2019

Sustainable Energy in America

Factbook

GROWTH SECTORS OF THE U.S. ENERGY ECONOMY

BloombergNEF

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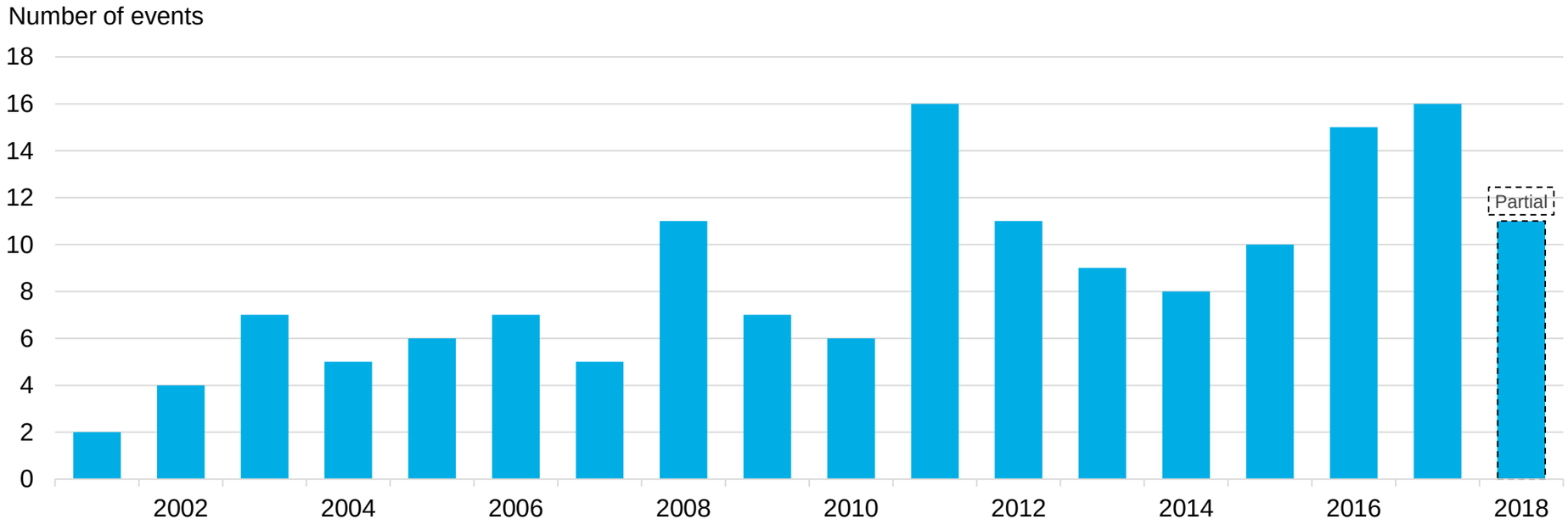
Policy: Infrastructure and resilience

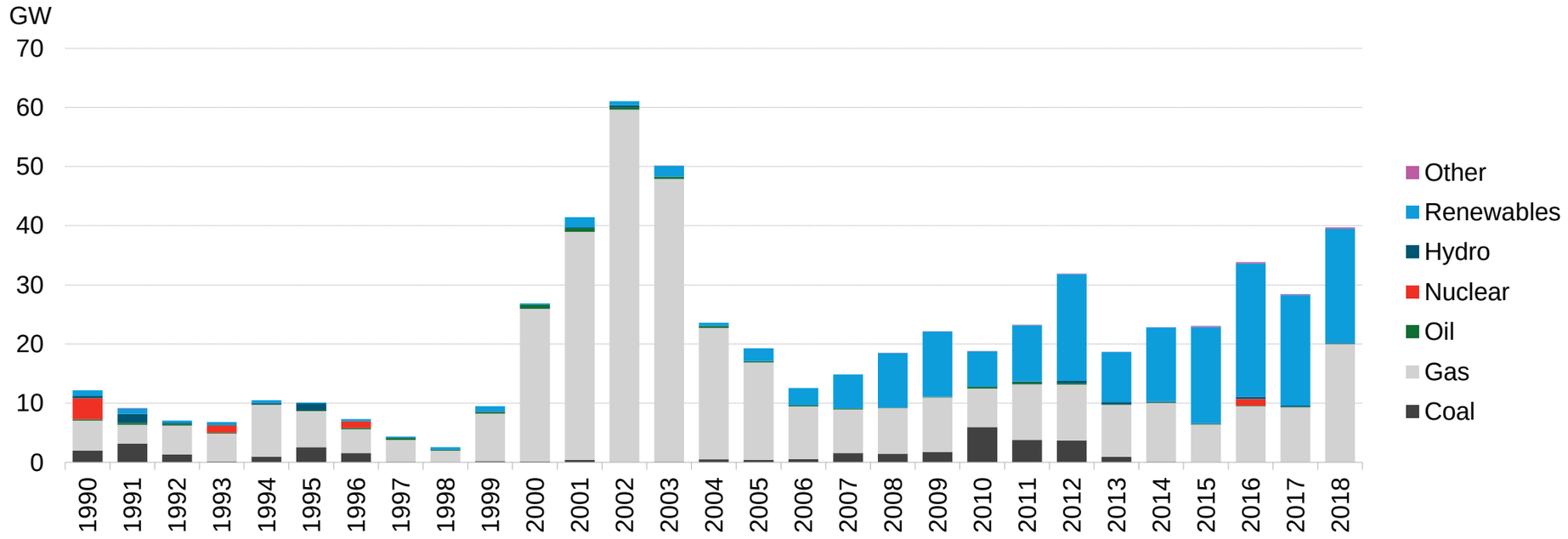
U.S. billion-dollar weather and climate disasters



- The Disaster Recover Reform Act, signed by President Trump on October 5, 2018, sets a new formula for pre-disaster mitigation funding. The likely result based on historic disaster costs is that billions of federal dollars annually will help prepare and defend states and localities.
- DRRA also strengthens building code enforcement (including energy codes), identifies qualifying mitigation activities for natural disasters and directs infrastructure repaired or constructed using Stafford Act funds to be built to the most recent code or standard.
- The McCain National Defense Authorization Act, signed on August 13, 2018, gives the Department of Defense the ability to make grants to states and localities to address threats to the resilience of military bases. It defines resilience as the readiness of a military installation to react to extreme weather events.

Source: National Oceanic and Atmospheric Administration, BloombergNEF. Note: Portrays annual counts of drought, flooding, freeze, severe storm, tropical cyclone, wildfire and winter storm events in the U.S. with losses of more than $1 billion each. 2018 count shown was as of October 9, 2018.

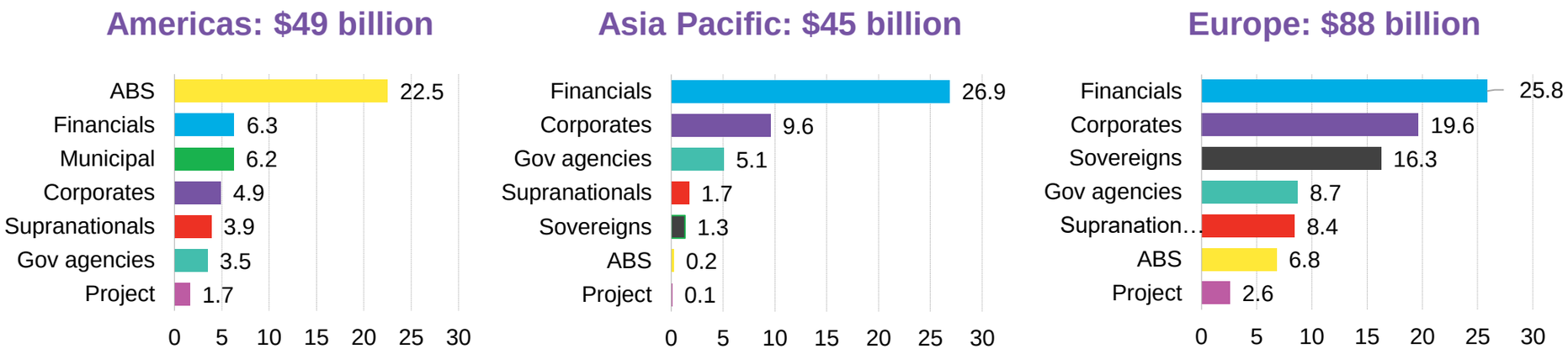
U.S. energy overview: Electric generating capacity build by fuel type



- 2018 represented another boom year for electric generating capacity additions, with just under 40GW added – the most in 15 years.
- Natural gas build soared as developers installed 20GW, seeking to take advantage of persistently low gas prices, particularly in the mid-Atlantic region. The 2018 build was more than double the capacity added in 2017.
- Non-hydro renewable energy annual build was its second highest of all time. Since 2006, these technologies (wind, solar, biomass, geothermal, others) have accounted for over half of cumulative additions.
- In total, gas, renewables and hydro have accounted for over 94% of all U.S. capacity additions in the past 25 years.

Source: EIA, BloombergNEF Note: All values are shown in AC except solar, which is included as DC capacity. "Renewables" here does not include hydro, which is shown separately. All capacity figures represent summer generating capacity. Includes installations or planned installations reported to the EIA through October 2018, as well as BNEF projections.

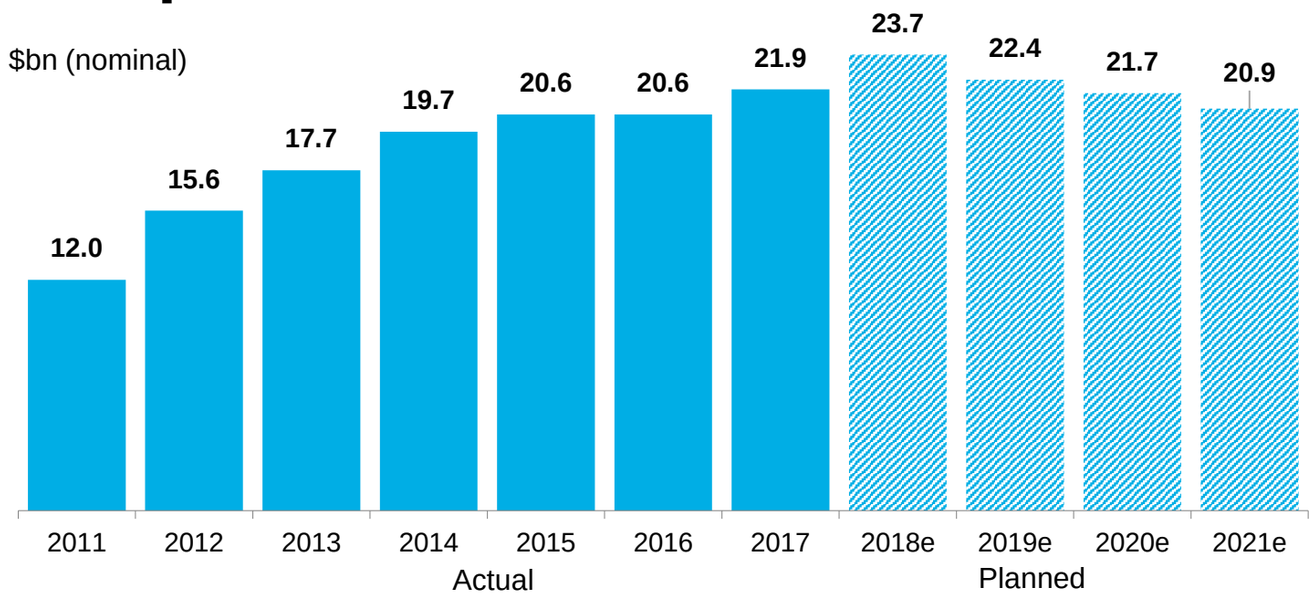
Finance: Global green bond issuance



- Europe was the most active region for green bond issuance in 2018, with $88 billion of green securities raised through the year, versus $45 billion in Asia-Pacific and $49 billion in the Americas.
- The European market was driven by major banks financing and refinancing renewable energy debt lending portfolios, as well as a surge in green sovereign debt. The government of Belgium joined France, Poland and Sweden with $16 billion in green sovereign debt sold in 2018.
- Asia's green bond market barely surpassed 2017's $44 billion total raised as debt lending restrictions and deleveraging initiatives impacted the wider market.
- The U.S. green bond market is almost entirely upheld by mortgage giant Fannie Mae. The enterprise's green mortgage program continues to expand, with over $22 billion of new commercial green pools sold into capital markets in the year. These securities finance efficiency-certified multifamily units throughout the country. U.S. municipal green debt slowed as many states and cities awaited updates on potential federal infrastructure legislation before selling bonds into the markets.

Source: BloombergNEF Note: ABS stands for asset backed securities (green mortgages, solar and EV auto loans)

Finance: U.S. transmission investment by investor-owned utilities and independent transmission developers

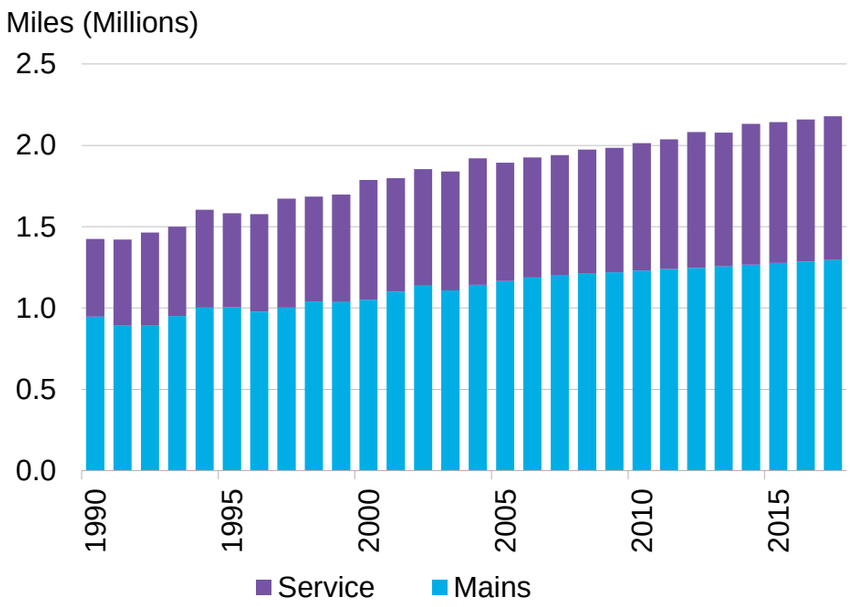


- Investor-owned utilities and independent transmission developers spent an estimated $21.9 billion on electric transmission in 2017, a new high, the Edison Electric Institute estimates. This is up 6% from 2016.
- Based on company reports, investor presentations and a survey conducted by EEI, transmission investment likely grew 8% in 2018 to $23.7 billion. Current capex plans suggest that investment will have peaked in 2018 and investment will slow in 2019 onwards. However, future-year budgets are not yet finalized, and these numbers may be revised upward.
- The transmission investment upswing is driven by a number of factors, all of which concern the utility's fundamental aim of providing reliable, affordable, and safe power. These include a need to replace and upgrade aging power lines, resiliency planning in response to potential threats (both natural and man-made), the integration of renewable resources, and congestion reduction.

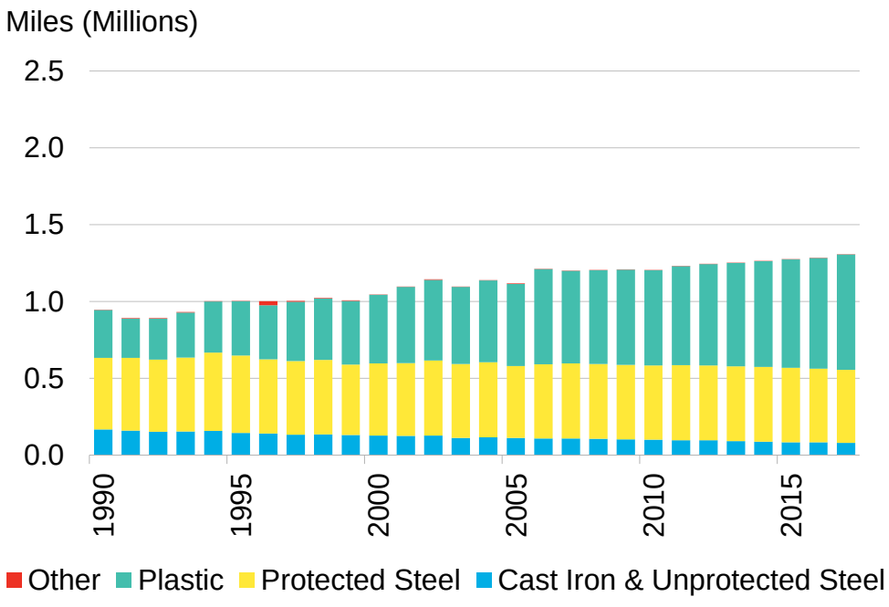
Source: Edison Electric Institute (updated December 2018), BNEF

Deployment: U.S. natural gas pipeline installations and materials

U.S. existing natural gas distribution pipelines



U.S. natural gas distribution mainline material

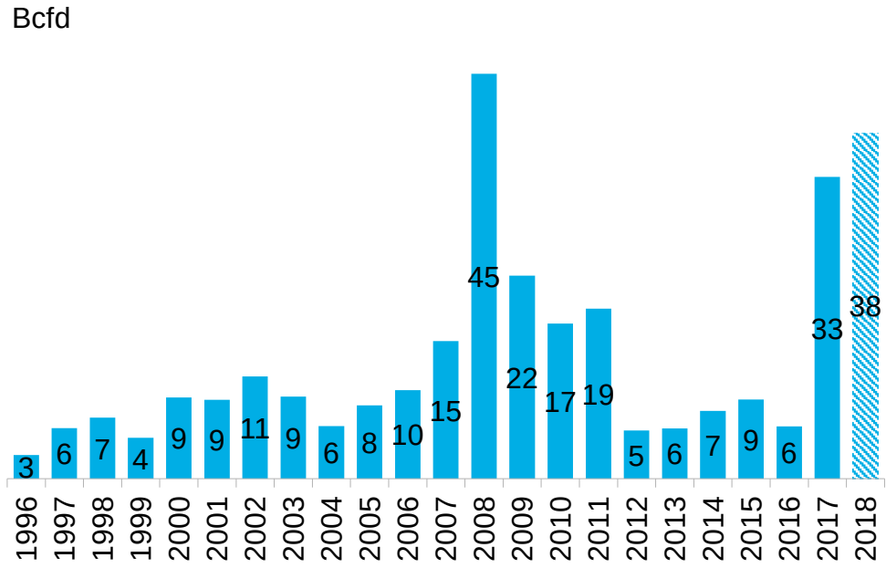


- Service and distribution pipelines that bring gas from transmission lines to end-users continue to rise incrementally, with growth averaging 1% per year over the past decade.
- Plastic is the material of choice for replacement and expansion efforts as U.S. pipelines are upgraded with more modern materials. Companies are removing older networks, which are made from cast iron and unprotected steel, and replacing them with newer plastic or protected steel pipes, which are less susceptible to leaks. At the same time, more miles of pipeline are being added to connect under-served and previously un-served customers.

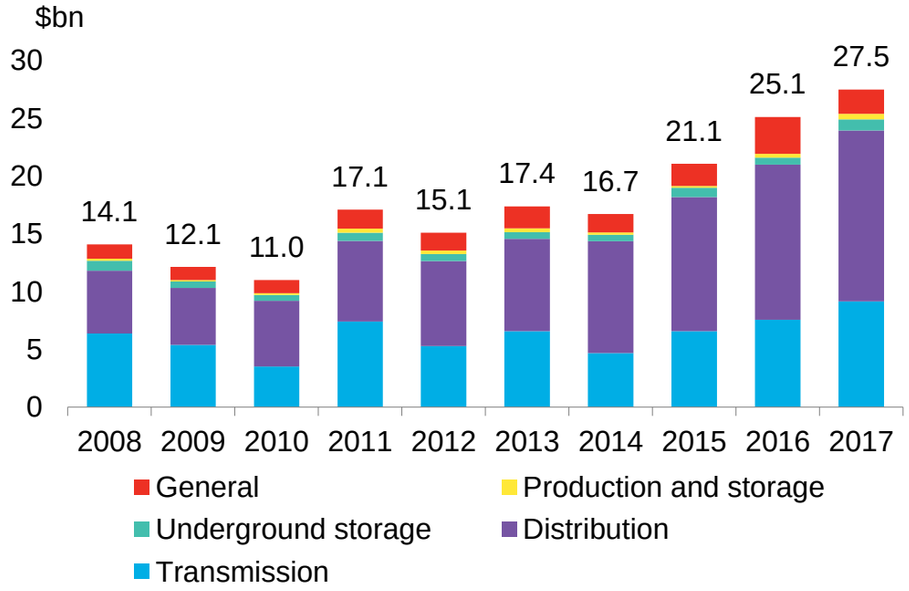
Source: American Gas Association, U.S. Department of Transportation

Deployment: U.S. midstream infrastructure capacity and investment

U.S. transmission pipeline capacity additions



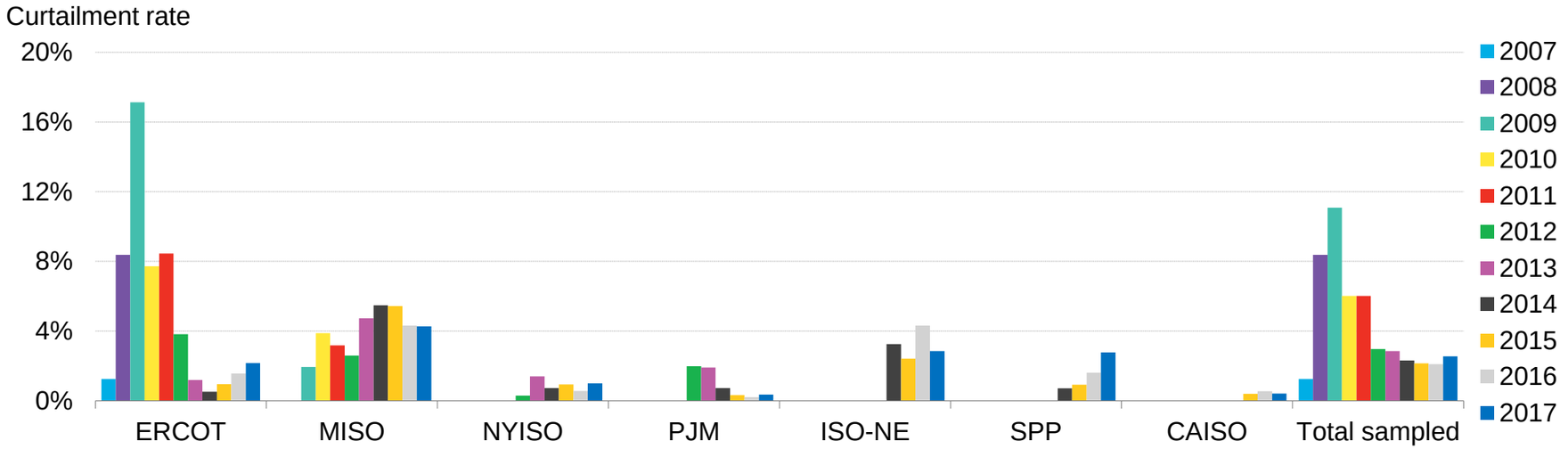
U.S. midstream gas construction expenditures



- Pipeline companies had plans to complete 38Bcfd of capacity additions by the end 2018, up slightly from the 33Bcfd constructed in 2017 and the largest single-year addition in capacity since 2008. Much of this capacity addition is a result of the need to disseminate record-setting amounts of gas production to end users in the U.S and to across the border to Mexico.
- Midstream expenditures continued a trend since 2015 of rising, posting a 9.4% jump from 2016 to 2017, the last year for which complete data exists. The majority of this was spent on transmission and distribution pipelines, connecting gas to consumption centers.

Source: BloombergNEF, American Gas Association, EIA Notes: EIA data include both first-mile takeaway capacity and pipeline additions that do not impact takeaway capacity. 2018 transmission capacity is a BNEF estimate. 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. Totals may not sum due to rounding.

Deployment: U.S. wind curtailment

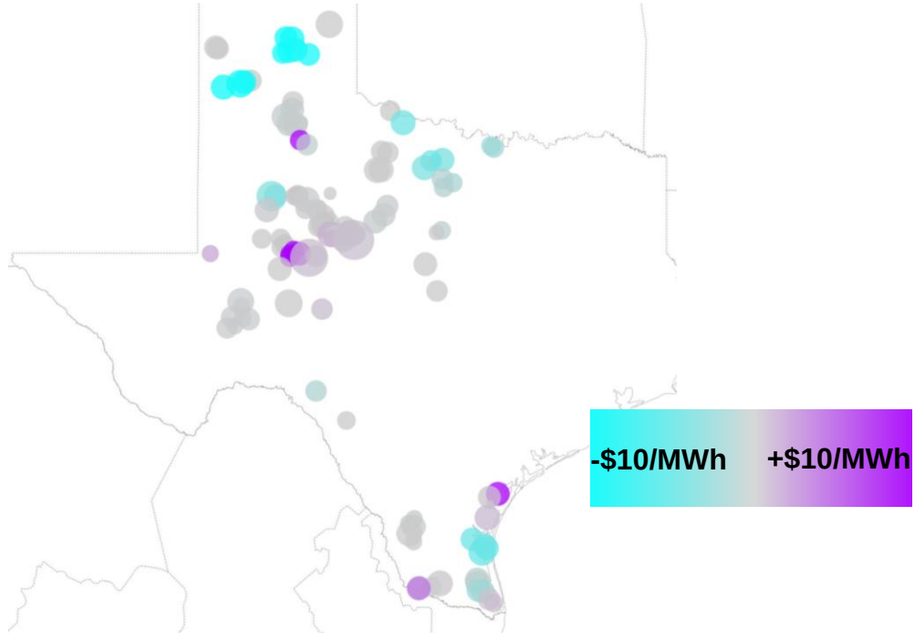


- Curtailment can occur due to transmission constraints, inflexibilities in the grid and environmental or generation restrictions.
- This was a significant problem in ERCOT (Texas) from 2008-2013, but the build-out and upgrade of the Competitive Renewable Energy Zone (CREZ) transmission lines and increased efficiency in ERCOT's wholesale electricity market lessened this concern in the short-term. Curtailment in this region fell to only 0.5% in 2014, down from a peak of 17% in 2009; however it has been slowly rising since 2015 as build continues, with about 2.2% curtailment observed in 2017.
- For the past three years, PJM experienced the lowest curtailment of any region, at 0.2%. MISO continued to experience a curtailment rate of over 4%, the highest out of all the regions sampled. However, MISO's wind curtailment dropped 27% from 2015 to 2017, as transmission build began to alleviate congestion; most of MISO's MVP transmission projects should be online by 2019. New England reined in its curtailment levels from 2016, down 33% in 2017 to under 3%. CAISO curtailment remained small (0.4%) while SPP's crept up to 2.78%, likely due to wind additions in the region.
- Total U.S. curtailment has shrunk since 2009. However, time-varying influences also played a role: in 2015, for example, the western and interior U.S. experienced below-normal wind speeds, reducing generation and therefore the need to curtail in constrained regions.

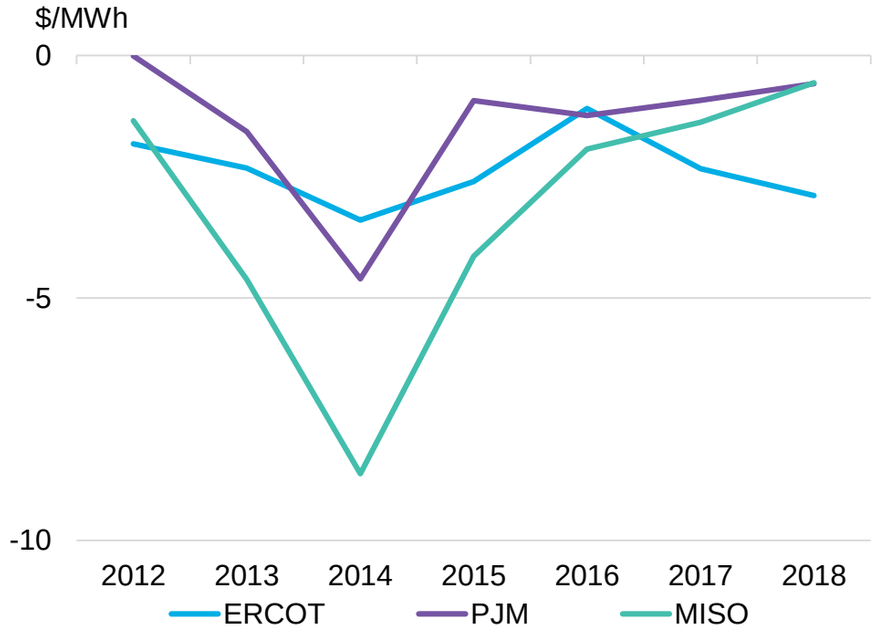
Source: BloombergNEF, Department of Energy. Note: All curtailment percentages shown in the figure represent both forced and economic curtailment. PJM's 2012 curtailment estimate is for June through December only. Department of Energy sourced data from ERCOT, MISO, CAISO, NYISO, PJM, ISO-NE, SPP.

Deployment: Transmission congestion in Texas, the Midwest and Mid-Atlantic

Congestion costs for Texas (ERCOT) wind farms, 2017 average



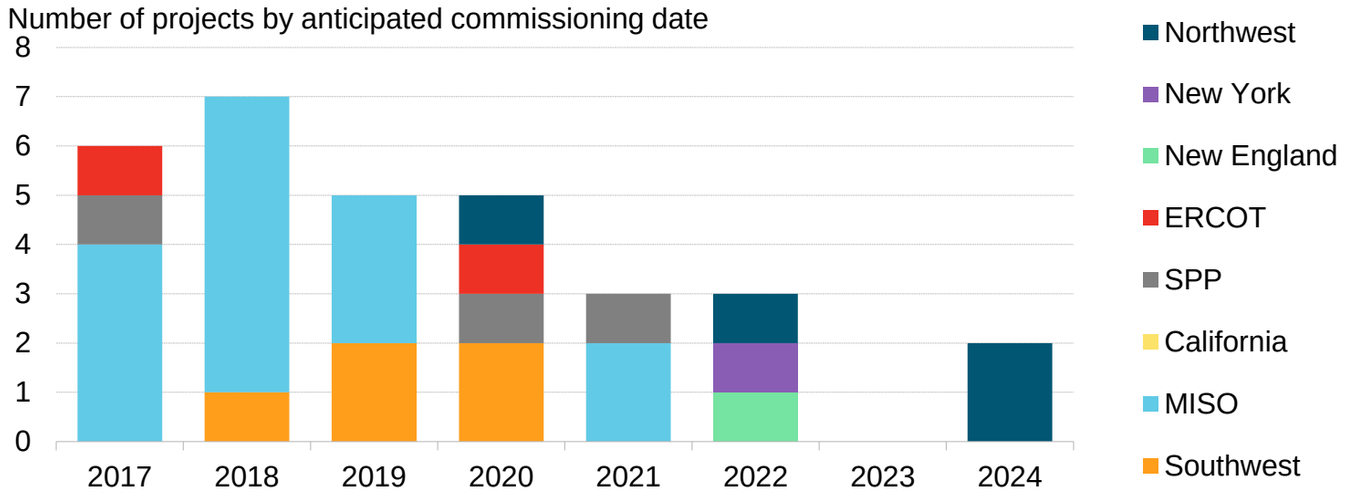
Average congestion across wind fleets



- Transmission congestion for remotely located wind farms can diminish what the plants earn in wholesale markets. Texas (ERCOT) is currently home to one-quarter of America's installed wind capacity, with well over half of that capacity clustered in the western part of the state.
- To alleviate congestion in West Texas, the state invested in the Competitive Renewable Energy Zone (CREZ) transmission lines, which connect West Zone and Panhandle wind to load centers in the East. This relieved $2/MWh of congestion pricing between 2014 and 2016. Those gain are being reversed as build persists in the West Zone. (Negative pricing in the graphs above represents congestion costs.) Congestion bit roughly $3/MWh on average out of ERCOT wind revenues in 2018.

Source: BNEF, EIA, NOAA, Genscape Note: 'Congestion' is calculated as the difference between the node at which the wind farm is located and the hub at which most power is traded, also known as 'basis'.

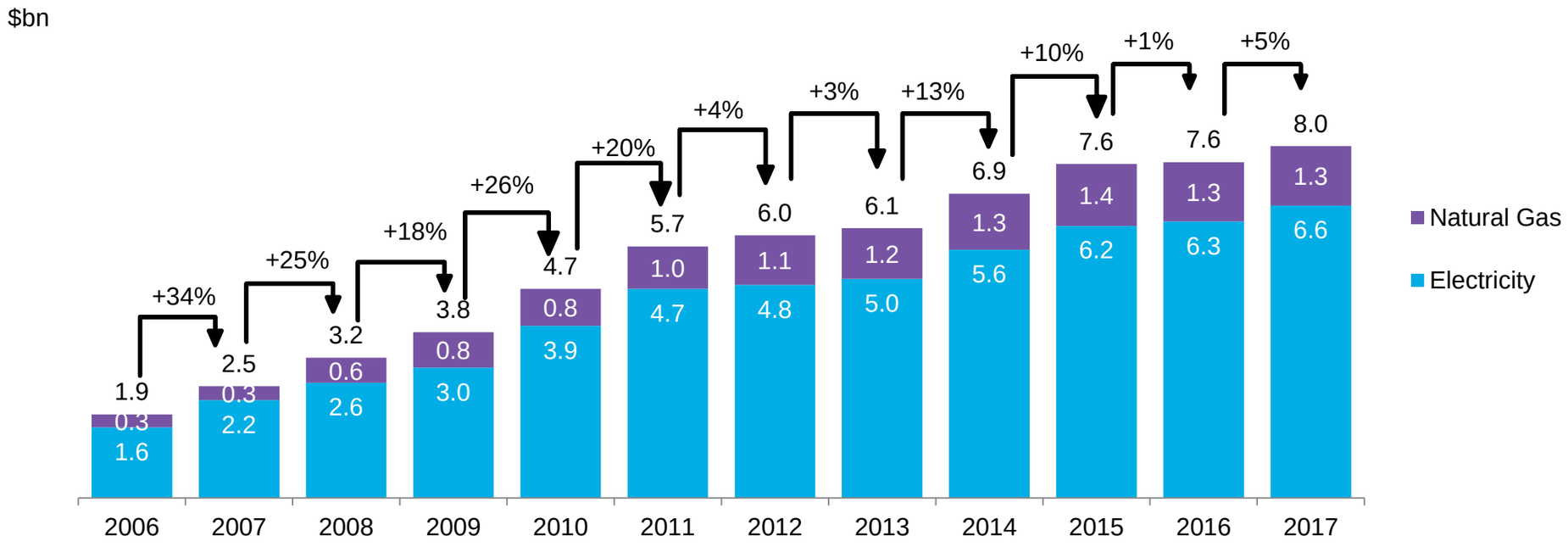
Deployment: Commissioned and planned transmission lines serving wind



- Wind tends to be one of the first sources to be curtailed when transmission congestion occurs, and congestion tends to rise as more units are added to the grid without accompanying transmission upgrades.
- New transmission can maximize the value of low-cost, emissions-free wind energy. The American Wind Energy Association (AWEA) estimates that transmission proposals across the U.S. could potentially enable 52GW of new wind capacity between 2017 and 2024.
- MISO led the way in 2018 with six projects brought in service, as part of their Multi-Value Project ("MVP") portfolio. Another three projects are due to come online in 2019. In its planning process, MISO predicted that the benefits of adding transmission are between 2.6 and 3.9 times greater than the costs.
- Several other regions have lines planned over the coming years, including five in the Southwest from 2018-20. Many of the proposed transmission projects have yet to begin construction, and projects may be delayed or canceled. Generally, transmission build within a specific state or region receives full approval faster than those lines that cross multiple jurisdictions. The TransWest Express, which is scheduled to come online in 2022 in the Northwest to connect Wyoming wind to customers in California, Arizona and Nevada, was first proposed in 2005.

Source: BloombergNEF, AWEA Note: two projects, Centennial West line through NM, AZ and CA, and Rock Island line through IL and IA don't yet have in service dates set and are not included. Graph includes 320, 345, 500, and 600kV lines.

Financing: U.S. utility energy efficiency spending

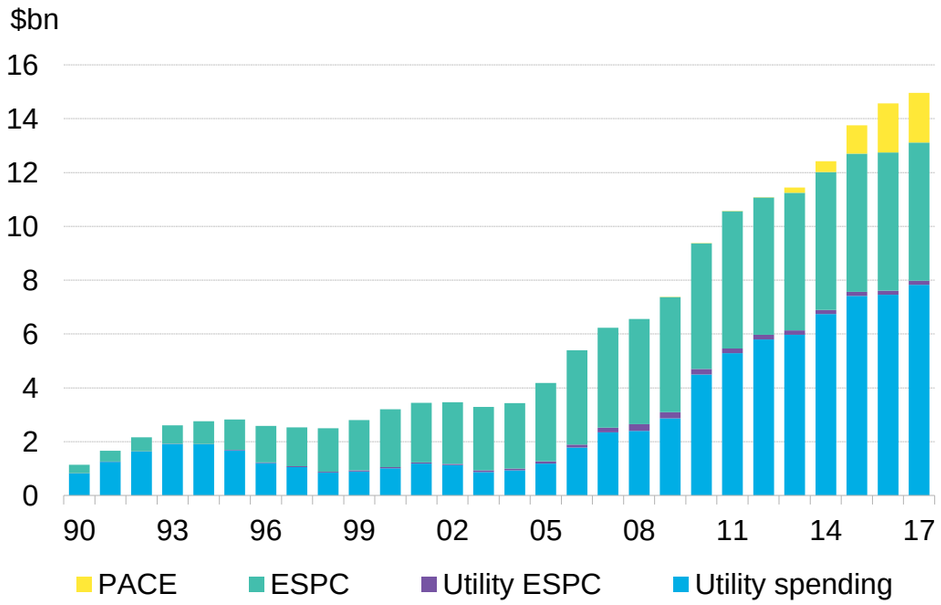


- In 2017, utility spending on energy efficiency rose to $8bn, 5% higher than the previous year. Most of the increase in spending is for electricity energy efficiency programs, as opposed to natural gas programs.
- While investment growth increased slightly nation wide, the picture was more dynamic at the state level. Utilities in Texas increased spending by $63.6m (+33%) and utilities in Illinois boosted spending by $86.3m (+33%). There were huge leaps in states with historically smaller utility budgets like Virginia (+$12.9m, 242%) and Delaware (+$0.4m, +264%).
- However, these gains were offset by falling investment in Pennsylvania(-$65.3m, -28%) and New Jersey (-$40.5m, -26%).

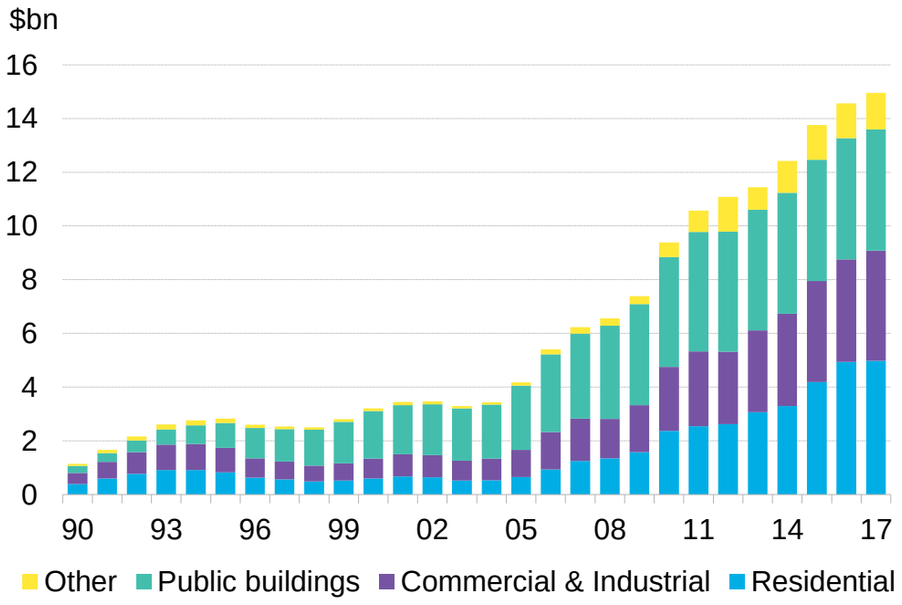
Source: CEE, ACEEE, BloombergNEF. Note that data for 2010-14 was sourced from CEE, and for 2006-2009 and 2015-18 from the ACEEE.

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

By framework



By sector

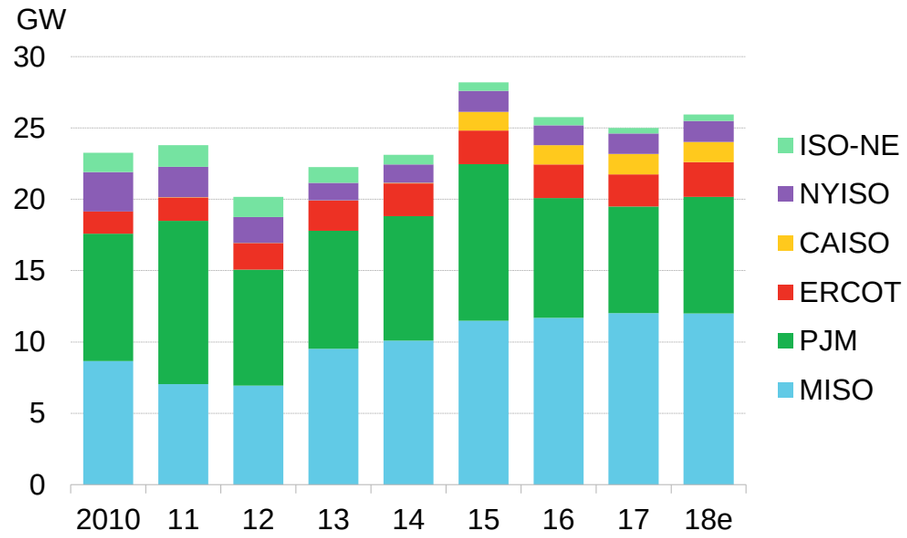


- Total U.S. spending on energy efficiency through formal frameworks climbed to an estimated record level of $15bn in 2017.
- Utility spending and ESPCs remain the most important frameworks. While the PACE financing framework was the fastest source of growth in 2016, particularly in the residential sector, 2017 was more muted. Instead, a boost in utility spending on energy efficiency accounts for over 90% of the estimated increase in energy efficiency investment. As discussed on the previous slide, most of this money was channeled through electricity energy efficiency programs.
- While our estimate for ESPC investment has leveled off in recent years, there is a certain amount of extrapolation involved due to the lack of detailed data on the market. The picture may change when new data becomes available.

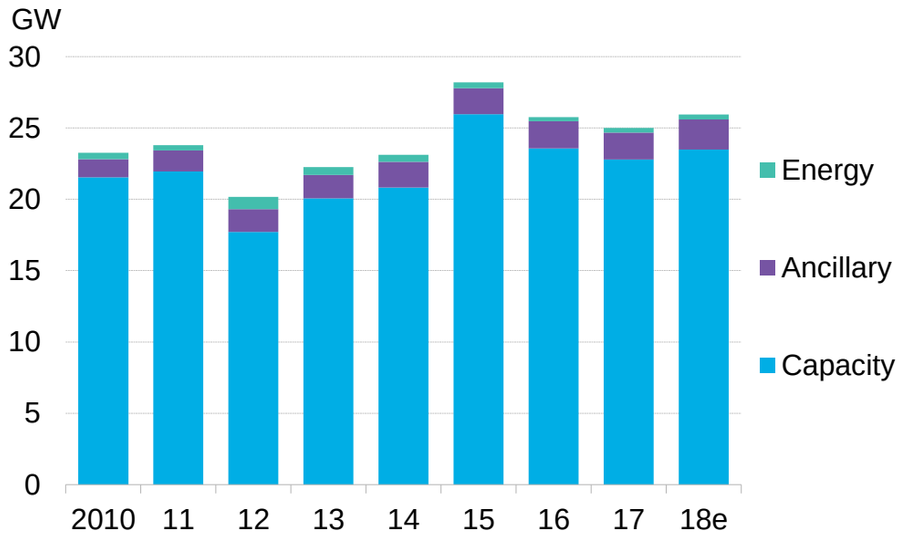
Source: ACEEE, NAESCO, LBNL, CEE, IAEE, PACENation, BloombergNEF Notes: The values for the 2015-17 ESPC market size shown here are estimates. The most recent data from LBNL reports revenues of $5.3bn in 2014. The 2015-17 estimates are based on a continuation of 2011-14 growth rates.

Deployment: U.S. wholesale demand-response capacity

By market



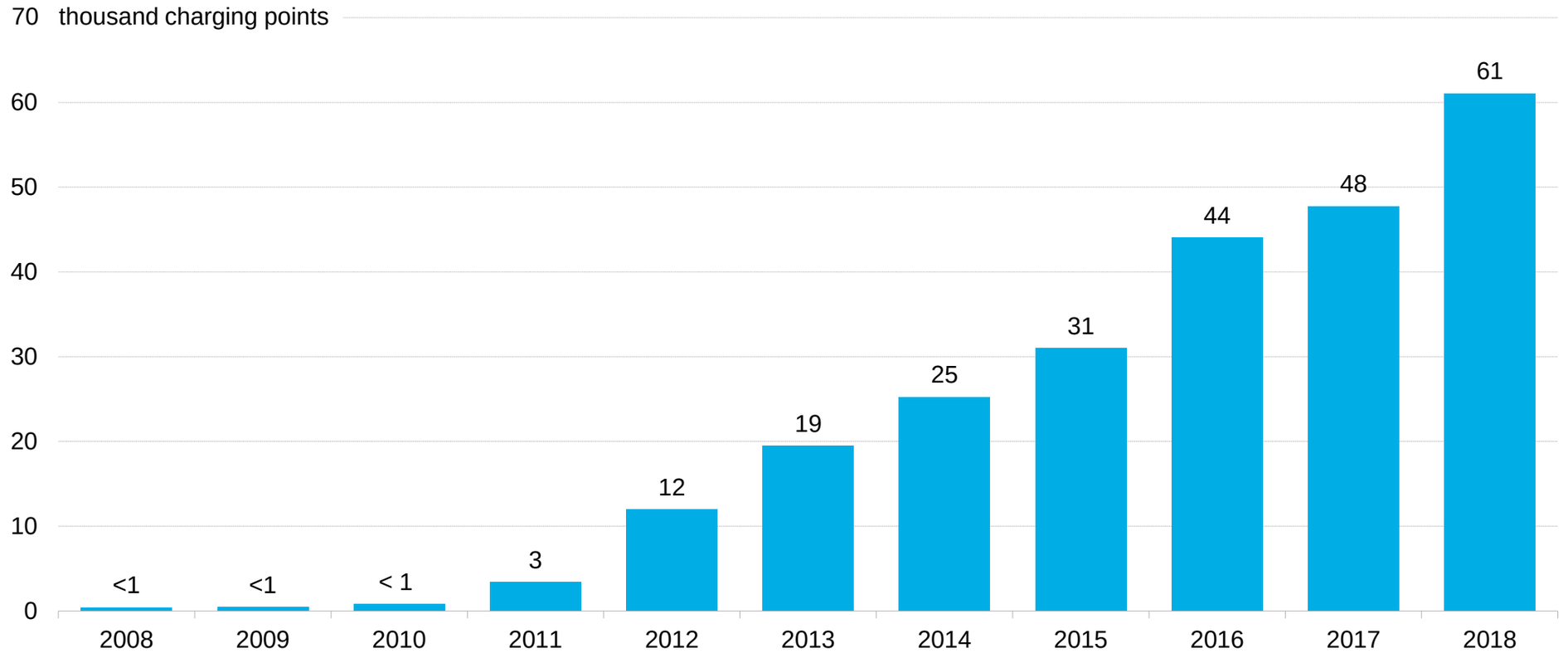
By application



- U.S. wholesale demand response (DR) capacity returned to growth in 2018 for the first time in three years. Almost all regions saw flat or increasing capacity. Most notably, ISO-NE brought its seven-year decline in demand response to a close with a 14% jump to 464MW. PJM, the most significant market, also produced a recovery as demand response performed better in the restructured capacity market than had been expected.
- The vast majority of wholesale demand response is concentrated in capacity markets and reliability mechanisms. Even in ERCOT, which has no formal capacity market, 948MW of DR has been contracted through its capacity-style Emergency Response Service. Ancillary service participation, which grew 9% annually on average over 2010-2015 but then stalled, has picked up again. In ERCOT there is almost 1.5GW of DR providing reserves and frequency regulation. Despite the furor surrounding FERC 745, demand response activity within the energy markets remains negligible.

Source: BloombergNEF. Note: Demand-response was only formally integrated with the CAISO market in 2015.

Deployment: Public electric vehicle charging points in the U.S.



- At the end of 2018 there were about 61,000 public and workplace EV charging points in the U.S., an increase of nearly 28% over 2017.
- About 81% of these EV charging outlets are Level 2. Another 16% are DC Fast and around 3% are Level 1.
- Despite the build-out of public EV charging infrastructure, the majority of EV charging in the U.S. continues to take place at home, usually with Level 1 or Level 2 outlets.

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

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