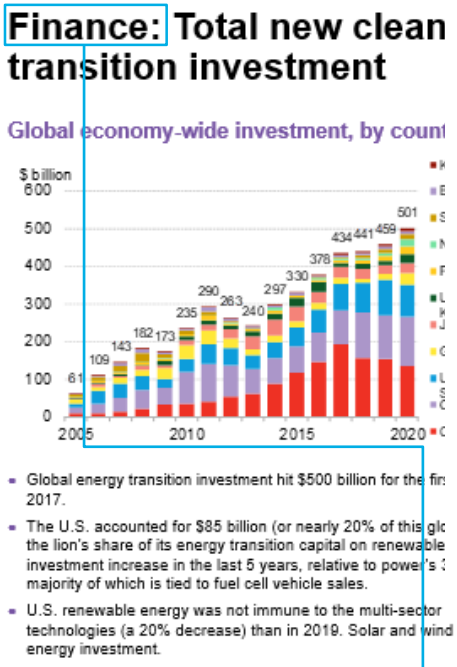
About the Factbook: Understanding terminology for this report

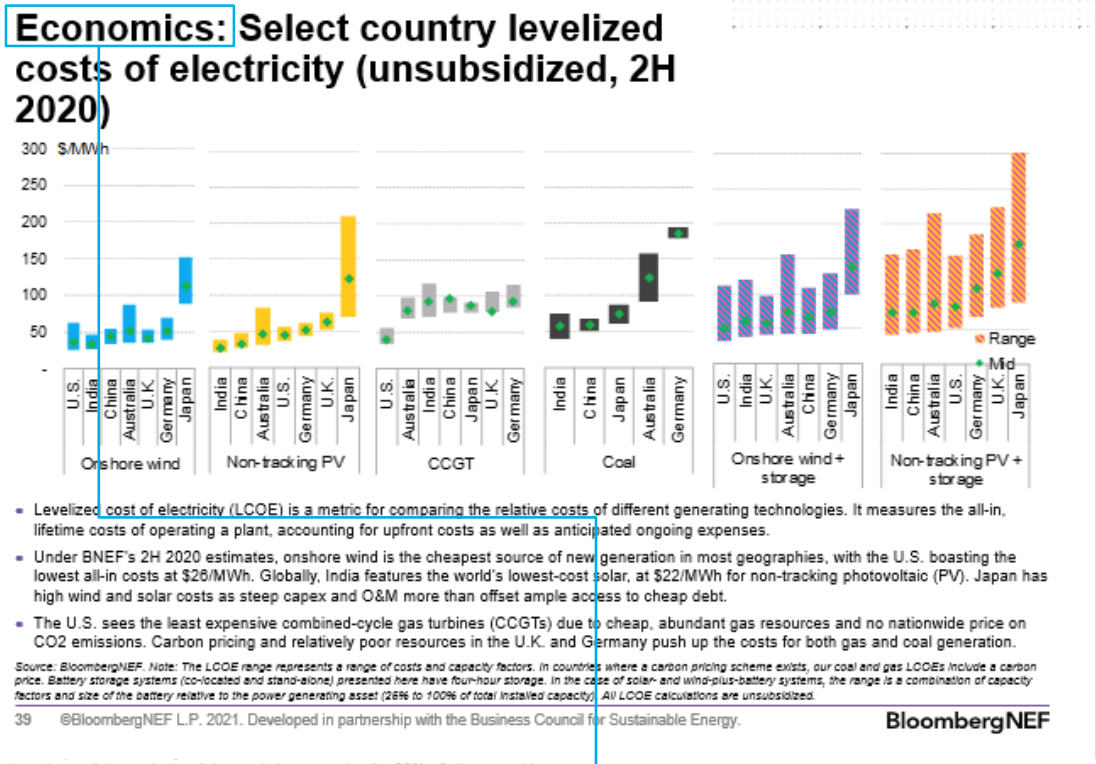
	FOSSIL-FIRED / NUCLEAR POWER	RENEWABLE ENERGY	DISTRIBUTED POWER, STORAGE, EFFICIENCY	TRANSPORT
SUSTAINABLE ENERGY (as defined in this report)	• Natural gas • CCS	• Solar • Wind • Geothermal • Hydro • Biomass • Biogas • Waste-to-energy • RNG	• Small-scale renewables • CHP and WHP • Fuel cells and hydrogen • Storage • Demand response / digital energy • Building efficiency • Industrial efficiency • Direct use applications for natural gas	• Electric vehicles (including hybrids) • Natural gas vehicles • Biofuels • Fuel cell vehicles
OTHER CLEAN ENERGY (not covered in this report)	• Nuclear	• Wave / tidal		

About the Factbook: The sub-sections within each sector

For each sector, the report shows data pertaining to three types of metrics (sometimes multiple charts for each type of metric)







Deployment: captures how much activity is happening in the sector, typically in terms of new build or supply and demand

Finance: captures the amount of investment entering the sector

Economics: captures the costs of implementing projects or adopting technologies in the sector

BloombergNEF

About the Factbook: Sponsorship of this report

The Business Council for Sustainable Energy (BCSE) is a coalition of companies and trade associations from the energy efficiency, natural gas and renewable energy sectors. It includes independent electric power producers, investor-owned utilities, public power, manufacturers, commercial end users and service providers in energy and environmental markets. Founded in 1992, the coalition's diverse business membership is united around the continued revitalization of the economy and the creation of a secure and reliable energy future in America. The Factbook is also supported by the following sponsors: American Clean Power Association, American Gas Association, Capital Power, Copper Development Association, Covanta, CRES Forum, ITC Holdings, Johnson Controls, JPMorgan Chase & Co., National Grid, National Hydropower Association, Polyisocyanurate Insulation Manufacturers Association, Renewable Energy Buyers Alliance, Sacramento Municipal Utility District, Schneider Electric, Sempra Energy, Solar Energy Industries Association, Trane Technologies and Washington Gas.

Executive summary (1 of 7)

The history books will remember 2020 for a series of momentous events with seemingly limited relevance to the U.S. sustainable energy sectors. A once-in-a-century global pandemic killed over 350,000 Americans during the year, shuttered schools and businesses and fundamentally altered how citizens lived their lives. The U.S. economy contracted sharply as workers lost jobs and consumers cut spending. The tragic killings of unarmed African-Americans inspired waves of protests and forced an overdue re-examination of inequities. A hard-fought national election highlighted deep societal fissures, culminating with the end of the Trump presidency and an attack on the U.S. Capitol.

While the industries that comprise U.S. sustainable energy did not originate these trends, they were significantly impacted by them. Clean energy manufacturing supply chains were disrupted by Covid-19 outbreaks. Residential energy efficiency programs were halted and solar systems integrators were unable to market their services door-to-door. The slowing economy called into question the availability of capital to finance projects. Demand for energy dropped precipitously. Thousands of clean energy workers were put on furlough or lost their jobs.

The extraordinary circumstances of 2020 make the sustainable energy sector's achievements all the more remarkable. Despite major headwinds, the transformation of how the U.S. produces, delivers, and consumes hydrocarbons, electrons, and heat marched onward. In fact, some key trends established over the last decade accelerated in 2020.

Some changes wrought by 2020 will no doubt prove fleeting, as they came directly in response to Covid-19 phenomenon. As the worst of the pandemic fades, vaccines are distributed and the economy recovers, status quo will return to many corners of the energy industry. Other changes could, however, prove more durable with lasting, positive implications for the decarbonization of U.S. energy.

Here are key findings from a tumultuous 2020:

- **Total U.S. primary energy use plummeted 7.8% as the economy contracted 3.5%**. This marked largest year-on-year decline in energy consumption in at least three decades.
- **Energy demand from the transportation sector fell hardest, slipping 14.4%** as Americans commuted and traveled less to stay safe.
- **Electricity demand declined least, falling just 3.8%.** Commercial and industrial demand falls were partly offset by growth in residential use as millions of Americans stayed home.
- **Renewables made another record contribution to the power grid with production rising 11% year-on-year**. Renewable sources generated a fifth of U.S. power in 2020.
- **Power from all zero-carbon sources (renewables plus nuclear power) set another record, meeting 40% of demand.** This was despite a decline in nuclear output.

Executive summary (2 of 7)

- **Natural gas remained the largest source of U.S. power generation at 41% and natural gas use in power hit a new record,** though its 2019-2020 growth was slower than 2018-19.
- **Coal-fired power's contribution slipped to 19% from 45% a decade ago** on weak demand and competition for lower-carbon power sources. Coal plants continued to retire rapidly.
- **A record 33.6GW of wind and solar was built.** Wind enjoyed its best year ever with 17.1GW constructed while solar exceeded its previous record with 16.5GW completed.
- **Total U.S. emissions sank 9.2% to end 2020 20% below 2005 levels.** The U.S. got on track to meet its Paris Agreement goal, but 2021 emissions will rebound with economic recovery.
- **CO2 emissions from road, rail, and aviation fell furthest (-14%) but transportation remains the highest emitting sector.** Lower travel rates were responsible for the decline.
- **U.S. energy "productivity" (GDP / total energy consumption) rose**, but not primarily for positive reasons as economic hardship prompted many consumers to curtail consumption.
- **Total use of U.S. natural gas dipped 0.8% year-on-year.** Power sector demand ticked up 1.9% as exports surged 21%. Industrial, commercial and residential demand all fell.
- **Already low power prices sank further on weak demand and low-cost natural gas.** Growing production from zero marginal-cost renewables also kept prices in check.
- **Renewable natural gas use is growing.** Production capacity grew another 8% 2019-2020. The share of RNG used in natural gas-powered vehicles rose from 32% to 34% in 2019.
- **Less extreme weather overall stressed the energy system less in 2020 vs. 2019.** However, the number of major weather-related events rose and costs were higher.
- **Corporate decarbonization commitments grew.** 65 companies joined the RE100 initiative to expand renewables use, 59 joined EP100 pledging to improve energy productivity.
- **But companies signed fewer contracts in 2020 to buy clean power.** Corporate power purchase agreements (PPA) for wind/solar slowed to 11.9GW due to pandemic worries.

Executive summary (3 of 7)

- **Congress boosted sustainable energy with legislation** to extend clean energy tax credits, spend $19 billion on energy RD&D, provide grants for EV charging and provide other support.
- **The election of Joe Biden bodes well.** The president made climate a top issue in his campaign, re-entered the U.S. into the Paris Agreement and plans many more actions.

The Covid-19 pandemic flattened 2020 U.S. energy demand

The outbreak of Covid-19, starting in March 2020 then ramping in the second quarter of the year, prompted an abrupt and historic contraction in U.S. economic activity. Consumers complied with stay-at-home orders or guidelines and in doing so dramatically cut back on spending. Many businesses did the same as uncertainty reigned. The latest estimate is that U.S. GDP shrank by 3.5% in 2020, marking the first year since the 2008-09 financial crisis the economy failed to grow. The energy sector was, of course, directly impacted by this unexpected contraction. Air travel virtually disappeared in April, limped back to life in the second half of the year but remained 40% below typical levels as 2020 ended. Gasoline demand sank by 44% in April 2020 and, despite some recovery, finished 13% down compared to 2019 as consumers worked from home and canceled vacations. Millions of Americans were forced to tighten their belts in myriad ways as job losses and economic hardship mounted. Ultimately, total U.S. consumption of energy fell by a whopping 7.8% on the year – the single biggest year-on-year drop in at least 30 years of federal record keeping. Not all segments suffered equally, however. While demand for transport-related energy cratered, electricity demand declined a much more modest 3.8%.

U.S. “energy productivity” rose in 2020 but not necessarily for the right reasons

While the U.S. economy contracted rapidly, demand for energy contracted even more swiftly. The result is that a metric used consistently in this report over the last 10 years – energy productivity – actually rose. In any normal year, this might be regarded as positive sign that American homes and businesses were finding ways to operate more efficiently as, like other advanced nations, the U.S. has made enormous strides improving its use of energy in recent decades. But the sharp uptick in productivity this year likely reflects economic hardship more than efficiency improvements. In millions of cases, suffering businesses and consumers cut back on energy use primarily to weather the downturn.

Executive summary (4 of 7)

The sustainable energy sectors were buffeted by the pandemic

At the start of the outbreak in the second quarter of 2020, there were very serious concerns that the sustainable energy sectors' progress over the last decade could get badly knocked off course. Covid-19 outbreaks at wind and solar equipment manufacturing plants in the Midwest and Mexico forced slowdowns or complete work stoppages. Rooftop solar installation rates collapsed in April and May in major U.S. markets as door-to-door sales ceased and consumers barred workers from entering their homes on Covid-19 concerns. Projects related to energy efficiency were similarly impacted, with utility energy efficiency programs stopping work. As the third quarter of 2020 began, virtually all the sustainable energy sectors were poised to post significant year-on-year drops in investment and activity in 2020.

But U.S. sustainable energy proved extraordinarily resilient in 2020

Rather remarkably, however, on most counts, 2020 proved to be an exceptionally strong year for lower-carbon technologies. The U.S. set a record for most wind and solar capacity built in a single calendar year with 33.6GW constructed. The solar sector exceeded its best year ever with 16.5GW built. The once-beleaguered residential segment of the solar market ended the year with a record 2.8GW built (the commercial rooftop segment fared less well with installations essentially matching 2019 levels at 1.4GW). Meanwhile, renewables' contribution to U.S. power generation rose both in proportional and raw terms. Wind, solar, hydro and other zero-carbon emitting technologies provided a record 20% of U.S. power, as output rose to 755TWh from 736TWh in 2019. Large-scale solar projects effectively tied an annual record for new investment at $23.1 billion. Natural gas set a record in terms of the volume of terawatt-hours produced and its share of overall production. Sales of electric vehicles also proved exceptionally resilient. While total U.S. car sales fell sharply in 2020 from the year prior, EV sales stayed level at 325,000. Further, the clean energy sectors took extraordinary steps to assist during the crisis. Fuel cell manufacturers switched production lines to ventilators, utilities and component manufacturers sequestered employees at sites to ensure reliable energy flows and essential products to be made, and propane companies provided space heating for pop-up COVID-19 testing and evaluation sites.

The popularity of "co-located" renewables, particularly PV with storage, grew

Utility-scale power projects that include both PV modules to generate energy and batteries to store and deploy it on an as-needed basis are rapidly becoming an asset class of their own. Such projects get at longstanding intermittency concerns associated with renewables-only projects by providing power for extended hours of the day. These projects are particularly popular in the Southwest and California but new markets are rapidly emerging. Texas now has 2GW of solar co-located with storage, for instance. "PV+S" projects have the flexibility to meet shifts in demand into the late afternoon and evening hours.

Executive summary (5 of 7)

Coal's sunset continued

The U.S. has moved swiftly over the past decade from its long-time reliance on coal-fired power. Most of this has occurred as the economy saw slow, but steady growth and energy demand largely remained flat. Might a sudden economic contraction and plummeting demand for energy of all sorts actually rejuvenate U.S. coal, a dispatchable generating resource? In short, no. Coal-fired generation sank to just 19% of U.S. power – its lowest share in the post-World War II era. In total, coal produced an estimated 751TWh, the least in absolute terms since 1979 and a 22% decline from 2019. Meanwhile, coal-fired power plant retirements continued in 2020 albeit at a slightly slower pace than the few years prior with 8GW of capacity coming offline, compared to 12GW in 2019. However, the pipeline of plants that have announced they will close in the future has continued to grow.

Total natural gas demand slid, but gas contributed more to power, and LNG exports grew

A decade of growth for U.S. natural gas came to at least a temporary end in 2020 as demand ticked down slightly to 86.5 billion cubic feet per day from 87.2Bcfd in 2019. Still, U.S. gas consumption in 2020 was more than a third higher than just a decade ago. While overall load fell, demand from the power sector grew by 0.6Bcfd to a new record due to continued coal-fired power plant retirements, hot summer weather, and lower year-on-year gas prices. LNG exports also set a new high with liquefaction capacity coming online via multiple export facility projects and strong demand from abroad. However, domestic demand from the industrial, residential and commercial heating segments all fell, 4.2%, 10.5%, and 10.2%, respectively. All reflected a slowing economy, less extreme weather in 2020, or both.

U.S. CO2 emissions plummeted

Lower overall energy demand, depressed petroleum-based transportation fuel use, surging renewables and natural gas-fired power generation, and the continuing decline of coal combined to reduce U.S. greenhouse gas emissions by a massive 9% 2019-2020. The decline put U.S. emissions approximately 20% below 2005 levels and, at least temporarily, put the country on a trajectory to meet its original Paris Agreement pledge of a 26-28% cut vs. 2005 levels by 2025. It also put the nation even further ahead of the Obama administration's Clean Power Plan goals of a 32% cut in power emissions vs. 2005 levels by 2030 (2020 power emissions were 40% below 2005 levels). Transportation-related emissions (-14%) dropped most but transport remained the largest single source of climate-warming emissions for the fifth consecutive year, hitting 27% of the total. In the power sector, emissions sank 10.9% to the lowest level in three decades and power on the year accounted for just 2% more emissions than the industrial sector. While any drop in emissions is good news in the long run, not all the gains achieved in 2020 will be permanent. Assuming the U.S. economy rebounds in 2021, emissions will also jump though probably not back to 2019 levels.

Executive summary (6 of 7)

Corporate commitments remained strong though clean energy contract signings slowed

The pandemic did little to slow companies from making or expanding existing commitments to decarbonization. The Climate Group's RE100 initiative, whose signatories pledge to offset 100% of their electricity consumption with renewables, had another record year of growth with 65 new companies joining, bringing the total number of signatories to 285. An additional 123 companies have now pledged to double their energy productivity by 2030 under the EP100 campaign. And 92 companies have promised to integrate electric vehicles (EV) fully into their fleet or support EV charging infrastructure at their operations by 2030 under the EV100. Still, the total volume of contracts signed by companies in 2020 to procure zero-carbon power fell for the first time since 2015-2016. U.S. firms signed deals for 11.9GW of equivalent capacity in 2020, down from 14.1GW in 2019. About two thirds of the volume was committed during the second half of the year, suggesting that companies delayed some decisions when pandemic stay-at-home orders were most prevalent and concerns were highest over the economy.

The push for "net-zero" has focused attention on longer-term decarbonization solutions

National governments, including Japan, South Korea, and China, in 2020 declared their intentions to eliminate their net CO2 emissions by 2050 or 2060. Some U.S. states have stated similar "net-zero" ambitions. While the current suite of zero-carbon energy technologies has made important progress cutting emissions to date, more solutions will certainly be required if nations are to completely decarbonize. This is manifesting itself in increased attention and investment in new, but generally not yet commercially-viable technologies or fuels. The list includes direct-air capture (DAC), carbon capture and sequestration (CCS) along with potentially lower-carbon fuels such as "green" hydrogen".

Sustainable energy got a major policy boost as 2020 came to a close

In its final major act of the year, the U.S. Congress overwhelmingly approved mammoth legislation to provide $900 billion in stimulus to the U.S. economy and $1.4 trillion to keep the federal government operating. The 5,600-page bill contained provisions to extend and expand key tax incentives for renewables, energy efficiency, and other technologies along with $19 billion in commitments over 10 years to fund research, development and demonstration of low- and zero-carbon energy technologies. The bill provided a particular boost to the nascent U.S. offshore wind sector, but its largesse is likely to flow to most corners of U.S. clean energy. The legislation will also allow the U.S. to make important progress addressing climate change by limiting hydrofluorocarbon emissions. The passage of the bill came a month after another very positive development for the sustainable energy sectors – the election of Joe Biden, who put addressing climate change at the center of his presidential campaign. On his very first day in office, Biden signed paperwork to re-enter the U.S. into the Paris Agreement. He promised further executive actions and to support key legislation in Congress with an eye toward decarbonizing U.S. power entirely by 2035.

Executive summary (7 of 7)

Some 2020 changes reflect once-in-a-century events, others could prove to be permanent

The year 2020 was a watershed in ways that most Americans will be happy to forget. A first-in-a-century pandemic upended 330 million lives and ended at least 350,000 others as the U.S. economy went into a tailspin. These events profoundly affected the sustainable energy sectors, but some changes 2020 wrought will inevitably prove fleeting. U.S. CO2 emissions, for instance, will almost certainly rebound as the economy recovers. Energy productivity could well tick down in 2021 from 2020 as Americans travel more or see their finances recover sufficiently to buy new or larger homes. That said, some 2020 changes will prove lasting. The coal-fired power plants that retired during the year are likely gone for good. The record volume of new renewable power commissioned will generate for decades to come. Both will keep U.S. power sector emissions lower than they might otherwise have been. The direction of these long-term trends is relatively easy to predict, but the specifics are much less so. How much will U.S. energy demand bounce back? Could some efficiency gains achieved in 2020 prove lasting? Yes, CO2 emissions will also rebound, but by how much? Has the U.S. now arrived on a permanently lower emissions plateau? These are the open questions that only the events of 2021 and beyond can answer.

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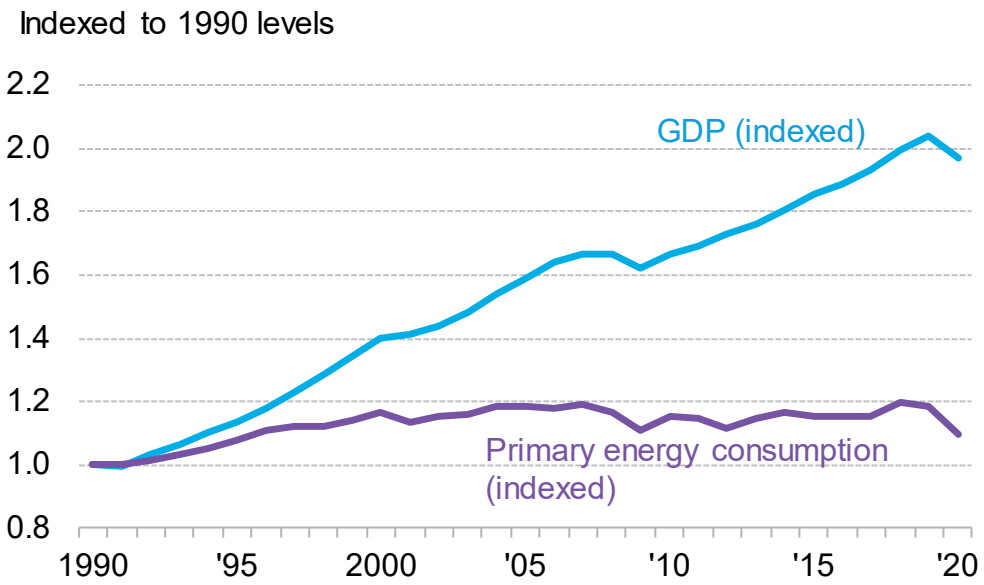
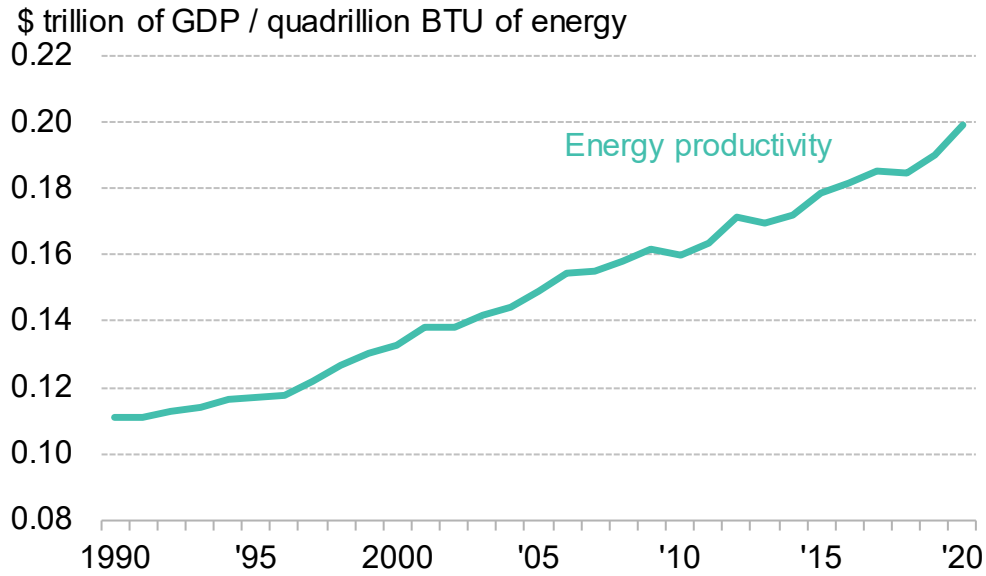
U.S. energy overview: Productivity

U.S. GDP and primary energy consumption



U.S. energy productivity

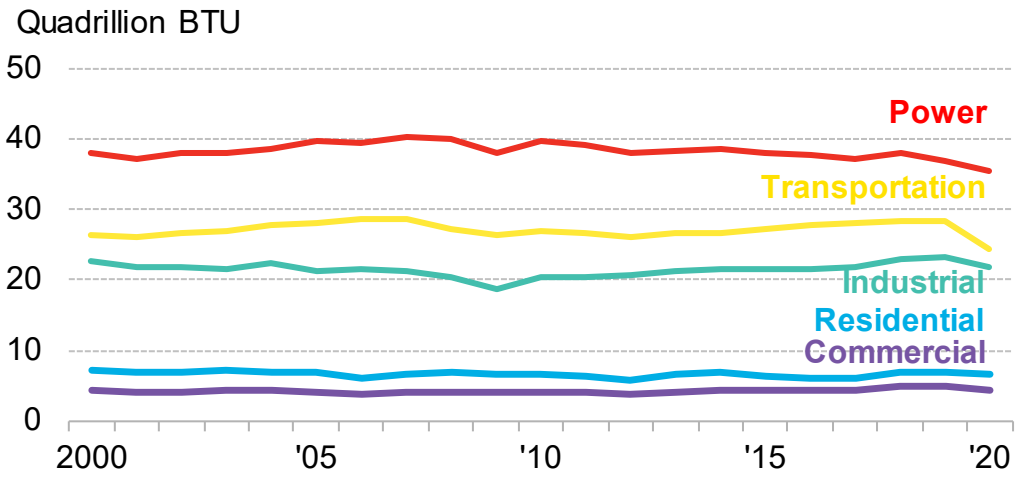


- The U.S. economy fell by 3.5% in 2020, the first drop since the 2008-2009 recession. Meanwhile, primary U.S. consumption of energy declined by 7.8%, the largest year-on-year retreat since at least 1990. Multiple factors influenced by the COVID-19 pandemic affected both of these metrics, ultimately leading to a 2020 4.6% gain in energy productivity.
- Prior to 2020, U.S. economic growth continued to be broadly “decoupled” from energy use, as reflected in improvements to energy productivity and efficiency: between 2010-2019, the overall U.S. economy grew 26% (in GDP terms) while primary energy consumption rose just 6.7%, marking an 18% increase in productivity.
- Between 1990-2019, the U.S. economy had more than doubled in size, while primary energy consumption had grown by just 19%. This suggests a 72% improvement in U.S. energy productivity over three decades.

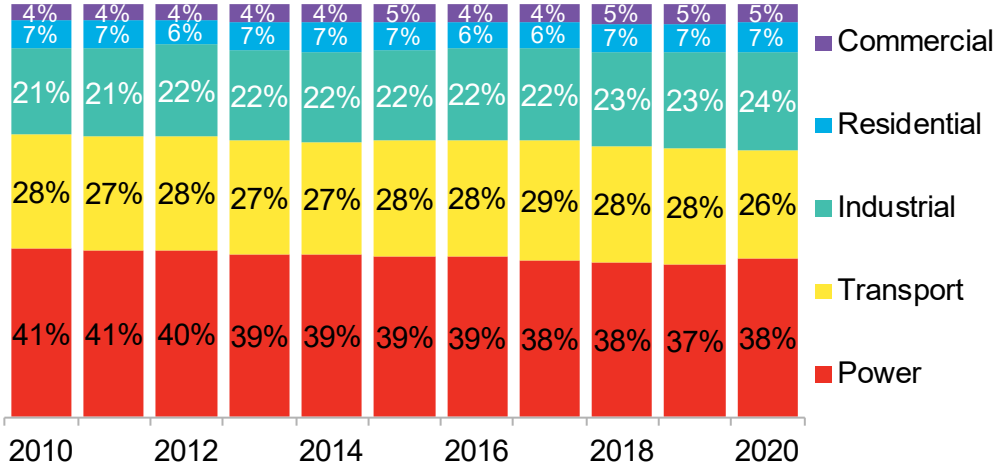
Source: Bureau of Economic Analysis, EIA, BloombergNEF Notes: Values for 2019 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through September 2020). 2020 GDP estimate is a projection from economists compiled at ECFC <GO> on the Bloomberg Terminal.

U.S. energy overview: Primary energy consumption by sector

U.S. primary energy consumption, 2000-2020



U.S. primary energy consumption, 2010-2020

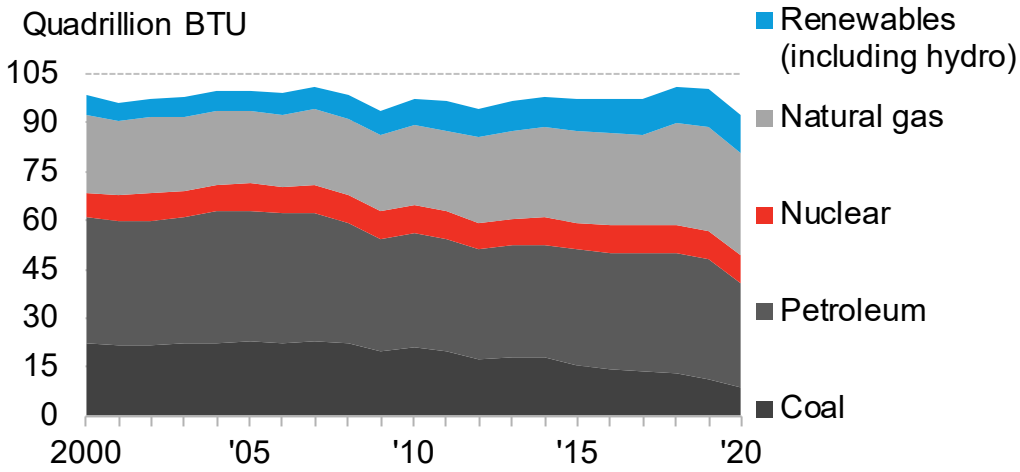


- Total U.S. primary energy consumption ticked down 7.8% in 2020 from the year prior as there were declines in all sectors. In 2020, power sector consumption fell the least at 3.8%, followed by 5.8% drops in industry, 6.7% in residential, 9.4% in commercial and 14.4% in transport.
- Transportation consumption decreased the most as states mandated stay-at-home restrictions, leading to decreased professional and personal commuting. Vehicle miles traveled per capita also steeply declined.
- Power consumption decreased the least in 2020. Depressed commercial and industrial power demand were partially offset by boosted residential power demand as people spent more time at home last year. In addition to this, “cooling degree-days”, which are indicative of particularly warm weather and the need to air condition, rose by less than 1% year-on-year (figures are annualized to include an assumption for October-December 2020 consumption that mirrors the 10-year average).
- Primary energy is mainly consumed in buildings for heating (electricity consumption is captured by the power sector’s primary energy consumption). This suggests that the annual decrease in their consumption was due to weather-related factors, especially given many U.S. Covid-19 lockdowns began after the major 2020 heating months. Data bears this out: the number of “heating degree-days”, a measure of cold weather, dropped 10% through September 2020 compared to the same period in 2019.

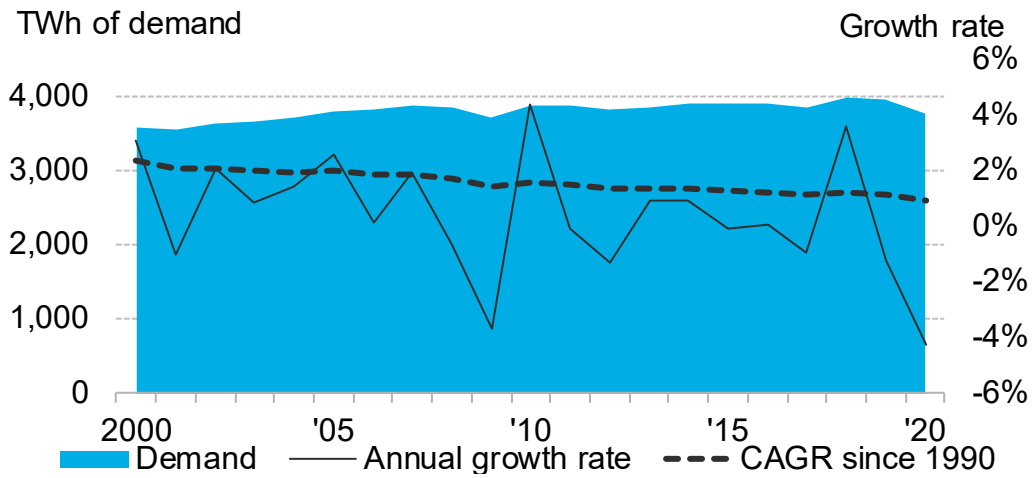
Source: EIA, EPA, BloombergNEF Notes: Values for 2020 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through September 2020)

U.S. energy overview: Energy and electricity consumption

U.S. primary energy consumption, by fuel type



U.S. electricity demand

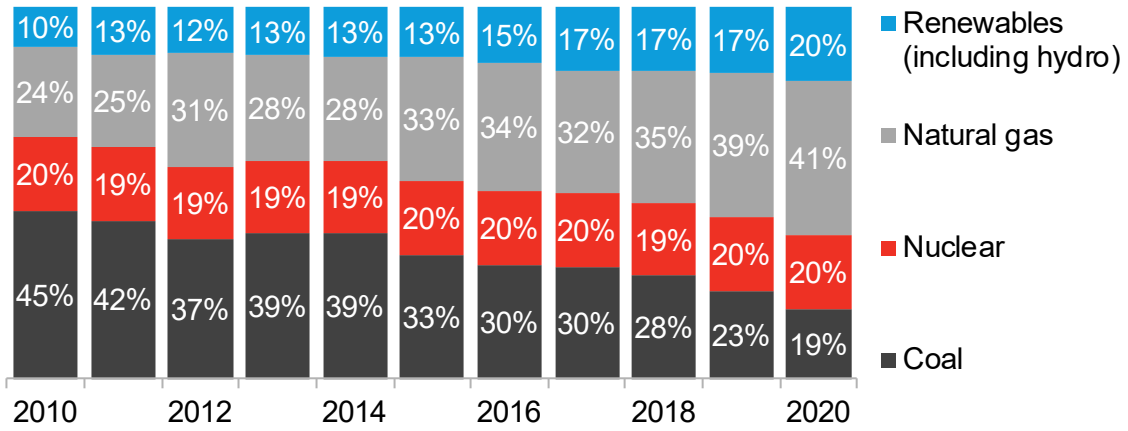


- U.S. total energy consumption slid 7.8% to 92 quadrillion British Thermal Units (BTU) in 2020 from the year prior. Coal consumption dropped sharply – by 21% -- in the wake of decreased power demand, collapsing gas prices and coal-fired power plant closures. At just 9.0 quadrillion BTU, coal made its smallest contribution to the U.S. economy since the mid-1970s. Between 2010-2019, coal usage had already dropped by 41% and was down nearly half since its peak of 22.8 quadrillion BTU in 2005.
- Contributions from non-hydro renewables (wind and solar, primarily but also biomass, waste-to-energy and geothermal) rose 2.8% in the wake of strong capacity additions in 2020. Natural gas consumption fell by 1.6%, despite natural gas-fired power generation rising 2.9%. This is likely due to declines in building heating while gas-fueled generation held strong due to low prices and the build-out of new gas-fired power plants in the power sector. Nuclear's contribution declined by 1.7% in 2020. Hydro consumption rose 1.1% in 2020.
- Petroleum use slid 13% year-over-year. Oil is rarely used in U.S. power generation but accounts for the vast majority of transportation fuel, the sector that saw the largest declines in consumption due to Covid-19.
- Retail electricity demand dipped, declining 4.3% year-on-year. Retail demand had risen just 5% between 2010-2019 (excluding contributions from distributed, small-scale facilities).

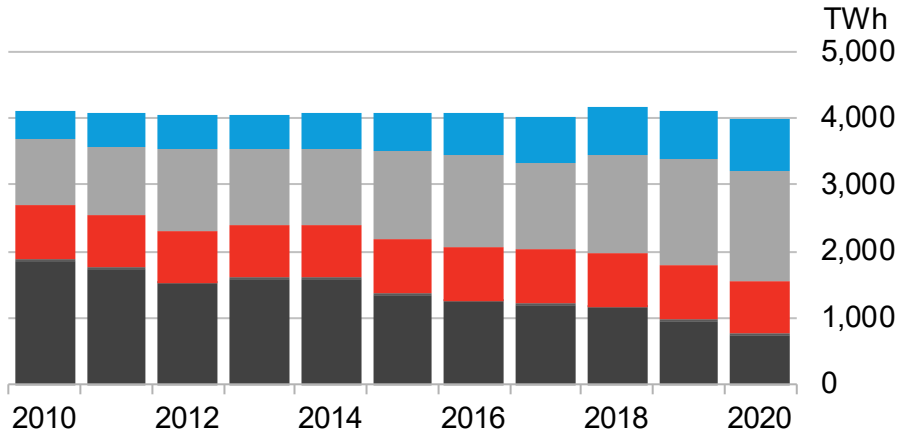
Source: EIA, BloombergNEF Notes: "CAGR" on the right hand side graph is compound annual growth rate. Values for 2020 are projected, accounting for seasonality, based on the latest monthly values from EIA (data available through September 2020). BTU stands for British thermal units.

U.S. energy overview: Electricity generation mix

U.S. electricity generation, by fuel type



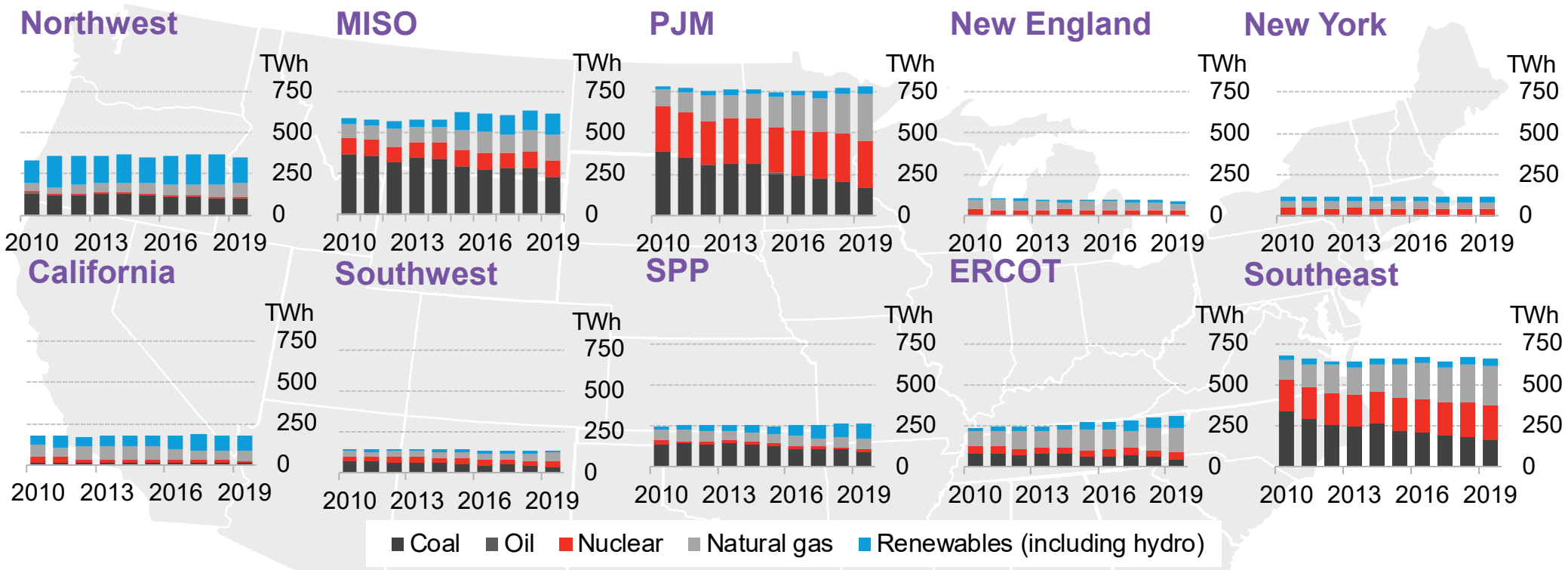
U.S. electricity generation, by fuel type



- Natural gas remains the largest source of power generation in the U.S. though its year-on-year rate of expansion 2019-2020 was down from 2018-19 growth. Gas accounted for 41% of generation, or 1,641TWh in 2020. That's a 2.19% rise in its contribution from 2019 despite the dips in 2020 demand – this is due to low 2020 fuel prices and the new gas-fired power plant build.
- Renewable power generation's contribution grew 11% year-on-year in 2020 (also mirroring power plant build), with a 15% jump in output from wind and solar and a 5% increase in hydropower generation. In absolute terms, renewables generation rose 79TWh to land at 799TWh, or 20% of the total.
- Prior to 2020, renewables and natural gas grew from a combined 35% to 56% of total power generation in a decade.
- Coal's role waned further in 2020, dropping to only 19% of the mix – the lowest share in the post-war era. In total, coal produced an estimated 751TWh, the least in absolute terms since 1979 and a 22% decline from 2019.
- Despite continuing financial troubles and the closure of the Indian Point, Duane Arnold and Davis Besse stations, nuclear's contribution to U.S. power generation declined only slightly by 2.1%, accounting for 20% of the total share.
- Total U.S. power consumption declined 3.8% 2019-2020 due to largely to shifts in demand patterns, as well as overarching trends of less extreme weather (which translated into lower usage of air-conditioning and other services) and continued energy-efficiency improvements.

Source: EIA, BloombergNEF Note: Values for 2020 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2020)

U.S. energy overview: Electricity generation mix by U.S. power market

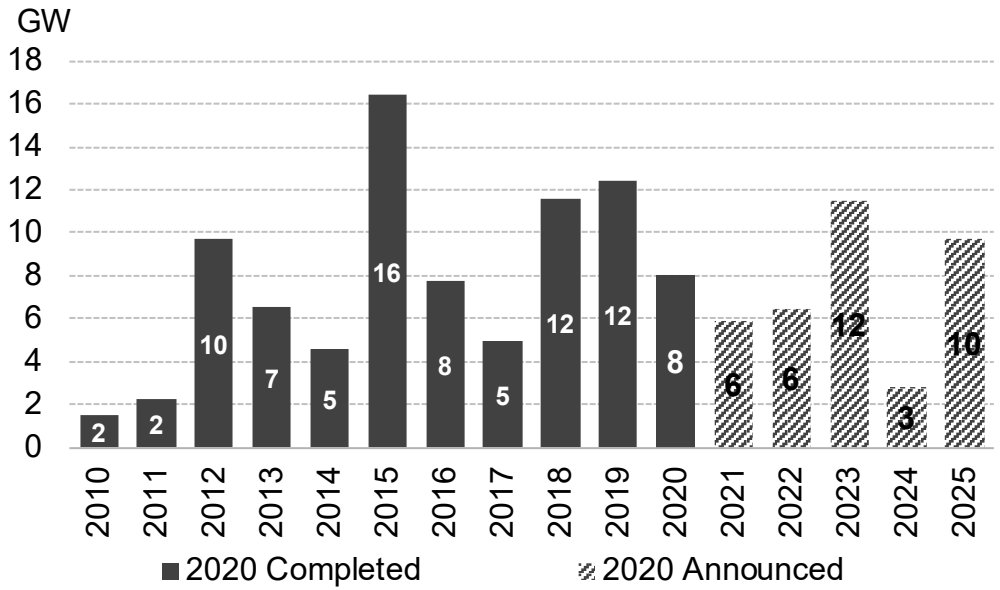


- The energy generation mix varies throughout the U.S. with different power-generating technologies contributing various amounts in different power markets. The top-line volume of generation also varies, with higher demand in some regions. Energy can also be sold between regions, incentivizing areas with lower prices to generate more.
- Major trends over the last 10 years have included the rise of natural gas-fired and the fall of coal-fired generation in the Southeast and PJM (which encompasses Midwestern and mid-Atlantic states) and the growth of renewables – particularly wind and solar – in ERCOT (Texas) and California.

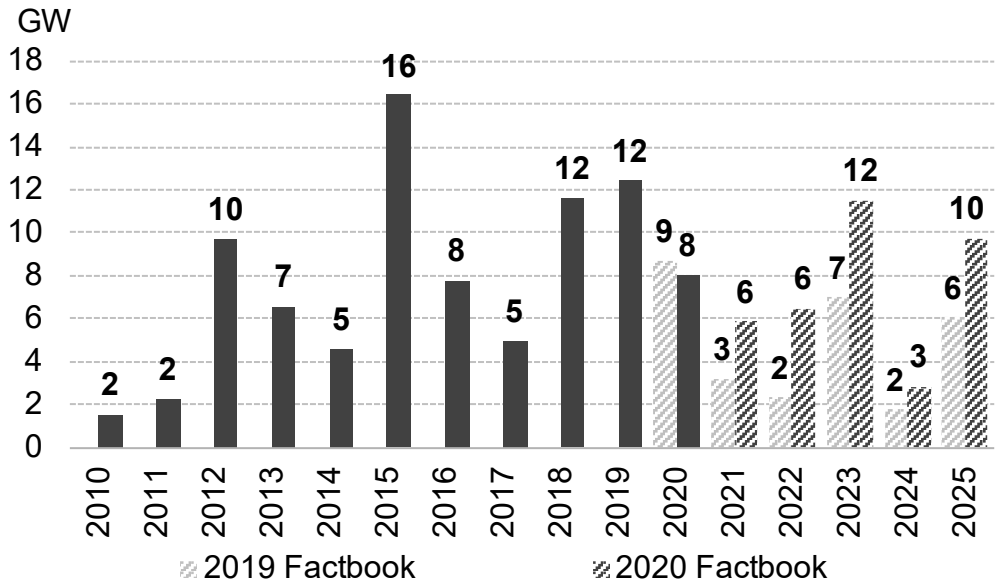
Source: EIA, BloombergNEF Notes: MISO is the Midwest region; PJM is the Mid-Atlantic region; SPP is the Southwest Power Pool which covers the central southern U.S.; Ercot covers most of Texas.

U.S. energy overview: Completed and announced coal-fired plant retirements

Coal plant retirements, by type



Coal plant retirement pipeline, 2019 vs 2020

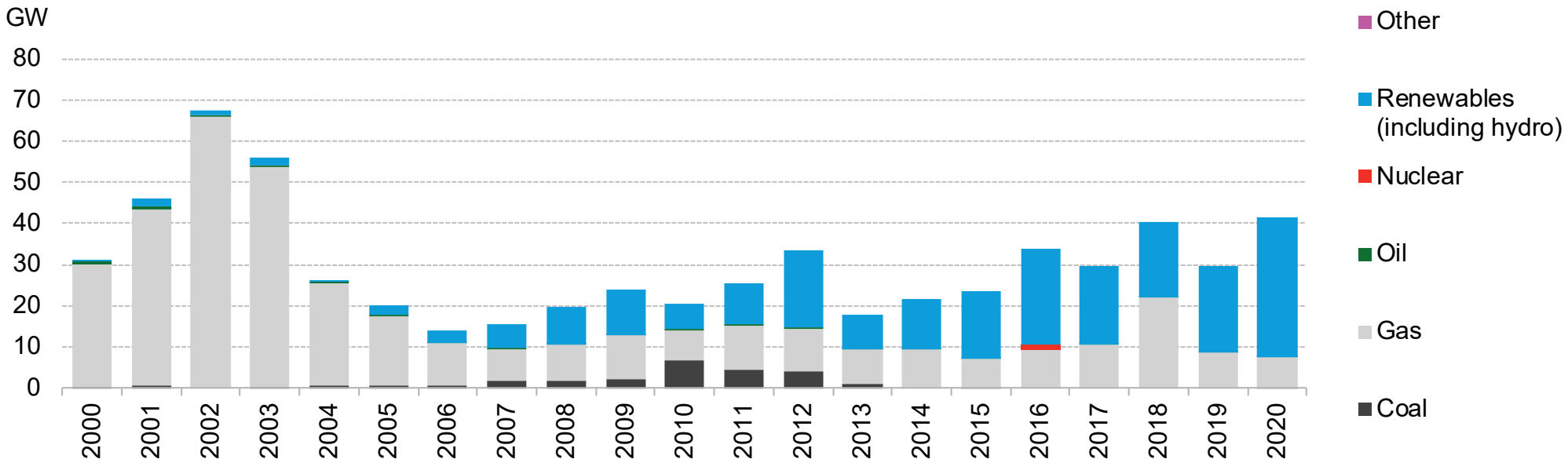


- Coal-fired power plant retirements continued in 2020 at a slightly slower pace than the couple of years prior. In all, plants totaling 8GW of capacity came offline, compared to 12GW in 2019. However, the pipeline of plants that have announced they will close in the future has continued to grow. As of year-end 2019, the outlook was for 20GW to retire 2021-2025. In 2020, that rose to 37GW for those same years.
- The U.S. coal fleet is now 25% smaller than a decade ago. Renewable penetration, low natural gas prices, and a slight dip in load have all compressed coal's margins. State-level support for ailing nuclear plants has also played a role in some regions.
- Outside of the 2020 demand dip, these trends are poised to continue and put further pressure on coal. However, even in states where these factors are less prevalent, utilities are announcing plans to retire coal in favor of lower-cost natural gas, renewables, and energy storage.

Source: EIA, company announcements, BloombergNEF Notes: "Retirements" does not include conversions from coal to natural gas or biomass; includes retirements or announced retirements reported to the EIA through October 2020. All capacity figures represent summer generating capacity.

U.S. energy overview: Electric generating capacity build by fuel type

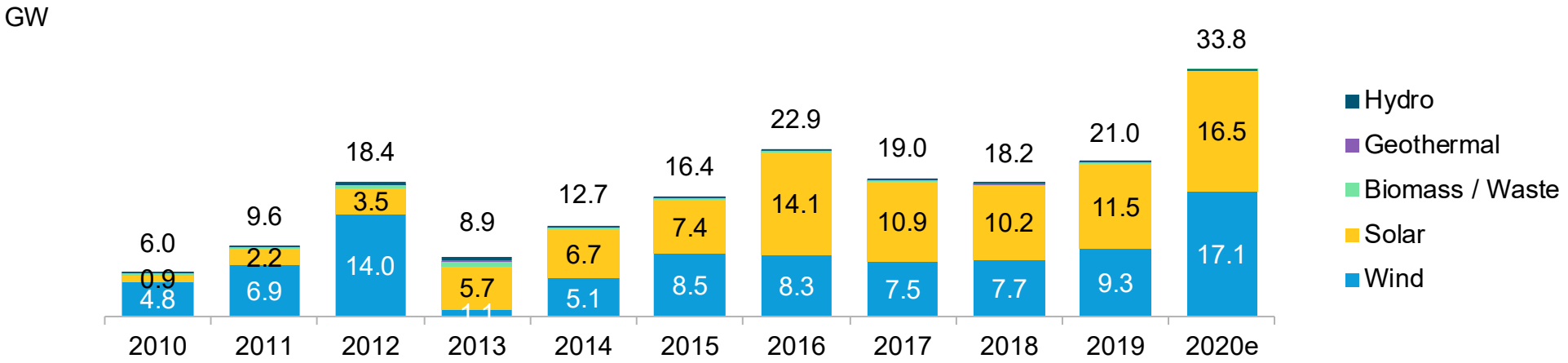
U.S. electric generating capacity build, by fuel type



- A testament to the resilience of clean energy development, 2020 represented another brisk year for total power-generating capacity additions, with 42GW commissioned. 2020 was the strongest year for generating capacity build since before 2005.
- Natural gas-fired power plant build continued as developers installed 7.5GW, seeking to take advantage of persistently low fuel prices and high profitability in the Northeast and mid-Atlantic regions. However, 2020 build was approximately one-third of the capacity added in 2018.
- Non-hydro renewable energy build was the highest of all time. These technologies (wind, solar, biomass, geothermal, others) accounted for 80% of total 2020 additions, also the highest percentage of all time. In all, they account for 60% of total additions in the last decade.
- Between them, natural gas and all renewables have accounted for 95% of all build in the last decade.

Source: EIA, BloombergNEF Note: All values are shown in AC except solar, which is included as DC capacity. "All capacity figures represent summer generating capacity. Includes installations or planned installations reported to the EIA through October 2020, as well as BloombergNEF projections.

U.S. energy overview: Renewable energy capacity build by technology

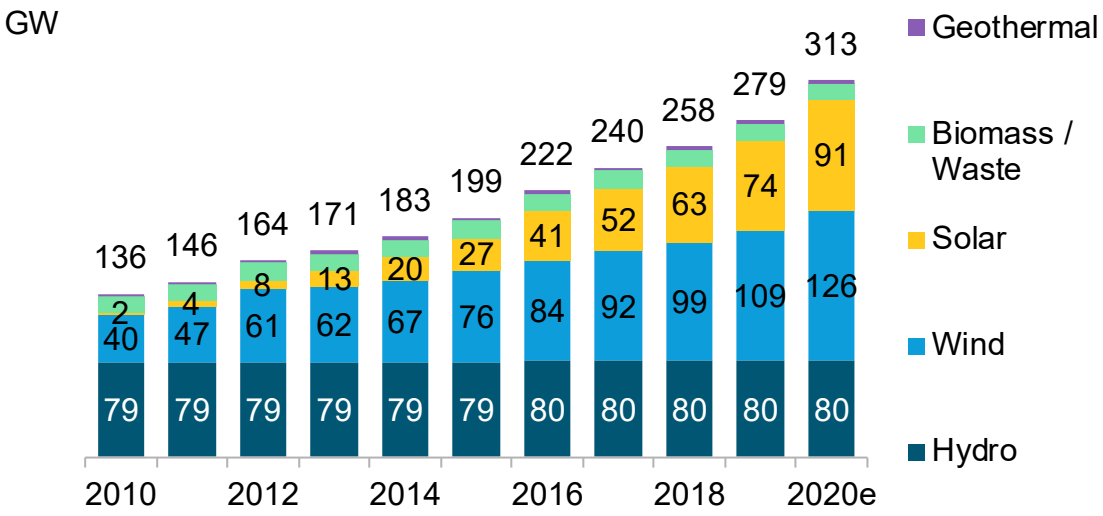


- The U.S. installed an estimated 33.8GW of renewable capacity in 2020, up 12.8GW from the year before, to mark the highest year on record. Preliminary reviews indicate this is a floor, and actual installations could be higher.
- Wind build hit a record-breaking 17.1GW in 2020. The sector received a boost as the onshore, utility-scale project build rush proceeded with construction largely unchecked. Developers started construction early in the year as they aimed to commission projects by 2020 to claim the highest level of the federal Production Tax Credit (PTC).
- Solar additions rose to 16.5GW from 11.5GW in 2020 as utility-scale and residential build proved resilient. Most utility-scale growth was in the southern half of the country, and projects financed or under construction at the start of the year proceeded smoothly. Residential solar also recovered from disruptions caused by lockdowns – homeowner demand remained strong through 2020.
- As part of federal Covid-19 relief provisions, Congress extended tax credits at their current levels of payout in December 2020. The PTC was extended for one year, while the solar ITC was extended by two years. Offshore wind also effectively received a new Investment Tax Credit (ITC) equal to 30% of project capex in December 2020. Projects must meet under construction requirements by 2025 to qualify.
- Build was muted in other clean energy sectors: hydro added 162MW, biomass and waste-to-energy added 35MW and geothermal added no new capacity. Policy support for these sectors has been shorter term and less consistent. However, they received a boost when Congress in December 2020 retroactively extended the tax credits from which they benefit.

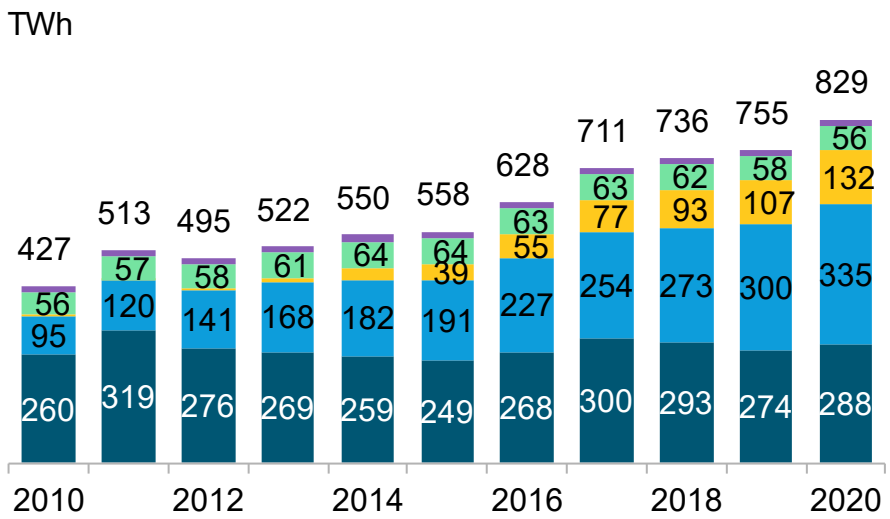
Source: BloombergNEF, EIA Notes: All values are shown in AC except solar, which is included as DC capacity. Numbers include utility-scale (>1MW) projects of all types, rooftop solar, and small- and medium-sized wind. Includes installations or planned installations reported to the EIA through October 2020, as well as BloombergNEF projections.

U.S. energy overview: Cumulative renewable energy

U.S. cumulative renewable capacity



U.S. renewable generation by technology

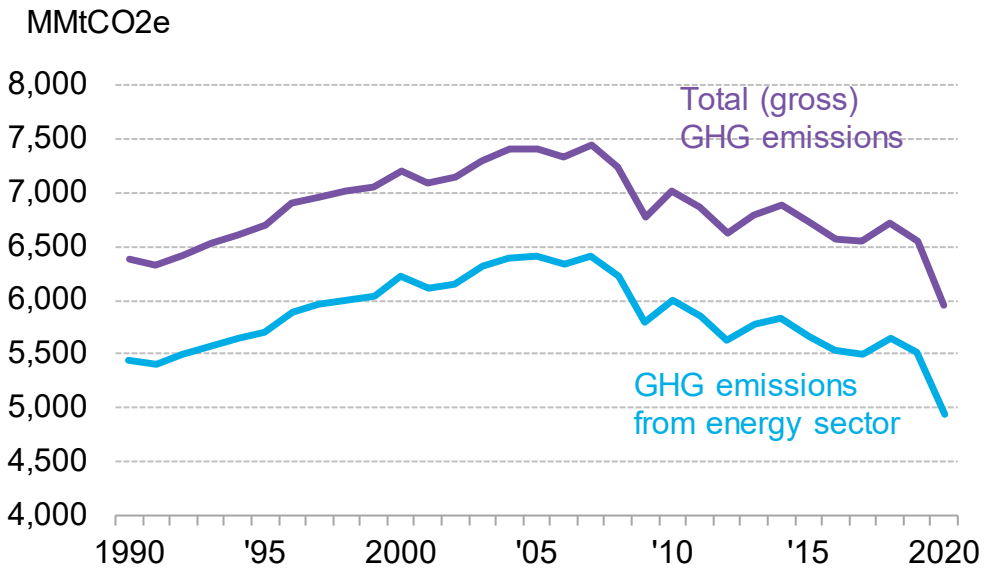


- Total renewable energy capacity has more than doubled in the past decade to 313GW (excluding hydro pumped storage facilities). Wind and solar have accounted for nearly all new additions, aided by policy support and rapidly falling equipment costs. Wind and solar capacity more than quintupled during the decade, rising from 42GW to 216GW.
- U.S. wind capacity reached 126GW in 2020 and continued to be the largest source of U.S. zero-carbon power generation for the second year in a row, at 335TWh. Solar power-generating capacity rose to 91GW from less than 5GW at the start of the decade.
- Thanks in part to strong wind and solar additions, renewables generation in 2020 rose 10% to 829TWh. Solar saw the largest year-on-year growth on a percentage basis, expanding by an estimated 25TWh, or 23%. Wind output jumped 12% year-over-year and now accounts for 40% of all renewable output.
- Hydro generation rose 14TWh, or 5%, and accounted for 35% of total renewable output.

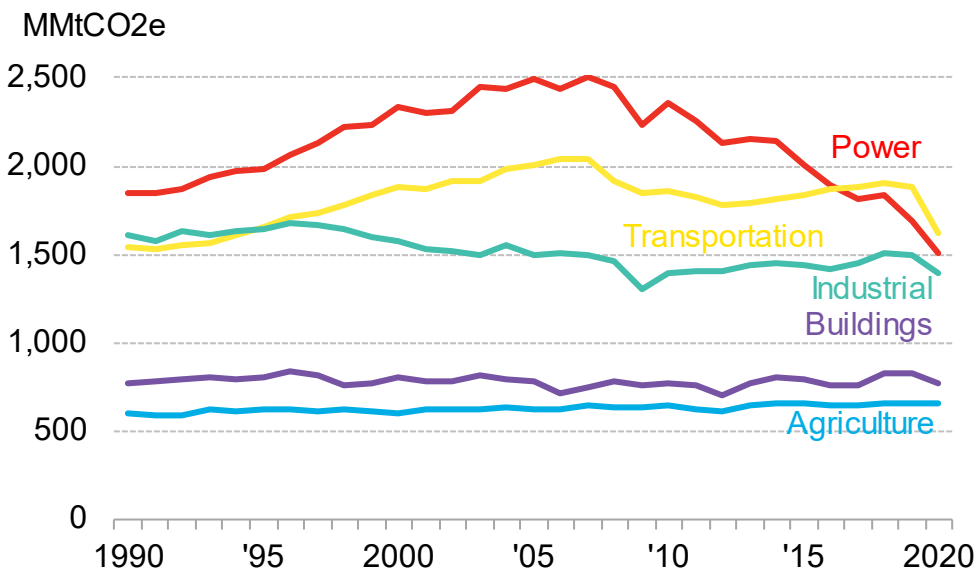
Source: BloombergNEF, EIA Notes: All values are shown in AC except solar, which is included as DC capacity. Hydropower capacity and generation exclude pumped storage facilities (unlike in past Factbooks). Totals may not sum due to rounding. Values for 2020 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2020)

U.S. energy overview: Greenhouse gas (GHG) emissions

Economy-wide and energy sector emissions



Emissions by sector

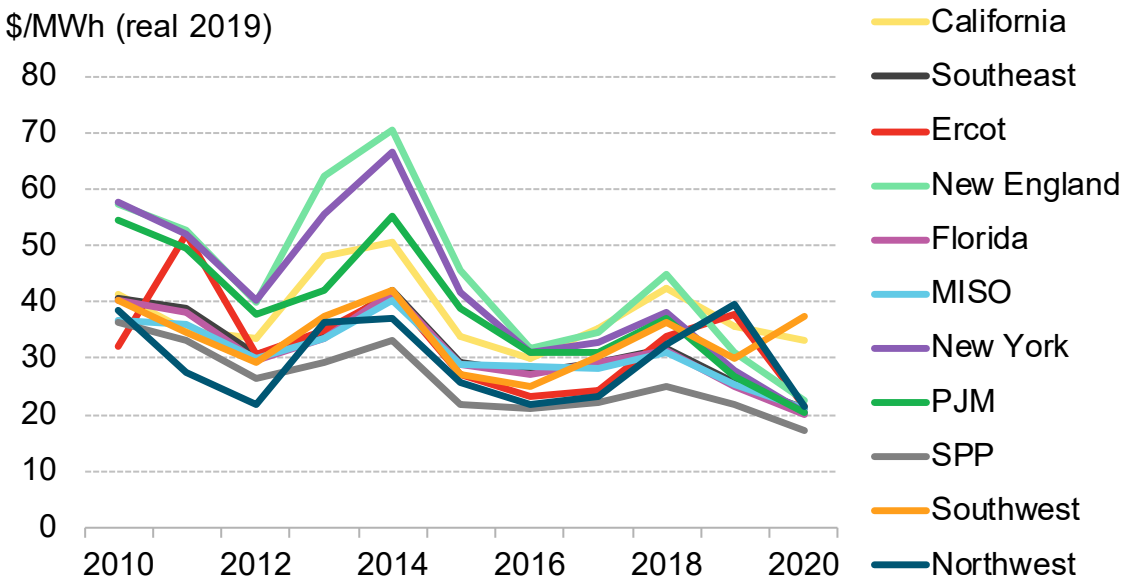


- U.S. GHG emissions plummeted in 2020, sinking an estimated 9.2% from the year prior, following a year of deeply depressed power and transportation sector emissions. This drop in energy-related emissions drove the decline in the headline figure.
- Transportation-related emissions took the steepest plunge at 14%, reflecting the sector's 14.4% drop in consumption. Even with this change, the sector remained the largest single source of climate-warming emissions for the fifth consecutive year, hitting 27% of total GHG emissions.
- The second sharpest drop in the last year came from the power sector. A cleaner generation mix and a 7.8% fall in overall consumption led to a 10.9% GHG decrease. Power now accounts for a 2 percentage point higher share of emissions than the U.S. industrial sector. Generation from natural gas displaced higher-emitting coal-fired generation as coal plants continued to retire and natural gas prices plummeted in 2020. Wind and solar generation also increased as build continued in earnest.

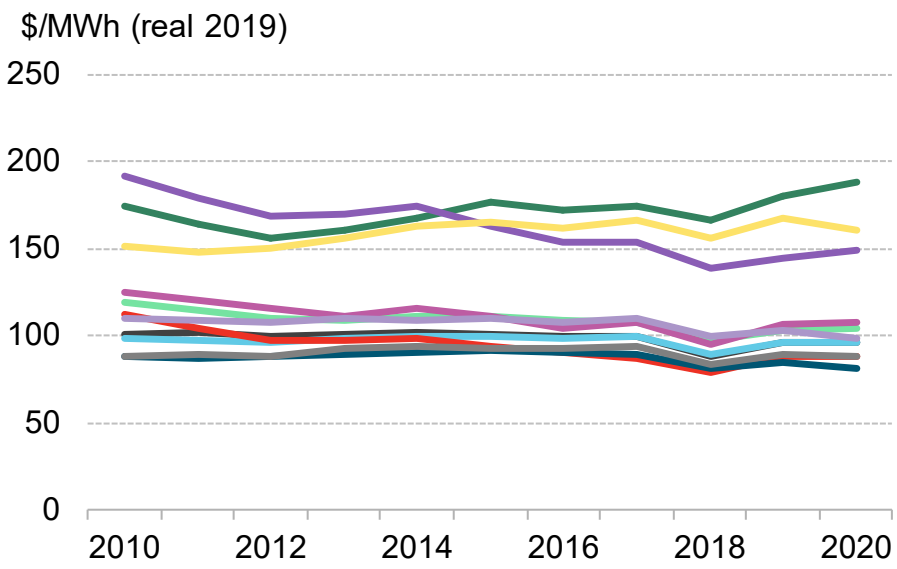
Source: BloombergNEF, EIA, EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016 Notes: "Sinks" refer to forests and green areas which absorb carbon dioxide. Values for 2020 are projected, accounting for seasonality, based on monthly values from EIA available through September 2020 and BNEF projections.

U.S. energy overview: Retail and wholesale power prices

Wholesale power prices



Retail power prices

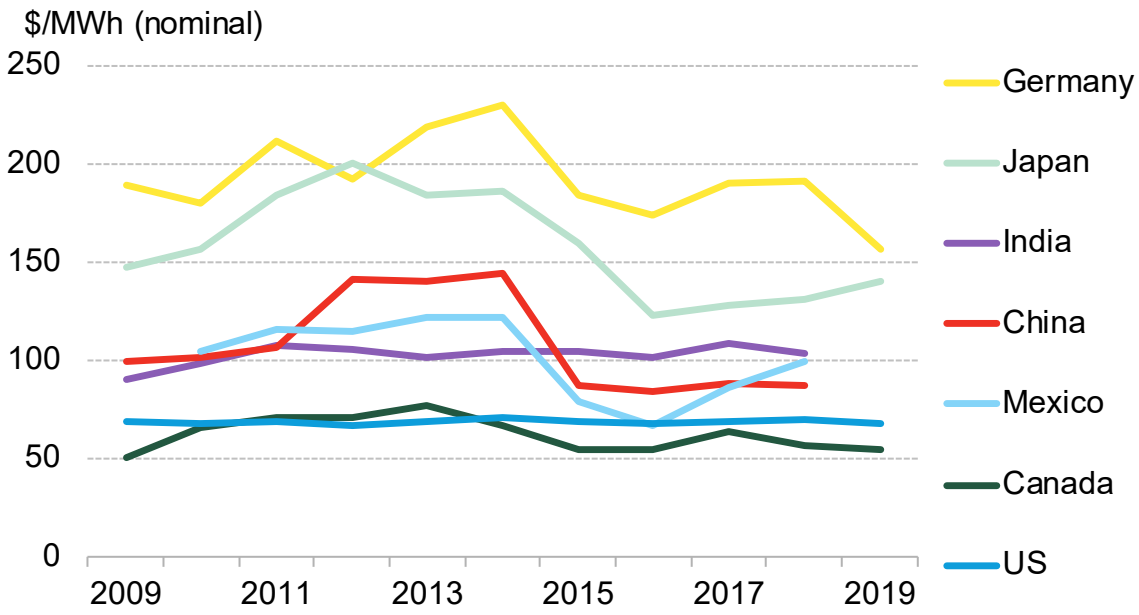


- Wholesale power prices declined in 2020 in most markets. Depressed power demand, low natural gas prices and the continuing national shift to renewable generation helped depress wholesale prices across the board relative to 2019 levels. In fact, steep declines in 2020 demand and resulting natural gas price declines led in part to decade-low wholesale prices at benchmark hubs in almost every market.
- Year-on-year, average wholesale prices dropped the most in the Northwest, Ercot, New England and New York markets, which fell 43%, 39%, 23% and 23%, respectively. Prices only rose in one market: the Southwest, which saw a 23% increase due to west-coast heatwaves, wildfires and power line congestion.
- Retail prices fell in California, SPP, the Southeast, Southwest and Northwest but rose in the other markets. Nationally, on average, they fell by 2.4%.

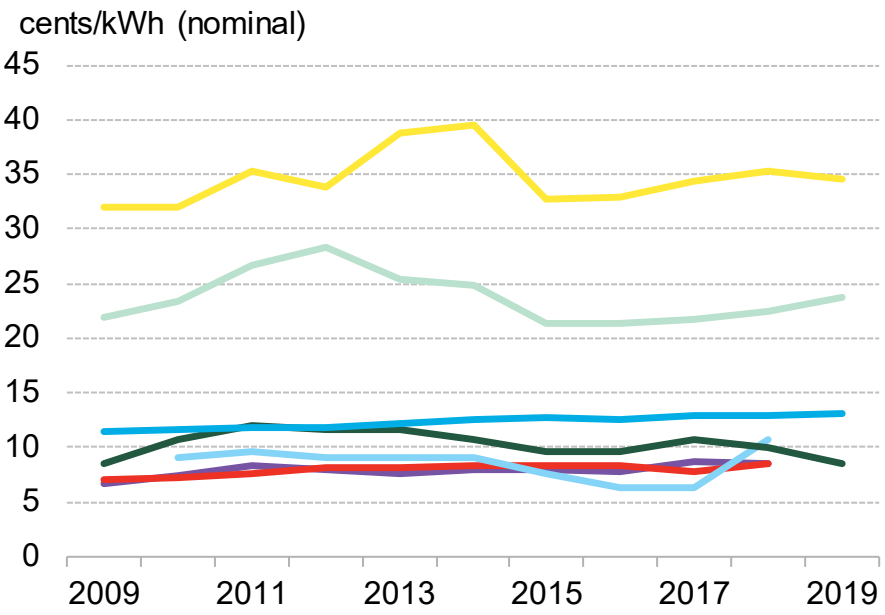
Source: BloombergNEF, EIA, Bloomberg Terminal Notes: Wholesale prices are taken from proxy power hubs in each ISO and are updated through end-2020. All prices are in real 2019 dollars. The retail power prices shown here are not exact retail rates but weighted averages across all rate classes by state, as published by EIA 861. Retail prices are updated through October 2020.

U.S. energy overview: Average electricity rates for industry by country

Industrial power prices



Residential power prices

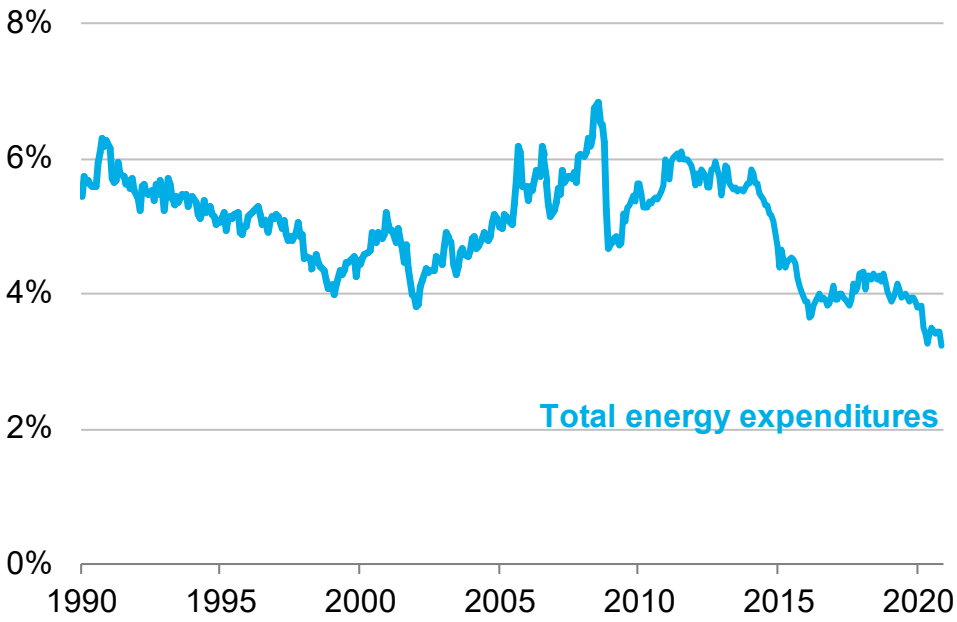


- The U.S. – and North America in general – offers industrial customers some of the least expensive electricity in the world. Among the G-7 nations, the U.S is second only to hydro-rich Canada and offered an average price for industrial customers of 6.8¢/kWh in 2019.
- Prices in Mexico rose sharply from 2017 to 2018. Mexico introduced energy market deregulation and wholesale power pricing in 2016. Since then, the country's oil-fired power plants have played a heavy role in dictating marginal power prices. Specifically, the 2018 power price hike came in the wake of a national oil price spike.
- Canadian power prices slightly declined in 2019, returning to 2016 levels. Canada has a hydropower-heavy energy mix, so prices generally sit relatively low and tend to fluctuate with rainfall levels in a given year.

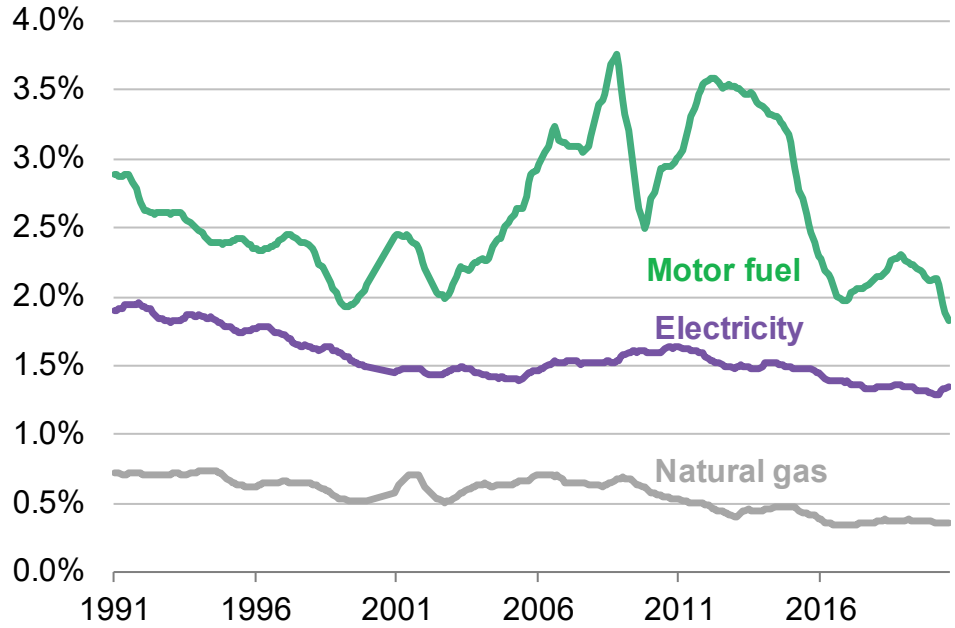
Source: BloombergNEF, government sources (EIA for the U.S.) Notes: Prices are averages (and in most cases, weighted averages) across all regions within the country. Japanese data are for the C&I segment and 2016 figures come from a different source than preceding years. Small Industrial prices in Germany were held flat from 2018.

U.S. energy overview: Energy as a share of personal consumption expenditures

Total energy goods and services as share of total consumption expenditure



Components of total consumption expenditure, 12-month rolling avg.

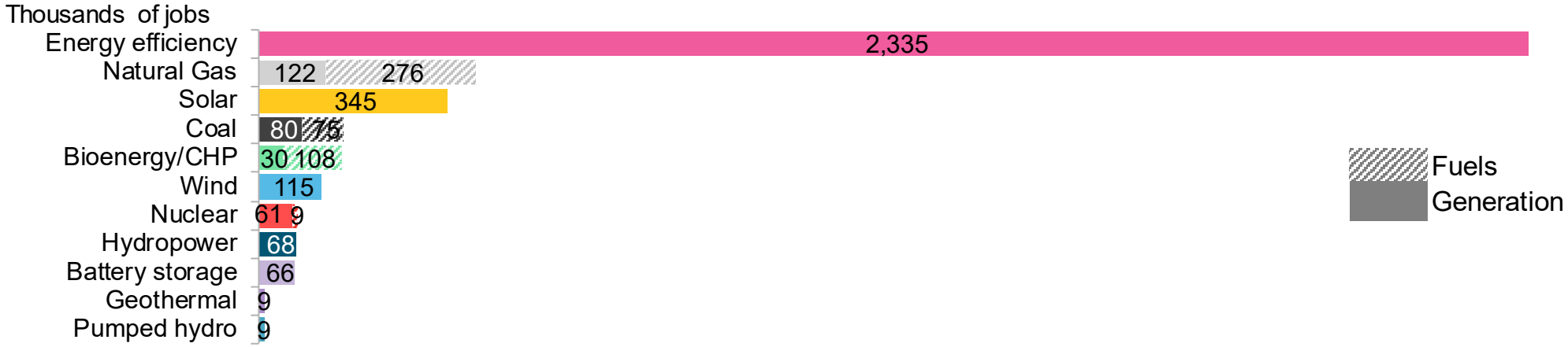


- Energy spending accounted for just under 3.5% of total U.S. personal consumption expenditures in 2020, down .5 percentage points from 2019 levels as overall energy consumption slid. While Covid-19 restrictions altered consumer behavior in 2020, the year also reflects the ongoing trend of consumers devoting relatively small shares of their total spending to energy compared to historical levels, helped along by the rise of renewables, energy efficiency measures, and technological changes.
- Consumer spending on electricity ticked up while natural gas held steady as people spent more cooling their homes starting in mid-March (when lockdowns swept the nation, after 2020's mild, early-year heating months). 1.73% of household expenditures went to electricity and gas in 2020, only slightly above 2019 levels of 1.53%. This slight uptick was offset by deep declines in motor fuel spend, which reflect the steep overall declines in transportation energy consumption, shifting from1.96% of spend in 2019 to 1.60% in 2020.

Source: Bureau of Economic Analysis, BloombergNEF

U.S. energy overview: Jobs in select segments of the energy sector

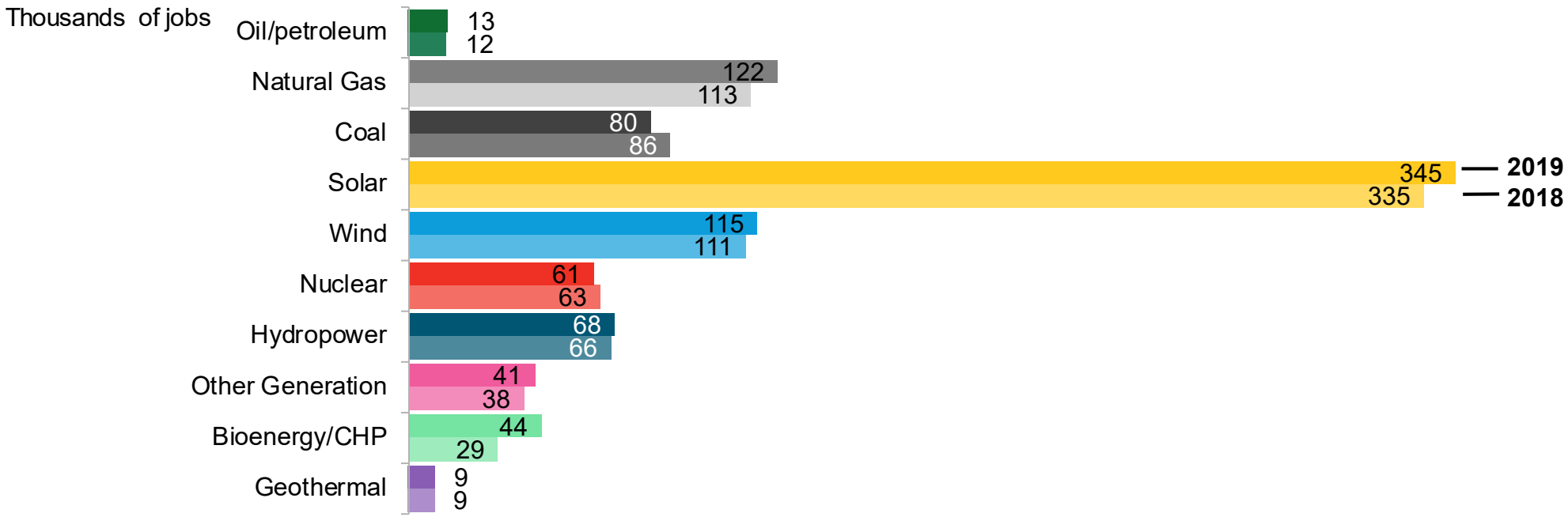
Jobs in select energy segments, 2019



- In 2019 (the last year for which complete data is available), the sustainable, nuclear and storage energy sectors employed an estimated 4.0 million Americans, according to the U.S. Energy and Employment Report. This number is slightly above 2018 levels. Energy efficiency alone supported 2.3 million jobs, while natural gas supported roughly 398,000 jobs and solar 345,000 jobs.
- Including upstream fuel-related jobs notably boosts total employment for fossil-fired generation and bioenergy. In 2019, 69% of the jobs associated with the natural gas sector came from fuel supply (down from 71% in 2018). Coal employed 161,000, with 49% in fuel supply (up from 46% in 2018).
- Energy efficiency jobs related to construction often involve individuals who also do other, non-efficiency related tasks. In fact, 78% of the 2.3 million employees involved in energy efficiency spent the majority of their time on energy efficiency tasks.
- In 2020, according to BW Research, the clean energy sector finished the year with the fewest number of workers since 2015. 429,000 (12% of the nation's clean energy workforce) remained unemployed by year's end, making 2020 the first year that clean energy employment saw a decline. 70% of the jobs lost in the clean energy sector had yet to be recovered by year end. At the rate of recovery over the last six months of 2020, the clean energy sector would not reach pre-COVID employment levels for another two and a half years.
- At the state level, 38 states and the District of Columbia continue to suffer double-digit unemployment in clean energy, with four states seeing unemployment of 20% or more.

Source: The U.S. Energy Employment Report, NASEO and EFI. Notes: This data relies on thousands of data points provided via survey. Transmission, distribution and storage jobs not included.

U.S. energy overview: Jobs in electricity generation



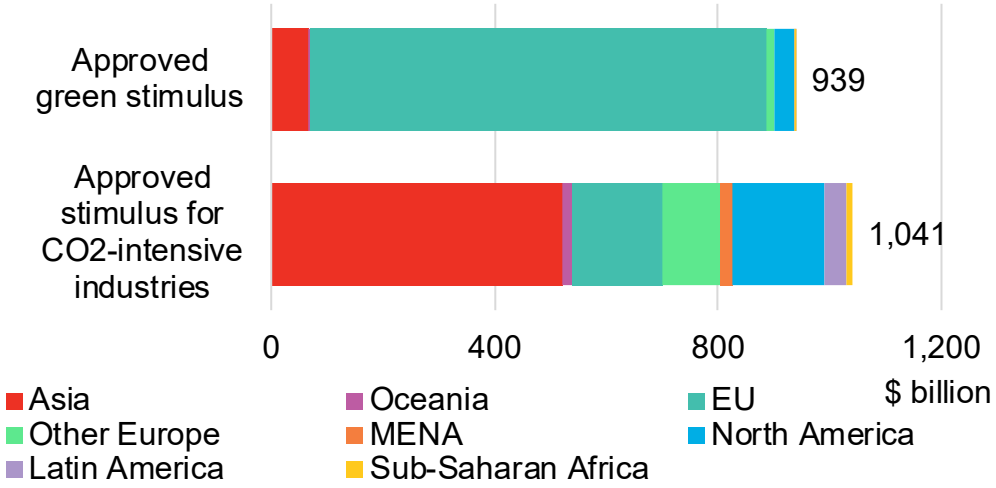
- U.S. power generators employed approximately 959,000 Americans in 2019 (the last year for which complete data are available). This excludes those involved in the upstream processing of fossil fuels. Among the sectors, solar was the single largest employer in generation, supporting 345,000 jobs. Fossil fuels (coal, gas, and oil combined) was the next largest category at 290,000, followed by wind with 115,000.
- Total U.S. generation-related jobs rose 4% from 2018 to 2019. Gains in almost all sectors outside of coal and nuclear offset the 8,000 job declines in those two. Jobs in the natural gas sector rose by a net 9,000 year-on-year. This largely reflects the growth in natural gas-fired generation in the last two years.
- Solar employees often work part-time in other, non-solar divisions of the same company. Of the 345,000 solar industry employees, around 28% spent the majority of their time employed in other, non-solar sectors.

Source: The U.S. Energy Employment Report, NASEO and EFI. Notes: 2018 data are from Q2 2018, 2019 data are from 2Q 2019.

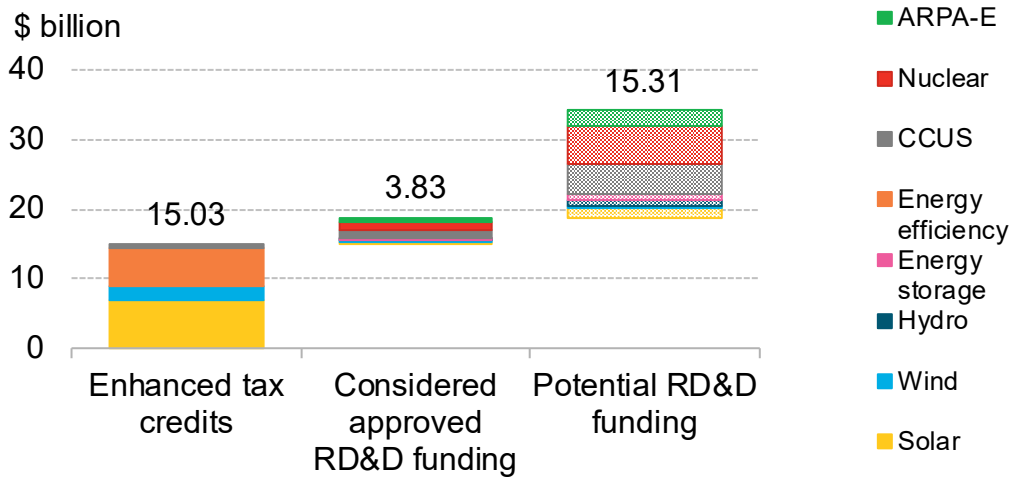
Table of Contents

Policy: Global stimulus support for decarbonization

Covid-19 stimulus approved as of January 2021



New U.S. green stimulus

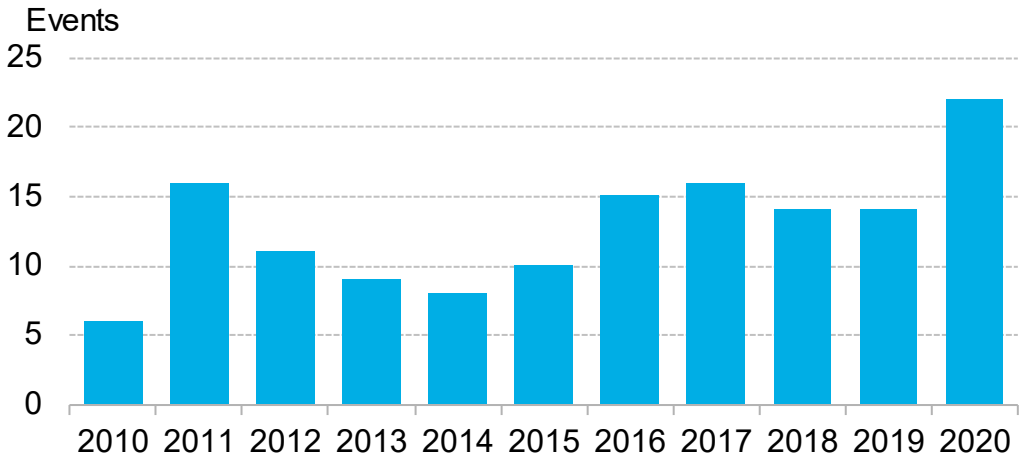


- Governments have approved nearly $1 trillion to date in Covid-19 stimulus funding aimed at cutting emissions or aiding climate adaptation. This represents 7% of global stimulus pledged in response to Covid-19 compared to 8% explicitly for carbon-intensive sectors, with the balance non-specified. Thanks to Congressional action, the U.S. joined the green stimulus club just in time for Biden's presidency.
- The U.S. recovery package enacted in December 2020 supports renewables, energy efficiency, CCUS and other technologies. In terms of the absolute support for green sectors, the U.S. now ranks fourth globally. But relative to its size, it performs less well, ranking 11th among other nations on a per-capita basis. The new $900-billion package could inject at least $34 billion in low-carbon spending into the country's economy over the next decade.
- In addition to the U.S. movement, EU leaders agreed in December on a recovery package and budget to deliver at least $717 billion to green sectors. This sum could grow pending member states' plans, which they must submit by May 2021. Canada also approved $12 billion of new green stimulus in December 2020, with over half to be spent on energy efficiency and nature-based solutions such as tree planting. In Japan, a draft stimulus, passed by the Cabinet in December, includes a 2-trillion-yen ($19-billion) fund to support R&D in next-generation energy storage, hydrogen and CCUS over the next 10 years, as well as other items such as EV subsidies.

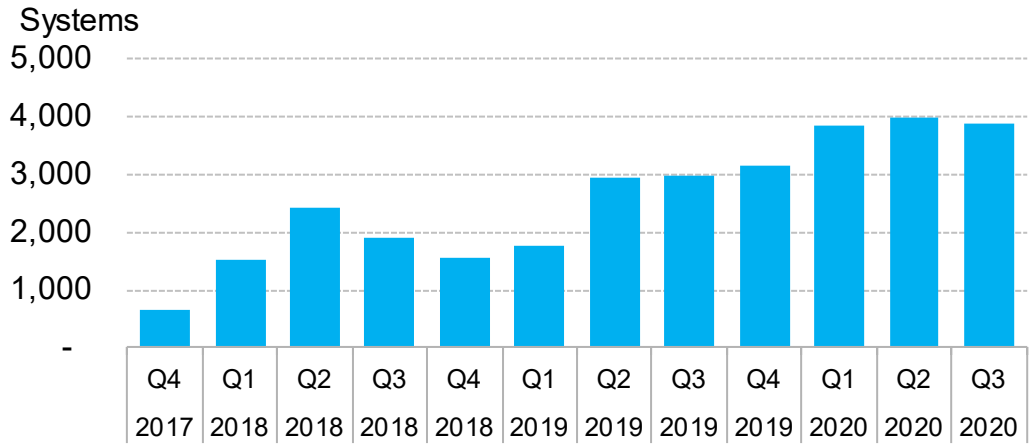
Source: Governments, media reports, BloombergNEF Note: 'Approved green stimulus' includes support to CO2-intensive sectors and companies with green conditions. *Enhanced tax credit funding levels are based on U.S. Congress Joint Committee on Taxation estimate of new spending for those functions during 2021-30 fiscal years. Excludes extension of excise tax credits relating to alternative fuels because this includes support for fossil fuels and green fuels.*

Policy: Infrastructure and resilience

U.S. billion-dollar weather and climate disasters



Quarterly residential energy storage systems installed in California

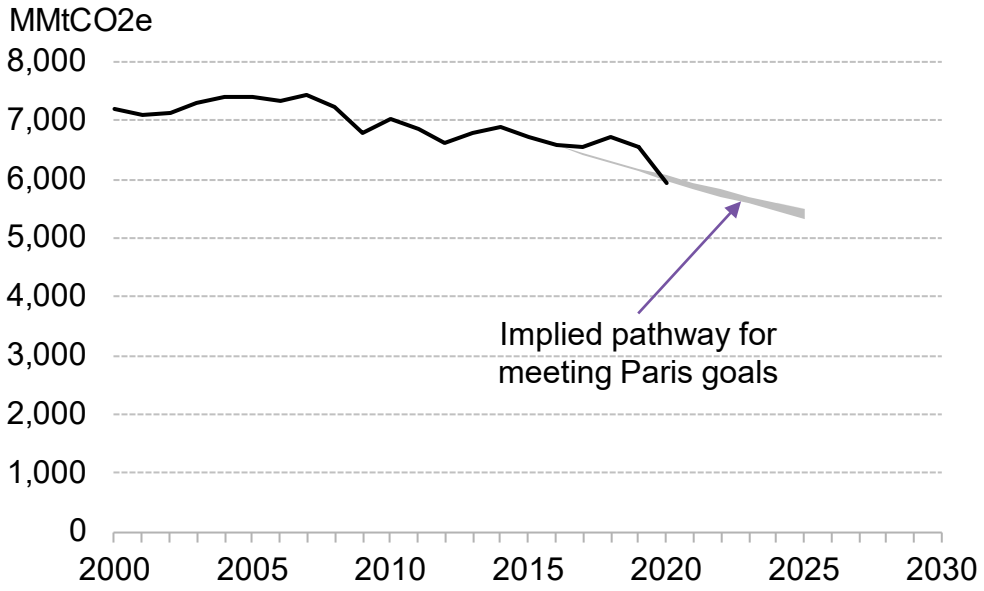


- The U.S. in 2020 experienced a record 22 climate disasters causing at least $1 billion in damage, far exceeding the previous record of 16 events in each of 2011 and 2017. The 2020 events, made up of tropical cyclones, severe storms, droughts and wildfires, are estimated to have caused $95 billion in damage.
- California last year recorded five of the six largest wildfires in its history. Millions of utility customers in the state were left without electricity as utilities cut service to address fire risk from arcing transmission lines.
- Motivated by policy incentives and concerns about grid reliability, California utility customers installed more than 11,500 residential energy storage systems in Q1-Q3 2020. This number is 52% greater that of the same time period in 2019.
- Additional investment in transmission will be key to meet renewable energy goals as well as to enhance grid resilience and reliability in the face of increasingly frequent extreme weather events. Additionally, transmission projects also deliver significant economic benefits via job creation as well as cost savings for consumers and millions of dollars in new state and local tax revenue

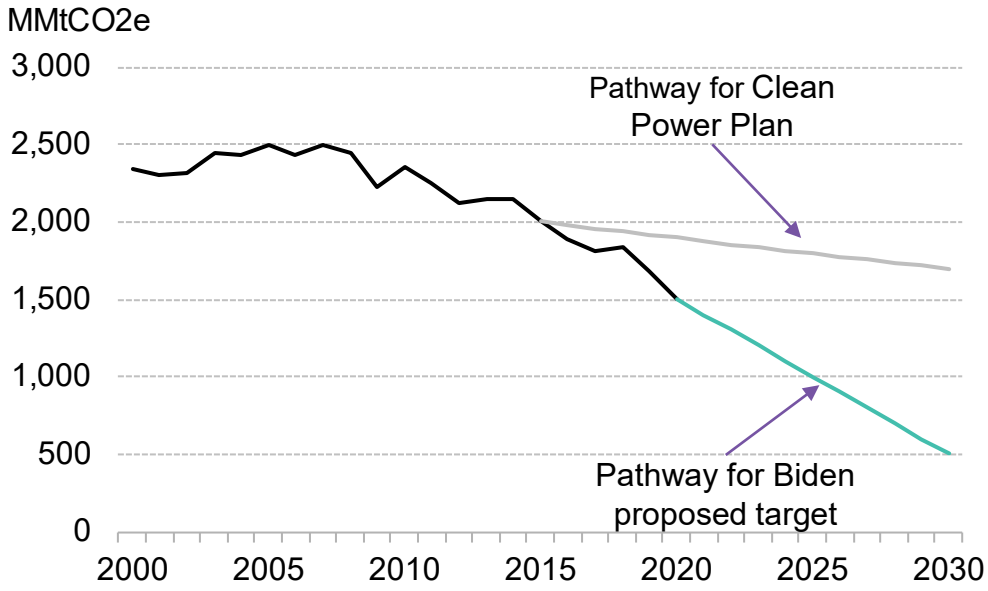
Source: National Oceanic and Atmospheric Administration, BloombergNEF. Note: Portrays annual counts of drought, flooding, freeze, severe storm, tropical cyclone, wildfire and winter storm events in the U.S. with losses of more than $1 billion each.

Policy: U.S. progress toward Paris and Biden's power plan

U.S. economy-wide emissions



U.S. power emissions

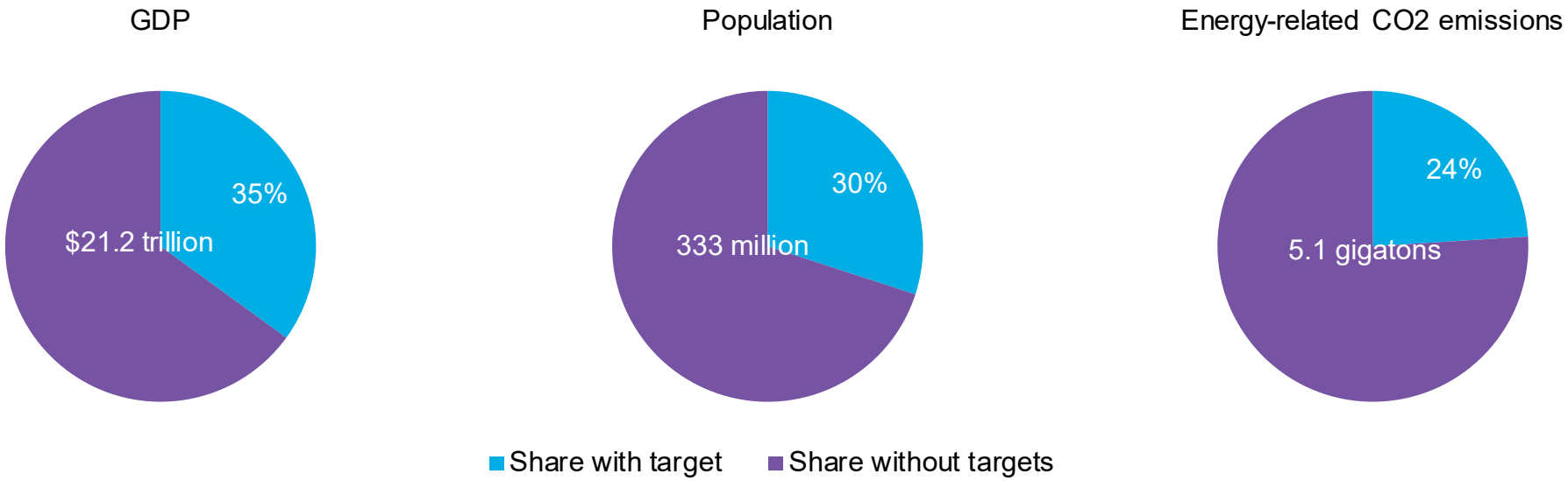


- Since taking office, President Biden has re-entered the Paris pledge of reducing emissions 26-28% below 2005 levels by 2025. The 2020 downtick in emissions brought the U.S. back on track to meet this goal, with emissions currently 20% below 2005 levels. However, prior to last year, the U.S. was well off track: 2019 emissions sat 12% below 2005 levels, slightly under half way toward meeting the minimum goal.
- At the time of its proposal, the EPA estimated that Obama's Clean Power Plan (CPP) would reduce U.S. power sector emissions 32% on 2005 levels by 2030. While the CPP was stayed by the Supreme Court even before the pandemic, and was recently vacated and remanded back to EPA by the U.S. Circuit Court of Appeals of the District of Columbia, the power sector was easily on track to easily beat this target n 2019. Then 2020 put the nation even further ahead of this goal as power emissions hit 40% below 2005 levels.
- During the past 5 years the U.S. has been behind on its Paris Agreement pledge, but way ahead on its power sector ambitions. This suggests that to hit its Paris pledge, the U.S. can either ramp up the ambition for the power sector (as proposed by the Biden administration) or introduce goals for non-power emissions.

Source: EIA, EPA, BloombergNEF

Policy: Sub-national actions to address climate change

GDP, population and emissions of states and cities with greenhouse gas targets, compared to U.S. totals (2019)

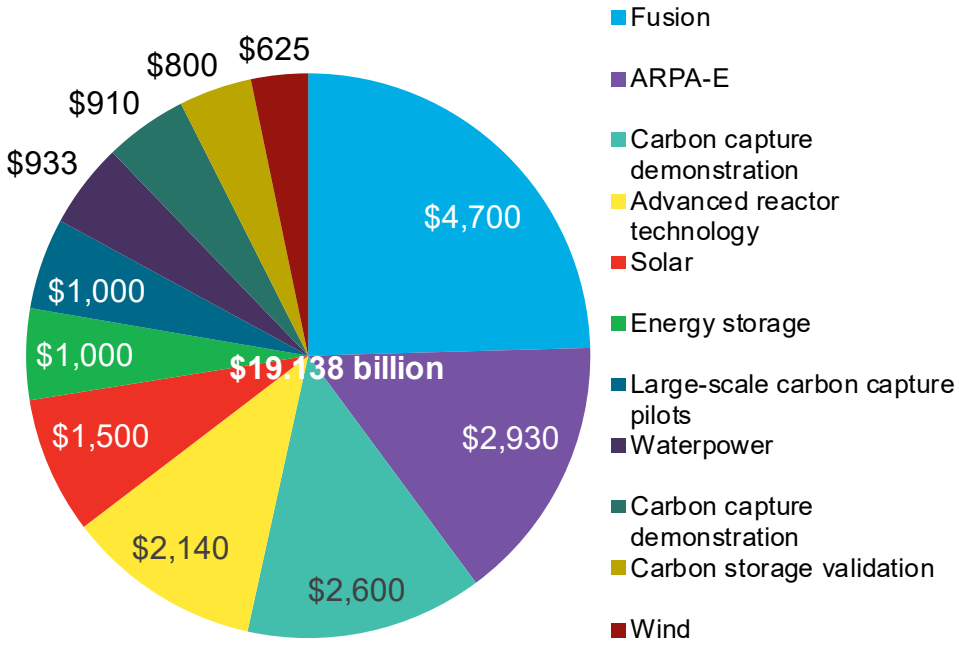


- As of 2020, 10 U.S. states (CA, LA, ME, MA, MI, MO, NV, NY, VT and WA) had set net zero emissions targets for 2050. While only a fifth of the states by number, they make up 35% of the country's Gross Domestic Product (GDP).
- Those 10 states represent fully 30% of the U.S. 2020 population of 333 million and almost one-quarter of its CO2 emissions.
- Twelve other states have gross-emissions goals that stop short of net-zero. Some states' goals are contained within executive orders, while others have been written into law as a statutory target. The latter form is more durable. Many state goals have been announced in the past two years.
- While renewable portfolio standard (RPS) development stalled in 2020, in 2019, nine states made significant revisions to their legislated goals (RPS or otherwise), including New York State increasing its RPS to 70% by 2030 and Nevada to 50% by 2030.

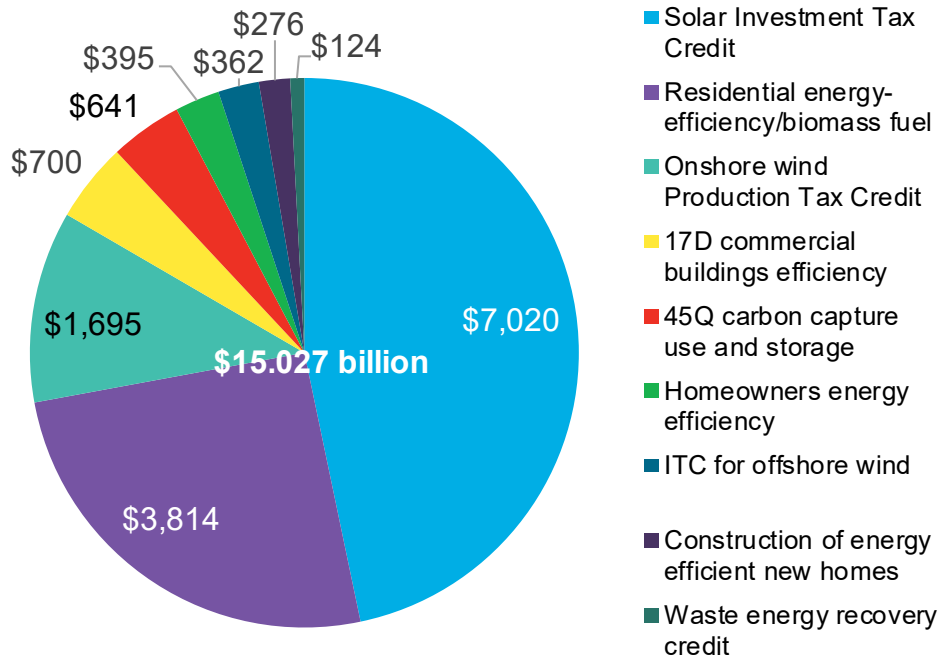
Source: BloombergNEF

Policy: Tax credits and clean energy investment

Energy RD&D spending in U.S. stimulus bill ($millions)



U.S. energy tax credit enhancements, 2021-2030 ($millions)

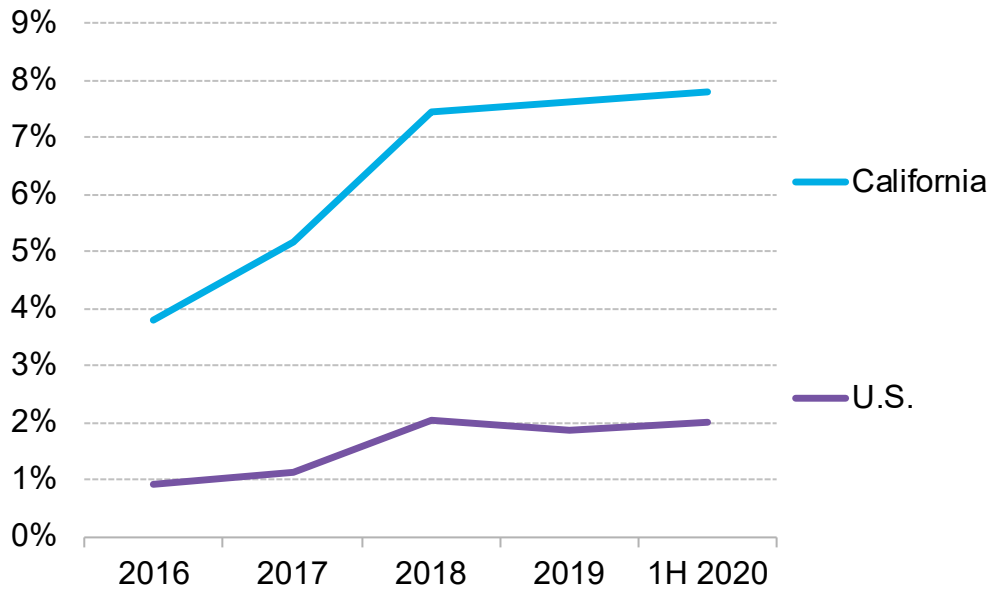


- A $900-billion U.S. Covid-19 recovery package enacted in December 2020 could inject at least $34 billion in new spending on decarbonization into the country's economy over the next decade.
- The bill contains more than $19 billion in the form of new spending on clean energy research, development and demonstration by the Department of Energy, including $6.8 billion for nuclear, $5.3 billion for carbon capture, use and storage and $1 billion for energy storage.
- The package also adds an estimated $15 billion over 10 years in new federal tax credit enhancements on top of existing credits, which peaked at $8.8 billion in 2020.

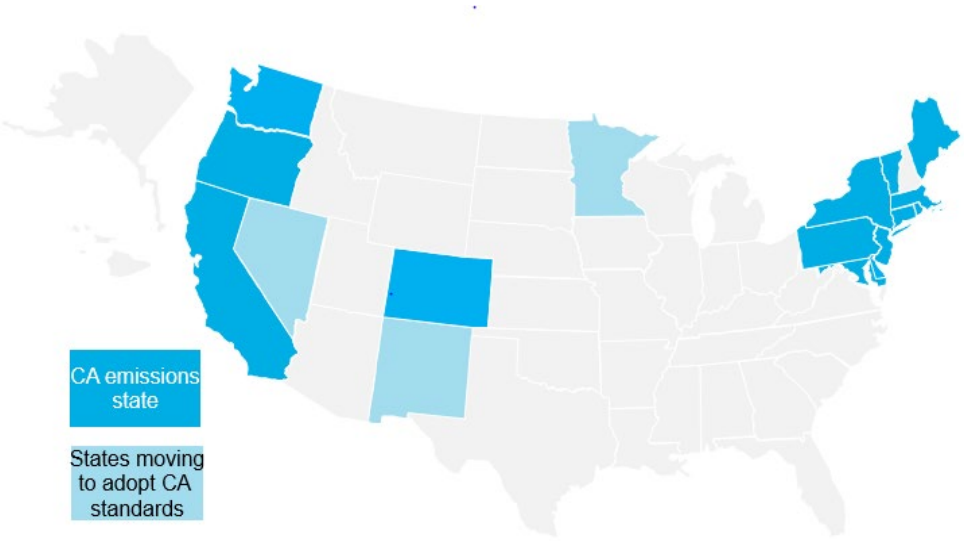
Sources: BloombergNEF, U.S. Congress Joint Committee on Taxation

Policy: vehicle fuel economy standards

EV share of light duty vehicle sales in California and nationwide



States that have adopted California's vehicle emissions standards

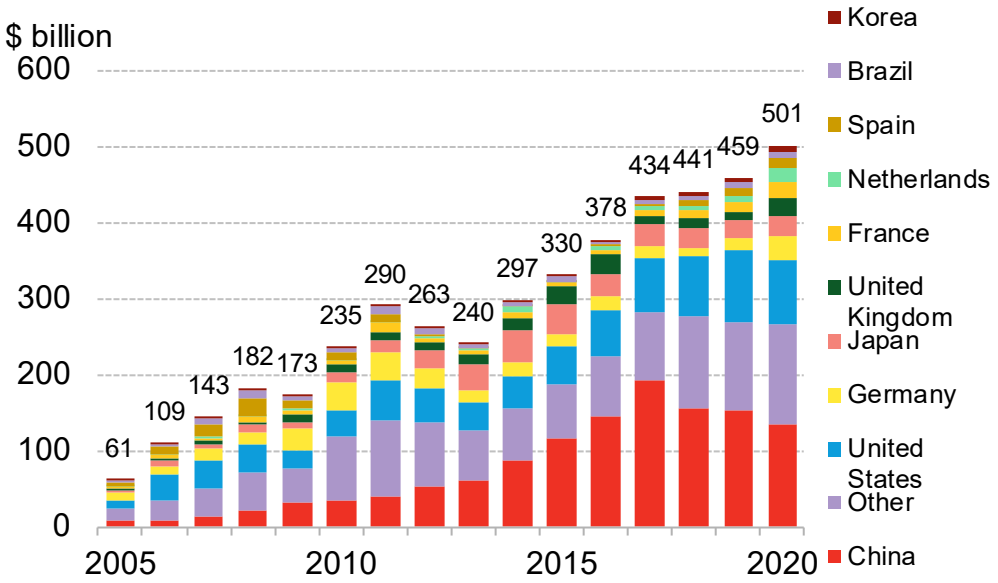


- The transportation sector is the largest source of greenhouse gas emissions in the U.S. Electric vehicle sales are growing but still represent less than 3% of the on-road fleet.
- President Biden has ordered U.S. federal agencies to review the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule, put in place by his predecessor, which canceled a steep increase in vehicle efficiency standards in this decade. Though an exact timeline is not set, the Biden administration intends to publish a more-aggressive fuel economy plan for public comment in 2021.
- California also has instituted a zero emissions vehicle (ZEV) program, which sets quotas on the sale of non-emitting cars. Most, but not all, of the states embracing California's fuel economy standards have adopted its EV program.

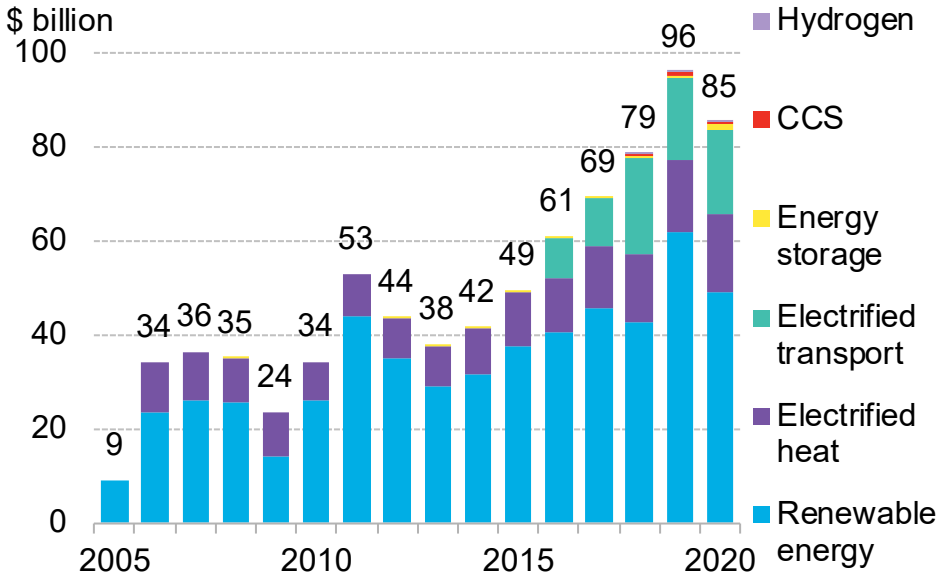
Source: BloombergNEF, California New Car Dealers Association, Auto Outlook. Note: The 14 jurisdictions that follow the California GHG standard are Colorado, Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Vermont and Washington.

Finance: Total new clean energy transition investment

Global economy-wide investment, by country



U.S. economy-wide investment, by sector

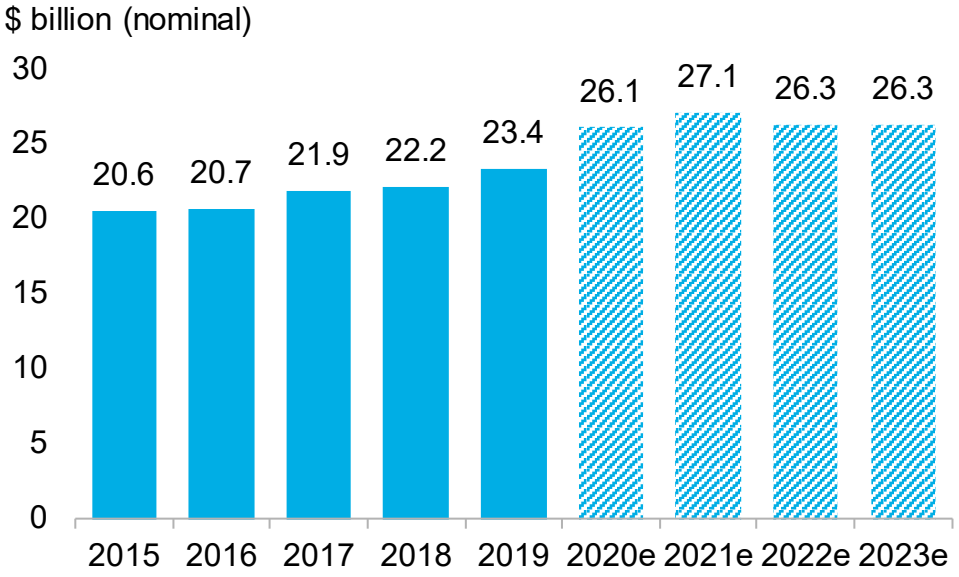


- Global energy transition investment hit $500 billion for the first time in 2020 – a 9% increase over 2019 – marking the largest growth since 2016-2017.
- The U.S. accounted for $85 billion (or nearly 20% of this global investment), but decreased 11% below 2019. The nation continues to spend the lion's share of its energy transition capital on renewable energy (58% of total spend) while transport remained a strong growth area (a 42% investment increase in the last 5 years, relative to power's 31%). Notably, the U.S. now invests roughly $100 million/year in hydrogen, the vast majority of which is tied to fuel cell vehicle sales.
- U.S. renewable energy was not immune to the multi-sector investment dip in 2020. Last year, $12 billion less was invested in renewable technologies (a 20% decrease) than in 2019. Solar and wind continued to pull the majority of the capital, accounting for 99% of all renewable energy investment.

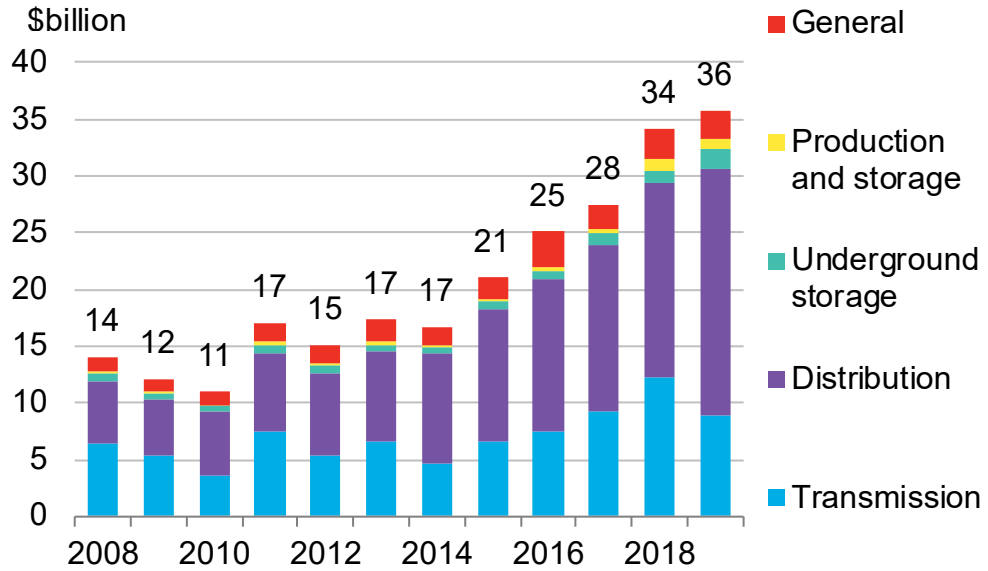
Source: BloombergNEF, "Energy Transition Investment Trends, 2021"

Finance: U.S. midstream infrastructure investment

U.S. electric transmission investment by IOUs and independent developers



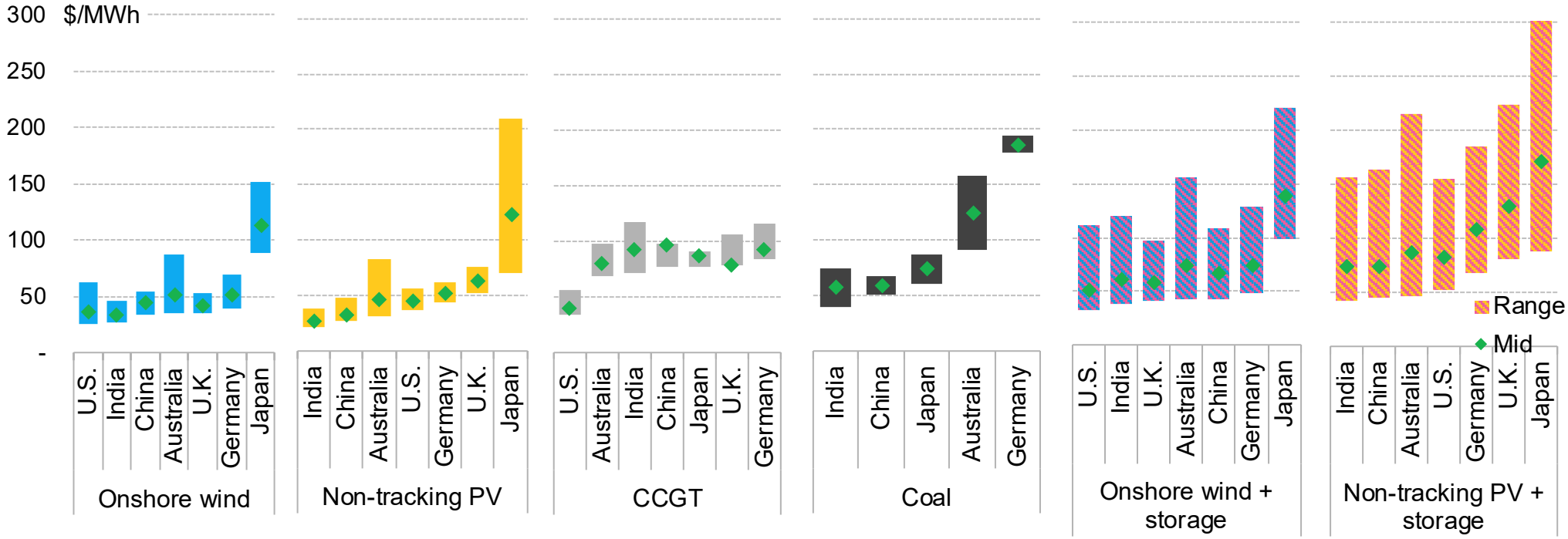
U.S. gas utility construction expenditures



- Investor-owned utilities and independent transmission developers spent a record $23.4 billion on electric transmission in 2019, Edison Electric Institute (EEI) estimates. This is up 5% from 2018 and up 14% from 2015. Based on company reports, investor presentations and a survey, transmission investment likely jumped 12% in 2020 to $26.1 billion, EEI estimates. Current capex plans suggest that investment will peak in 2021 and investment will then slow. However, future-year budgets are not yet finalized, and these numbers may be revised upward.
- The electric transmission investment upswing is driven by a number of factors, all of which concern the utility's fundamental aim of providing reliable, affordable, increasingly clean and safe power. These include a need to replace and upgrade aging power lines, resiliency planning in response to potential threats (both natural and man-made), the integration of renewable resources, and congestion reduction.
- Midstream gas utility construction expenditures also continued to rise in 2019, with the increase in distribution expenditures overwhelming the decrease seen in transmission. Total expenditure grew by 5% in 2019, after two years of near 25% growth.

Source: Edison Electric Institute, American Gas Association, BloombergNEF Note: IOU means investor-owned utility. Gas expenditure values reflect figures reported to the AGA by companies across the supply chain, including transmission companies, investor-owned local distribution companies, and municipal gas utilities. "General'" includes miscellaneous expenditures such as construction of administrative buildings.

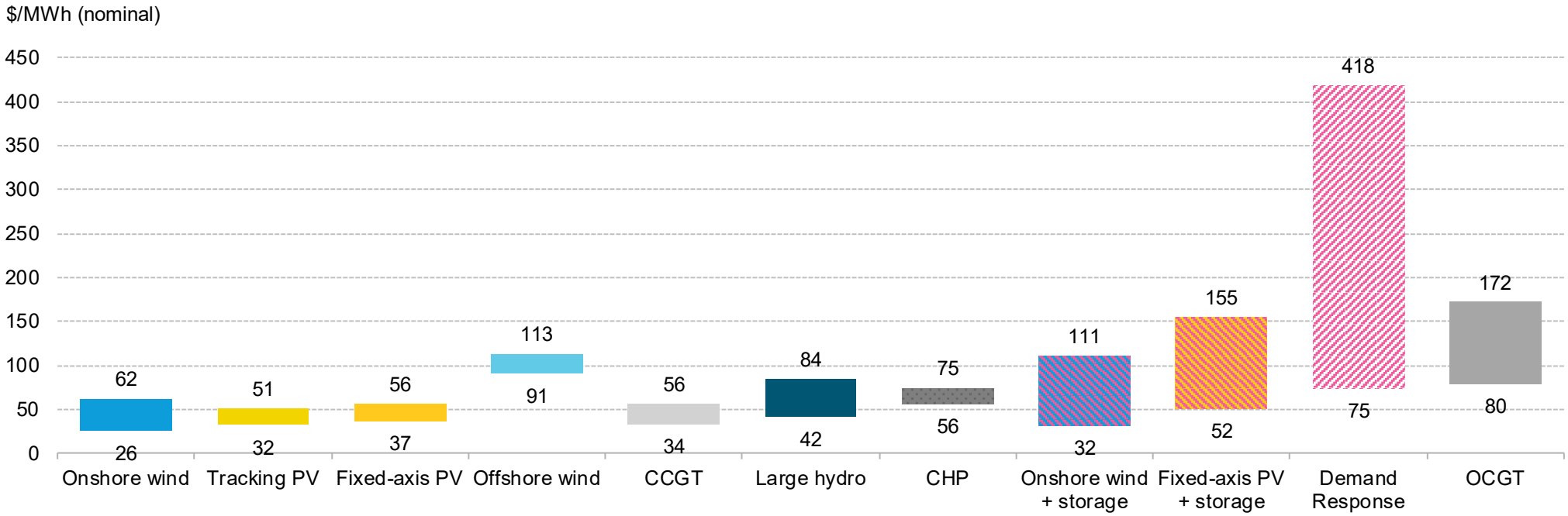
Economics: Select country levelized costs of electricity (unsubsidized, 2H 2020)



- Levelized cost of electricity (LCOE) is a metric for comparing the relative costs of different generating technologies. It measures the all-in, lifetime costs of operating a plant, accounting for upfront costs as well as anticipated ongoing expenses.
- Under BNEF's 2H 2020 estimates, onshore wind is the cheapest source of new generation in most geographies, with the U.S. boasting the lowest all-in costs at $26/MWh. Globally, India features the world's lowest-cost solar, at $22/MWh for non-tracking photovoltaic (PV). Japan has high wind and solar costs as steep capex and O&M more than offset ample access to cheap debt.
- The U.S. sees the least expensive combined-cycle gas turbines (CCGTs) due to cheap, abundant gas resources and no nationwide price on CO2 emissions. Carbon pricing and relatively poor resources in the U.K. and Germany push up the costs for both gas and coal generation.

Source: BloombergNEF. Note: The LCOE range represents a range of costs and capacity factors. In countries where a carbon pricing scheme exists, our coal and gas LCOEs include a carbon price. Battery storage systems (co-located and stand-alone) presented here have four-hour storage. In the case of solar- and wind-plus-battery systems, the range is a combination of capacity factors and size of the battery relative to the power generating asset (25% to 100% of total installed capacity). All LCOE calculations are unsubsidized.

Economics: U.S. levelized costs of electricity (unsubsidized for new build, 2H 2020)

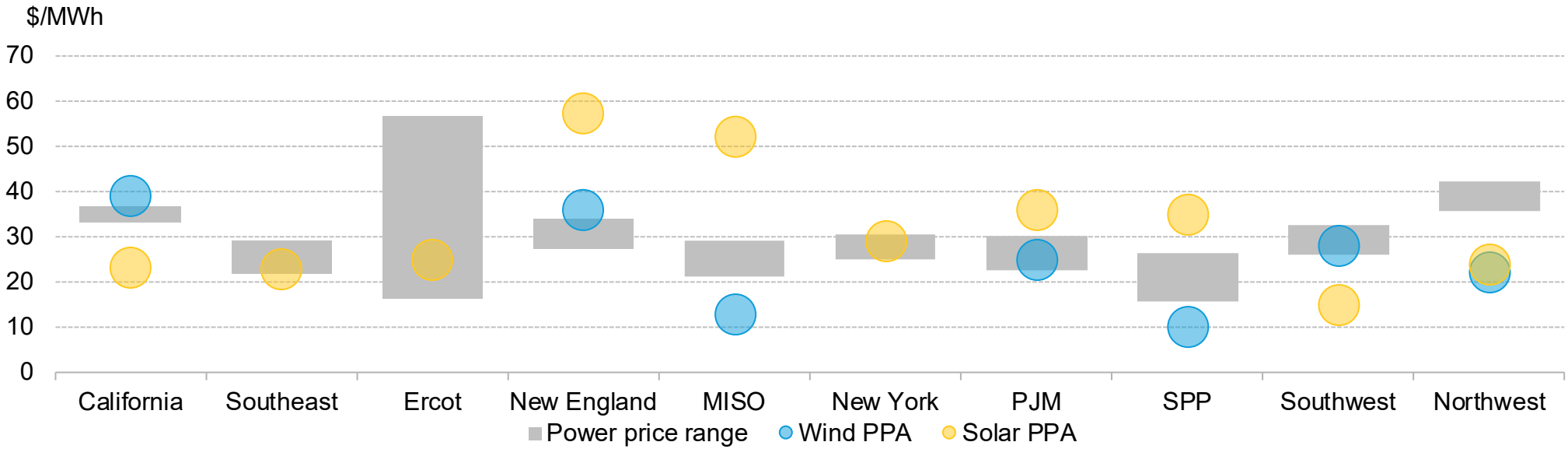


- At $26-62/MWh without accounting for tax credits, onshore wind is cheaper than new gas-fired plants for bulk electricity generation in many areas of the U.S. Combined-cycle gas turbines (CCGTs) represent the cheapest source of dispatchable power, with an LCOE of $34-$56/MWh.
- Projects equipped with photovoltaic (PV) modules that track the sun's progress feature U.S. LCOEs of $32-51/MWh and are essentially at parity with new CCGT projects. PV projects without tracking are still getting cheaper each year with LCOEs of $37-56/MWh.
- The levelized cost of paired onshore wind-plus-battery (four-hour) systems ranges from $32-111/MWh, while solar-plus-battery (four-hour) is at $52-155/MWh.

Source: BloombergNEF. Note: The LCOE range represents a range of costs and capacity factors. Battery storage systems (co-located and stand-alone) presented here have four-hour storage. In the case of solar- and wind-plus-battery systems, the range is a combination of capacity factors and size of the battery relative to the power generating asset (25% to 100% of total installed capacity). OCGTs are open cycle gas turbines. All LCOE calculations are unsubsidized. Categorization of technologies is based on their primary use case.

Economics: U.S. wind PPA prices compared to wholesale power prices

Regional power prices and lowest recent PPA prices

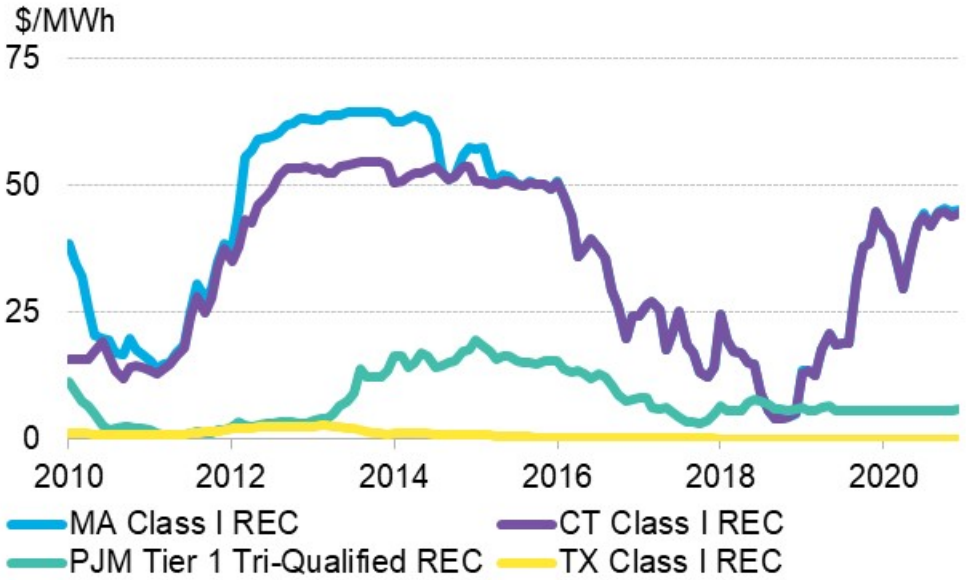


- Prices for wind power purchase agreements (PPAs) have fallen dramatically as levelized costs declined. According to FERC datasets and interviews with project developers, projects secured offtake agreements in the mid-teens in the middle of the U.S. in 2019. For comparison, data reported to FERC in 2011 indicates that offtake prices for contracts signed then averaged $47/MWh.
- The top regions for utility PPAs are high wind-speed regions with low development costs like SPP and MISO. Conversely, developing projects in New England can be costly and time consuming, and average project capacity factors are typically among the lowest in the country.
- A significant number of wind projects commissioned in 2016 – representing 1.6GW of capacity – secured corporate PPAs. The popularity of corporate PPAs has grown in recent years and a record volume of such contracts was once again signed in 2019.

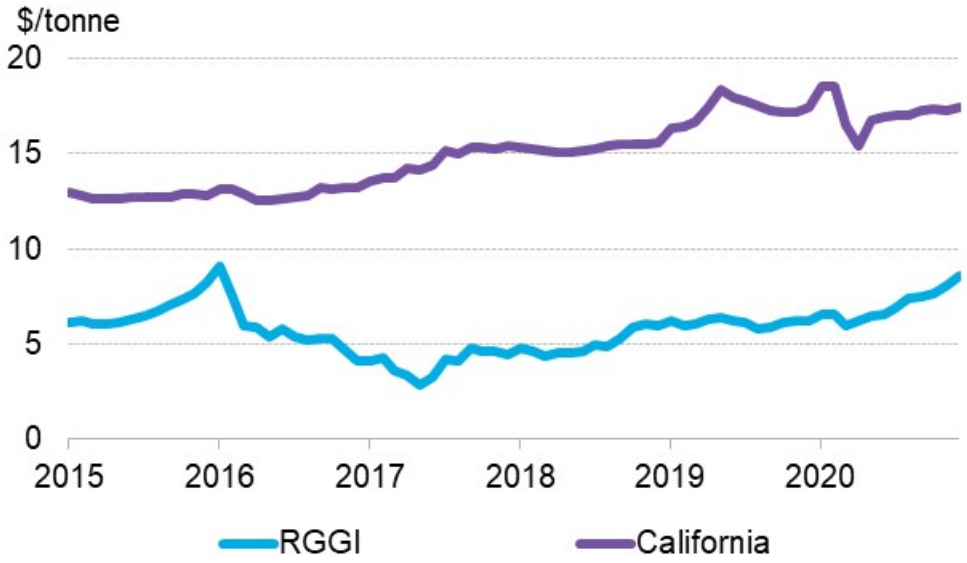
Source: BloombergNEF, SEC filings, interviews, analyst estimates Notes: MISO is the Midwest region; PJM is the Mid-Atlantic region; SPP is the Southwest Power Pool which covers the central southern U.S.; NEPOOL is the New England region; ERCOT covers most of Texas. Wholesale power prices are based on market-traded futures for calendar year 2019 for select nodes within the region.

Economics: U.S. environmental markets

Class I REC prices in select U.S. markets



U.S. carbon allowance auction prices

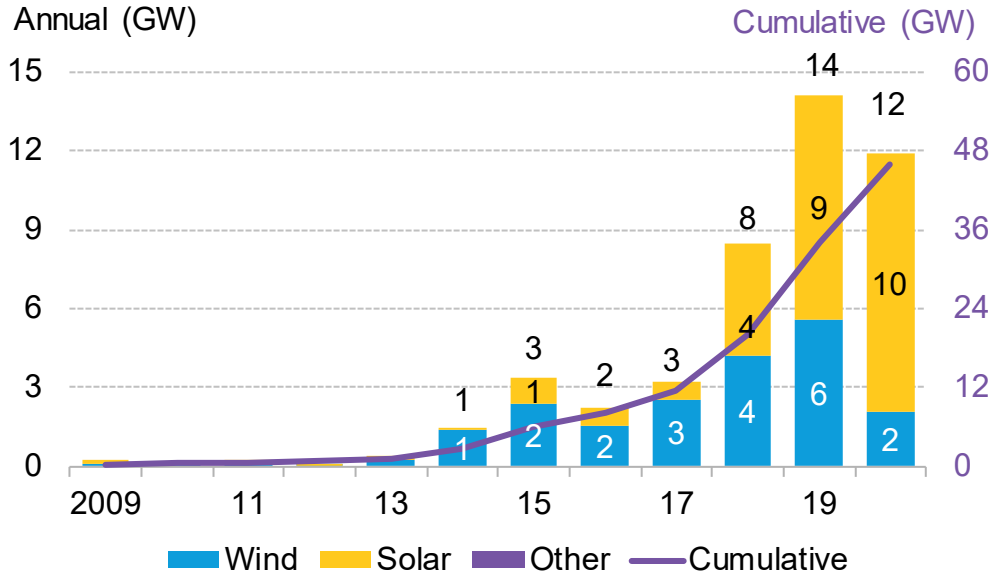


- In states with Renewable Portfolio Standards (RPS), eligible renewable generators receive Renewable Energy Credits (RECs) for each megawatt-hour of electricity they supply to the grid. REC prices typically rise when policy-makers raise overall goals for clean energy generation, increasing demand for credits. The U.S. also has two carbon cap-and-trade markets. In participating states, emission allowances are won by bidding entities in auctions held each quarter. Those allowances can then be traded in the secondary markets between auctions.
- REC markets have been bolstered as clean energy targets have risen and will react to dynamics such as increasingly ambitious clean energy mandates increasing REC demand, and therefore REC prices. Carbon markets have seen little movement as they remain oversupplied. The auction and trade prices tend to follow the floor prices determined by auction organizers. In California, the carbon price is making the economics of the state's coal-fired power plants less tenable.
- In 2020, environmental markets remained relatively stagnant with the exception of early spring behavior when trade volumes boosted and prices dipped in the New England Class I REC markets and the California carbon market.

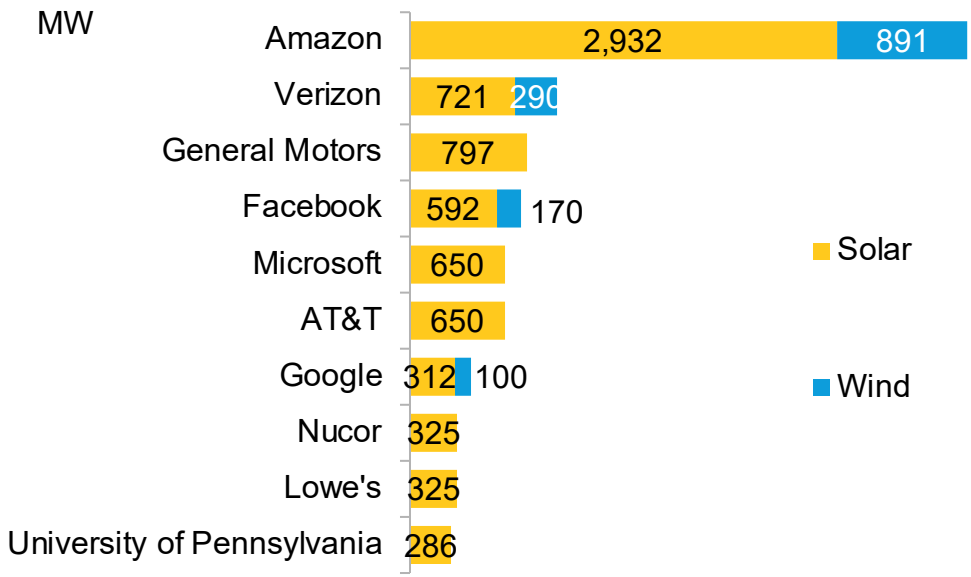
Source: BloombergNEF, Bloomberg Terminal, CARB, RGGI NOTE: RGGI is the Regional Greenhouse Gas Initiative. RGGI auction is in short tons and CCA auction is in metric tons

Finance: Corporate procurement of clean energy in the U.S.

Renewable capacity contracted by corporations, by technology



Largest corporate offtakers, 2020



- Corporate power purchase agreements (PPAs) for clean energy totaled 11.9GW in 2020. This is down from 14.1GW in 2019, and is the first drop in annual corporate PPA volumes since 2016. Covid-19 was the biggest factor in the drop – just 4.3GW of deals were announced in the first half of the year as companies tightened budgets and shifted priorities internally in response to the pandemic. Some 7.6GW of deals were announced in the second half of the year, signaling that companies will be better prepared to carry on sustainability initiative during any future disruptions.
- Solar has become the dominant clean energy technology sought by corporations. This is emblematic of a growing power markets expertise among buyers, who are trying to capture peak power pricing, which solar tends to capture better than wind. Additionally, many wind projects in popular markets like ERCOT and SPP have seen their revenues erode as more zero marginal cost clean energy is built, which depresses prices. This has prompted companies to instead seek solar contracts in these markets.
- Amazon was by far the largest corporate buyer of clean energy in 2020, at 3.8GW. The company announced 21 individual clean energy PPAs in the U.S., with most projects cited in Virginia and Ohio. Verizon (1GW) and General Motors (797MW) were the next largest buyers. A slew of first-time buyers also entered the market in 2020, including Applied Materials, Henkel and Nucor.

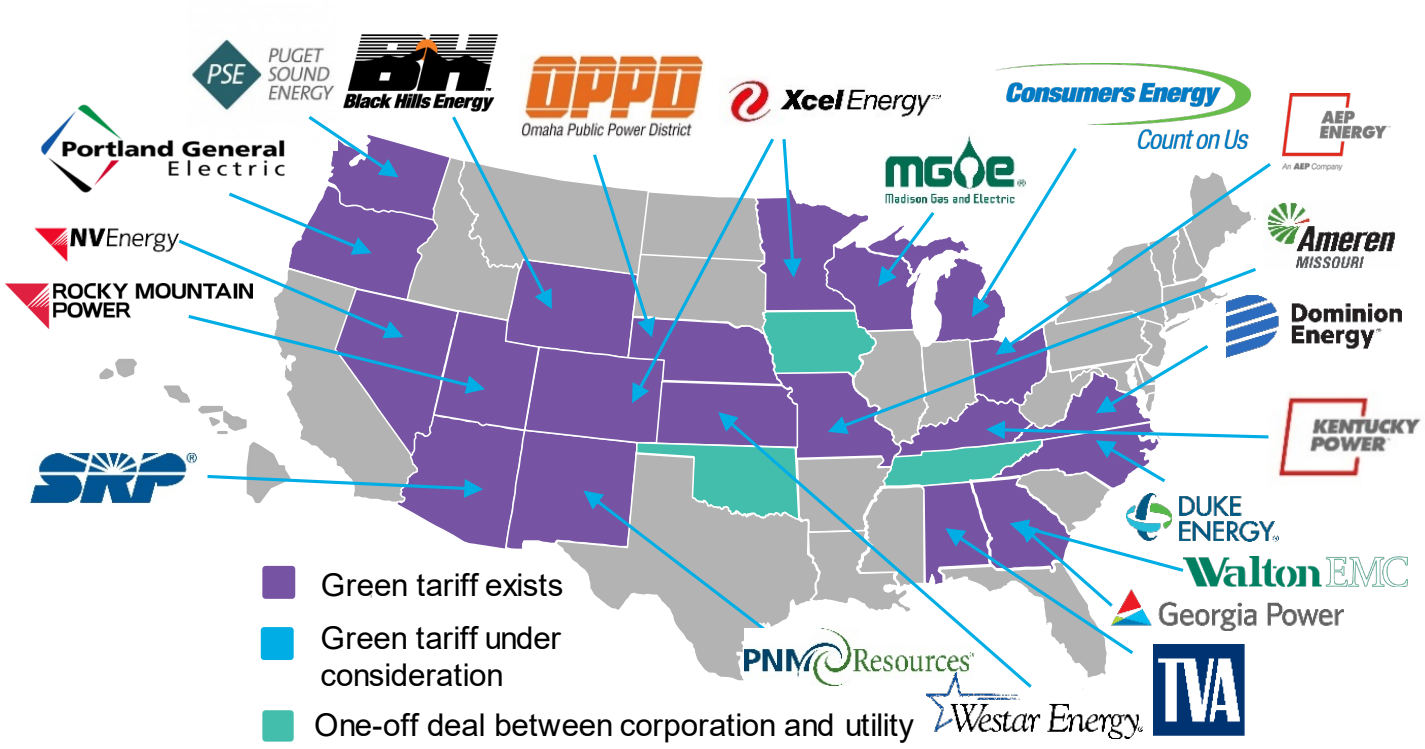
Source: BloombergNEF Note: Charts show offsite PPAs only

Finance: Corporate sustainability targets

- The Climate Group's RE100 initiative, whose signatories pledge to offset 100% of their electricity consumption with renewables, had another record year of growth in 2020. Some 65 new companies joined, bringing the total number of signatories to 285. The U.S. holds onto its title as the most dominant market, with 79 (28%) of these companies. Technology (18) and Financials (18) are the most prominent sectors in the U.S.
- Through 2020, 123 companies have joined The Climate Group's EP100 campaign, which is nearly double the 64 that had joined at the end of 2019. Signatories pledge to double their energy productivity by 2030, while also cutting energy waste and owning and operating energy-smart buildings. Notable companies to join in 2020 include Lloyds Banking Group, Mitie and Derwent.
- The Climate Group's EV100 campaign, under which companies make a public commitment to integrate electric vehicles (EV) into their fleet or support EV charging infrastructure at their operations by 2030, is now up to 92 companies. Members such as DHL and EDF have already made significant progress in electrifying their vehicle fleets, purchasing 22,300 and 3,600 EVs, respectively.

Source: BloombergNEF, The Climate Group, company announcements Note: Chart is a list of companies that have either joined a respective campaign or made other efforts in these sectors.

Deployment: Corporate procurement of clean energy through green tariffs

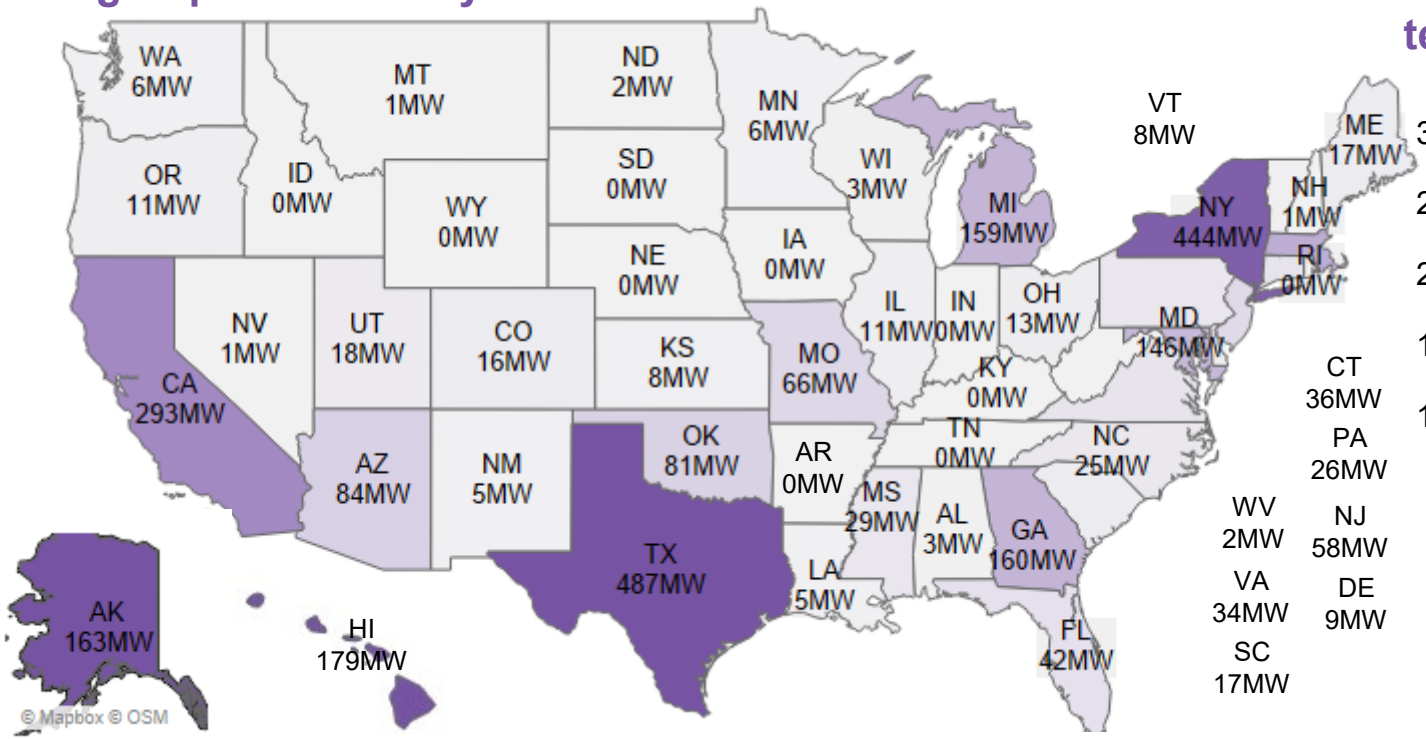


- The U.S. green tariff model in the U.S., where a regulated utility purchases clean energy on behalf of a corporate customer, has failed to grow after a record 2.6GW of clean energy was purchased through this mechanism in 2018. Companies announced 2.4GW of green tariffs in 2019 and just 1.5GW in 2020.
- Despite the slowdown, the number of utilities offering these programs continues to grow. Some 20 regulated utilities in 20 states offer green tariff programs for corporate customers through 2020.
- Green tariffs are still popular with large, experienced buyers with operations in regulated markets. Google, Facebook and Toyota are some of the major companies to announce green tariff deals in 2020.
- Green tariffs are desirable for more risk-averse companies as well. By serving as the offtaker and firming up intermittent renewable power with its existing energy portfolio, utilities can absolve their customers of things like shape, weather and operational risk. Throughout the country, the design of green tariffs vary.

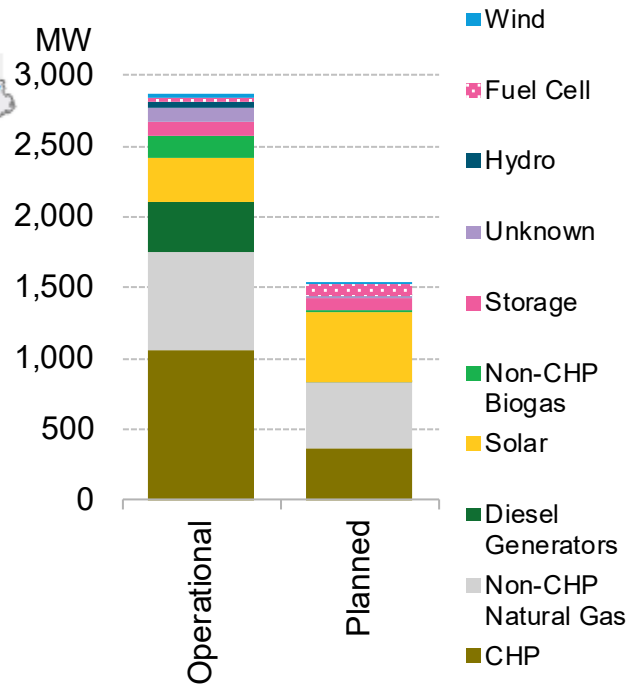
Source: BloombergNEF, World Resources Institute

Deployment: National microgrid penetration

Microgrid penetration by state



Microgrid capacity by technology



- There are 2.9GW of operational and 1.6GW of planned microgrids in the U.S. spread across 462 and 221 sites, respectively. This is up from 2.7GW (242 sites) of operational and 1.4GW (138 sites) of planned in 2019.
- Of these, 1,065MW of operational and 374MW of planned microgrid capacity come from combined heat and power (CHP) systems, representing around 33% of all operational and planned capacity. There are currently 44 CHP sites paired with solar generating capacity, 19 with diesel generators and 30 with storage. Other technologies have ten or fewer sites paired with CHP.
- The commercial sector has the largest number of microgrid systems with a combined 250 operational and planned sites. The municipal and military sectors have the second and third largest with 92 and 63 sites. The commercial and military sectors have 181 and 52 sites currently in operation. With only 35 current sites, the city/municipal sector has the second largest "planned" pipeline (commercial's is 69).

Source: ICF Microgrid Database, BloombergNEF Note: Microgrid is defined as a group of interconnected loads and distributed energy resources (DERs) that can disconnect and re-connect to the utility grid as a single entity, allowing facilities to remain operational during utility outages.

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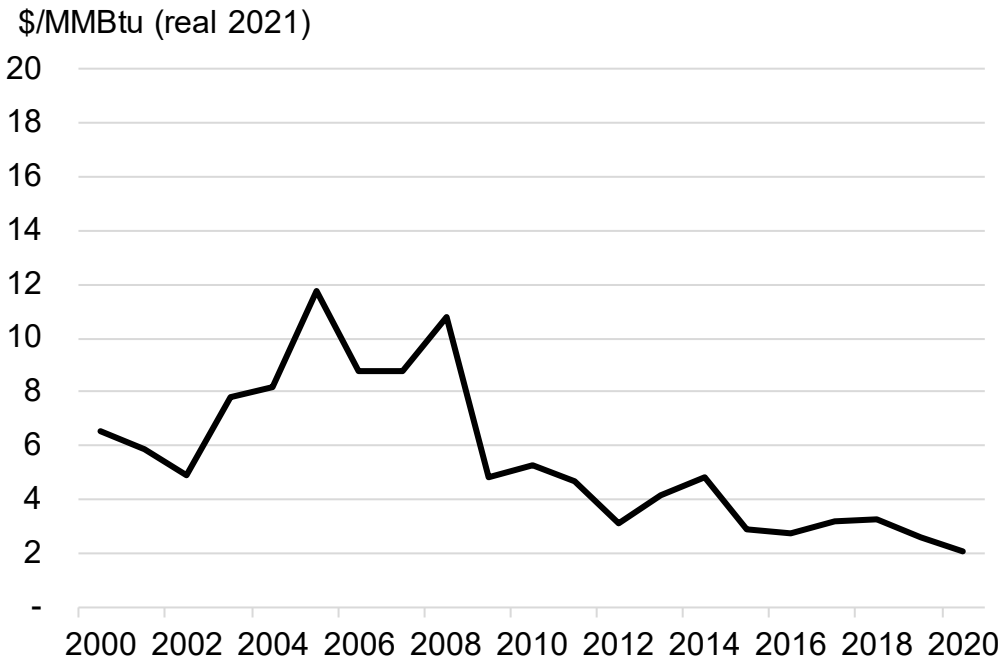
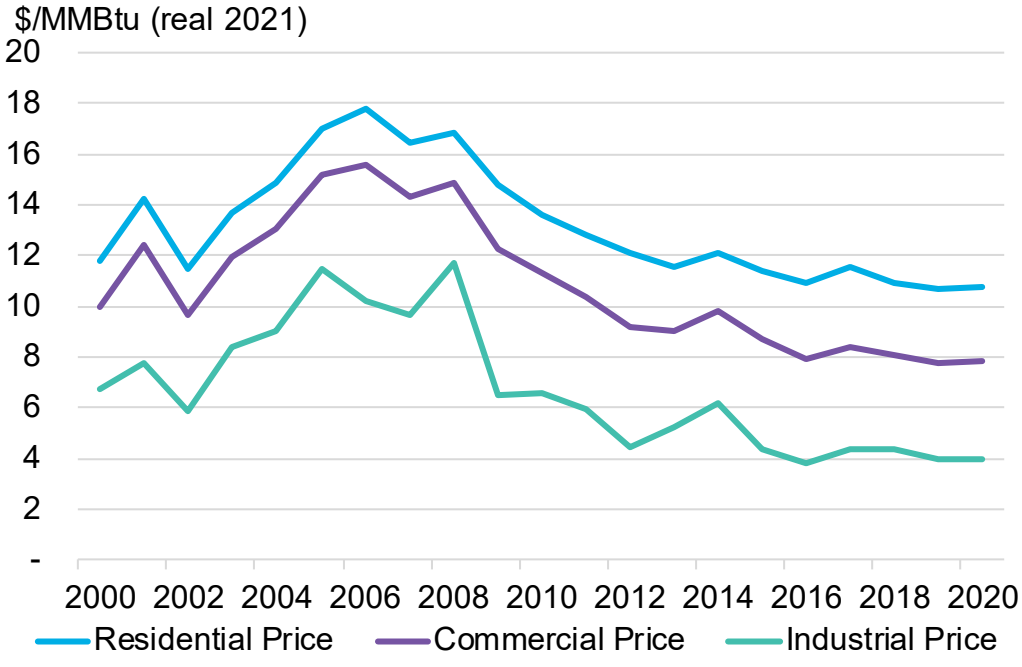
Deployment: U.S. natural gas pricing, wholesale and by end use

Natural gas spot prices



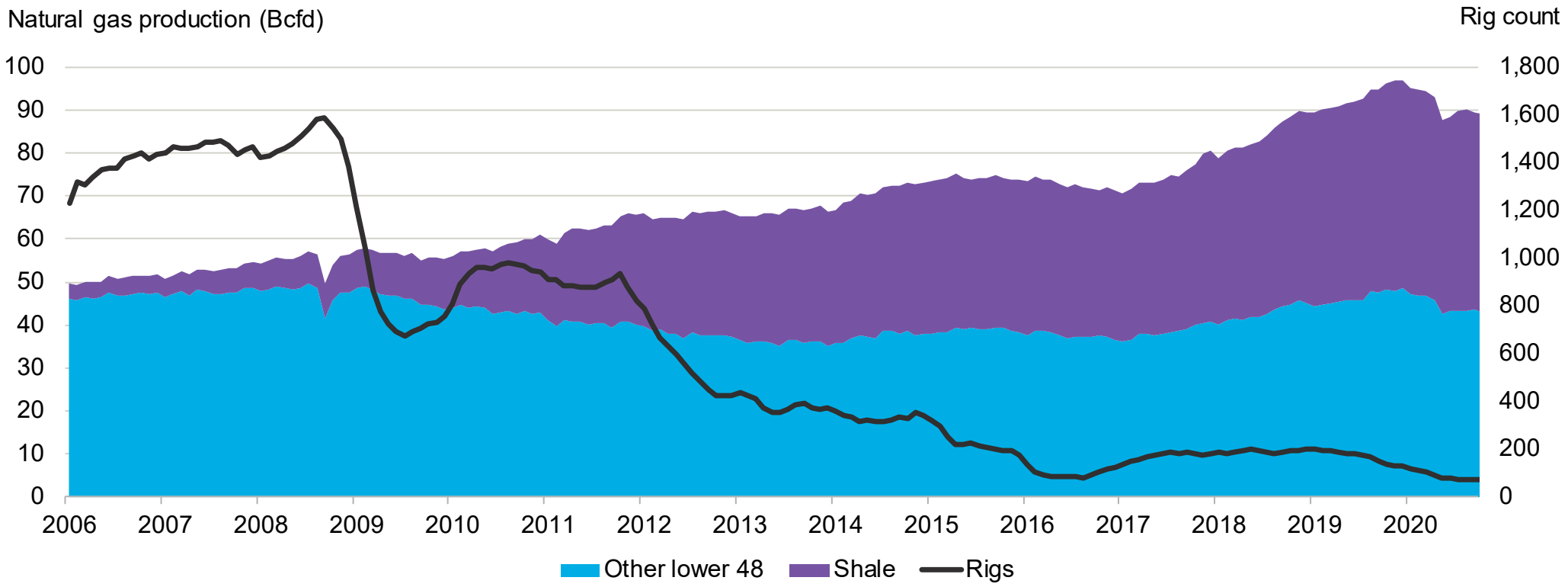
Natural gas prices to end users



- U.S. natural gas prices fell in 2020 due to lost demand from the Covid-19 pandemic. Year-over-year wholesale prices declined 22%.
- Natural gas prices rose just under 1% for residential consumers in 2020. Since 2010, all three segments saw steep declines: residential (-21%), commercial (-31%), and industrial (-39%).
- Residential price adjustments tend to lag behind index prices by 6-12 months depending on utility practices.

Source: BloombergNEF, EIA; Note: Natural gas spot prices derive from Henry Hub annual spot prices. Values for 2020 commercial and industrial prices are projected based on EIA forecasts for residential prices.

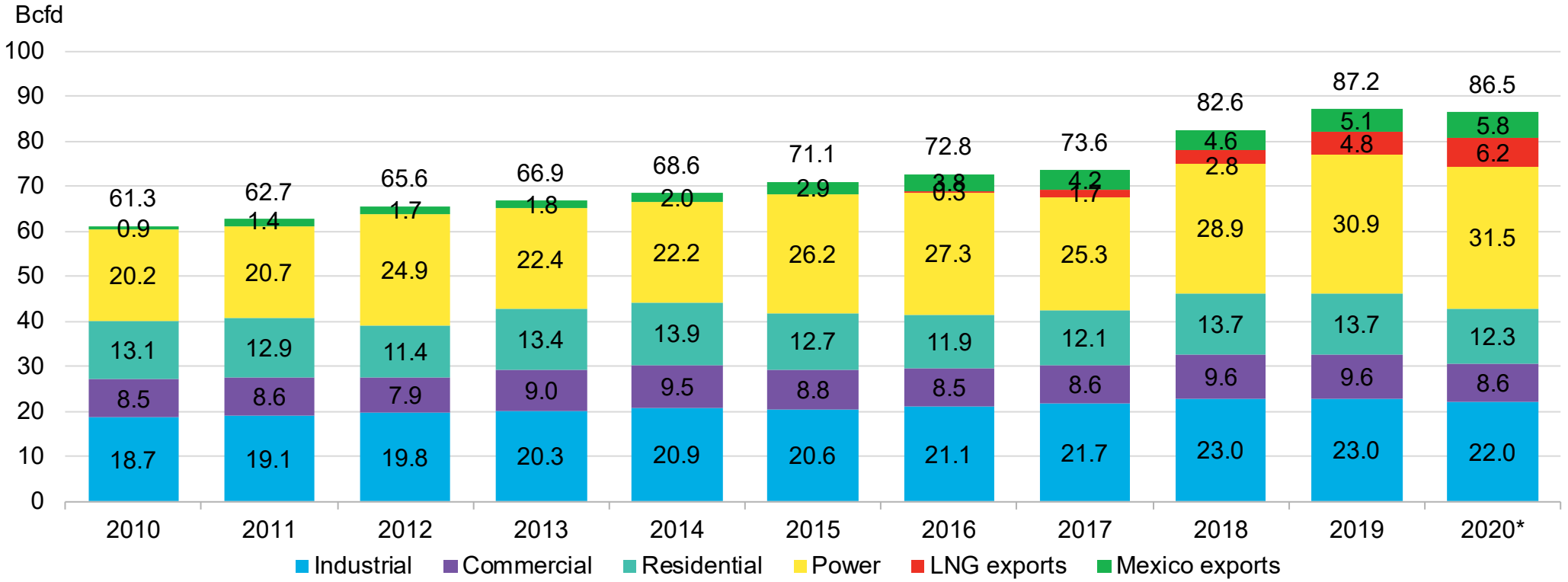
Deployment: U.S. gas-directed rig count and gas production



- Impacts from Covid-19 were felt across the production sector. Rig counts and production fell in early 2020, with companies reporting plans to drill fewer wells going forward while focusing on paying down debt and cleaning up their balance sheets.
- After averaging growth of close to 12% for 2018 and 2019, year over year growth rates in 2020 came in at 1.6%.
- From the end of 2010 through 2020, average monthly production rose from 57Bcfd to 92Bcfd – a 61% jump.

Source: Bloomberg Terminal, EIA, Baker Hughes Note: Data are through October 2020

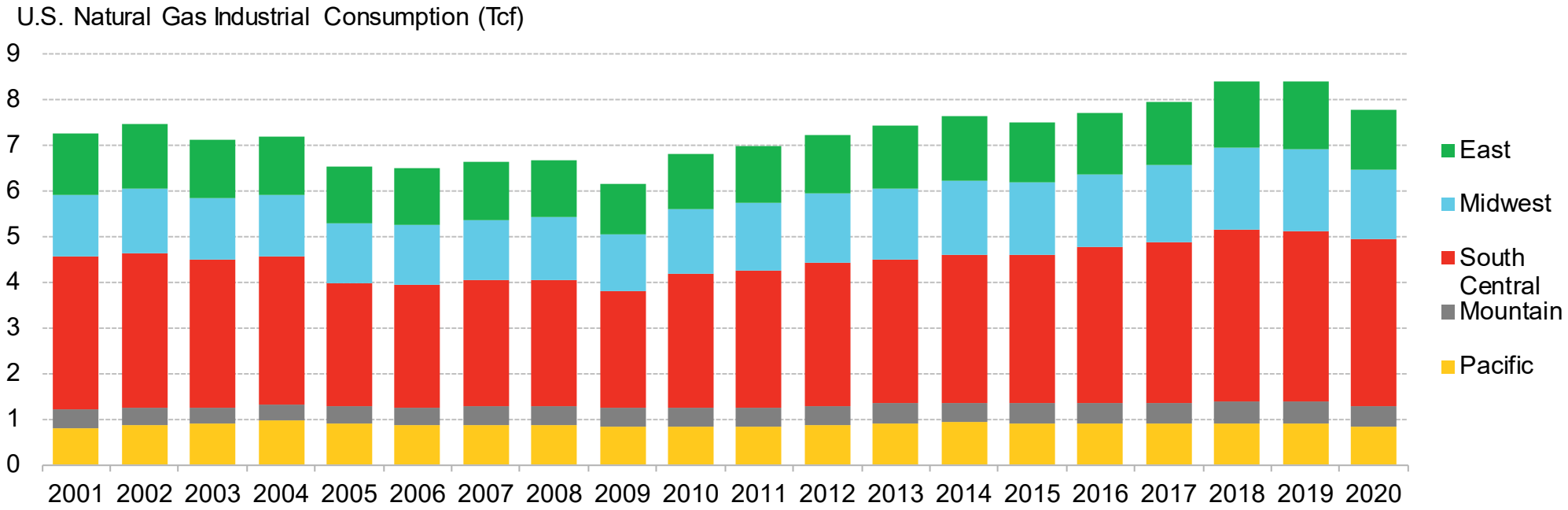
Deployment: U.S. natural gas demand by end use



- After a decade of growth, total demand for U.S. gas decreased for the first time since 2009 due to the Covid-19 pandemic.
- While overall load fell, gas demand for power generation grew by 0.6Bcfd due to lower year-on-year gas prices and continued coal-fired power plant retirements.
- LNG exports also grew significantly due to new liquefaction capacity coming online via multiple export facility projects.
- Industrial, residential and commercial heating demand decreased 4.2%, 10.5%, and 10.2%, respectively.

Source: BloombergNEF, EIA. Note: Values for 2020 are projected, accounting for seasonality and impacts of covid-19; data based on the latest monthly values from EIA (available through October 2020) and reported pipeline deliveries.

Deployment: Industrial gas demand by region

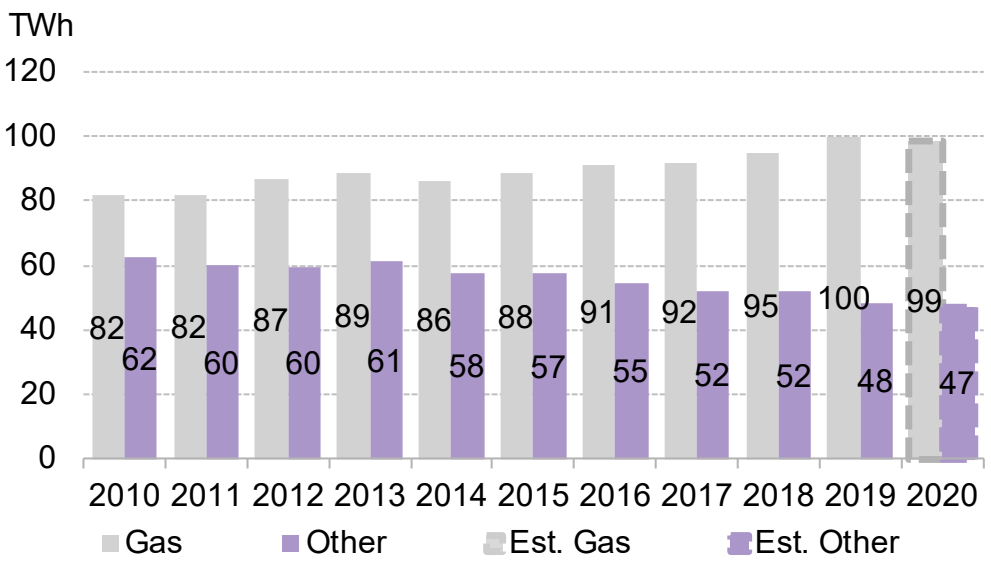


- Industrial gas consumption slipped 7.5% in 2020 from the year prior. Consumption decreased in all regions, but by varying amounts: the East was down 14%; the Midwest by 14%; South Central by 2%; the Mountain region by 6%; and the Pacific by 9.5%. In the decade prior to 2020, however, overall U.S. gas industrial consumption has jumped 32%, spurred by lower prices. The majority of industrial consumption continues to come from facilities in the South Central region.
- Industrial sector gas consumption totaled 7.8Tcf in 2020, of which 1.3Tcf was consumed in the East, 1.5Tcf in the Midwest, 3.7Tcf in South Central, 0.5Tcf in the Mountain region, and 0.8Tcf in the Pacific.
- There has been a long-term gradual slide in gas consumption from the Pacific region. Demand peaked there in 2014 at 0.92Tcf and has declined nearly every year since.

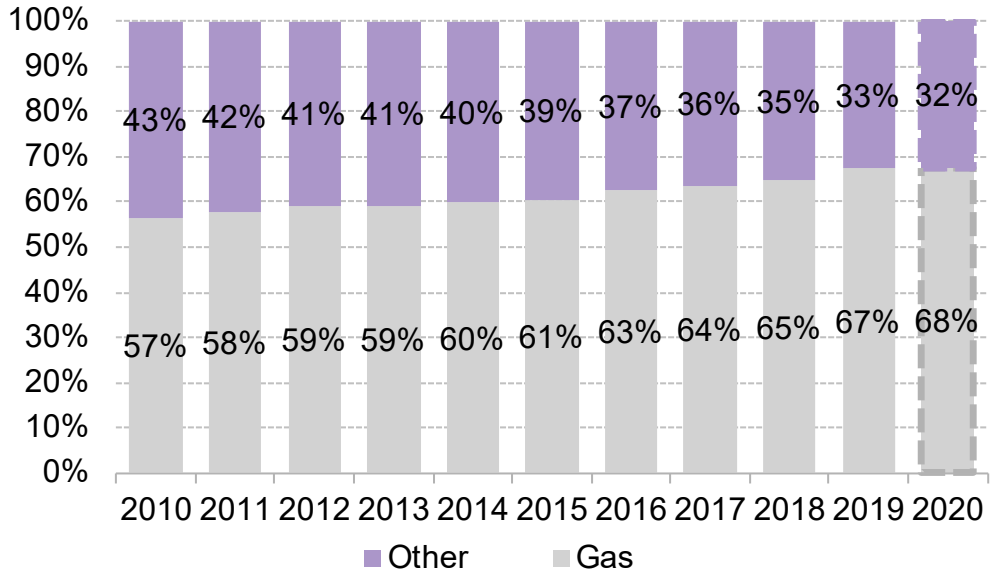
Source: BloombergNEF, EIA; Note: Values for 2020 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2020). 2017 industrial consumption numbers were used as proxies for missing monthly values for a number of states.

Deployment: Industrial on-site power generation, by type of fuel

Industrial, on-site power generation, TWh



Industrial, on-site power generation, % total

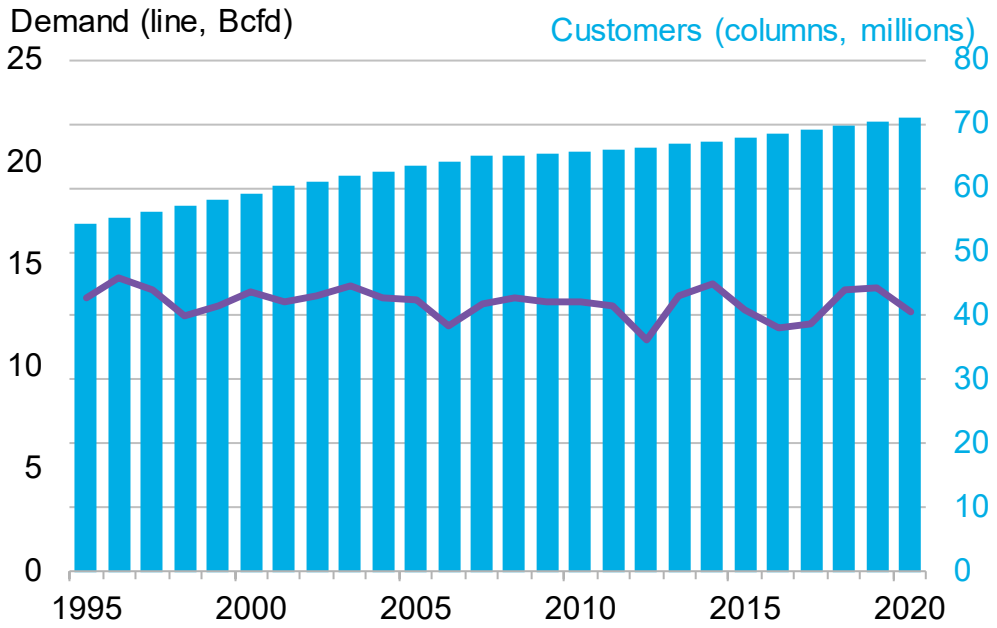


- Total industrial sector energy consumption had risen 24% in the decade before 2020. In 2019, it accounted for 23% of total U.S. primary energy demand. The sector's total emissions of greenhouse gases rose at a slower, 14% pace over the same period. The industrial sector also accounted for 23% of total U.S. GHG emissions in 2019. However, 2020 was an anomaly: the sector's consumption fell by 5.8% last year.
- Industrial sector, on-site power generation is when electricity is produced at an industrial plant's premises rather than coming from the grid. From 2019 to 2020, on-site industrial power generation fell 2%. Before 2020, it was up 12% since the start of the decade.
- In 2020, natural gas was responsible for an estimated 99TWh of on-site generation at industrial facilities. Other sources provided an additional 47TWh. In total, industrial on-site generation decreased 3TWh over 2019 levels. Prior to 2020, the percent of on-site generation provided by natural gas had increased in the last decade, from 57% in 2009 to 66% 2019, as natural gas displaced other, more expensive fuels, namely coal. This shrunk the size of an otherwise more carbon-intensive, coal-dominated fuel mix.

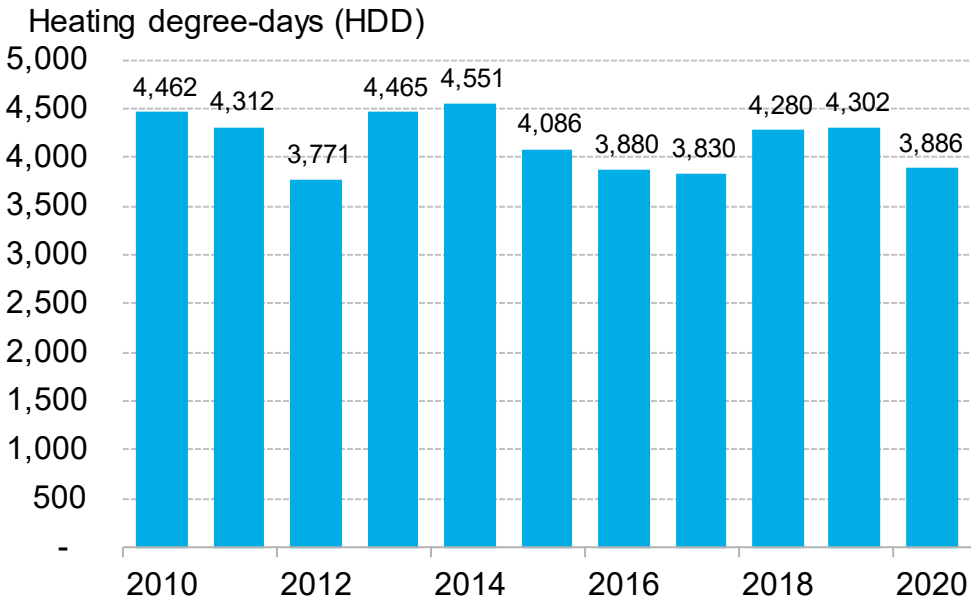
Source: BloombergNEF, EIA; Note: Values for 2020 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2020)

Deployment: U.S. natural gas residential customers vs. consumption

Residential demand vs. consumption



Heating degree-days

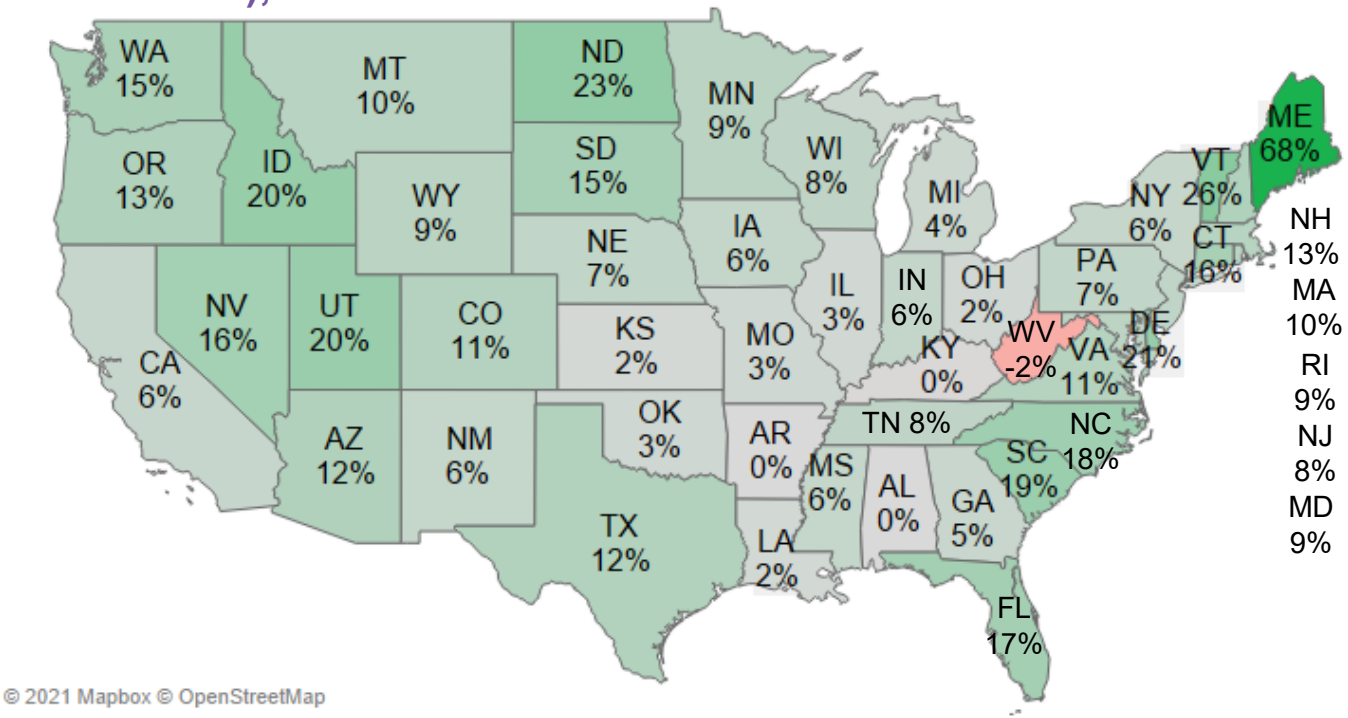


- Residential natural gas consumption decreased by 8% in 2020 even as the number of customers grew by 1%. Prior to 2020, the customer base for residential gas has expanded by 5 million, or 8%, in the last decade – and by 12.1 million, or 21%, over the past 20 years. Meanwhile, residential consumption remained largely flat over the same time, rising 7% in 10 years, but only 8% in 20 years, due to efficiency gains in the use of gas.
- Residential gas consumption is volatile year-to-year as it's driven by weather patterns. Consumption dropped during the abnormally mild winter of 2012, which saw a 13% fall in the number of heating degree days from the previous winter. It then jumped during the polar vortices of 2013 and 2014. 2020 was another mild winter (after an atypically cold 2018 and 2019), driving the 8% decrease in consumption.

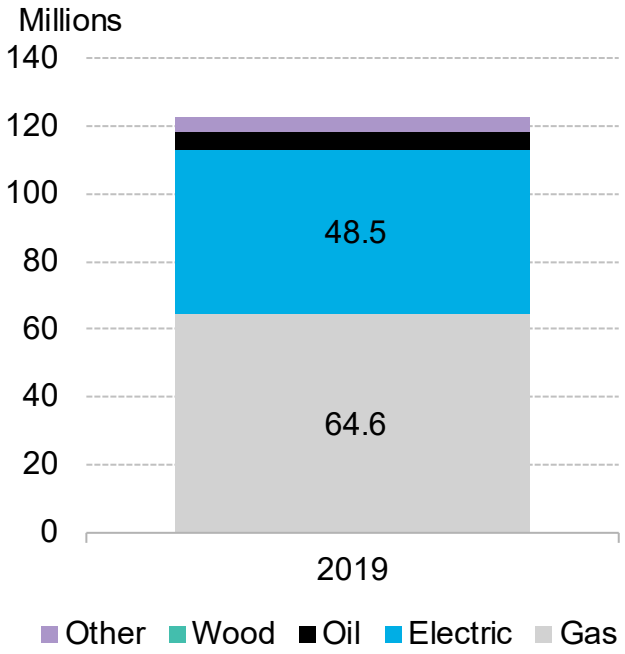
Source: BloombergNEF, EIA Notes: Values for 2020 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2020). Heating degree-day data are available through September 2020.

Deployment: Heating demand for natural gas

Percent change in total end use customers (residential, commercial, and industrial), 2009-2019



Primary heating source by household

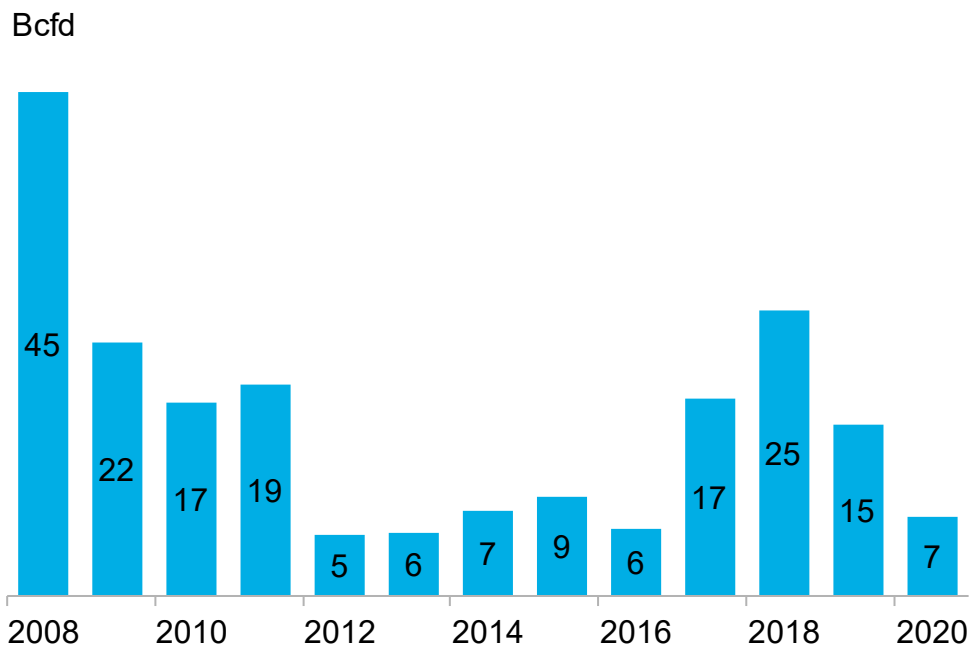


- Natural gas is the largest heating source in the residential sector, with 58.7 million homes heated by utility natural gas. That is equivalent to 48% of U.S. households. The second largest heating source, electricity, accounts for 39% of households.
- In absolute terms nationwide, the total number of end users burning natural gas for heating has risen by 7.4% since 2009. However, usage changes vary substantially by region. For example, usage grew swiftly in the New England states as the share of consumers displacing more costly fuels rose by double digits.
- An additional 5.8 million households rely on propane to meet their primary space heating needs. In 2020, propane companies also provided space heating to pop-up Covid-19 testing and evaluation sites around the country.

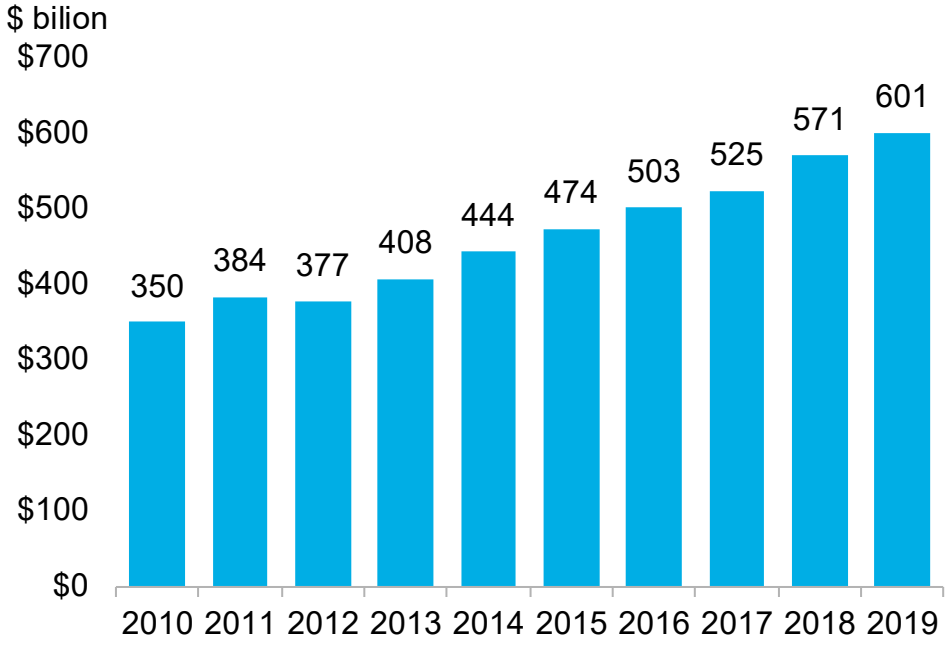
Source: BloombergNEF, US Census Bureau

Deployment: U.S. midstream gas infrastructure capacity and investment

U.S. transmission pipeline capacity additions



U.S. gas transmission and distribution rate base (gas utility plant)

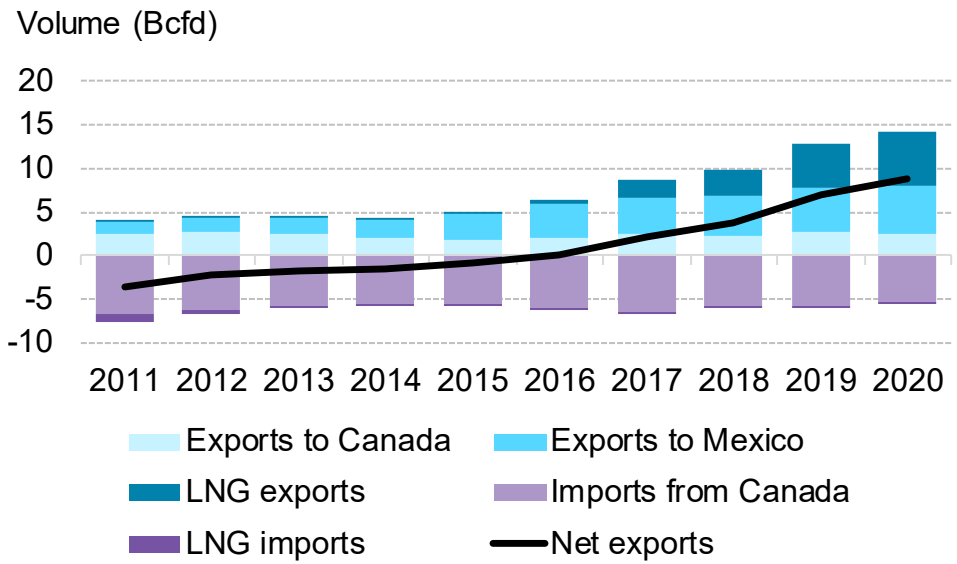


- Growth in the lower 48 states pipeline network slowed considerably in 2020 with the lowest level of capacity additions since 2016. Only two projects completed were new pipelines (as opposed to conversions, expansions, laterals, or upgrades) for combined capacity of less than 1 Bcfd.
- Natural gas infrastructure investment grew in 2019, hitting $601 billion. The vast majority of this investment was spent on the natural gas transmission and distribution systems, accounting for 47% and 43% of the spending, respectively.

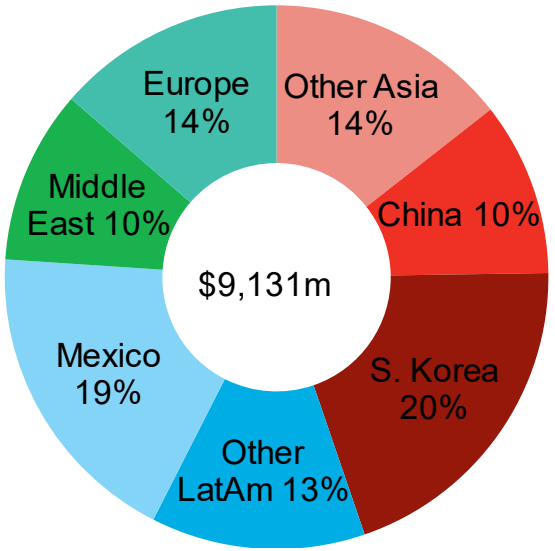
Source: BloombergNEF, American Gas Association, EIA Notes: EIA data include both first-mile takeaway capacity and pipeline additions that do not impact takeaway capacity. 2019 transmission capacity is a BloombergNEF estimate.

Deployment: U.S. natural gas exports and imports

Volume of LNG exports, 2011 – Oct 2020



Value of select LNG exports, 2016 – Oct 2019

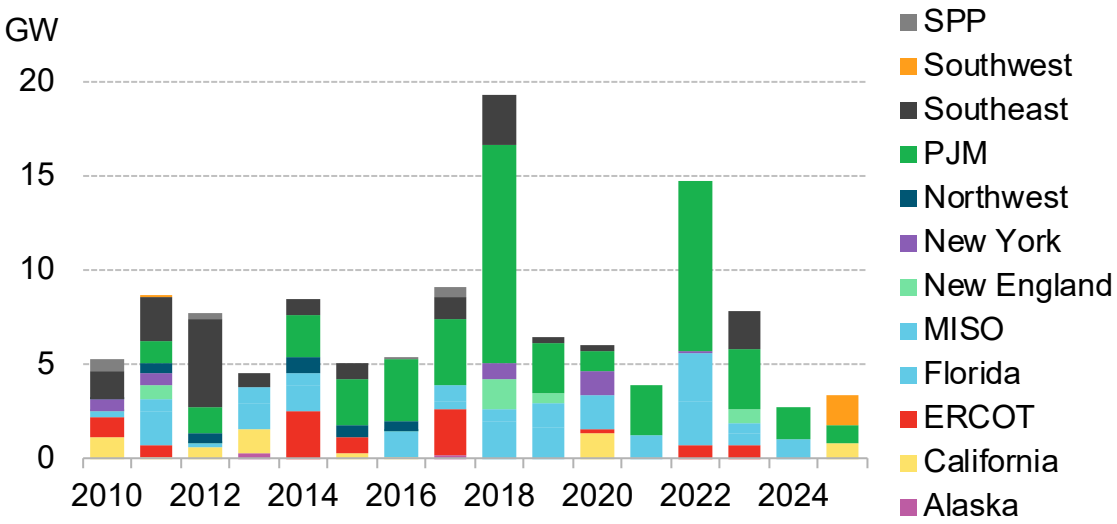


- Both pipeline and liquefied natural gas capacity additions contributed to increased gas exports in 2020.
- LNG exports grew by an annual average 1.2Bcfd thanks to the commissioning of the Cameron and Freeport LNG terminals (train 3 each), the entirety of the Elba Island facility (10 units) as well as the start-up of train 3 at the Corpus Christi terminal in South Texas.
- Gas exports to Mexico also grew in 2020 as a number of gas infrastructure projects were completed both on the U.S.-Mexico border as well as within Mexico. These include: Sierrita lateral expansion, Villa de Reyes-Aguascalientes-Guadalajara pipeline, Guadalajara pipeline reversal, Cempoala phase II compressor reversal and the Samalayuca-Sasable pipeline.
- As of 2019, South Korea was the single largest destination of U.S. LNG exports by value, representing 20% or $1.83bn of revenues. This contributed to Asia being by far the largest regional market for U.S. LNG, making up 44% of total export value from the start of 2016 through October 2019.

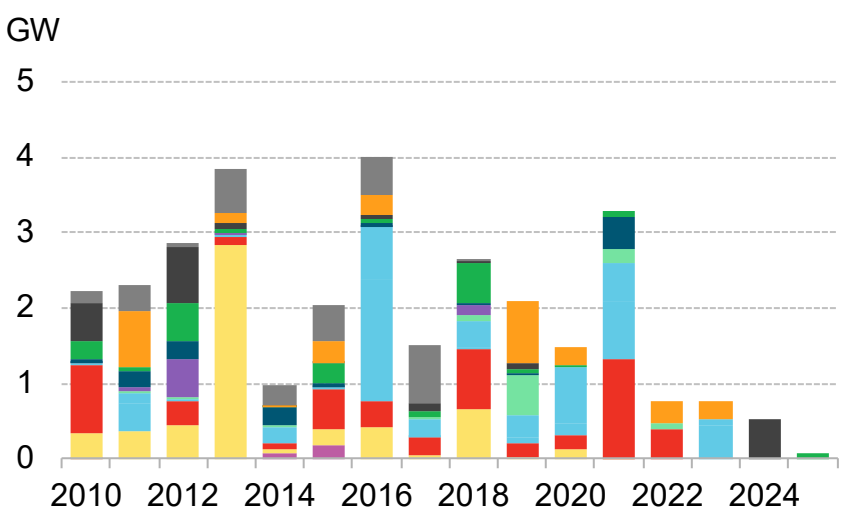
Source: Bloomberg Terminal, EIA, Department of Energy. Notes: Data through October 2019; dollar values represent the price at export point, times the value exported.

Deployment: U.S. combined and open cycle gas power plant build

Combined cycle build, historical and filed future



Open cycle build, historical and filed future



- There are two primary types of natural gas power plants in the U.S.: combined cycle gas turbines (CCGTs) and open cycle gas turbines (OCGTs). CCGTs tend to be larger and run as “baseload” power plants used to meet power demand in the majority of – if not all – hours of the day. OCGTs are smaller and more nimble, operating as “peaking” systems during high demand hours.
- Natural gas-fired power plant build accounted for 35% of total power plant build over the last 10 years. CCGT build boomed in the late 2010s with the shale revolution depressing gas prices in PJM. In the U.S., power is the primary source of natural gas demand elasticity. When the price of natural gas falls below that of coal, gas burn rises until the price differential (in $/MWh) between the two fuels closes.
- Despite mandated and announced ambitions on both the state and federal levels to decarbonize the power sector, the numbers of natural gas-fired power plants filed with the EIA to come online in the next five years totals 38GW: 33GW of CCGTs and 5GW of OCGTs. Considering historical trends, not all of these plants will come online and it is likely that many will be canceled and remove their filings before turning on.
- PJM remains the most popular region for gas build, totaling 46% of the total, filed natural gas 2021-2025 build. The region continues to have ample, stable fuel for power plants that are filed to be built among an aging coal plant fleet across the region, including in Appalachia.

Source: BNEF

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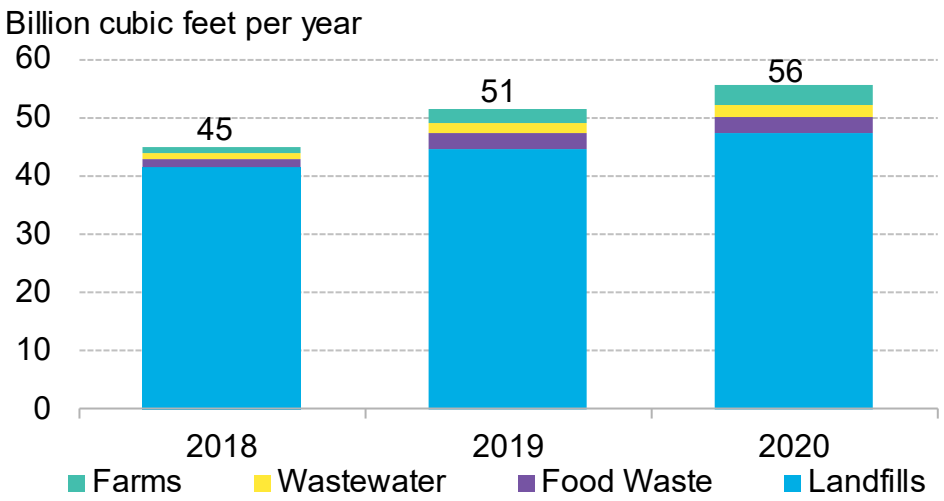
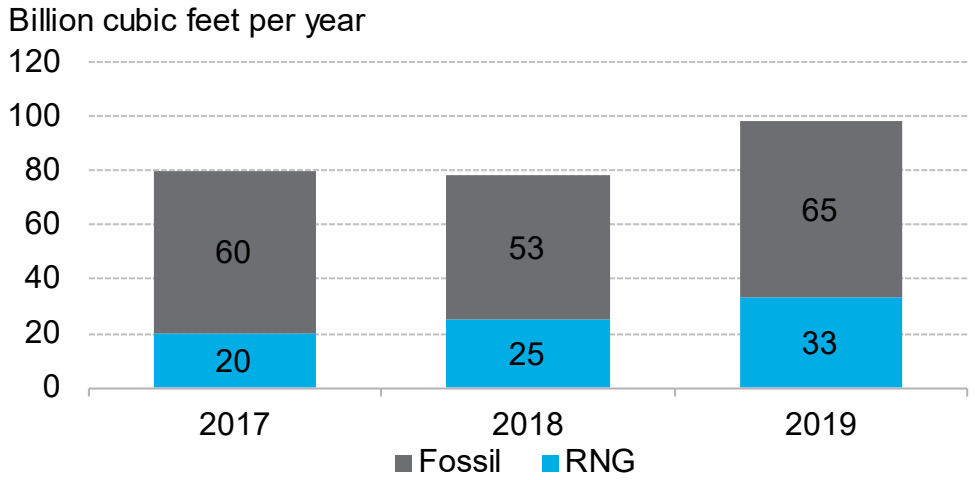
Renewable natural gas (RNG) deployment: production and use in transportation

RNG production capacity, by source



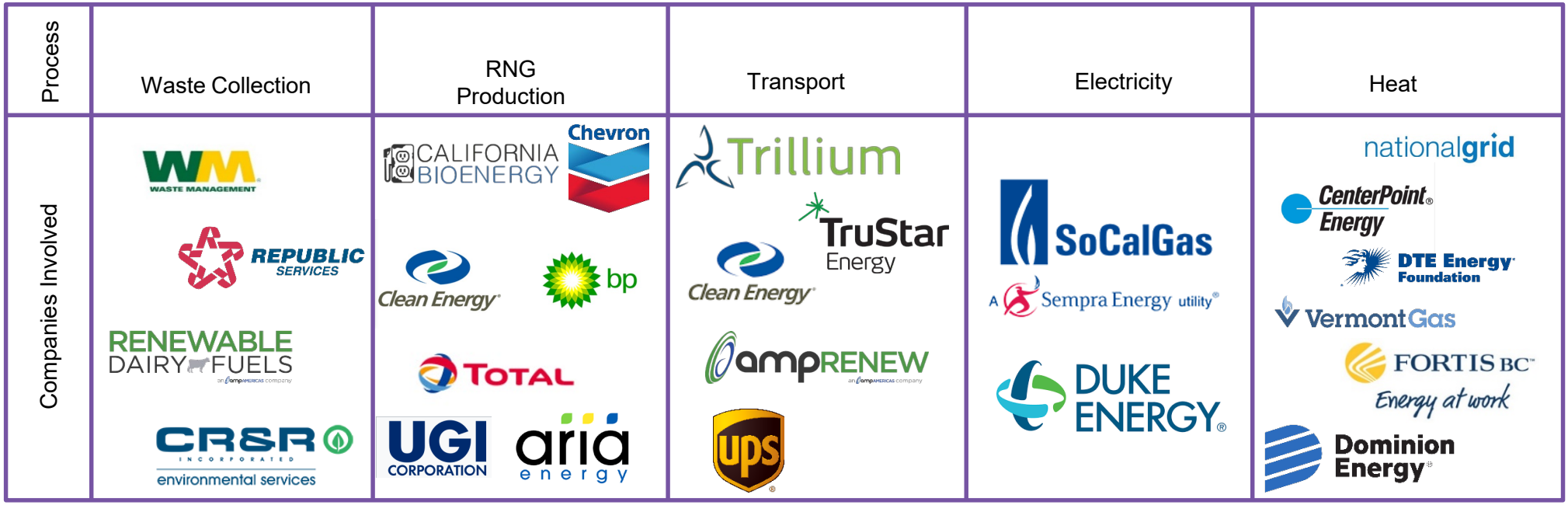
U.S. natural gas vehicle fuel consumption



- The vast majority of U.S. RNG is produced through biological decomposition of waste in landfills. In 2017, RNG met 25% of natural gas demand from the transportation sector, according to the EPA and EIA. In 2019 (the last year for which complete data exists), that rose to 34%.
- Estimated RNG production capacity grew 14% year on year in 2019. In 2020, RNG growth slowed to 8% compared to 2019 levels. This decrease in RNG expansion is likely due to project delays driven by the Covid-19 pandemic and regulatory uncertainty around the renewable volume obligation set by the EPA.
- The price of D3 renewable identification numbers (RINs) the federal incentive that supports RNG production as a renewable fuel pathway, started the year at all time lows of $0.80 and finished the year at $2.07, up 159% from January 2020.
- As of December 31, 2020, action to promote the use of RNG for thermal heating purposes in the residential or commercial sector had taken place in 26 states, according to the AGA RNG tracker.
- There were also an estimated 5.24 million gallons, 5.9 million gallons, 7.14 million gallons and 7.55 million gallons of U.S. renewable propane production in 2017, 2018 and 2019, respectively.

Source: The Coalition For Renewable Natural Gas, Argonne National Laboratory (As of December 2020), RNG: EPA – Moderated Transaction System, Fossil – EIA AEO

The RNG value chain



- Traditionally, biogas (the feedstock for RNG) was used for electric generation onsite or sold into the power market. However, thanks to supportive policies and industry growth, energy incumbents from the oil & gas and utility sectors are developing strategic partnerships and investment opportunities to convert biogas into pipeline compatible natural gas with a much lower carbon footprint than geologic natural gas.
- Investor-owned utilities that have made net-zero carbon emissions targets by 2050 are investing in RNG projects to achieve those goals. For example, Dominion Energy and Smithfield Foods have formed a partnership to invest up to $500 million over the next 10 years.
- Oil and gas companies with decades of experience in production and transportation of energy products see RNG as an extension of their core business and an opportunity to make clean energy investments. Total and BP committed to invest a combined $100 million in partnership with the natural fueling company, Clean Energy Fuels, to develop new RNG production facilities. UGI Corporation, a gas and electric distribution company purchased GHI Energy, a Houston-based RNG marketing company.
- More gas utilities are making carbon emissions reduction goals and are leveraging the low carbon intensity of renewable natural gas as a pathway to achieve these net zero goals.

Source: BloombergNEF

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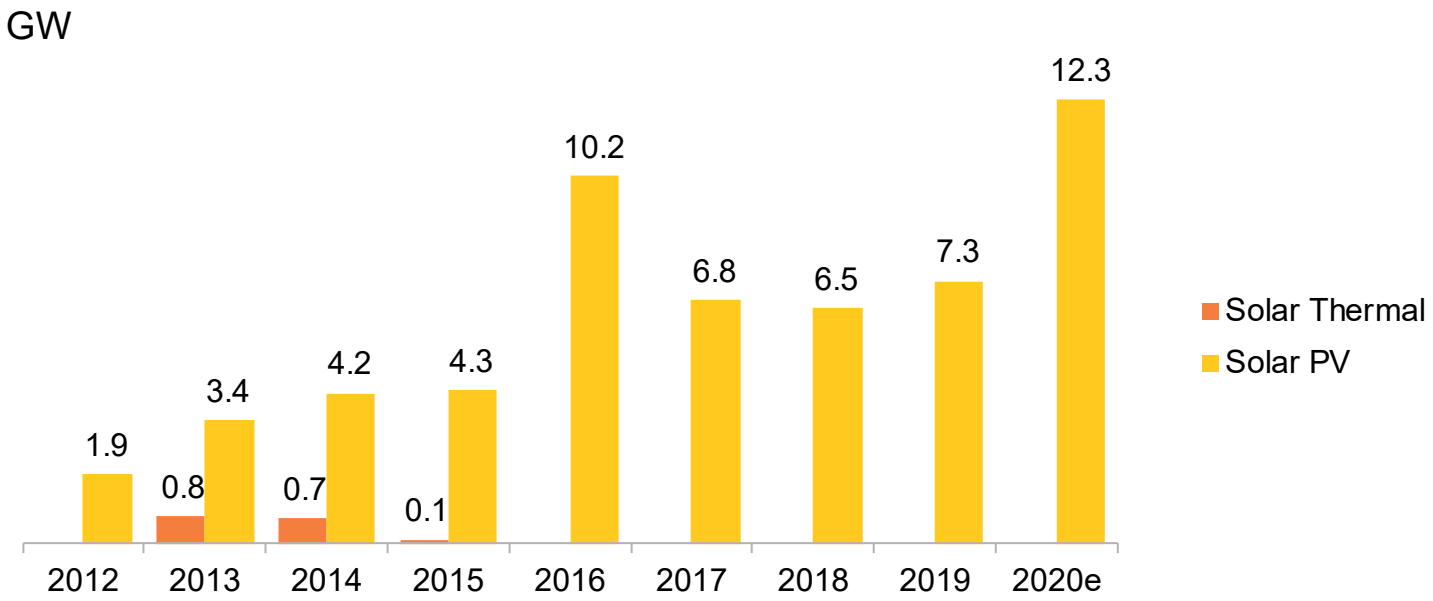
Deployment: U.S. large-scale solar build

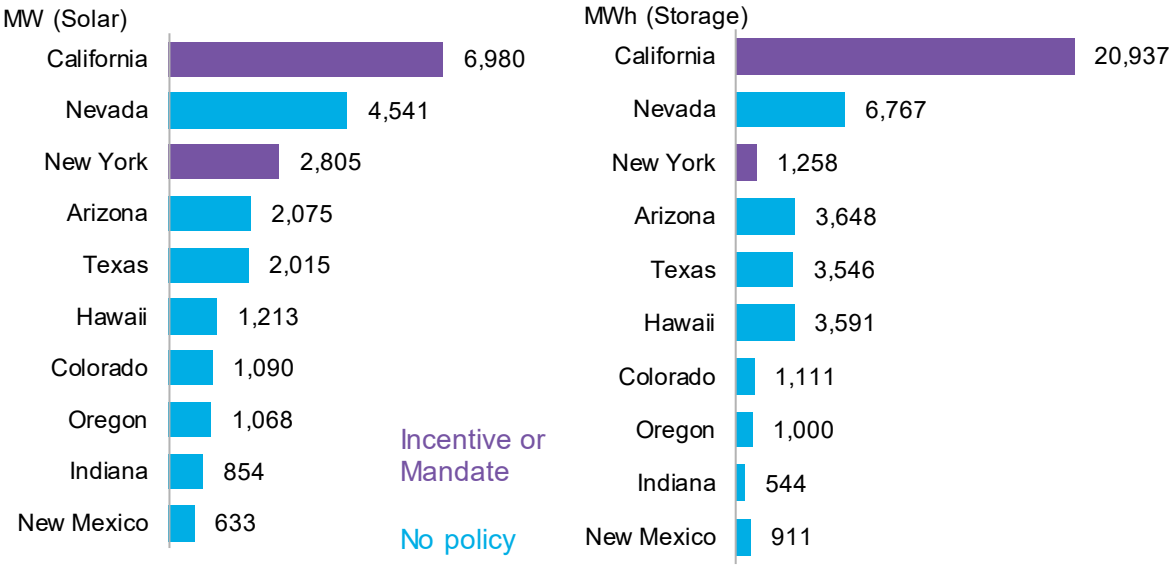


- Utility-scale installations rose to 12.3GWdc in 2020. This brought capacity additions to their highest level ever, beating the former peak of 10.2GWdc in 2016. Solar thermal build remained non-existent. The pandemic had little to no impact on construction activity but stifled the availability of tax equity for solar PV. As economic activity slowed, the amount of taxes owed to the government slowed as well, and major tax equity providers had limited clarity on their tax appetite over the duration of the year.
- However, projects that had secured their finances in advance were not affected. Commissioning activity ramped up in response to the anticipated phase-out of the tax credits. Projects that began construction by 2019 had until 2023 to commission, and safely retain their credits. As part of end-of-year legislation passed to stimulate the economy, tax credits for solar projects were extended for two more years at the 26% level. Projects that commence construction in 2021-22 can secure 26% of the project's costs as a credit.
- Tariffs on bifacial panels were alternately removed and re-applied, leading some developers to procure large volumes of bifacial panels during the periods when they were not subject to tariffs. The tariffs on imported solar panels are expected to end in February 2022.

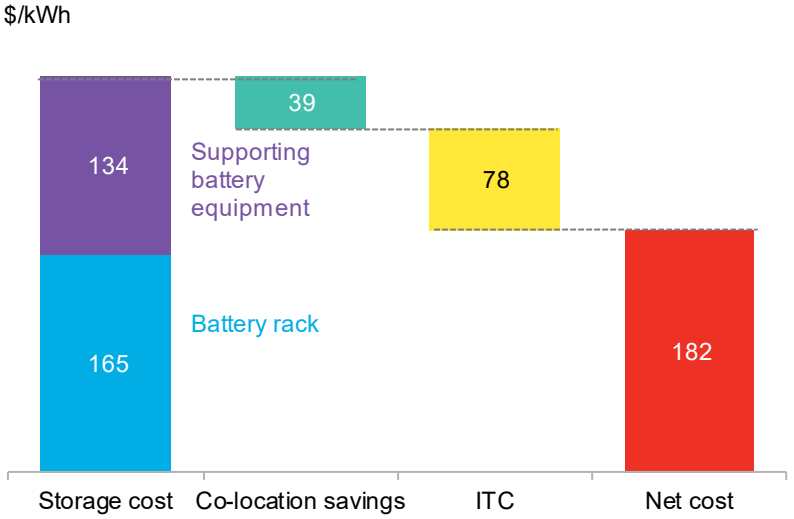
Source: BloombergNEF. Note: All solar capacity in the Factbook portrayed in GWdc.

Deployment: Solar + storage

Co-located solar and storage projects announced and commissioned, by state



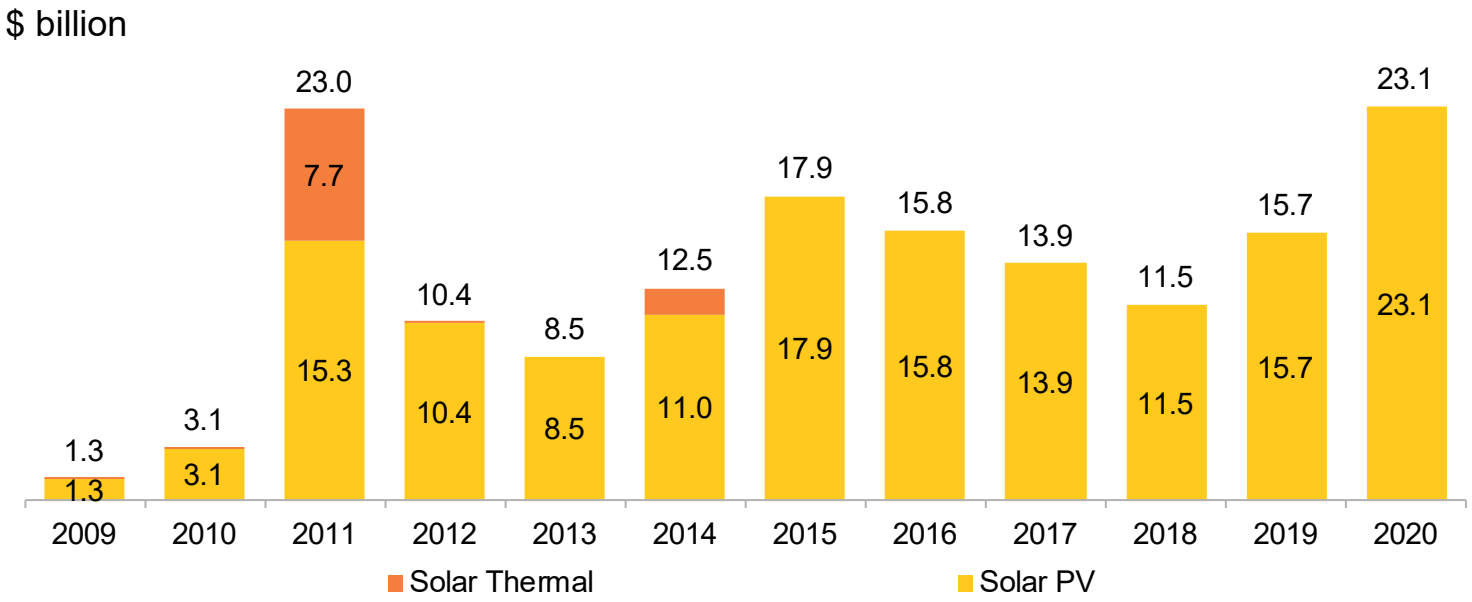
Cost advantage to co-locating storage with solar



- Co-located solar and storage project pipelines have grown year-on-year. Developers continued to plan in key regions like the Southwest and California, even as new state markets grew. Texas now has 2GW of solar co-located with storage, as storage developers look to secure the cost advantage provided by the tax credit.
- The storage capacity co-located with solar is highest in California, where 21GWh of energy shifting capacity is either commissioned or planned. California's clean energy goals require renewable energy additions, but system reliability concerns were raised over the summer, when rolling brownouts went into effect. Firming solar capacity using batteries is an inevitable step toward greater system reliability, and commissioned solar projects also announced plans to undergo storage retrofits.
- The tax credit extension at the end of 2020 allows solar projects to claim a 26% credit for projects starting in 2020-22. This applies to battery storage systems as well, and is the only form of tax credit that batteries can access in the current policy environment.

Source: BloombergNEF. Note: Storage capacity uses two metrics: MW which signifies power output (based on the inverter capacity) and the MWh which specifies the energy storage capacity and relates to the duration the input/output can be sustained for (ie, a 10MW/40MWh system can sustain 10MW for 4 hours). The ITC is the federal investment tax credit.

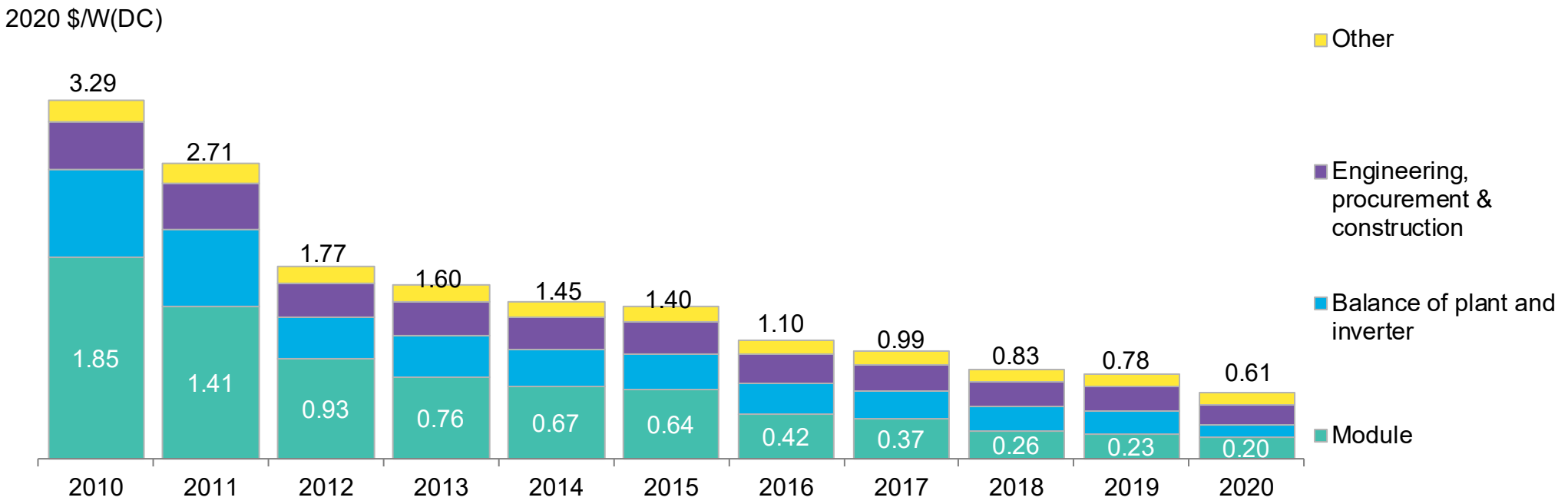
Financing: Asset finance for U.S. large-scale solar projects by technology



- Asset finance activity for new-build U.S. solar rose to the highest level of the last decade, reaching $23.1bn in 2020, from $15.7bn in 2019. This represents new investment in solar build across various forms of debt and equity.
- As assets are typically funded a year before commissioning, the investment volumes indicates record commissioning activity ahead. As technology costs fall, the same dollar value of investment supports a higher GW capacity of projects commissioned in the future.
- Acquisition activity also rose from 2019 to 2020, driving more funds into the sector. In 2020, BNEF tracked 4.3GW of commissioned capacity that changed hands, compared to 4.2GW in 2019.
- The yieldco model has not had many takers over the last few years, but IPOs in solar are gaining interest. Two tracker companies listed on the public markets in 2020: New Mexico-based Array Technologies, and Chinese firm ArcTech.

Source: BloombergNEF

Economics: Global benchmark capex for utility-scale solar PV



- Global module costs fell once again; globally, the average price for modules at the end of the year was 20c/W. In countries like China and India, utility-scale solar projects can be built for nearly 50c/W, excluding the cost of land and interconnection. Globally, the average cost of a solar project was estimated at 61c/W, an 81% decrease from 2010 and 22% decrease from last year.
- U.S. costs are higher; tariffs on modules, high demand, a preference for premium products, and various local and regulatory costs lead to capex costs averaging 96c/w for systems that use single-axis tracking.
- These cost declines have continued to manifest despite short term disruptions to the supply chain. Key components for module manufacturing, like polysilicon, glass, and silver saw prices rise in the second half of the year. The tight supply of solar materials highlighted the increasing exposure of solar manufacturing to volatility in global commodities such as silver, aluminum and ethylene vinyl acetate (EVA) resin.

Source: BloombergNEF Note: 'Other' refers to developer fees, land acquisition fees, finance arrangement, contingency and other miscellaneous costs. Does not include tariff costs.

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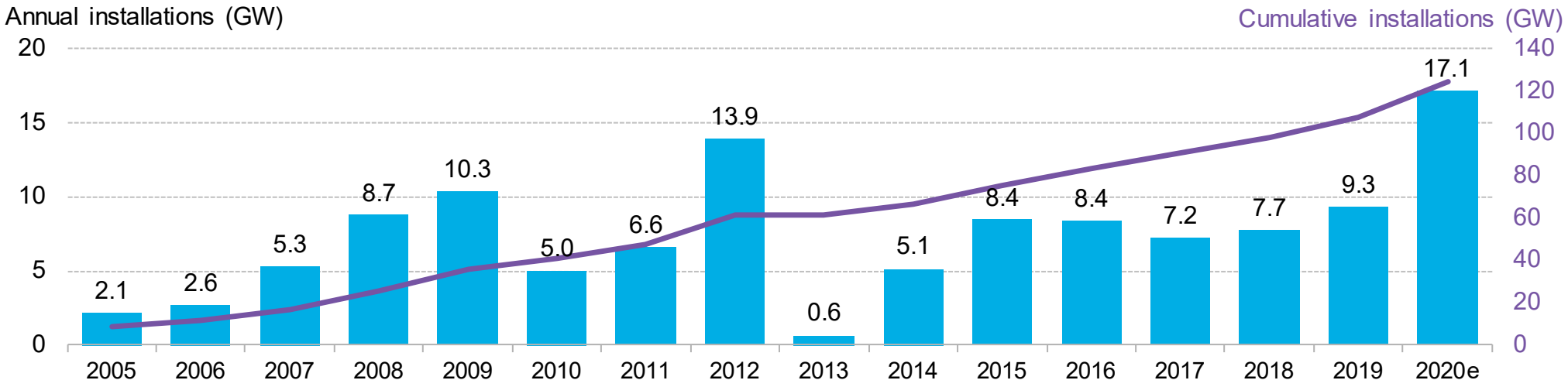
Deployment: U.S. large-scale wind build

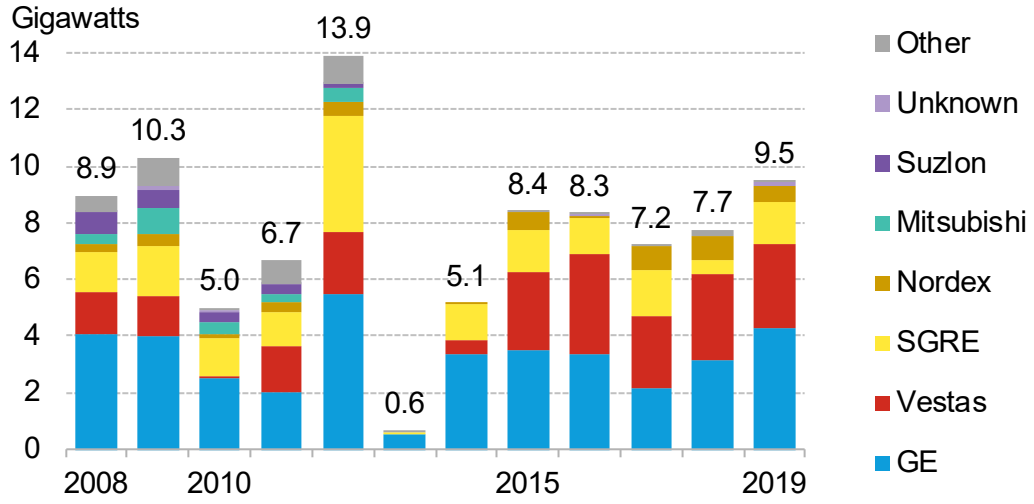


- The U.S. onshore wind sector posted its highest-ever year of installations in 2020, topping 17GW. The sector has shown remarkable resilience in the face of the pandemic. While some major developers reported construction delays, many projects still made up for lost time and came online by the end of the year. Developers had fortunately started construction early, as they raced to meet a deadline for the production tax credit (PTC) by year end. After intense industry lobbying, the Internal Revenue Service also extended the commissioning deadline for projects that started construction in 2016 and 2017 from four to five years. The extension has eased pressure on the sector, which was already facing a shortage of cranes, trucks, and construction crews before the virus hit.
- On December 22, 2020, Congress extended the PTC by one additional year. The PTC is on a step-down schedule, and 2020 had been the last year projects could qualify. As a result of the action by Congress, projects that qualify in 2021 and commission by the end of 2025 will receive the credit at 60% of its original value of $25/MWh, or $15/MWh.
- Half of the new 2020 wind capacity was added in just five states: Texas, Iowa, Oklahoma, Wyoming and Illinois. This is thanks to high capacity factors in those states and relatively low build costs. Despite the economic viability in these states, transmission congestion remains pervasive across much of the interior U.S. In response, developers are diversifying, particularly into new states with renewables targets in the Northwest and Southwest.

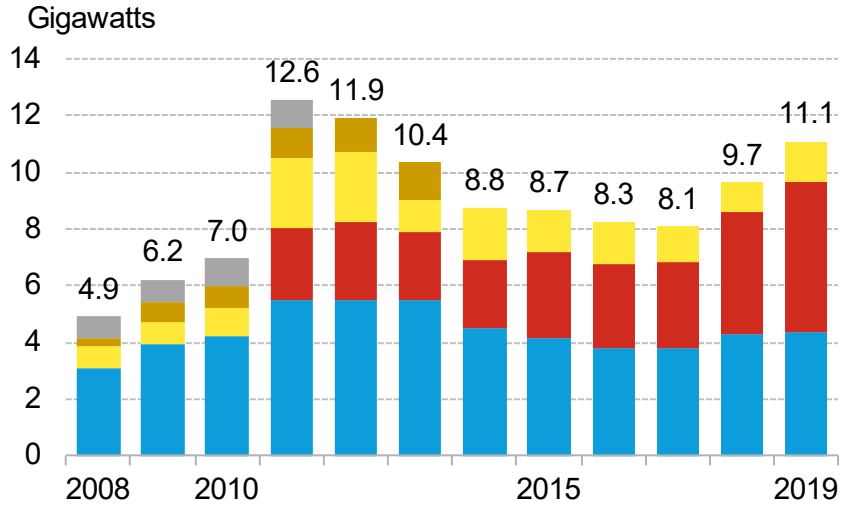
Source: BloombergNEF. Notes: Includes all utility-scale wind development, excluding partially commissioned projects and including distributed turbines that are above 1MW (BloombergNEF threshold for utility-scale). These values are BNEF's view as of December 17, 2020.

Deployment: U.S. wind turbine production and contracting

U.S. wind turbine supply contracts for projects by commissioning year, by manufacturer



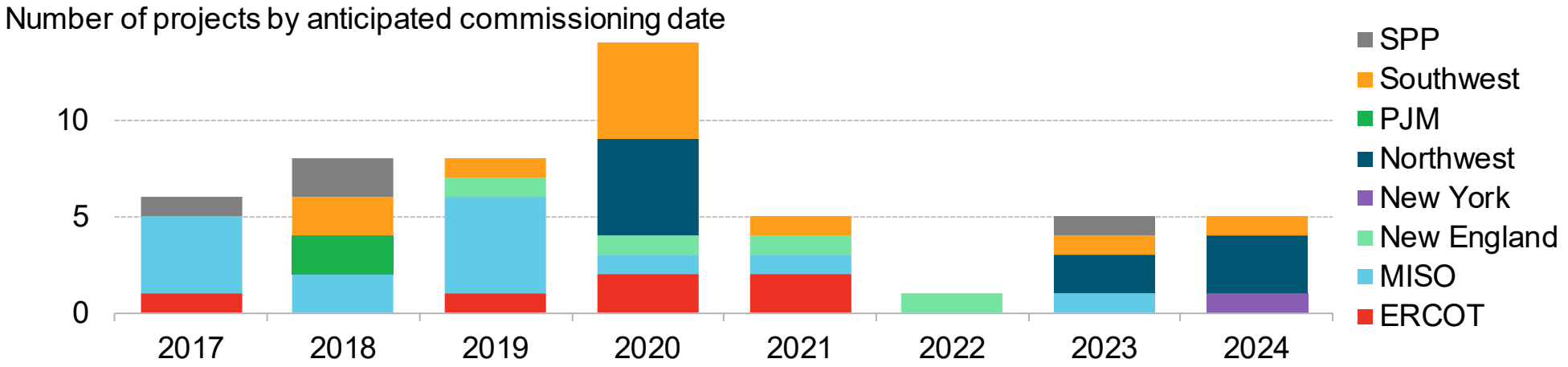
U.S. wind turbine production capacity by manufacturer



- Consolidation in the U.S. wind turbine market has continued in recent years, following global trends. The U.S. is now home to four major turbine manufacturers: General Electric (GE), Vestas, Siemens Gamesa Renewable Energy (SGRE). In the U.S., GE and Vestas accounted for 87% of local manufacturing capacity in 2019, the last year for which BNEF has complete data. Despite being Nordex's biggest market in 2019, the German turbine maker has no factories in the U.S. after closing its only facility in 2013.
- Market share of installed turbines follows a similar trend to manufacturing. In 2019, GE Renewable Energy supplied turbines for 4.3GW of the total 9.3GW commissioned, beating its nearest competitor, Vestas, who supplied 3GW of the market. Collectively, the two companies accounted for 78% of the market. Siemens Gamesa tripled its total from 2018 to install 1.5GW of turbines, while Nordex's installations fell 37% to 548MW. Goldwind, a Chinese supplier, provided turbines for just 14MW of projects in 2019, down from 200MW the year before.
- GE was the top wind turbine maker for U.S. project installations from 2003-2015, but was displaced by Vestas in 2016 and again in 2017. The U.S. has become an important market for all major turbine makers based outside of China. The top four manufacturers installed more turbines in the country than anywhere else. Historically, almost two-thirds of GE's all-time installations by capacity have been in its home market, the U.S., compared to a quarter for Vestas.

Source: BloombergNEF. Notes: Production capacity measured by nacelle assembly on U.S. soil.

Deployment: Commissioned and planned transmission lines serving wind

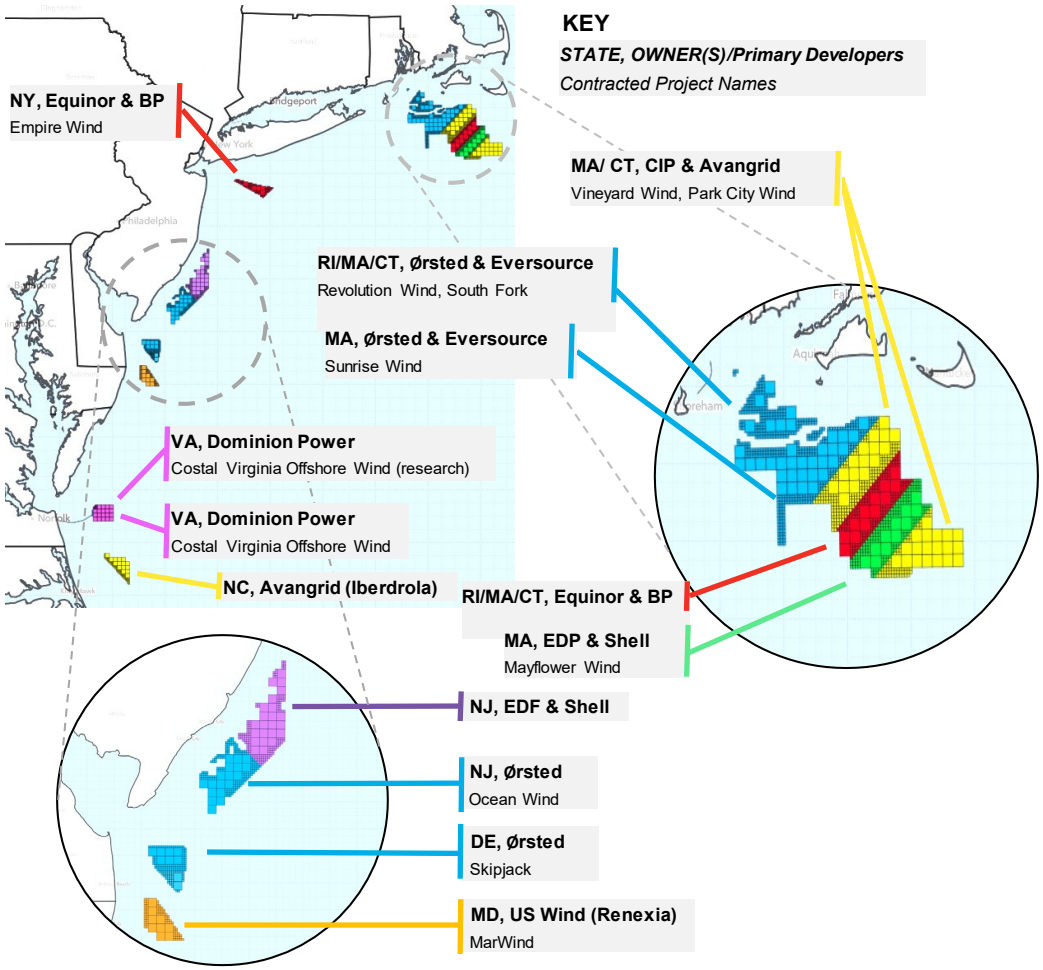


- Wind tends to be one of the first sources curtailed when transmission congestion occurs, and congestion tends to rise as more generation assets are added to the grid without accompanying transmission upgrades. New transmission can maximize the value of low-cost, emissions-free wind energy. American Clean Power Association (ACP) estimates that new transmission lines across the U.S. set for commission by 2024 could enable tens of thousands of megawatts of new wind capacity.
- From 2017-2020, MISO led the way on new transmission lines, commissioning projects serving wind across Iowa, Minnesota, Missouri, Illinois, Wisconsin, North Dakota and South Dakota. There are several projects in development in the Northwest and Southwest. Many of these aim to bring more wind energy to power-hungry California to help the state meet its renewable energy targets. Historically, U.S. curtailment rates have declined by about 80% since 2009 thanks to transmission buildouts. Time-varying influences have also played a role: In 2015, for example, the western and interior U.S. experienced below-normal wind speeds, reducing generation – and curtailment.
- There are plans for lines in several other regions in coming years, including two in Texas (ERCOT) and one in New York. Many of the proposed transmission projects have yet to begin construction, and projects may be delayed or canceled. Generally, transmission built within a specific state or region receives full approval faster than those lines that cross multiple jurisdictions. The TransWest Express, which is scheduled to come online in 2023 in the Northwest to connect Wyoming wind to customers in California, Arizona and Nevada, was first proposed in 2005. If successful, however, this project will enable more than 2GW of new wind projects to come online in Wyoming.

Source: BloombergNEF, American Clean Power (ACP) Note: two projects, Ledyard-Colby line in Iowa, and MVP 7 line through IA and MO don't yet have in service dates set and are not included. Graph includes lines with voltages 320kV-765kV, and includes both AC and HVDC.

Deployment: Offshore wind, permitting problems holding back rapid growth

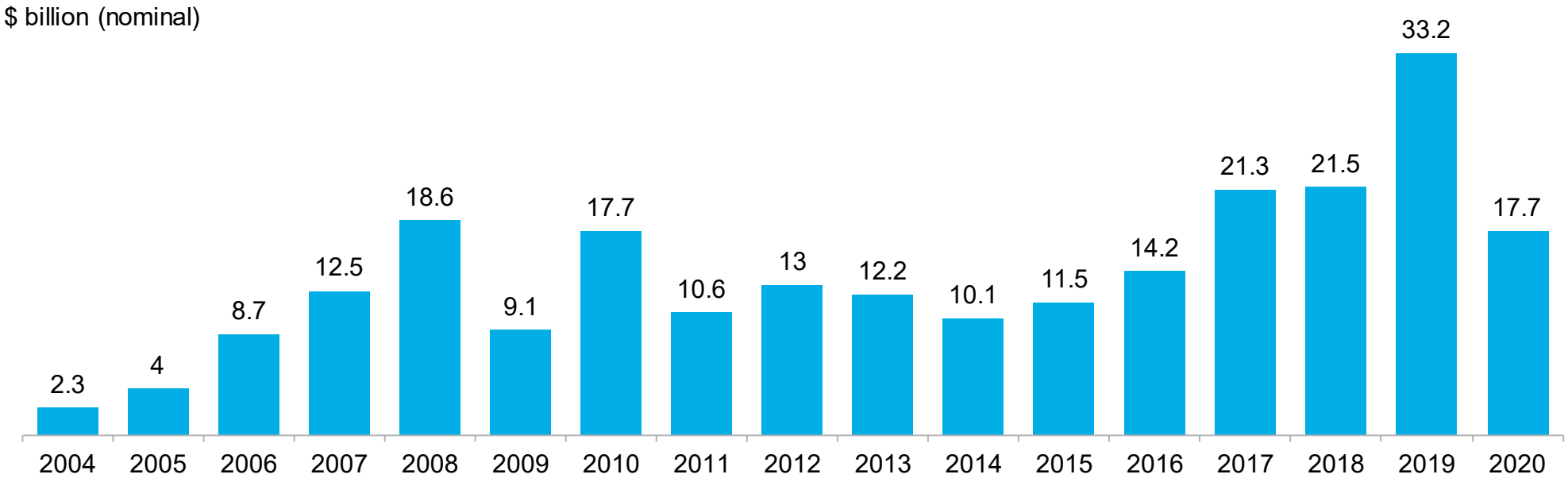
Location and owners of U.S. offshore wind leases issued by BOEM



- The U.S. offshore wind sector is poised for rapid growth but has been in limbo as as the country's first potential large-scale project awaits a federal permit. Despite the sector's great promise, there are still only 42MW of turbine installed in U.S. waters.
- At the end of 2020, Congress extended a 30% investment tax credit for offshore wind farms until 2025. The Internal Revenue Service also increased the commissioning deadline for offshore wind from four to 10 years. This means every project installed until at least at least 2030 will receive the subsidy. BNEF estimates this could cost the U.S. government a total of over $16 billion.
- Northeastern states have among them approved measures targeting 31.6GW offshore by 2035.
- Vineyard Wind, which stands to become the first large-scale project in U.S. waters, continued to experience permitting delays in 2020. The 804MW project, a joint venture between Avangrid and Copenhagen Infrastructure Partners, was originally scheduled for commissioning in 2021. After several further delays this year, the project's original preferred turbine supplier agreement expired. The project has temporarily withdrawn from federal permitting while it incorporates a new turbine model into the project design.
- Despite the industry's teething problems, states continue to hold large-scale solicitations for offshore wind power. In the final quarter of 2020, New York and New Jersey closed requests-for-proposals for up to a total almost 5GW. Results are expected in 2021.

Source: Bloomberg New Energy Finance, Bloomberg, CARTO, Mapbox, OpenStreetMap, BOEM. Notes: This map was created using MAPS <GO> on the Bloomberg Terminal. The shape file of U.S. offshore wind zones can be found on BOEMs website (link)

Financing: Asset finance for U.S. large-scale wind projects



- Some $17.7 billion worth of wind projects were financed in 2020. This is just over half of the 2019 total of $33.2 billion.
- Asset financing has tracked closely with the status of the Production Tax Credit (PTC), which has expired and been retroactively extended multiple times since 2012. The final chance to receive the full value of the PTC was for projects financed and under construction in 2016. The U.S. set a new wind installation record in 2020 as developers raced to commission these projects and qualify for the subsidy. This build rush, along with the time lag between a project securing funding and coming online, explains the large financing figure in 2019.
- Projects that qualified for the PTC in 2017 and later will receive a phased-down credit. We expect this will result in lower installations in 2021 and 2022, meaning a dip in investment in 2020. Projects that qualify for the PTC after 2021 (online after 2025) will receive no federal support.
- Bolstering asset finance over a longer time horizon is falling costs. Since 2009, global turbine prices have fallen 58% to $700,000/MW. In 2019, turbine makers reported sector-wide price stabilization on a per-turbine basis.

Source: BloombergNEF. Note: Values include estimates for undisclosed deals. The 2015 figure includes a $323m investment in an offshore wind project, the Deepwater Block Island Offshore Wind Farm.

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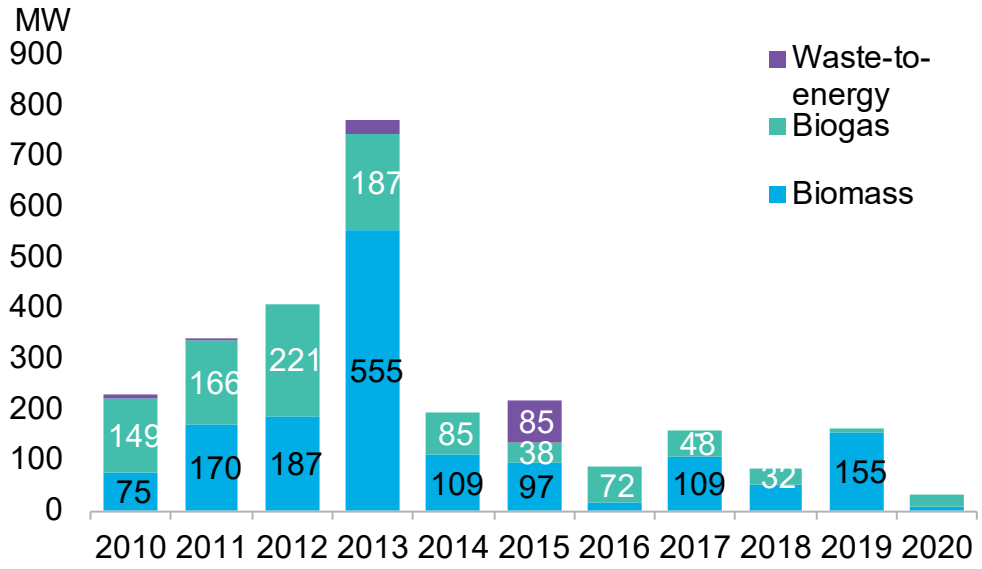
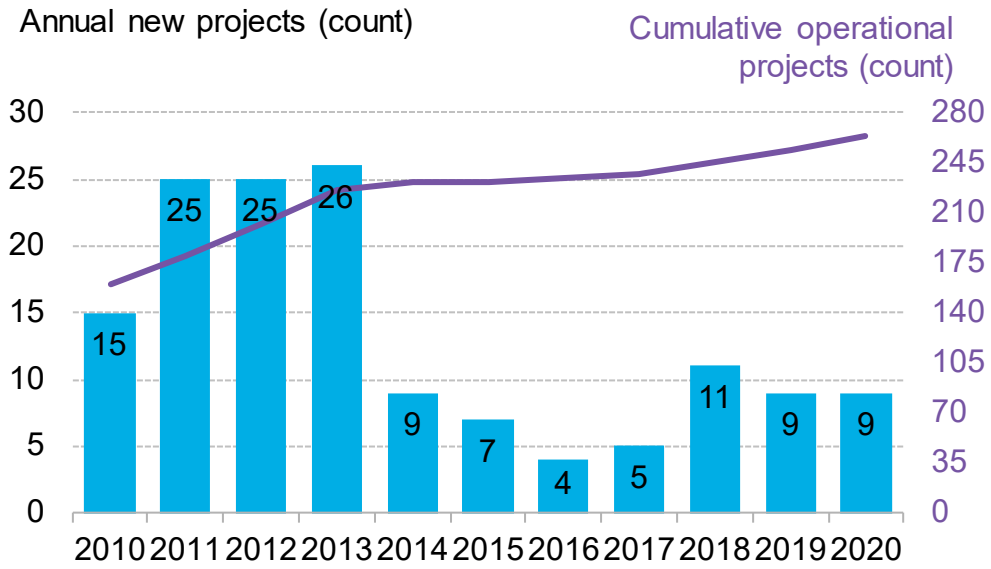
Deployment: U.S. bioenergy and anaerobic digester build

Annual build: large-scale bioenergy



Annual build: farm-based anaerobic digesters

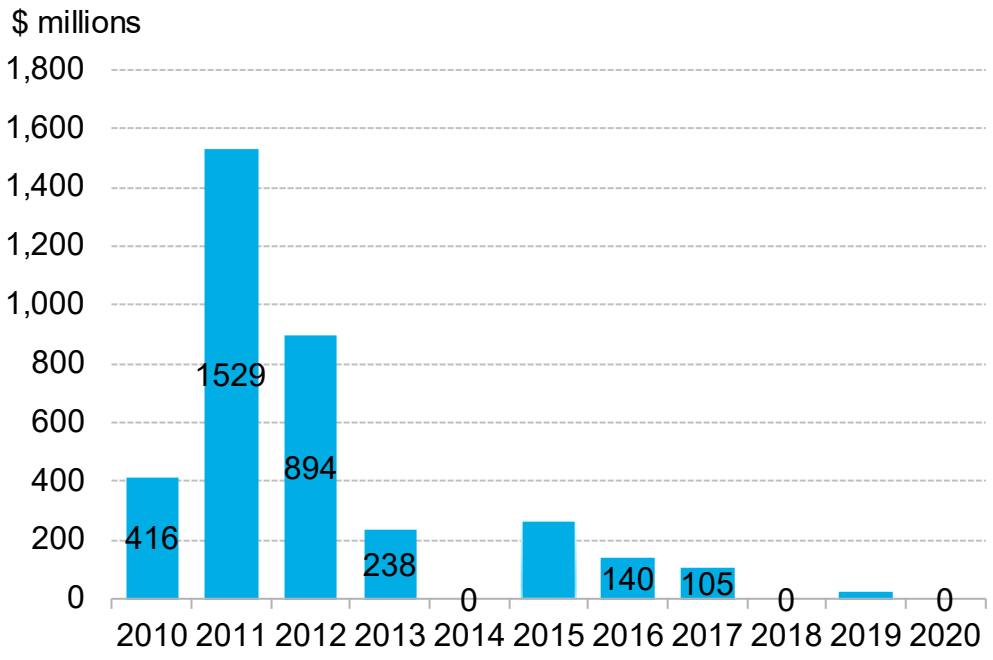


- In 2020, the U.S. installed 9MW of biomass and 22MW of biogas projects. Bioenergy build has tapered since 2013, when the Production and Investment Tax Credits, as well as the 1603 Treasury grant program, encouraged almost 800MW of new installations. However, these technologies will benefit from the PTC extension that Congress approved at the end of 2020.
- Waste-to-energy technology has seen continued growth in countries such as China, where 2019 saw 45 new facilities from the previous year representing approximately 900MW. In all, over 6,500MW of waste-to-energy projects is expected online in China by 2020 to meet the goal of 54% of MSW managed by WTE over half of which will have been added since 2015. The U.K. also provided important policy support to waste-to-energy. There are 42 operational plants in the U.K., 17 under construction or commissioning, and another 10 possibly on the way.
- Nine new anaerobic digesters were added in 2020 in the U.S. On average, since 2014, eight new systems have been built annually. The total count of operational projects (accounting for retirements) has increased 13% since 2014.

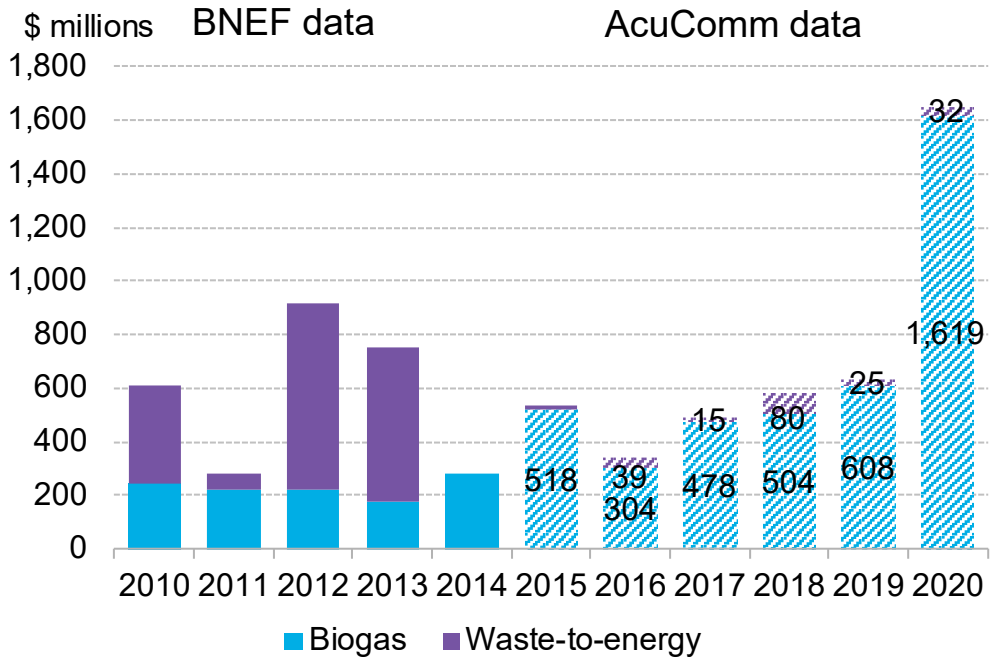
Source: BloombergNEF, EIA, company announcements, EPA, WEF Notes: Biomass includes black liquor. Biogas includes anaerobic digestion (projects 1MW and above except wastewater treatment facilities). The graph on the right reflects anaerobic digesters on livestock farms in the U.S. and is sourced entirely from the EPA AgSTAR database.

Financing: U.S. bioenergy asset finance

Asset finance for U.S. biomass



Asset finance for U.S. biogas, waste-to-energy

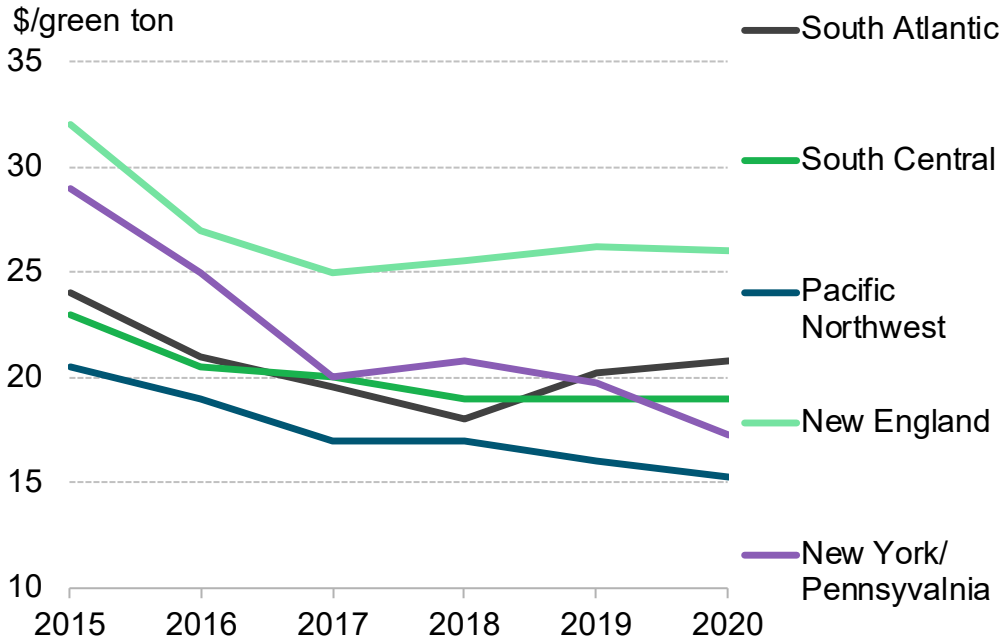


- Asset (project) finance for new biomass continues to fluctuate as biogas investment continued its resurgence that began in 2017. In 2020, AcuComm tracked 15 investments into large biomass, biogas and waste-to-energy projects with a combined capacity of over 156MW and total investment value of $1.65 billion, over double the investment value of bioenergy plants financed in 2019.
- Lower investment for biomass in the past five years suggests that new build will continue to be subdued. Plants take two to four years to build and commission, so investment functions as a leading indicator for build.
- AcuComm is an alternate data provider providing coverage of select bioenergy plants throughout the U.S.

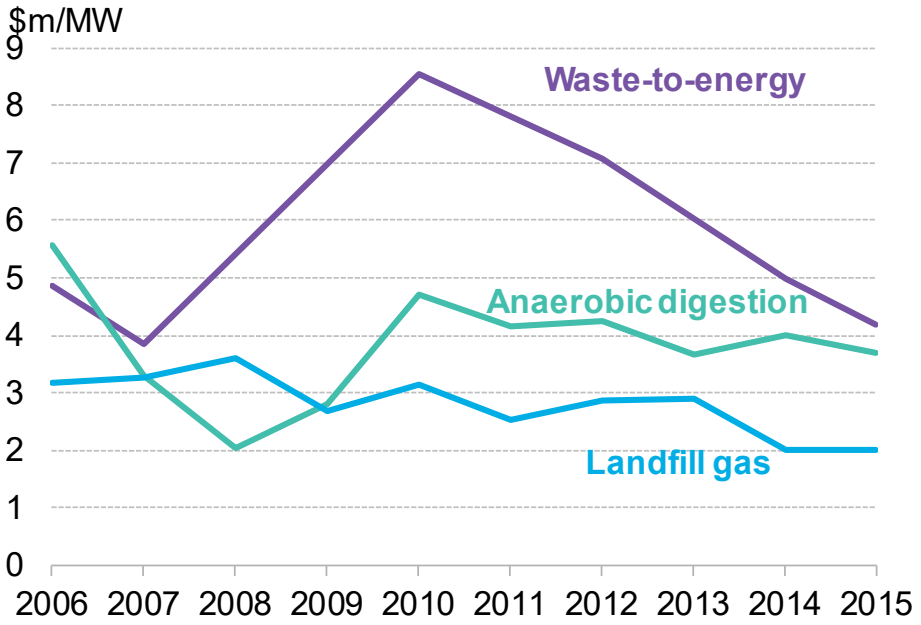
Source: BloombergNEF, EIA, company announcements, AcuComm Notes: Values are nominal and include estimates for deals with undisclosed values. Biogas includes anaerobic digestion (1MW and above, except for wastewater treatment facilities) and landfill gas.

Economics: Bioenergy feedstock prices and capex

Biomass feedstock prices in select U.S. markets, 2013-2020



Capex for biogas and waste-to-energy projects by type



- Biomass feedstock prices either flat lined or declined across the U.S. in 2020 with the exception of a 2% rise in the South Atlantic. Pacific Northwest and New York prices slipped by 5% to $15/green ton and by 13% to $17/green ton, respectively. New England slightly decreased by only $0.30/green ton and South Central plateaued at $19/green ton.
- The capex associated with waste-to-energy projects fell sharply from 2010 through 2015 (the last year for which complete data are available). Anaerobic digester costs have also declined over that time but not as dramatically.
- There are very few projects under development domestically using these technologies, so the annual changes in capex figures can be strongly influenced by the costs and circumstances of individual projects.

Source: BloombergNEF, Fastmarkets RISI's Woodfiber & Biomass Markets, U.S. Department of Agriculture, EIA Notes: Capex values are for projects 1MW and above. A 'green ton' is 2,000lbs of fresh cut woody material.

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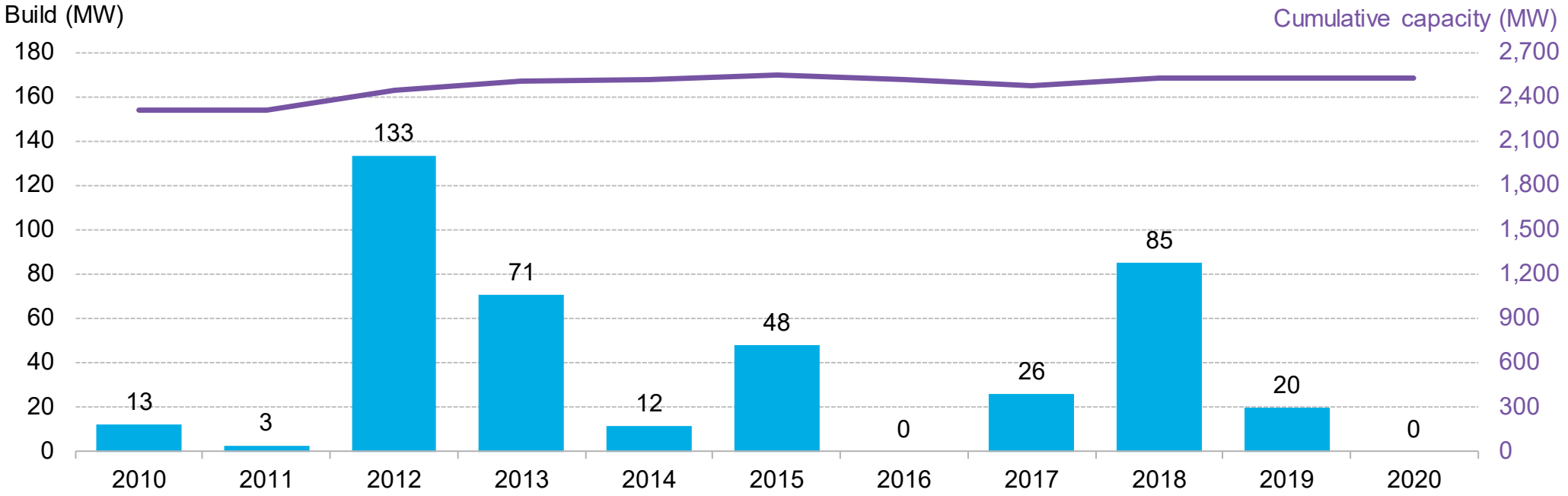
Deployment: U.S. geothermal build



- No major U.S. geothermal plant was commissioned in 2020. Unlike other renewable resources, geothermal projects have long project completion periods of 4-7 years. In addition, the technology lacks strong policy support and faces high development costs. These factors contributed to the low build volumes.
- Two geothermal plants are in the EIA build queue. The 25MW summer capacity North Valley and 17MW CD4 power plants are filed to come online in Nevada and California in 2021. Both plants are owned by Ormat Technologies and will likely sell power into the California market.
- The 2.9MW of the Soda Lake Geothermal project in Churchill, Nevada, was retired in 2019. No geothermal projects were retired in 2020.

Source: BloombergNEF, EIA. Note: Cumulative figure refers to summer project capacity, not nameplate.

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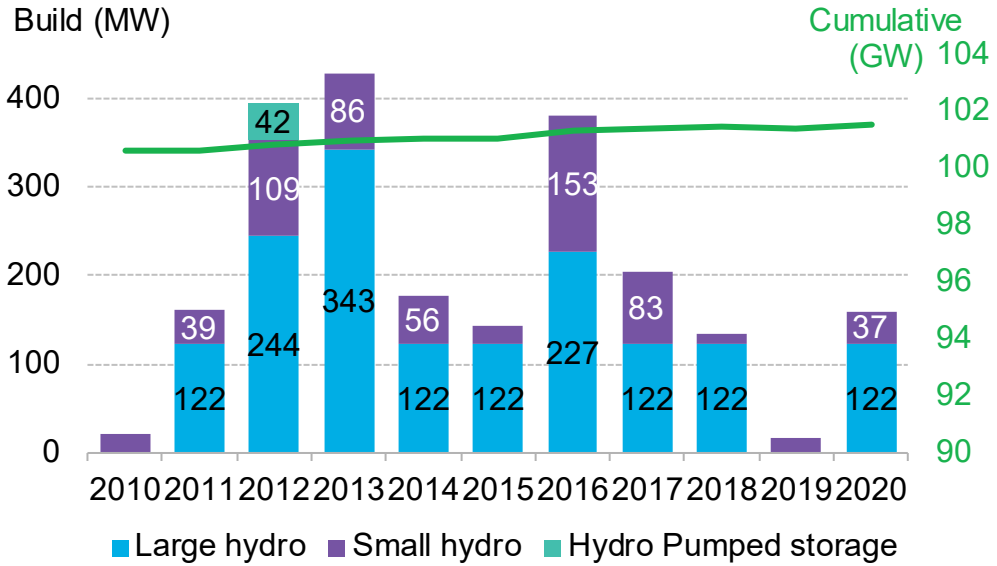
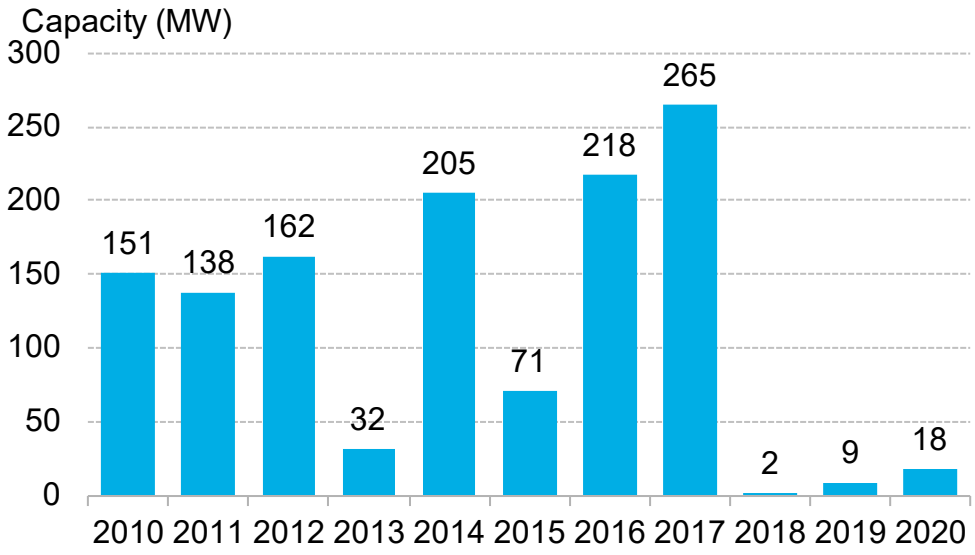
Deployment: U.S. hydropower build and licensed capacity

U.S. hydropower build and cumulative capacity



U.S. new hydropower capacity licensed or exempted by FERC

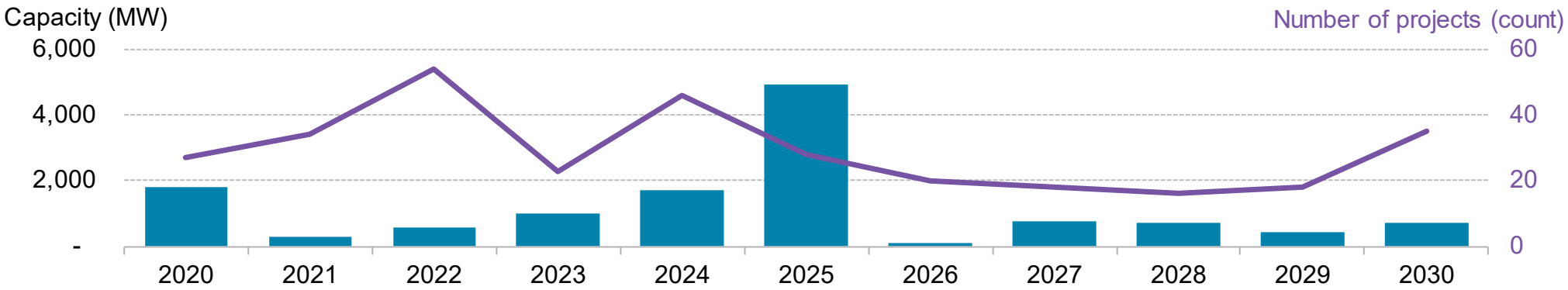


- In 2020, hydropower experienced an increase in commissioned megawatts, as the industry saw new growth. Two new hydropower projects were built on existing non-powered dams, representing 60.4MW. East Texas Electric Cooperative placed in service the 24.0MW Lake Livingston Hydroelectric Project in Livingston, Texas, while the 36.4 MW Red Rock Hydroelectric Project in Pella, Iowa completed construction.
- In January-November 2020, 18MW of new hydropower capacity was licensed by the Federal Energy Regulatory Commission (FERC), while 40MW is currently under FERC review. With the simpler qualifying pathway for small, non-federal conduit projects, which first became available in 2013, 125 conduit projects totaling 39MW have been deemed eligible for construction by FERC – up 1MW from the previous year. 38 of these projects (representing 13MW) are already operational.
- Climate Adaptive Infrastructure, an investment firm, announced a $150 million fund to development 22 hydropower projects on existing non-powered dams in Kentucky, Louisiana, Mississippi, Ohio, Pennsylvania and West Virginia. All told, the facilities would produce 250MW.

Source: BloombergNEF, EIA, FERC, ORNL Notes: Licenses data are from the Office of Energy Projects' (OEP) Energy Infrastructure Update in November 2020. Licensing figures exclude pumped storage and qualifying conduit hydro facility information which has a separate FERC filing process. Conduit hydro facility information can be found here.

Pipeline for licensing and relicensing hydro plants

U.S. hydropower plants seeking to be re-licensed by FERC



- High cost and delays associated with licensing remain primary threats to existing and new U.S. hydropower and pumped storage projects. Licensing typically takes 3-10 years but can last even longer in certain cases.
- As of year-end 2020, 319 hydropower projects totaling 13GW were up for relicensing from 2020 to 2030, according to the Federal Energy Regulatory Commission (FERC). Hydropower and pumped storage projects go through relicensing every 30-50 years. During the process, the licensee works with stakeholders to balance power and non-power benefits of the project, including recreation, irrigation, environmental restoration, and energy generation.
- 35.2GW of pumped storage projects have received preliminary permits from FERC, with over 9GW in Arizona, and 15.5GW have preliminary permits pending. Additional projects totaling 740MW are currently pending original licenses. Preliminary permits, which are issued for up to four years, do not authorize construction, but maintain priority of application for license while the permittee studies the site and prepares to apply for a license.
- Kauai Island Utility Cooperative and AES Corp. executed a power purchase agreement to develop a solar-powered pumped hydro storage project in Hawaii. The pumped storage hydro units would produce 24MW on average daily.

Source: BloombergNEF, FERC

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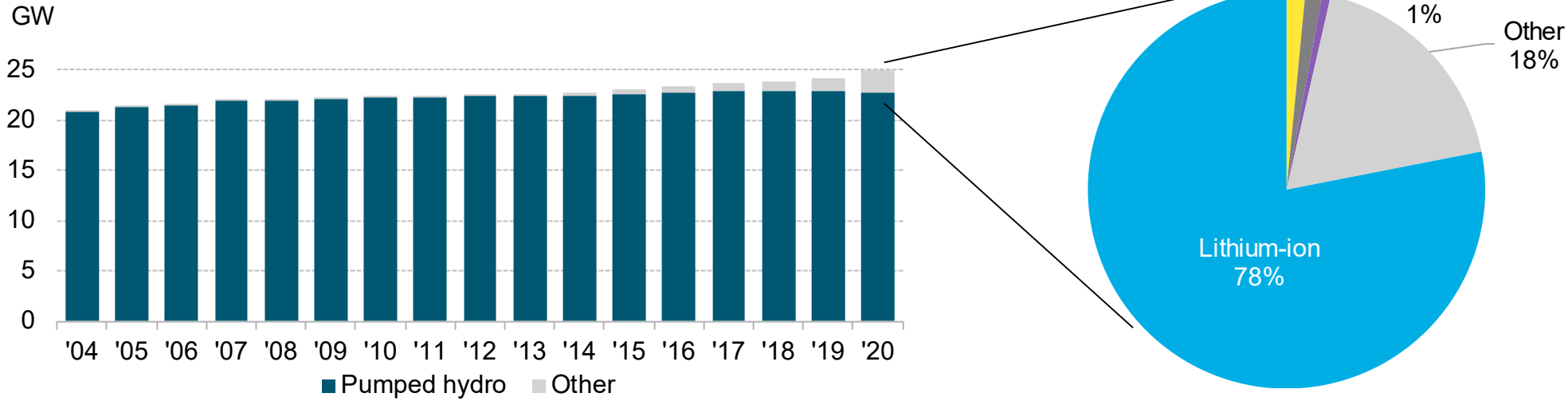
Deployment: U.S. cumulative energy storage

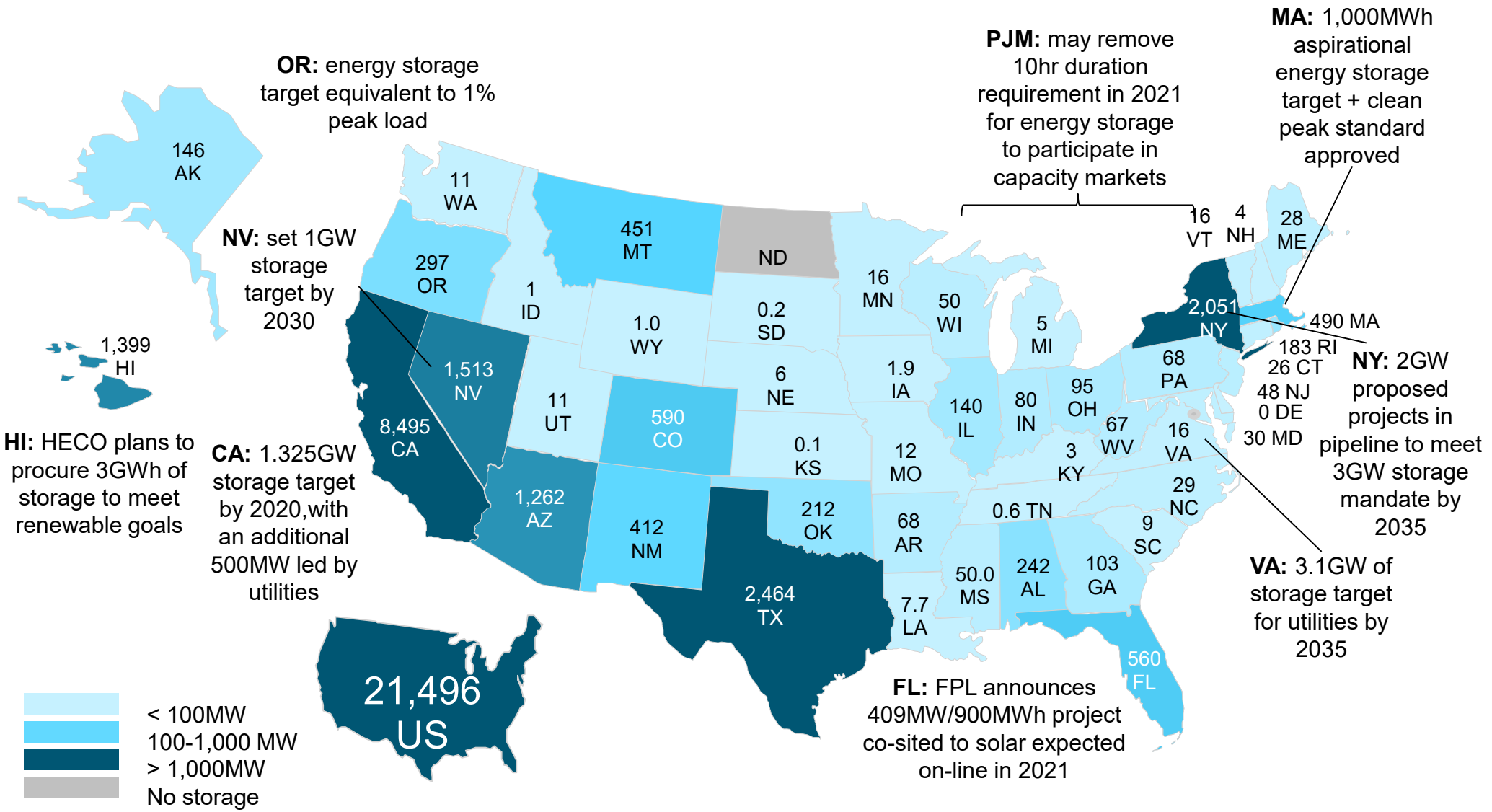
Commissioned capacity



- Pumped hydropower storage projects account for about 91% of installed energy storage capacity in the U.S. While pumped hydro will remain the bulk of energy storage capacity in the U.S., other technologies, mainly lithium-ion batteries, have dominated new build since 2011. State-level energy storage targets and utility solicitations generally exclude pumped storage.
- Three new pumped storage projects with a combined capacity of 2.1GW have received licenses in the last few years – Eagle Mountain in California, Swan Lake in Oregon, and Gordon Butte in Montana. Construction on all could potentially start in 2021. The last large pumped storage facility was built in 1995.
- As of the end of 2020, all six U.S. jurisdictional wholesale market operators were at least partially compliant with FERC Order 841 (some operators have extended their compliance timelines to finalize specific components). Issued in February 2018, Order 841 is a landmark rule that will remove barriers to energy storage and bring a measure of consistency to how these assets participate across organized power markets. By enabling energy storage systems to obtain compensation for the services they can provide to the wholesale markets, the rule allows energy storage to compete fairly against other generators. This will create new opportunities for energy storage and encourage additional storage deployments.
- While lithium-ion holds the majority of the remaining market share, thermal energy storage in the form of ice-based systems is emerging in North America. 12.5MW of these systems were installed in 2020 with projections showing a potential of 38MW by 2028.

Source: EIA, FERC, BloombergNEF Note: "Other" includes projects where the technology is unknown, which is frequently lithium-ion batteries.

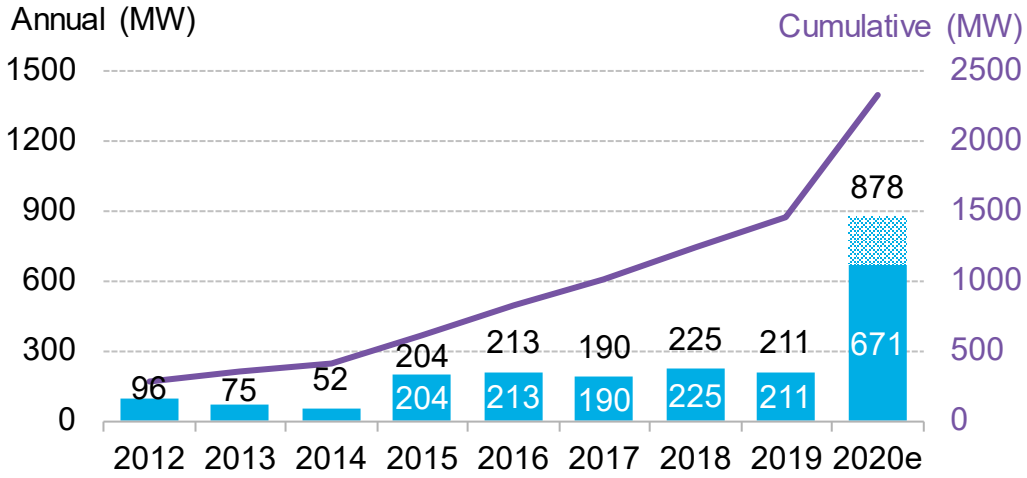
Deployment: U.S. announced and commissioned energy storage projects



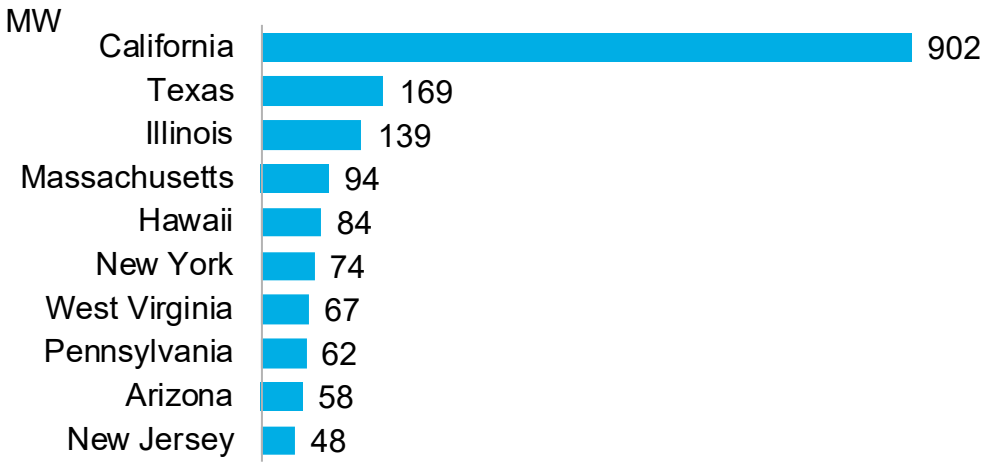
Source: BloombergNEF Note: Includes projects that are larger than 500kW/500kWh, have announced a specific location, and has been confirmed by the relevant company through public data. Indiana NIPSCO capacity not included in state capacity because individual project capacity is not yet disclosed. Capacity excludes thermal storage.

Deployment: U.S. non-hydropower commissioned energy storage capacity

Commissioned capacity



Capacity by state (top 10 states in 2020)

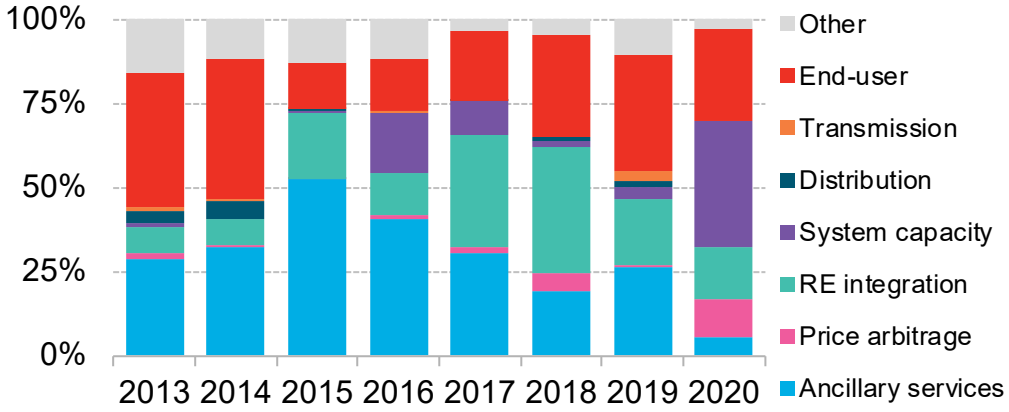


- 2020 marked the largest year of energy storage installations across the United States to date. Despite the pandemic, installations boomed due to two large projects in California that make up 550MW of the total expected 878MW of energy storage projects commissioned in 2020.
- California firmly holds its place as the largest energy storage market in the U.S. after surpassing PJM in 2019. California remains a storage deployment leader due to state policy support and generous bilateral resource adequacy contracts with utilities and Community Choice Aggregators. The states' appetite for storage continues to grow as it looks for firm capacity to meet peak demand when the sunset quickly decreases PV output.
- Markets continued to expand beyond California. Massachusetts added 37MW of storage capacity in 2020, second-most to California. Massachusetts' energy storage target, clean peak energy standard, grants, and SMART incentive program spurred a variety of 1MW to 5MW distributed storage additions co-located with solar. Georgia, Texas, and Indiana added 44MW of capacity from larger-scale (10MW+) projects.
- Falling lithium-ion battery pack prices have helped to lower costs for new stationary storage applications.
- Ice storage systems have been proven to be cost-effective for schools and other commercial buildings. The majority of installations are in Florida, Texas, California and New York, with over 900 ice storage projects totaling 1,674 MWh through 2020.

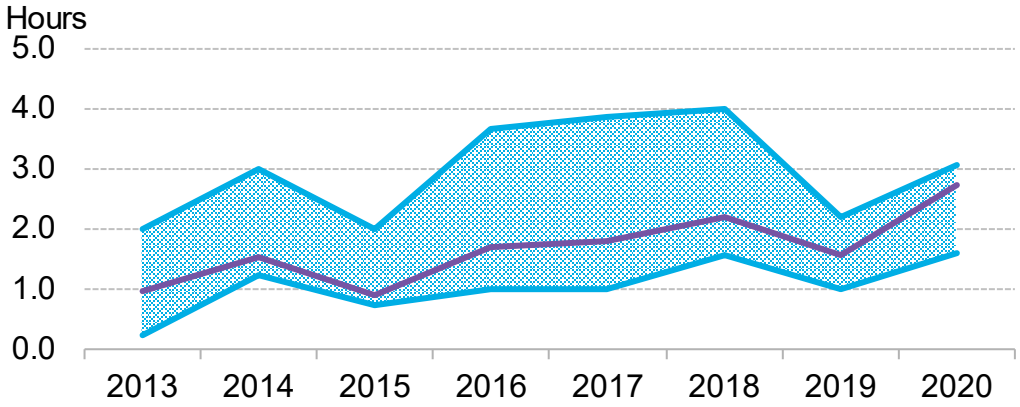
*Source: BloombergNEF Notes: *2020 includes expected but unconfirmed capacity as of January 11, 2021. Unconfirmed capacity is marked in white. Does not include underground compressed air energy storage or flooded lead-acid batteries. Minimum project size for inclusion in this analysis is 500kW or 500kWh. Cumulative capacity subtracts capacity that was decommissioned.*

Deployment: U.S. non-hydropower energy storage by application

Applications (% by MW)



Project duration volume weighted average (line) and top and bottom quartiles (shaded area)

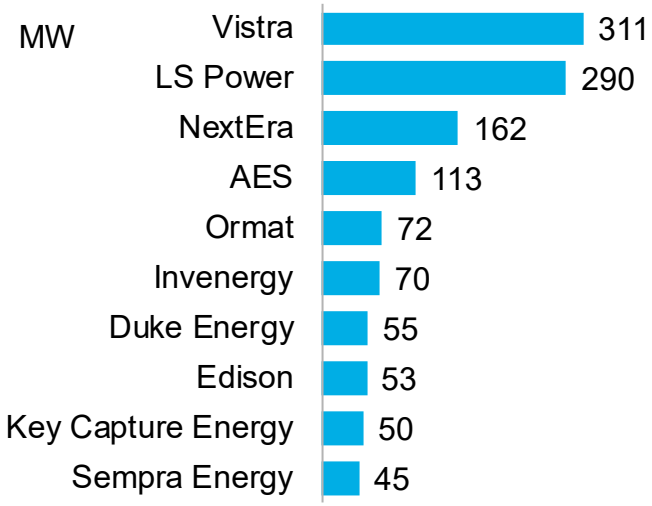


- The primary application for battery storage systems has become more diverse over time as markets evolve and storage value increases. In the middle of the previous decade, ancillary services and end-user applications dominated, followed by a few years in which renewable integration and eventually capacity applications became more prevalent. In 2020, system capacity and renewable energy integration together accounted for 53% of total deployments.
- Average duration increased as applications changed. System capacity rose in relevance in 2016, 2017 and 2020, driven by a wave of projects commissioned in California tied to Resource Adequacy contracts that required four-hour storage when called upon. The shift from PJM frequency regulation projects to California Resource Adequacy projects and growth of renewable energy integration projects (which support the addition of more wind and solar to the grid) explains the upward trend in average project duration, which increased from 0.9 hours in 2013 to 2.7 hours in 2020.
- In 2020, the demand for larger longer-duration projects increased. Eight California Community Choice Aggregators issued a Request for Offers for 500MW of long-duration storage in October 2020, seeking projects eight or more hours of duration. Contracts shall be signed in 2021.
- From 2011 to 2016, ancillary services were the most common application for new storage systems. Much of this was driven by short-duration system deployments for frequency regulation in PJM. However, the market for frequency regulation in PJM is now essentially saturated.

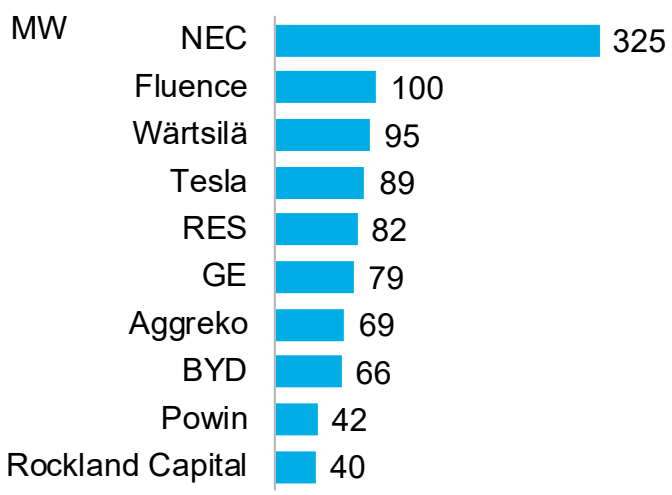
Source: BloombergNEF Notes: Pumped hydropower storage is not included as it would dwarf all other technologies. "Other" refers to applications not represented in the legend; many of these are government-funded technology testing or proof-of-concept pilot projects. Purple duration line represents volume weighted duration, range represents interquartile ranges.

Deployment: U.S. non-hydropower energy storage, top 10 companies

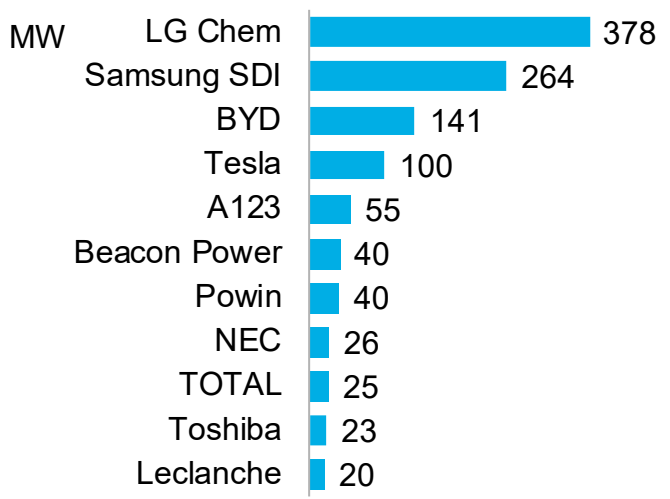
Storage owners



Storage integrators



Technology providers

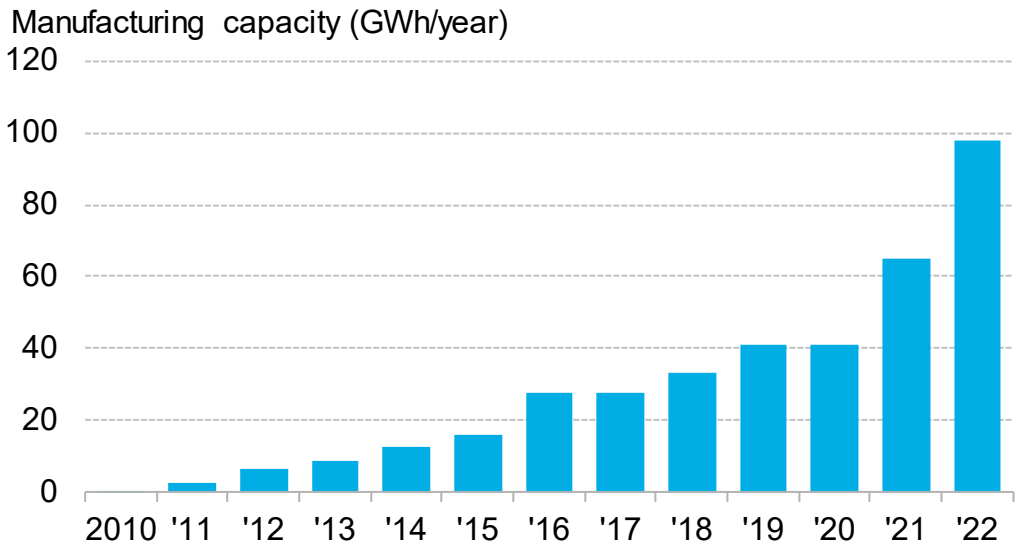


- Large independent power producers and utilities such as Vistra, LS Power, NextEra and AES dominated storage project ownership. These owners together have operational portfolios of at least 880MW of capacity, generally a small but rapidly growing portion of their total generation fleet. 'Pure-play' storage developers and owners such as Key Capture Energy have become more prominent. Vistra and LS Power rose in the ranks in 2020 due to two large storage projects that came online in California.
- Most major storage integrators – suppliers of turnkey systems to customers such as Fluence, Wartsila, and NEC – are part of large power equipment providers. NEC exited the energy storage business in 2020, indicating the competitive nature of the space.
- Projects using lithium-ion batteries produced by established manufacturers such as Samsung SDI and LG Chem are more bankable due to the perceived risk of emerging companies. Lithium-ion is also cheaper than other technologies on a turnkey basis, and its price is falling faster.
- Lithium-ion batteries are widely available and mass-produced globally although manufacturing is concentrated in Asia. They are modular and can be installed in multiple scales ranging from a few kilowatts at residential scale to hundreds of megawatts for bulk system applications. Li-ion batteries can provide high power for short-duration applications (e.g., frequency regulation) and up to (and sometimes more than) four hours of energy capacity for longer-duration applications (e.g., transmission or distribution network investment deferral).

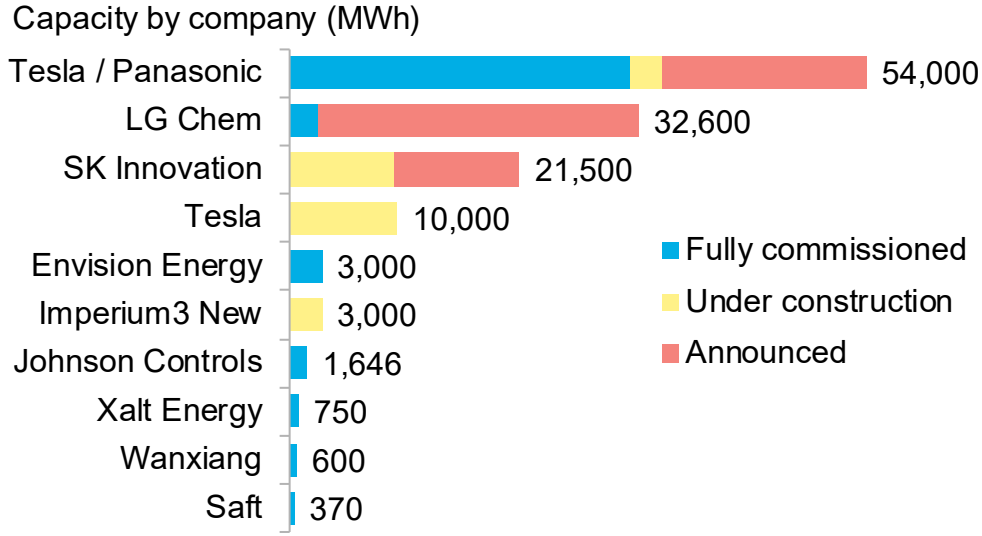
Source: BloombergNEF Notes: Top 10 based on commissioned capacity. Top 10 storage providers based on disclosed capacity, may exclude capacity not disclosed at a project level.

Deployment: Current and planned manufacturing capacity

U.S. lithium-ion battery manufacturing capacity



U.S. lithium-ion battery manufacturing capacity by company

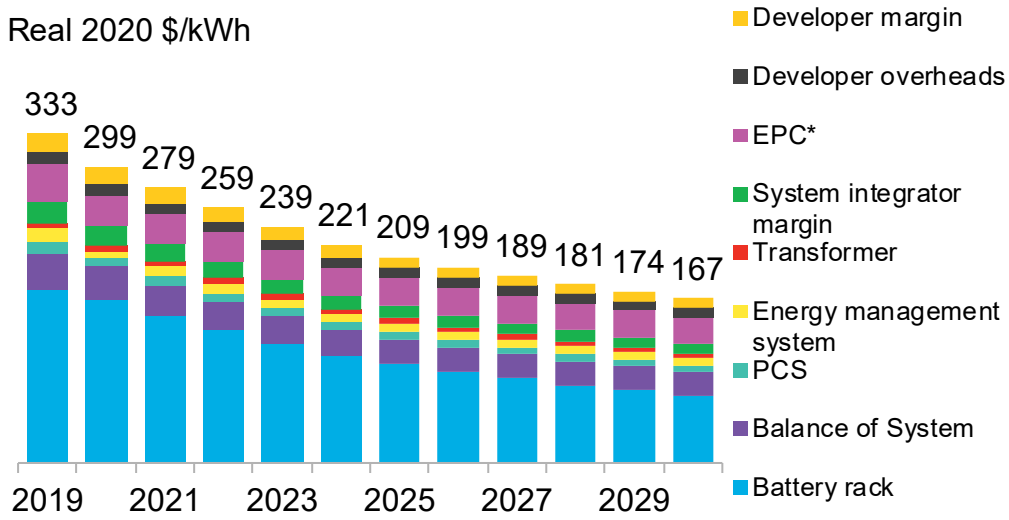


- As of the end of 2020, the U.S. has 41GWh of lithium-ion battery manufacturing capacity. Capacity did not grow in cumulative terms from 2019 because manufacturing capacity expansion slowed during the Covid-19 pandemic.
- In 2020, there were two major battery manufacturing plant developments:
  - South Korean SK Innovation announced an additional $940 million investment to expand in Commerce, Georgia, co-located to an under-construction plant, eventually reaching 32GWh by 2023. The plants are expected to supply batteries for multiple vehicle manufacturers including Volkswagen in Chattanooga.
  - Tesla announced in its Tesla Battery Day in October 2020, an ambitious 3TWh manufacturing capacity ambition (globally, not just in the U.S.), and that it would build a cathode factory in the U.S.as well as bringing recycling in-house.
- The U.S. is expected to reach almost 100GWh of battery manufacturing by the end of 2022. Growth is expected mainly from the Tesla Nevada Gigafactory, LG Chem's joint investment with General Motors in Ohio, and SK Innovation's investment in the Georgia facility.

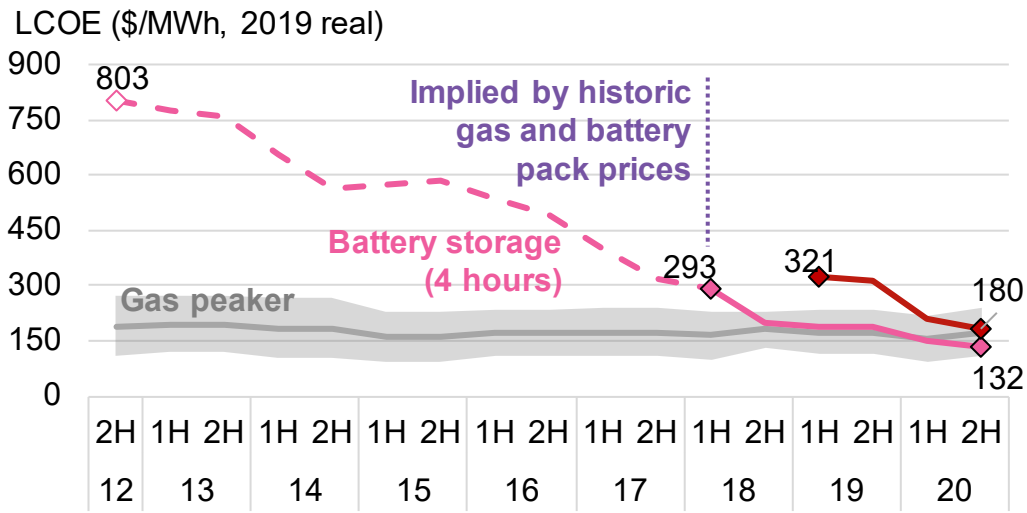
Source: BloombergNEF. Note: manufacturing capacity is based on nameplate capacity and includes manufacturing for multiple segments such as electric vehicles, stationary storage and others. Tesla Battery Day exact capacity expansions in the U.S. are not clear yet beyond Freemont 10GWh pilot plant (under Tesla-only in the chart).

Economics: Capex - energy storage system costs

Capital costs for a fully-installed large four-hour duration AC energy storage at beginning of life



Global levelized cost of electricity (LCOE)



- Fully installed cost for a large four-hour utility-scale system in 2020 was $299/kWh, a 10% drop in benchmark costs from 2019. Lithium-ion battery price declines are the biggest contributor to storage system cost declines, and is expected to continue to be through to 2030.
- Energy storage systems consist of battery racks (battery modules installed onto racks), balance of system (electrical infrastructure, containers, HVAC, fire suppression systems), power conversion system, energy management system (software), transformer and the margins related to the installation of the system – system integrator margin, EPC, developer overheads and margins.
- A number of factors account for the continued decline in full-system prices: technology improvements, manufacturing scale, competition among manufacturers, greater product integration ahead of installation, and more overall industry expertise.
- In February 2020, the U.S. reduced tariffs on lithium-ion batteries imported from China from 15% to 7.5%. Limited purely to battery rack, the new tariff would make overall system costs 4% higher in the U.S., assuming global benchmark costs. Potential additional knock-on effects could incur a price increase of 4% to 7.5%.

*Source: BloombergNEF Note: Excludes warranty costs, which are often paid annually rather than as part of the initial capital expenditure. These costs do not explicitly include any taxes, although due to a lack of transparency in the market, some may be unknowingly included. This is for a brownfield development so excludes grid connection costs. *Includes a 5% engineering, procurement and construction (EPC) margin for 2019. Does not include salvage costs or project augmentation.*

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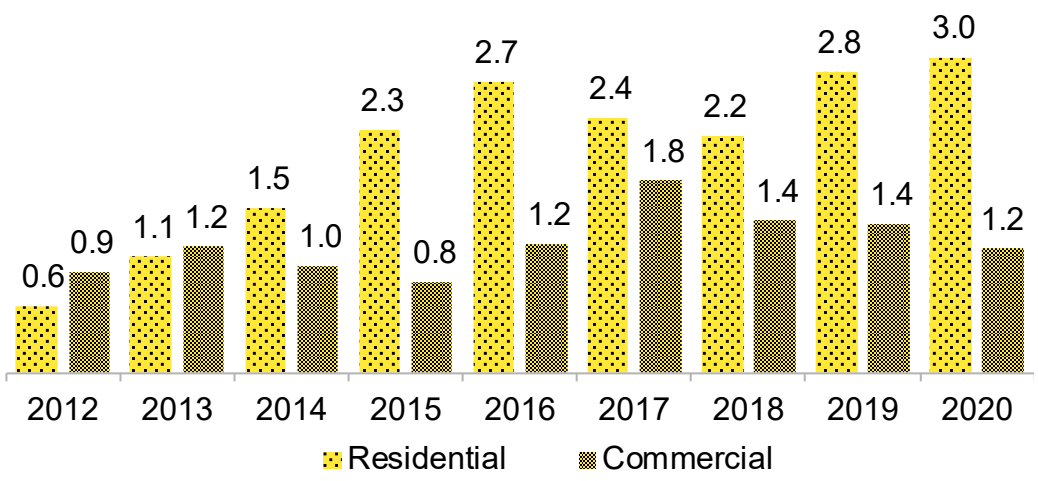
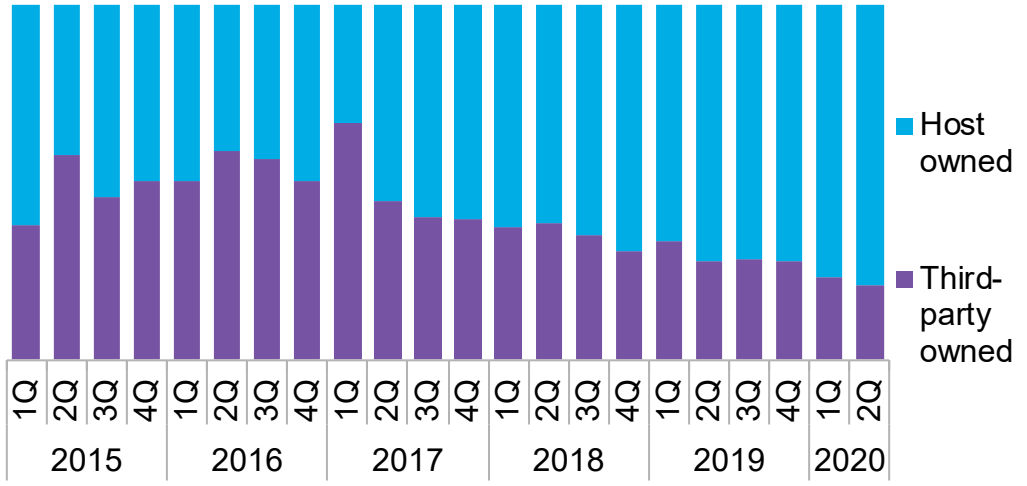
Deployment: U.S. small-scale solar build by type

Annual U.S. small-scale PV build (GW)



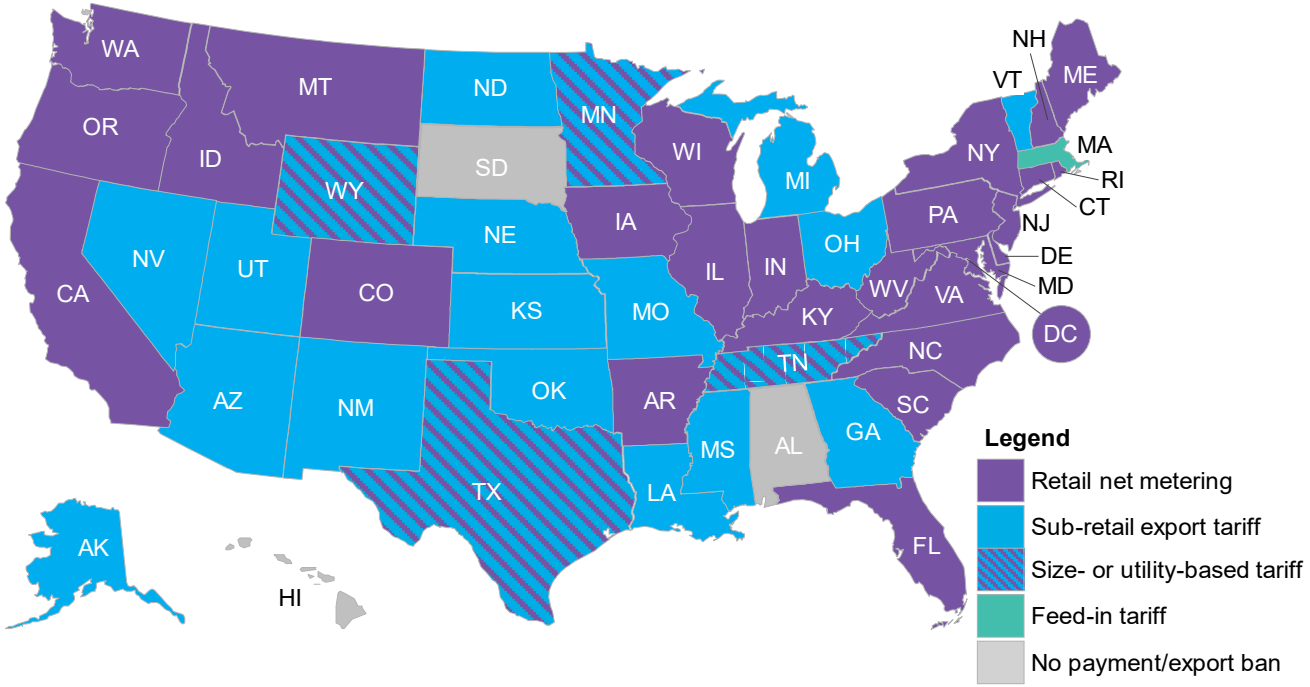
New residential solar capacity by ownership



- Residential solar installations grew in 2020 despite delays in permitting and construction activity stemming from lockdown orders imposed in many states in 2Q. Solar has become increasingly attractive to homeowners who seeking to reduce their grid consumption and save on electricity bills. The shift away from third-party ownership towards customer-owned residential solar continued in 2020 as declining system prices and improved loan products make customer-owned systems more attractive to buyers.
- Installers were able to reach new customers during lockdowns through online sales and digital tools, which yielded higher sales productivity and allowed consumers to compare multiple quotes. Despite some efforts by building authorities to move to digital permits in 2Q, many permitting offices were unable to make the transition, leading to construction delays. Most offices cleared backlogs in 3Q and 4Q, allowing deployment growth in those quarters to offset steep declines in 2Q and push 2020 to a record year for residential installations.
- New commercial and industrial solar build slowed in 2020 due to revenue uncertainty across businesses as well as longer timelines for contract negotiation and construction. Firms had to prioritize their resources towards their core businesses in 2020, which caused delays and paused solar projects until economic conditions improve.

Source: BloombergNEF, EIA 861M

Policy: Net metering state compensation as of December 2020



- As of December 2020, net metering compensation at the full retail rate was available to most customers within 28 states and Washington, D.C. Retail compensation for excess solar generation varied depending on the utility or the size of the system across five other states.
- Compensation for grid exports was less than retail rate for rooftop solar customers in 14 states. In most cases, customers received the utility's avoided cost rate, which is the price that a utility pays for energy in the wholesale market.
- Rocky Mountain Power (RMP) in Utah lowered its export tariff from 9.2c/kWh to 5.8c/kWh in 2020. The settlement came after tensions between the utility and solar advocates during proceedings. RMP initially suggested a tariff of 1.5c/kWh, while opponents argued for 24c/kWh.
- Several proposals to adjust net metering rates to time-of-use prices are underway in places with high solar penetration like California and the Carolinas. Other states such as New York, California and Connecticut are transitioning (NY, CA) or investigating (CT) new compensation structures that better reflect the value of distributed solar to the grid. The results of such a study can vary across service territories.

Source: BloombergNEF, DSIRE. Note: the map displays the compensation mechanism offered to the majority of residential and commercial customers within a state.

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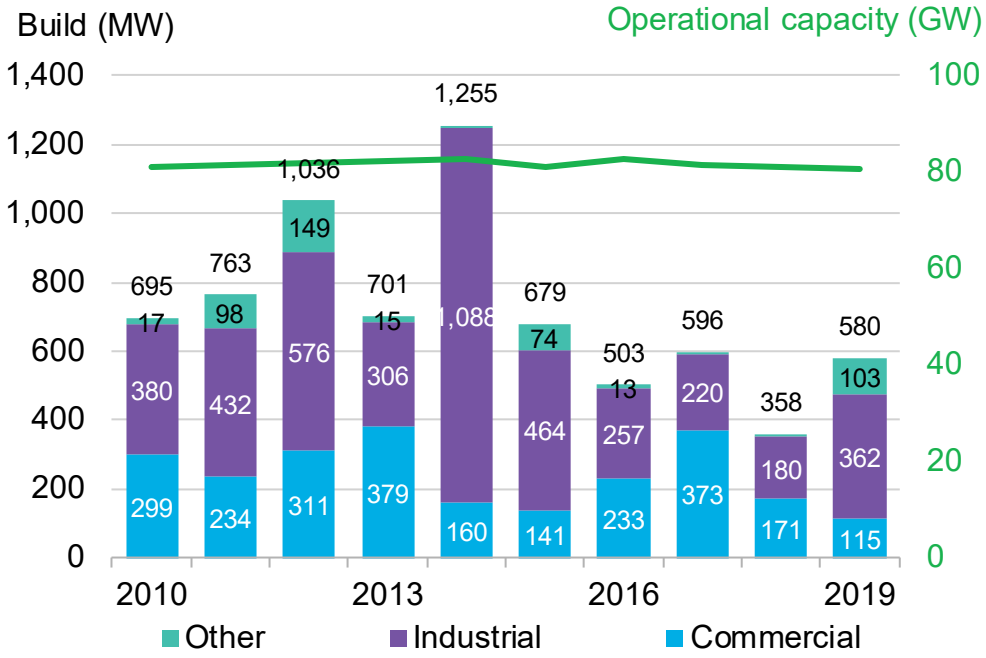
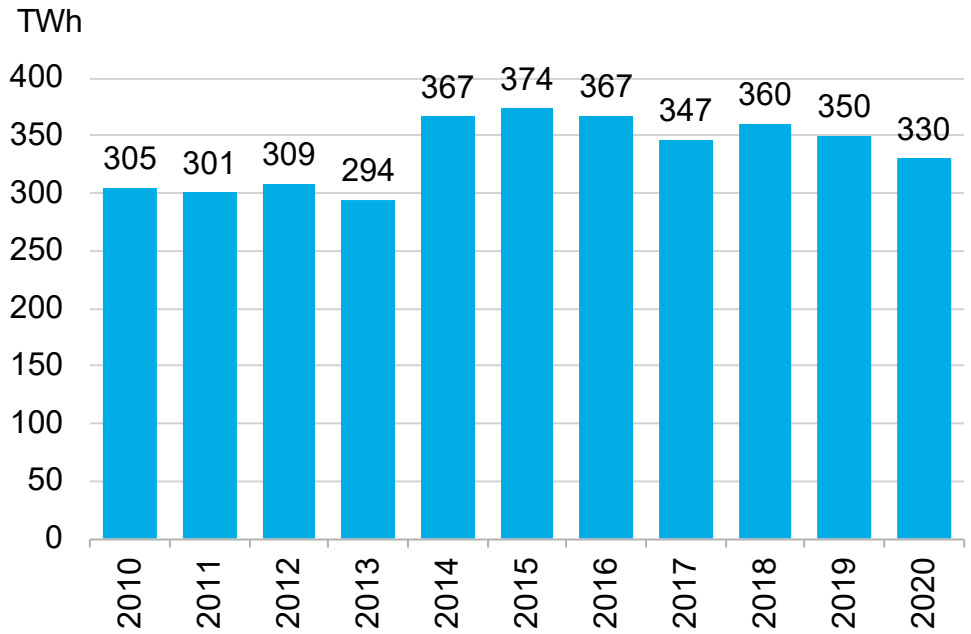
Deployment: U.S. CHP build and generation

U.S. CHP build and cumulative capacity



U.S. CHP generation (EIA-tracked plants)

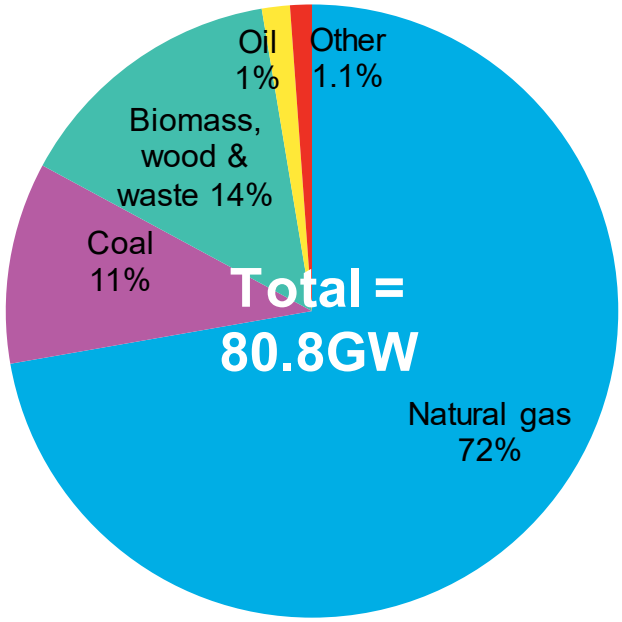


- CHP new capacity build rebounded in 2019 (the last year for which complete data are available) after a 2018 lull with 580MW coming online.
- However, operational CHP capacity continued to decline from its 2014 peak of 82.7GW to 80.8GW in 2020, its lowest level since 2008. This is mostly due to industrial plant site retirements of approximately 1GW outpacing new build.
- Generation from CHP plants remained consistent between 2018 and 2019, accounting for 350TWh (8.6% of total 2019 U.S. generation), but then fell 6% to 330TWh in 2020.

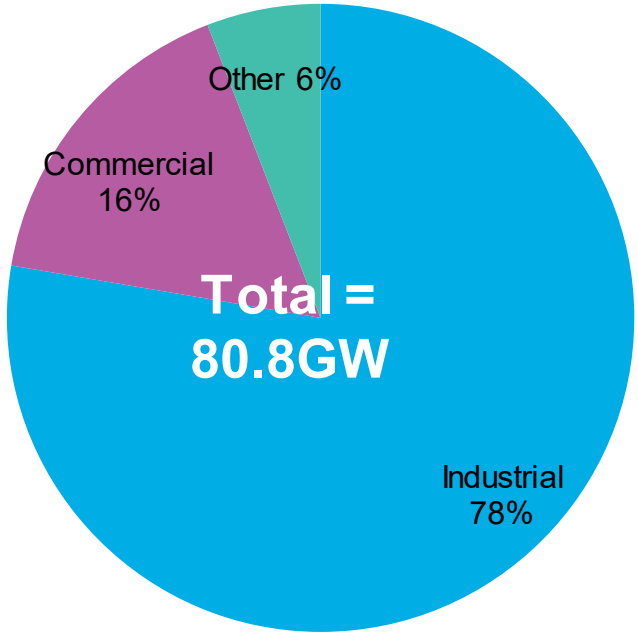
Source: BloombergNEF, DOE CHP Installation Database (maintained by ICF) Notes: EIA is the best available source for generation data, but runs through November 2020 (December is estimated) and is not comprehensive for CHP. The generation figures here are thus underestimated. Specifically, EIA does not collect data for sites <1MW, and EIA categorizes some CHP systems as "electric power" rather than "industrial CHP," among other reasons.

Deployment: U.S. CHP deployment by fuel and sector, 2019

U.S. CHP deployment by fuel source



U.S. CHP deployment by sector



- Fuel source distribution of CHP essentially remained the same from 2018 to 2019 (the last year for which complete data exists). Natural gas continued to supply the majority of CHP fuel at 72% (58MW). 14% of total operational capacity relies on units using biomass, wood, or waste. Coal's contribution ticked down 1%, from 12% to 11%. Additionally, there are 13 propane systems operating in the U.S. and its territories. And two of these systems help provide energy to critical infrastructure.
- For both the commercial and industrial sectors, CHP facility build and retirements balanced in 2019, leading to relatively flat shares of the market held at 16% and 78%, respectively.

Source: BloombergNEF, DOE CHP Installation Database (maintained by ICF) Note: totals may not add to 100% due to rounding.

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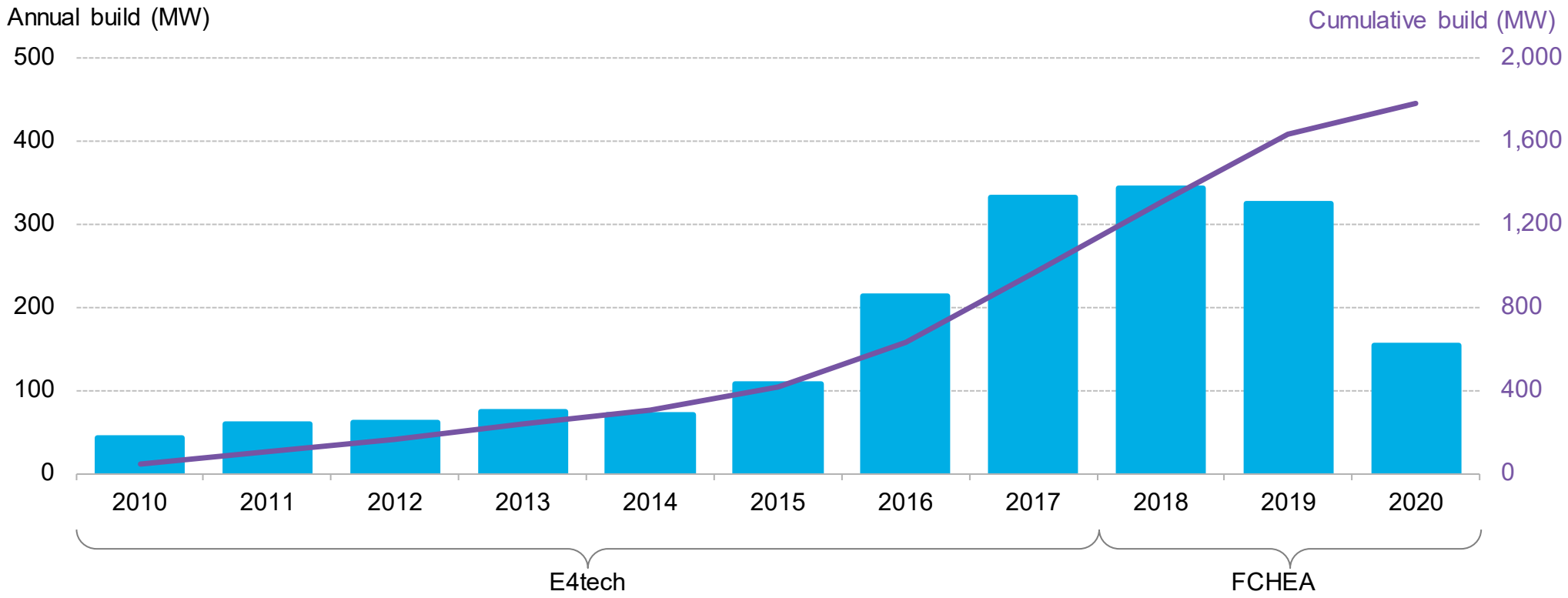
Deployment: Fuel cells in stationary, material handling and transport



- As of December 1, 2020, 8,890 light-duty fuel cell vehicles have been sold or leased in the United States, fuelled by a network of 42 hydrogen refuelling stations. In December 2020, the California Energy Commission approved a plan to invest up to $115 million to fund up to 111 new hydrogen stations by 2027.
- Over 40,000 fuel cell systems have been deployed for material handling applications. Throughout 2020, approximately 30% of all retail food and groceries in the United States went through a distribution center powered by hydrogen e-mobility systems.
- In 2020, the fuel cell and hydrogen industry quickly adapted to assist in Covid relief efforts, with many companies shifting to manufacturing and donating critical equipment such as ventilators, masks, sanitizer, and more. Other companies powered auxiliary hospitals and kept essential services online and operating.

Source: Fuel Cell and Hydrogen Energy Association (FCHEA), E4tech Fuel Cell Industry Review

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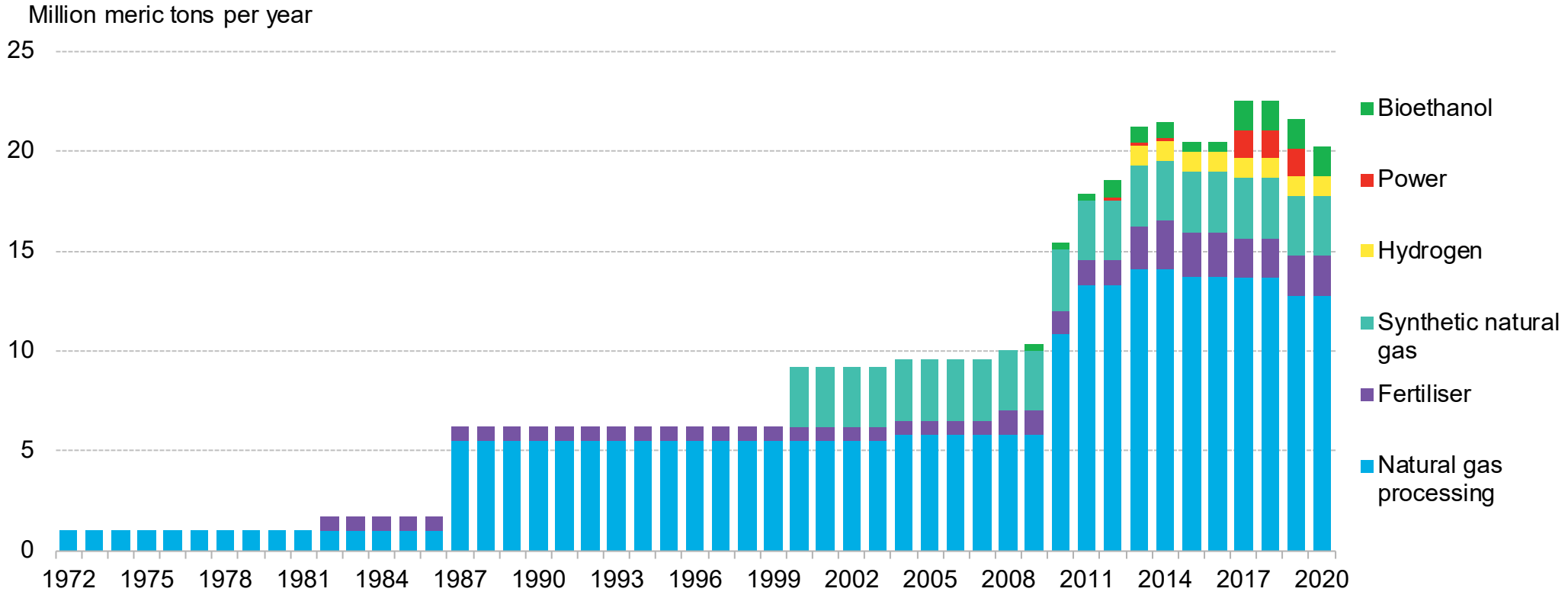
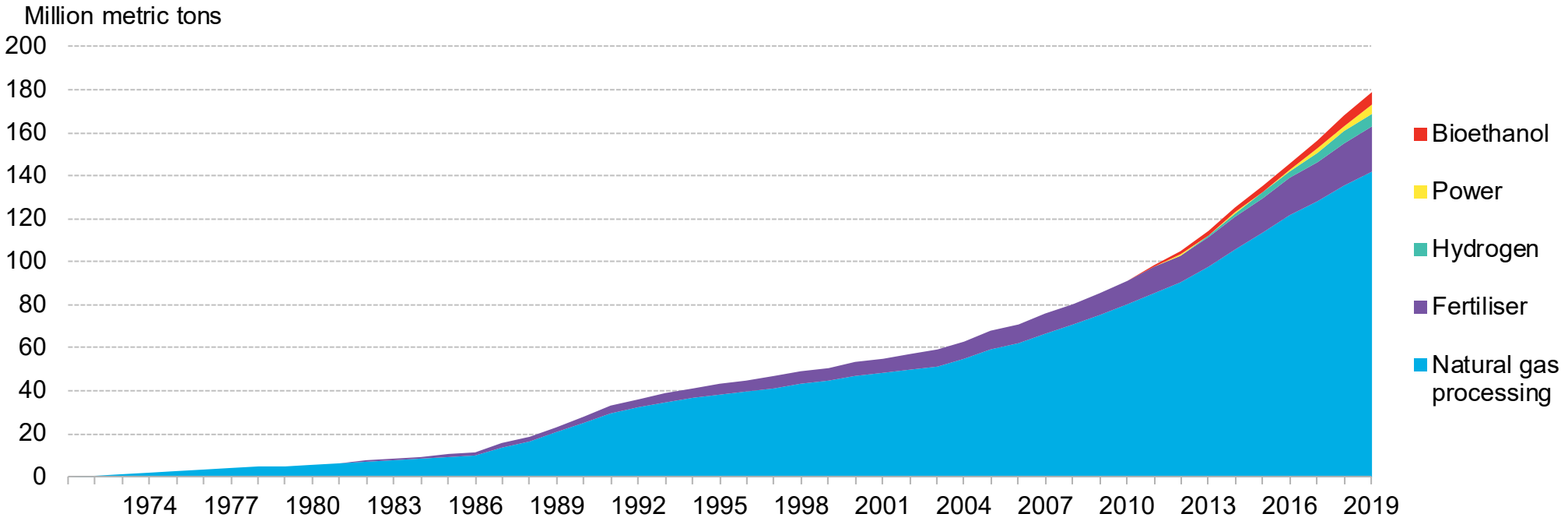
Deployment: Installed carbon capture & storage (CCS) capacity in the U.S.



- In the U.S., there are now 32 commercial facilities in operation or various stages of development, and two facilities that have suspended operations. This represents about half of the total CCS projects around the globe. The total capacity of CCS facilities, either operating or in development, is over 60 million tons per year.
- The Petra Nova carbon capture plant in Texas – intended to capture 1.4 million metric tons of CO2 a year from a 240MW slipstream of flue gas – was suspended in 2020. The Lost Cabin Gas plant was also suspended in 2019.
- In April 2017, the Illinois Industrial Carbon Capture and Storage project, capturing 1 million metric tons of CO2 a year for geological storage, began operating. The project was funded with $141 million from the DOE and about $66 million from private sources.

Source: BloombergNEF, Global CCS Institute

Deployment: Cumulative CO2 injection in the U.S., by technology



- As of 2019, cumulative CO2 injected in the U.S. since the early 1970s was just under 180MMt. This cumulative volume total equals approximately 3% of 2020 total U.S. greenhouse gas emissions.
- CCS gained momentum in the U.S. with the 2018 passage of the Future Act, which expanded the tax credit for CCS projects that commence construction before 2024. The act also eliminated a cap on eligible volumes, providing certainty for projects that take years to develop, and lowered the eligibility threshold from 500,000 to 100,000 tons of carbon stored on an annual basis.
- Industrial processes that cannot easily substitute renewable energy sources for fossil-fuel power generation are drawing more attention from government funding programs and technology developers. The U.S. Department of Energy has said it expects hubs of CCS infrastructure to develop in certain industrial areas, suggesting some momentum behind U.S. CCS projects linked to chemicals production and other industries.

Source: BloombergNEF, Global CCS Institute

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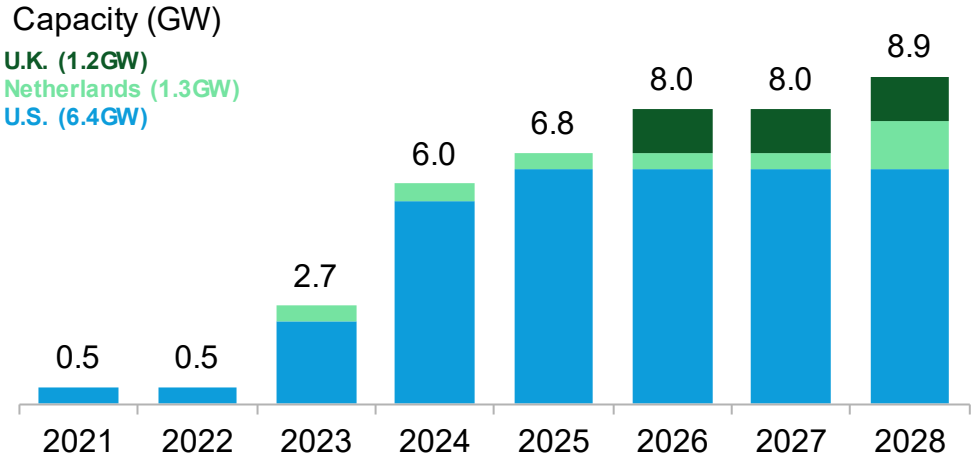
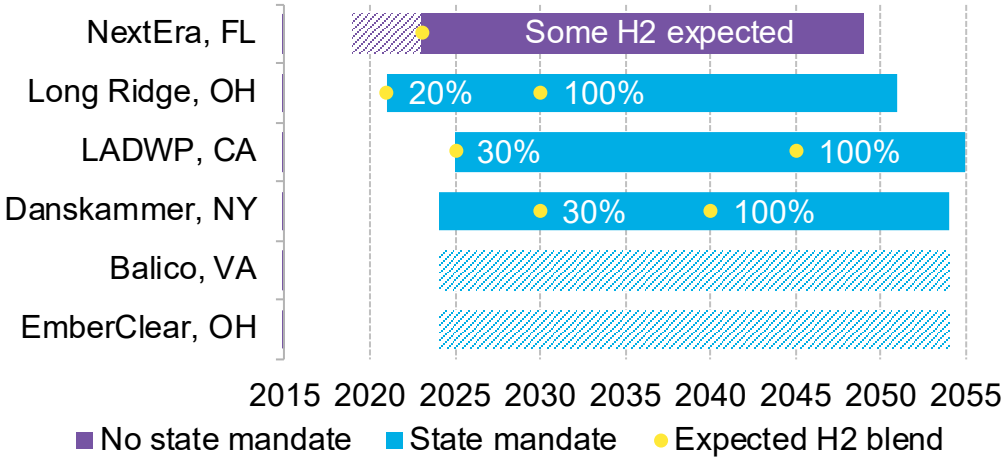
Deployment: Hydrogen-fired power plants

Cumulative announced capacity of H2-ready power projects by country



H2 blending targets of hydrogen-ready power projects, U.S.



- Recent announcements show 8.9GW of hydrogen-ready gas turbines operating worldwide by 2028, with projects set to be commissioned as early as 2021. U.S. generators are leading the way, accounting for six of the nine projects and three-quarters of this capacity.
- State-level clean energy targets are a clear driver in the U.S., with five of the six projects providing electricity in states with a clean energy mandate. Two-thirds of these projects have hydrogen-natural gas blend targets and half expect to run on 100% H2 by 2045.
- Only one project – the Long Ridge Energy Terminal in Ohio – is under construction. Originally intended to use natural gas only, it now expects to burn a blend of hydrogen and natural gas once commissioned in 2021, potentially reaching 100% green hydrogen by the end of the decade.
- Most projects are on brownfield sites: Power plant owners acquire hydrogen-ready turbines as their existing plant approaches retirement. But hydrogen upgrades in the middle of the lifetime of an asset are possible, too. For example, NextEra aims to blend green hydrogen with natural gas at its 1.75GW Okeechobee plant, commissioned in 2019, with hydrogen coming from a 20MW electrolyzer co-located with a solar farm.
- BNEF has also tracked a sharp decline in the dollar-per-Watt cost of electrolyzer systems. The price of an alkaline electrolyzer system has dropped 40%, from $2/W in 2014 to $1.2/W in 2019. Polymer electrolyte membrane electrolysis (PEM) electrolyzer systems have fallen by an even sharper 50% over that same period. BNEF also finds that Chinese firms sell electrolyzer systems at $0.2/W.

Source: BloombergNEF. Note: Left chart reflects announced and financed commercial projects. On right chart, Dashed = No announced hydrogen blend timeline. LADWP = Los Angeles Department of Water and Power. Bars begin at expected commercial operation date. 30-year asset lifetime assumed. State mandate means there is a state-level clean energy target.

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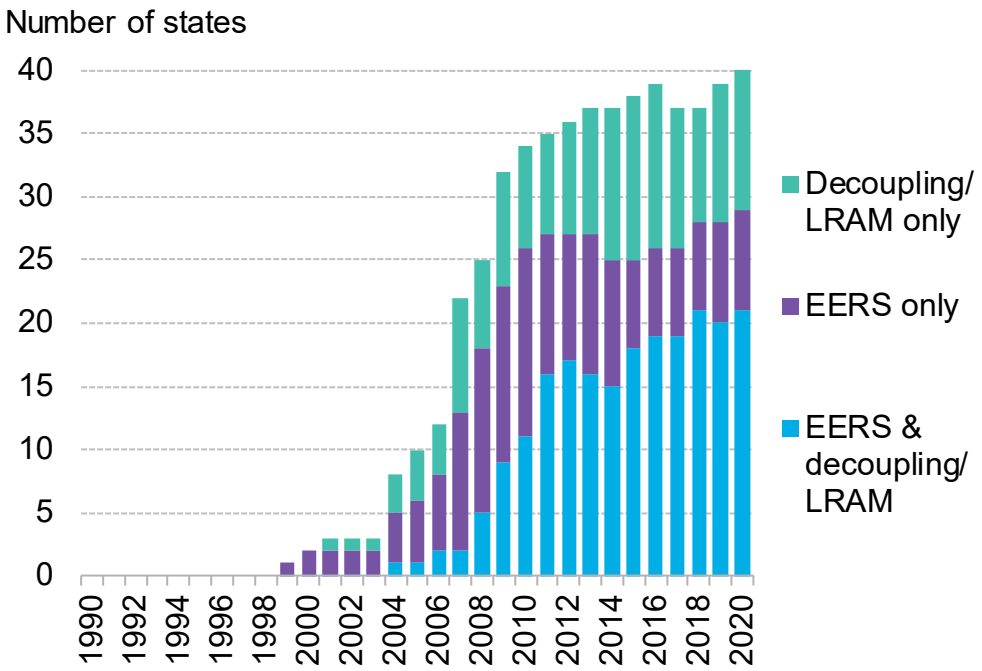
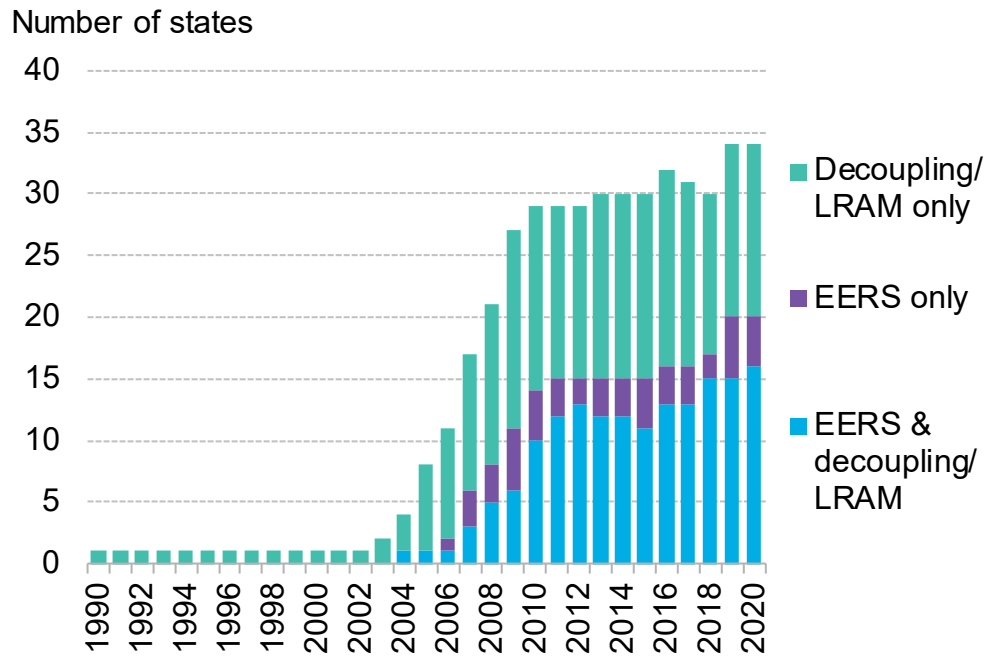
Policy: U.S. states with EERS and decoupling for electricity and natural gas

Electricity



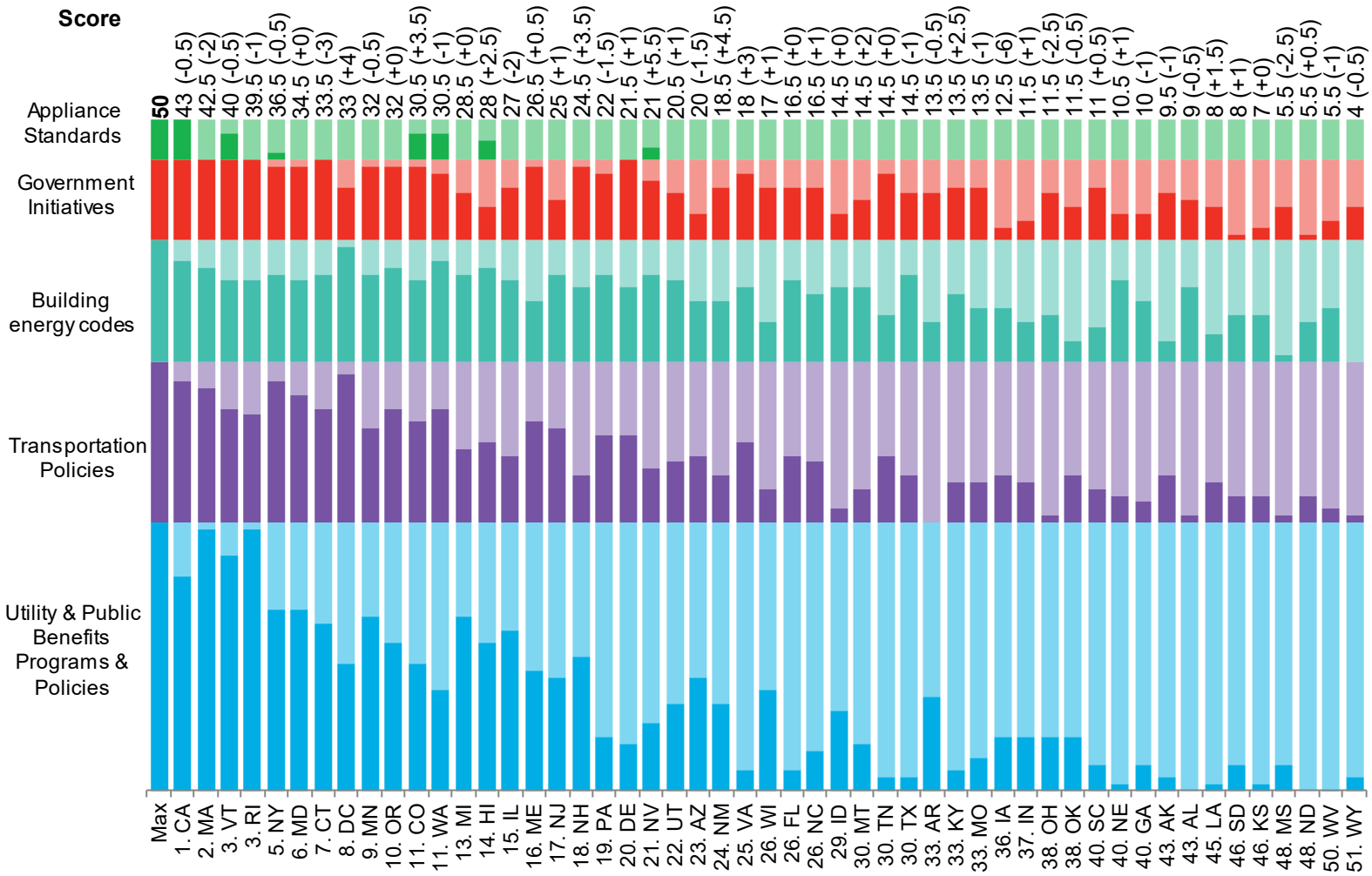
Natural gas



- Energy efficiency resource standards (EERS) are state-level policies that require utilities to invest in measures that improve end-user efficiency in order to meet energy-savings goals set by the government. Decoupling is a regulatory framework in which utilities' revenues are based on the reliable provision of energy but not on the volume sold. Decoupling removes the disincentive for utilities to invest in efficiency. Utilities are most likely to invest in energy efficiency in states with both EERS and revenue decoupling.
- More states than ever participate in EERS or decoupling incentives. Virginia was added to the list of now 27 states with EERS. Lawmakers in Virginia passed the Virginia Clean Economy Act in April 2020, which, in addition to putting the state on a path to 100% clean electricity, establishes the state's first-ever energy efficiency resource standard, requiring that by 2025 Dominion and Appalachian Power reach 5% and 2% of savings (leading to a projected 1.2% savings in the state).

Source: ACEEE, BloombergNEF Notes: Decoupling includes all lost revenue adjustment mechanisms, but no longer includes pending policies as per methodology changes in ACEEE reporting.

Policy: ACEEE state-by-state scorecard for energy efficiency policies, 2019

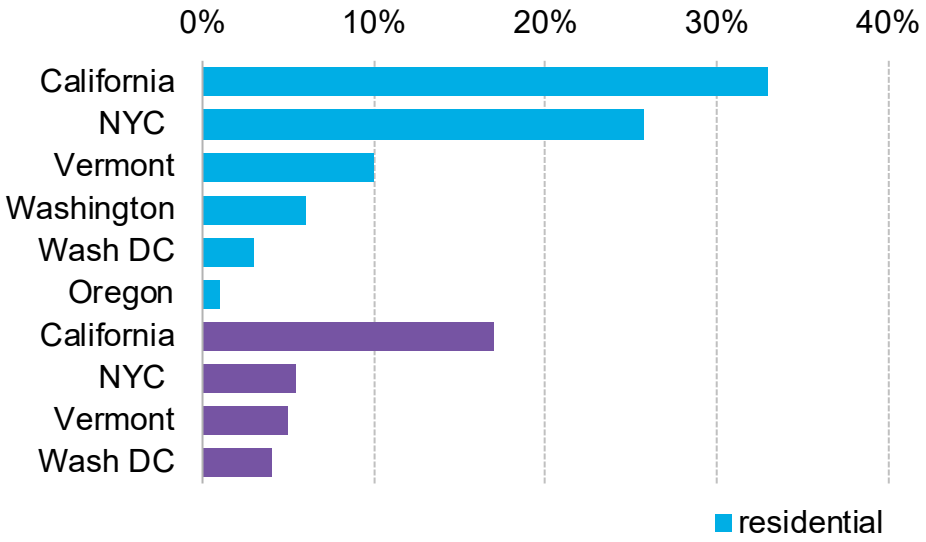


- The pandemic dramatically affected the energy efficiency sector, which saw the loss of 400,000 jobs by the summer. Despite this, some states continued to prioritize energy efficiency, which helps households and businesses to manage energy bills, create jobs and reduce emissions.
- California scored highest, passing nine-year leader Massachusetts, as the state adopted net-zero energy building codes, stringent vehicle emissions and appliance standards.
- Nevada was most improved. AB4 was signed into law to maintain energy-saving light bulb standards. The state also adopted the 2018 International Energy Conservation Code for residential and commercial buildings and plans to adopt California's Zero-Emission Vehicle (ZEV) mandate.
- Iowa lost 6 points, dropping 13 positions to 36th place, the largest decline in 2020. Iowa's point loss is due to a 2018 legislation that placed a spending cap on demand-side investments at a low level and allowed customers to opt out of otherwise effective EE programs.

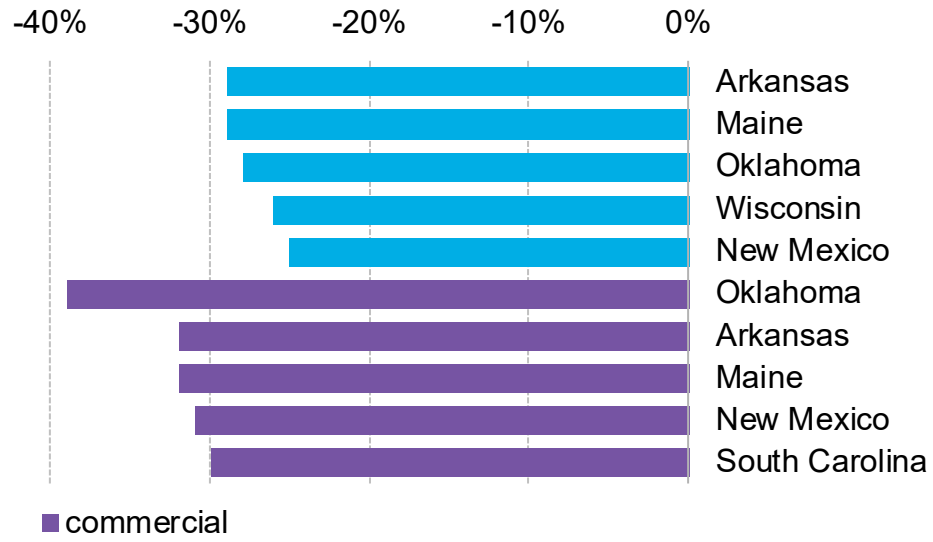
Source: ACEEE, EIA, BloombergNEF Note: Numbers in parentheses at the top denote the change in score from 2019 levels.

Policy: State adoption of building energy codes

States with strongest code, % savings greater than model code (2018 IECC)



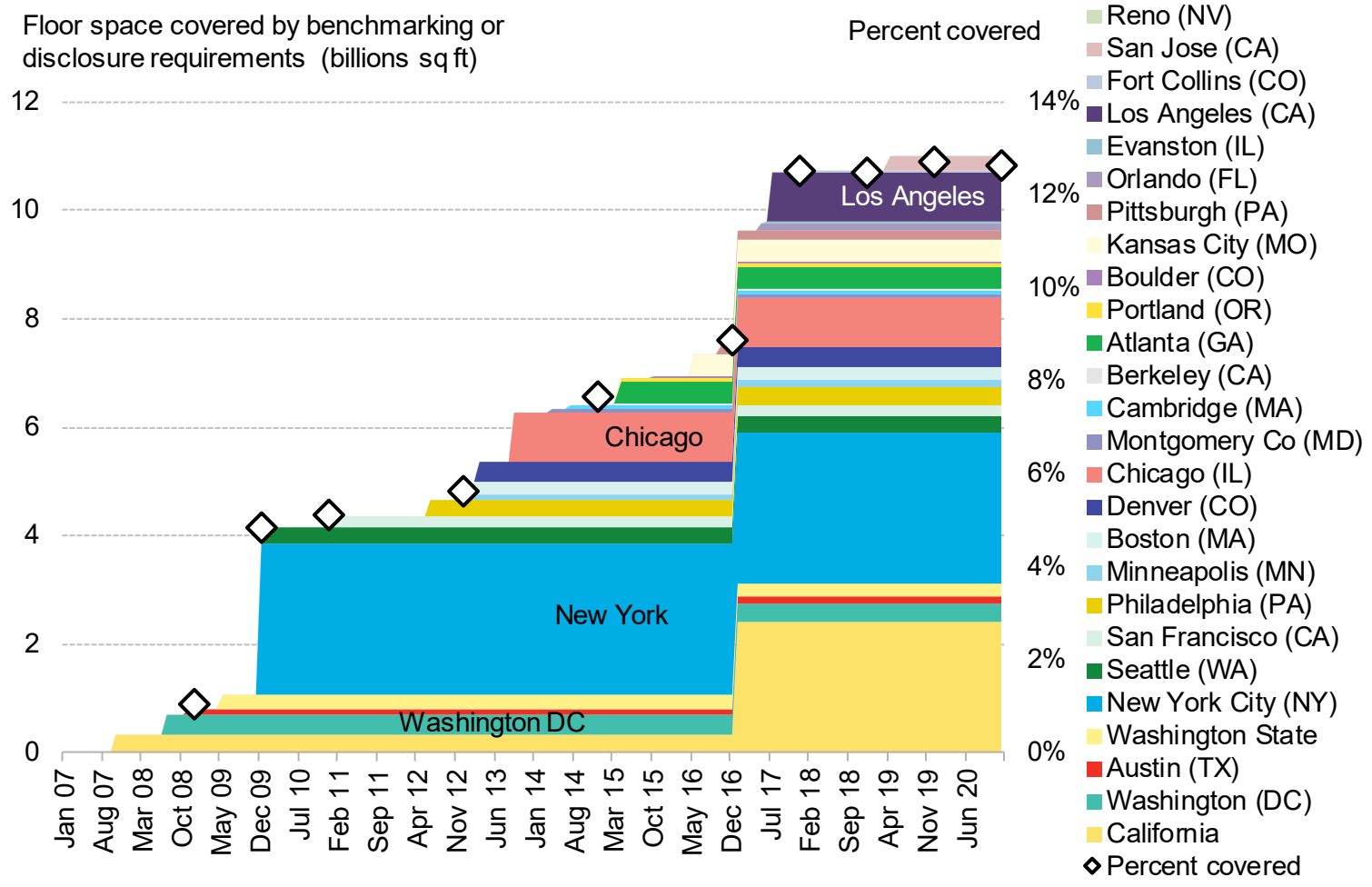
States with highest potential % savings, with adoption of unamended model code (2018 IECC)



- The majority of states have adopted some version of the International Energy Conservation Code (IECC) for both residential and commercial buildings, including some of the nation's more populous states, which have adopted either the 2015 or the 2018 IECC (the two most recent versions). Many of the larger local jurisdictions have also adopted a recent version of the IECC, even if the states they are located in have not.
- The percentage of the U.S. population living in a jurisdiction that has adopted one of the most recent versions of the IECC (2015 or 2018 version) increased from 46% of the population in January 2018 to 69% and 74% of the population in January 2020 (residential and commercial buildings, respectively).
- In adopting these codes, some states make improvements that increase energy savings (e.g., California, Vermont, Washington state, and Washington, D.C.). However, many states have also adopted amendments that weaken the codes, resulting in greater building energy consumption. For states without the 2015 or 2018 codes – or states with excessive weakening code amendments – adopting the most recent model code (without amendments) presents a significant opportunity to lower consumer costs and address climate change.

Source: U.S. Department of Energy, NYSERDA, ECOTOPE, NEEA, BloombergNEF.

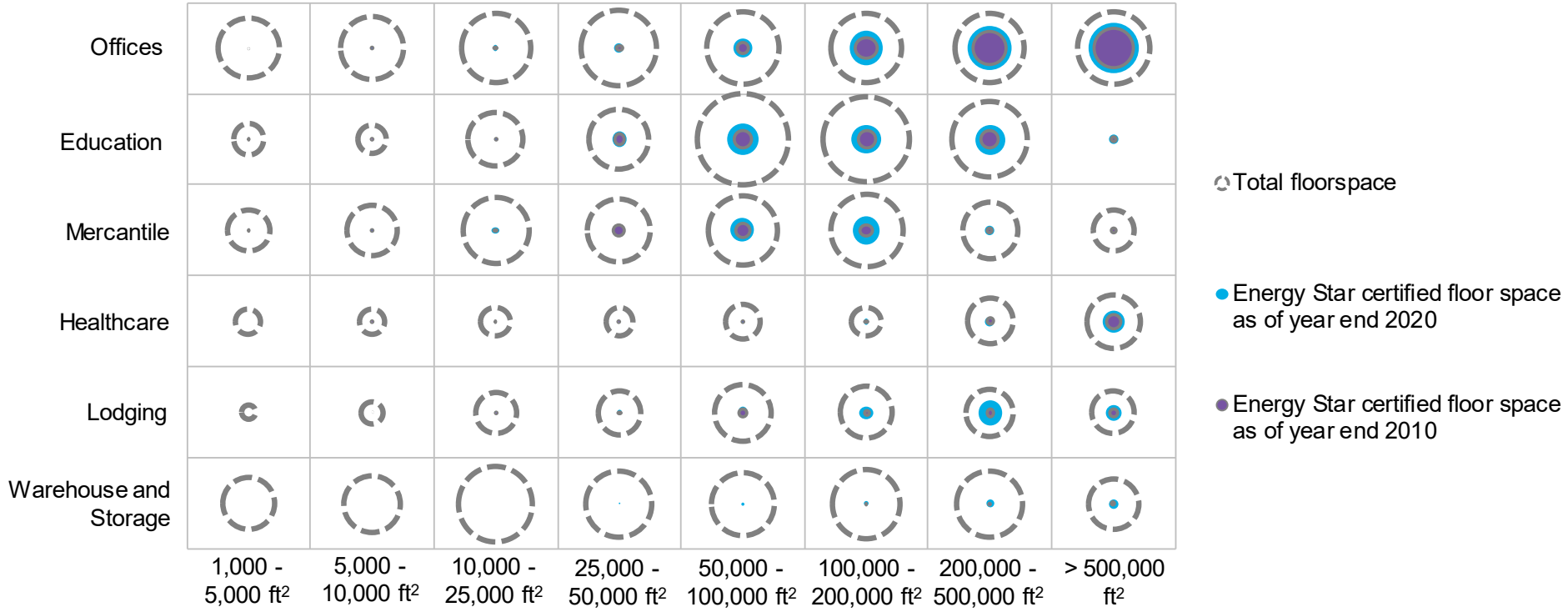
Policy: U.S. building floor space covered under state or local energy use benchmarking/disclosure policies



- To boost transparency of building energy usage, states and cities have created building energy use policies such as energy efficiency benchmarks and mandates. The square footage of commercial building space covered by such policies jumped from 9% in 2017 to 13% in 2020, covering around 11 billion square feet.
- California's existing law required utilities to begin disclosing whole-building aggregated energy use data to owners of commercial buildings and multifamily homes at the start of 2017. On the county level, San Jose passed new benchmarking laws that came into effect for multifamily, non-residential and public/government buildings in May 2019.
- Similar laws for Reno, Nevada, also came into effect mid-2019. No significant laws came into effect in 2020.

Source: Institute for Market Transformation (IMT), U.S. DOE's Buildings Energy Data Book, BloombergNEF Notes: Accounts for overlap between cities and states (e.g., no double-counting between Seattle and Washington state). Assumes that the Buildings Energy Data Book's definition of floor space covered at least roughly corresponds to IMT's definition. Shaded areas show amount of floor space covered, diamonds represent percentage of U.S. commercial sector floor space covered.

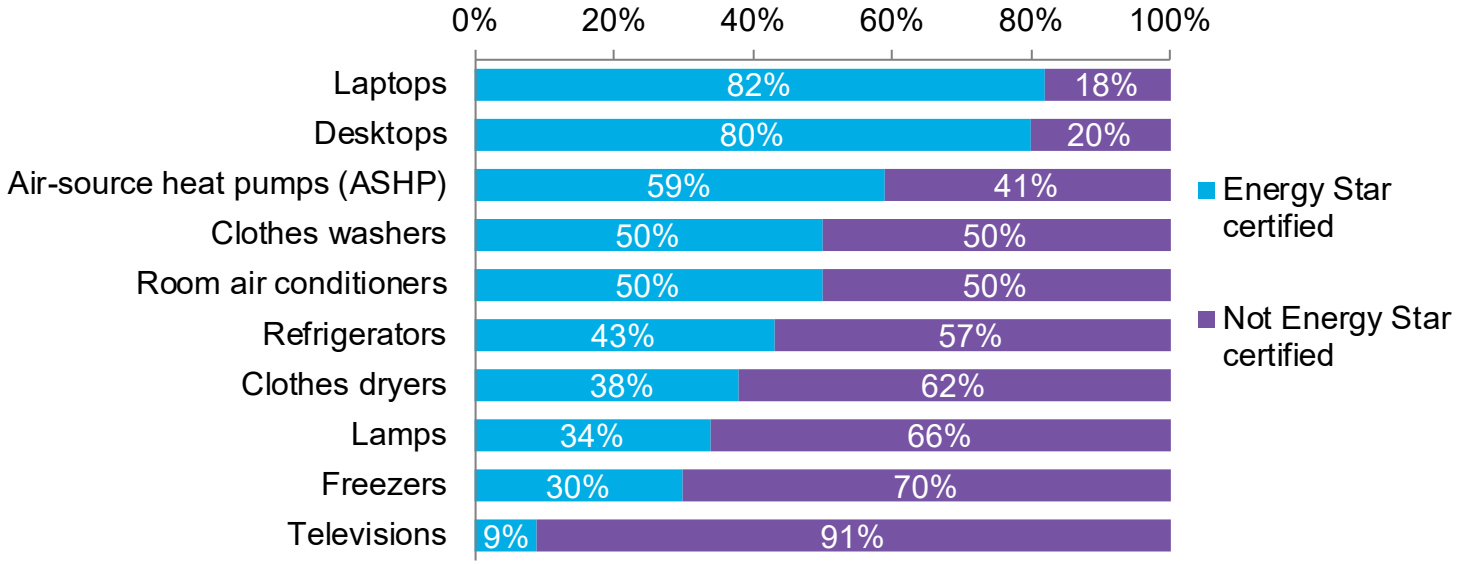
Deployment: Energy Star-certified floor space and total floor space for U.S. commercial buildings



- Energy Star certification is highest in large buildings, particularly offices. This is unsurprising given that the scale of large buildings means that certification can have a greater impact for the same amount of effort as would be the case for smaller buildings.
- Although the majority of early certification was in offices, the past decade has seen buildings used for education and retail emerge as important segments for certification. Warehouse and storage have had the largest improvements since 2010.
- Lodgings have had the largest improvement since 2019, with a 26% jump in energy star-certified floor space, likely driven by the interest and time to pursue certification during 2020, a time of otherwise low business and leisure travel given the Covid-19 pandemic.
- The key challenge remains finding an effective strategy for increasing uptake in buildings below 50,000 square feet, where uptake remains low.

Source: EPA, EIA, BloombergNEF Notes: There is insufficient data for total U.S. floor space of educational buildings in excess of 500,000ft².

Deployment: Energy Star-certified products sold by product type, 2019

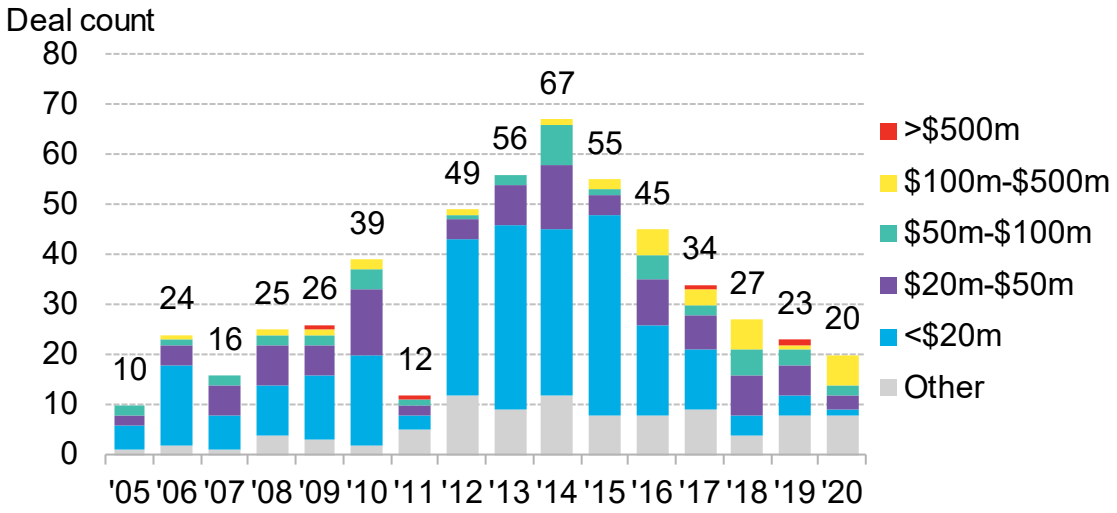


- Of the products considered, laptop computers have the highest rates of certification at 82%. In 2019, the percentage of certified desktop computers certification increased significantly to 80% from 63% in 2018. This may be driven by consumer preference for more efficient computers.
- Televisions had a significant dip in Energy Star-certified products, from 58% certified in 2018 to just 9%. This is most likely due to a more stringent requirement in the certification approved in March 2019.
- Air conditioning products remain among the products with lower certification rates, but made significant improvements in 2019. Room air conditioning is at 50% Energy Star certified, up from 42%.
- Penetration rates can change year to year due to factors such as actual increases in the number of Energy Star-certified products, as well as falling penetration due to the introduction of new, more stringent certification standards or the introduction of new products that are not certified.

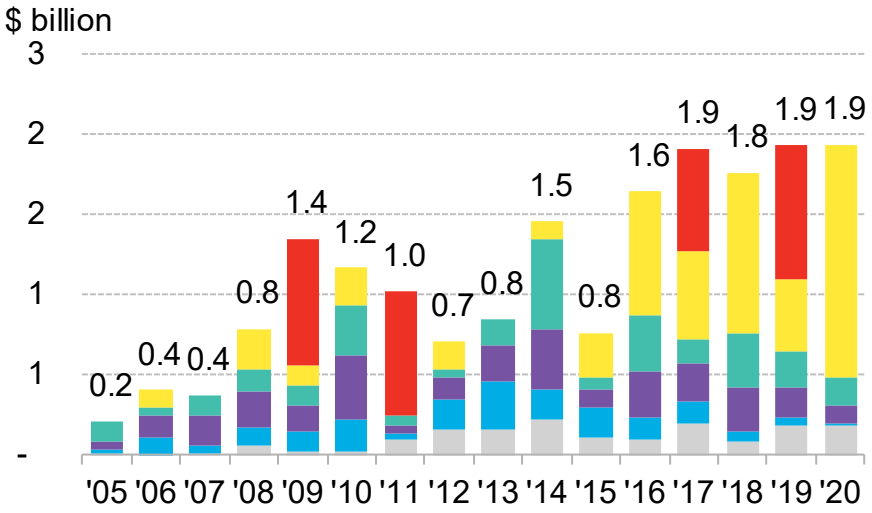
Source: Energy Star, BloombergNEF Note: Non-exhaustive selection of appliances; share of certified appliances sold is based on sales data compiled by Energy Star.

Policy: U.S. federal energy efficiency contracts

Number of deals



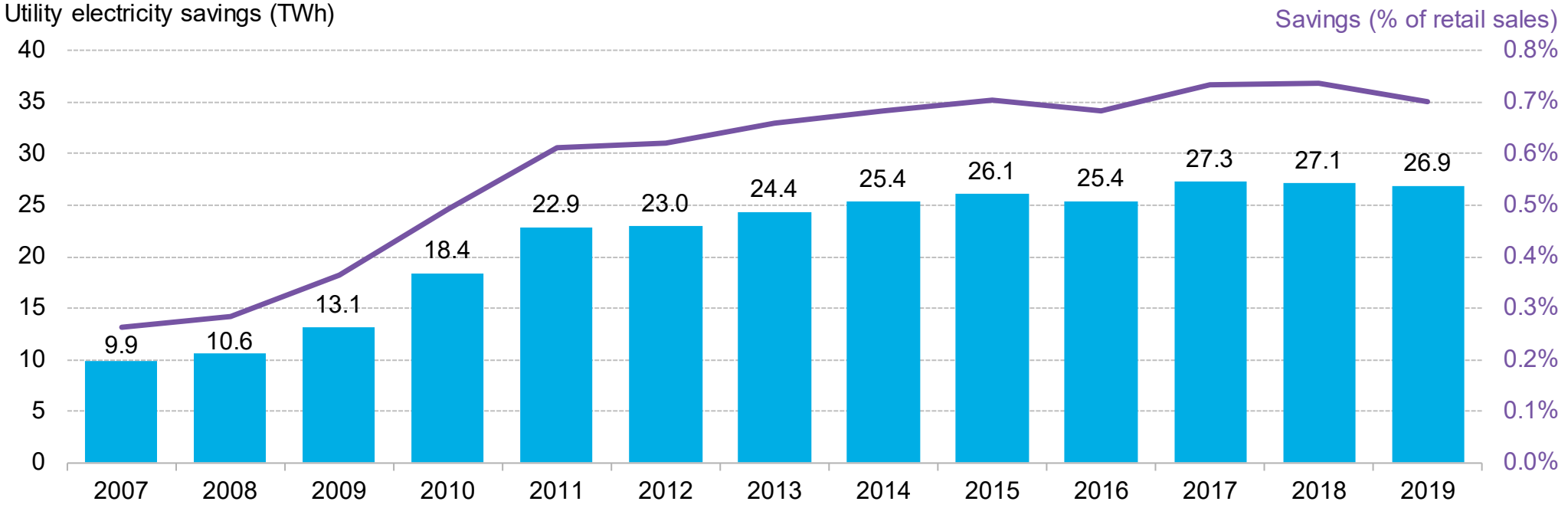
Total contract values



- Federal government entities signed $1.9 billion of energy efficiency contracts in 2020. These charts contain the most up-to-date energy service performance contract (ESPC) and utility energy service contract (UESC) data accounted for and made available by the federal government.
- Federal ESPCs and UESCs have average lifetimes of 16 and 15 years, respectively. These longtime horizons (as compared to those under contracts in the commercial sector) are typical for government agencies.
- President Obama's efficiency targets set in 2014 marked a shift toward larger projects, particularly for ESPCs. While the number of deals struck continued to decline in 2020, the average deal size has increased over four-fold since 2014. Larger deals included more comprehensive energy efficiency retrofits (including buildings and power system upgrades), touching on multiple sectors of the energy economy.
- The largest project in 2020 was a $170 million water and energy distribution, distributed power generation, and building system upgrade at a naval shipyard in Virginia.

Source: Federal Energy Management Program (FEMP), U.S. Department of Energy (DOE), USACE, BloombergNEF Notes: Totals here are summed in terms of calendar years in order to facilitate comparison with government targets, as opposed to DOE sources which commonly sum over fiscal years. The figures are the most comprehensive provided by the federal government but do not include data for every federal agency.

Deployment: Incremental annual energy efficiency achievements by electric utilities to date

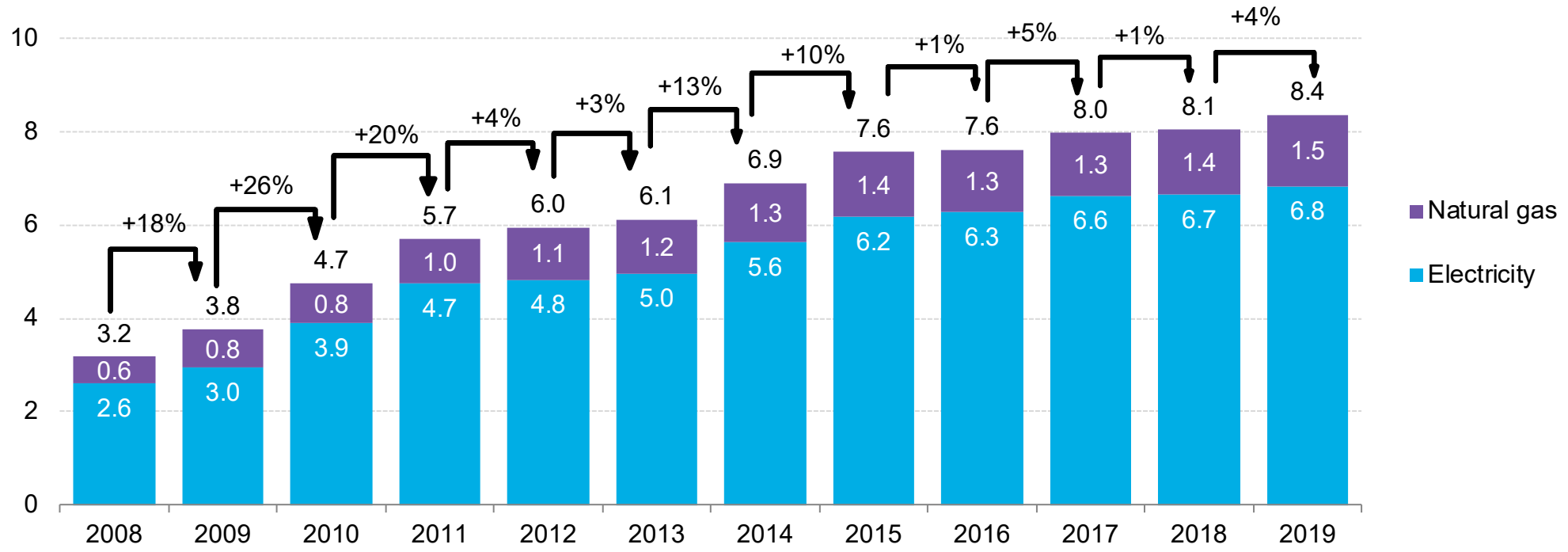


- The years leading up to 2011 saw a growing number of states introducing Energy Efficiency Resource Standards (EERS) mandating utilities to invest in energy savings among their customer-base. There was a corresponding increase in investment in utility energy efficiency programs.
- Since 2011, the number of states with EERS policies in place has leveled off at 27 as investment growth has slowed. 2019 utility energy efficiency savings decreased slightly by 1% from the previous year, totaling 26.9TWh of energy and 0.7% of retail sales. The percentage savings relative to overall retail sales also declined by 0.8% from previous year.
- The ACEEE, which collects this data, attributes the difference to adjustments in its qualifying criteria for utility energy efficiency savings, rather than a decrease in energy efficiency activity.

Source: ACEEE Note: The ACEEE Scorecard points to caveats in the energy efficiency savings data reported by states. ACEEE uses a standard factor of 0.825 to convert gross savings to net savings for those states that report in gross rather than net terms. The ACEEE currently reports electric and natural gas savings separately in their report but a handful of states have been considering savings in a fuel-neutral basis, which is appropriate when electrification brings net positive effect on emissions, ACEEE may adjust methodology if practice becomes commonplace.

Financing: U.S. utility energy efficiency spending

$ billion

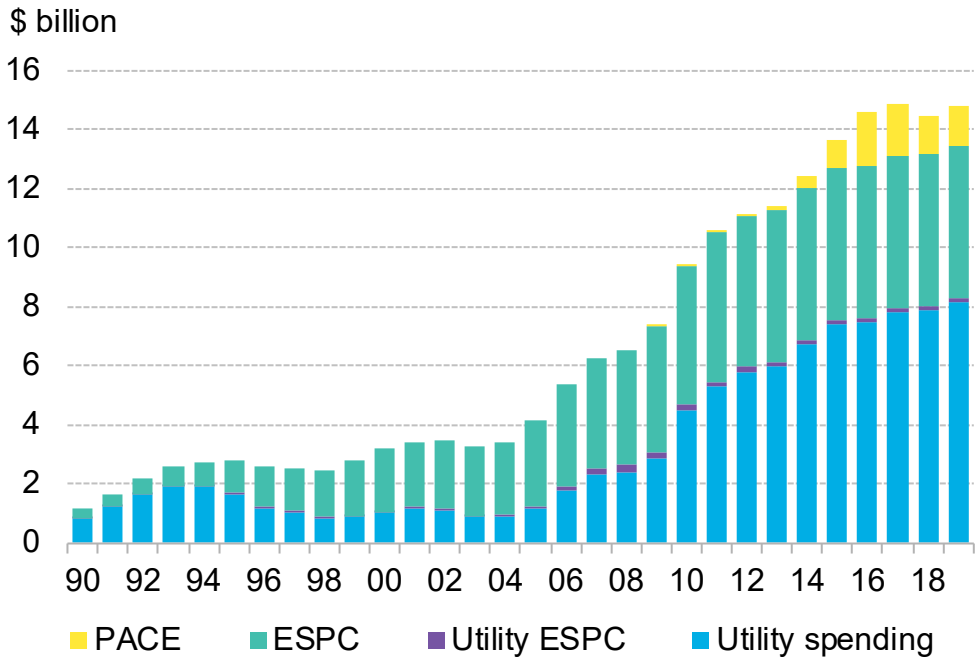


- In 2019, utility spending on energy efficiency kept pace at $6.84 billion for electricity and $1.53 billion for natural gas. Total spending is 4% higher than the previous year.
- Investment increased marginally nationwide, although the picture was more dynamic at the state level. Large states continue to spend large amounts. California invested the most in both natural gas, $386 million, and electricity, $1.5 billion. Texas saw the largest jump in electric program spending, up 19% to $92 million, and New York saw the largest jump in gas program spending, up 25% to $177 million.
- Nine states cut their efficiency budgets by more than 10% in 2019. Florida was the largest, dropping to $132 million (-41%). Florida was followed by Washington ($218 million, -27%), Iowa ($57 million, -37%) and Wisconsin ($99 million, -14%).

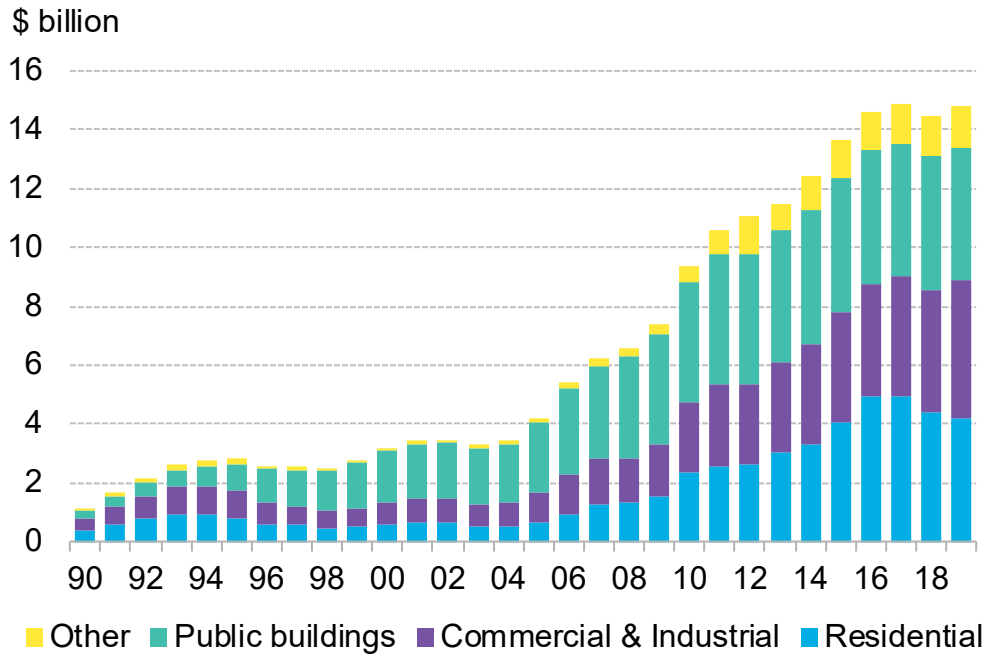
Source: CEE, ACEEE, BloombergNEF. Note that data for 2010-14 was sourced from CEE, and for 2006-2009 and 2015-20 from the ACEEE.

Financing: U.S. estimated investment in energy efficiency through formal frameworks

By framework



By sector



- Total U.S. spending on energy efficiency through formal frameworks rebounded to an estimated $14.8 billion in 2019, hovering just 1% below the 2017 peak.
- Utility spending and Energy Savings Performance Contracts (ESPC) remain the most important frameworks. The Property Assessed Clean Energy (PACE) mechanism had been the fastest source of growth from 2013-2016 and again saw significant (8%) growth in 2019. On the state level, residential PACE investment volumes have trended down in California while trending up in Florida for the past four years.
- While our estimate for ESPC investment has leveled off in recent years, there is a certain amount of extrapolation involved due to the lack of detailed data on the market.

Source: ACEEE, NAESCO, LBNL, CEE, IAEE, PACENation, BloombergNEF Notes: The values for the 2015-19 ESPC market size shown are estimates. The most recent data from Lawrence Berkeley National Laboratory report revenues of $5.3bn in 2014. The 2015-19 estimates are based on a continuation of 2011-14 growth rates.

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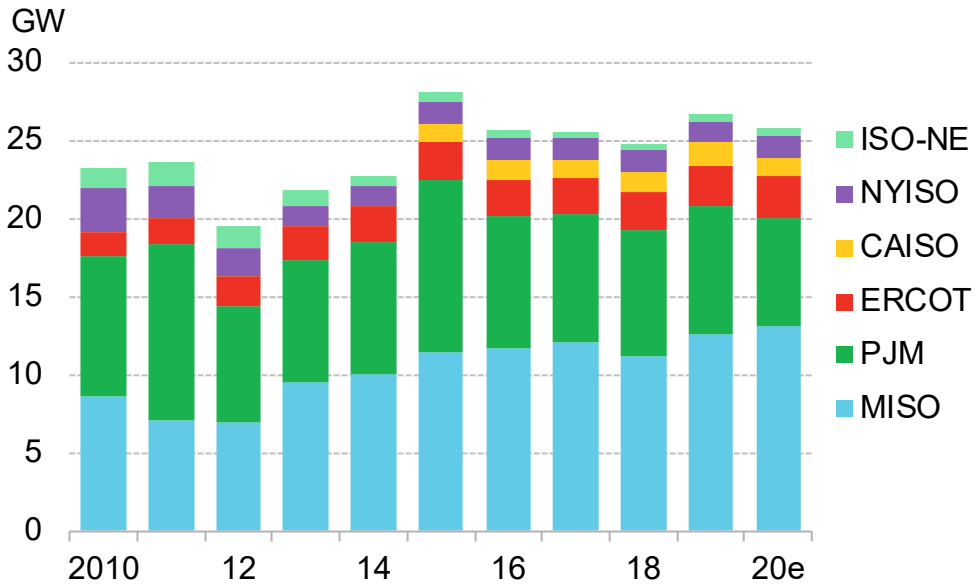
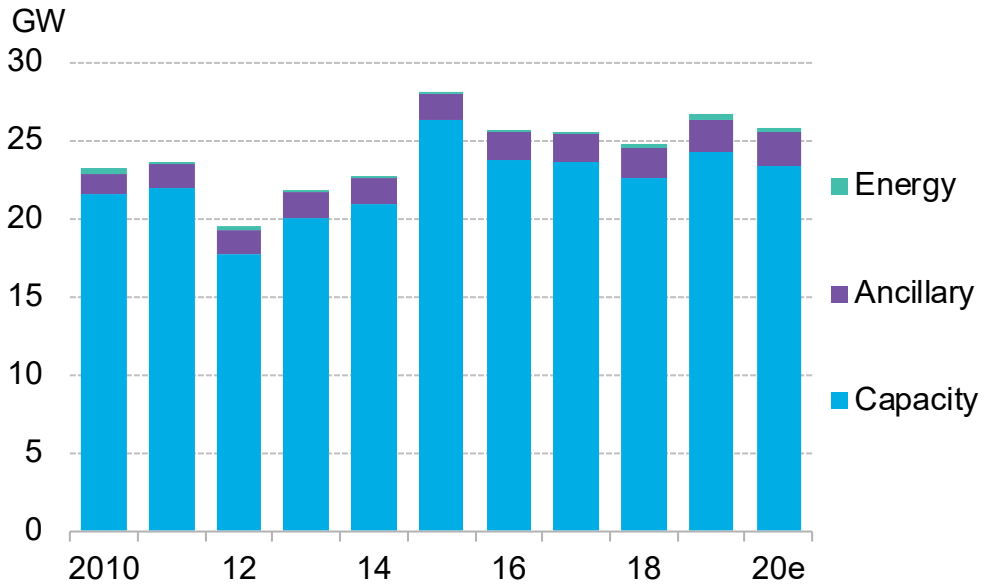
Deployment: U.S. wholesale demand-response capacity

By market



By application

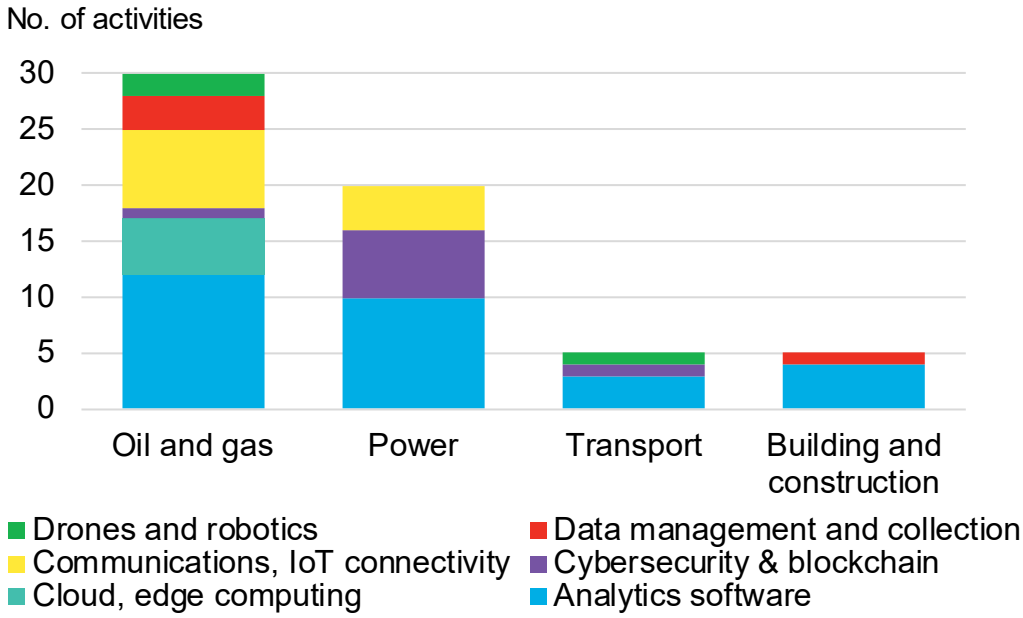


- Demand response (DR) capacity in U.S. wholesale markets declined in 2020. Gains in MISO were more than offset by declines in CAISO and PJM. ERCOT, ISO-NE and NYISO remained more or less flat compared to 2019. The vast majority of wholesale demand response is concentrated in capacity markets and reliability mechanisms.
- In PJM, there is 1.3GW, or 16%, less demand response capacity committed for 2020/21 than the previous year. PJM has been phasing in its annual capacity requirement for the past four capacity auctions and the 2020/21 delivery year was the first time that 100% of capacity must be available year-round. It does, however, provide a matchmaking service for summer and winter resources.
- In CAISO, the Demand Response Auction Mechanism capacity halved in 2020 from 373MW to 176MW. In 2019, the California Public Utilities Commission ordered a four-year extension of the program. It also required utilities to make a number of changes such as penalties for underperformance and requiring providers to provide customer composition information.

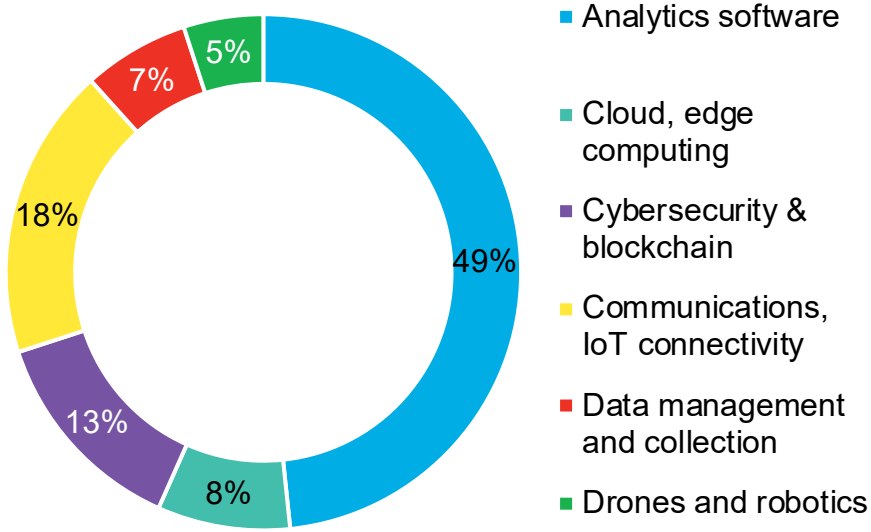
Source: BloombergNEF; Federal Energy Regulatory Commission, 2020 Assessment of Demand Response and Advanced Metering. Note: Capacity is the peak amount of capacity available, ancillary services are the annual average. Demand response was only formally integrated with the CAISO market in 2015.

Deployment: Progress in the digitalization of the energy sector

Industrial digitalization activity in U.S. by sector and technology, 2020



Most common technologies adopted in U.S. industrial digitalization for energy, 2020

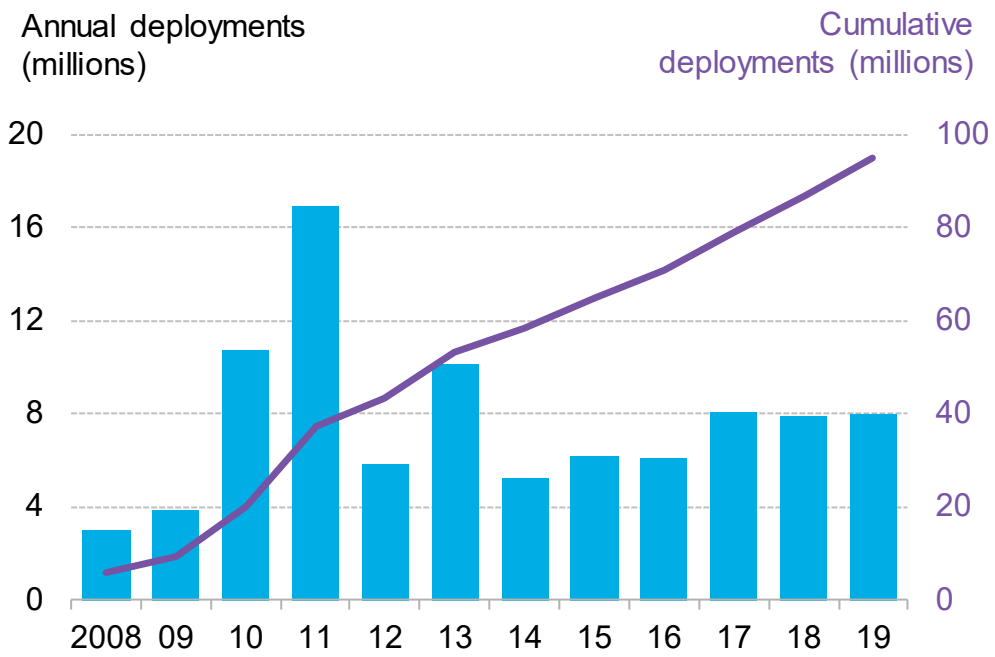


- Of U.S.-based companies, Honeywell, Halliburton and Microsoft announced the most digital projects and partnerships in the energy sector in 2020. With the ongoing pandemic, energy companies have become more reliant on remote monitoring and cloud computing to continue operations. Analytics software such as artificial intelligence and predictive maintenance accounted for around half of 2020 activity.
- In the U.S., energy companies are fast adopting smart meters, IoT sensors, analytics platforms, cloud computing, drones and other technologies. The oil and gas sector was the most active, comprising 50% of total U.S. activity in 2020. Service providers Halliburton and Schlumberger were particularly active in partnering with cloud providers Microsoft, Amazon and IBM. In the power sector, utilities such as Edison, Ameren, Southern and NYPA are all building smart grid technologies and working with software providers GE, Schneider Electric, Siemens and startups to reap the benefits of reduced operating costs and less outages.
- However, regulated utilities have not been the most active corporations in announcing new projects because they cannot rate-base any cloud computing or other software purchases, making them slower to adopt large digital projects compared to European and Asian peers.

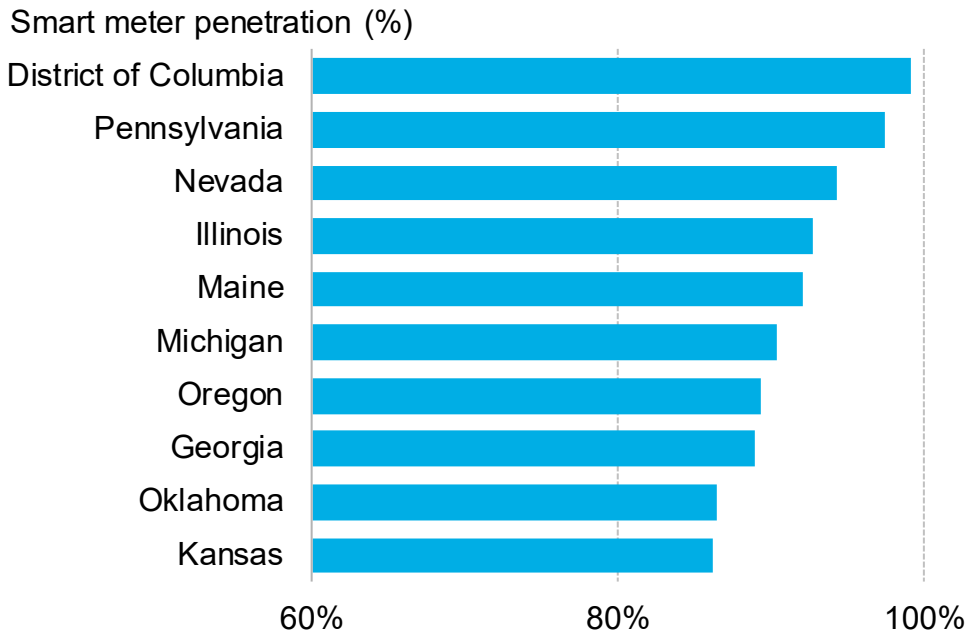
Source: BloombergNEF

Deployment: U.S. smart electricity meter deployments

U.S. smart meter deployments



Top 10 states by penetration, 2018



- Smart meter installations hit a peak in 2011, supported by stimulus funding awarded in 2009. Many of the largest U.S. utilities took advantage of the Smart Grid Investment Grant to roll out smart meters across their territories. As grant funding dried up, deployments slowed, hitting a trough in 2014. Smart metering activity has since picked up though it remains well below the peak of 2011.
- At the end of 2019, 60% of U.S. electricity customers had a smart meter, but with enormous regional variation. The top 10 states all had penetration greater than 86% whereas 22% or fewer customers had smart meters in the bottom 10 states. In 2019, Florida accounted for 15% of new smart meters, with 1.2 million deployed. The next most active states were Texas, Indiana, Ohio, New York, the District of Columbia, and Louisiana, each deploying 400,000 to 600,000.

Source: BloombergNEF, EIA. Note: there is a 10-month lag in official smart meter statistics.

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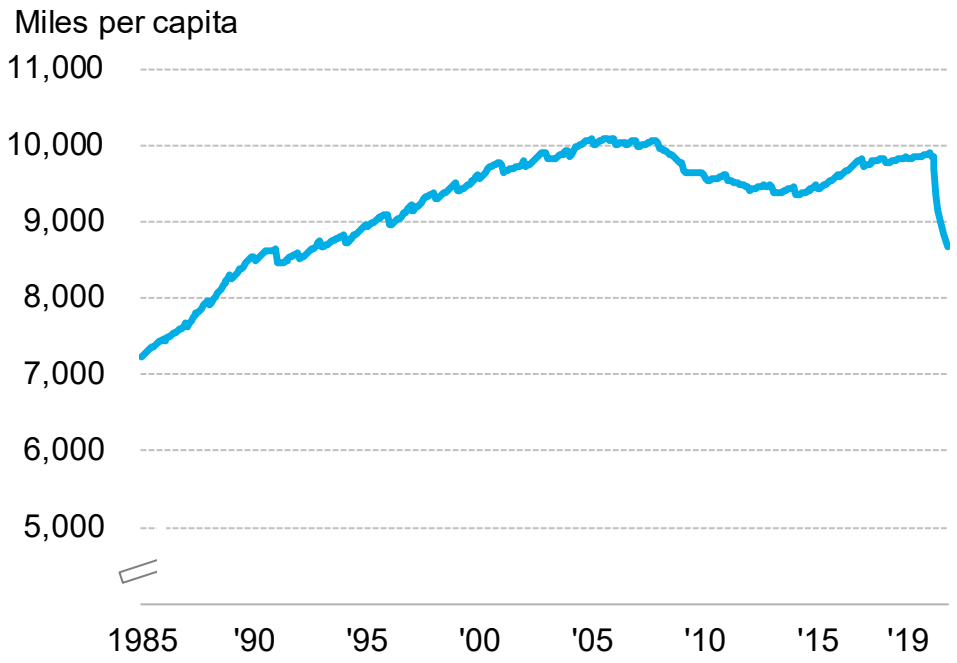
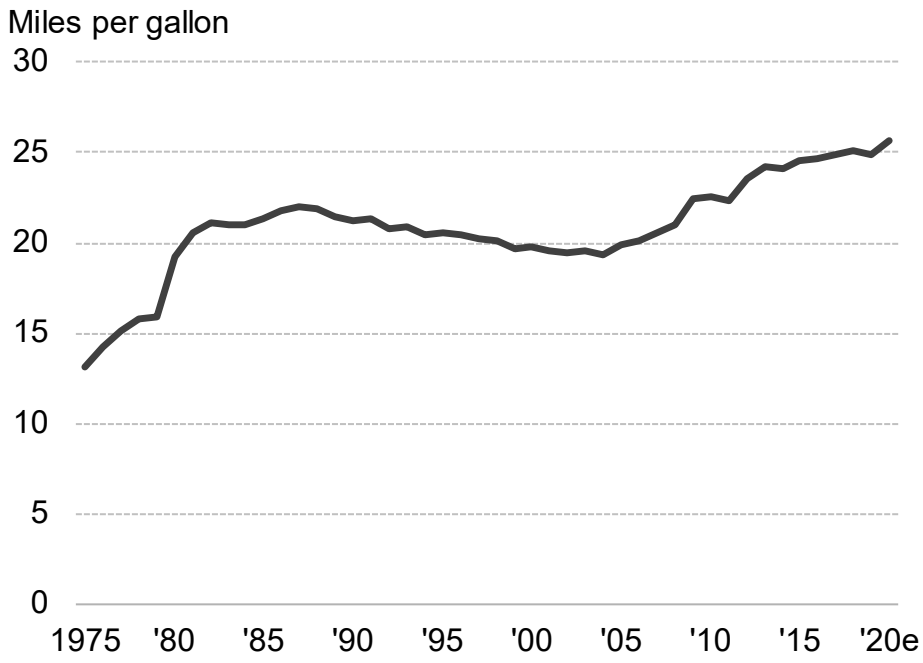
Deployment: U.S. gasoline consumption and fuel economy

U.S. vehicle miles traveled, per capita



U.S. light-duty vehicle real-world fuel economy

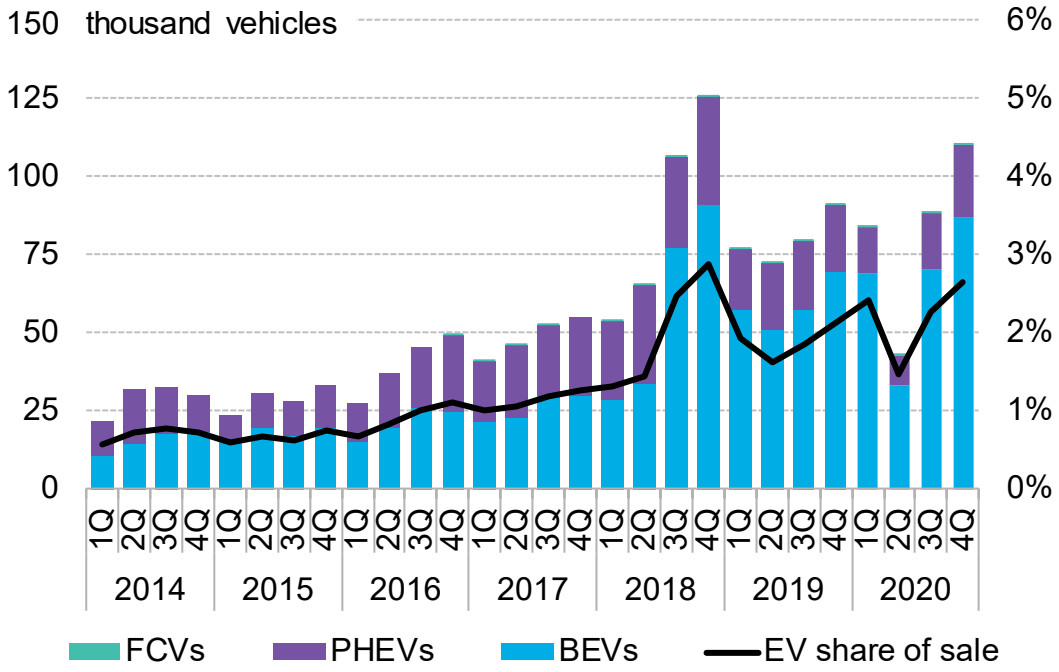


- Vehicle miles traveled per capita dipped steeply in 2020, after holding fairly steady for the few years prior. Americans drove the least they had since the winter of 1993 and 6% less than they did in 2019. This reflects the 2020 trend of depressed transportation sector activity and energy consumption generally. Prior to 2020, lower fuel prices helped spur mild increases in travel: gasoline prices in November 2019 sat 10% below their recent 2014 peak of $3/gallon, and 35% below the all-time high reached in 2008 of $4.11.
- In 2020, vehicle sales fell across the board, although SUVs saw the smallest drop. Between 2019 and 2020, SUV sales fell 10.5% whereas large, medium and small passenger car sales fell by a total 30%. Despite 2018 and 2019 gas prices hitting their highest levels since 2014, Americans continued to purchase heavier, less fuel-efficient vehicles prior to 2020. Sport-utility vehicle sales increased 8.4% from 2017 to 2018 and 3.7% from 2018 to 2019. Meanwhile, large, medium and small passenger car sales fell in both of those time frames .

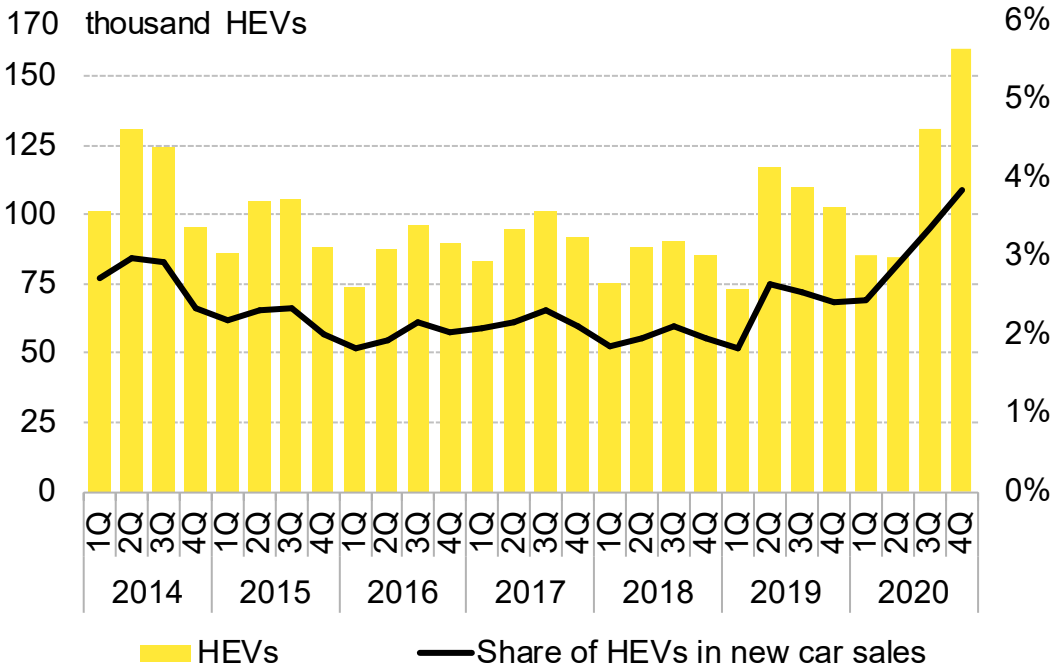
Source: Federal Highway Administration, Census.gov, EPA, DOE, Marklines, BloombergNEF Note: Miles per gallon are estimated real-world fuel economy as calculated by the EPA.

Deployment: Electric vehicle and hybrid electric vehicle sales in the U.S.

U.S. EV and FCV sales



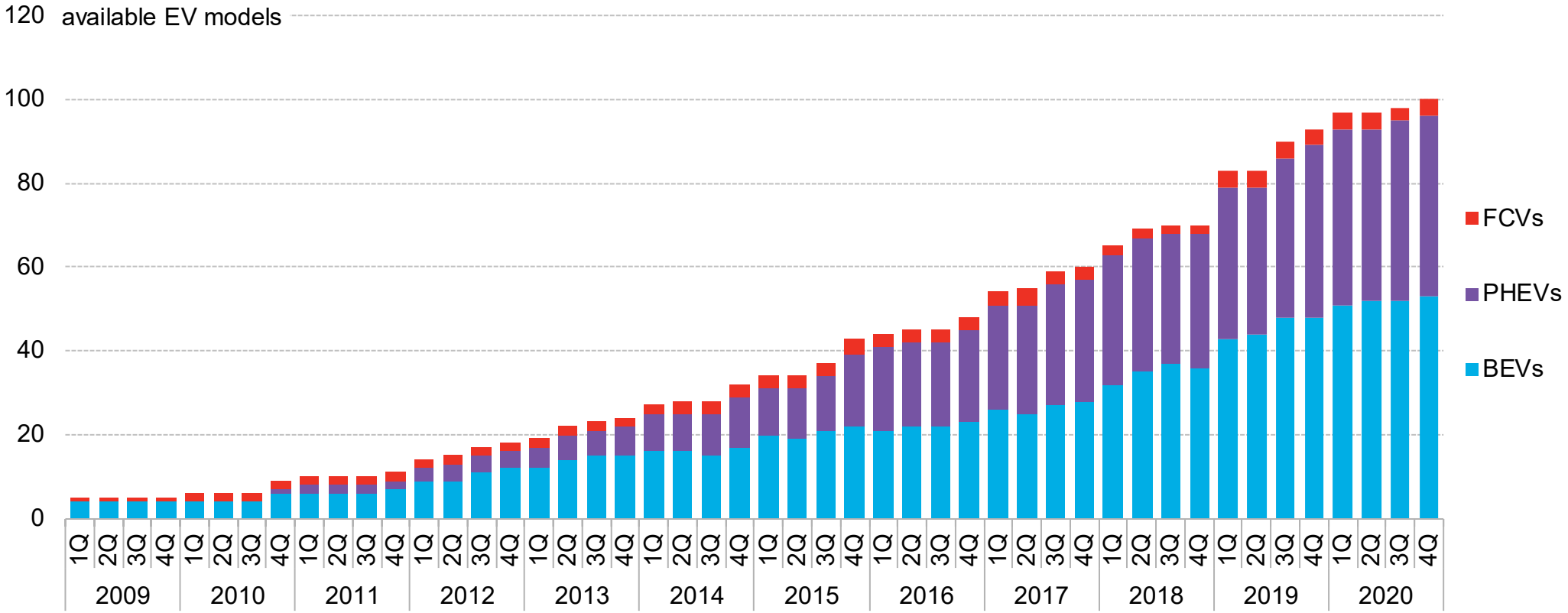
U.S. HEV sales



- Sales of electric vehicles (EVs) – a category that includes battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) – were flat last year, increasing from 320,000 units in 2019 to 325,000 units in 2020. Much of the auto industry was harmed by the strength of the Covid-19 pandemic.
- The Tesla Model 3 continues to be the highest selling EV at 119,000 units. Tesla, which sold 206,000 BEVs in total, accounted for nearly 63% of overall U.S. EV sales in 2020.
- BEV sales increased 10% year-over-year, reaching 259,000 units. Meanwhile, PHEV sales fell 22% year-over-year – totalling 66,000 units.
- Sales of hybrid electric vehicles (HEVs) reached 361,000 units in 2020 – a 15% increase from 2019. Sales of fuel cell vehicles (FCVs), meanwhile, decreased by 61% compared to 2019, falling to over 900 units.

Source: BloombergNEF, Bloomberg Terminal, Marklines. Note: PHEV stands for plug-in hybrid electric vehicle, BEV stands for battery electric vehicle, HEV stands for hybrid electric vehicle and FCV stands for fuel cell vehicle. EV includes BEVs and PHEVs. FCV sales data not available prior to 2016. FCV sales numbers too low to be visible.

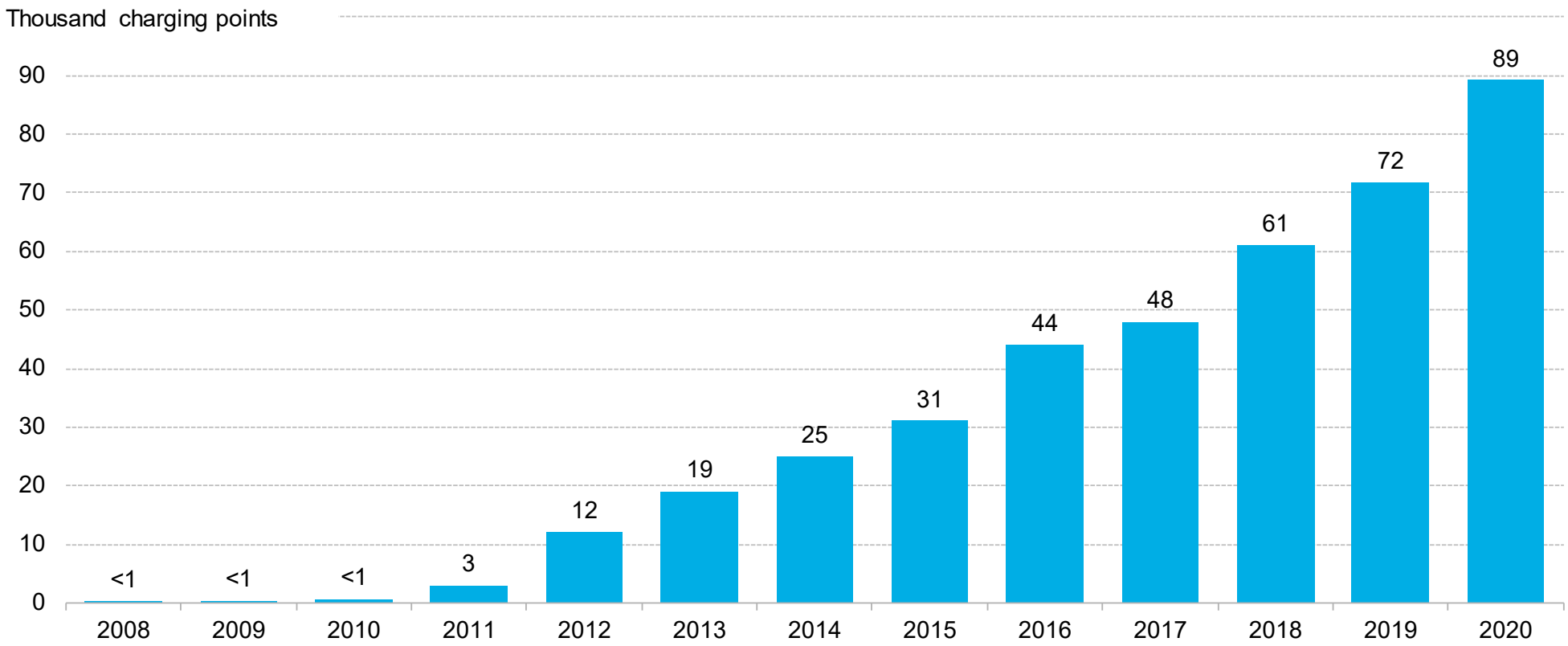
Deployment: EV and FCV model availability in North America



- By year-end 2020, consumers in North America looking for a new passenger vehicle had access to 4 FCVs, 43 PHEVs and 53 BEVs.
- The availability of BEVs has grown by 194%, growing from 18 in 1Q 2016 to 53 in 4Q 2020. Having taken market share from PHEVs, BEVs now account for over 53% of all EV and FCV models on offer.
- New EVs launched in 2020 included the Tesla Model Y (BEV), Polestar 2 (BEV) and Toyota RAV4 Prime (PHEV).

Source: BloombergNEF, Marklines. Note: EV includes BEVs and PHEVs. FCV stands for fuel cell electric vehicle, PHEV stands for plug-in hybrid electric vehicle and BEV stands for battery electric vehicle. Data as of December, 31 2020.

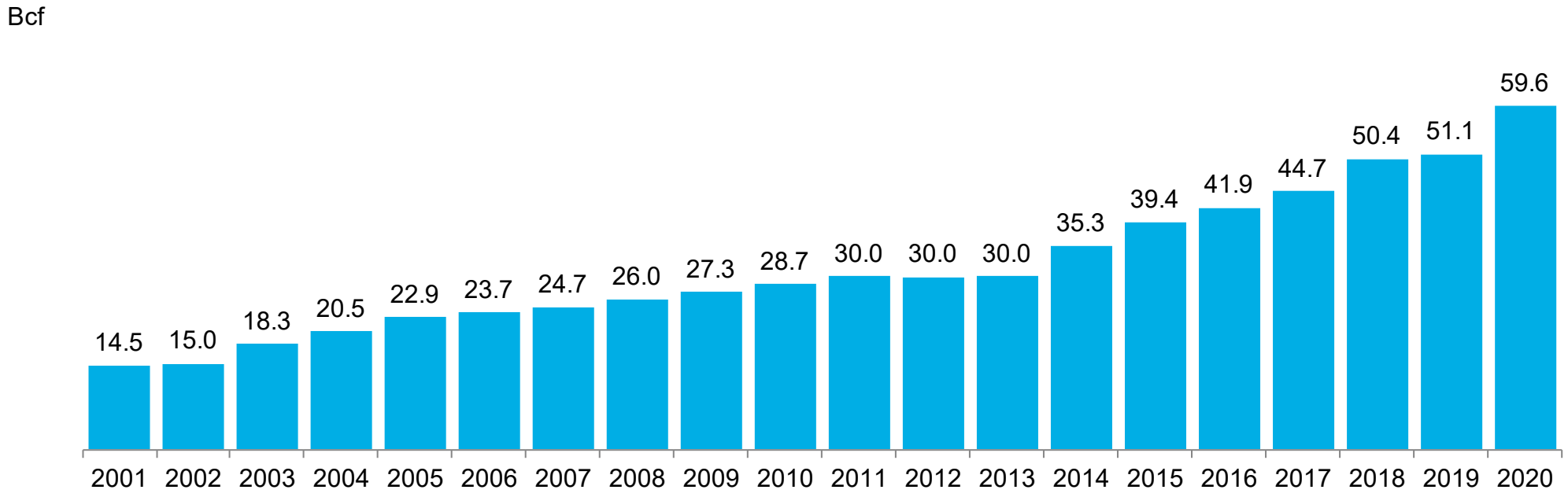
Deployment: Public EV charging points in the U.S.



- As of year-end 2020 there are about 89,000 public EV charging points in the U.S., an increase of 24% from at the start of 2019. The 17,000 chargers installed were a record, surpassing the previous record of 13,000 installed in one year.
- About 81% of these EV charging outlets are Level 2 or less. Another 19% are fast or ultra-fast.
- As in 2019, about 32% of the EV charging outlets are in California. The number of EV charging outlets is much lower in other states.
- Despite the build-out of public EV charging infrastructure, the majority of EV charging in the U.S. continues to take place at home, usually with Level 1 or Level 2 outlets.

Source: BloombergNEF, U.S. Department of Energy. Note: Data does not include residential EV charging infrastructure.

Deployment: Natural gas demand from natural gas vehicles on U.S. roads

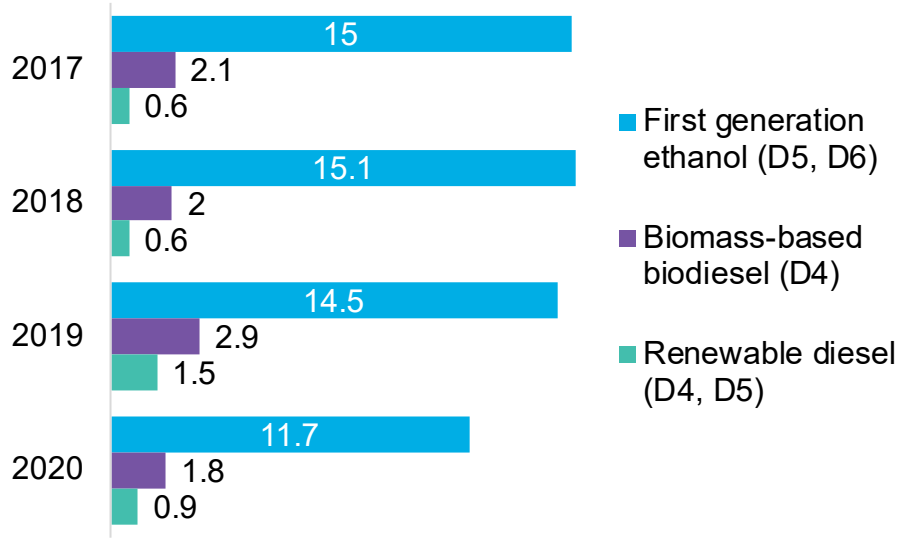


- Natural gas use in vehicles has grown steadily since 2013, and jumped 16% in 2020 from the year prior to reach 60Bcf. This represents a 7.6% compound annual growth rate over the last decade. A consumption uptick in 2014 coincided with the start of a period of low natural gas prices across the U.S.
- Compressed natural gas (CNG) remains more widely used than liquefied natural gas (LNG), and this is reflected in the amount of fueling infrastructure available for each technology. As of October 2019, there were 1,591 CNG stations across the U.S., compared to 119 LNG stations (including public and private stations). The number of CNG stations shrank by 4% from 2018, and the number of LNG stations fell by an even steeper 13%.
- Comparatively, there are now 2,991 propane stations in U.S., down 4% from 2019. Of these, 950 are primary propane refueling stations, a number that increased by 16% from 2019. There are 20,090 propane school buses deployed in 48 states.

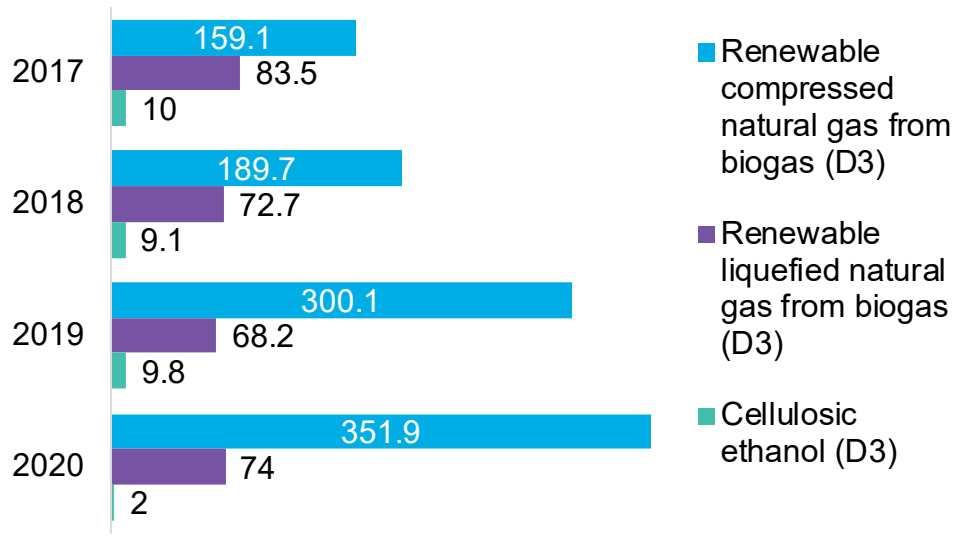
Source: EIA, natural gas monthly Notes: Values for natural gas demand in 2020 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through September 2020). Data exclude gas consumed in the operation of pipelines.

Policy: Volumes of biofuels blended under the federal Renewable Fuels Standard

First generation biofuels (billion gallons)



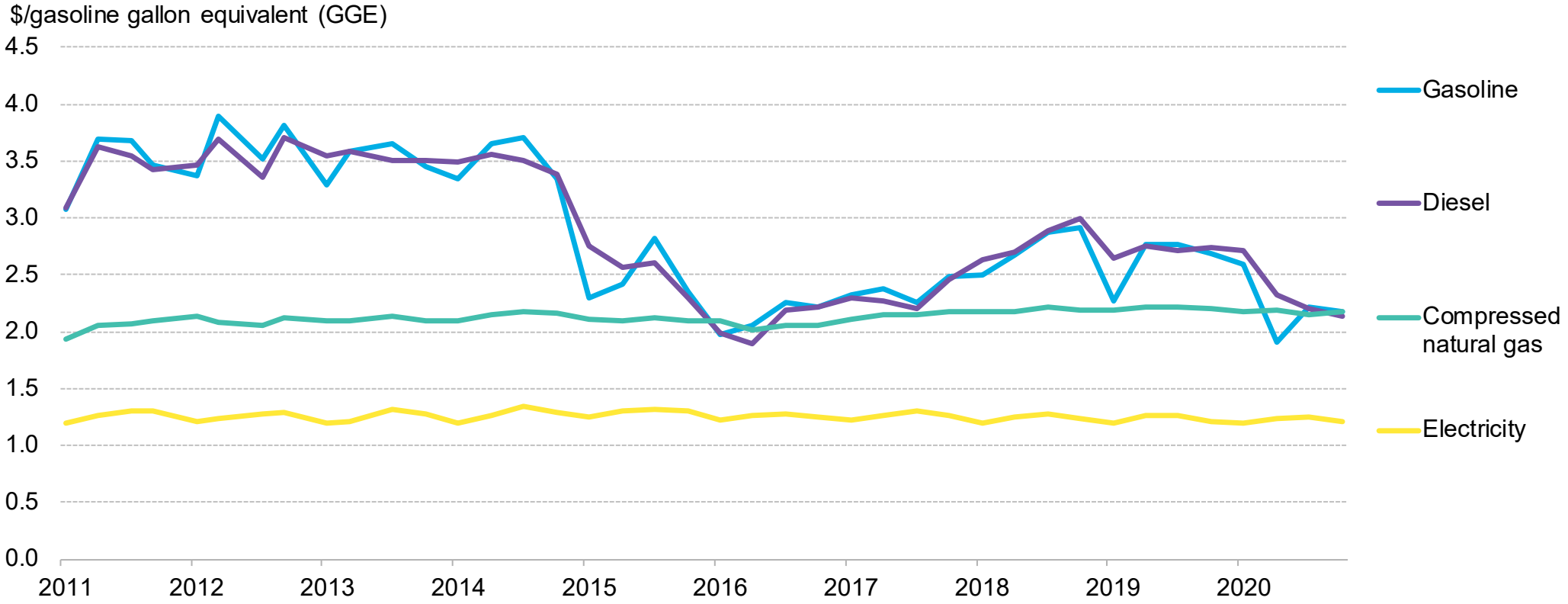
Next generation biofuels (million gallons)



- Each gallon of biofuel receives a renewable identification number (RIN) upon blending, which the blender can count towards annual mandated targets or sell to other blenders who otherwise would not meet targets. Prices rose through 2020 for biomass-based diesel and advanced biofuel RINs (D4 and D5), which in both cases began the year at less than $0.50 and ended it within a few pennies of $1.
- The highest value are cellulosic or 'next generation' biofuels. These include cellulosic ethanol, diesel and biogas (including renewable natural gas), which are made from non-food feedstocks and possess low carbon footprints. Cellulosic RINs (D3) recovered from a low of $0.98 during the March 2020 pandemic retreat to more than $2 at year-end.
- Using RINs as a proxy for physical volumes, we estimate that refiners blended an estimated 14.4 billion gallons of first-generation biofuels in 2020, 32% less than in 2019. The volume of next-generation biofuels blended in the year grew 13% to 428 million gallons.

Source: BloombergNEF, EPA Notes: Fuels under the Renewable Fuel Standard are categorized by D codes, to determine fuel type. D3 stands for Cellulosic Biofuels, D4 for Biomass-based Diesel, D5 for Advanced Biofuel, D6 for Renewable Fuel, D7 for Cellulosic Diesel. See the EPA's website for more information. Volumes exclude imported biofuels.

Economics: Average gasoline, diesel, natural gas and electricity prices for vehicles in the U.S.



- Electricity has been the most competitive fuel for transportation in the U.S. for over a decade, remaining well below gasoline prices. In 2020, this discount remained greater than 40%. This can help overcome the larger upfront cost of a battery-electric vehicle, which is already decreasing due to falling battery prices and will approach upfront price parity by mid-decade in the U.S.
- Compressed natural gas (CNG) enjoyed a substantial discount to diesel and gasoline from 2011-2014, but falling crude oil prices erased this gap in 2015 and 2016. While CNG had a 25% discount to gasoline and diesel in 2019, as of October 2020, there was no discount.
- Electricity and CNG prices are generally less volatile than gasoline and diesel prices.

Source: BloombergNEF, U.S. Department of Energy. Note: Data as of October 1, 2020.

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