Sustainable Energy in America 2023 Factbook

Tracking Market & Policy Trends

BloombergNEF

The Business Council for Sustainable Energy®

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About the Factbook: 2023 updates

What is it?

- The Factbook **aims to augment existing sources** of information on US energy
- It **focuses on renewables, efficiency, natural gas, distributed power and storage, as well as sustainable transportation**
- It **fills important data gaps** in certain areas (e.g., clean energy investment flows, contribution of distributed energy)
- It **contains data through the end of 2022** wherever possible
- It **employs BloombergNEF data** in most cases, augmented by the Energy Information Administration, the Environmental Protection Agency, the Federal Energy Regulatory Commission, The American Council for an Energy-Efficient Economy, Lawrence Berkeley National Laboratory, and other sources where necessary.
- It **contains the very latest information on new energy technology costs**
- It **has been graciously underwritten by the Business Council for Sustainable Energy** with the help of supporting sponsors
- This is the Factbook's 11th edition (first published in January 2013)

What's new?

- This year's report contains annual views of and commentary on driving factors in the energy sector. It includes new data on multiple sectors plus discussion around implications of the Inflation Reduction Act, the landmark climate law Congress passed in August 2022.

About the Factbook: Sponsorship

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 *Sustainable Energy in America Factbook* is commissioned by the BCSE and supported by the generous contributions of the following sponsors: Adobe, American Clean Power Association, American Gas Association, Clean Energy Buyers Association, Copper Development Association, Covanta, CRES Forum, Johnson Controls, JPMorgan Chase, National Grid, National Hydropower Association, Polyisocyanurate Insulation Manufacturers Association, Sacramento Municipal Utility District, Schneider Electric, Sempra, Solar Energy Industries Association, Trane Technologies, and Washington Gas.

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Executive summary (1 of 7)

Confronted with inflationary pressures and an uncertain economic outlook, the US made key strides decarbonizing its energy sector in 2022. In Washington, Congress passed legislation that provided record-setting funding for the energy transition, showing it is serious about climate leadership. Largely in response, during the last third of the year a slew of solar, battery and other clean energy equipment makers announced plans for new manufacturing plants on US soil.

Here are some of the high-level findings from this year's Sustainable Energy in America Factbook:

- **Total US total energy consumption rose 2.95%** year-on-year as the US economy continued to rebound from the worst effects of the Covid-19 pandemic.
- **A record-shattering $141 billion in energy transition financing was deployed in the US** for clean energy technologies, including renewables, electric vehicles and others.
- **32GW of new renewable power-generating capacity was added to the US grid,** down from 37GW commissioned in 2021. This was due to higher costs, trade challenges and other issues.
- **However, renewables broke records in 2022,** by meeting 13% of total US energy demand and 23% of electricity demand.
- **The US remains the largest energy storage demand market in the** world and commissioned an estimated 4.8GW of non-hydropower storage capacity in 2022.
- **EV sales surged 50% to nearly 982,000, or 7.1% of new cars sold.** This was despite rising battery costs and semiconductor shortages.
- **Bucking a long-term trend, US "energy productivity" stalled slightly in 2022** as energy consumption outpaced economic growth, resulting in a 1% decline. Over a decade, however, US GDP has grown 22.9% while primary energy consumption has risen 6.7%. The result: a 15.2% increase in energy productivity.
- **Corporations signed contracts to purchase a record 19.9GW of zero-carbon power**, up from 17.1GW in 2021. The number of companies signing slid to 49 from 67 but deals were bigger.
- **10 new US companies joined the RE100, pledging to offset their power consumption with clean power at a future date,** including Applied Materials, Eli Lilly, Lear Corporation and Pfizer.
- **Energy spending accounted for 4.6% of total US personal consumption expenditures in 2022,** up 0.63 percentage points from 2021 as fuel costs were up across the board, but still historically low.

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- **Demand for US natural gas rose 5.5% to reach 95.8 billion cubic feet per day**. The jump was led by stronger power sector demand and rising LNG exports, plus modest increases across industrial, commercial, and residential sectors.
- **Natural gas met 39% of US power demand with a record estimated output of 1,694TWh,** up 6.5% from the year prior. Despite higher gas prices, the fuel still provided more power.
- **Coal's contribution to power generation slid to 19.4% in 2022,** slightly above its recent low of 19.1% hit in 2020.
- **US CO2 emissions ticked up 1.0%, BloombergNEF (BNEF) estimates, but were still 3% below pre-Covid levels.** Transport remained the top emitting sector at 28% with power now tied with industry for next highest at 24% apiece.
- **2022 was the third most costly climate disaster year on record.** The country experienced 18 climate-related disasters causing at least $1 billion in damage apiece with an $165 billion total, causing 3.4 million Americans to evacuate .
- **Inflation and higher interest rates boosted levelized costs of electricity (LCOE) for most power-generating technologies in 2022**, but particularly for coal and natural gas plants because of their marginal fuel costs.
- **Congress passed the most consequential sustainable energy law in US history.** The Inflation Reduction Act (IRA) offers at least $369 billion in support for clean energy deployment and climate action. The legislation supports multiple sectors and most of their value chains.
- **Energy efficiency spending stabilized in 2021** (the last year with complete data). Utility spending on power and natural gas improvements rose 1% year-on-year to reach $7.7 billion.
- **Interest in "clean" US hydrogen is growing.** About 92MW of new electrolyzers were shipped in 2022, but the number is expected to be much more this year. The Department of Energy has released a long-term "roadmap" for ramping hydrogen production.
- **Post-IRA passage, EV and battery manufacturers raced to identify investment opportunities,** with the North American battery supply chain reaching almost $17 billion in new commitments by the end of 2022.
- **Major oil and gas firms are upping investment in Renewable Natural Gas (RNG) in an effort to deliver "green molecules".** BP and Shell each made moves to acquire RNG producers in 2022.

These trends are discussed at a high level below then in far greater depth graphically in the Factbook itself.

Executive summary (3 of 7)

The construction of new renewables facilities slowed, but renewables' contributions to the grid broke records

The US added 32GW of new renewable power-generating capacity to the grid in 2022. That was down 5GW from the 37GW installed in 2021 and marked the first year-on-year slide in new build since 2018 as developers struggled with tangled supply chains and higher costs. The US solar market specifically was challenged in the first half of 2022 after the Commerce Department announced it was investigating whether to impose higher tariffs on solar equipment from four Southeast Asian nations. By June, President Biden had issued an executive order effectively postponing the imposition of any such tariffs for two years.

For wind, tax credit uncertainty, coupled with supply chain constraints, interconnection delays, and high input costs were the year's primary complications. While the IRA revives the tax credit mechanism for new wind farms, it will take time for the support offered by the new law to translate into new capacity additions. New biomass, geothermal, waste-to-energy and small hydro capacity build remained comparatively small in 2022. In all, 21MW of new biomass and waste-to-energy capacity came online in 2022. However, for the first time, the IRA provides a more level playing field and long-term support for the full portfolio of renewable energy technologies which could impact the investment in the slower growing renewable energy sectors.

Even with the challenges, sustainable sources met a record volume of US energy demand in 2022. The contribution of renewables, including wind, solar, biomass, waste-to-energy, geothermal and hydro, rose at the fastest pace among major sectors. Renewable power jumped to 974TWh from 864TWh in 2021, a 12.6% year-on-year rise. Renewables accounted for 22.7% of total US power generation in 2022 – their highest level ever. The growth was driven by surges in output from wind and solar and growth in hydro production.

Renewables and natural gas have grown from a combined 43% of total power generation to 62% in just a decade. In 2022, zero-carbon power (renewables generation plus nuclear power) accounted for an all-time high of 40.6% of all output. Meanwhile, coal-fired generation dipped to 19.4% of production, slightly above its recent low of 19.1% in 2020.

The process of securing all needed federal permits can be slow and laborious for energy infrastructure projects. One recent study found that the large majority of infrastructure projects take between two and six years secure all sign-offs. A quarter of such projects take longer than six years, in some cases much longer. A separate study found that renewable power projects take an average of 2-3 years to complete National Environmental Protect Act reviews specifically with a significant number of such projects taking four, five or even six years to reach completion.

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US energy productivity dipped in 2022, but the long-term trend is clear

In 2022, the US economy expanded by 1.9% while primary energy consumption rose at a faster clip of 3%. Taken together, US "energy productivity" (the ratio of US GDP vs. total US energy consumption) dipped 1%. While both GDP and energy consumption rose, the former rose faster than the latter year-on-year. With Covid-19 fading, US primary energy consumption returned to pre-pandemic levels, roughly matching activity in 2019. Over the past 10 years, US GDP has grown 22.9% while primary energy consumption has risen 6.7%. The result: a 15.2% increase in productivity.

Another year of highs for US natural gas

Demand for US natural gas rose 5.4% in 2022 from the year prior to reach another record of 95.8 billion cubic feet per day (Bcf/d). The jump was led by stronger power sector consumption, rising liquified natural gas (LNG) exports, and more demand from commercial customers. The industrial and residential sectors grew more modestly. A hotter-than-normal summer and constraints on coal-fired power generation lifted use of natural gas in power. Consumption proved resilient to higher natural gas prices and the US broke seasonal demand records despite extended periods in which natural gas traded above $5 per million BTU at Henry Hub.

US exports of natural gas have risen briskly over the past decade and in 2022 LNG exports posted a 13.1% increase from the year prior to record highs. Commercial and residential demand rose on the back of the frigid start to winter 2022-23. Colder than normal weather in the second half of both November and December 2022 boosted overall consumption. Two days before Christmas, the lower-48 states set a single day record for natural gas demand.

EV sales surged

2022 was another landmark year for electric vehicles (EVs). Sales of EVs and fuel cell vehicles hit nearly 982,000, up 50% from 2021. Despite headwinds including rising battery costs and semiconductor chip shortages, EV sales surged. Tesla remained the biggest player in the market, accounting for half of new sales in 2022, but Ford, Stellantis, VW, Geely, BMW and GM also posted strong numbers. Tesla accounted for 63% of all EV sales as recently as 2020.

Battery electric vehicles (BEVs) made up 81% of 2022 sales, with plug-in hybrid electric vehicles (PHEVs) making up the remaining 19% and fuel cell vehicles accounting for under 1% of sales.

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Higher prices for key clean energy commodities

Prices for key commodities that underpin the clean power sector were stubbornly high through much of 2022, but eased somewhat by year end. Polysilicon prices touched new highs in August 2022 due to temporary supply disruptions and strong demand. However, supply rose and prices fell toward the end of 2022 as existing plants returned to services and new factories were commissioned. Lithium carbonate prices spiked in 2022 and at one point the material traded at 14 times its January 2021 price. Spot prices have jumped in the past year due to high EV demand from China. By September 2022, an LFP battery cell cost $144/kWh given spot market prices for lithium carbonate, BNEF estimated. This was up 9% from November 2021 when manufacturers were just starting to see large raw material price increases. While lithium benchmarks descended slightly in December 2022, they remain at much higher levels than before the pandemic. Australia, Chile and China remain the top nations for mining lithium. The Democratic Republic of Congo remains the top producer of cobalt. Both are used in lithium-ion batteries in electric vehicles.

Elevated natural gas costs

For the second year in a row, US natural gas prices rose significantly due to tight market conditions that included rising demand for gas at home and abroad. The average benchmark Henry Hub wholesale natural gas price for the year rose 52% while residential and commercial prices rose 11% and 19%, respectively. Industrial users saw the biggest year-on-year change, with prices jumping 32%. Despite the rise, 2022 prices were still about half of those seen in 2005. Residential price adjustments tend to lag index prices 6-12 months, depending on utility practices. Industrial prices tend to be most correlated to wholesale markets. Of note, natural gas prices in the last quarter of 2022 began to decrease to below $5/MMBtu by the last week of December 2022.

US emissions ticked up, but remain below pre-Covid levels

US economy-wide emissions inched up 1.0% from 2021, BNEF estimates. This reflected the continuation of a trend begun in 2021 when the economy first began rebounding from the Covid-19 pandemic. Despite the uptick, 2022 US emissions were still 3% below pre-pandemic (i.e. 2019) levels. Emissions from the transport, power, industrial and agricultural sectors of the US economy all rose but finished 2022 below 2019 levels. This suggests that some emissions reductions made in 2020 have persisted, particularly for transportation, the top emitting sector, and for the power sector that has seen steady decarbonization for the last decade due to clean generation and energy efficiency. As recently as 2016, the power sector was the number one source of US CO2 emissions. In 2022, emissions from the power sector were essentially level with those from industrial sources.

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The third most costly year for climate-related disasters

The impacts of climate change continue to be felt throughout the US and 2022 was the third most costly climate disaster year on record. The country experienced 18 climate-related disasters causing at least $1 billion in damage apiece over the 12 months. Three tropical cyclones accounted for 70% of the $165 billion total cost. An estimated 3.4 million Americans were forced at some point to evacuate their homes during 2022 due to natural disasters, according to the Census Bureau. In response, citizens and communities are installing a growing number of residential back-up power storage systems and mini-grids.

Energy storage deployment and manufacturing

The US commissioned an estimated 4.8GW of utility-scale non-hydropower storage to bring total capacity to 11.4GW. Pumped storage is the largest energy storage resource at 67% with battery and thermal storage accounting for the rest. Despite supply-chain related delays in project development, the US remains the largest demand market for energy storage in the world. Energy shifting is the dominant use case for new batteries as pairing renewables with storage is becoming a common cost-effective option to displace fossil fuel projects. Utilities across the nation are beginning to cite energy-storage technologies in their long-term resource planning and as solutions to their power system flexibility needs.

The US also made important strides toward becoming a hub for battery manufacturing in 2022. After the IRA introduced a $45/kWh of cell and module production tax credit, automakers and battery manufacturers have raced to identify investment opportunities. Post-IRA commitments to the North American battery supply chain reached almost $17 billion by the end of 2022. A number of developers have announced plans to build or expand plants in Ohio, Michigan, Tennessee, New York and other states.

Offshore wind

The US offshore wind sector continued to make progress in 2022 with increased federal support, additional state targets and the first two commercial-scale projects under construction. However, rising equipment costs complicated some developers' plans. Critically, the IRA extended the Investment Tax Credit (ITC) for offshore wind until at least 2032, allowing developers to reduce their projects' building costs potentially by 30%. The Bureau of Ocean Energy Management (BOEM) held three lease auctions in 2022. At the state level, California, Louisiana, and New Jersey all either created or expanded offshore wind targets.

Executive summary (7 of 7)

The most important federal energy transition investment in US history

In a surprise turn of events in August, Congress passed the IRA, the most consequential law ever intended to address climate issues. The law represented a major victory for various clean energy sectors. The IRA provides at least $369 billion in support to energy transition technologies. The law primarily uses tax credits to achieve its goals, estimated at least at $271 billion, over a ten-year time horizon. It extends or expands credits for virtually every energy transition sector, with a transition to a technology-neutral approach for many after year two. Within each major sector, it offers support from the bottom to the top of the value chain, from end consumers up to raw materials providers.

The law stands to put the US far closer to the Biden administration goal of halving economy-wide CO2 emissions by 2030 (vs. 2005). The Treasury Department is in the process of writing many of the rules in 2023 on how these and other tax policies are implemented.

Interest in "clean" hydrogen grows with IRA passage

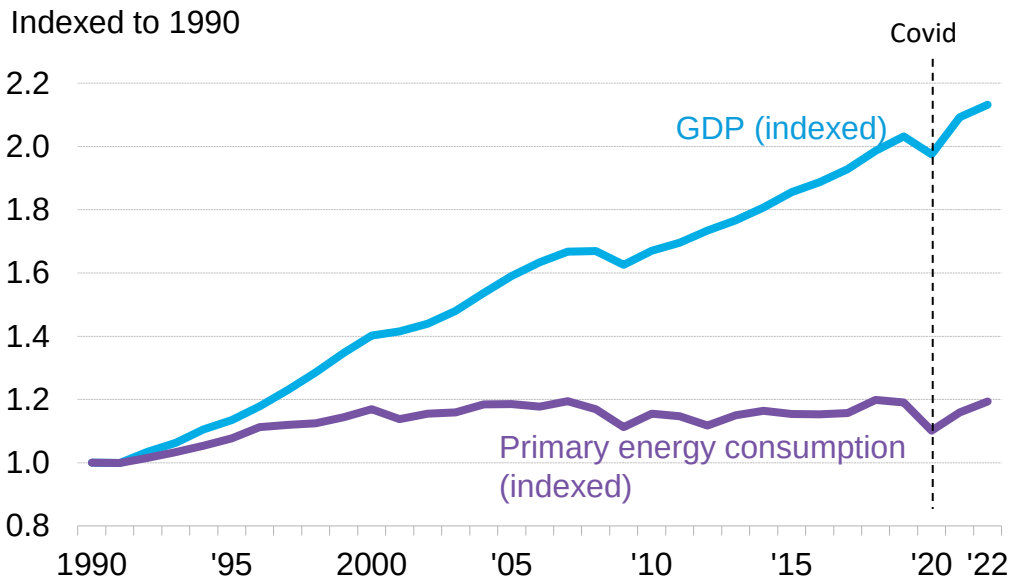
Today, the US consumes approximately 10 million metric tons of conventional hydrogen annually in industries such as oil refining and ammonia production. These industries, along with others like steel production and energy storage, could shift the US from carbon-intensive hydrogen consumption to low-carbon hydrogen consumption in the coming years. In 2022, BNEF tracked 92MW of hydrogen-producing projects commissioned. A more diverse slate of players is now poised to get involved in production. SolCaGas announced the Angeles Link project in 2022, a green hydrogen production pipeline serving the Los Angeles region – anticipated to be the nation's largest. In 2023, CF Industries Inc. is expected to commission an electrolyzer at a large ammonia production facility. Air Products and Chemicals Inc. plans to commission an electrolyzer focused on road transport. Florida Power and Light seeks to commission a facility to generate power. RNG is also attracting new interest and investment, stemming from new incentives for RNG production from the IRA.

Energy efficiency spending stabilized after a Covid-related drop

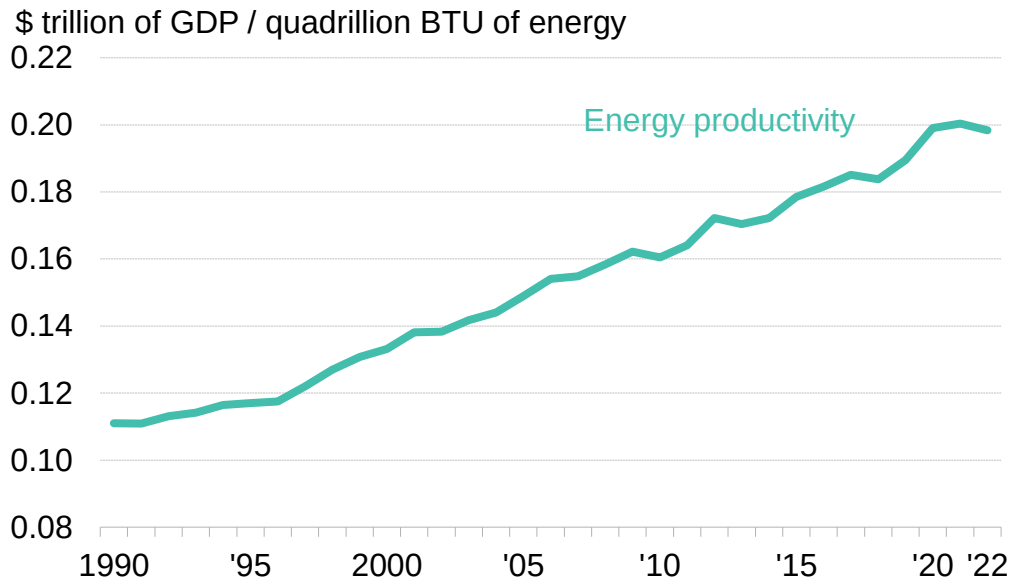
After a sharp drop in efficiency spending from 2019 to 2020 due to the pandemic, efficiency spending stabilized in 2021 (the last year for which there is complete data). Spending rose 1% year-on-year from 2020 to 2021 to reach $7.7 billion, according to data compiled by the American Council for an Energy Efficient Economy (ACEEE). Spending on efficiency improvements related to electricity stayed essentially flat at $6 billion in 2021 while spending on improving the efficiency of natural gas delivery grew from $1.5 billion to $1.7 billion. The total impact of all ratepayer-funded electric energy efficiency programs in place in 2021 was a savings of about 290 million MWh– equivalent to approximately 7.63% of 2021 electricity consumption, according to ACEEE.

US energy overview: Energy productivity

US GDP and primary energy consumption



US energy productivity

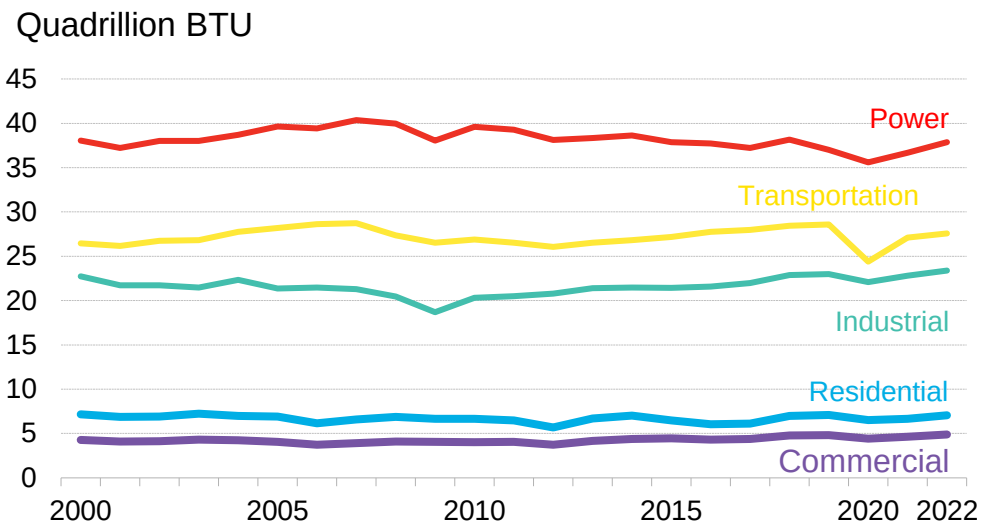


- In 2022, the US economy expanded by 1.9% while primary energy consumption rose at a faster clip of 3%. Taken together, US "energy productivity" (the ratio of US GDP vs. total US energy consumption) dipped 1%. While both GDP and energy consumption rose, the former rose faster than the latter year-on-year.
- With Covid-19 fading, US primary energy consumption returned to pre-pandemic levels, roughly matching activity in 2019. Over the past 10 years, US GDP has grown 22.9% while primary energy consumption has risen 6.7%. The result: a 15.2% increase in *productivity*.
- Looking even further back, the long-term trend remains clear. From 1990-2022, the US has logged a 79% improvement in energy productivity.

Source: Bureau of Economic Analysis, EIA, BloombergNEF Notes: Values for 2022 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through September 2022). 2021 GDP estimate is a projection from economists compiled at ECFC <GO> on the Bloomberg Terminal.

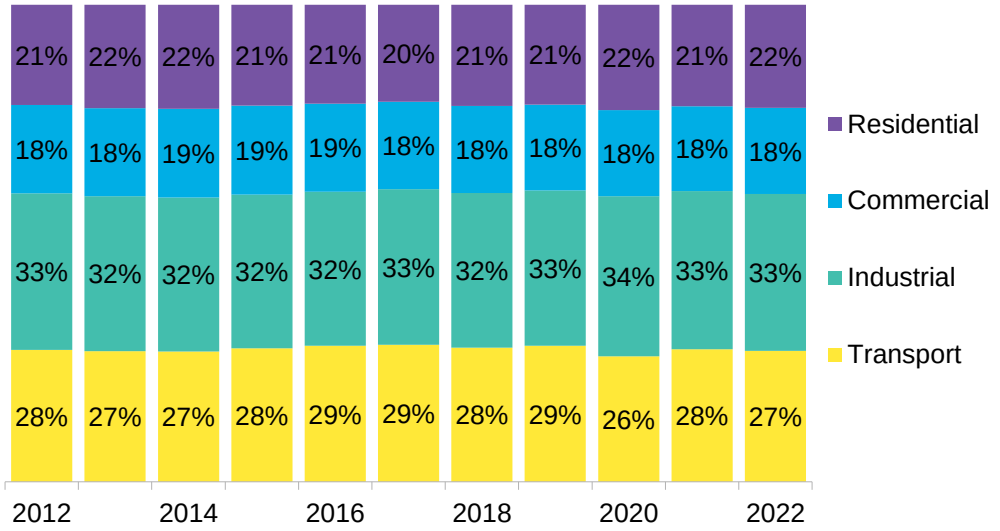
US energy overview: Primary energy consumption by sector

US primary energy consumption



Note: Electricity is excluded from Industrial, Residential, Commercial and Transportation sectors and aggregated in "Power"

US end-use energy consumption



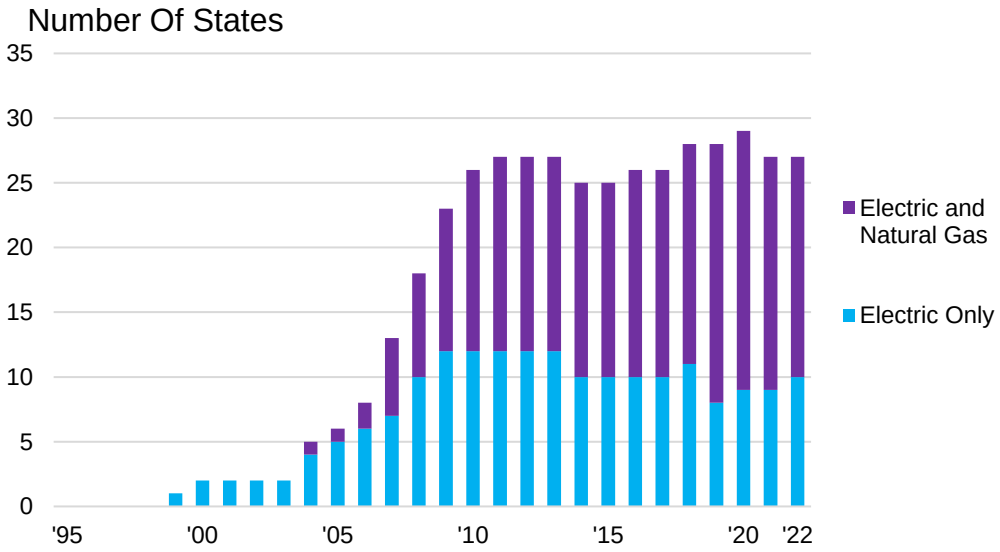
Note: Sector end uses include electricity use

- Demand for energy rose across each of the major segments of the US economy in 2022. This included energy used for power, transportation, and industry, as well as energy used in homes and businesses. Total US primary energy consumption returned to pre-pandemic levels.
- Among the segments depicted in the left-hand chart, power grew at the fastest clip on a volume basis to reach a total 38 quadrillion BTU, up 1.2 quadrillion BTU from 2021. On a percentage basis, the residential and commercial segments grew fastest with upticks of 6% apiece year-on-year.
- While electric vehicle sales surged in the US in 2022, energy used in transportation remains dominated by liquid fuels. Energy used in transportation rose to 27.7 quadrillion BTU in 2022 but remains below its pre-pandemic peak of 28.7 quadrillion BTU in 2019. Electricity accounts for just 0.3% of energy demand for transportation.
- Among end-use segments as measured on a percentage (right-hand chart), demand levels remained roughly the same from 2021 to 2022.

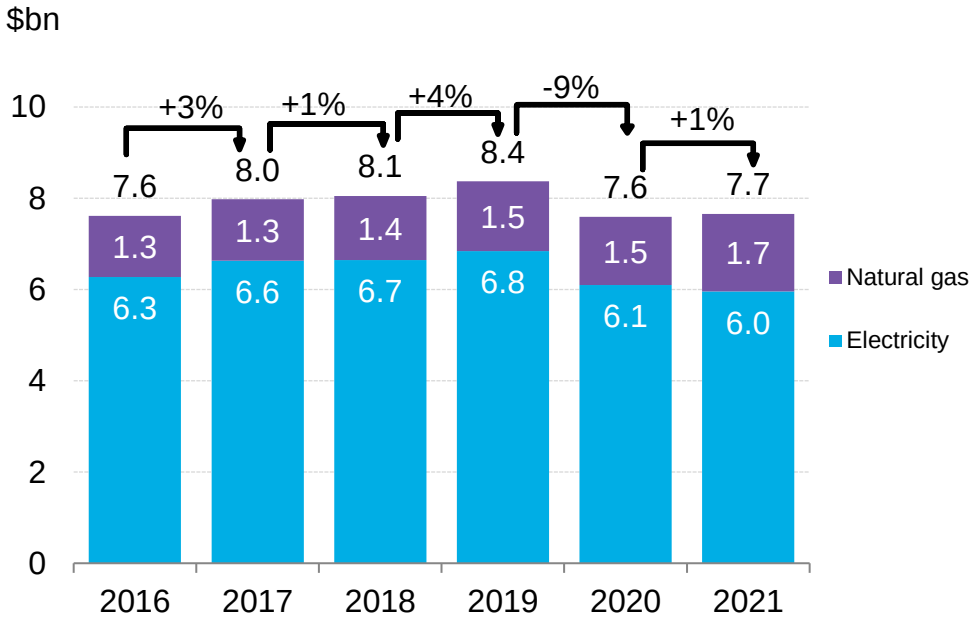
Source: EIA, EPA, BloombergNEF Notes: Values for 2021 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through September 2022)

US energy overview: Energy efficiency

US states with Energy Efficiency Resource Standards (EERS)



Utility energy efficiency spending

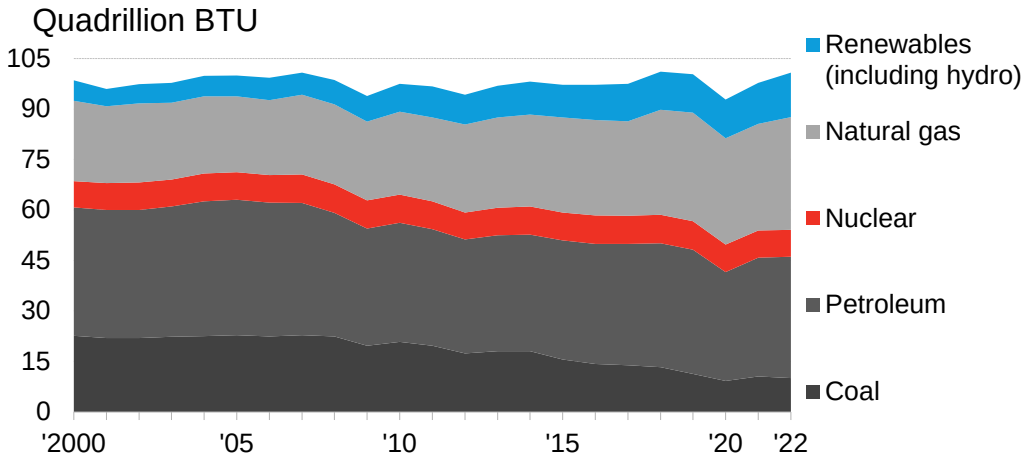


- Energy Efficiency resource standards (EERS) are state-level policies that require utilities to invest in measures that improve end-user efficiency to meet energy-savings goals set by the government. In 2022, 26 states and the District of Columbia had EERS policies.
- After a sharp drop in efficiency spending from 2019 to 2020 due to the pandemic, efficiency spending stabilized in 2021 (the last year for which there is complete data). Spending rose 1% year-on-year from 2020 to 2021 to reach $7.7 billion, according to data compiled by the American Council for an Energy Efficient Economy (ACEEE).
- Spending on efficiency improvements related to electricity only stayed essentially flat at $6 billion in 2021 while spending on improving the efficiency of natural gas delivery grew from $1.5 billion to $1.7 billion.
- The total impact of ratepayer-funded energy efficiency programs was a savings of about 290 million MWh in 2021 – equivalent to approximately 7.63% of 2021 electricity consumption, according to ACEEE.

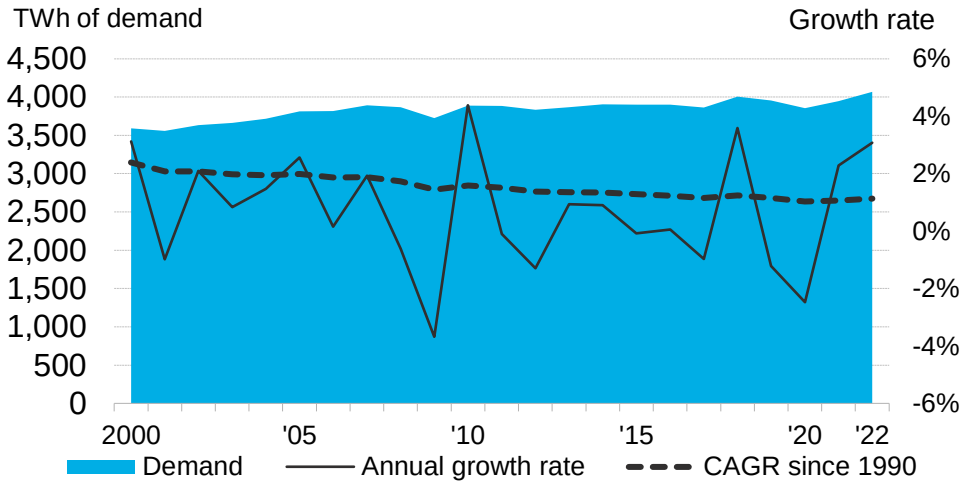
Source: American Council for an Energy Efficient Economy (ACEEE) State Energy Efficiency Scorecard: 2022 Progress Report

US energy overview: Energy and electricity consumption

US primary energy consumption, by fuel type



US electricity demand

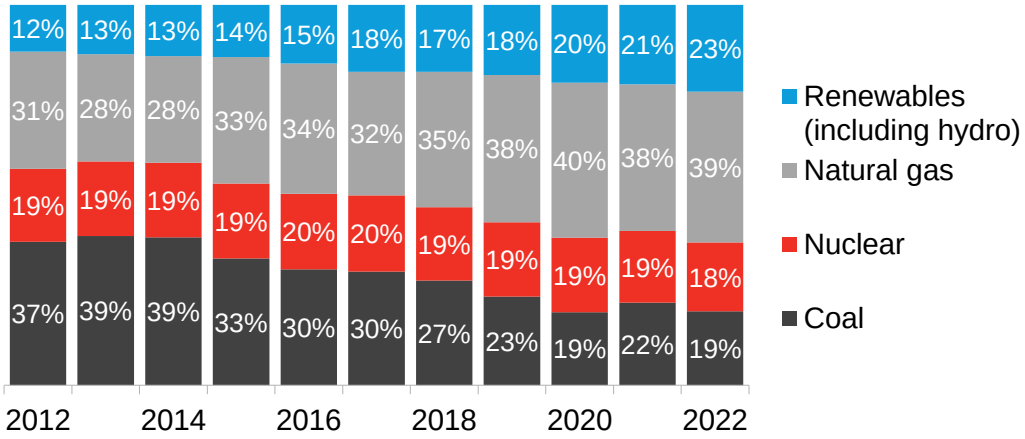


- US total energy consumption rose 2.95% from 2021 to 2022 to an estimated 100.7 quadrillion BTU as the US economy continued to recover from the worst effects of the Covid-19 pandemic. Contributions from non-hydro renewables (wind and solar, primarily but also biomass, waste-to-energy and geothermal) rose 10.2% from the year prior to account for 13.2% of total US energy demand.
- The role of natural gas in overall US energy consumption continued to grow, rising 5.5% year-on-year. Natural gas now accounts for approximately one third of all US energy consumption.
- Nuclear's contribution remained essentially level in 2022. Coal consumption slipped 4.9% year-on-year to 10.03 quadrillion BTU, less than half its all-time peak of 22.8 quadrillion BTU in 2005. Petroleum use grew by 2.22% year-over-year. Oil is rarely used in US power generation but accounts for the vast majority of transportation fuel.
- Total retail demand for electricity posted its second straight year of growth after dipping during the pandemic. It rose 3.1% 2021-2022. Electricity demand has risen just 6% in the last decade (excluding contributions from distributed, small-scale facilities). The compound annual growth rate (CAGR) for electricity has been generally sliding since 1990 as the US economy has used power more efficiently.

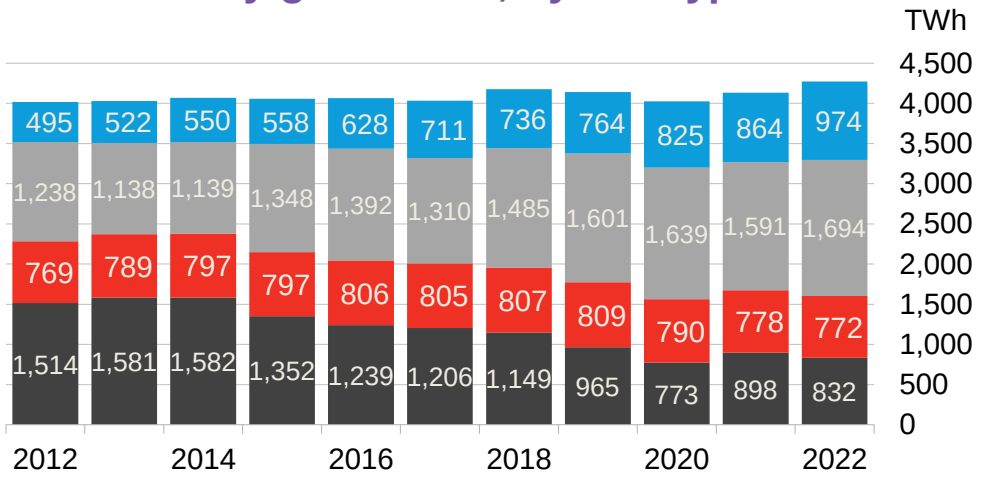
Source: EIA, BloombergNEF Notes: "CAGR" on the right hand side graph is compound annual growth rate. Values for 2022 are projected, accounting for seasonality, based on the latest monthly values from EIA (data available through September 2022). BTU stands for British thermal units.

US energy overview: Electricity generation mix

US electricity generation, by fuel type



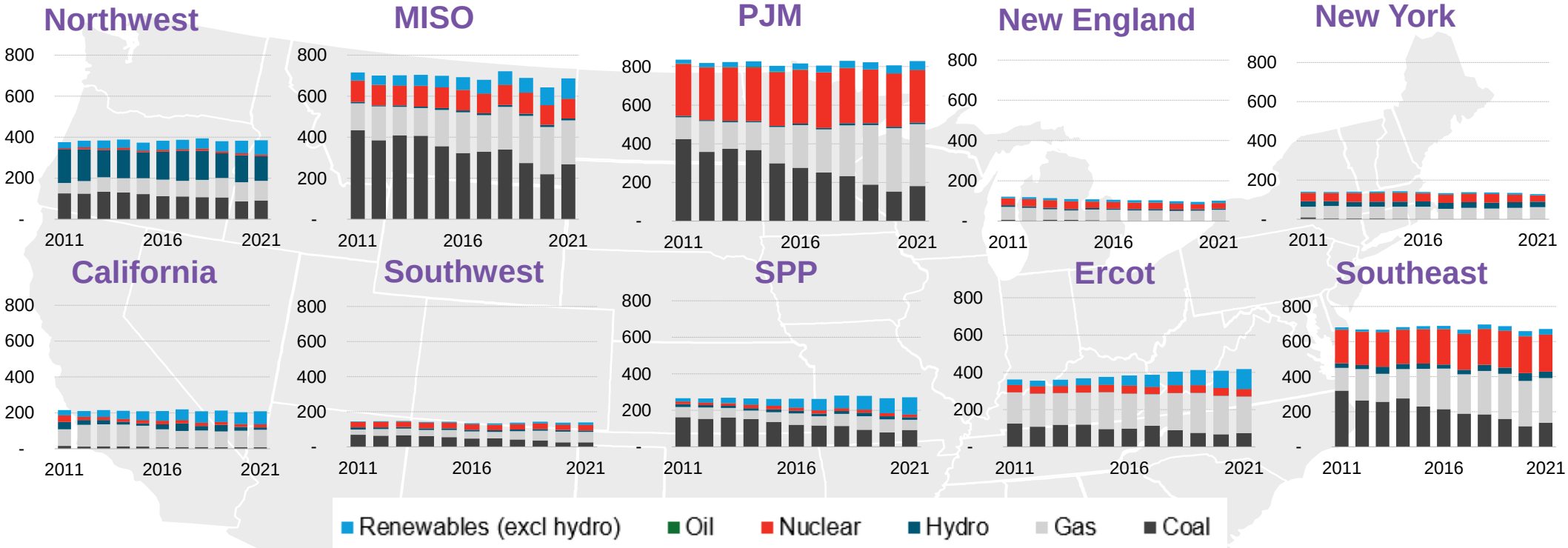
US electricity generation, by fuel type



- Total US power generation rose by an estimated 3.4% year-on-year to a new all-time high of 4,298 terawatt hours (TWh) in 2022.
- Natural gas remained the largest source of US power and set another record with 1,694TWh of production in 2022, up 6.5% from the year prior. Overall, natural gas accounted for 39.4% of 2022 US power generation.
- The contribution of renewables, including wind, solar, biomass, waste-to-energy, geothermal and hydro, rose at the fastest pace among major sectors. Renewable power jumped to 974TWh from 864TWh in 2021, a 12.6% year-on-year rise. Renewables were 22.7% of total US power generation in 2022. The growth was driven by surges in output from wind and solar and growth in hydro production.
- Renewables and natural gas have grown from a combined 43% of total power generation to 62% in just a decade. In 2022, zero-carbon power (renewables generation plus nuclear power) accounted for an all-time high of 40.6% of all output.
- Coal-fired generation declined 66TWh 2021-22 and dipped to 19.4% of all production. This was slightly above coal's recent low of 19.1% of generation in 2020.

Source: EIA, BloombergNEF Note: Values for 2022 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2022)

US energy overview: Electricity generation mix by US power market (TWh)



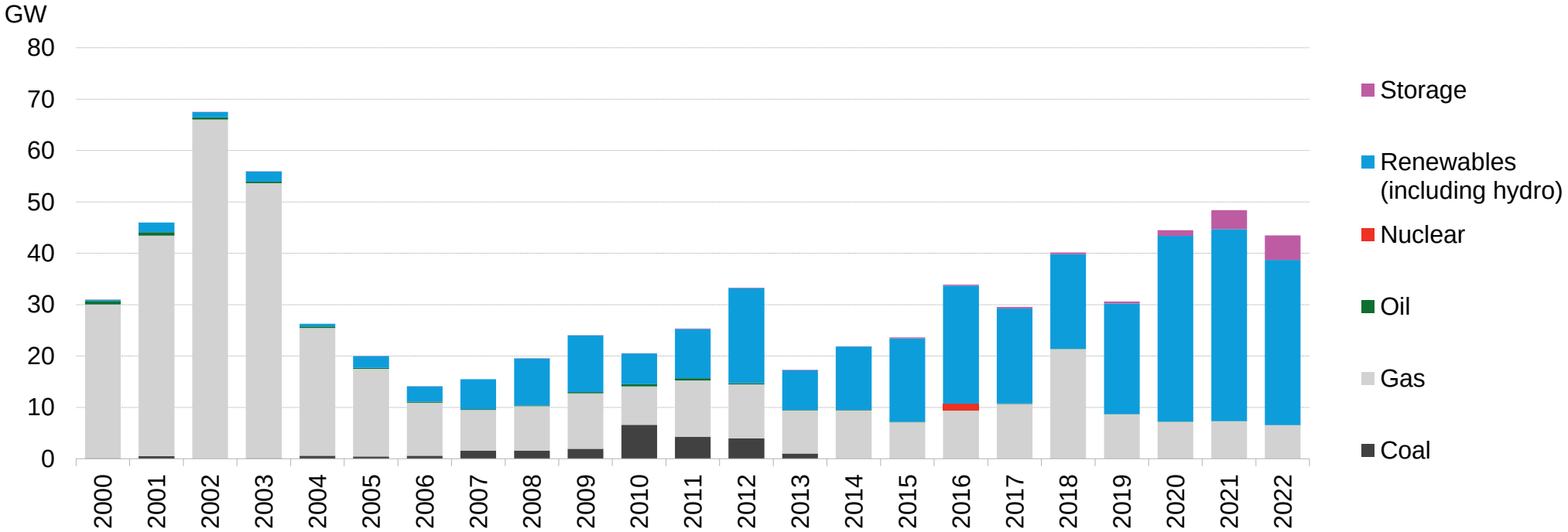
- The power generation mix varies throughout the US with different power-generating technologies contributing various amounts in different markets. The top-line volume of generation also varies, with higher demand in some regions. Power can also be sold between regions, incentivizing areas with lower prices to generate more. About two thirds of US power sales are in competitive wholesale markets, with the largest markets being PJM, MISO, and Ercot.

- Major trends over the last decade have included the rise of natural gas-fired generation and the fall of coal-fired generation in the Southeast and PJM. For 2021 (the last year for which there is sufficiently complete regional data), coal generation rebounded in most regions, rising 16% compared to 2020. Renewables use also grew across most markets 2020-21. In 2022, coal use no doubt fell in some markets.

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

US energy overview: Electric generating capacity build by fuel type

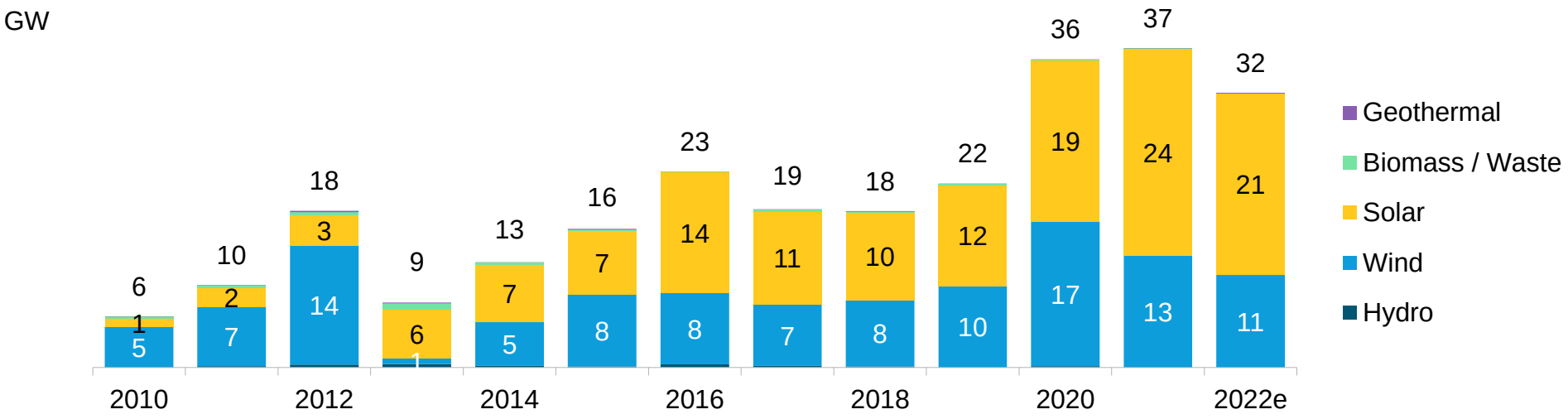
US electric generating capacity build, by fuel type



- The US commissioned an estimated 43GW of new power-generating and power-storage capacity in 2022. Renewables accounted for approximately three quarters of this at 32GW. Still, the build out of new wind, solar, biomass, geothermal, waste to energy, and other zero-carbon technologies others slowed from the record level achieved in 2021.
- The addition of new natural gas-fired power generating capacity slid slightly to 6.5GW commissioned in 2022 from 7.3GW the year prior. This marked the lowest annual volume of new gas added to the US grid in over two decades.
- The rising contribution of variable renewable generation to the grid has created greater demand for energy storage capacity. In 2022, the US set a new record for storage build with 4.8GW added, up from the prior record build of 3.7GW in 2021.

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 2021, as well as BloombergNEF projections.

US energy overview: Renewable energy capacity build by technology

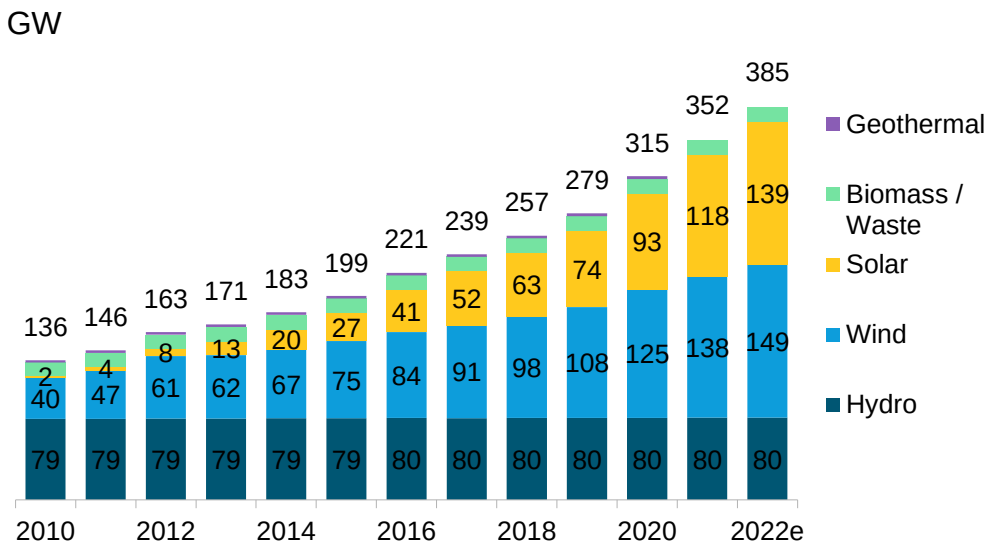


- The US added 32GW of new wind and solar power-generating to the grid in 2022. That was down 5GW from the 37GW installed in 2021 and marked the first year-on-year slide in new build since 2018 as developers struggled with tangled supply chains and higher costs.
- New solar projects completed in 2022 totaled 21GW, down from 24GW the year prior. The US solar market was upended in the first half of 2022 after the Commerce Department announced it was investigating whether to impose higher tariffs on solar equipment from four Southeast Asian nations. By June, President Biden had issued an executive order effectively postponing the imposition of any such tariffs for two years.
- Wind capacity additions for 2022 declined to 11GW from 13GW the year prior. Tax credit uncertainty, coupled with supply chain constraints, interconnection delays, and high input costs were the year's major headwinds. While the Inflation Reduction Act revives the fading tax credit mechanism for new wind farms, it will take time for the supports offered by the new law to translate into new capacity additions.
- New biomass, geothermal, and small hydro capacity build remained comparatively small in 2022. In all, 21MW of new biomass and waste-to-energy (WTE) capacity came online in 2022. In 2022, Miami Dade and Pasco Counties in Florida publicly announced intentions to expand or build new WTE capacity.

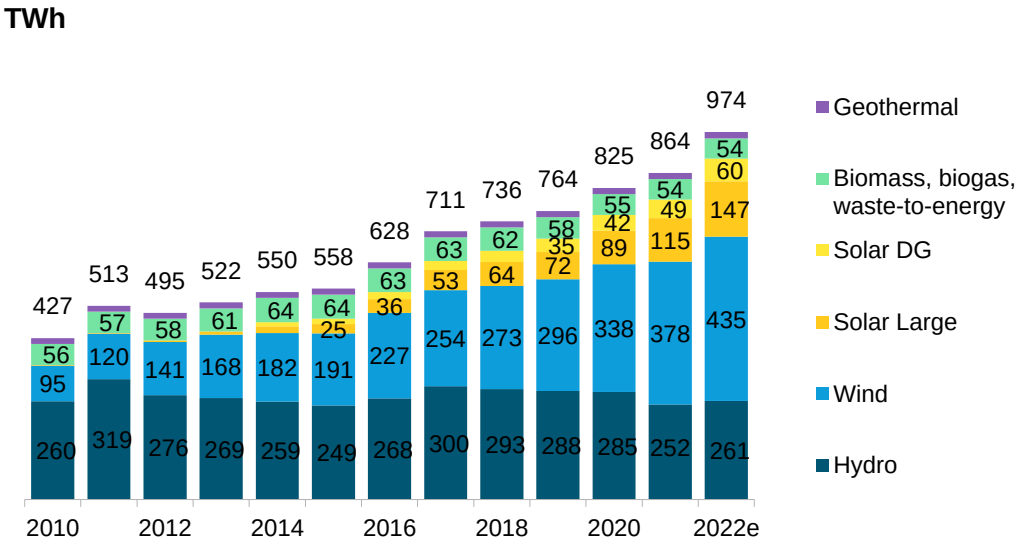
Source: BloombergNEF, EIA Notes: All values are shown in AC except solar, which is included as DC capacity. Numbers include utility-scale (>1MW) projects of all types, rooftop solar, and small- and medium-sized wind. Includes installations or planned installations reported to the EIA through October 2021, as well as BloombergNEF projections.

US energy overview: Cumulative renewable energy

US cumulative renewable capacity



US renewable generation by technology

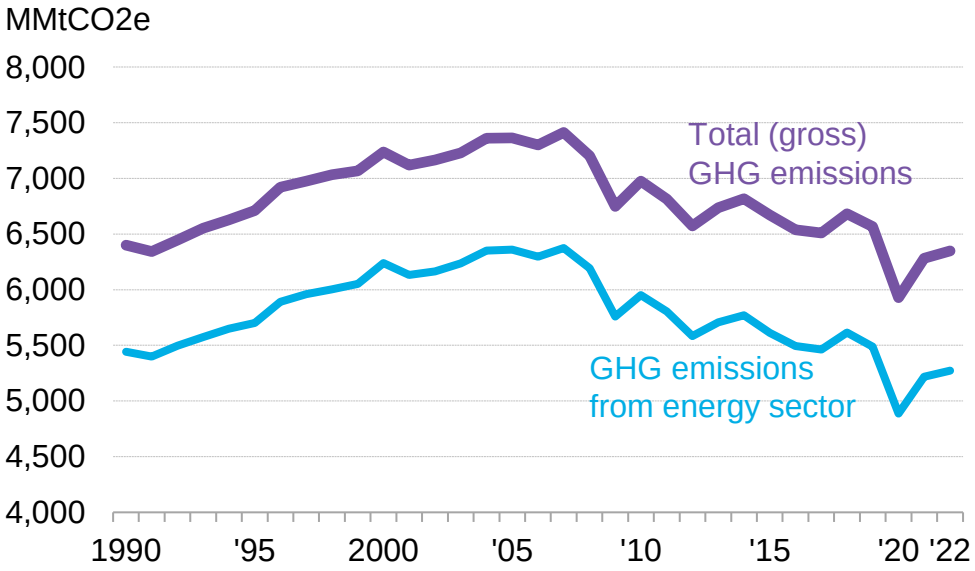


- Total US renewable energy capacity, excluding pumped hydro facilities, stands at 385GW. Despite snarled supply chains, inflationary pressures, and trade policy worries, the installed fleet of wind and solar grew 13% year-on-year. Total renewable electricity generation in the US rose 12% year on year, to 974TWh or 23% of total US power generation.
- Among renewable technologies, wind was the largest generating source. The nearly 149GW wind fleet produced 435TWh of electricity in 2022. That was followed by hydroelectric generation at 261TWh, up from 252TWh in 2021.
- Production from all types of solar generating projects hit 207TWh in 2022, making it the third-largest renewable generating source. Rooftop solar atop residential and commercial building now represents 35% of all solar installed capacity.

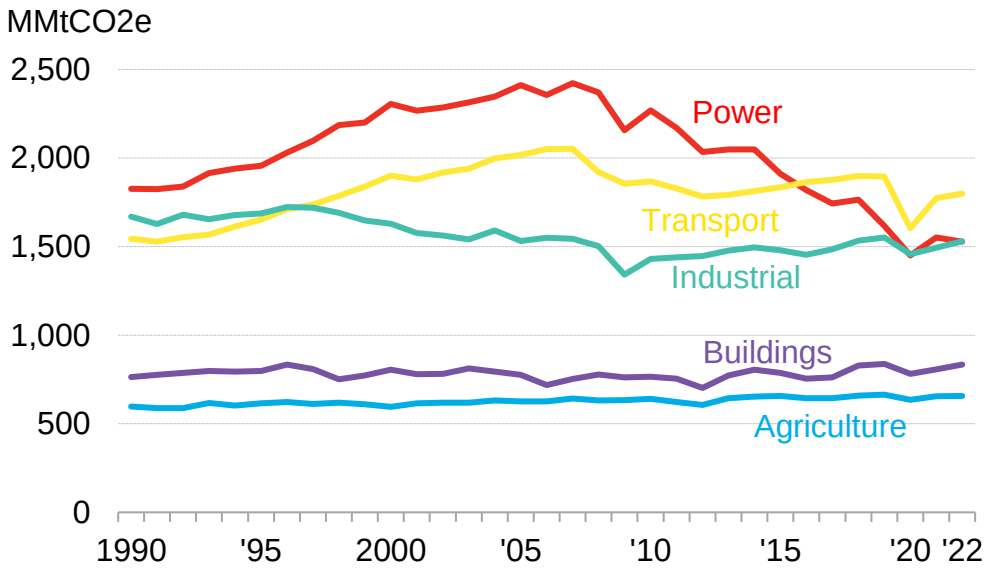
Source: BloombergNEF, EIA Notes: All values are shown in AC except solar, which is included as DC capacity. Hydropower capacity and generation exclude pumped storage facilities (unlike in past Factbooks). Totals may not sum due to rounding. Values for 2021 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2021)

US energy overview: Greenhouse gas (GHG) emissions

Economy-wide and energy sector emissions



Emissions by sector

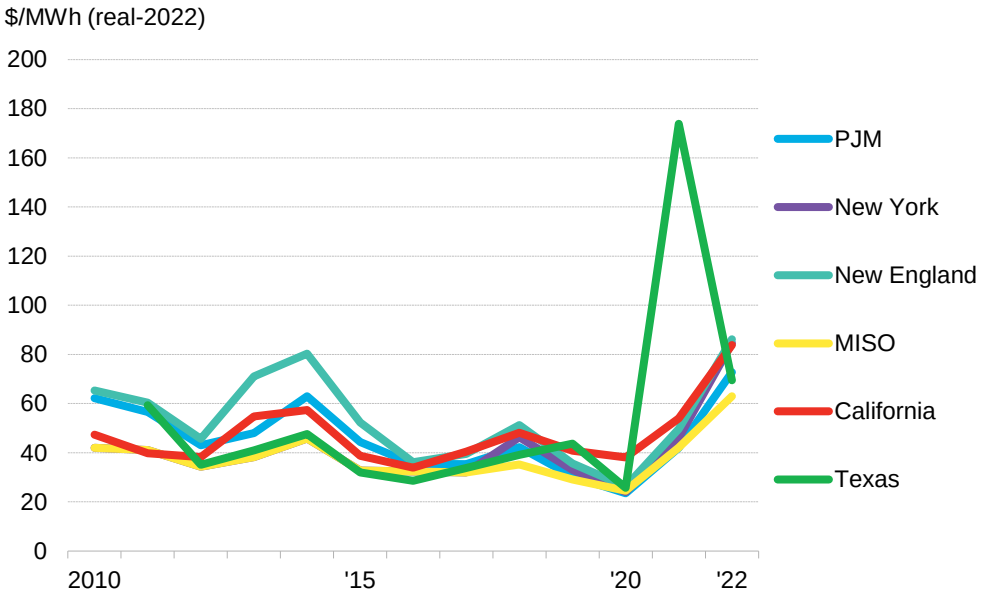


- BNEF estimates that US economy-wide emissions inched up 1.0% in 2022 from the year prior with emissions rising in every major sector of the economy. To an extent, this reflected continuation of a trend begun in 2021 when the economy first began rebounding from the Covid-19 pandemic. From 2020-2021, US emissions jumped 5.8%.
- Despite the year-on-year uptick, 2022 US emissions were still 3% below pre-pandemic (i.e. 2019) levels. Given that economy-wide emissions have trended down since 2005, this was not a significant surprise. Emissions from each individual sector in 2022 remained below 2019 levels. The exception was the buildings sector with 2022 emissions that matched 2019. This suggests that some of emissions reductions made in 2020 have persisted, particularly for transportation with 2022 emissions 5% below 2019 levels.
- Power went from being the highest emitting sector in the US economy, to second when it fell behind transport in 2016. In 2022, emissions from the power sector were essentially level with those from industrial sources.

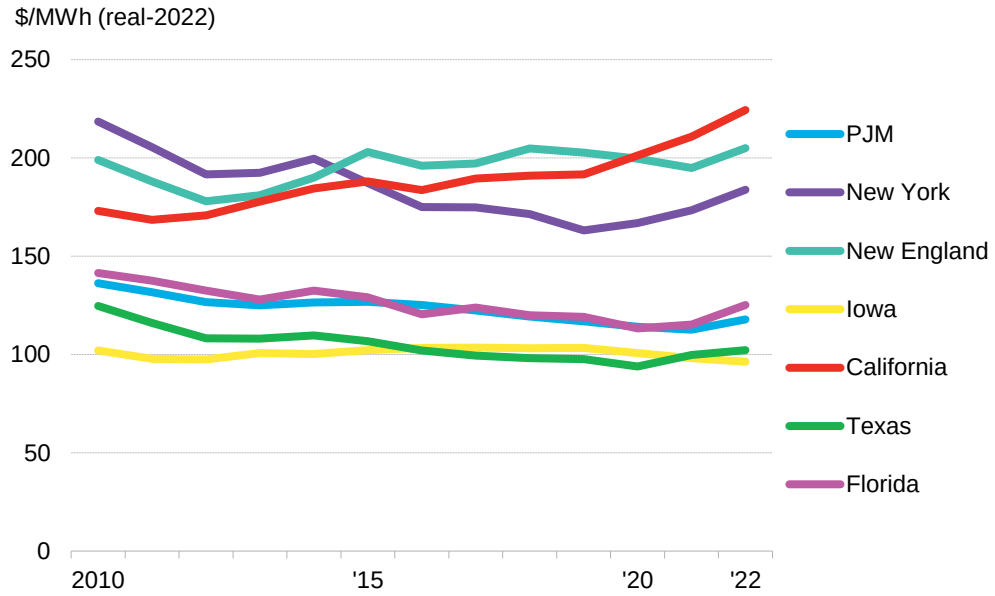
Source: BloombergNEF, EIA, EPA.

US energy overview: Retail and wholesale power prices

Wholesale power prices



Retail power prices

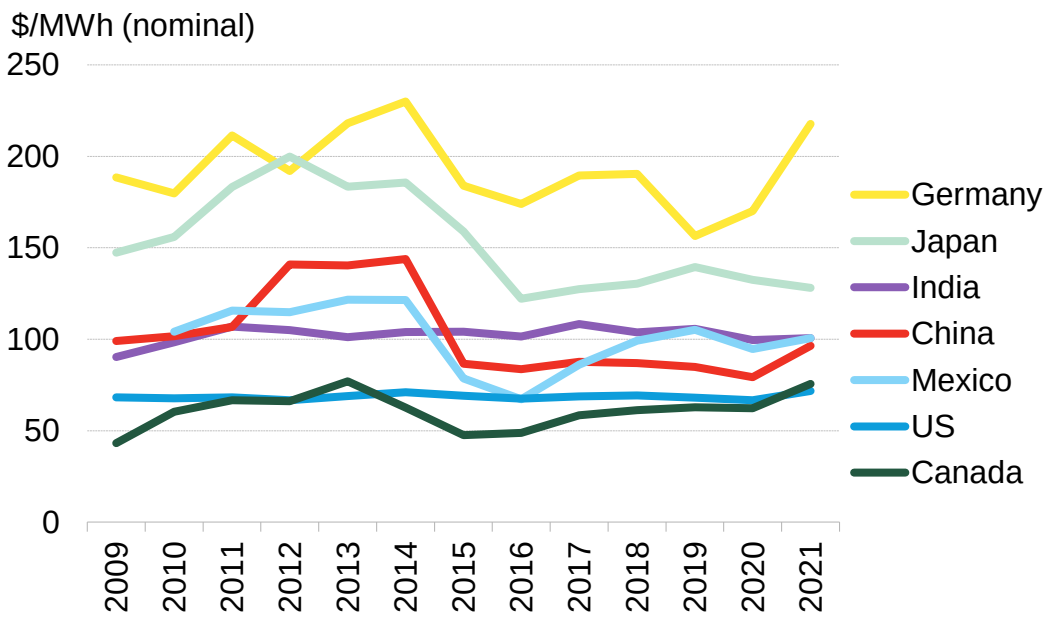


- Wholesale power prices continued to rise in 2022, reflecting the higher price of natural gas around the country. In most wholesale markets prices were at their highest level (in real terms) since 2014.
- With wholesale power prices increasing for the last two years in succession, retail rates have also risen, with the average price rising by 4.1% in the past year on top of inflation. While this is less dramatic than the swings of the wholesale market, it is the biggest year-on-year increase since 2006, when rates rose 5.8%.
- This picture differs substantially at a state level. Electricity consumers in North Dakota, Wyoming, South Dakota, Nebraska, Michigan, Montana, Washington and Oregon all benefited from rate changes that were substantially below inflation, bucking the national trend. These states are mostly in regions with high levels of wind capacity and exposure to Canadian gas prices, which were substantially below US benchmarks in 2022.

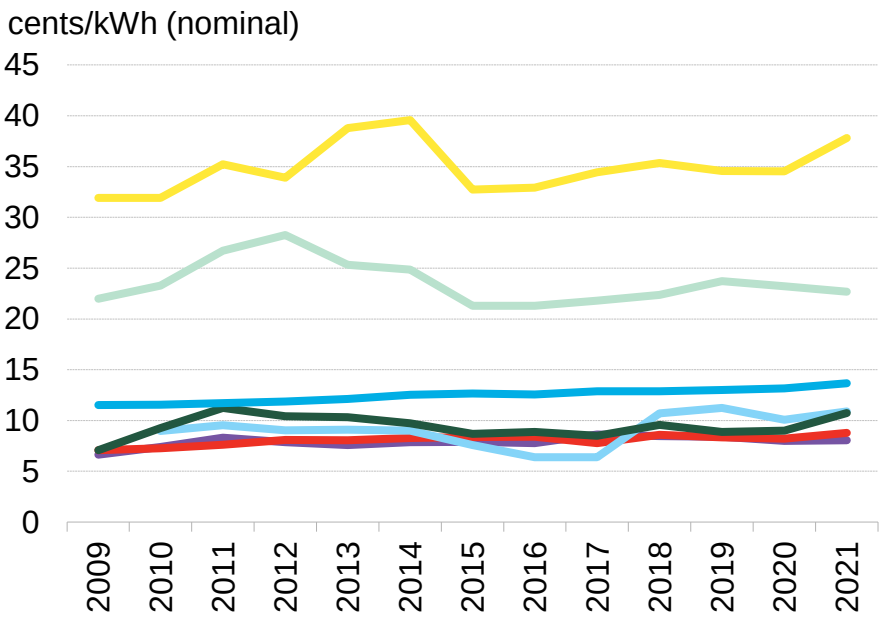
Source: BloombergNEF, EIA, Bloomberg Terminal Notes: Wholesale prices are taken from proxy power hubs in each ISO. All prices are in real 2022 USD. Retail power prices shown here are not exact retail rates but weighted averages across all rate classes by state, as published by the EIA. Retail prices are updated through November 2022.

US energy overview: Average electricity rates by country

Industrial power prices



Residential power prices

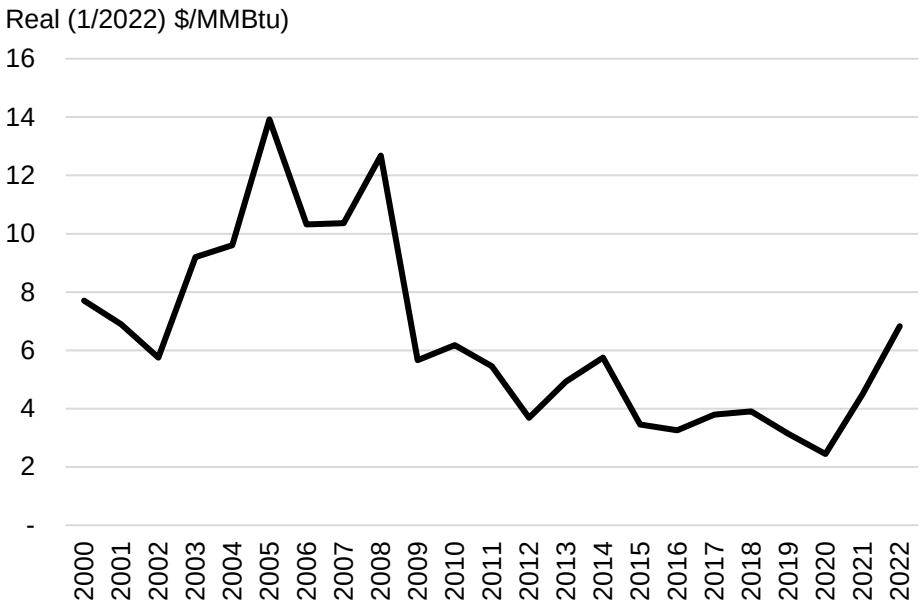


- The US – and North America in general – offers industrial customers some of the least expensive electricity in the world. Among the G-7 nations, the US offered the lowest average industrial power price of 7.2 cents per kilowatt-hour in 2021 (the last year for which there is complete data).
- The prices households pay for power in the US has been relatively stable over the past decade, rising just 12.5% in nominal terms from 2012 through 2021.
- In Germany, power prices surged in 2021 due to rising natural gas prices, which rose further in 2022 after the outbreak of the war in Ukraine. Japan's power prices slid somewhat in 2021 as the country relied more on domestic renewable, nuclear and coal generation and less on imported natural gas.

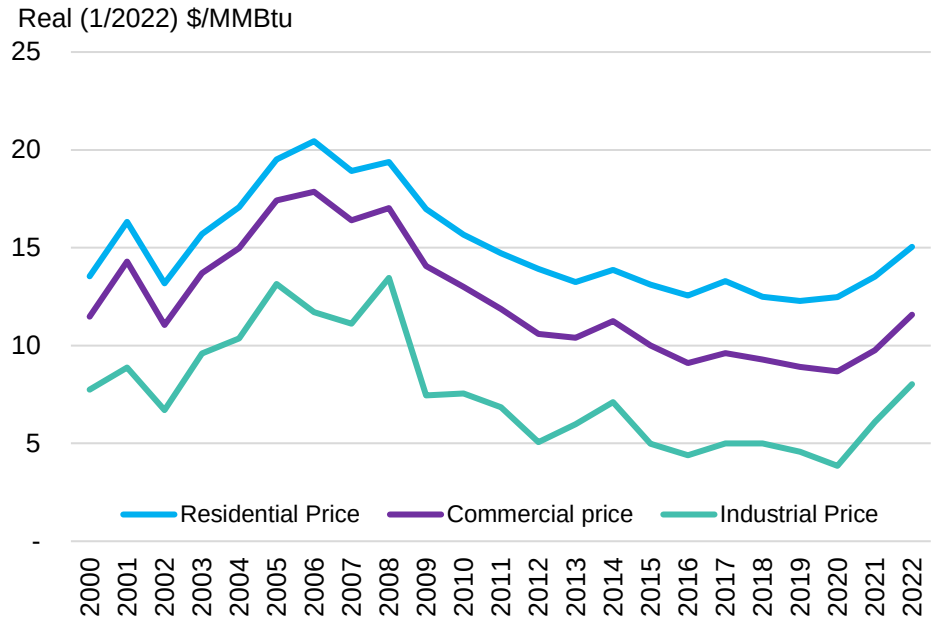
Source: BloombergNEF, government sources (EIA for the US) Notes: Prices are averages (and in most cases, weighted averages) across all regions within the country. Japanese data are for the C&I segment and 2016 figures come from a different source than preceding years.

US energy overview: US natural gas pricing, wholesale and by end use

Natural gas wholesale prices at Henry Hub, LA



Natural gas prices to end users, US average

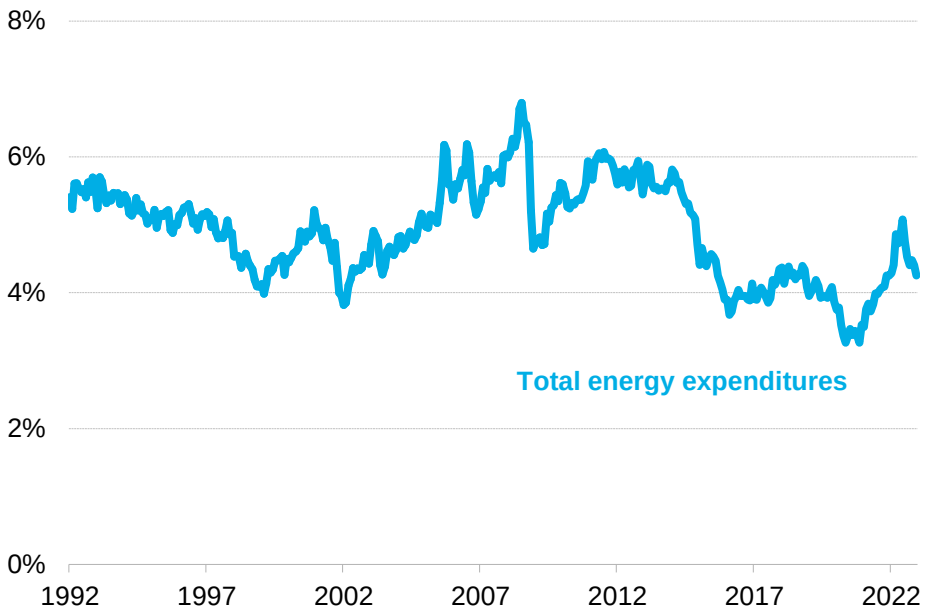


- For the second year in a row, US natural gas prices rose significantly due to tight market conditions that included rising demand for natural gas at home and abroad.
- The average benchmark Henry Hub wholesale natural gas price for the year was rose 11% for the year and was up 19% for residential and commercial consumers, respectively. Industrial users saw the biggest year-on-year change, with prices jumping 32%. Despite the rise, 2022 prices were still about half of those seen in 2005.
- Residential price adjustments tend to lag index prices 6-12 months, depending on utility practices, Industrial prices tend to be most correlated to wholesale markets. Of note, natural gas prices in the last quarter of 2022 began to decrease to below $5/MMBtu by the last week of December 2022.

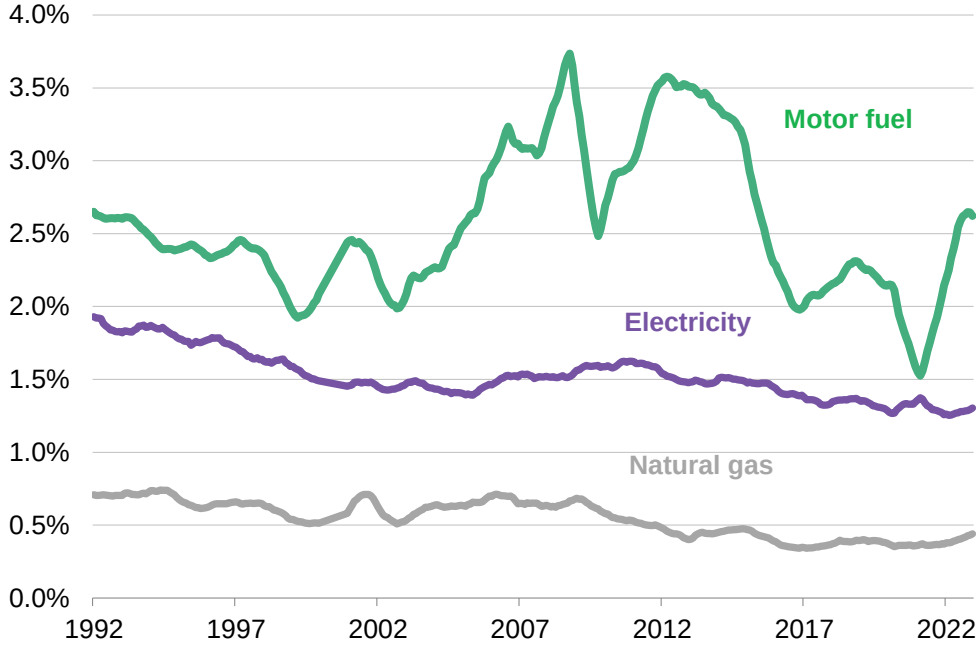
Source: BloombergNEF, EIA Short Term Energy Outlook

US 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.

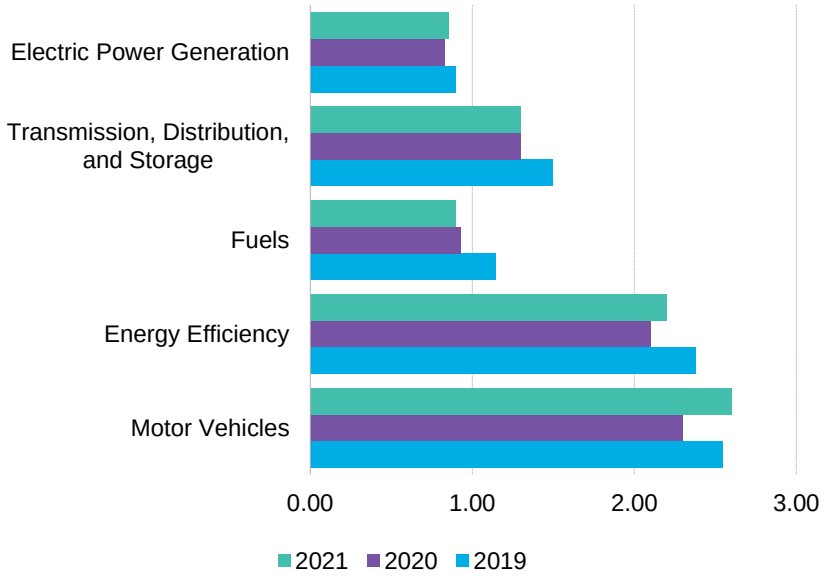


- Total consumer spending, including all energy goods and services, rose significantly in 2022 as inflationary pressures affected the broader US economy. But consumers still devoted a relatively smaller share of their total spending to energy compared to historical levels, helped by low-cost renewables, energy efficiency measures, and relatively inexpensive natural gas. Energy spending accounted for 4.6% of total US personal consumption expenditures in 2022, up 0.63 percentage points from 2021.
- The 1.74% share of household expenditures that went to electricity and natural gas in 2022 was only slightly above 2021 levels of 1.63%. This contrasted with the steep jump in motor fuel spend. Transportation-related energy consumption spending rose from 2.1% in 2021 to 2.65% in 2022. Since the start of 2023, US natural gas prices have fallen dramatically.

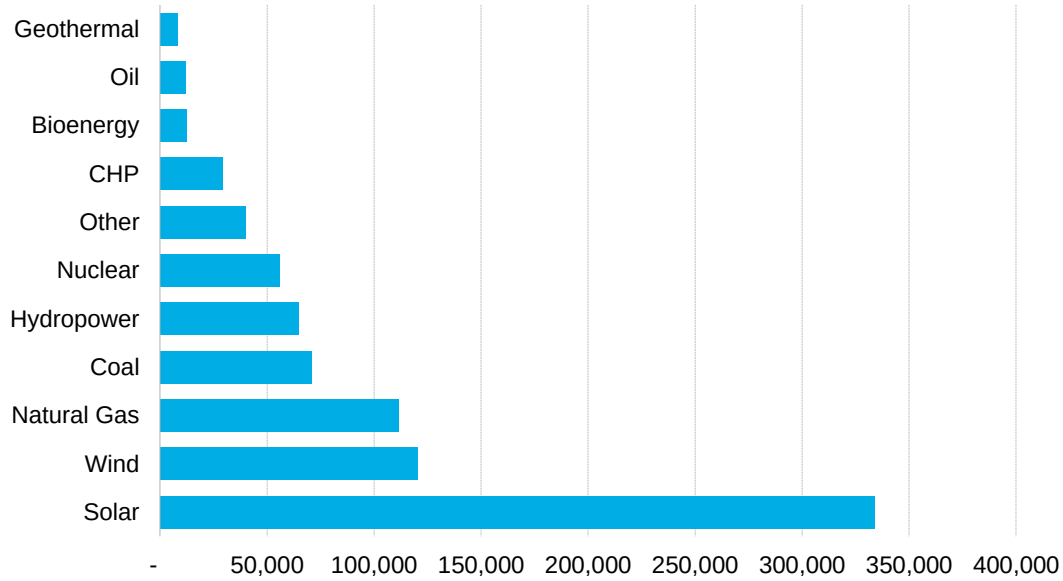
Source: Bureau of Economic Analysis, BloombergNEF

US energy overview: Jobs in select segments of the energy sector

Jobs in select energy segments, 2019-21



Employment by power-generating technology, 2021

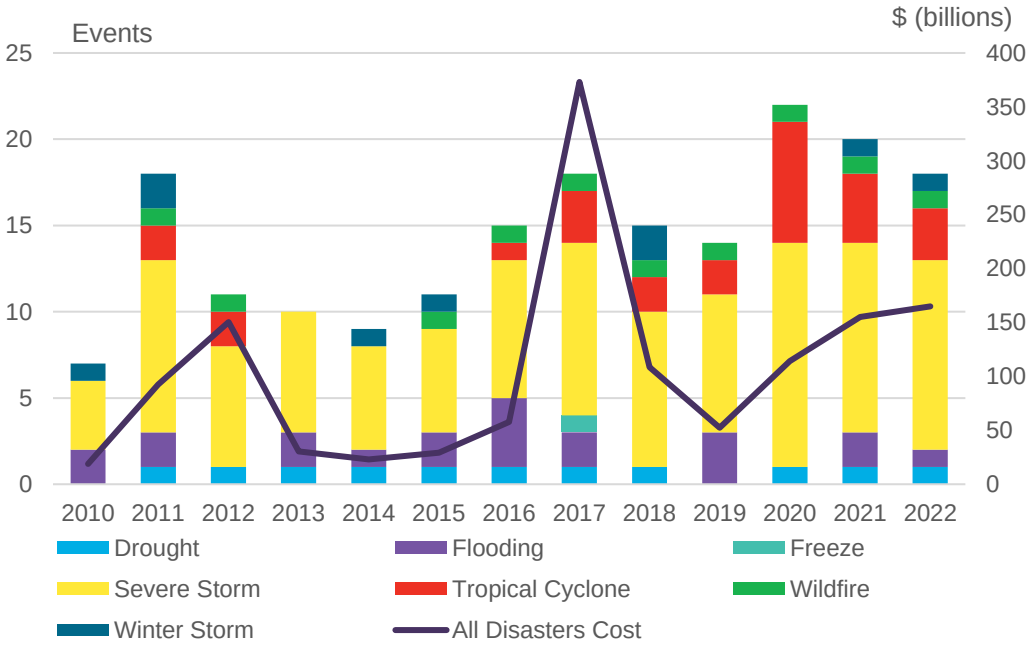


- The total number of workers employed in the energy sector grew by 4% to 7.8 million in 2021 (the last year for which there is complete data), according to an annual US Department of Energy report.
- While energy-sector employment has not recovered entirely to pre-COVID levels, it did outpace overall US employment in 2021, which grew 2.8% year-on year.
- Among power-generating technologies, solar represents the largest share of total jobs, accounting for nearly 40% of power-sector employment.
- Energy efficiency, one of the hardest hit sectors during Covid-19, represented over 2.1 million jobs in 2021, up 58,000 from the year prior as efficiency programs resumed in many parts of the country.

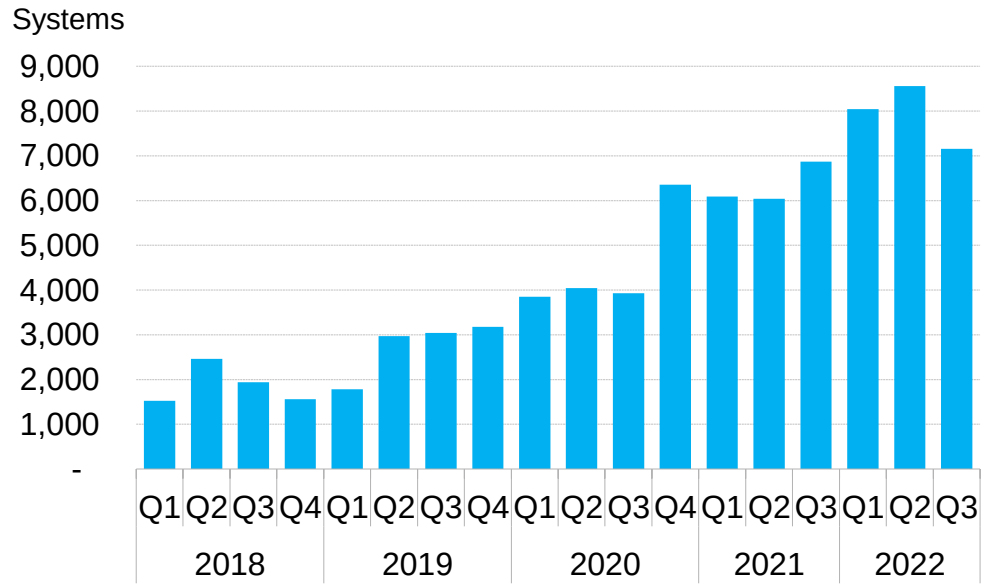
Source: The US Department of Energy's 2022 Energy & Employment Report

Policy: Infrastructure and resilience

US billion-dollar weather and climate disasters



Quarterly residential energy storage systems installed in California

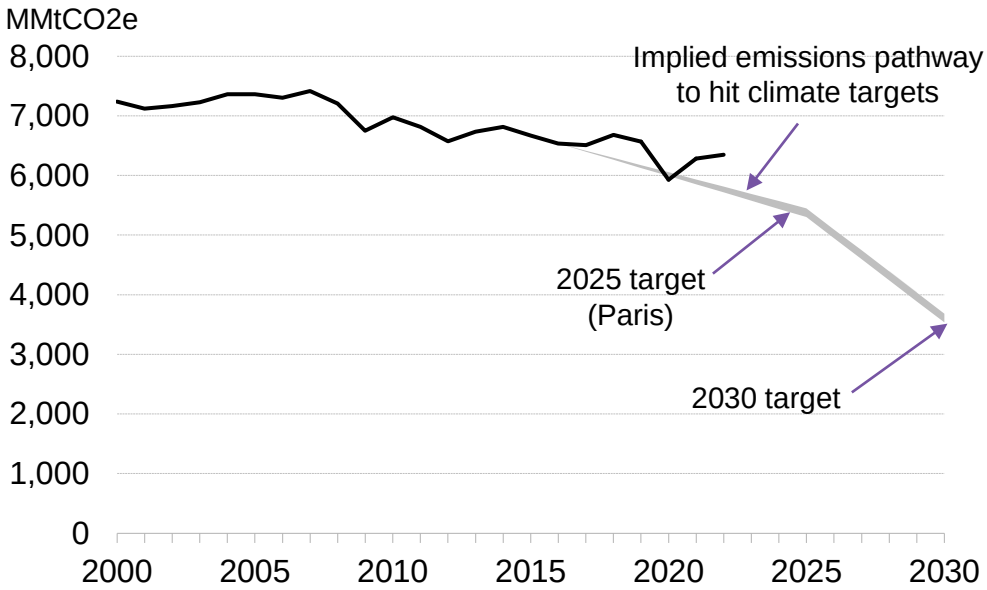


- The US in 2022 experienced 18 climate disasters causing at least $1 billion in damage. Three tropical cyclones made up 70% of the $165 billion dollars in damage, making 2022 the third most costly climate disaster year after 2017 and 2005. A total of 3.4 million Americans were forced at some point to evacuate their homes during 2022 due to natural disasters, the Census Bureau has estimated.
- Motivated by policy incentives and concerns about grid reliability, California utility customers installed more than 23,760 residential energy storage systems Q1-Q3 2022 (the latest quarter for which there is complete data). This number is 25% greater than for the similar three quarters of 2021 and 61% higher than in 2020.
- Microgrids, primarily comprised of batteries, solar, and combined heat and power (CHP) systems, are growing in California, Texas and Florida. In 2022, there were 101 microgrids online, with 85MW/188MWh of capacity installed in the US.

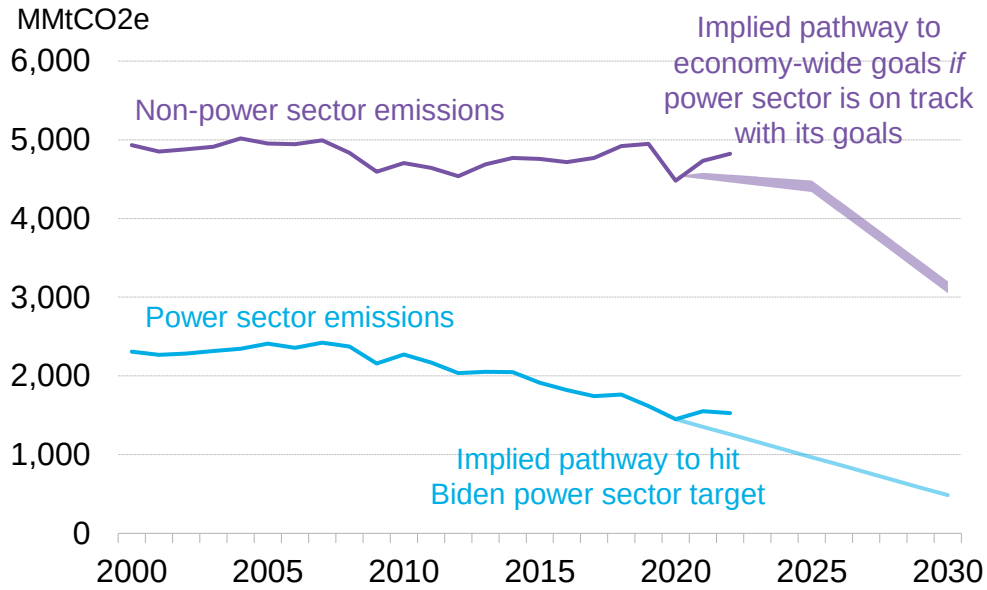
Source: National Oceanic and Atmospheric Administration, BloombergNEF. Note: Portrays annual counts of drought, flooding, freeze, severe storm, tropical cyclone, wildfire and winter storm events in the US with losses of more than $1 billion each.

Policy: US progress toward emissions goals

US economy-wide emissions



US power emissions

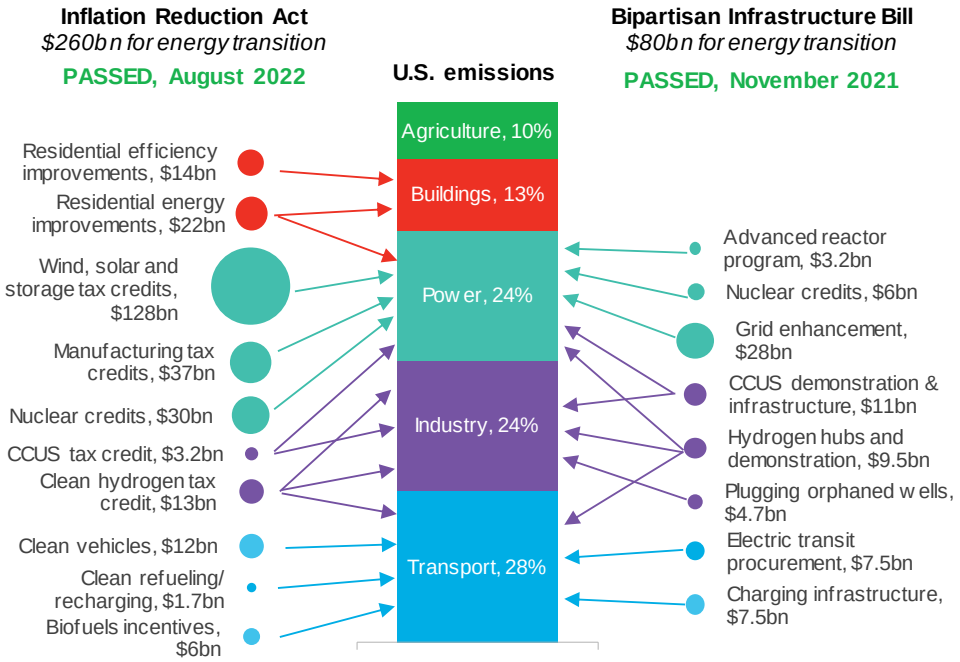


- The Biden administration has pledged the US to a Nationally Determined Contribution (NDC) of cutting emissions to 50-52% below 2005 levels by 2030, under the framework of the Paris agreement. This follows on from the original Paris pledge made under the Obama administration of reaching 26-28% below 2005 levels by 2025. BlooombergNEF estimates that US emissions for 2022 were 13.8% below 2005 levels, leaving the US about half the way toward its Paris target.
- While the downtick in emissions in 2020 offered a sliver of hope that the US could honor its original Paris pledge, the sharp rebound in 2021 followed by 2022's incremental year-on-year increase has set the country back from hitting its goals.
- Power is the only sector for which the administration has explicitly set an emissions reduction target. Netting out the power goal from the overall US emissions goal offers an implicit pathway non-power US emissions must follow for the US to hit its overall target. For the US to have stayed on track toward meeting its goals in 2022, power sector emissions needed to fall by 6% or more. Instead, they dipped just 1.5%. Across all other sectors, emissions would have needed to slide 0.9% in 2022 to keep the US on course. Instead, they rose 1.9%.

Source: EIA, EPA, BloombergNEF

Policy: Inflation Reduction Act key details

Estimated 2022-31 energy transition spend in Inflation Reduction Act, Bipartisan Infrastructure Law



Inflation Reduction Act key dates

2023

- **January 1:** Many tax provisions take effect
- **February 18:** Credit transfer elections become possible. EPA greenhouse gas reduction fund grants offered. Advanced Energy Project Credit award begins. EPA offers clean heavy-duty vehicles grants for cities, states, tribes, and schools. Solar and wind environmental justice capacity limitation takes effect.
- **May 13:** Initial offering of EPA greenhouse gas plan and implementation grants
- **August 16**: Clean hydrogen guidance expected

2024

- **January 1:** Clean vehicle China/Russia battery component exclusion, clean vehicle tax transfer provisions, and 45U clean nuclear tax credits take effect
- **August 16:** Lifecycle emissions methodology for alternative fuels released. EPA issues new methane reporting guidelines.
- **August 22:** Unspent state energy office home rebate funds distributed to states
- **September 30:** EPA greenhouse gas reduction fund spend deadline. Defense production act spend deadline
- **December 31:** Energy storage and microgrid controller construction initiation deadline

2025

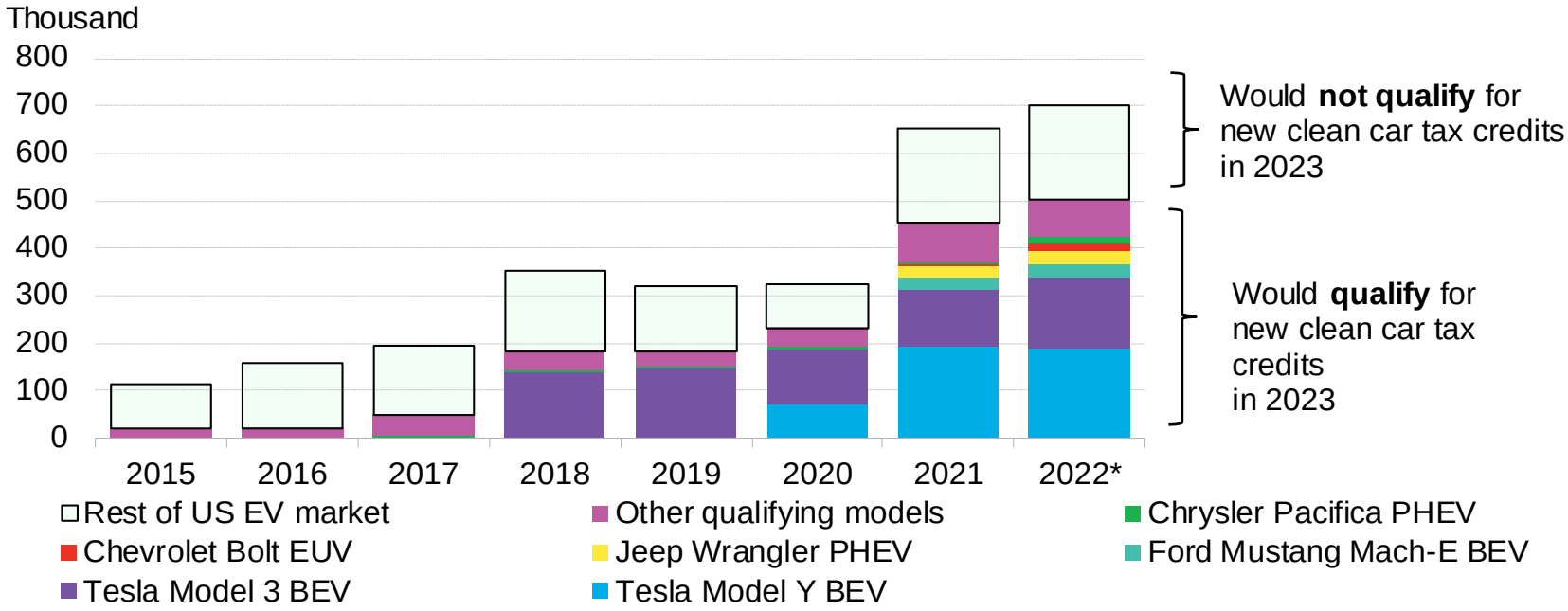
- **January 1:** Clean fuel production credit and clean electricity investment and production credits take effect. Cost recovery for facilities/energy property/storage takes effect. Solar and geothermal initial construction deadline. Ban on car batteries using critical minerals from sanctioned countries.

- Congress in August 2022 passed the Inflation Reduction Act (IRA), the most consequential US federal law ever intended to address climate issues. The law represented a major victory for various clean energy sectors.
- The IRA would provide at least $369 billion in support to energy transition technologies. The law stands to put the US far closer to the Biden administration goal of halving economy-wide CO2 emissions by 2030 (vs. 2005) and in 2023 and 2024, the Treasury Department will write many of the rules in 2023 on how these and other tax policies are to be implemented.
- While the IRA is arguably the most significant, it is not the sole piece of climate legislation to be passed during the 116th Congress. The Infrastructure Investment and Jobs Act (aka Bipartisan Infrastructure Bill) of 2021 and the CHIPS and Science Act of 2022 both contained significant support for climate-related sectors.

Source: EIA, EPA, Joint Committee on Taxation, Inflation Reduction Act, BloombergNEF. Note: Left-hand chart only captures tax credits and incentives, not grant programs or loans.. CCUS is carbon capture, utilization and storage.

Policy: Federal EV tax credit overview

US passenger EVs qualifying for new tax credits

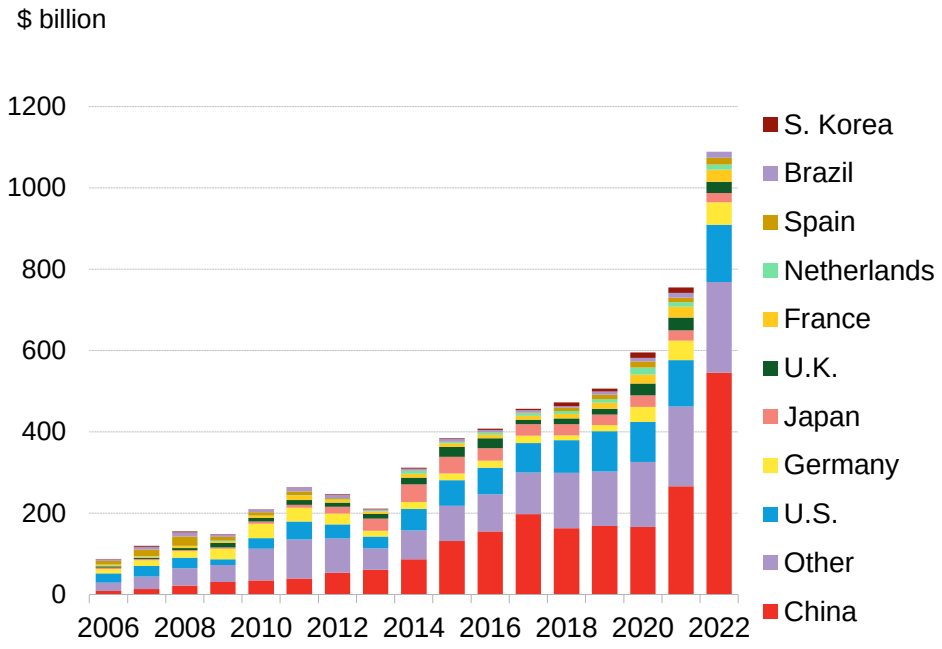


- Transportation is the largest source of US greenhouse gas emissions and in 2022 EVs were a record 7% of US passenger vehicle sales.
- The biggest policy change to affect the industry in 2022 was the passage of the Inflation Reduction Act, which extends and modifies the clean car tax credit. The new policy, which is undergoing implementation, allows new EVs to receive up to $7,500 if they meet strict sourcing requirements for battery components and critical minerals, as well as have final assembly in the US. As of the end of January, the two sourcing requirements were delayed until March by the Treasury Department, which is working to finalize criteria. Domestic automakers are most likely to benefit from the delay. Of EVs sold in the US in 2022, under a third would not have qualified for the full credit had the new version of the rules been in place.
- At the state level, in 2022, California finalized its Advanced Clean Cars II policy, which calls for 100% zero-emission vehicle sales starting in 2035. New York, Massachusetts, Washington and Oregon are among the states set to follow the Golden State's new policy. In California, about 19% of 2022 passenger car sales were electric vehicles.

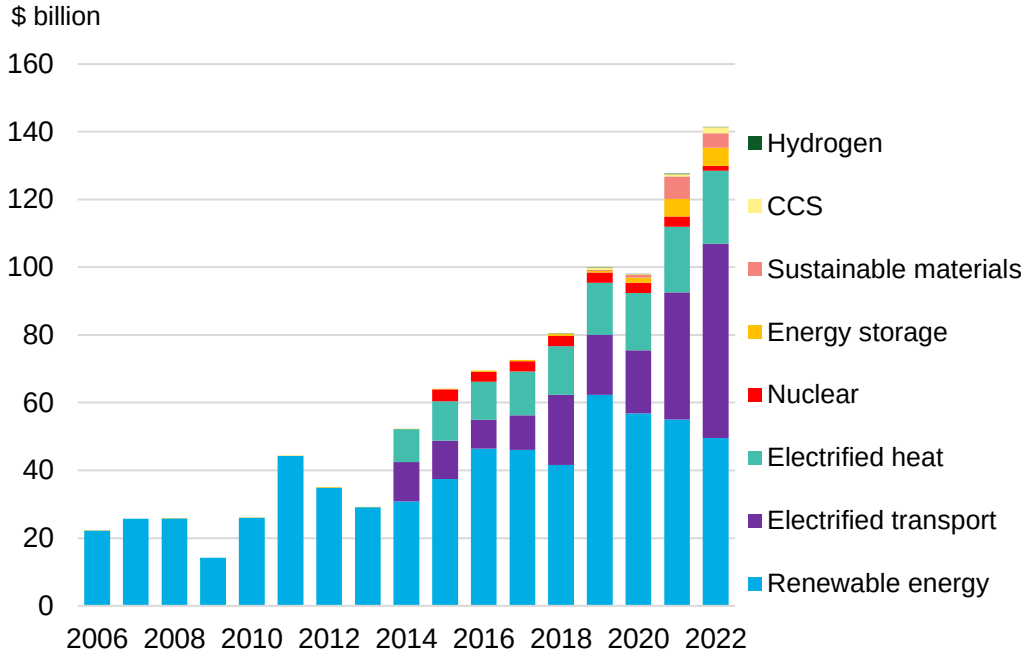
*Source: BloombergNEF, IRS. Note: * 2022 sales are 1Q-3Q. Considers IRS requirements, including manufacturer's suggested retail price (MSRP) and North American "final assembly" rules. Some Tesla Model Y trims are close to MSRP cap, eligibility will depend on Tesla's pricing strategy.* ***Chart based on IRS rules from before March 2023. See slide 61 for full-year 2022 EV sales.***

Finance: Energy transition investment

Energy transition investment, by country



US energy transition investment, by sector

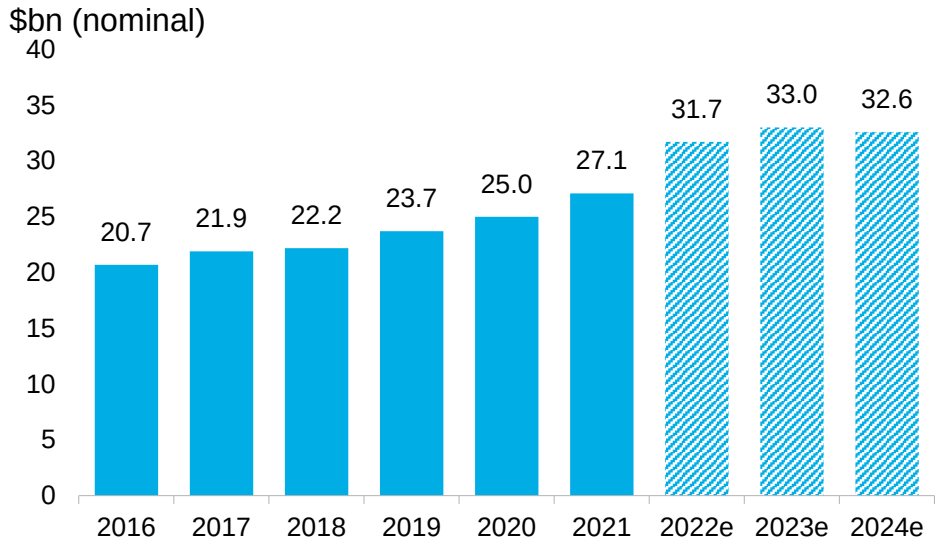


- BloombergNEF tracks investment into the technologies accelerating the trend toward decarbonization of the global economy. In 2022, over $1 trillion went toward supporting the global energy transition. China led the way, accounting for just over half with $546 billion of funds deployed.
- The US is the second largest energy transition investor, with investment rising 11% year-on-year to $141 billion, largely reflecting the growth in electric vehicles sales during the year. Electrified transport, a category that includes revenues from the sale of EVs plus investment in charging infrastructure, was 41% of total US investment in 2022. Renewables accounted for 35%, down somewhat from the year prior.
- BloombergNEF counted an estimated $130 million in new investment in US hydrogen producing projects for 2022. Separately, some hydrogen firms did raise start-up capital in the US.

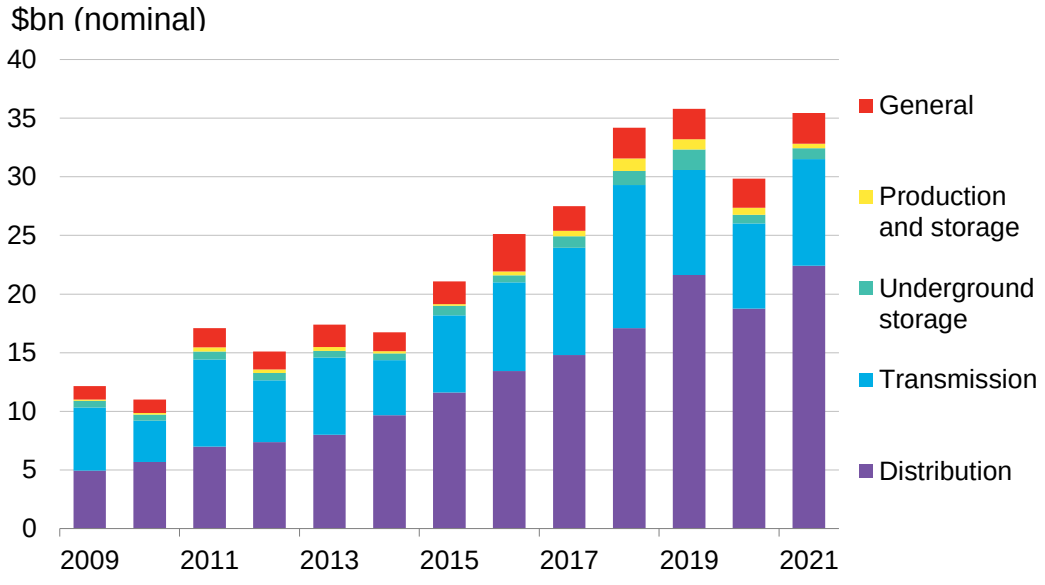
Source: BloombergNEF, "Energy Transition Investment Trends, 2022". Note: BNEF has updated and expanded its coverage of energy transition investment and slightly modified its methodology. For more see https://www.bnef.com/flagships/clean-energy-investment.

Finance: US midstream infrastructure investment

US electric transmission investment by IOUs and independent developers



US natural gas utility construction expenditures

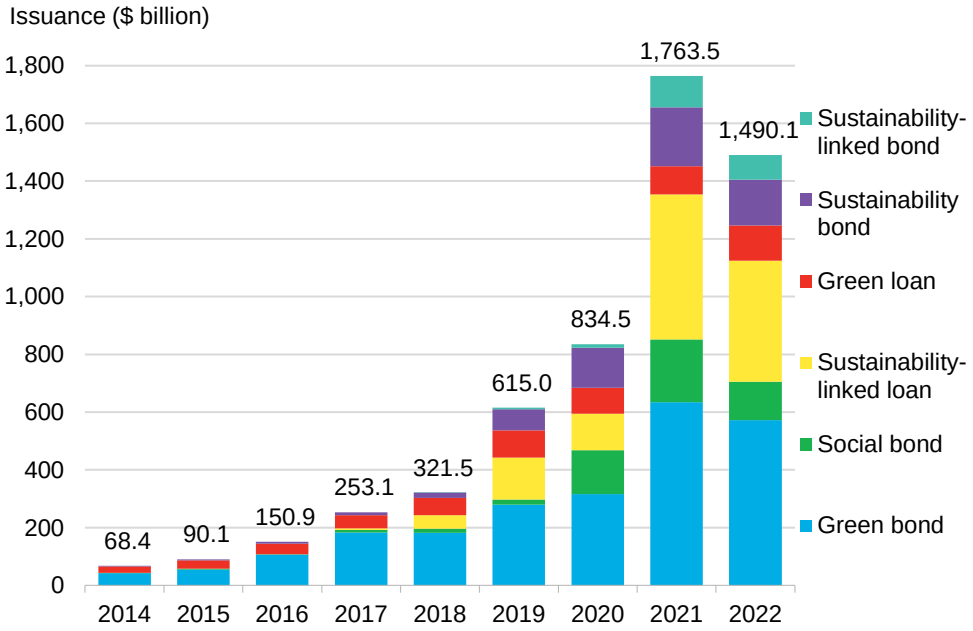


- Investor-owned utilities (IOUs) and independent transmission developers spent a record $27.1 billion on electric transmission in 2021, according to the Edison Electric Institute (EEI). This was up 8.4% from 2020 and up 24% from 2017. Based on company reports, investor presentations and a survey, EEI estimates transmission investment in 2022 likely jumped 17% to $31.7 billion. Current capex plans suggest investment will peak in 2023 then slow. However, future-year budgets are not yet finalized, and these numbers may be revised upward.
- The transmission upswing has been driven by the 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 increased by $5.6 billion in 2021 from the prior year, to $35.4 billion, according to the American Gas Association. While total US natural gas transmission investment rose, there was a 39% fall in investment in production and storage, from $614 million to $377 million.

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.

Finance: Sustainable debt raised globally/Green finance definitions

Annual sustainable debt issuance



Sustainable debt labels and characteristics

Debt Type	Debt style	Purpose	Market size ($bn)	Proportion of sustainable debt market	Growth rate 2021- 2022
Green bond	**Activity-based**	Environmental projects	2,422	42%	-10%
Sustainability-linked loan	**Behavior-based**	Institutional ESG targets	1,243	21%	-16%
Green loan	**Activity-based**	Environmental projects	735	13%	26%
Sustainability bond	**Activity-based**	Environmental and social projects	615	11%	-23%
Social bond	**Activity-based**	Social projects	548	9%	-39%
Sustainability-linked bond	**Behavior-based**	Institutional ESG targets	210	4%	-21%

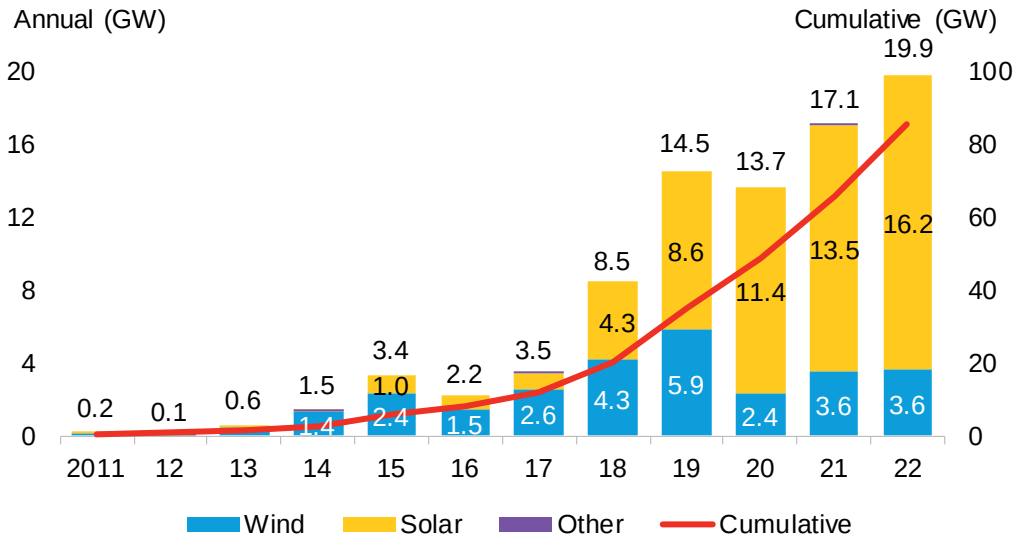
Source: BloombergNEF, Bloomberg Terminal. Note: Instruments included are from 1996 to 1H 2022. Colors depict growth rate/size from green (most/greatest) to red (least/lowest).

- Global sustainable debt issuance hit $1.5 trillion in 2022 – its first ever year-on-year drop. The 15.5% decline was due to poor macroeconomic conditions and a broader pushback against Environmental, Social and Governance (ESG) efforts. Concerns over the quality of certain sustainable investments dented activity. In the US, the backlash against ESG investing has grown stronger with some states even forbidding their pension fund managers to take extra-financial metrics into account in their investment processes.
- Although green loans saw a 26% increase in 2022, all other debt types decreased with social bonds seeing the largest drop (39%). EMEA (Europe, Middle East, Africa) make up about 45% of total annual sustainable debt issuance, the biggest regional contributor. Then comes APAC (Asia Pacific) at 26%, AMER (Americas) at 21%, and finally SNAT (Supernationals) at 8%.
- Meanwhile, regulators globally built frameworks to define what constitutes a sustainable investment, bolster disclosure and integrate climate into corporate and financial strategies, suggesting the turbulence in 2022 may be an aberration rather than the new normal.

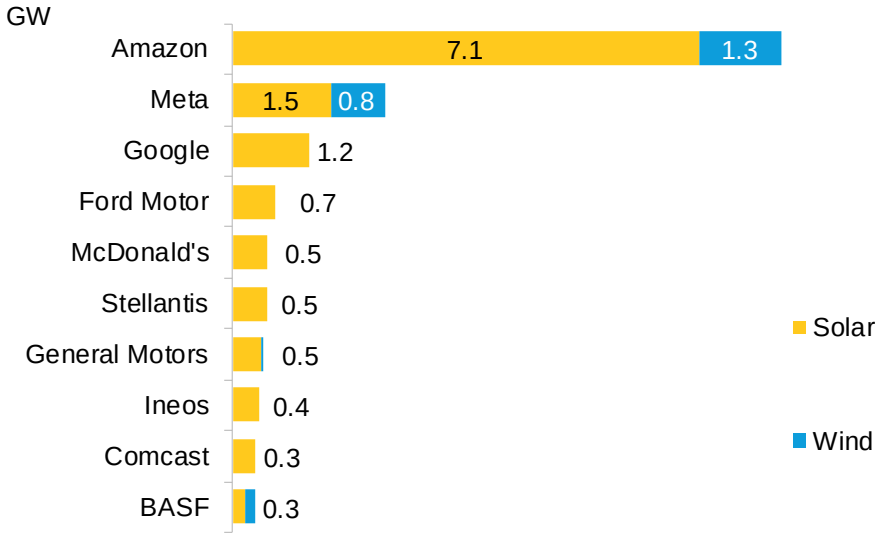
Source: BloombergNEF, Bloomberg Terminal.

Finance: Corporate procurement of clean energy in the US surges to new record

Renewable capacity contracted by corporations, by sector



Largest corporate offtakers, 2022

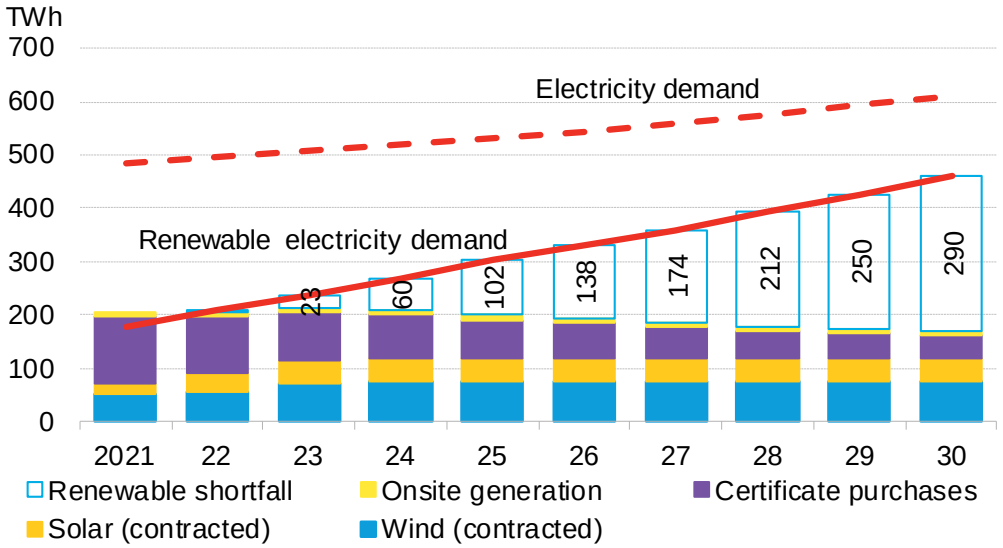


- Corporate power purchase agreement (PPA) volumes in the US reached a record 19.9GW in 2022, easily surpassing the previous record of 17.1GW in 2021. Companies announced 112 individual PPAs, down from 118 the previous year but much greater in average size (178MW compared with 145MW). The overall number of different companies signing PPAs in the US totaled 49, down noticeably from 67 in 2021.
- Virtual PPAs reached a record 17GW in 2022, crushing the previous record of 12GW in 2021 and making up 85% of activity in the US. Under this structure, the project sells power directly into the wholesale market and captures the spot price at the time. The buyer in turn gets ownership of the certificates from the project and pays a fixed price. The virtual PPA is becoming more popular both due to the simplicity of signing them – a major positive for new entrants to corporate procurement – but also due to increasing volatility in the US power market. Extreme power price spikes like those seen in February 2021 in Texas and in December 2022 across the US have pushed buyers to hedge their exposure to this volatility.
- Amazon's activity in the US (8.3GW) is more than all of the corporate PPA activity in Europe in 2022 (8.1GW). The company signed deals in 16 different US states in 2022. Other major buyers in the US in 2022 included Meta (2.3GW), Google (1.2GW), Ford (0.7GW) and McDonald's (0.5GW). Technology companies are expected to need to sign more deals in the coming years to keep pacing with rising electricity consumption.

Source: BloombergNEF Note: Charts show offsite PPAs only. Microsoft, not depicted in the right-hand chart, uses a different methodology from BNEF to disclose its PPA activity.

Finance: Corporate sustainability targets

Clean electricity supply and demand for RE100 members



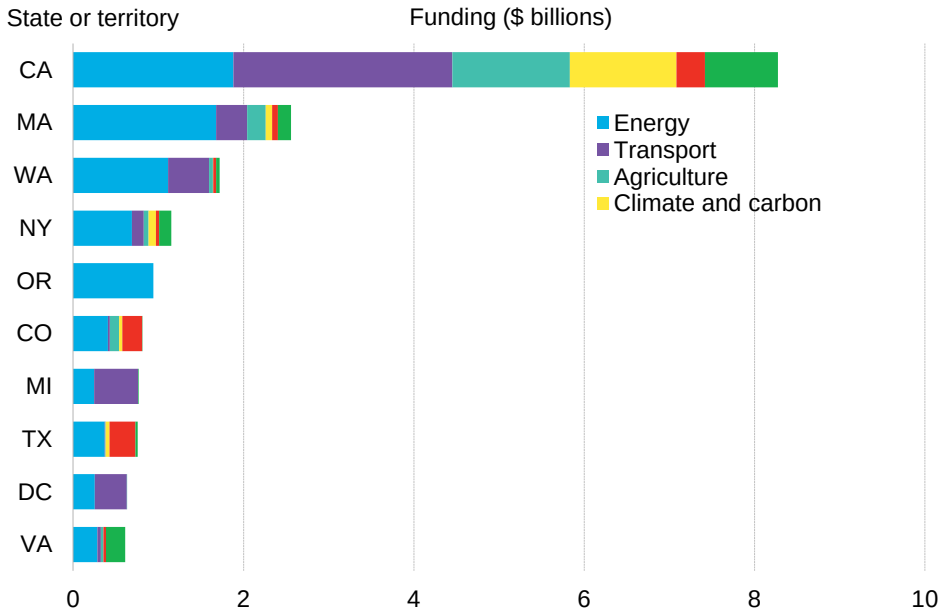
US RE100 members in 2022

- 56 new companies joined the RE100 in 2022, pledging to fully offset their electricity consumption with clean power at a future date. This was down from 67 new companies that joined in 2021, suggesting the RE100's momentum is slowing as companies prioritize other sustainability targets, like net-zero goals. Just 10 of the new joiners in 2022 were from the US, compared with 42 across Asia Pacific. New US members included Applied Materials, Eli Lilly, Lear Corporation and Pfizer. Over 100 companies in the US have now joined the RE100 – more than any other market. These companies collectively consumed 165TWh of electricity annually, based on their latest disclosures.
- There are now 397 RE100 members globally across 25 markets. These companies collectively offset 41% (438TWh) of their electricity demand with renewables as of 2021, led by certificate purchases (123TWh) and offsite wind (51TWh).
- In total, the 397 RE100 members will need to purchase an additional 290TWh of clean electricity in 2030 to meet and maintain their RE100 goals. Meeting this entirely through offsite solar and wind deals would catalyze an estimated 99GW of solar and wind build globally. An estimated 132TWh of the above demand is expected to come from the Americas region – most of this from the US. This suggests that corporate demand from RE100 members will catalyze significant clean energy build in the US in the coming years.

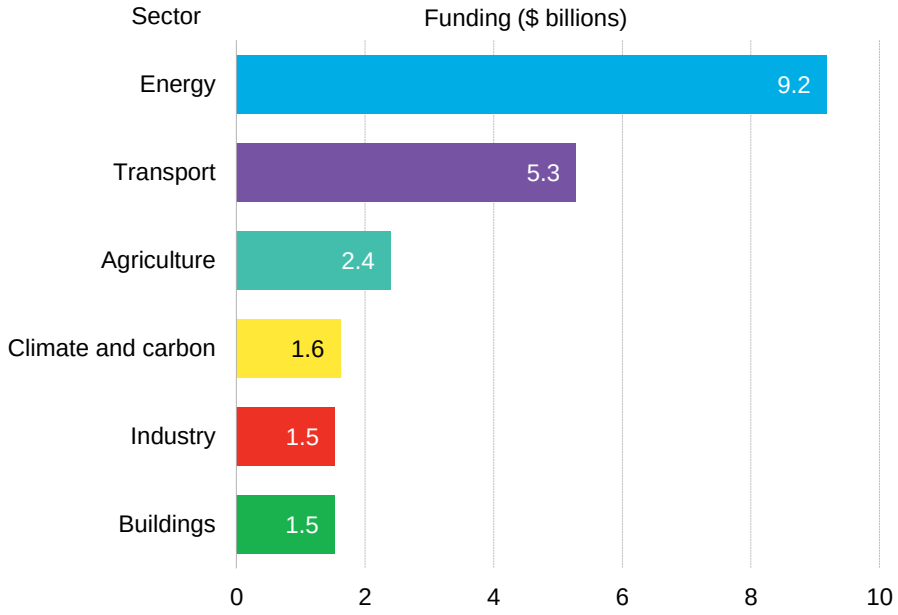
Source: BloombergNEF Note: Charts show offsite PPAs only

Finance: Venture Capital/Private Equity Investment

Top 10 states for climate-tech VC/PE investment



US climate-tech VC/PE investment sector

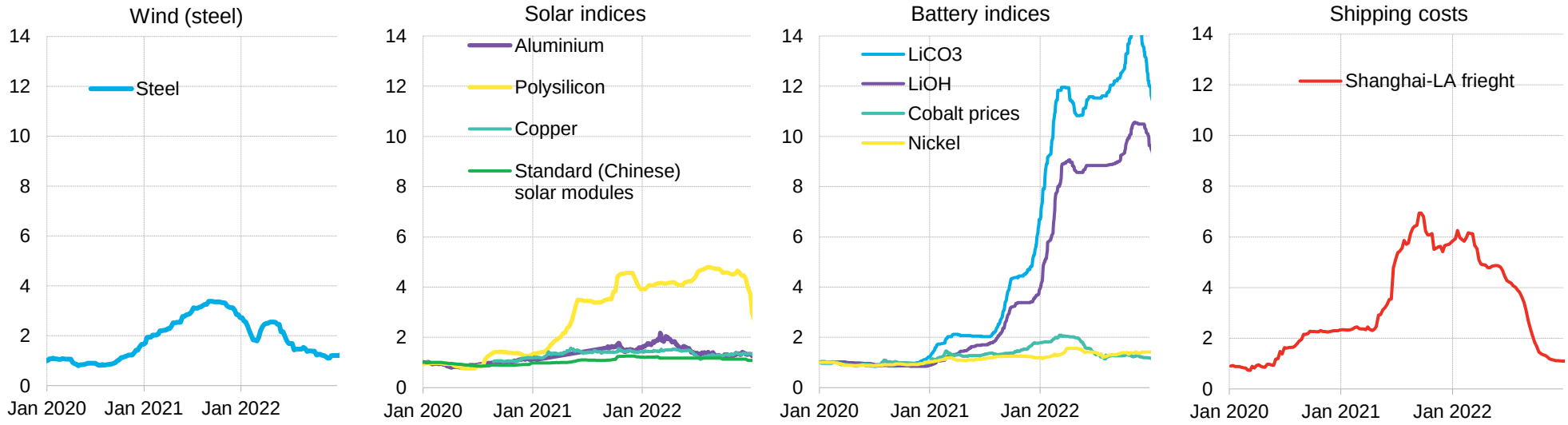


- For 2022, US venture capital and private equity investment totaled $21.5 billion with 422 different deals completed – a slight dip from 2021. The top 10 states received $18.23 billion or 85% of all funding. No less than 38% of all funding went to entities in California alone ($8.27 billion) with transportation firms receiving the highest share at 2.57 billion.
- Nationwide, energy and transport sectors were the two most funded areas for climate-tech VC/PEs. They made up 67% of all the investments in 2022.
- The US continues to be the largest market for VC/PE investment in new companies. China was the second biggest, attracting $14.6 billion in 2022.

Source: BloombergNEF, PItchBook.

Economics: Commodity costs for wind/solar/batteries/other equipment

Price movements since January 2020

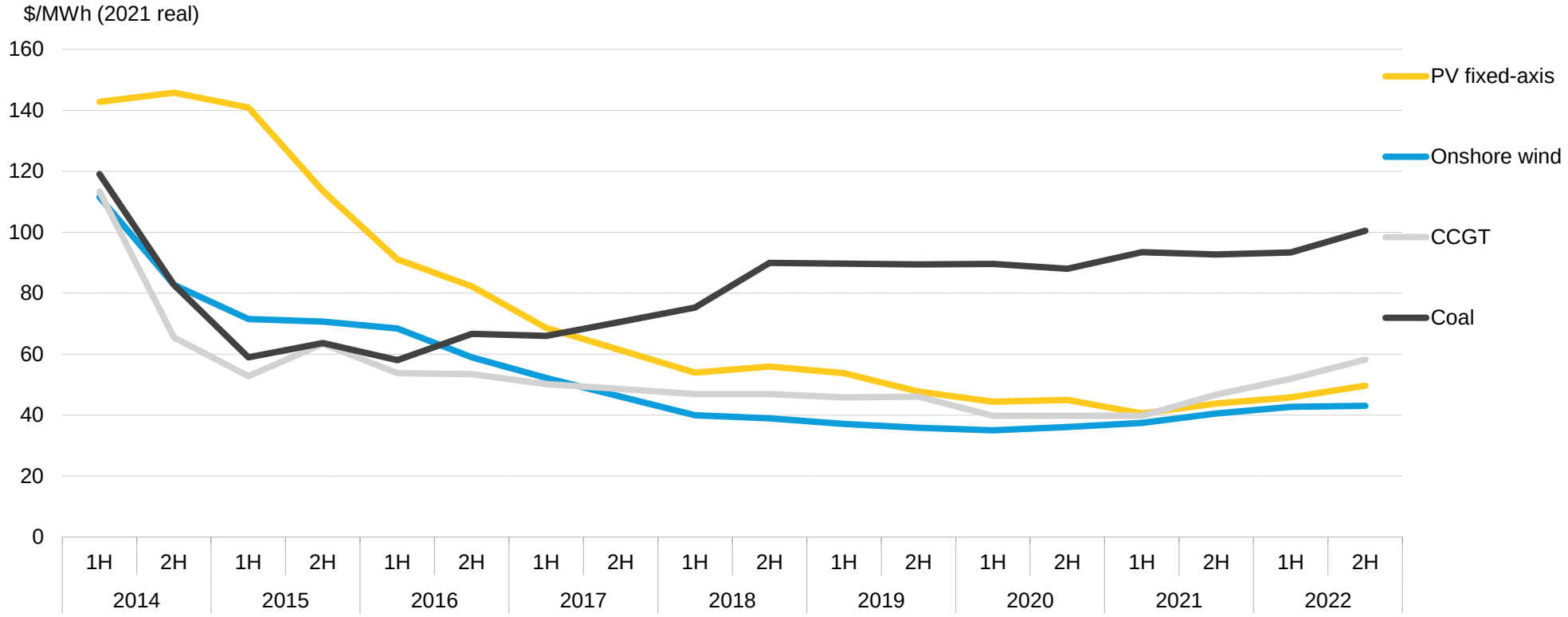


Prices for key commodities that underpin the clean power sector were stubbornly high through much of 2022, but eased somewhat by year end.

- Shipping costs returned to pre-pandemic levels from highs reached in December 2021. Easing congestion helped, particularly at the ports of Los Angeles and Long Beach where many pan-Pacific shipments of solar panels and batteries arrive from Asia. Steel prices also declined over the course of the year, easing costs associated with wind turbines and racking equipment used with solar modules.
- Polysilicon prices touched new highs in August 2022 due to temporary supply disruptions and strong demand. However, supply rose and prices fell toward the end of 2022 as existing plants returned to services and new factories were commissioned.
- Lithium carbonate prices spiked in 2022 and at one point the material traded at 14 times its January 2021 price. Spot prices have jumped in the past year due to high EV demand from China. By September 2022, an LFP battery cell cost $144/kWh given spot market prices for lithium carbonate, BNEF estimated. This was up 9% from November 2021 when manufacturers were just starting to see large raw materiel price increases. While lithium benchmarks descended slightly in December 2022, they remain at much higher levels than before the pandemic.

Source: 2H 2022 US Clean EnergyMarket Outlook, BloombergNEF, Bloomberg Terminal. Note: Data rebased to 1 on earliest available date in January 2020. Steel reflects North America costs, while aluminum and copper are China prices –more details as well as Bloomberg Terminal tickers available in the Excel attached to the report.

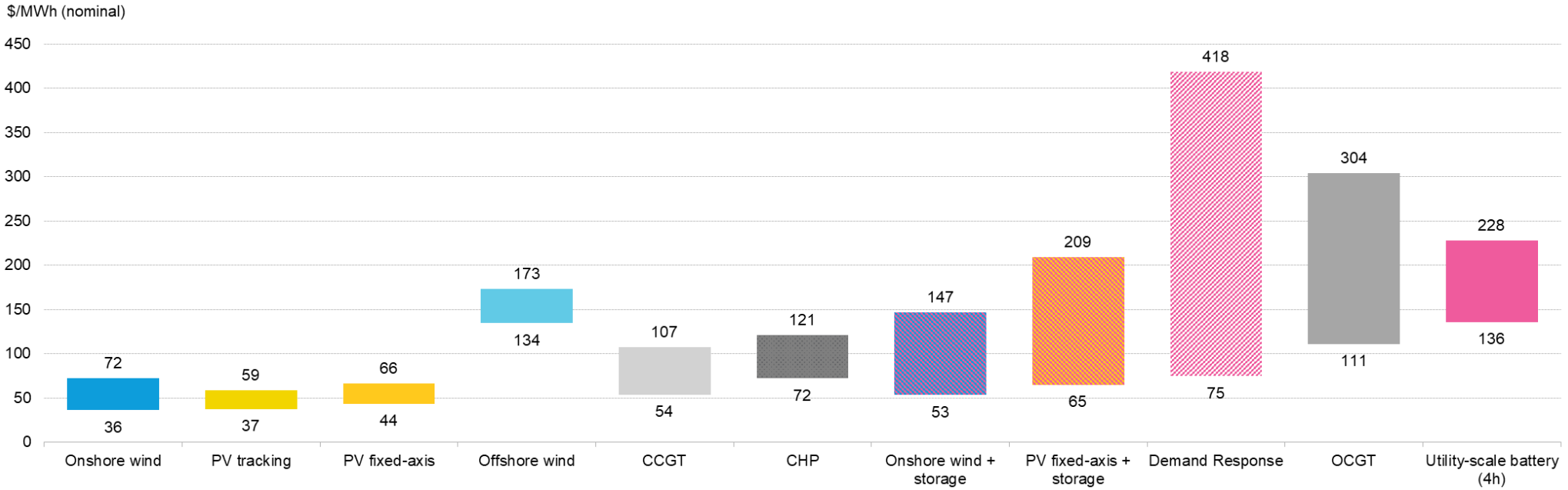
Economics: US levelized costs of electricity, 2014-22



- Higher fuel prices, elevated material prices and higher debt costs pushed up the levelized costs of electricity (LCOE) for coal, gas, solar and wind technologies over the course of 2022. From the first half to the second half of 2022 alone, combined-cycle gas turbine (CCGT) LCOEs rose 23% while coal increased by 9%. Both reflected higher commodities costs.
- Higher interest rates served to raise LCOEs for wind and solar as well, but to a lesser degree. Both technologies have benefited from not having associated marginal operating fuel costs. Wind's LCOE effectively stayed flat from 1H to 2H. However, solar's jumped by about 16%.

Source: BloombergNEF. BNEF started collecting country-level LCOE inputs in 2014, prior to 2014 only global LCOE are available see LCOE report. LCOE displayed by financing date.

Economics: US levelized costs of electricity (unsubsidized for new build, 2H 2022)

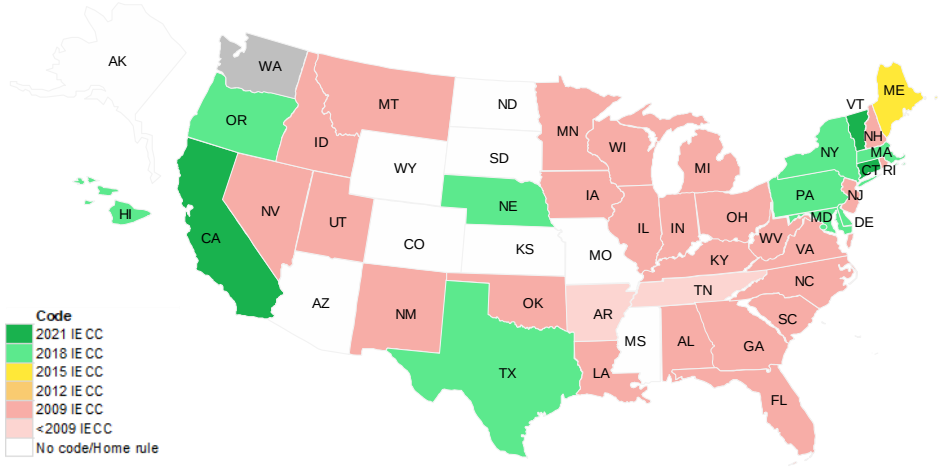


- The US levelized costs of energy (LCOE) for most power-generating technologies rose in 2022 with costs associated with fossil fuel projects seeing the highest increase. This was attributable to soaring commodities prices after Russia's invasion of Ukraine.
- Despite climbing costs, new-build renewables remain cheaper than new gas-fired plants for bulk generation in many areas of the US, with the exception of offshore wind. Onshore-wind and tracking PV projects have LCOEs of $36-72/MWh and $37-59/MWh, respectively, without accounting for tax credits. Combined-cycle gas turbines (CCGTs) represent the cheapest source of dispatchable power on an unsubsidized basis, with an LCOE of $54-$107/MWh.
- The levelized cost of paired onshore wind-plus-battery (four-hour) systems ranges from $53-147/MWh, while solar-plus-battery (four-hour) is at $65-209/MWh. PV projects without tracking increased compared to last year with LCOEs of $44-66/MWh.

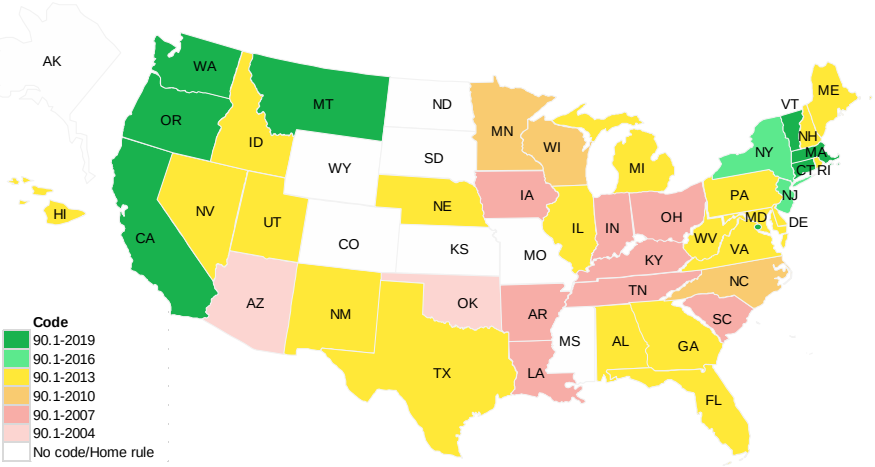
Source: BloombergNEF. Note: The LCOE range represents a range of costs and capacity factors. Battery storage systems (co-located and stand-alone) presented here have four-hour storage. In the case of solar- and wind-plus-battery systems, the range is a combination of capacity factors and size of the 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.

Deployment: Statewide energy code adoption

Residential



Commercial

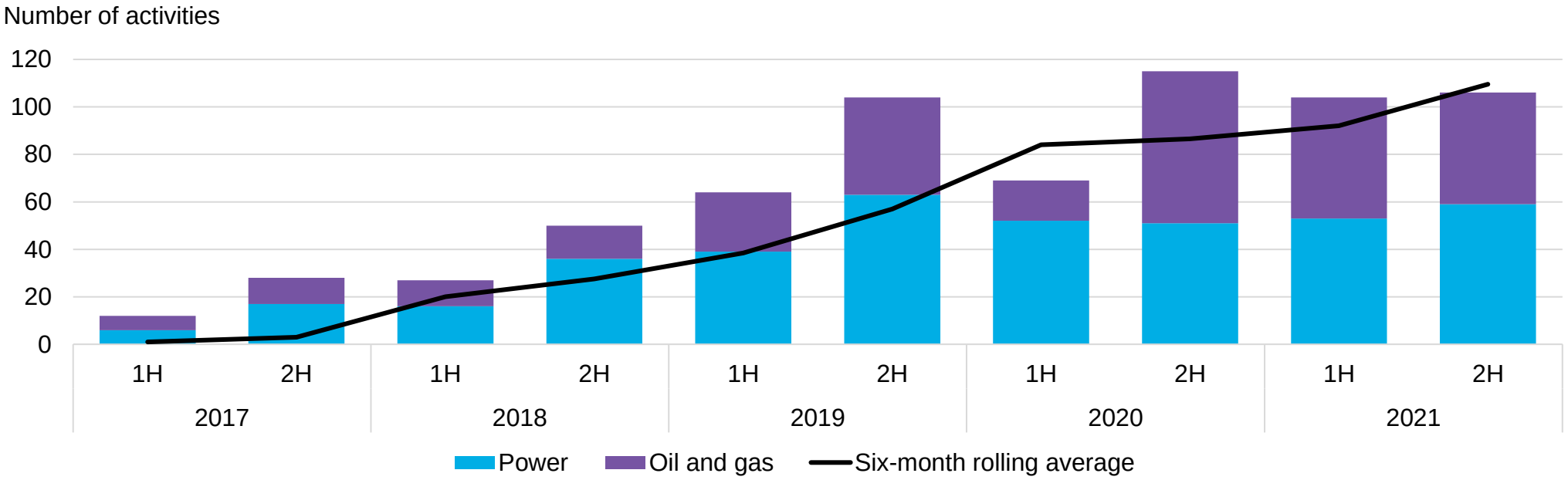


- Building energy codes set minimum standards for both new buildings and renovations. The International Energy Conservation Code (IECC) sets standards for both residential and commercial buildings. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1 is an alternative standard to IECC provisions for commercial buildings (and is an alternative pathway to meet IECC). Building energy codes can be mandated at a state level, but in some states local governments can and often do set more stringent requirements.
- The most recent editions of IECC and Standard 90.1 are considerably more ambitious than their predecessors. Analysis by the DOE estimates that the 2021 IECC leads to efficiency gains of 9.4% over the 2018 edition. Similarly, the most recent 90.1 edition, released in October 2019, is 5% more energy efficient than the 2016 version and 12% more efficient than the 2013 version.
- State energy code adoption is often a multi-year process for individual states and 2022 showcased steady progress in certain jurisdictions. State-wide energy code updates took effect in 2022 (or early 2023) for the following states: California, Connecticut, Hawaii, Rhode Island, Montana, New Hampshire, New Jersey, North Dakota, and Pennsylvania. In Colorado, legislation was signed into law that would generally require all jurisdictions in the state to adopt and enforce the 2021 IECC or equivalent beginning July 1, 2023 when they adopt or modify other building codes.

Source: EERE, ACEEE, BloombergNEF. Note: The maps represent EERE analysis of energy savings impacts from state code adoptions. Any code for which the Energy Index is not more than 1% higher than that of an IECC or Standard 90.1 edition is considered equivalent to that code edition. For more on the EERE methodology see link.

Deployment: Digitalization techs boost efficiency, track emissions

Projects and partnerships undertaken by large energy firms to integrate digitalization in operations

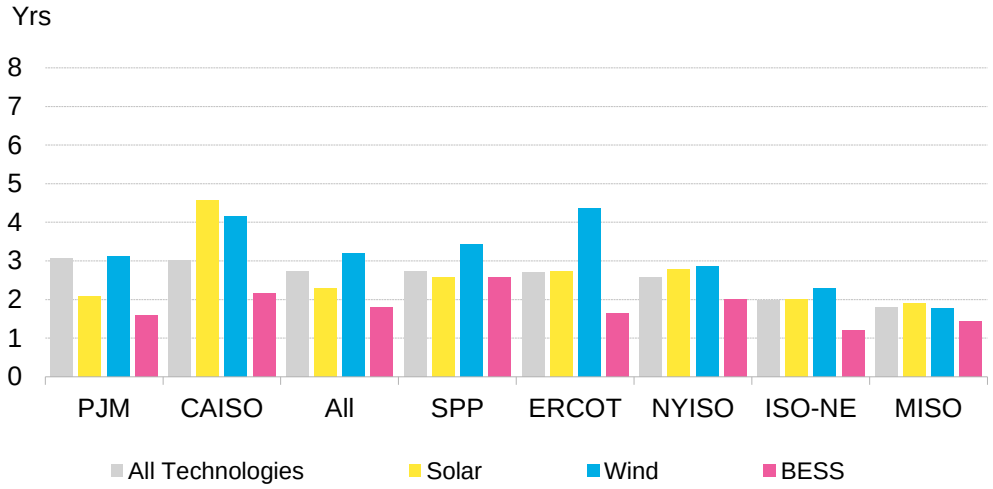


- BloombergNEF tracked 210 new activities started and partnerships formed by utilities, oil, gas and other energy companies to integrate digital technologies into their operations in 2021, the last year for which there is complete data.
- Companies are often employing Internet of Things (IoT) sensors and software to optimize assets and track emissions. In the second half of 2021, analytics software accounted for the largest share of digital activity in both the oil and gas and power sectors, at 50% and 36% respectively. This includes technologies such as artificial intelligence (AI) and digital twins. For power, a significant share of partnerships also focused on IoT connectivity. BloombergNEF has tracked 679 such activities launched and partnerships established since 2017.
- Thousands of startups are building software, sensors, chips, and drones for industrial digitalization. In 2021, IoT and AI chip companies were the biggest fundraisers, raising $6.79 billion and $4.95 billion respectively, almost triple the amount of 2020.

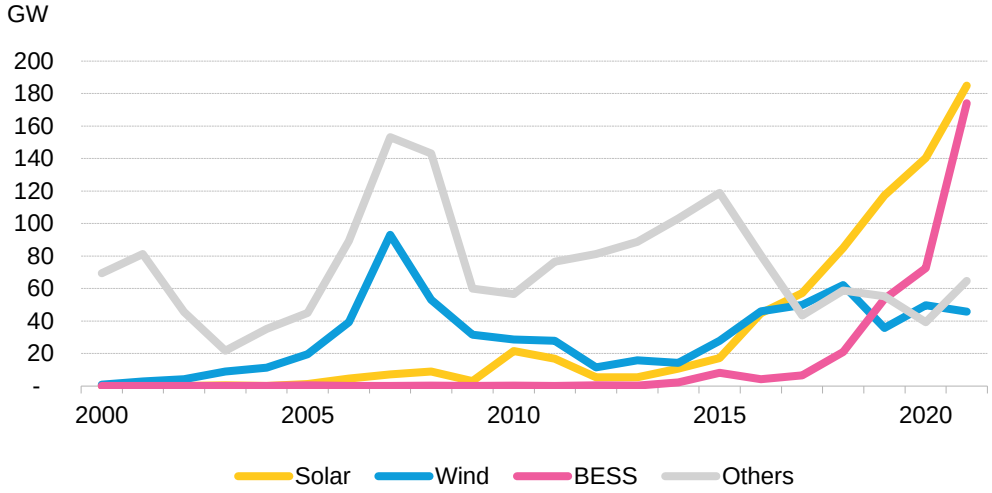
Source: BloombergNEF

Deployment: Wait times for power projects seeking grid access

Average time active projects in US grid interconnection queues have been waiting for approval



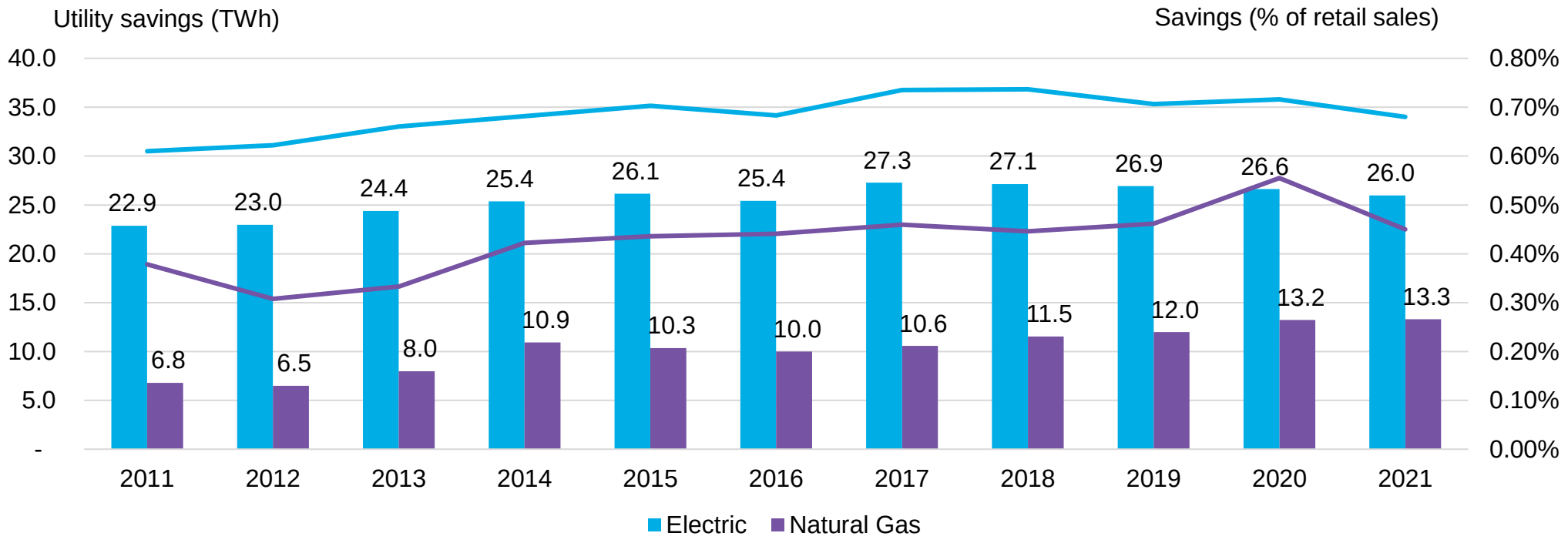
Total yearly generation capacity that applied for interconnection to US ISO power grids



- It is estimated that well over 1,000GW of potential power projects today are awaiting access to some segment of the nation's power grid. Delays vary by independent system operator (ISO). PJM and CAISO have the longest wait times, averaging three or more years, compared to other ISOs. MISO and ISO-NE have the shortest wait time for approval or denial of less than two years. The bottlenecks have restrained renewable energy deployment, particularly in PJM where fossil fuels tend to predominate. Renewables make up the majority of capacity on hold in the interconnection queue due to the increase of applications in the past decade.
- As the number of utility-scale battery energy storage systems under development has surged so too has the volume of battery capacity that has applied for interconnection on power grids. The process of securing all needed federal permits can be slow and laborious for energy infrastructure projects. One recent study found that the large majority of infrastructure projects takes between two and six years secure all sign-offs. A quarter of such projects take longer than six years, in some cases much longer. A separate study found that renewable power projects take an average of 2-3 years to complete National Environmental Protection Act reviews specifically with a significant number of such projects taking four, five or even six years to reach completion.

Source: CAISO, ISO-NE, MISO, NYISO, PJM, SPP, ERCOT, Berkeley Lab, BloombergNEF. Note: BESS is battery energy storage systems.

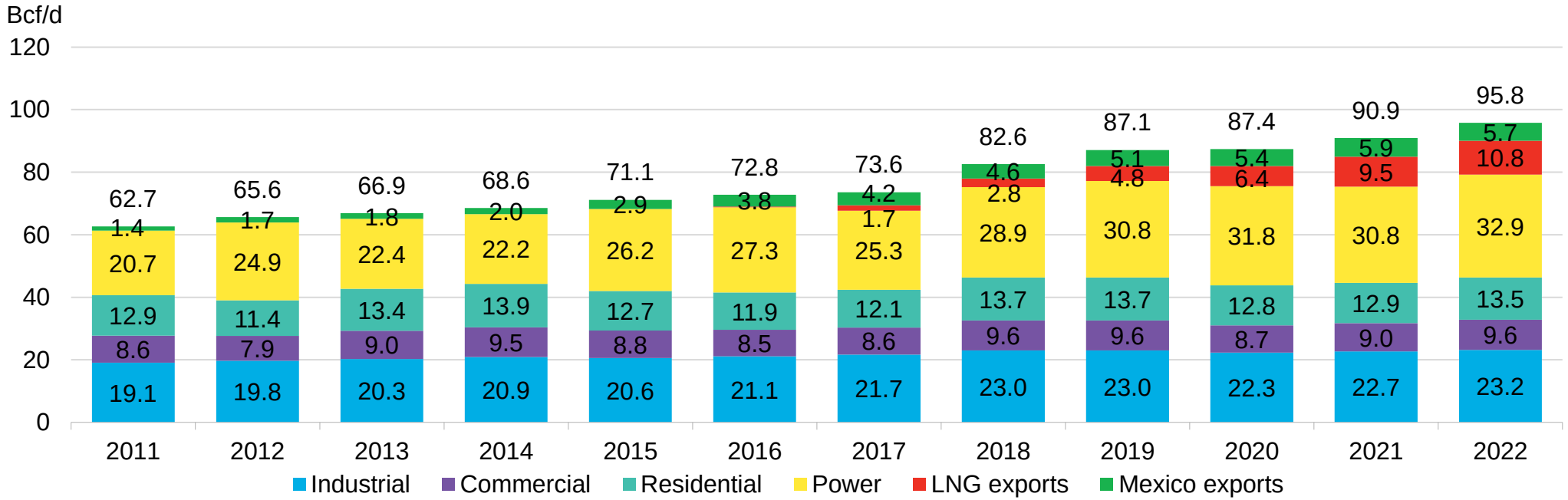
Deployment: Incremental annual energy efficiency achievements by utilities



- 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 and jurisdictions with EERS policies in place has leveled off at 27. In 2021 (the last year for which there is complete data), utility electric energy efficiency savings slipped to 26TWh of energy and 0.68% of retail sales. 2021 utility gas energy efficiency savings inched up by 0.1TWh to total 13.3TWh but dropped to 0.45% of retail sales.
- 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 , AGA. 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.

Deployment: US natural gas demand by end use

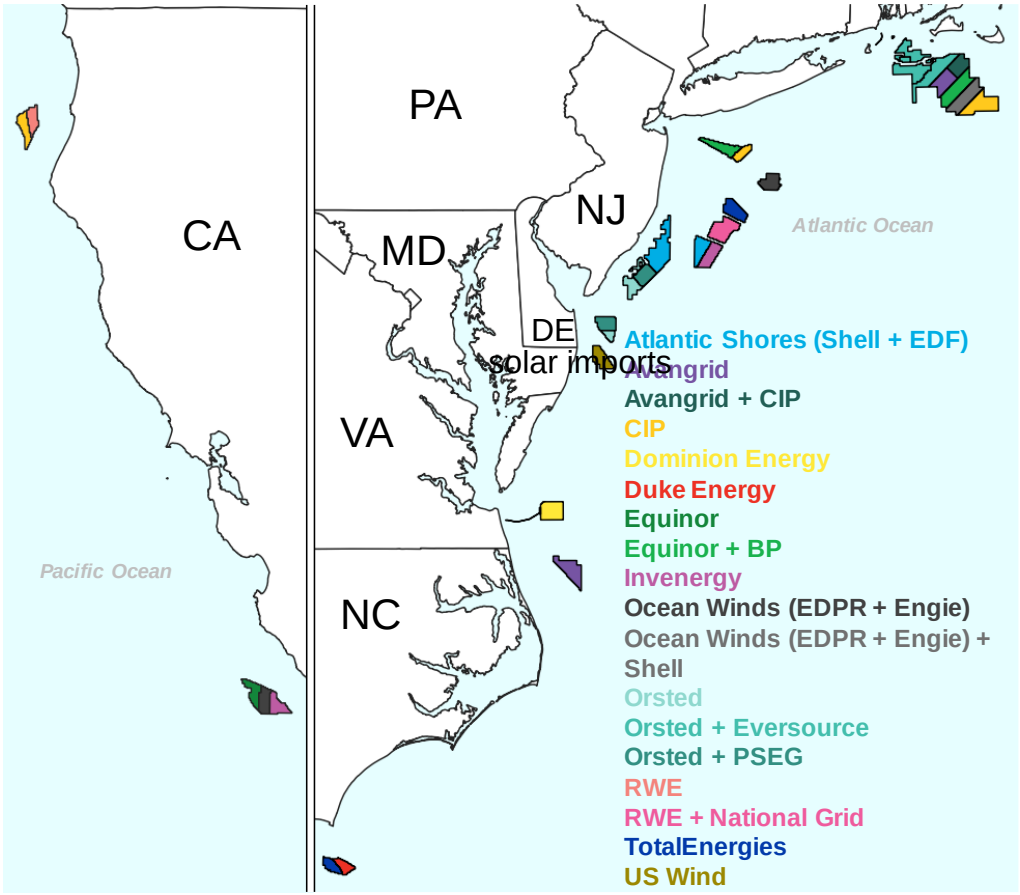


- Demand for US natural gas rose 5.4% in 2022 from the year prior to reach 95.8 billion cubic feet per day (Bcf/d). The jump was led by stronger power sector consumption, rising liquified natural gas (LNG) exports, and more demand from commercial customers. The industrial and residential sectors saw more modest growth.
- A hotter-than-normal summer and constraints on coal-fired power generation lifted use of natural gas in power. Consumption proved resilient to higher natural gas prices and the US broke seasonal demand records despite extended periods in which natural gas prices traded above $5 per million BTU at Henry Hub. US exports of natural gas have risen briskly over the past decade and in 2022 LNG exports posted a 13.1% increase from the year prior. The ramp in activity at the Calcasieu Pass LNG export facility in Louisiana helped offset lower demand after the Freeport LNG export hub in Texas shut down in June 2022. With all major US LNG terminals expected back online in 2023, the US is poised to set another record for LNG exports.
- In 2021 (the last year with complete data), total retail propane sales totaled 9.54 billion gallons, a 1.12% increase from 2020, with the residential and commercial sectors representing 76% of all fuel sold. 6.3 million households rely on propane to meet their primary space heating needs. Commercial and residential demand rose on the back of the frigid start to winter 2022-23. Colder than normal weather in the second half of both November and December 2022 boosted overall consumption. Two days before Christmas, the lower-48 states set a single day record for natural gas demand and natural gas storage played a role in mitigating storm impacts.

Source: BloombergNEF, EIA, DOE. Note: December 2022 values are forecasts.

Deployment: Offshore wind, seabed leases and targets drive growth

Federal US offshore wind leases by owner

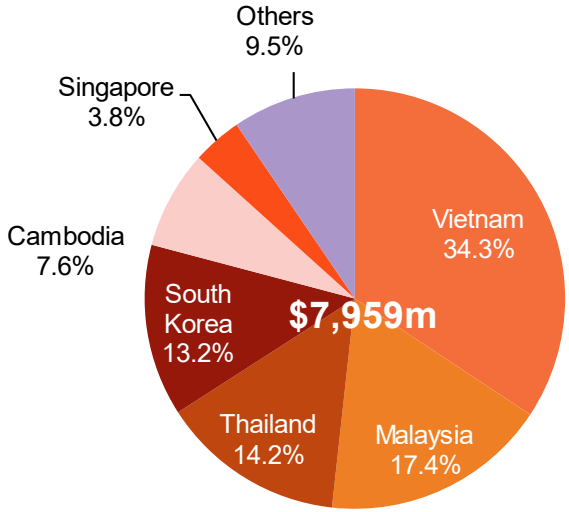


Source: BloombergNEF, Bureau of Ocean Energy Management. Note: CIP = Copenhagen Infrastructure Partners. PSEG announced it will sell its 25% stake in Ocean Wind I off New Jersey to Orsted, set to close in 1H 2023.

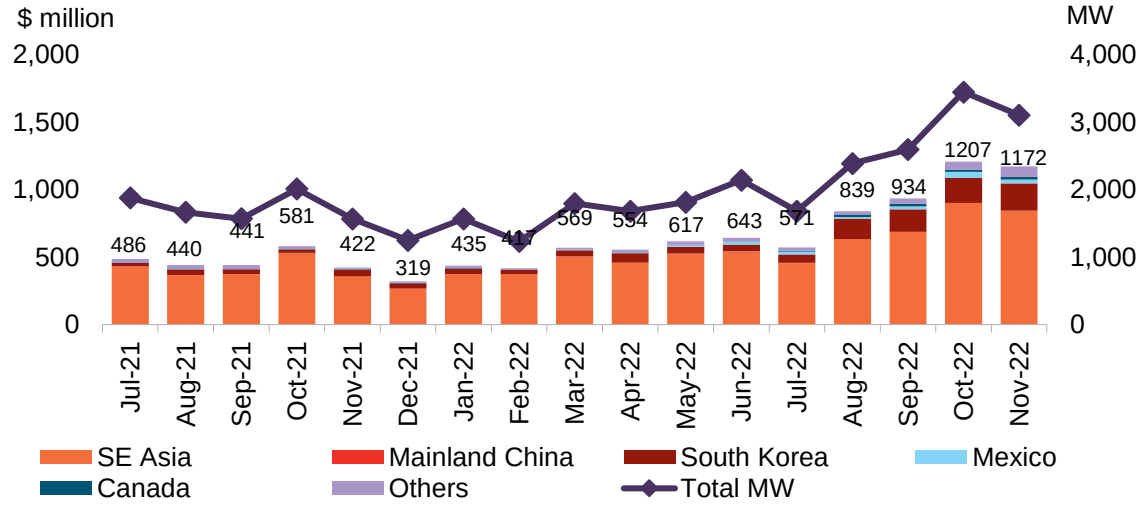
- The US offshore wind sector has been gaining momentum with federal support, more state targets and the first two commercial-scale projects continuing construction.
- The Inflation Reduction Act (IRA) extended the Investment Tax Credit until at least 2032, allowing developers to save 30% on offshore wind capex. The IRA introduced domestic manufacturing credits for floating and bottom-fixed offshore wind foundations as well as a 10% credit for offshore wind vessels. The legislation also allocates transmission planning funds, removes a Trump-era moratorium on leasing off the Carolinas and enables lease auctions in territories.
- The Bureau of Ocean Energy Management (BOEM) held three lease auctions in 2022, the most ever to date. The New York Bight auction in February broke records with the highest offshore wind seabed lease prices in the US to date. The Carolinas auction followed in May, along with California in December.
- The California auction was the first in the US to lease sites requiring floating foundations. This came after the Biden administration announced a target to install 15GW of floating offshore wind by 2035 and reduce the costs of floating wind by 70% to $45/MWh over the same period.
- California set preliminary offshore wind targets of 2-5GW by 2030 and 25GW by 2045 in August. Louisiana also set an offshore wind goal of 5GW by 2035 and New Jersey expanded its target to 11GW by 2040 last year.
- Inflation and supply chain constraints have been hitting offshore wind. Developer Avangrid claimed its Commonwealth Wind project in Massachusetts was no longer economically viable, unsuccessfully asking to renegotiate its power contracts with the state.

Deployment: Solar imports

US imports of PV modules by origin, January to November 2022



US imports of PV modules, by month and origin

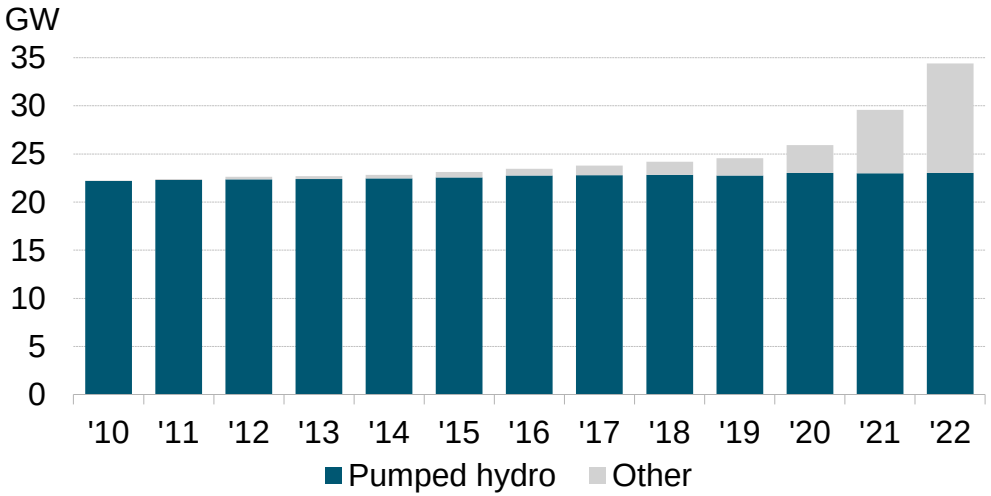


- US solar installers had a somewhat unsettling year in 2022 due partly to policy decisions from Washington. In April 2022, the US Commerce Department began investigating whether PV modules imported from Cambodia, Malaysia, Thailand and Vietnam contained components made in China and would therefore potentially subject to higher import tariffs. The move chilled the US solar market, which has relied heavily on equipment assembled in those four southeast Asian nations in recent years. However, in June 2022 the White House effectively suspended imposition of such tariffs for at least two years. Imports then surged. The Commerce Department also continued with its investigation and in December 2022 issued a preliminary ruling, with final determination expected in May.
- US solar installers faced other trade-related challenges in 2022. At one point, up to 1GW of modules entering the US were being held up in US ports by officials as importers worked to provide documentation demonstrating that their products contained no materials from Xinjiang, China. The Uyghur Forced Labor Prevention Act (UFLPA) bans imports of such materials from that province.

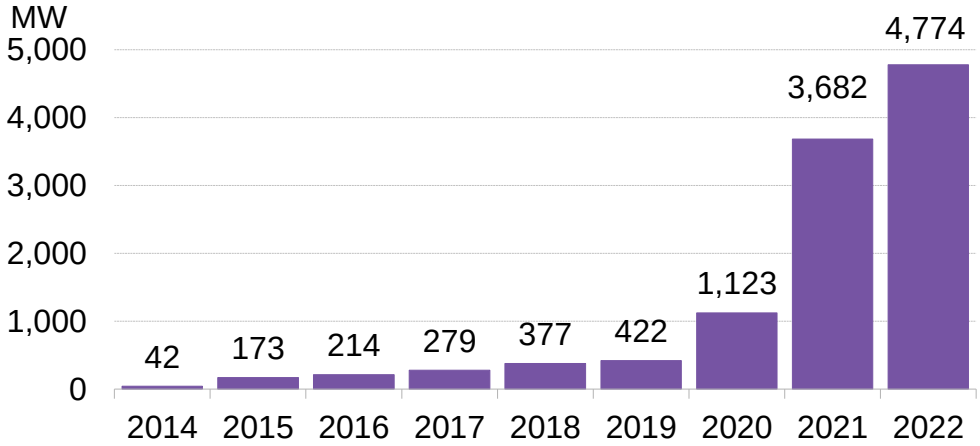
Source: BloombergNEF, Sinoimex.

Deployment: US cumulative energy storage

Commissioned US energy storage capacity



Non-hydro commissioned energy storage

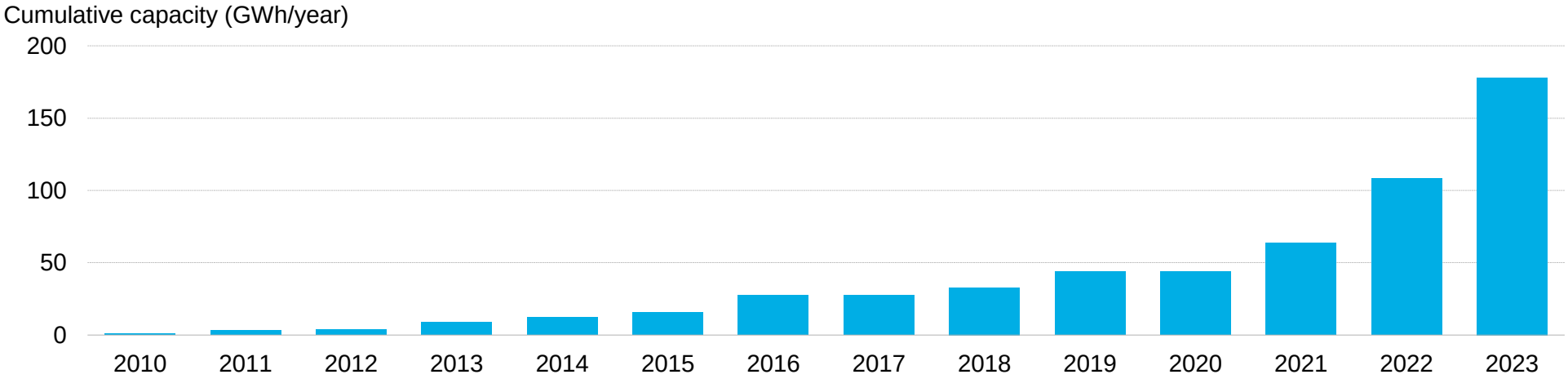


- In 2022, the US commissioned an estimated 4.8GW in non-hydropower storage capacity to bring total capacity to 11.4GW. Despite supply-chain challenges delaying some project pipelines, the US continues to be the largest energy storage market in the world. The passage of the landmark Inflation Reduction Act in August 2022 will spur additional storage deployments in the future. The bill includes direct benefits to stationary storage deployments through a standalone investment tax credit (ITC) and indirect benefits energy storage through additional incentives for wind and solar and through battery production tax credits.
- Due mainly to growing deployment of large-scale lithium-ion batteries on the grid, pumped hydro's share of total energy storage in the US dropped to 67% in 2022 from 78% the year prior. Still, raw material prices for lithium-ion batteries have risen in the past year and this could prompt a renaissance for pumped hydro storage projects, which qualify for support under the IRA.
- Energy shifting is the dominant use case for new batteries as pairing renewables with storage is becoming a common cost-effective option to displace fossil fuel projects. Utilities across the nation are beginning to cite energy-storage technologies in their long-term resource planning and as solutions to their power system flexibility needs.

Source: EIA, FERC, BloombergNEF. Note: "Other" includes projects where the technology is unknown, which is frequently lithium-ion batteries. Confirmed capacity refers to projects that have secured financing.

Deployment: Current and planned manufacturing capacity

US lithium-ion battery manufacturing capacity

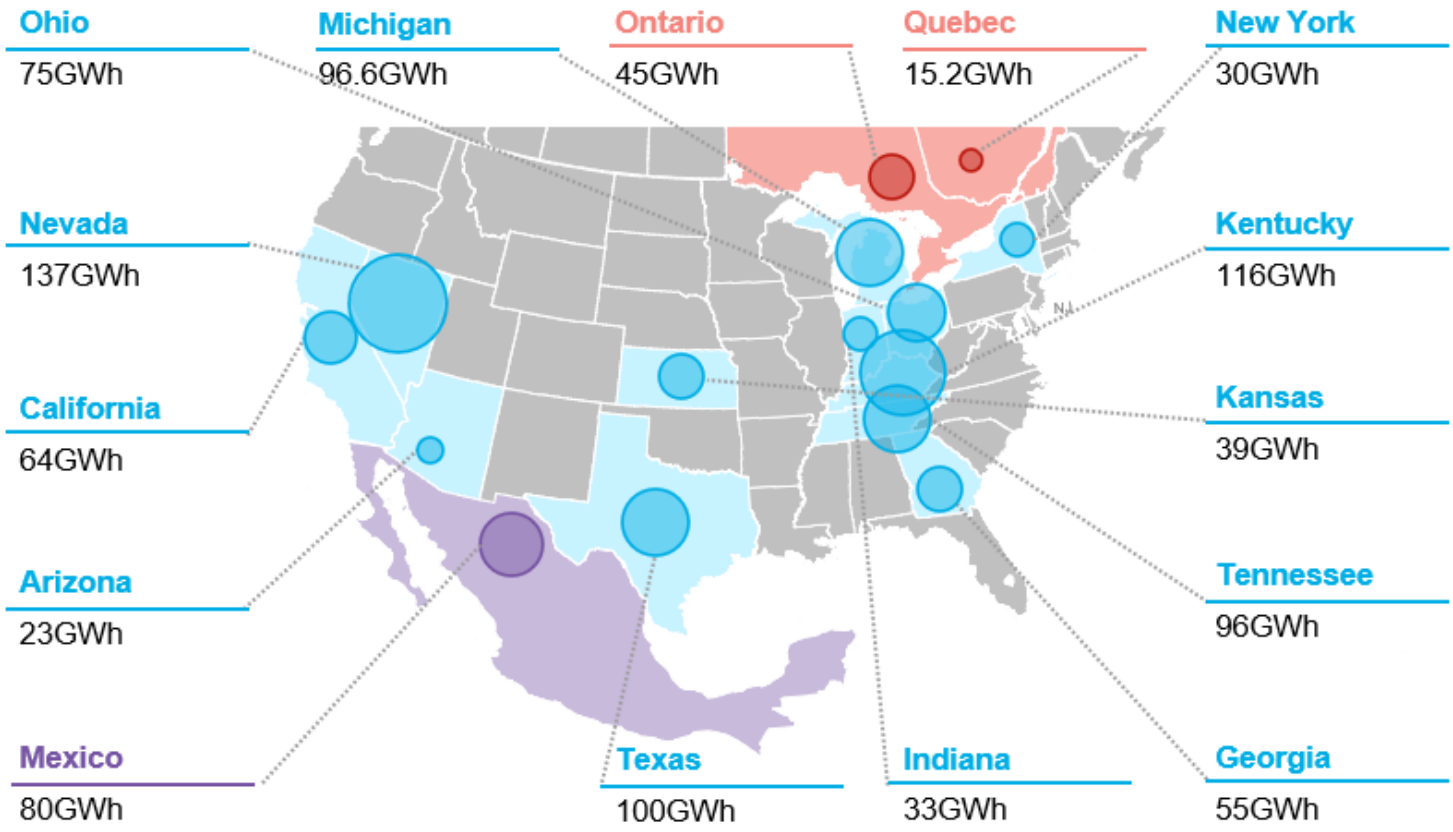


- The US Inflation Reduction Act (IRA) introduced a $45/kWh cell and module production tax credit which will significantly boost battery manufacturing in the coming decade. Since the IRA's passage, automakers and battery manufacturers have been racing to identify investment opportunities in the growing US EV market, with post-IRA commitments to the North American battery supply chain reaching almost $17 billion by the end of 2022.
- As of the end of 2022, the US had 108GWh of lithium-ion battery manufacturing capacity commissioned. Capacity additions almost doubled compared to 2021 with 45GWh being added. Notable plant openings included:
  - Ultium Cells, GM's joint venture with LG Energy Solution, commissioned a 35GWh battery plant in Warren, Ohio. The joint venture has confirmed two additional plants in Spring Hill, Tennessee and in Lansing, Michigan that will supply batteries for GM's electric vehicles (EVs), starting in 2023 and 2024, respectively.
  - iM3NY's plant in Endicott, New York started production with plans to expand to 38GWh in the future. Their batteries are catered to EVs and energy storage, among other sectors.
- The US is expected to reach 178GWh of battery manufacturing capacity by the end of 2023. Growth will be led by companies including Ultium Cells, LG Energy Solution and SK On.

Source: BloombergNEF. Note: Manufacturing capacity is based on nameplate capacity and includes manufacturing for multiple segments such as electric vehicles, stationary storage and others.

Deployment: Manufacturing projects announced since IRA passage

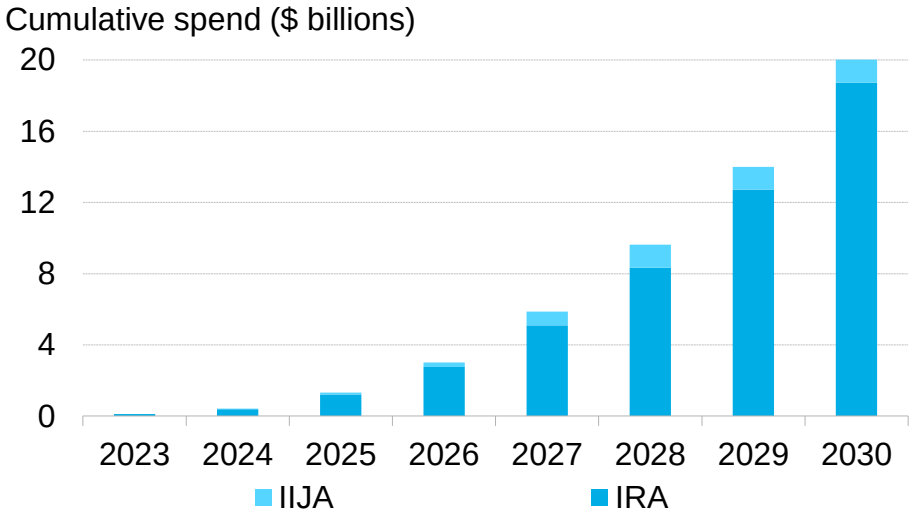
North America's battery cell manufacturing landscape



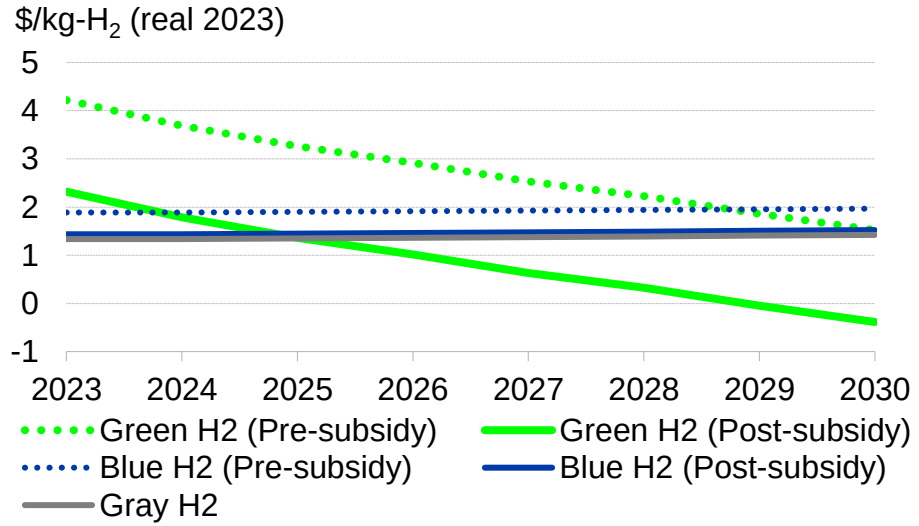
Source: BloombergNEF. Note: Bubble size corresponds total capacity commissioned, under construction and announced.

Deployment: Public spending on hydrogen poised to lower costs

Projected federal government support for hydrogen



Projected effect of $3/kg tax credit on hydrogen costs

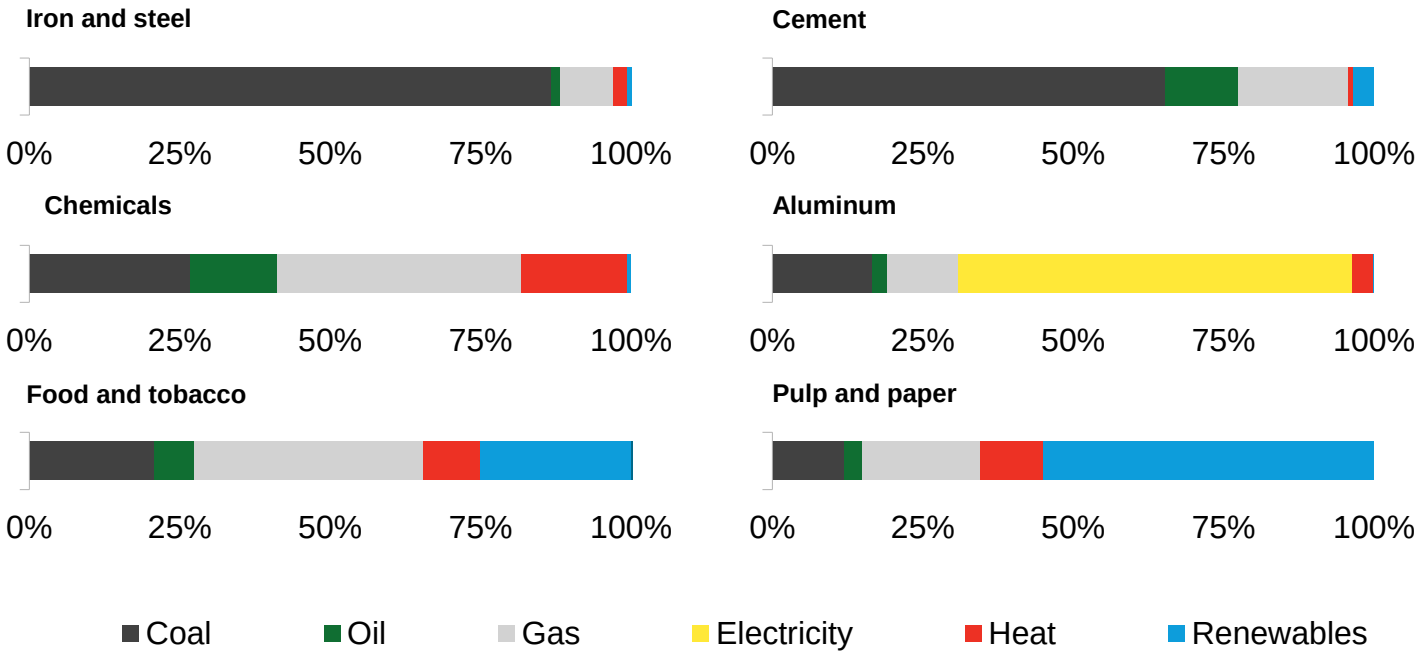


- The US became the world leader in supply-side subsidies for hydrogen production with passage of the Inflation reduction Act (IRA) in August 2022. Combined with support from the Infrastructure Investment and Jobs Act (IIJA), the US government is now poised spend over $20 billion on hydrogen activities through 2030.
- This public funding, accompanied by similar support from governments abroad, should help renewable hydrogen scale. This should drive dramatic cost declines through 2030 for electrolyzers, the equipment used to make hydrogen. As a result, levelized costs for the production of the fuel should fall to $1-2/kg by the end of the decade, BloombergNEF projects.
- The hydrogen production tax credit as offered under IRA will provide $3 (indexed to inflation) for every kilogram of hydrogen produced in a project's first 10 years. The cost of renewable hydrogen, produced through electrolysis powered by renewables, could start to compete with conventional hydrogen by mid-decade, BloombergNEF estimates. By 2030, the tax credit could completely cover the cost of production for hydrogen produced in the US.

Source: BloombergNEF. Note (Left chart): IIJA = Infrastructure Investment and Jobs Act, IRA = Inflation Reduction Act. Note (Right chart): This modeling uses project level assumptions available in BloombergNEF's H2val. Green hydrogen calculation assumes production tax credit of $3/kg taken over equal production in each year. Blue hydrogen calculations assume projects choose 45Q credit.

Deployment: The role of heat in industrial processes

Share of energy supply for industrial process heat, 2018

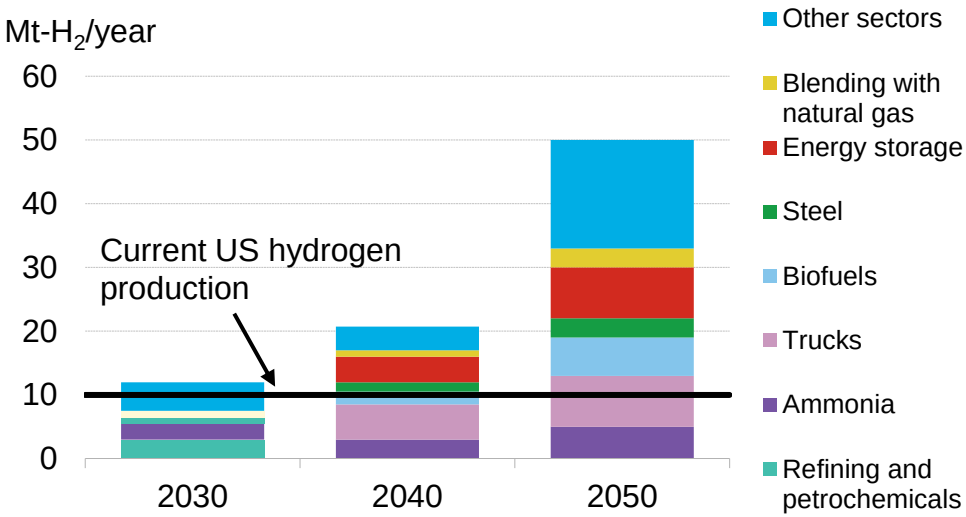


- Industrial processes account for 29% of global energy use and around one fifth of all greenhouse gas emissions. The majority of industrial energy consumption is used to produce process heat.
- Six sectors have significant demand for process heat: Iron and steel, cement, chemicals, aluminum and non-ferrous metals, food and tobacco, and pulp and paper. Some industries use significant amounts of renewable energy for heat. Food and tobacco, and pulp and paper, for example, use a relatively high proportion of renewable heat sources such as biomass and biogas thanks to the ready availability of organic waste at their sites.
- Other industries use mostly fossil fuels. Chemicals, cement and iron and steel use a higher proportion of fossil fuels. These industries have high heat requirements and use fossil fuels as feedstocks as well.

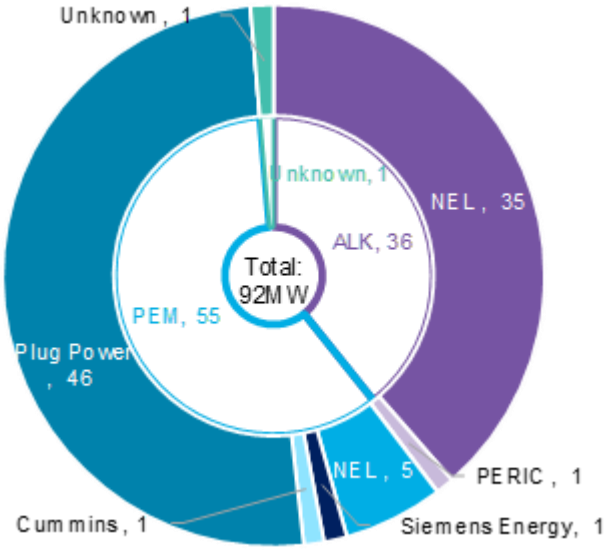
Source: BloombergNEF, Marklines, US Department of Energy.

Deployment: With new funding, hydrogen production expected to rise

Projected demand under DOE Clean Hydrogen Strategy and Roadmap



2022 electrolyzer shipments by company

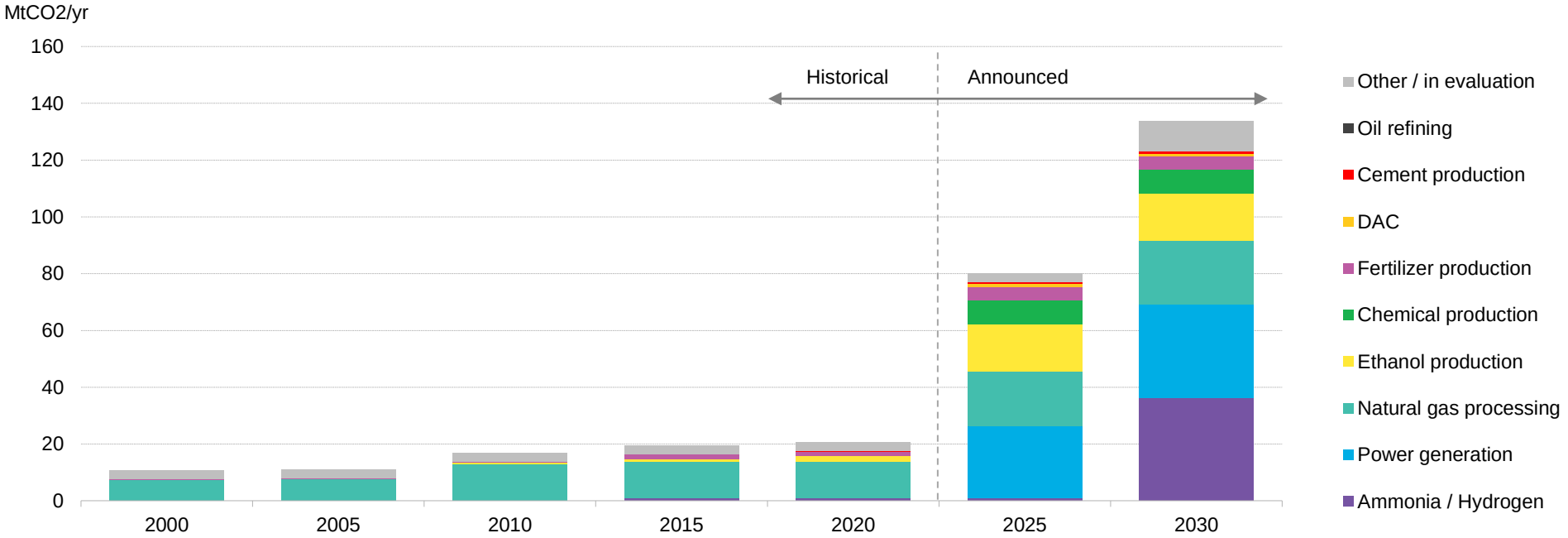


- In October, the US Department of Energy released a draft Clean Hydrogen Strategy and Roadmap, which included projected demand estimates from sectors by 2050. Today, the US consumes approximately 10 million metric tons of conventional hydrogen annually in industries such as oil refining and ammonia production. These industries, along with others like steel production and energy storage, will shift the US from carbon-intensive hydrogen consumption to low-carbon hydrogen consumption in the coming years. BloombergNEF's 2030 outlook sees US low-carbon hydrogen production from electrolysis reaching 2 million metric tons per year by the decade's end, using over 20 gigawatts of electrolysis capacity.
- Today's low-carbon hydrogen market is quite small by comparison. BloombergNEF tracked 92MW of hydrogen-producing projects commissioned 2022. Plug Power Inc. added the most capacity, primarily to meet the company's own internal demand for hydrogen.
- A more diverse slate of players is now poised to get involved. In 2023, CF Industries is expected to commission an electrolyzer at a large ammonia production facility. Air Products plans to commission an electrolyzer focused on road transport. Florida Power and Light seeks to commission a facility to generate power. SoCalGas announced the Angeles Link project in 2022, a green hydrogen pipeline serving the Los Angeles region – anticipated to be the nation's largest.

Source: BloombergNEF, US Department of Energy. Note (right chart): Data is estimated based on publicly available information as of September 1st, 2022.

Deployment: CCUS US deployment pipeline

US historical and announced capture capacity by source

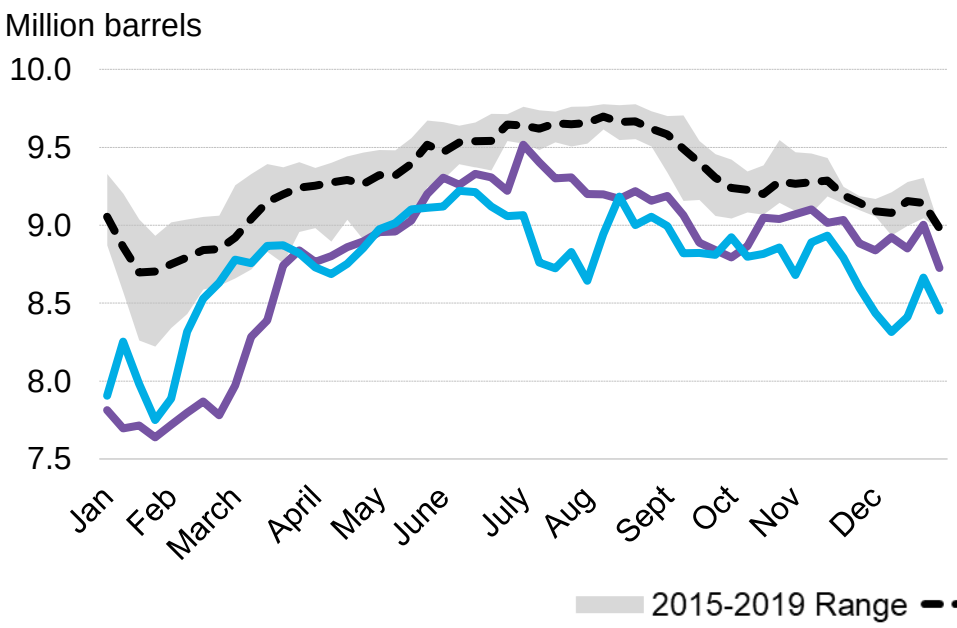


- US carbon capture, utilization and storage (CCUS) capacity is poised for major growth over the next decade, based on recent announcements and thanks to the expanded benefits potentially to be offered under the Inflation Reduction Act (IRA).
- Should developers follow through on their plans, US CCUS capacity will jump 292% from 2020 levels by 2025. By the end of this decade, US CCUS would be much more diverse with multiple sources potentially contributing to emissions cuts. Storage associated with power generation, natural gas processing, ethanol production, and chemical production plants are all poised to rise. Should developers follow through with their plans, those four sources will make up 87% of all the capture capacity by 2025.
- The US remains a leader in CCUS deployment due to policy frameworks, government funding and incentives. Most important among these is the tax credit for storing or using CO2 known as “45Q”. The IRA boosted the potential value of 45Q project operators to $85/tCO2 for point-source capture and $180 for direct air capture.

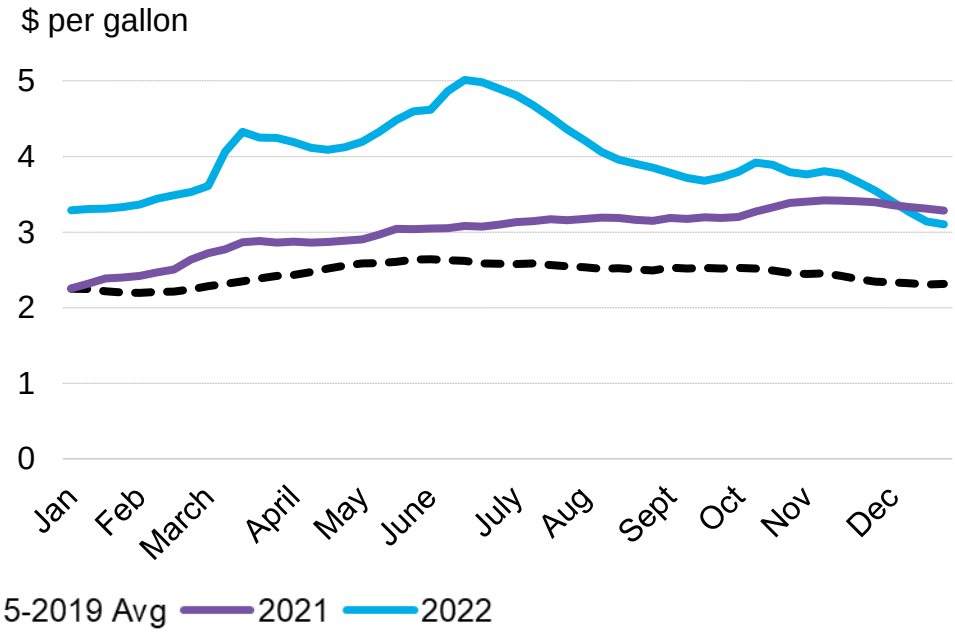
Source: BloombergNEF.

Transportation: Gasoline demand and prices

US gasoline demand



US wholesale gasoline prices

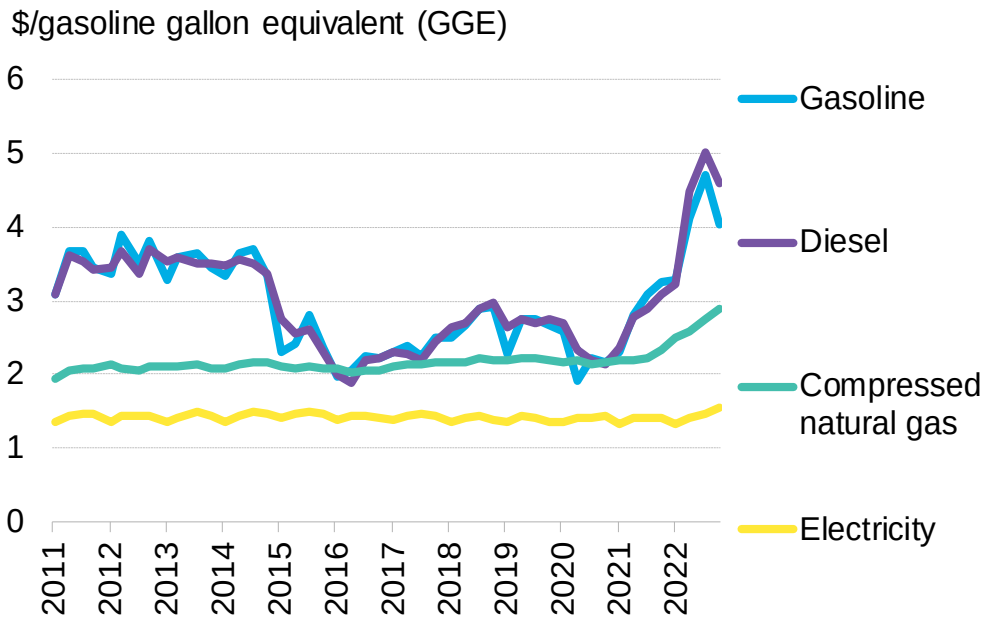


- US gasoline demand nearly returned to pre-pandemic levels during the first two months of 2022, closing a nearly 1 million barrel per day gap to the pre-Covid 2015-2019 seasonal average. However, Russia's invasion of Ukraine caused crude prices to surge. This, compounded by a severe lack of global refining capacity, sent retail prices at the pump to over $5 per gallon in July, their highest level on record.
- In response, gasoline consumption subsided. The four-week moving average of motor gasoline product supplied, the most widely used indicator for demand, sunk to its lowest seasonal level since 1997 in July 2022. Prices fell gradually through the second half of the year but demand still lags both seasonal averages and 2021 levels.
- In all, nearly 200 million fewer barrels of gasoline were consumed in 2022 compared to the 2015-2019 average. This reflected higher prices but also structural shifts in commuter behavior and the improved fuel efficiency of vehicles.

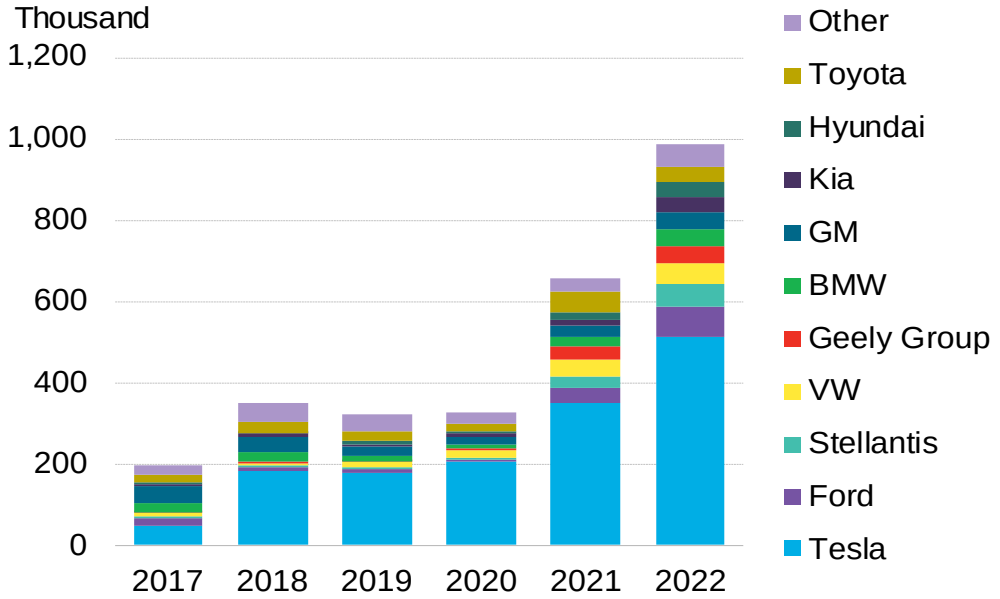
Source: BloombergNEF, US Energy Information Administration, American Automobile Association; Note: Gasoline demand data is the four-week rolling average for gasoline supplied data from the Energy Information Administration. 2021 and 2022 values are adjusted to align with the EIA's monthly data. Wholesale gasoline prices are the daily national average gasoline price.

Vehicle fuel prices and EV sales

Average vehicle fuel prices



US electric vehicle sales



- Electricity has been the most competitive fuel for transportation in the US for over a decade, priced well below gasoline. Following Russia's invasion of Ukraine, gasoline prices spiked with the US seeing an average of $4.04 per gallon for 2022. Electricity prices were an average of $1.44 in 2022. Gasoline prices were more than 2.5 times higher than electricity.
- As the gap between gasoline and electricity prices widened on a per-gallon equivalent basis, EVs became more appealing. At the same time, higher battery costs put manufacturers under pressure to raise EV prices. However, with passage of the Inflation Reduction Act, which caps the price at which EVs qualify for tax credits, manufacturers are looking to lower sticker prices.

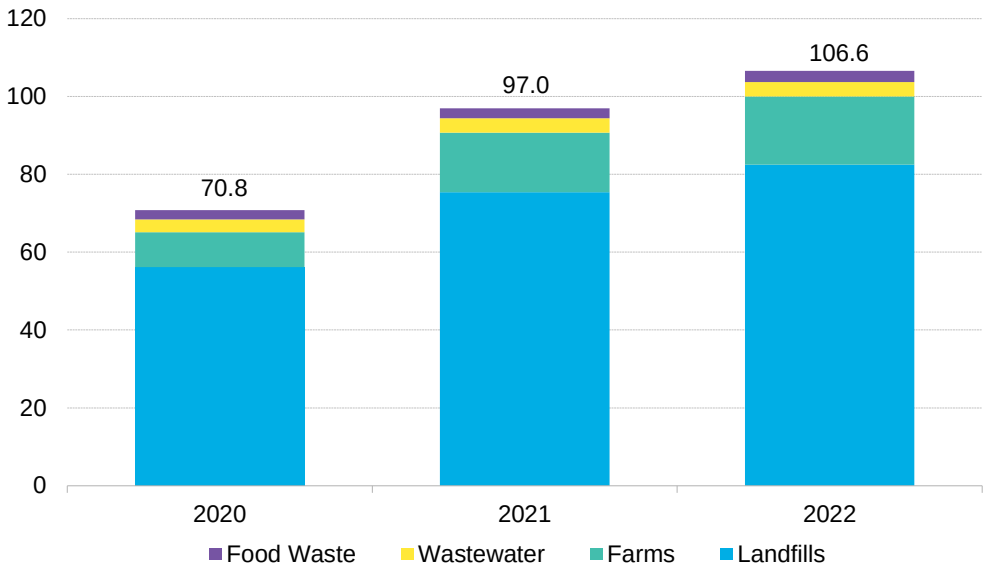
Source: BloombergNEF, Marklines, US Department of Energy.

- In terms of units sold and percentage of total cars sold, 2022 was another landmark year for vehicles employing new technologies. Sales of EVs and fuel cell vehicles hit nearly 982,000 units, up 50% from the 656,000 units sold in 2021. Even with the many turbulent headwinds against growth – including the cost of battery components rising, semiconductor chip shortages, and the general slow scale-up by many automakers – EVs ended on strong footing at 7.1% of all US sales.
- Tesla still is the most dominant automaker in the US EV market. Ford, Stellantis, VW, Geely, BMW and GM also had strong sales in 2022. Tesla accounted for 63% of all EV sales as recently as 2020.
- Battery electric vehicles made up 81% of 2022 sales, with plug-in hybrid electric vehicles making up the remaining 19% and FCVs accounting for well less than 1% of sales.

Transportation: Renewable natural gas production and vehicle demand

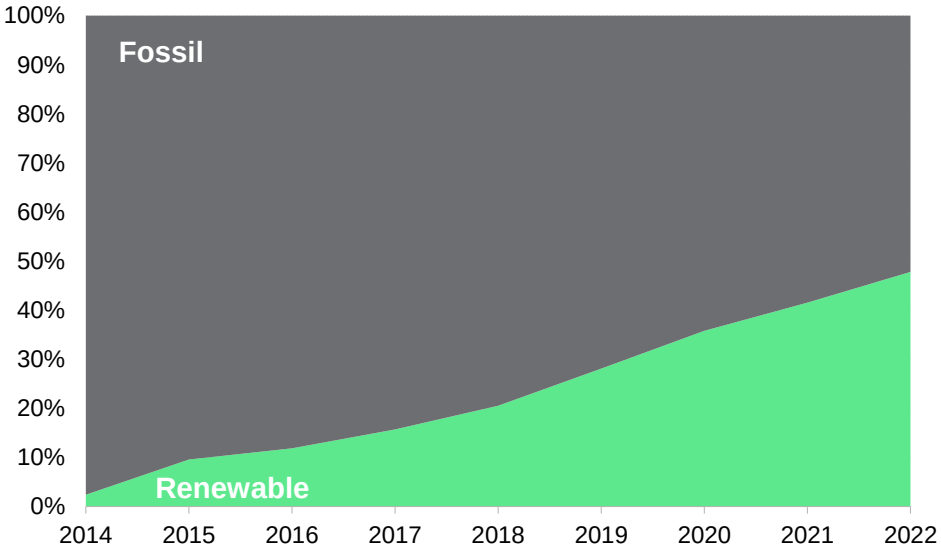
RNG production capacity, by source

Billion cubic feet per year



US natural gas vehicle demand, by source

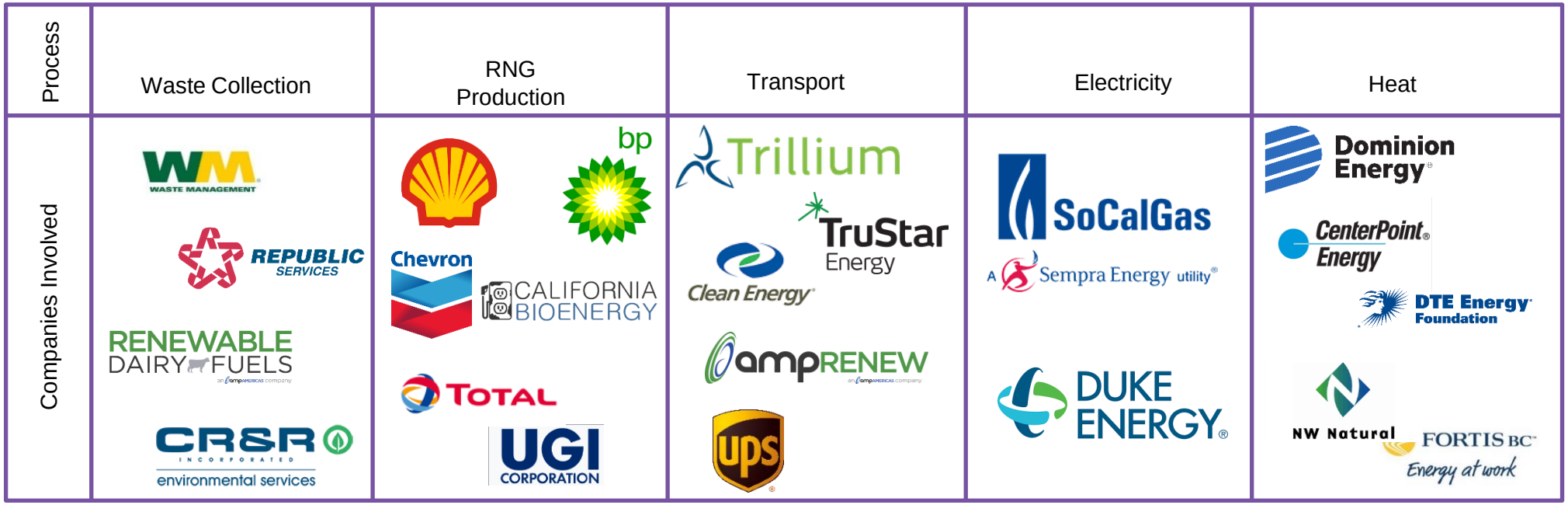
Share of vehicle fuel



- Renewable natural gas (RNG) production capacity and consumption have both grown swiftly off a low base over the past decade thanks in part to the requirements of the federal Renewable Fuel Standard (RFS) and California' Low Carbon Fuel Standard (LCFS). From 2015 to 2022, RNG's share of total natural gas used in US transportation grew from 10% to 48%, BloombergNEF estimates.
- To date, the vast majority of RNG by volume has been produced at landfill sites. On the demand side, nearly all has been used in transportation. Both of these dynamics are set to shift in the coming years as more non-landfill/anaerobic digestion projects are developed and large natural gas customers choose to buy RNG. The rate at which the US is building new RNG production capacity has slowed somewhat. After posting year-on-year growth rates of over 30% for 2019-2020 and 2020-2021, capacity grew 10% in 2022 from 2021.
- While RNG represented nearly half of gas consumed in natural gas-powered vehicles in 2022, it accounted for nearly all natural gas used by such vehicles in California. However, California LCFS credit prices slumped to an average of $120 per metric ton in 2022 from $187 in 2021. There are approximately 175,000 natural gas-powered vehicles on US roads today compared to nearly 290 million total cars and trucks.
- 37 states have acted to promote the use of RNG for thermal heating purposes in the residential or commercial sectors, up from 26 in 2020.

Source: BNEF, Argonne National Labs, RNG Coalition, Company announcements, California Air Resources Board, ICF

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 policies that incentivize its use as a transportation fuel, energy incumbents are developing strategic partnerships and acquiring companies to convert biogas into RNG which is compatible with pipeline natural gas.
- 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 or self generate credits for compliance with transportation policies.
- In 2022, BP announced the acquisition of the largest RNG company in the US, Archaea Energy, for $4.1 billion. The deal was equivalent to 54% of BP's total low-carbon energy investment from 2015 to 2021 and represented 25% of its planned capex spend for 2022. Months later, Shell announced it planned to acquire the largest European RNG producer, Nature Energy for $2 billion.
- In similar fashion, natural gas pipeline companies are investing more in RNG to demonstrate how pipeline infrastructure can play a role in the transition to using more low-carbon fuels. Kinder Morgan, the largest gas pipeline distributor in North America has said it plans to invest $1.1 billion in RNG by 2024, boosting production from 1.8 billion cubic feet (Bcf) in 2022 to 7Bcf by 2024.

Source: BloombergNEF

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