2019

Sustainable Energy in America

Factbook

GROWTH SECTORS OF THE U.S. ENERGY ECONOMY

BloombergNEF

The Business Council for Sustainable Energy®

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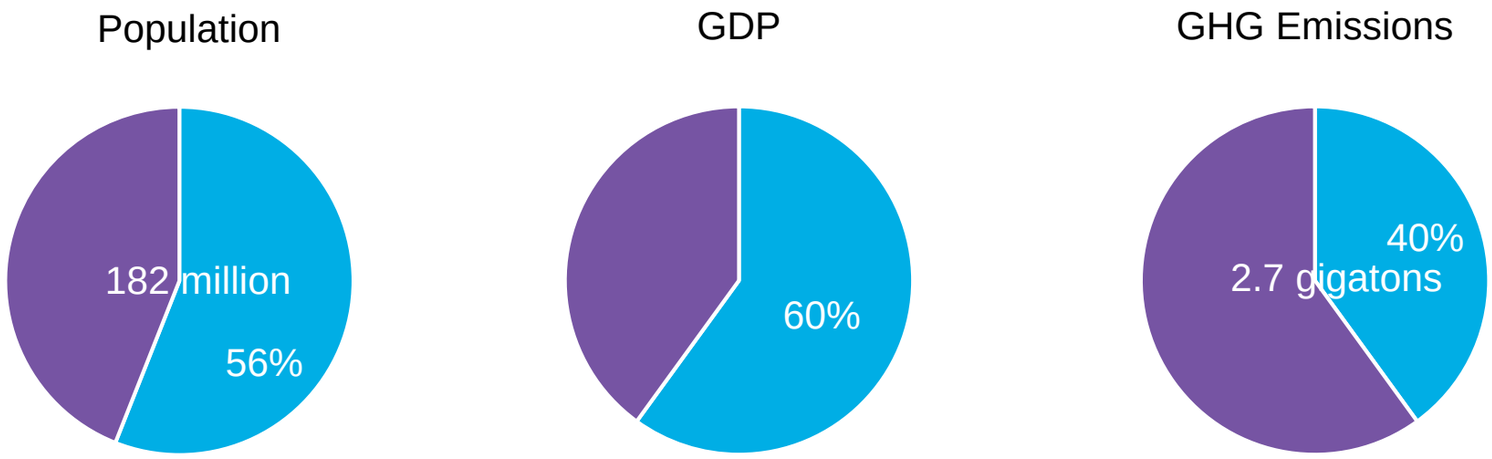
Policy: Sub-national actions to address climate change

Population, GDP and emissions of states and cities with greenhouse gas targets, compared to U.S. totals (2016)



- “Real economy actors” that have pledged support for the Paris climate agreement now represent more than half the U.S. population, more than half the American economy and more than one-third of nationwide GHG emissions, according to a 2018 report from Fulfilling America’s Pledge, a coalition of U.S. state and local governments, businesses and other organizations funded by Bloomberg Philanthropies.
- One example of municipal action has come in Los Angeles, which in partnership with a unit of France’s Bolloré Group, launched BlueLA, the nation’s first all-electric carshare service aimed at serving low-income citizens. The service is funded by the city, Bolloré and revenue from California’s cap-and-trade program. BlueLA placed stations in the city’s most disadvantaged areas and employs residents of those areas.

Source: America’s Pledge, BloombergNEF

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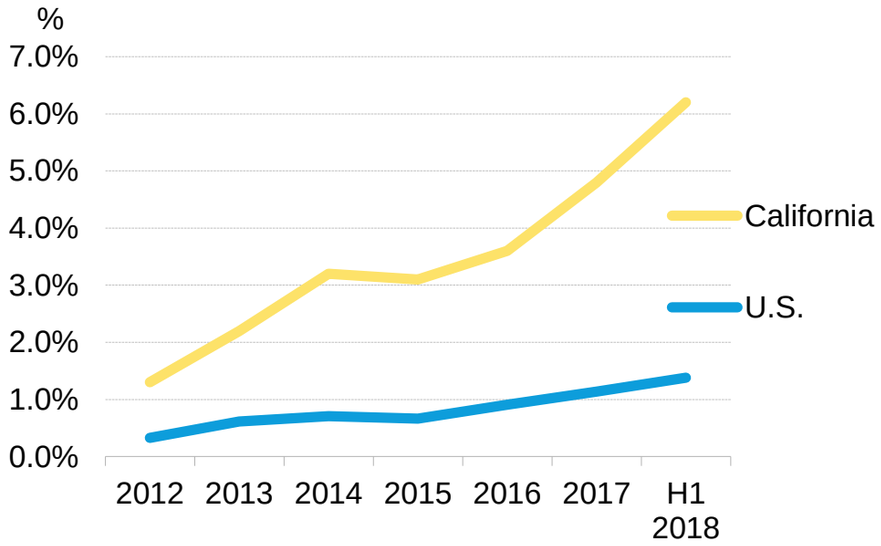
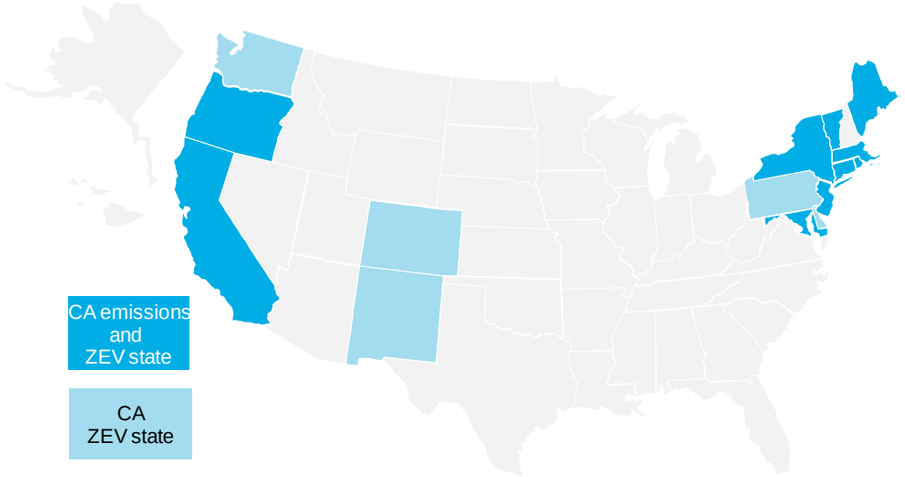
Policy: vehicle fuel economy standards

EV share of light duty vehicle sales in California and nationwide



States that have adopted California's vehicle emissions standards



- The transportation sector is now the largest source of CO2 emissions in the U.S. Electric vehicle sales are growing but still represent a miniscule share of the on-road fleet.
- The Trump administration proposed to freeze Corporate Average Fuel Economy (CAFE) standards for model years 2021-2025 at 2020 levels, which by its own estimates would increase both motor fuel consumption and greenhouse gas emissions. The state of California declared that it will not freeze or dilute its CAFE standards, which have been adopted by 13 other states and the District of Columbia.
- California also has instituted a zero emissions vehicle (ZEV) program, which sets quotas on the sale of non-emitting cars. Most, but not all, of the states embracing California's fuel economy standards have adopted its EV program.

Source: BloombergNEF Note: The 14 states that follow the California GHG standard are Colorado, Connecticut, Delaware, Maine, Maryland, Massachusetts, New Jersey, New Mexico, New York, Oregon, Pennsylvania, Rhode Island, Vermont and Washington, plus the District of Columbia.

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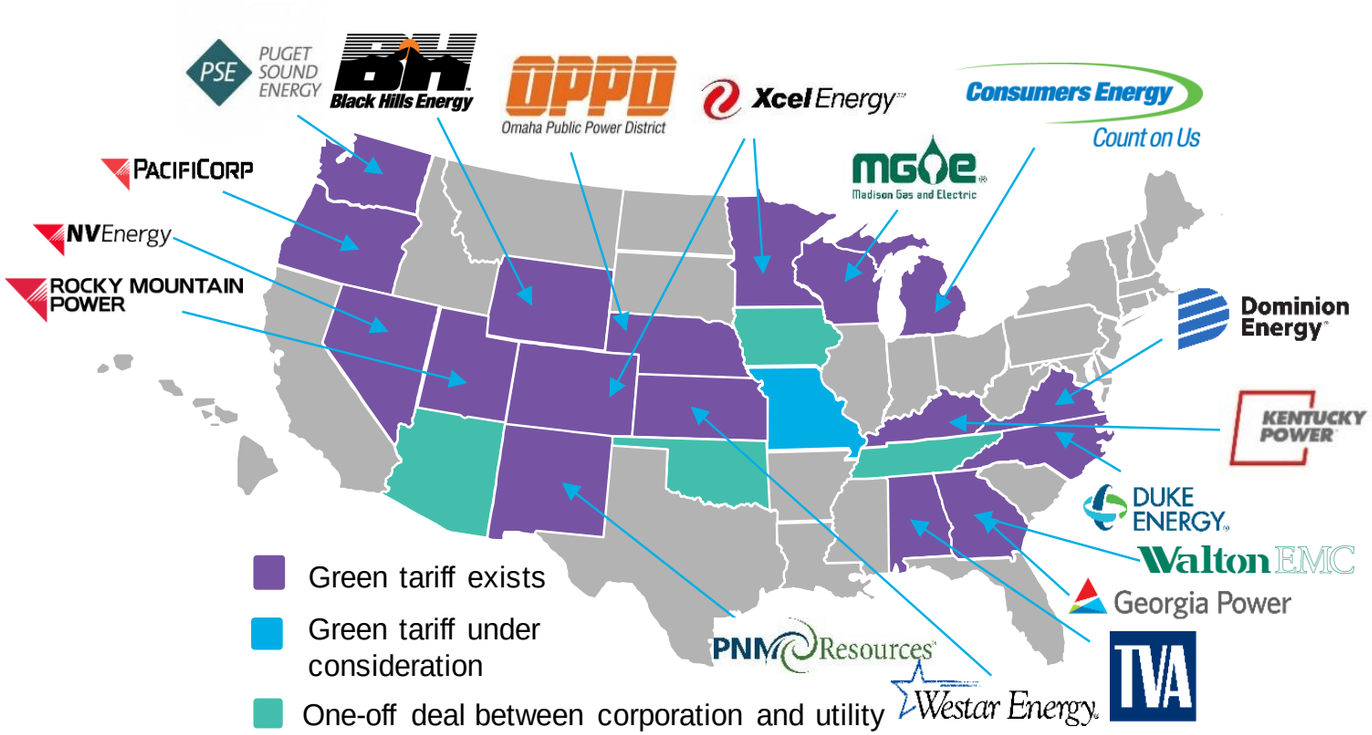
Deployment: Corporate procurement of clean energy through green tariffs



- Corporations are increasingly working with utilities in regulated U.S. markets to purchase clean energy, through programs known as green tariffs. Through green tariffs, corporations aim to limit their exposure to plummeting wholesale power prices and purchase clean energy locally.
- Through 2018, 17 regulated utilities in 17 states offer green tariff programs for corporate customers.
- Companies purchased 2.7GW of clean energy through green tariffs in 2018, quintupling the record 500MW of activity in 2017.
- Companies like Facebook, Google, General Motors and Walmart have leveraged green tariffs to date, but the programs remain a work in progress. While each program is different, many are prohibitive to all but the biggest energy buyers, and some have clauses that don't allow for customers to save on electricity by switching to the program.

Source: BloombergNEF, World Resources Institute

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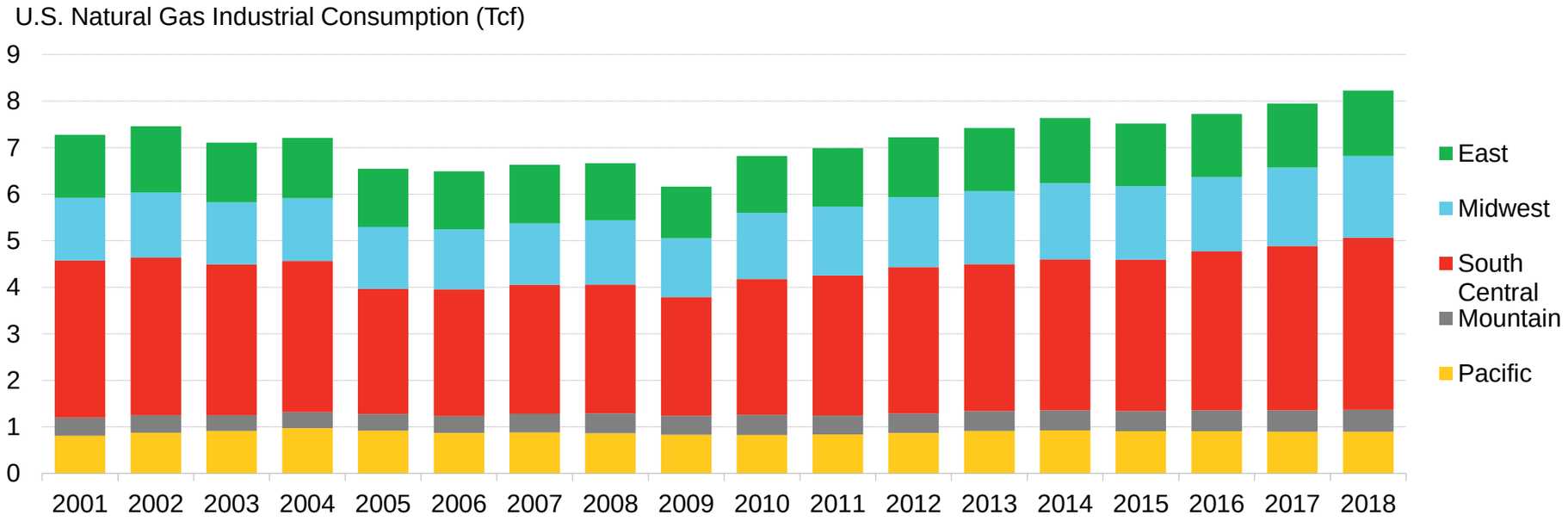
Deployment: industrial gas demand by region



- In the past decade, overall natural gas consumption has increased 23% from 2008 levels, helped by lower natural gas prices. The majority of industrial consumption continues to come from facilities in the South Central region, where natural gas is readily available.
- Industrial sector gas consumption totaled 8.2Tcf in 2018, of which 3.7Tcf was consumed in the South Central region, 1.7Tcf in the Midwest, 0.5Tcf in the Mountain region, 0.9Tcf in the Pacific and 1.4Tcf in the East.
- Industrial gas consumption rose 3.5% in 2018 from the year prior. Consumption increased in most regions, but by varying amounts: the East was up by 2%, the Mountain region by 2%, the Midwest by 4% and the South Central by 5%. Consumption in the Pacific did not change.
- There has been a long-term decrease in gas consumption in the Pacific region, where demand peaked in 2014 at 0.92Tcf and has declined nearly every year since.

Source: BloombergNEF, EIA; Note: Values for 2018 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2018). 2017 industrial consumption numbers were used as proxies for missing monthly values for a number of states.

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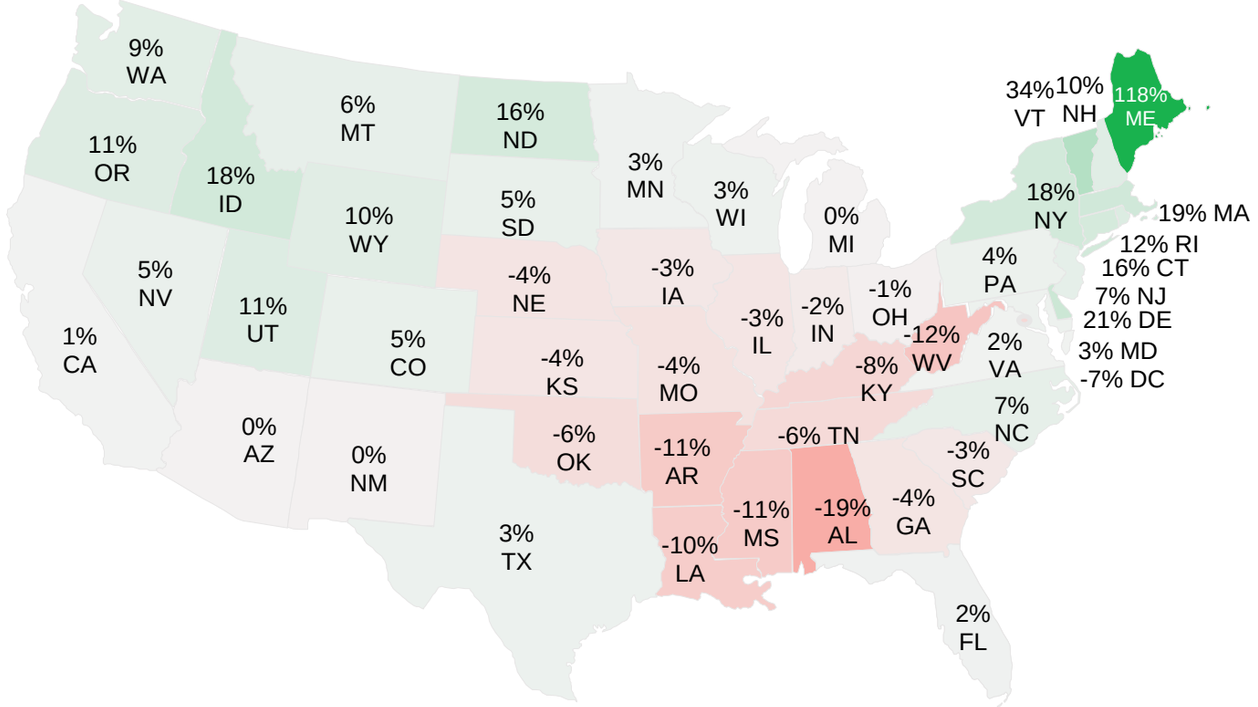
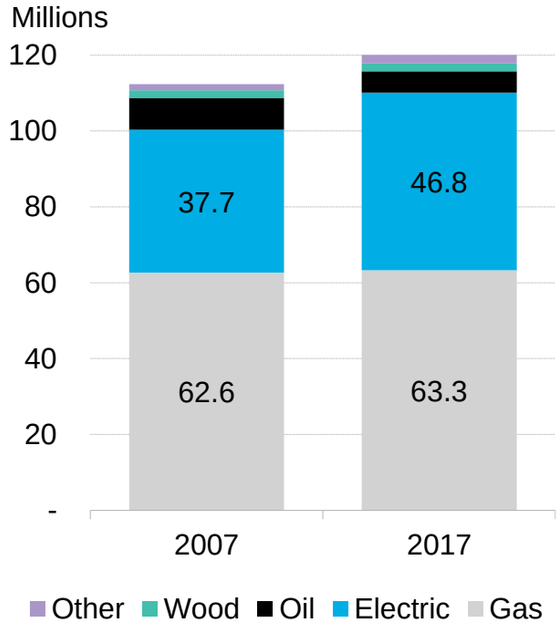
Deployment: heating demand for natural gas

Change in percent of households using natural gas for heating, from 2007 to 2017



Primary heating source by household



- Natural gas is the largest heating source in the residential sector, with close to 70 million households connected to the national gas distribution system. In total, 63.3 million homes are heated with utility natural gas or bottled propane. That is equivalent to 53% of U.S. households.
- In absolute terms nationwide, the total number of households using natural gas for heating has risen slightly since 2007.
- However, changes have varied substantially by region. Usage grew swiftly on a percentage basis in the New England states as consumers moved away from burning more costly home heating oil. Gas usage also grew in the Northwest states, while declining in the Southeast.

Source: BloombergNEF, US Census Bureau

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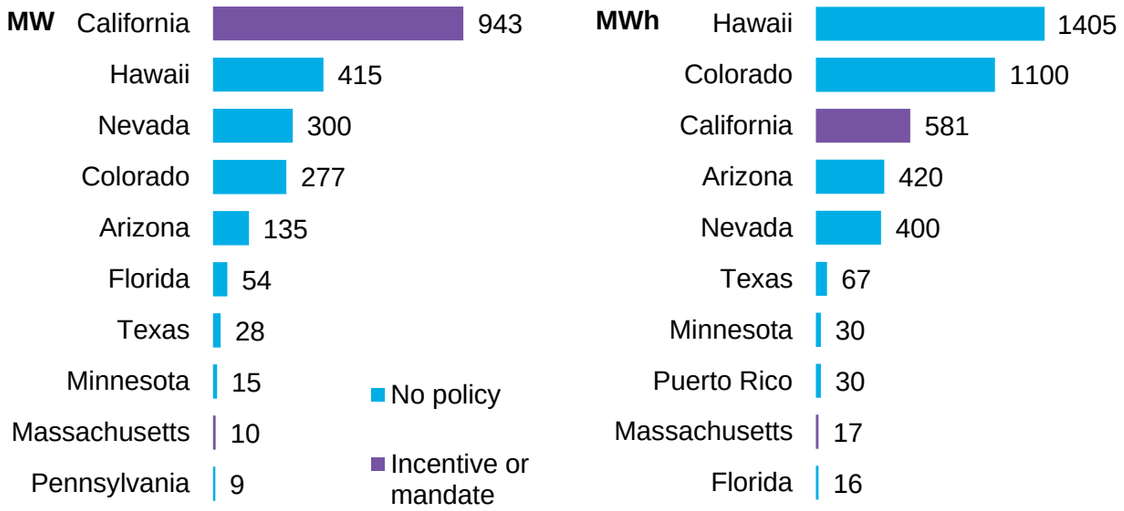
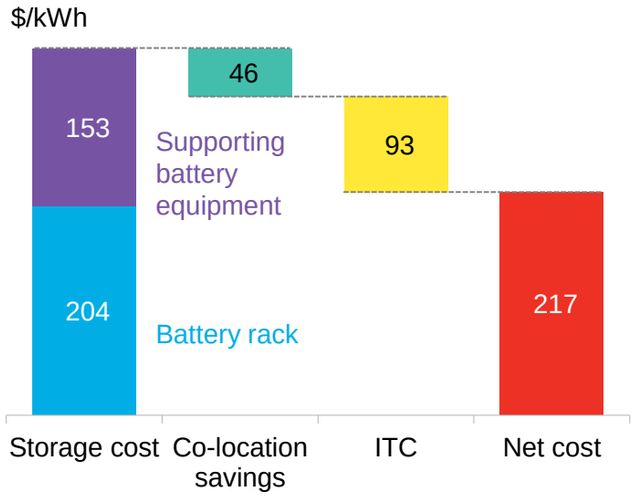
Deployment: Solar + storage

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



Cost advantage to co-locating storage with solar



- Co-located photovoltaics and storage (PV+S) development activity jumped in 2018. California and Hawaii led the nation with total planned and commissioned projects of 943MW/581MWh and 415MW/1405MWh, respectively. Colorado recently issued a solicitation; BNEF estimates it will seek 1,100MWh through 275MW of storage co-sited with solar.
- The Southwest saw a surge in large-scale PV+S announcements, led by solar developers bidding into utility solicitations at prices that undercut other firm generation sources, including natural gas. Developers with solar-storage offerings have expanded opportunities compared to those that only have solar products, as solicitations that explicitly call for firm resources or electricity delivery after sunset are now open to them as well.
- Battery storage systems that function as supporting equipment to solar projects, through co-location, are eligible for the ITC worth 30% of their upfront capital cost. Co-located systems are also able to share interconnection, hardware and operation costs. Together, these cost savings are worth nearly 40% of the cost of a standalone system.

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

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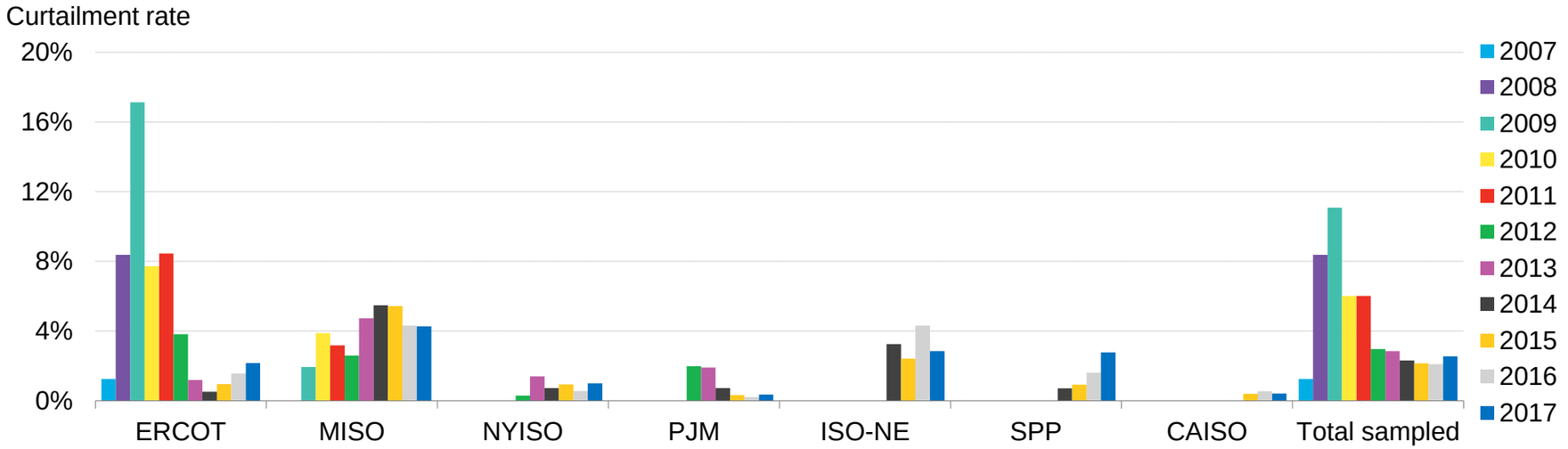
Deployment: U.S. wind curtailment



- 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.

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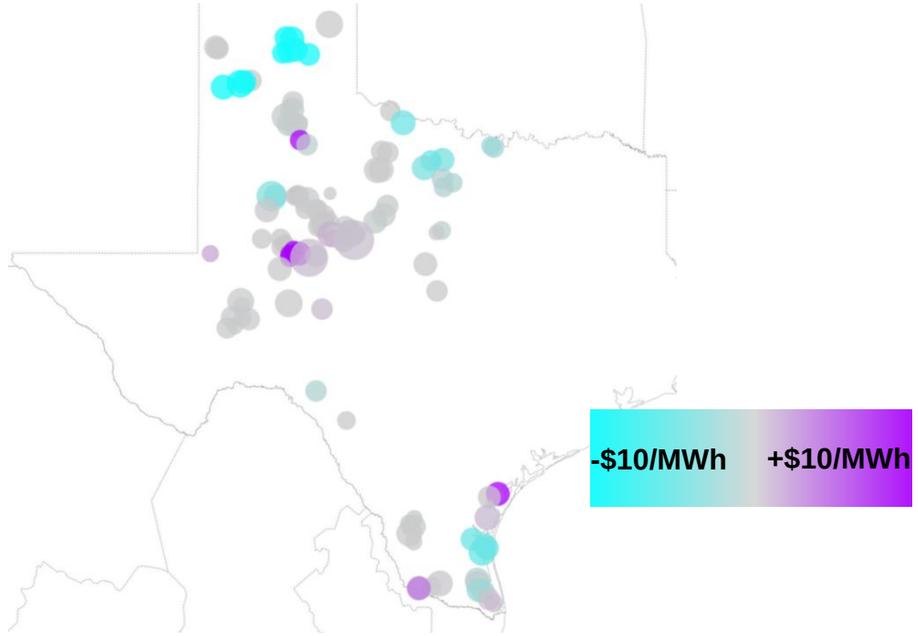
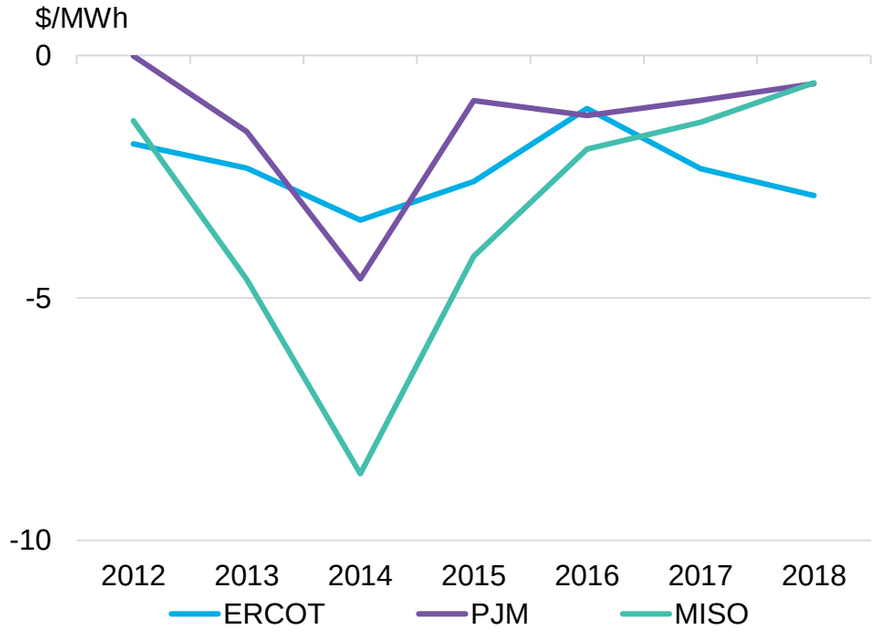
Deployment: Transmission congestion in Texas, the Midwest and Mid-Atlantic

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'.

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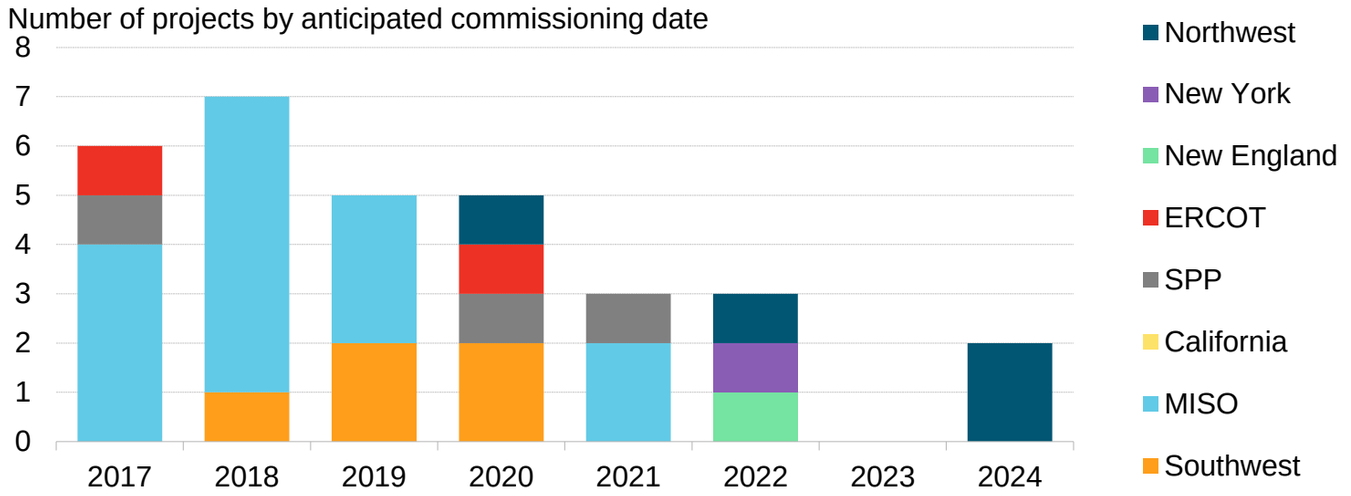
Deployment: Commissioned and planned transmission lines serving wind



- 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.

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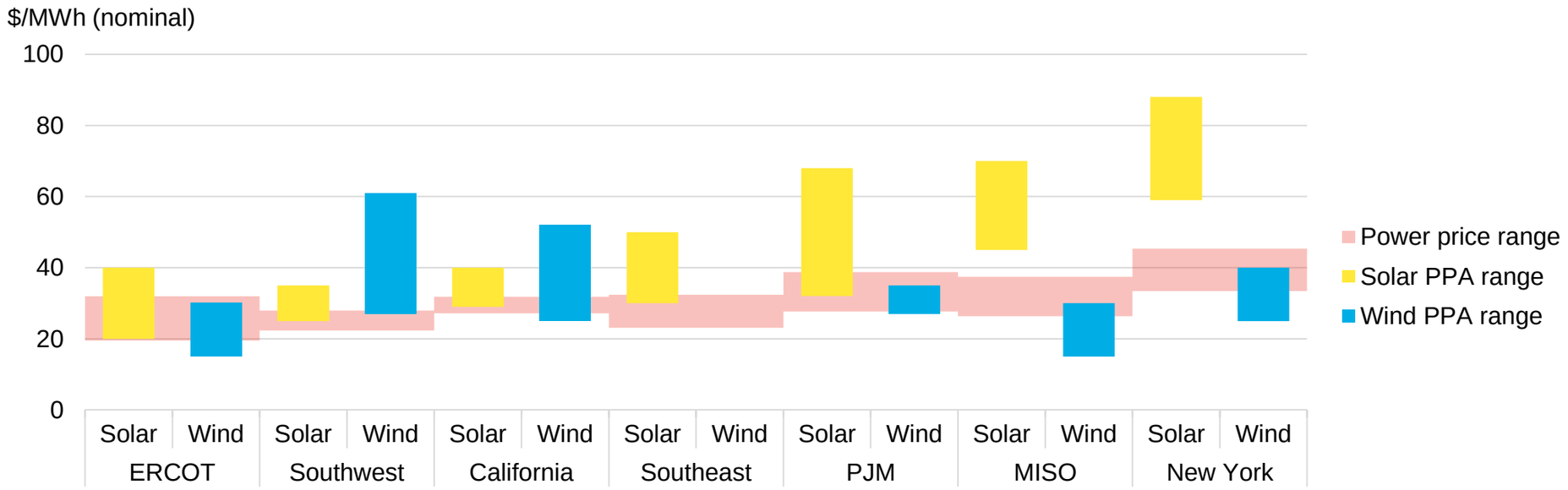
Economics: U.S. wind PPA prices compared to wholesale power prices



- Prices for wind power purchase agreements (PPAs) have fallen dramatically as levelized costs declined. According to interviews with project developers, projects secured offtake agreements in the mid-teens in the middle U.S. in 2018. For comparison, data reported to the Federal Energy Regulatory Commission indicate that offtake prices for contracts signed in 2011 averaged $47/MWh.
- The top regions for utility PPAs are high wind-speed regions with low development costs like SPP, MISO and ERCOT. Conversely, developing projects in New England can be costly and time consuming, and average project capacity factors are among the lowest in the country.
- A significant number of wind projects commissioned in 2016 – representing 1.6GW of capacity – secured corporate PPAs. The popularity of corporate PPAs continued in more recent years, with an additional 2.3GW contracted in 2017 and 4.1GW in 2018.

Source: BloombergNEF, SEC filings, interviews, analyst estimates Notes: MISO is the Midwest region; PJM is the Mid-Atlantic region; SPP is the Southwest Power Pool which covers the central southern U.S.; NEPOOL is the New England region; ERCOT covers most of Texas. Wholesale power prices are based on market-traded futures for calendar year 2018 for select nodes within the region.

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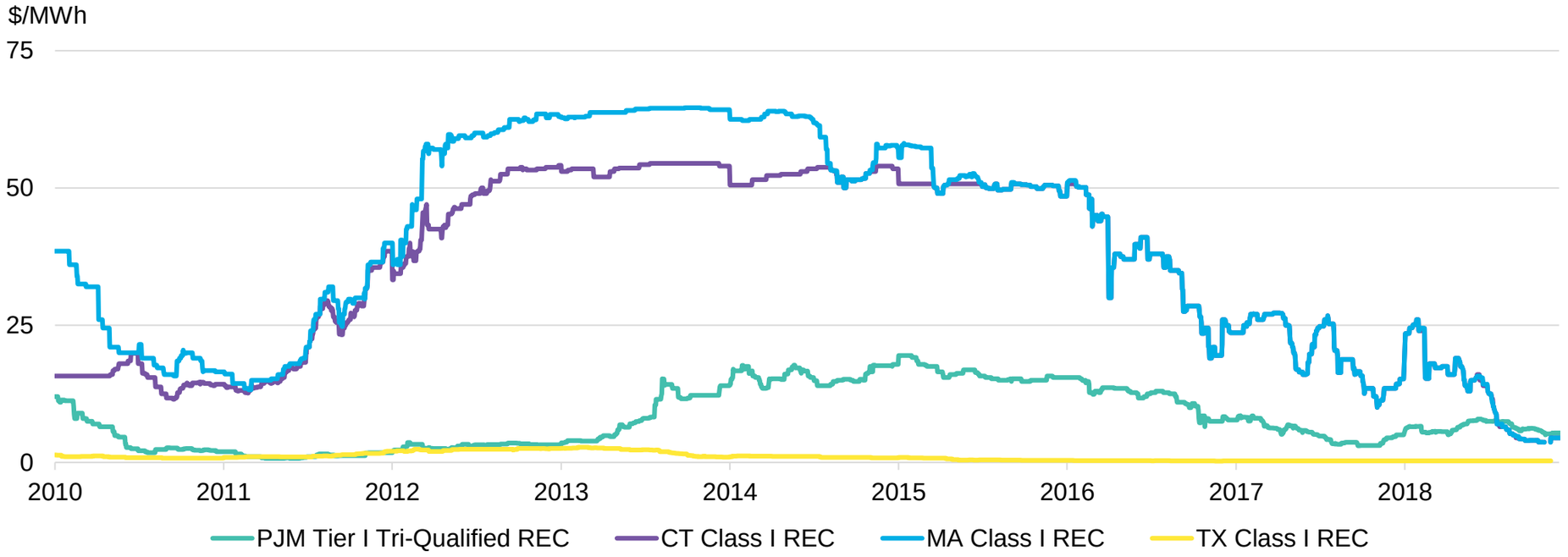
Economics: ‘Class I’ REC prices in select U.S. state markets



- In areas with Renewable Portfolio Standards (RPS), Renewable Energy Credits (RECs) are given to eligible renewable generators for each MWh of electricity they supply to the grid. Credit generators can sell their RECs for additional revenue. When REC prices are high, renewable energy investment sees a higher rate of return and new renewable build is encouraged.
- Over 2018, many major RPS markets boosted targets. California adopted SB100, which stipulates an RPS target of 60% by 2030. Connecticut raised its RPS target to 48% by 2030 and New Jersey raised its RPS target to 50% by 2030. REC price futures in both markets rose substantially as the new targets stand to reduce oversupply.

Source: BloombergNEF, ICAP, Evolution, Spectron Group Notes: “Class I” generally refers to the portion of REC markets that can be served by a variety of new renewables, including wind. The “Class I” component is usually the bulk of most states’ renewable portfolio standards. Solar REC (SREC) are not Class I. Data in the charts above is the sole property of ICAP United, Inc. Unauthorized disclosure, copying or distribution of the Information is strictly prohibited and the recipient of the information shall not redistribute the Information in a form to a third party. The Information is not, and should not be construed as, an offer, bid or solicitation in relation to any financial instrument. ICAP cannot guarantee, and expressly disclaims any liability for, and makes no representations or warranties, whether express or implied, as to the Information's currency, accuracy, timeliness, completeness or fitness for any particular purpose.

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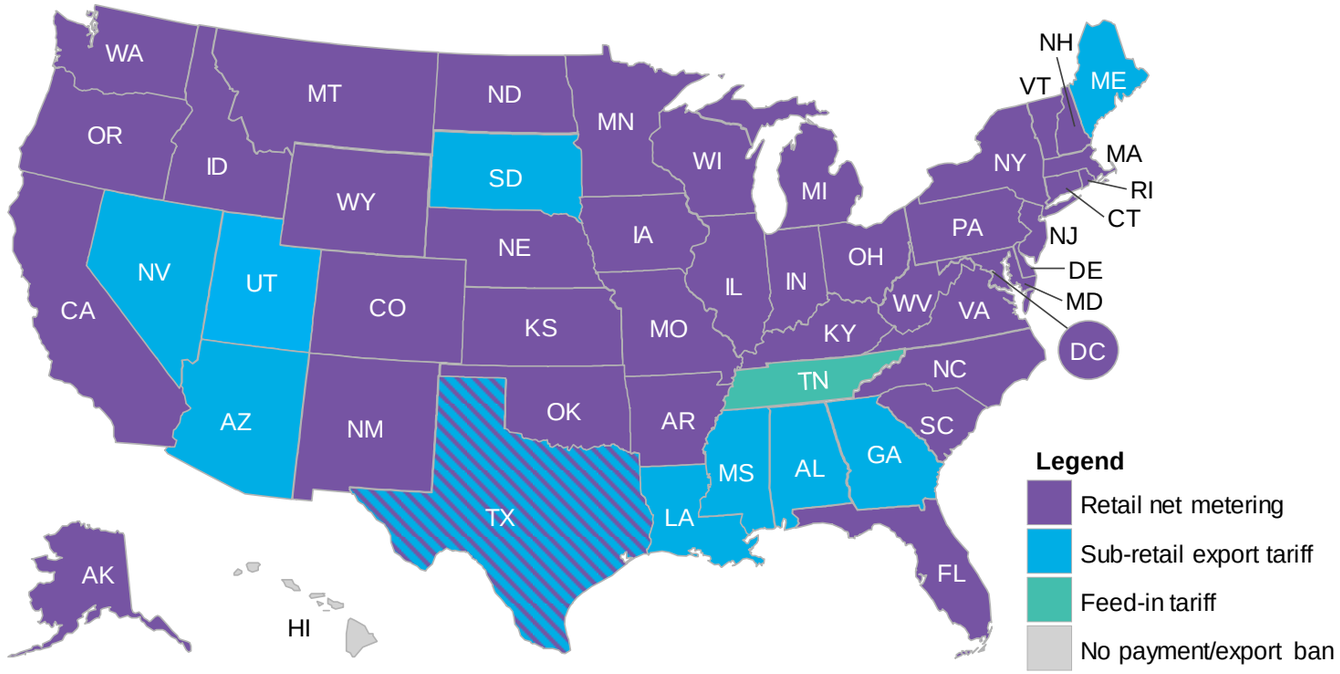
Policy: Net metering state policies as of December 2018



- As of December 2018, net metering at the full retail rate was available to most customers within 38 states and Washington, D.C.
- The rooftop solar markets were once again threatened in 2018 by regulators' willingness to dismantle net metering regimes at low adoption levels. Maine became the first state in the Northeast to compensate residential solar generation below the retail rate. Several other states are set to follow. Connecticut, Michigan, and Utah are among the states that enacted suspensions or phase-outs in the past year.
- Net metering successor schemes vary widely. Several states, including Nevada and Maine, are phasing down the value of net metering credits over time; Arizona will compensate small-scale PV systems at the five-year-average utility-scale PPA price, and only for 10 years; and Indiana will only offer net metering to systems connected before 2022. New York's commercial PV market has transitioned from net metering to a *Value of Distributed Energy Resources* tariff that varies by location, system, and time of generation. NY mass market customers will transition to the complex scheme in 2020.

Source: BloombergNEF, DSIRE. Note: the map displays the mechanism offered to the majority of residential customers where the incentives vary within a state.

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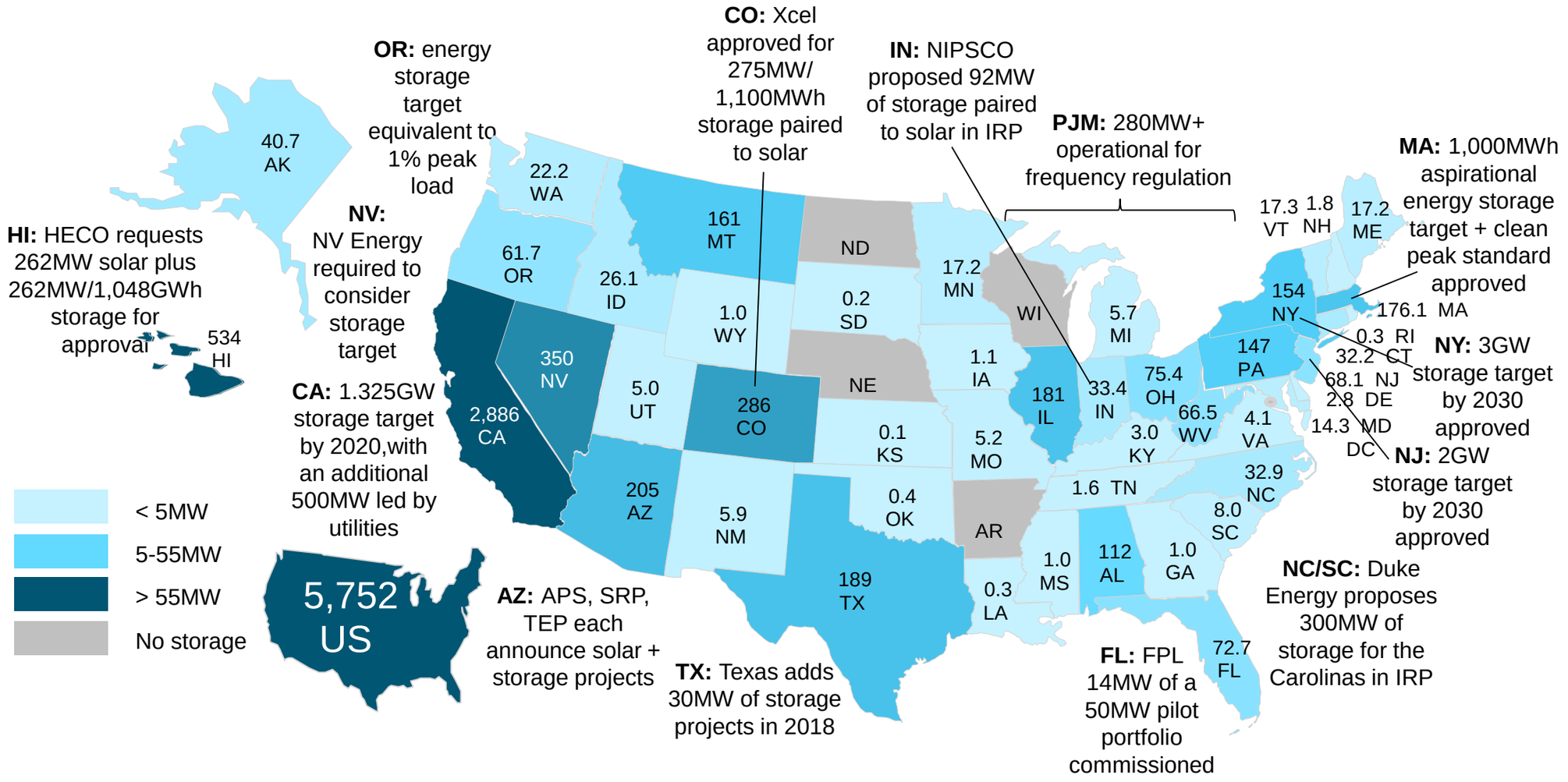
Deployment: U.S. announced and commissioned energy storage projects



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

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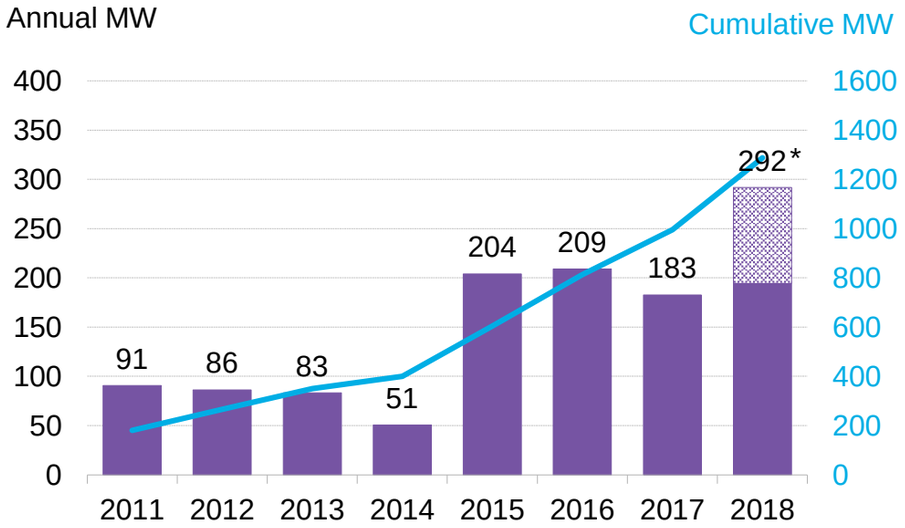
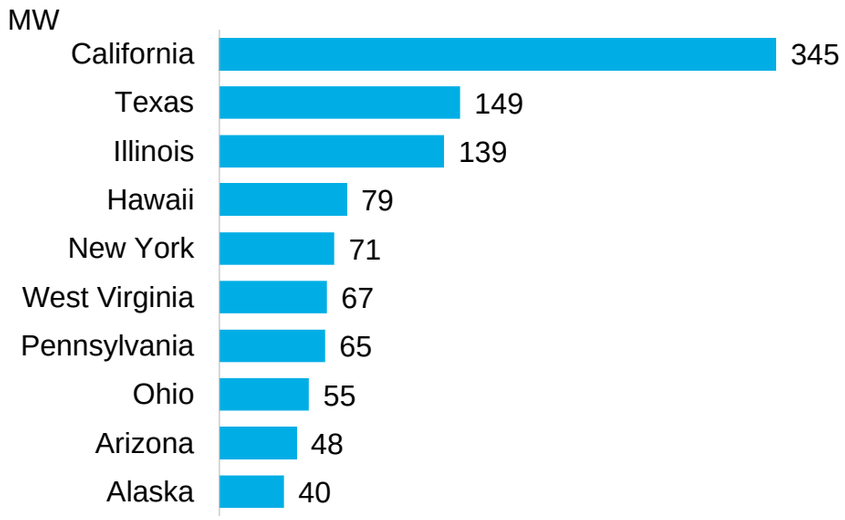
Deployment: U.S. non-hydropower commissioned energy storage capacity

Commissioned capacity



Installations by state (top 10 states in 2018)



- Annual energy storage installations have increased significantly since 2014. Build ramped up in 2015 from projects seeking to participate in the PJM frequency regulation market – these assets represent most of the capacity in Illinois, West Virginia, Ohio and Pennsylvania.
- While PJM states are still, in aggregate, the biggest energy storage market in terms of commissioned capacity in the U.S., California is the largest single state market. California build surged in 2016 and early 2017 in response to emergency gas supply shortages expected from the Aliso Canyon gas storage facility leak-mitigation efforts.
- In 2018, markets began to expand beyond PJM and California. New Jersey, Texas, North Carolina, Illinois and Massachusetts each added more than 20MW of capacity.
- Falling lithium-ion battery pack prices have helped to lower costs for new stationary storage applications.

*Source: BloombergNEF Notes: *2018 includes expected but unconfirmed capacity as of December 5, 2018. Unconfirmed capacity is marked in white. Does not include underground compressed air energy storage or flooded lead-acid batteries. Minimum project size for inclusion in this analysis is 500kW or 500kWh. Cumulative capacity subtracts capacity that was decommissioned.*

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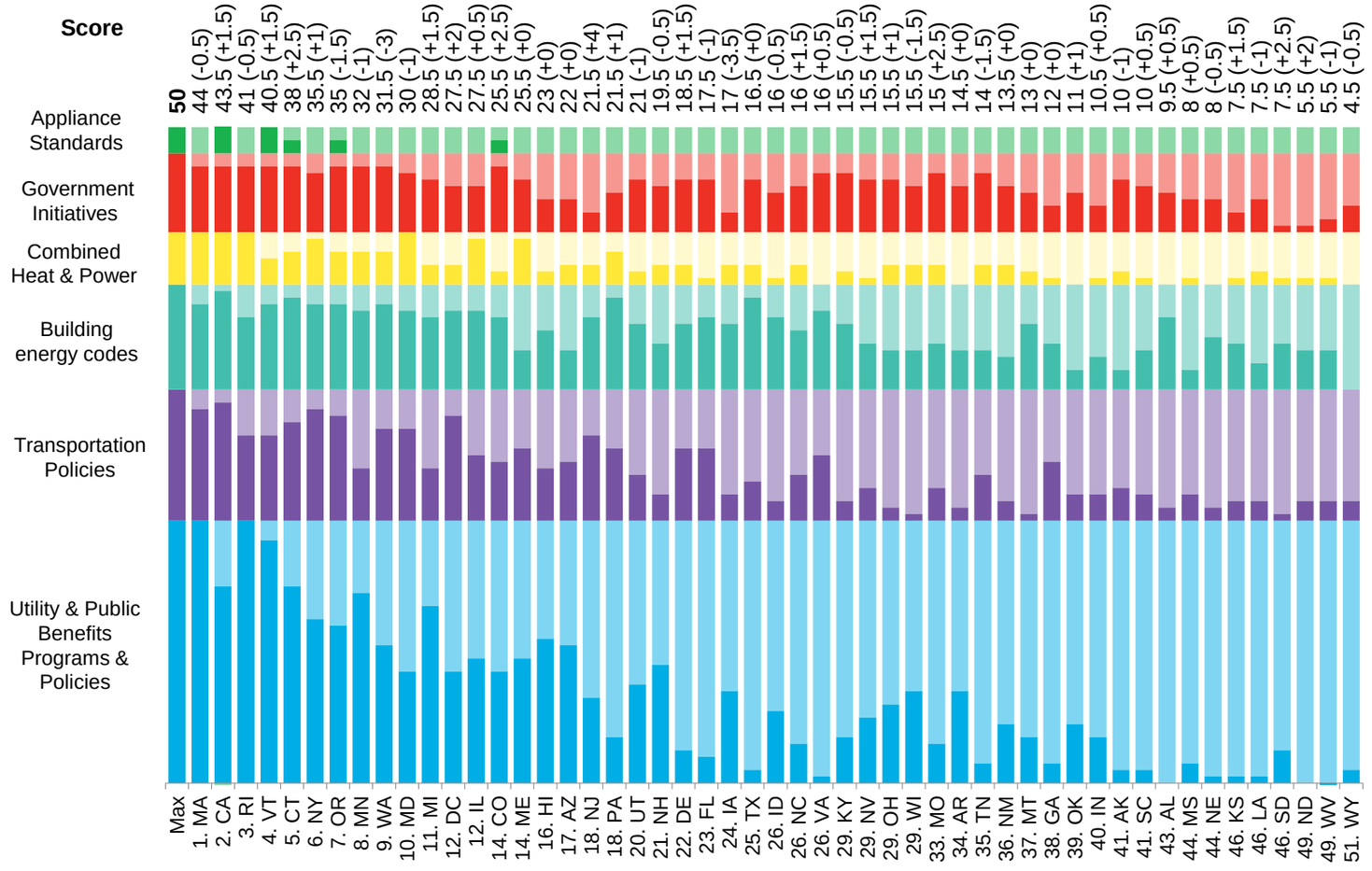
Policy: ACEEE state-by-state scorecard for energy efficiency policies, 2017



- Massachusetts retains its position as the highest-ranked state in 2018. With its fuel-neutral savings target and adequate utility funding it achieved record-high electricity savings equal to 2.7% of sales.
- Second-placed California scored maximum points across a number of categories, including building energy codes, state government initiatives and appliance standards, reflecting a number of major policy initiatives.
- New Jersey was a notable climber in the middle-rankings, moving from 23rd to 18th year-on-year due to increased utility spending on efficiency, new energy efficiency targets and RPS goals.
- Iowa fell the furthest in points for the second time in a row. New policies that deregulate efficiency requirements, cut efficiency spending, and set opt-out provisions have led to large drops in electricity energy and natural gas savings.

Source: ACEEE, EIA, BloombergNEF Note: Numbers in parentheses at the top denote the change in score from 2016 levels.

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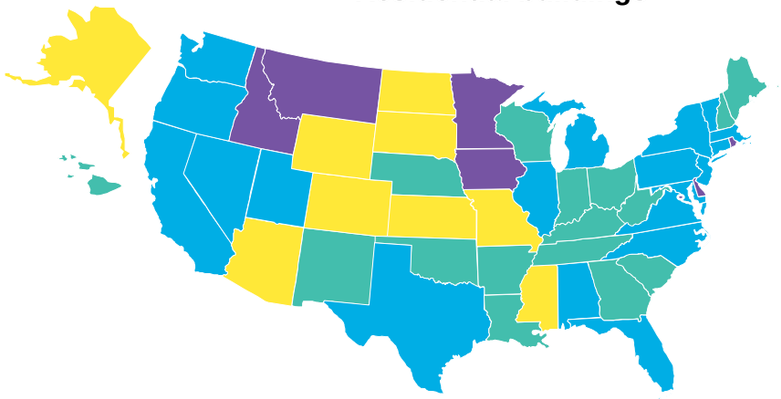
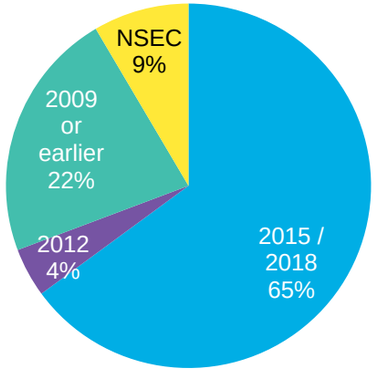
Policy: State adoption of building energy codes

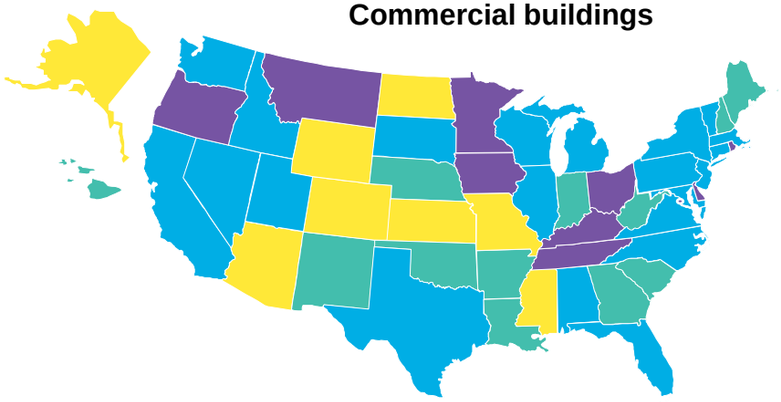
Residential buildings



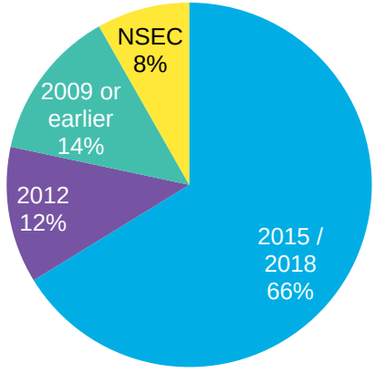
As a percentage of U.S. population



Commercial buildings



As a percentage of U.S. population



2015 / 2018 IECC | 2012 IECC | Earlier IECC | No state energy code

- The majority of states have adopted some version of the International Energy Conservation Code (IECC) for both residential and commercial buildings.
- The more populous states have adopted the 2015 and 2018 IECC. Even for states that are labeled as having "no state energy code," some jurisdictions within these states have adopted a recent version of the IECC.
- Over time, codes are updated and become more stringent. States that have adopted the most recent (2018) standard have stronger programs in place.
- Adoption of the most recent versions of the IECC (i.e., 2015 and 2018) has increased from 46% of the U.S. population in January 2018 to 65% in January 2019.
- About a quarter of the U.S. population still lives in an area with an energy code that would be considered outdated (i.e., 2009 or earlier).

Source: U.S. Department of Energy, U.S. Census Bureau, BNEF. Note: 2015 IECC is 38 times more efficient than codes available in 2009.

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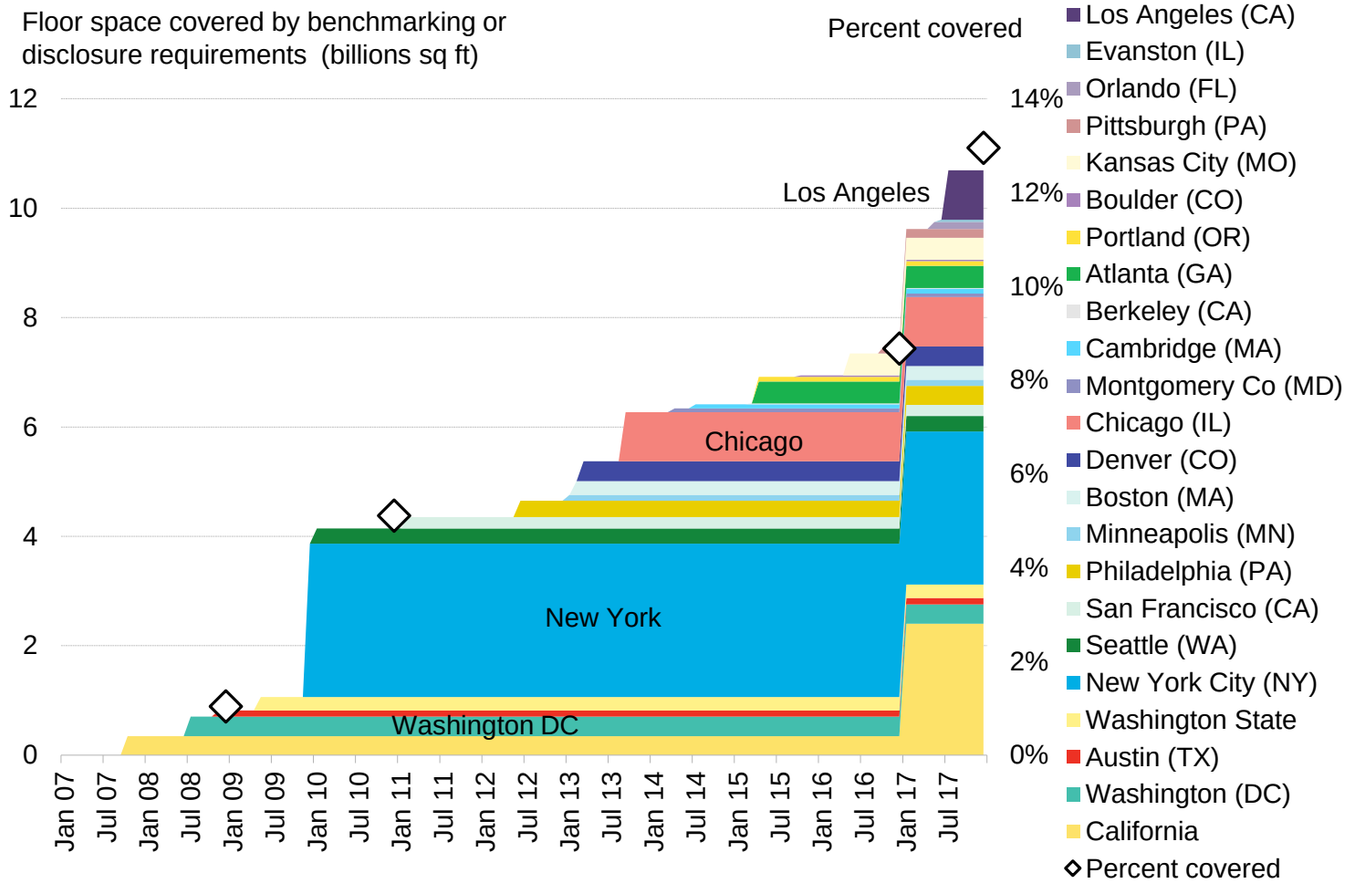
Policy: U.S. building floor space covered under state or local energy use benchmarking/disclosure policies



- In order to increase the transparency of building energy usage, states and cities have created building energy use policies such as energy efficiency benchmarks and mandates. The square footage of commercial building space covered by such policies jumped in 2017 from 9% to 13%.
- California's existing law required utilities to begin disclosing whole-building aggregated energy use data to owners of commercial buildings and multifamily homes at the start of 2017. On the county level, Los Angeles passed new benchmarking laws that came into effect for public and non-residential buildings in July 2017.
- Similar laws for Evanston, Illinois and Orlando, Florida also came into effect mid-2017. Kansas City, Missouri passed a disclosure law that came into effect in May 2016.

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

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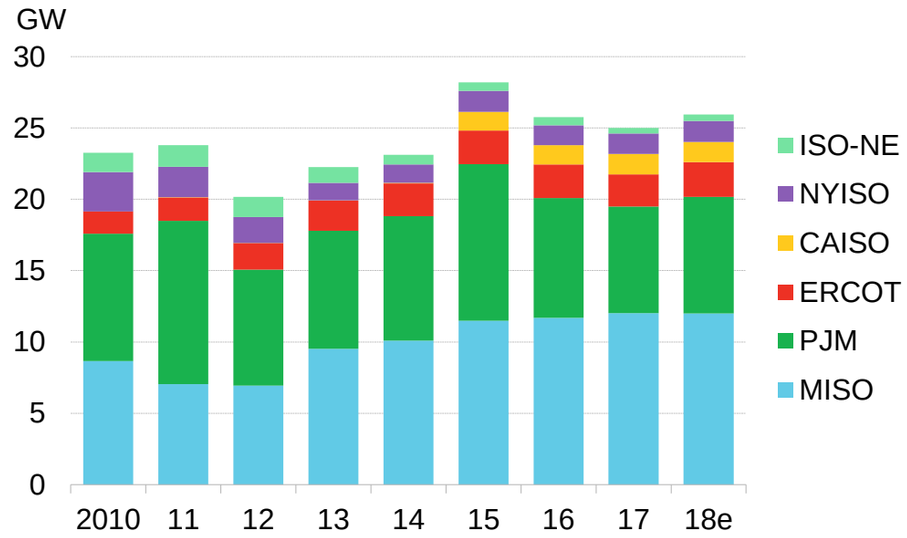
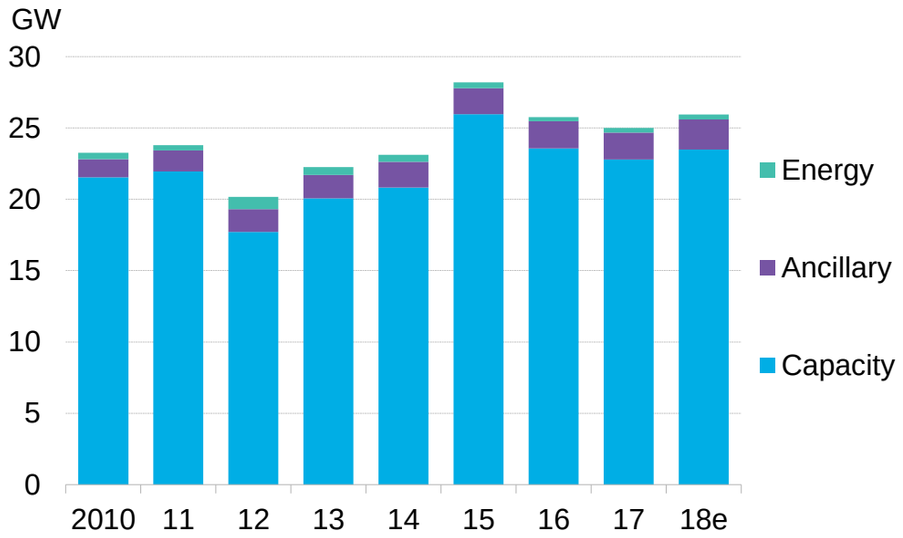
Deployment: U.S. wholesale demand-response capacity

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.

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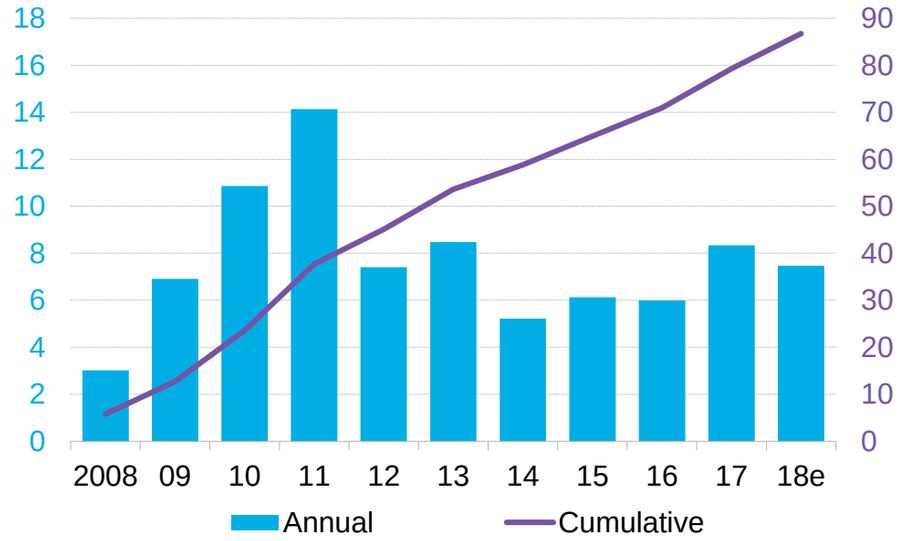
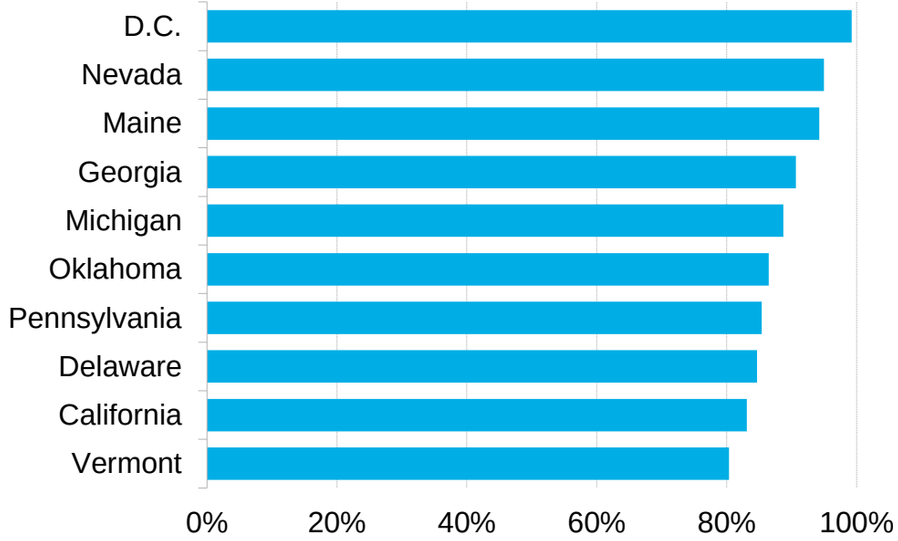
Deployment: U.S. smart electricity meter deployments

U.S. smart meter deployments



Top 10 states by penetration, 2017



- Smart meter installations hit a peak in 2010 and 2011, supported by stimulus funding awarded in 2009. Many of the largest U.S. utilities took advantage of the Smart Grid Investment Grant to roll out smart meters across their territories. As grant funding dried up, deployments slowed, hitting a trough in 2014. Smart metering activity has since picked up though it remains well below the peak of 2011.
- Today 57% of U.S. electricity customers have a smart meter, but there is enormous regional variation. The top 10 states all have penetration greater than 80%. In contrast less than one in 10 customers has a smart meter in the bottom 10 states. Over 2016-17, Pennsylvania, Illinois, Texas and North Carolina were the most active smart metering markets, each deploying over a million meters according to estimates.
- The greatest cost saving for utilities from smart metering is replacing the need for manual meter reads. But a renewed focus on grid modernization and growing interest in dynamic retail tariffs is leading state regulators and utilities that have shied away from the technology to reassess the benefits of deployment. Hold-out states, such as New York and Rhode Island (where smart meters currently number in the hundreds), have both committed to extensive smart meter rollouts over the next five to 10 years.

Source: BloombergNEF, EIA. Note: there is a 10-month lag in official smart meter statistics, as a result 2018 figures include BloombergNEF estimates.

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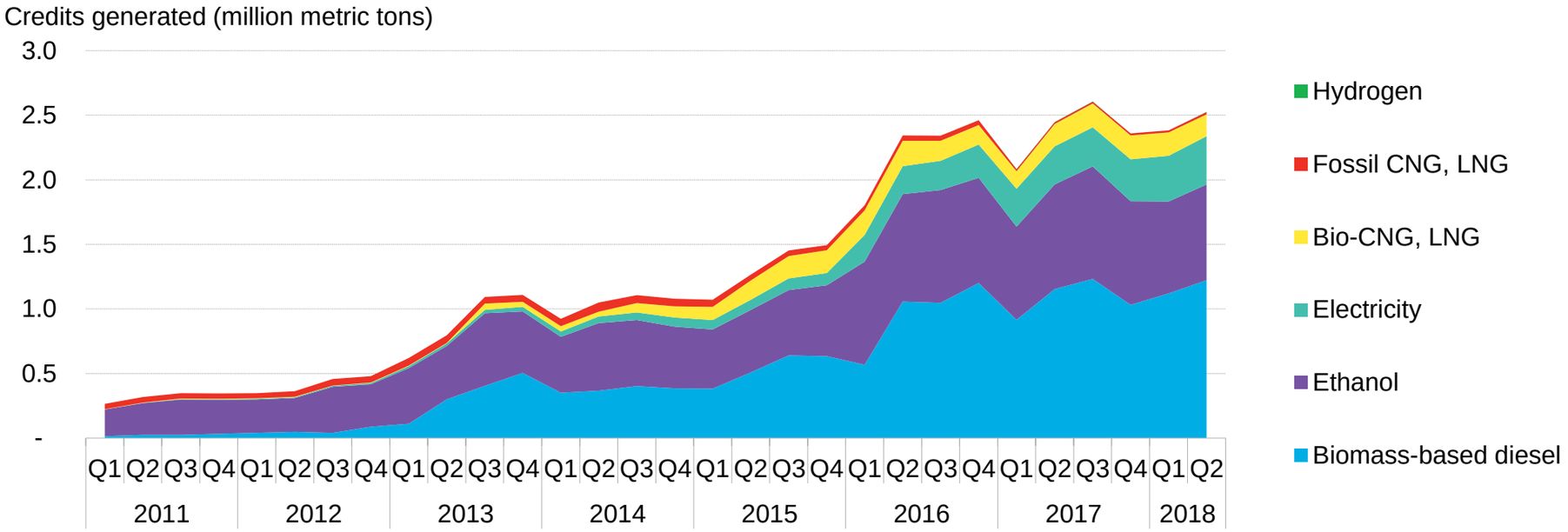
Policy: California Low-Carbon Fuel Standard



- The California Low-Carbon Fuel Standard incentivizes the use of fuels with lower carbon footprints. Its goal is to reduce the carbon intensity of transportation fuels in California by 10% by 2020 (relative to 2010 levels), as part of California's broader suite of climate change regulations.
- Through blending lower-carbon fuels into gasoline and diesel, or supplanting their use with other fuels or sources of energy (such as natural gas or electricity), blenders generate credits under the program. Since its launch, the sources of credit generation have shifted: in 2011, most credits were generated by traditional ethanol, which is blended with gasoline. Biomass-based diesel (including renewable diesel and biodiesel) became more common in 2013 and produced 48% of total credits in the first half of 2018, while ethanol generated 30%.
- Electricity, bio-CNG, and bio-LNG have also provided a growing share of credits. Electric vehicle charging made up 15% of the market in 1H 2018, while bio-CNG and bio-LNG made up 7%.
- Hydrogen still makes up only 0.1% of the LCFS credit market, due to low penetration of fuel cell electric vehicles.

Source: BloombergNEF, California Air Resources Board Note: CNG stands for compressed natural gas; LNG stands for liquefied natural gas.

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