

The WECC 2018-2038 Scenarios: Early Indicators and Trends Analysis

Third and Fourth Quarters of 2018

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INTRODUCTION

This report by the Quantum Planning Group (QPG) to WECC and the Scenario Development Subcommittee (SDS) covers events and developments in the electric industry, energy markets, and the following topics for the third and fourth quarters of 2018:

1. Significant Key Driver Events for the 2018-2038 WECC Scenarios and their implications,
2. Significant Uncertainties, Major Trends, and Wild Cards, and
3. Trend developments in each Scenario.

This report also includes coverage of Scenario 5: Energy, Water, and Climate Change since EPSs can be related to this Scenario, even though there are no specific Early Indicators for this Scenario other than a 3-degree F temperature rise by 2034.

While this report details events scanned, reviewed, and selected for this report in July – December 2018 inclusively, our analysis considers and builds on learnings from the trends reports since 2011. We refer the reader to the previous *WECC Scenarios: Early Indicator, Trends and Scenario Movement Analysis reports (Trends Reports) of October 2015 - Summer 2018* for additional background information found [here](#).

As of this report date, the WECC EPS System is under revision for the WECC 2038 Horizon Scenarios and no new EPS have been submitted since February 2018. Therefore, this report follows the format of the Summer Trends Report and events are grouped by Key Driver. Once the EPS System revisions are complete – expected in January 2019 - we will be able to submit EPS, and again be able to group events by Scenario, Early Indicators, as well as by Key Drivers as in past reports, providing a more robust and detailed trend analysis. We expect that format to be in place for the next quarterly report scheduled for publishing on April 7 2019, covering the first quarter of 2019. The absence of the working EPS system also means that sections of the report where we would normally show EPS by Scenario will not be included in this report.

We have been asked to keep a focus on the implications for electric reliability in our trends analyses. To address this we will include summary remarks about what we see as possible implications for electric reliability at the conclusion of each of the Key Driver sections below.

The links to the event source articles that follow in this report are “hot” and, when clicked, will take the reader directly to the referenced articles. If the reader finds a problem with a link in this report, you can contact QPG directly for help.

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We think direct reporting of the source article is important for the reader’s learning, and therefore the event items (all from July through December of 2018) that follow include excerpts taken directly from the referenced article text as well as Quantum Planning commentary. Because of the wide diversity and interests of the readership, and how the reader elects to read the report – printed or screen - we have erred on the side of more detail rather than less in the excerpted text.

EXECUTIVE SUMMARY

This report of Early Indicators (EIs) and Trends (the Trends Report) by the Quantum Planning Group (QPG) is produced for WECC and the Scenario Development Subcommittee (SDS). The report covers the third and fourth quarters of 2018. EIs and Trend identification and analysis in these reports are done by review of media and industry reports by WECC members, WECC staff, and QPG consultants.

Scenario Trends

[Past reports](#) focused on an analysis of movement from one scenario to another scenario of the Western Interconnection as a whole. As we noted in the last SDS meeting, we believe that in the 2038 Scenarios, given the choices by the SDS for the Primary Scenario Drivers and other Key Drivers, states and provinces within the region will not move in lockstep towards any particular scenario. Considering the new Scenario Matrix, this would imply that there would not be a region-wide “movement” that could be charted against the new scenario matrix as in the Legacy Scenarios. We think that developments and trends within each scenario, noting specific events at the state and local levels that fit that scenario is, at least at the beginning of this 20-year span, more useful to WECC and the SDS. Please see Figure 1 below, in which we offer a starting point for discussion and further enhancement with SDS members.

However, we can say that, based on the Key Driver events we have seen in the past six months and from a high level, events *tend to support movement in the Western Interconnection toward Scenario 4: Mandates and Standards for State & Provincial Policy with High Levels of Choices in the Evolution of Customer Supply and Demand.*

Uncertainties, Key Driver Trends, and Wild Cards & Outliers

While there were no Significant Uncertainties noted in the past six months, there were events of significant impact for each of the Key Drivers chosen by the SDS for the 2038 Horizon Scenarios:

1. Changes in State and Provincial Electric Energy Market Policies
2. Evolution of Customer-side Energy Supply Technology and Service Options
3. Changes in Federal Electric Energy Market Policies
4. Changes in the Character and Shape of Customer Demand for Electric Power
5. Changes in Utility-scale Power Supply Options
6. Changes in State and Federal Electric System Regulations for Reliability
7. Evolution of Climate Change and Environmental Issues on Electric Power Service
8. Evolution of Fuel Markets in the Electric Power Sector
9. Shifts in the Cost of Capital and Financial Markets
10. Economic Growth Within the Western Interconnection
11. Worldwide Developments in the Electric Power Industry

Summary and Conclusions

Changes in State and Provincial Electric Energy Market Policies: There were no significant near-term developments in this driver, however, there were three events that will play out over the long term: The November elections were a mixed bag, with green energy proposals winning in Nevada and Oregon and losing in Arizona, while the much-watched carbon tax proposal in Washington lost - again. Renewable power supporting candidates won governorships in seven states, including New Mexico and Colorado in the Western Interconnection. US Courts of Appeals upheld nuclear power subsidies in New York, and the right of Illinois to craft energy, environment, and public health policies which include subsidies for its nuclear power plants. FERC issued a ruling that disallows utilities to treat customers with storage devices differently than those who do not. As mentioned further below, in future reports we hope to see some resolution by FERC of the capacity pricing issues being debated in the area of the PJM ISO, as they may have national implications.

Customer Adoption of Energy Service Options: In the near-term, adoptions of new energy services are proceeding at a snail's pace, and retail choice, where it is available, has declined since 2014. We do not expect significant increases in energy service adoptions until states and provinces craft market enhancing policies and corresponding legislation.

Evolution of Customer-side Energy Supply Technology and Service Options: There is difficulty in quickly adopting and implementing new and innovative technology into the existing power system which has interests from current service providers in maintaining the existing infrastructure and sources of power supply. While there were some new devices announced (e.g., micro gas turbines for the home) and plans for increased options for EV charging, community solar, battery systems, and high-tech metering, the current moderate pace of innovation in new supply-side energy sources continues.

Changes in the Character and Shape of Customer Demand for Electric Power: There are no significant developments in this driver, as it is itself directly driven by customer adoption of new energy devices and services, as well as the evolution of customer-side power supply options. As noted above, there were no significant movements in those areas.

Changes in Federal Electric Energy Market Policies: Capacity market rules and their implementation dominated developments in the past six months. FERC is considering PJM's proposed plan that includes a carve-out for state-subsidized- resources, and how FERC acts could allow states more options to add capacity. Coupled with the new FERC order 841, which opens up storage participation in wholesale markets, there may be significant impacts to the power system in both near and long-term.

Changes in Utility-scale Power Supply Options: The shift away from fossil fuels and towards renewable power continues. More utilities are seeing the basic economics of renewable power drive decisions to replace both coal and gas-fired generation with lower cost renewables – in some cases by buying renewable power from existing sources in lieu of building new generation. New hybrid systems combining storage and renewables are now being built in the US. An emerging challenge for pricing and cost recovery by regulators is the aging of existing wind turbine installations, and the increasing costs associated with maintenance and operations. However, long-term, we expect the shift away from fossil fuels to continue and accelerate as renewables continue to decline in cost.

Changes in State and Federal Electric System Regulations for Reliability: In general, events in this area are seen to support conditions that reduce risks and enhance reliability.

Evolution of Climate Change and Environmental Issues on Electric Power Service: As we note below, developments in this area have the most implications for the power system. Recent reports by the US government and the UN have both described an acceleration of climate change to the point that we will begin to see significant and more intense impacts to the power system and infrastructure – including higher temperatures, stronger storms, increased flooding and longer, more intense droughts - much sooner than originally thought, and well with the timeframe of the WECC 2018-2038 Scenarios.

Evolution of Fuel Markets in the Electric Power Sector: Developments in this area see a continuation of what has occurred over the past few years. In the near-term, lower natural gas prices through 2020 will continue as exploration and development in the US continues. In both the near and long-term, retirements of coal-fired power generation will continue through 2024 with replacement generation mostly by gas in the eastern US and largely by renewables with some gas in the western US.

Shifts in the Cost of Capital and Financial Markets: Currently, there is still enough capital at a cost that does not impact investment decisions in the power sector. However, we are seeing evidence and signals of a slowdown in the global economy that could presage another recession in late 2019 or early 2020, which would impact the availability and cost of capital, including in the US.

Economic Growth Within the Western Interconnection: Economic indicators for the US and Canada show stable and growing economies, even in the midst of a global trade war, slowing global growth, and extremely volatile

financial markets. In the longer term, however, new economic challenges (tariffs, banking risks, and national policy changes such as BREXIT) are beginning to appear both domestically and globally, and we are well past the normal period for a slowdown following in the recovery from the 2008-2009 recession.

Worldwide Developments in the Electric Power Industry: The main message is that the diversification of power generation worldwide continues, yet fossil fuels will still make up the majority of global generation well into 2040. However, new installations of wind and solar power with reduced costs are continuing.

Wild Cards and Outliers: Cybersecurity continues to be a primary concern for the power sector. Attacks continue as Russian hackers probe the grid looking for weak points. New research is adding to the understanding of Internet of Things (IoT) devices susceptibility to cyber-attacks. This area remains a near and long-term growing concern for the power industry, especially as digital technologies are used more widely.

Implications for Reliability

Broadly speaking, with two exceptions, in looking at trends across all of the Key Drivers and Wild Cards, at this time we see no exceptional challenges emerging that will lead to a decline in the ability of the industry to meet historical levels of reliability. One exception is in developments related to the evolution of climate change and environmental issues that could impact the power sector. Actions by humans and policy developments to address climate change nationally and globally are not sufficient to slow the forecasted increasing destructive effects. The second exception is cybersecurity - and whether the power industry successfully adopts the necessary tools and operating processes that can prevent or mitigate large-scale or cascading power system failures due to cyber-attacks.

We also suggest in general that it is prudent to continue to monitor customer adoption of new energy services as the operational and infrastructure developments needed to integrate these might present a risk to reliability if that integration is not done well.

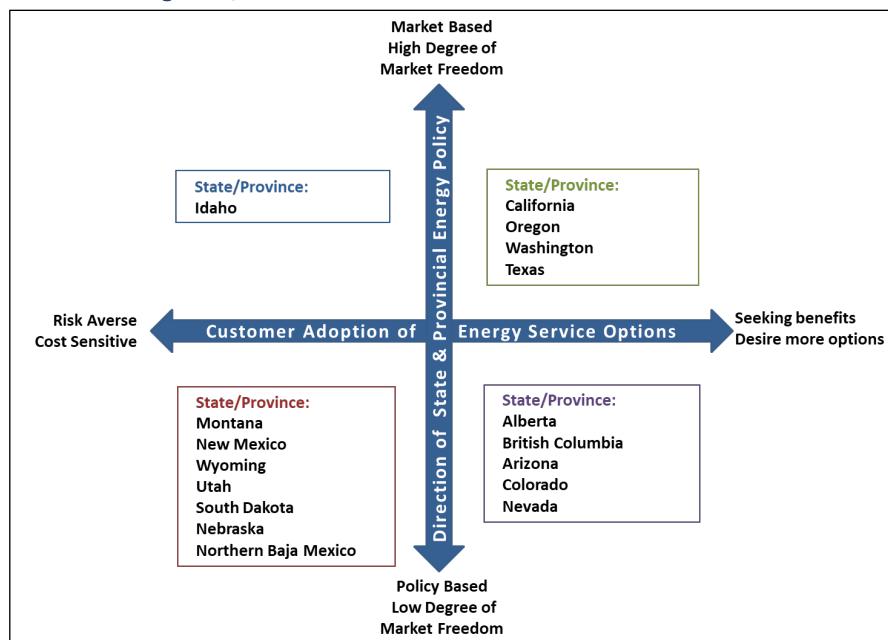
State and Provincial Scenario Assessment

As noted above, we believe that in the 2038 Scenarios, given the choices by the SDS for the Primary Scenario Drivers and other Key Drivers, states and provinces within the region will not move in lockstep towards any particular scenario. For purposes of discussion, we have placed each State and Province of WECC into the Scenario Matrix to give a broad indication of where their policies and energy developments might indicate each State or Province sits.

Figure 1, State and Provincial Scenario Matrix

During future SDS meetings, we will seek review, comments and suggestions from SDS members from those States and Provinces to improve upon our starting effort.

Over time, we think reviewing those placements on the matrix will provide useful information for SDS members and for WECC planning efforts.



SIGNIFICANT UNCERTAINTIES FOR CONSIDERATION

While there were no Significant Uncertainties noted in the past six months, there were events of significant impact for each of the Key Drivers chosen by the SDS for the 2038 Scenarios.

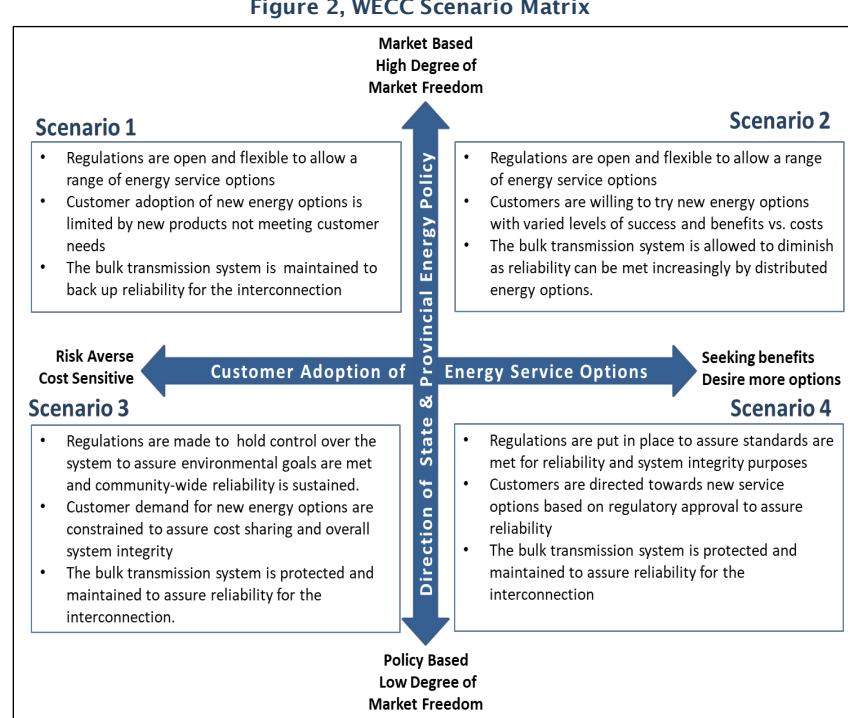
SCENARIO PRIMARY DRIVER TRENDS

The WECC Scenario Matrix

Each of the four WECC 2038 Horizon Scenarios fits into one of four quadrants within a 2 x 2 matrix, using the two primary scenario drivers chosen by the SDS of 1), Direction of State and Provincial Energy Policy, and 2), Customer Adoption of Energy Service Options.

Each Scenario can thus be described – *at a high level* – by the combination of the matrix axes.

For example, Scenario 1 could be called *Open Markets Yet Restricted Customer Choice*, and would be characterized as: “High Degree of Market Freedom yet Limited Desirable Customer Choice Options”.



The matrix provides both a quick visual model for the Scenarios and a reference for the discussions that follow. However, for a complete understanding of the Scenarios, we encourage readers to read the WECC 2038 Horizon Scenarios Narratives [found here](#).

Changes in State and Provincial Energy Market Policy

Fourteen Western states, two Canadian provinces, and Northern Baja California make up the geographical footprint of the Western Interconnection supported by WECC. They set policies and rates which directly impact how electricity markets function within their areas of jurisdiction and influence regional patterns as well. How electricity supply and demand are met is governed in large part by the policies set by individual states and provinces. This includes rules that govern markets - in conjunction with federal regulations - in places like California and Alberta where formal markets are in place to procure services such as imbalance energy and ancillary services. This also includes policies on cost recovery for plant investment in utility rates, renewable portfolio standards, climate change policies, rules governing the use of local distribution systems, and much more.

November Election: Energy Issues Results - November 2018 elections delivered mixed results for clean energy on the state level, with wins for renewable power supporters in key gubernatorial races tempered by the failure of high-profile ballot initiatives in Arizona and Washington.

1. In Arizona, voters resoundingly rejected a 50% renewable energy mandate opposed by utilities with nearly 70% of the vote.
2. In Washington, voters rejected a proposed fee on carbon emissions for the third time.

3. In Nevada, voters gave preliminary approval to a 50% renewable energy mandate, but rejected a proposal to break utility NV Energy's monopoly.
4. The night also included wins for gubernatorial candidates who have endorsed 50% renewable energy standards or higher — in Illinois, Colorado, Nevada, New Mexico and Maine (see details in the Climate Change driver below)
5. Colorado leaves fracking basically the same - Two important oil and gas initiatives were up in Colorado — both would have had radical and long-lasting effects in the state but neither passed.
6. Voters in Portland, Oregon, passed Measure 26-201, which would put a 1 percent tax on the gross receipts of all large retailers in the city to pay into a Clean Energy Fund, which would help the city hit its clean energy goals. The tax will fund clean energy projects and job training in the city.

Further Reading

- Oregon Public Broadcasting, [Portlanders Pass Measure To Create Clean Energy Fund](#)
- Utility Dive, [Ballot initiative flops mask strong election for clean energy](#)

Illinois' Effort to Increase Clean Energy, Cut Pollution Upheld - In a case that will have far-reaching impact across the US, The US Court of Appeals for the Seventh Circuit [upheld a clean energy policy](#) created by the state of Illinois and reaffirmed states' right to craft critical energy, environmental, and public health policies for their citizens. Opponents objected to a state policy that is part of the Illinois Energy Future Jobs Act – an effort to reduce dangerous pollution, create jobs in Illinois, and save families money on their power bills. The Illinois policy will provide Zero Emission Credits (ZEC) to non-polluting power generators, *including nuclear plants*. Opponents argued that it was discriminatory and violated the Commerce Clause of the Constitution because it usurped the authority of the Federal Energy Regulatory Commission.

The court noted that "The Commerce Clause does not cut the States off from legislating on all subjects relating to the health, life, and safety of their citizens, [just because] the legislation might indirectly affect the commerce of the country" and "because states retain authority over power generation, a state policy that affects price only by increasing the quantity of power available for sale is not preempted by federal law." Fossil fuel generators fossil fuel generators appealed the ruling on September 27.

Further Reading:

- Environmental Defense Fund, [Appeals Court Upholds Illinois' Effort to Increase Clean Energy, Cut Pollution](#), September 13 2018
- Utility Dive, [Nudged by FERC, Federal Appeals Court Upholds Illinois Nuclear Subsidies](#), September 14 2018

Nuclear Subsidies Upheld in New York - A federal appeals court on September 27 2018 upheld nuclear energy subsidies put in place by New York, the second ruling in a month affirming states' ability to support clean energy resources. The US Court of Appeals for the 2nd Circuit [upheld New York's Zero Emission Credit \(ZEC\) program](#), ruling it does not overstep state authority because it does not mandate participation in wholesale power markets and is little different than renewable energy policies already allowed under established legal precedent.

Further Reading:

- Utility Dive, [Federal Court Again Upholds State Nuclear Subsidies, This Time in New York](#), September 28 2018

Nevada approves a plan to integrate more DER - Nevada regulators this week [adopted a framework for distributed resource plans](#) that the state's investor-owned utilities will be required to file every three years beginning 2019 as part of an improved approach to evaluating necessary resources and grid upgrades. Clean energy advocates cited the potential for Distribution Resource Plans (DRP) to utilize solar generation, energy storage and demand management to manage the grid more efficiently and reliably.

Further Reading:

- Utility Dive, [Nevada Approves 4-part Plan to Integrate More DER](#), September 27 2018

California law aims for a 100 percent carbon-free electricity grid by 2045 – California has a new law to make the state's electricity grid 100 percent carbon-free by 2045, using wind, solar, geothermal and hydropower. The issue of course, is just how this goal will be accomplished. The effort is "...betting big on innovation (especially in storage), engineering, scientific research, and political collaboration over several state administrations..." The scale of the attempt is simply huge by any measure: California is the world's fifth largest economy. Its population will grow by several million over the next 27 years, and the economy is expected to more than double, straining the electricity grid. Waves of electric vehicles, if they catch on, could also add to the demand for electricity. Storage technology is especially critical, as the use of renewables goes higher, storage needs and costs will add to the cost of solar and wind energy. California is in the top five states for wind energy production, yet natural gas still makes up about one-third of the state's generation, and the state imports about 25% of its electricity.

Two additional laws, designed to help implement the new law and speed the achievement of 100% renewable power did not pass. One of the bills was designed to jumpstart renewables procurement, and the other would have expanded the state's wholesale power market.

It's all about the cost - Sometimes two ideas that seem joined at the hip end up butting heads. A couple of current discussions in the energy blog-o-sphere illustrate this point. One is the debate over moving to 100% carbon-free electricity in California. Another is the push for "electrification" of transportation, water heating and anything else that rely on burning natural gas, oil or coal. The two conversations raise the question: Could California's ambitious zero carbon electricity policy actually make it harder to cut greenhouse gasses overall?

Over the long term analysts are pointing out that energy sources are fungible (one can be exchanged or shifted to another) and that rising costs will cause consumers to make changes that can defeat the policy goals aimed at carbon reduction. Electricity prices cannot go too high in pursuit of clean energy goals if less expensive but dirtier alternatives exist. Complex interactions between markets need to be watched, which is one of the roles of good scenarios.

Further Reading:

- The Washington Post, [California Law Would Make State's Electricity Grid 100 Percent Carbon Free by 2045](#), September 13 2018
- Utility Dive, [California Has a 100% Clean Energy Goal, But Not the Laws to Get It There](#), September 11 2018
- UC Berkeley Haas School of Business, [100% of What?](#), September 2018

California Microgrids get help - California lawmakers gave a final okay in August to a microgrid bill (SB 1339) designed to boost microgrid development and streamline what at times is a lengthy wait to interconnect projects. The Senate analysis of the bill noted that even though customers show "great interest in the development of microgrids but also great frustration. While the technology is ready, the protocols and standards for interconnection are not. Some customers have been successful in navigating the challenges, but many are just lined up and the door waiting for the energy regulators to clear the path." The bill should accelerate adoption of microgrids, and continued improvements and innovations in the technology.

Further Reading:

- Microgrid Knowledge, [California Lawmakers Approve Bill to Bolster Microgrid Development, End Lengthy Wait](#), September 5 2018

FERC rules against Southern California Edison - The Federal Energy Regulatory Committee (FERC) last week [denied proposed revisions](#) to Southern California Edison's (SCE) wholesale distribution access tariff (WDAT) that would have treated customers with energy storage devices differently from those without them. During times of peak demand, SCE sought authority to curtail electricity service to customers with energy storage devices before it did so with other retail customers. FERC said that would be "unduly discriminatory" and violate Section 205 of the Federal Power Act (FPA). FERC wrote that SCE did not study alternatives or give

wholesale and retail customers the chance to upgrade their systems in order to gain charging access. [FERC also approved other changes to SCE's WDAT](#) not related to storage.

FERC's decision in the SCE docket could help set a precedent for how utilities can treat the increasing number of customers who install energy storage at their homes and businesses.

Further Reading:

- Utility Dive, [FERC says SCE Can't Treat Storage Customers Differently in Service](#), August 28, 2018

California lawmakers rejected CAISO expansion bill AB 813 - Participants are instead looking to evolve the energy imbalance market. Western utility leaders' political push to expand California's grid system into a regional power market was dismissed in the state's most recent legislative session — but now those leaders are looking toward a different market. Policymakers and utility leaders in California, Washington, Oregon, Nevada and Arizona remain committed to developing some kind of regional cooperation and are discussing an expansion of CAISO's real-time [energy imbalance market](#) (EIM) to its day-ahead operations. "Cautiousness in the West about these things makes evolution better than revolution," former California Public Utilities Commissioner Mike Florio, a leader in [the new regionalization effort](#), told Utility Dive. Now maybe the time to expand the EIM to the day-ahead market, which has probably always been a more natural Plan B."

Regional coordination through voluntary transactions [reduces costs and increases reliability in three key ways](#), according to CAISO. Participants reduce the need for reserves, reduce greenhouse gas emissions (GHGs) by more efficiently integrating renewables and reduce curtailment.

The authority of [the EIM's Governing Body](#) to supervise market operations is delegated by the CAISO Board of Governors. Use of the market is voluntary. This is key to the system's success because it preserves participating utilities' autonomy, the Governing Body's Vice Chair, Carl Linvill, told Utility Dive.

Further Reading:

- GreenTech Media, [California's Alternative to Grid Regionalization: Expanding the Energy Imbalance Market](#), September 7 2018
- Utility Dive, [Western Regionalization Plan B: Utilities Take an Interim Step to Expand the Grid](#), October 30 2018

Implications for Reliability: Based on recent changes on State and Provincial Energy Market Policies we see no new significant challenge to electric reliability in any of the four key categories of resource adequacy, operational integrity, infrastructure integrity, and system stability risks.

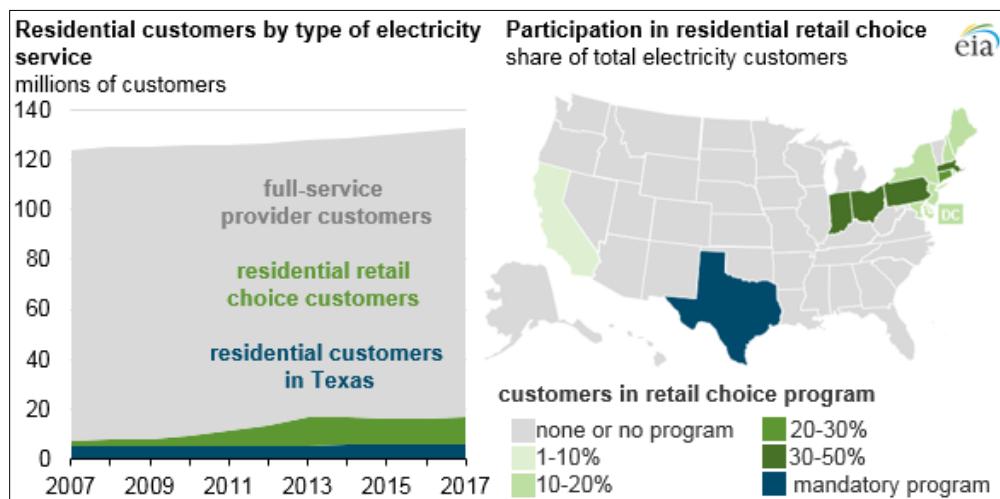
Customer Adoption of Energy Service Options

The scenario matrix east-west longitudinal axis descriptor of Customer Adoption of Energy Service Options was created by combining two of the Key Drivers: 2) Evolution of Customer-side Energy Supply Technology and 4) Service Options, and, Changes in the Character and Shape of Customer Demand for Electric Power. For the ease of the reader, we will list those events dealing with customer adoption first, and then list the two drivers and their associated events. We think this format will provide the reader with a more nuanced look at the components of the axis and the impacts on reliability.

Commercial and industrial customers have distributed energy resource options as well as residential consumers. Technological innovation appears to be expanding those options by making them less costly, easier to install, and by adding more features for management and customer engagement. As electric distribution systems evolve, more of those distributed energy supply options may become a part of the electric power infrastructure of the industry and change how assuring electric power reliability is managed.

Residential retail choice declines since 2014 peak - In states with residential retail choice programs, customers can elect to purchase their electricity directly from their choice of energy suppliers, with the electricity delivered to them by their local utility. The number of customers participating in retail choice programs peaked at 17.2 million customers (13% of total residential customers) in 2014 and has since declined, reaching 16.2 million customers (12% of the national total) in 2016 and 16.7 million customers (13% of the national total) in 2017. Currently, 13 states and the District of Columbia have active, statewide residential retail choice programs. In Texas, the retail choice program is mandatory under state law in the part of the state operated by the Electric Reliability Council of Texas (ERCOT). Retail customers in ERCOT (which covered 87% of residential customers in the state in 2017), must either choose a competitive supplier or be assigned one. Four other states - Michigan, Nevada, Oregon, and Virginia—each have a form of limited retail choice that is mostly available to non-residential customers.

Figure 3, Residential Retail Choice, Source: The Energy Information Administration (EIA)



Further Reading:

- Energy Information Administration (EIA) Today in Energy, [Electricity Residential Retail Choice Participation](#), November 8 2018

California raises costs for CCAs - In October, after a year of collecting testimony, the California Public Utilities Commission voted unanimously to raise costs on Community Choice Aggregation (CCA) programs and direct access customers in a move aimed at avoiding cost shifts that may arise when consumers switch electricity providers. The changes to the Power Charge Indifference Adjustment (PCIA) will result in varying impacts depending on customer class, service provider, energy usage and more. In Pacific Gas & Electric's (PG&E)

territory, CCA residential customers departing in 2018 would pay an additional 1.68% on their bills. In San Diego Gas & Electric's (SDG&E) territory, the increase would top 5%.

Opinions on the decision varied by interest group: While CCAs say the higher bills could [destroy the business](#) case for aggregation, while customers remaining with an investor-owned utility's (IOU) supply say all customers must contribute equitably to clean energy investments. Eight states – California, Illinois, Massachusetts, New Jersey, New York, Ohio, Rhode Island and Virginia – have enacted Community Choice Aggregation (CCA) legislation that empowers local governments to aggregate the electricity loads of residents, businesses, and/or municipal facilities. However, CCAs exist in only six of the states, Massachusetts, Ohio, California, Illinois, New Jersey, and New York. California has the largest number of CCAs with 19 programs, covering more than 8 million customers and more planned.

Further Reading:

- Los Angeles Times, [Southern California Edison wants departing customers to hand over \\$125 million](#), December 13 2018
- Utility Dive, [California decision means higher costs for community choice programs](#), October 12 2018
- Lean Energy, [CCA by State](#)
- Wikipedia, [Community Choice Aggregation](#)
- [Cal-CCA.org](#)

San Jose's energy program threatened by higher exit charge - San Jose became the largest US city to launch a community choice (CCA) energy program as Mayor Sam Liccardo officially launched on September 12 [San Jose Clean Energy](#), which the city says will provide residents and businesses with a more affordable, cleaner power alternative than PG&E currently provides. But advocates of the new community choice energy program worry it could be thwarted by the state's Public Utilities Commission, which approved a policy that would increase charges on customers who leave PG&E for the new system (see above).

Further Reading:

- The Mercury News, [New Energy Program Under Threat as PG&E Pushes Higher Exit Charges](#), September 12 2018

San Diego will form its own power program - San Diego is on track to becoming the largest city in the US to create a community-choice aggregation program, with a goal of 100% clean energy by 2035. The Southern California city of 1.4 million residents announced on October 29 that it is forming its own government-run power program, as an alternative to service from investor-owned utility San Diego Gas & Electric. The program is expected to lower electricity rates by up to 5 percent, and achieve 100% carbon-free electricity a decade before the state of California hits that milestone. We will watch and see what impact the recent CPUC decision to raise exit rates, discussed above, will have on the San Jose and San Diego programs.

Further Reading:

- GreenTech Media, [San Diego Moves Ahead With 100% Clean Energy Community Choice Program](#), October 25 2018
- PV Magazine, [San Diego to form world's largest single city CCA](#), October 29 2018

What replaces net-metering in rooftop solar? - The future of rooftop solar will depend in large part on a fair replacement for net-metering, one of the primary drivers of rooftop solar growth to date. Replacements to the controversial solar incentive have cropped up in Hawaii, California, and elsewhere, but policymakers have struggled to devise a replicable model. The challenge is structuring a successor tariff to compensate rooftop solar customers fairly for their generation without imposing costs on non-solar customers. Experts say a good successor tariff should also support the growth of distributed energy resources (DER) in a way that benefits customers and the grid. In the search for [the right successor tariff](#), stakeholders face the challenge of balancing uncertain costs and benefits with the right mix of detail and flexibility in a new kind of rate. Key versions have appeared in Hawaii, California and some Midwestern states, but with the increasing affordability of energy storage, policymakers are beginning to include residential battery incentives in the

successor tariff structure as well. The referenced article has case study details for Hawaii, the Midwest, and California.

Further Reading:

- Utility Dive, [As Rooftop Solar Expands, States Grapple with Successors to Net Metering](#), September 13 2018

Solar industry growth picks up as tariff uncertainty eases – Home installations are steady and utility procurement seeing a "massive rebound," [according to research](#) from Wood Mackenzie Power & Renewables and the Solar Energy Industries Association (SEIA). The outlook is particularly strong on the utility side, according to the report. Utilities procured 8.5 GW in the first six months of 2018, a record for that timeframe. The residential solar market contracted about 15% in the last year, and analysts say the relatively flat recent numbers are a positive sign. The residential market saw 577 MW installed in the second quarter of 2018, marking three quarters of consecutive, albeit modest, growth.

Utility projects make up the largest share of annual installations in the US solar market, and the second quarter of 2018 was the 11th consecutive quarter with over 1 GW installed. But the most impressive and telling number may be found in utility plans. Some 1.2 GW went online from April through June, and 2.7 GW is now under construction and targeted for completion later this year. According to SEIA and Wood Mackenzie, some projects which had been delayed were green-lighted when the tariffs were set lower than had been anticipated.

Further Reading:

- Utility Dive, [Solar industry rebounds from tariff uncertainty](#), September 14 2018
- Reuters, [U.S. utility solar contracts 'exploded' in 2018 despite tariffs](#), September 12 2018

Steep global decline in solar panel costs offset tariffs – As of June 2018, the cost of solar panels had dropped enough to offset at least 50% of the increase due to tariffs, muting the tariff impacts. Solar module prices were down about 12% globally since China announced changes to its incentives for solar power on June 1 that have led to an oversupply of panels that had been intended for installation in China, the world's largest solar market. Further drops in solar panel costs are projected for 2018 according to the Bloomberg New Energy Finance (BNEF) analysis. The report notes that the price of photovoltaic panels is expected to decline by 34% this year, roughly the equivalent to the fall in module prices in 2016, and only exceeded by the 40% price drop in 2011. Experts at BNEF also predict that module prices will fall by another 10% to 15% in 2019. The decline in the price of photovoltaic panels is seen as mainly driven by solar industry reforms in China.

Further Reading:

- Reuters, [Solar panel glut is muting effect of Trump tariffs](#), July 30 2018
- United Nations Climate Change, [Further Dramatic Fall in Price of Solar Energy Forecast for 2018](#), June 6 2018
- PV Magazine, [BNEF expects 34% fall in PV module prices in 2018](#), June 5 2018

California ISO board approves measures on storage and DERs - The board of directors of the California Independent System Operator (CAISO) on Wednesday approved a variety of measures aimed at fostering greater participation of distributed energy resources (DERs) in the state's wholesale power market. One of the approved measures makes adjustments to how behind-the-meter (BTM) energy storage resources participate in the ISO. Another measure changes the ISO's bidding requirements, making it easier for demand response resources to participate in the wholesale market.

Further Reading:

- Utility Dive, [California ISO board approves measures to propel energy storage](#), DERs, September 7 2018

Utility and Auto Companies deepen cooperation to support EV adoption - Car and electric power companies are beginning to work together to ensure that a good supply of electric power is available to charge electric vehicles and at a price consumers will desire. They are cooperating in the development of programs that

support EV adoption not only with charging station but real-time pricing signals that use communications devices built into the autos. Much of this is in beta testing mode and the full longer-term implementation is unclear, as is whether standards will emerge that support widespread adoption.

Further reading:

- New York Times, [As More Cars Plug In, Utilities and Makers Juggle Ways to Power Them](#), December 13 2018

Implications for Reliability: In general, we see trends in customer adoption of energy services and products as enhancing ways that reliability risks may be addressed, e.g., through the growing use of storage, distributed generation, and innovative use of EVs. However, we think continued monitoring is prudent in these areas as the level, pace and timing of the rollout and adoption of some customer-side energy service and products are unclear. We also do not know how these systems may interact with each other and impact economic and cost factors for consumers or system-wide for service providers. In particular, operational integrity and system stability risk may emerge in unforeseen patterns.

Evolution of Customer-side Energy Technology and Supply Options

Distributed and smaller scale energy supply options are evolving and expanding rapidly, especially solar power (both rooftop and ground-based), energy storage, fuel cells, demand response, energy efficiency, and small-scale natural gas-fired generators. Commercial and industrial customers have distributed energy resource options as well as residential consumers. Technological innovation appears to be expanding those options by making them less costly, easier to install, and by adding more features for customer management and engagement. As electric distribution systems evolve, more of those distributed energy supply options may become a part of the electric power infrastructure and change how assuring electric power reliability is managed.

Companies outline difficulties in deploying behind-the-meter (BTM) storage - The top 3 headaches for behind-the-meter Commercial & Industrial (C&I) storage were discussed by companies at the Energy Storage International/Solar Power International Conference panel in September.

The issues discussed in the panel illustrate the difficulty in quickly adopting and implementing new and innovative technology into a system that is designed around a slow pace in maintaining the existing infrastructure.

1. Figuring out the landscape as a trailblazer of new applications – [Advanced Microgrid Solutions](#): Only five years old, the company noted that most of what it is doing, no one has done before. Not having more established processes can force a process to slow down, even when regulators, the utility and the customer are onboard to build the asset. "When it's time to build the asset, use it to do retail service for the customer like demand-side management, capacity service for the utility, and bid into this wholesale market, then all manner of complications come up because nobody's actually even figured out how do you register a system that's doing retail service into CAISO"
2. Waiting for regulations to catch up – [ENGIE Storage](#): Working at the pace of regulators (independent system operators and utilities who are not traditionally "fast-moving") when you have the technology, you can install and implement now, but the utility moves as a decidedly slower speed. ENGIE Storage faced regulatory issues in terms of aggregation or interconnection, as well as with metering for storage. "You need to take that step back and do a kind of a hand holding, creating processes to get these things rolling."
3. Expecting better utility interconnection - [Borrego Solar Systems](#): The interconnection process is facing major revisions under Order 841, but Borrego spokesperson Dan Berwick stipulated that storage businesses and the utility markets would benefit greatly if utilities were in a different mindset, wherein "they wanted to accelerate the adoption" of renewable resources and other third-party resources such as storage. "...utilities needed that shift in their perspective for the deployment process to improve. That process reliability would be key for C&I customers that want assurance of

their investment but for the storage market on the whole." Energy storage, "once it's interconnected," can be automated and "what it is doing can change over its life," and utilities struggle to model that. It's much more complex than solar for example. And to understand that complexity, it's a matter of experiencing more system deployments and setting more storage standards in place.

Further Reading

- Utility Dive, [The top 3 headaches for behind-the-meter C&I storage](#), September 26 2018

Micro gas turbine technology demonstrated – The Australian company ecoJet Engineering is developing a micro gas turbine that works with renewable sources to take households off the electricity grid. The company has developed a lightweight, portable 20 kW micro gas turbine with funds from the Royal Australian Air Force and the South Australian Government. The project aims to replace diesel generators typically used to provide electricity to units in the field. The prototype unit is only about 10 percent of the weight of a typical internal combustion diesel generator and can be configured to run on a range of liquid and gaseous fuels including propane, natural gas and diesel. A series of demonstrations showcasing the new technology for senior Defense personnel was held in Canberra last week.

Of note, the company plans to use its technology to develop a commercial product for households and industry to complement existing technologies such as solar panels and battery storage. "A military product is a commercial product with a bunch of extra stuff on top so we can easily tweak it to suit both markets because we are very much looking to break into both areas," a company spokesperson said, "...a household unit would be smaller – around the 10 kW size – and would likely be fueled by the home's existing natural gas supply..."

Further Reading:

- Climate Control News, [Micro gas turbine technology to reduce energy costs](#), December 3 2018

It's not just electricity any more - Homeowners interested in security systems, air conditioning repair and water purification don't have to look too hard these days. Most likely, they can buy them from their retail electricity providers. Electricity sellers have added a wide range of services with higher profit margins to sell alongside low-margin electricity contracts, adopting the strategies pioneered by banks and gas stations to attract and hold onto customers.

Just Energy, a Canadian company that sells electricity in Texas under the brands Just Energy, Amigo Energy and Tara Energy, recently added water purification to a list of ancillary services that include smart thermostats, shower heads and weather-stripping. In a recent presentation, CEO Pat McCullough told analysts and investors that adding these extra services have allowed Just Energy to raise its electricity prices four times over six months without losing more customers than usual and boost gross profit margins on new and renewing power contracts by 25 to 40 percent.

Further Reading:

- The Houston Chronicle, [Electricity sellers aren't just selling power these days](#), December 7 2018

California utilities ready TOU rate roll out to more than 20 million people - In 2015, in response to a number of successful pilot programs, including a landmark Sacramento Municipal Utility District (SMUD) 2012 to 2014 Time of Use (TOU) rate pilot, the California Public Utilities Commission (CPUC) ordered the state's three investor-owned utilities (IOUs) to transition to "default" rates by 2019, requiring customers pay TOU rates unless they opt out. San Diego Gas & Electric (SDG&E) will begin moving its customers in March, and Southern California Edison (SCE) and Pacific Gas & Electric (PG&E) were given until October 2020 in order to prepare their billing systems. SMUD began another system-wide rollout of default TOU rates as well, Oct. 1.

"TOU empowers customers, and if they shift their usage to lower cost time periods when solar and wind are abundant, they will not only lower their bills, they will also use cleaner energy," SCE's Ramirez said, adding [their proposed rate](#) will save an estimated \$55 million per year.

Further Reading:

- Utility Dive, [California utilities prep nation's biggest time-of-use rate rollout](#), December 6 2018

Utility launches new flexibility management program - Colorado Springs Utilities (Springs Utilities) has teamed up with AutoGrid to deploy new demand response software. The partnership will allow Springs Utilities to consolidate management of its demand response resources into a unified system, that leverages demand response to accomplish peak-load management, allowing the utility to defer generation additions and aiding in its transition toward a higher carbon-free electric generation mix. With the deployment of this software, qualifying commercial and industrial customers now have the option to participate in Springs Utilities' Peak Savings Program, which is designed to save energy by reducing use during critical peak-demand periods and provide savings to its customers. The Peak Savings Program is slated to achieve 40 MW of flexible load capacity by 2020.

With the platform, Springs Utilities can offer cost-saving opportunities to its customers from a single, unified dashboard. Springs Utilities can also automatically and remotely shift or reduce electricity use as per the contract with its participating customers, enroll and engage customers dynamically, send personalized notifications based on customer preferences and measure and verify energy-savings results in a statistically robust and rigorous manner.

Further Reading:

- Smart Energy International, [Colorado Springs Utilities launches new flexibility management program](#), December 4 2018

PG&E proposes new EV charging plan – PG&E has proposed to drop demand charges for commercial EV charging, and replacing them with a new subscription rate plan. Businesses generally need to see cost savings in order to justify switching to an electric vehicle fleet. “They need the rates to be better than gas or diesel if they’re going to give up their diesel bus or truck,” said Cal Silcox, clean transportation strategy manager at California utility Pacific Gas & Electric. Right now, there’s no guarantee that commercial and industrial customers in PG&E territory will see any fuel savings, he said. That’s largely because of the demand charges C&I customers are required to pay when their electricity use spikes — such as during a high-powered EV charging event. That’s why PG&E is hoping to replace demand charges with a new subscription rate plan for customers that are using commercial EV (CEV) charging. The proposal, submitted to the California Public Utilities Commission Monday, allows customers to choose the amount of power they need for their charging stations and pay for it with a flat monthly fee — similar to picking a cellphone data plan. The proposal would create a new rate class for CEV charging and would offer two types of rates within that: one for customers with charging up to 100 kilowatts and one for customers with charging over 100 kilowatts.

Further Reading:

- GreenTech Media, [PG&E Proposes Ditching Demand Charges for Commercial EV Charging](#), November 7 2018

SoCal Edison wants to redesign community solar - The utility would gather customers for community projects, alongside other new 100 percent clean electricity options. Southern California Edison [is asking regulators](#) for permission to improve clean energy offerings for customers who can't install rooftop solar. The utility connects between 3,000 and 5,000 solar roofs per month, but many of its 15 million customers don't own their homes or have access to a suitable rooftop for solar generation. By the company's own admission, the existing program to serve those residents with community solar didn't work well enough.

SCE has proposed a suite of clean retail offerings in late September, including 100 percent clean energy and a new community renewables option. The former would drive additional utility-scale renewables development; the latter would enlist the utility as a customer aggregator on behalf of community solar projects.

“Community solar is going to be built by a third-party developer, but currently, it's challenging for that developer to amass all of these different little subscribers...What we're doing is helping connect customer demand to the market”, noted a company spokesperson. The utility has [asked the California Public Utilities](#)

[Commission](#) for permission to recover up to \$5.87 million in administrative costs for the new “Green Energy Programs,” to be launched in 2021.

Further Reading:

- GreenTech Media, [California Community Solar Isn't Working](#), October 10 2018

CAISO board approves measures for energy storage and DERs - The board of directors of the California Independent System Operator (ISO) approved a variety of measures aimed at fostering greater participation of distributed energy resources (DERs) in the state’s wholesale power market. One of the approved measures makes adjustments to how behind-the-meter (BTM) energy storage resources participate in the ISO. Another measure changes the ISO’s bidding requirements, making it easier for demand response resources to participate in the wholesale market. The article referenced below has a detailed look at the set of measures approved.

Further Reading:

- Utility Dive, [California ISO board approves measures to propel energy storage](#), DERs, September 7 2018

US power companies and automobile manufacturers seek to deepen their connections with EVs and charging systems - A news report indicates that automakers such as GM and BMW are serious about the long-term future of electric vehicles. They are piloting programs which will use the software in the vehicle to communicate with local utilities about the best and most economical times to charge the vehicles. This will allow the utilities to learn those charging patterns in great detail and manage capacity additions and costs with some ability to manage demand.

Further Reading:

- The New York Times, [As More Cars Plug In, Utilities and Makers Juggle Ways to Power Them](#), December 13 2018

Salt River Project opens up pilot on customer installed meters - The smart meter business is very diverse with lots of large and small players in the sector. To learn more about what customers may want, the Salt River Project is allowing customers to “bring their own” meter and thus allow customers to determine what features they may find most attractive.

Further Reading:

- Utility Dive, Press Release: [EnergyHub and Salt River Project announce new Bring Your Own Thermostat® demand response program](#), July 10 2018

Implications for Reliability: We see no significant development in changing in the character of customer demand for electric power that presents challenges to electric reliability at this time. However, as customers adopt new energy options operational integrity and system stability risk could arise as the power system managers adapt to those new options.

Changes in the Character of Customer Demand for Electric Power

Customer demand for electric power can shift for a wide range of reasons, including costs and need for new features and benefits (like carbon reduction). The many segments of customers include large and small industrials, large and small commercial, large and small agriculture, and high income to low-income residential consumers. Customers within all of the segments may change the features they desire for electric power service as market conditions change. Economic factors may influence costs and features offered. Social values may shift and change how customers value different aspects of their electric power consumption, e.g., how clean or how exposed to cyber-security risk. The basis upon which customers are segmented or put into categories may shift as customers adopt new service options (especially those customers who have some level of onsite self-generation or use new information services). Customers’ adjustments will affect how power is supplied and thus have implications for sustaining electric reliability.

Connected devices energy use increasing - Results from EIA's 2015 *Residential Energy Consumption Survey* (RECS) show that televisions and related peripheral devices—such as digital video recorders (DVRs), video game consoles, and streaming devices—consumed 7% of the electricity used in American homes in 2015 and cost \$103 per home per year to operate. Peripheral device consumption accounted for slightly less than half of this electricity consumption, collectively using almost as much energy as televisions.

As more Internet of Things (IoT) devices are brought into the home, we expect this trend to continue, and perhaps accelerate. We will watch for updates from the EIA on this trend.

Further Reading:

- Energy Information Agency Today in Energy, [Peripheral devices consumed nearly as much electricity as televisions](#), September 6 2018

Silicon Valley firm addresses power outages - Faced with escalating power outages and an increased risk of interruptions to its precision manufacturing operations, Silicon Valley's JSR Micro, Inc. will deploy a microgrid to provide its primary power. The microgrid at JSR Micro will draw on-site electric power from [Bloom Energy](#) Servers. It will enable the company's manufacturing, test and measurement, and other facilities to operate independently of the grid. JSR Micro expects to significantly reduce its electricity costs and its carbon footprint over the lifetime of the deployment. JSR Micro develops electronic materials for the semiconductor industry and its advanced manufacturing operations are highly sensitive to even small power interruption, as are most Silicon Valley manufacturing processes. We expect this trend among industries sensitive to power interruptions to continue.

Further Reading:

- Business Wire, [High tech manufacturer implements microgrid](#), August 23, 2018

Implications for Reliability: We see no new developments in customer demand that alone present significant challenges to electric reliability by raising the risk to resource adequacy, operational issues, infrastructure needs or system operations. However, how energy services companies manage those shifts in demand by integrating new service options, if not done well, could raise such risks. Monitoring developments in this area are warranted.

RECENT KEY DRIVER TRENDS

Changes in Federal Electric Energy Market Policies

The US, Canadian, and Mexican national governments set policies that have national impacts on electric energy markets. In terms of electric service reliability, the very foundation of WECC itself is an example of this. Entities such as the FERC, NERC, the DOE, and other federal agencies that oversee nuclear power, oil and gas development, coal development, and environmental standards are among those which can have great influence on the evolution of electricity markets and on the ways in which electricity services are delivered aside from market rules. Federal laws on consumer protection, taxes and other areas can also have an influence on the evolution and nature of electric customer demand.

PJM takes defense of capacity market plan to FERC - PJM market participants presented wide-ranging criticism of a proposal from the grid operator to reform its capacity market rules in comments filed at the Federal Energy Regulatory Commission (FERC) this week. Fossil fuel generators argued FERC should reject PJM's proposed market carve-out for state-subsidized resources, writing that it would endanger competitive pricing in the remaining market. Consumer advocates, meanwhile, argued that PJM's plan to boost payments for remaining capacity market resources is unnecessarily costly and has already been rejected by FERC. PJM wrote that its plan, meant to accommodate state preferences for clean energy, represents an acceptable compromise between the two camps. The grid operator was joined by nuclear generator Exelon, whose plant subsidies sparked the FERC effort to reform PJM's market rules. We see a number of issues at play:

1. Too much power supply is chasing too little demand and state authorities are trying to iron out who will be saved and who will be left in the cold.
2. In moving to support cleaner power supplies, regulators don't know how to handle existing supplies that are still operationally viable, and which may also have power supply contracts.
3. Demand growth is flat in the power business and offers no easy way out.
4. Investors who are developing new technology want to get in on the supply-side of the market, but their prices are higher in some cases and they want some kind of pass in the name of "innovation." The net effect is still more supply
5. Market mechanism in the power market, if left alone, will drive prices to really low levels as competitive behavior will push many to just cover their variable costs for a short time in hopes of driving out competition and seeing prices rise later. This is a crazy game and can cause price fluctuations that regulators don't want the consumer to experience.
6. Politics, politics, politics...who can tell a story to politicians to get them to set the rules to give an advantage to one interest group versus another?

Further Reading:

- Utility Dive: [PJM aims for middle in defense of capacity market plan at FERC](#), November 8 2018

Governors note economic benefits from unified grid - A bipartisan group of 18 governors, including Massachusetts Gov. Charlie Baker, is proposing that the federal government take a serious look at stitching together the three main United States power grids, comparing the importance of grid modernization to the creation of the interstate highway system 60 years ago. The idea the governors are pushing is that by improving connections at the seams between the eastern, western and Texas-based grids to energy to be shared between grids would make the nation's overall electrical power system "more resilient, efficient, reliable, competitive, and less vulnerable to cyber-attack." In a letter last week, the Governors' Wind & Solar Energy Coalition urged the head of the Federal Energy Regulatory Commission (FERC) to begin a discussion with states, regional transmission organizations, Congress and businesses around unifying the nation's power grids. Of note, the bi-partisan makeup of the group is significant.

The coalition is chaired by **Montana Gov. Steve Bullock**, and its vice chairman is Gov. John Carney of Delaware. Baker is a member of the coalition, along with Arkansas Gov. Asa Hutchinson, **California Gov. Jerry Brown**, **Colorado Gov. John Hickenlooper**, Hawaii Gov. David Ige, Illinois Gov. Brice Rauner, Iowa Gov. Kim

Reynolds, Kansas Gov. Jeff Colyer, Maryland Gov. Larry Hogan, Minnesota Gov. Mark Dayton, New York Gov. Andrew Cuomo, **Oregon Gov. Kate Brown**, Pennsylvania Gov. Tom Wolf, South Dakota Gov. Dennis Daugaard, Virginia Gov. Ralph Northam and **Washington Gov. Jay Inslee** (bold text ours).

Further Reading:

- The Telegram, [Governors say cost, reliability, and renewable benefits would flow from unified power grid](#), November 13 2018

ISO-NE proposes plan to add storage into real-time energy markets - ISO New England has submitted proposed rule revisions to federal regulators that would allow batteries and other energy storage technologies to more fully participate in wholesale energy markets, including the real-time energy market. In February, the Federal Energy Regulatory Commission (FERC) approved Order 841, directing grid operators to develop rules for energy storage participation in the wholesale energy, capacity and ancillary services markets. There is a Dec. 3 deadline, and ISO New England expects to make additional filings before then. Analysts say Order 841 "opens the floodgates" for storage participation in wholesale markets if battery costs continue to decline and states adopt complementary policies.

Further Reading:

- Utility Dive, [ISO-NE looks to incorporate storage into real-time energy markets](#), October 31 2018

Transmission system operators look to Rule 841 - Transmission system operators in the US have begun making their moves to accommodate energy storage into their wholesale markets, with New England ISO and Southwest Power Pool both making filings in the past month. In February the US' main regulator the Federal Energy Regulatory Commission (FERC), issued FERC *Order 841, instructing the US' six regional electricity transmission organizations (includes CAISO and AESO in the Western Interconnection) to reconfigure their wholesale markets to allow energy storage to participate. The ISOs and RTOs have about a year to respond in full.* Order 841 would open up the markets for capacity, energy and ancillary services to even small or aggregated behind-the-meter energy storage resources. FERC branch chief Nancy Bowler that the move "[really expands the place where storage can play in the US, pretty dramatically](#)".

Further Reading:

- Energy Storage News, Ahead of biggest energy storage rule change yet, [US' transmission network operators open up markets](#), November 5 2018

Implications for Reliability: We see no major reliability related risks from recent developments in Federal Electric Market Policies. However, the final resolution by FERC on the PJM capacity markets issue could open new options for states related to adding new capacity to meet resource needs, and how they are defined could have significant implications. Recent trends in Federal policies are generally leaning toward further reductions in reliability risk.

Changes in Utility-scale Power Supply Options

Technological innovation, improved sales and marketing programs, and improvements in customer services will continue to occur at the wholesale and traditional utility-scale level of the electric business. Some customers may even prefer to maintain the historically traditional utility service and its levels of reliability. Some states and provinces may also prefer this form of service for regulatory reasons or for local economic and social factors. Additionally, technological innovation may continue to lower the cost of utility-scale clean energy supply options such as wind energy, solar power, and new forms of energy storage, as well as innovation and cost reductions in conventional technologies such as carbon capture and sequestration (CCS) and modular nuclear power generation, allowing them to compete effectively with distributed energy resource options. Technological innovation is also likely to enable utility-scale renewable resources to provide greater essential reliability service capabilities, and therefore additional flexible resource adequacy.

Two US electric utilities to go 100% green - Two US electric utilities within the Western Interconnection recently declared something remarkable: It's cheaper to tear down their coal plants and build renewable-energy plants than to keep the old boilers running. For the utilities, the goal is now to retire their coal plants and exceed the economy-wide climate targets set in the Paris Agreement: an [80% reduction of carbon emissions](#) from 2005 levels by 2050. The first to make the announcement was Xcel Energy, a utility serving 3.6 million people in eight states from Minnesota to New Mexico (and Colorado's largest utility). On Dec. 4, the company said it would hit an 80% reduction target by 2030, and eliminate all carbon emissions from its power plants by 2050. Two days later, Colorado's Platte River Power Authority (an Xcel competitor) [approved its own goal](#) of 100% carbon-free energy by 2030. Jason Frisbie, general manager of Platte River Power Authority, said it was just an admission of economic realities, not a political statement. "This whole thing started because the board wanted to recognize the shift that has already been taking place in the business for several years," he [told a local newspaper](#). Cities buying its electricity were demanding clean energy, and the price of renewables had tumbled below even the cheapest fossil fuels.

Further Reading:

- Quartz, [Two US electric utilities have promised to go 100% carbon-free](#), December 13 2018
- The Denver Post, [Xcel Energy wants carbon-free electricity by 2050](#), December 4 2018
- The Larimer Reporter-Herald, [PRPA board unanimously endorses 100 percent non-carbon electricity by 2030](#), December 6 2018

NYPA will create real-time transmission system model - The New York Power Authority (NYPA) last week announced an ambitious goal on its path to becoming the "first fully digital utility" — committing to develop a digital, real-time simulation model of the state's entire transmission system by the end of this year. The utility plans to collect and analyze data across its entire system as it looks to dramatically reduce its carbon footprint. NYPA will get help with modeling from the Electric Power Research Institute (EPRI), in order to bring together a range of clean energy resources on both sides of the meter.

Once complete, the Advanced Grid Innovation Laboratory for Energy (AGILE) network will utilize new computing models to simulate the implementation of new technologies and to assist with the commercialization of emerging technologies. Almost a year ago, NYPA struck a deal with GE to help the grid operator with its digitization plans at 16 generating facilities along 1,400 miles of transmission lines as well as in the more than 1,000 public buildings it monitors in the state. As NYPA works to bring more renewable and advanced energy technologies online, the grid operator says it will use AGILE to simulate the impacts before deployment and evaluate their effects on reliability, performance and resiliency.

Further Reading:

- Utility Dive, [NYPA to create a real-time simulation model of New York's transmission system](#), September 18 2018

Lazard releases Levelized Cost of Energy (LCOE) annual report - The numbers in the report offer economic insight into how energy choices were made in the previous year and how the energy landscape will likely change in the coming year. The report notes that the cost of coal-fired electricity per megawatt-hour hasn't

changed since 2017, while wind and solar costs per MWh are still falling. The cost of building brand-new renewable installations is cheaper than the cost of operating existing coal and gas plants—a situation that [Lazard says is happening with increasing frequency](#) (PDF). The direction of the cost of storage is less clear and depends on metals prices.

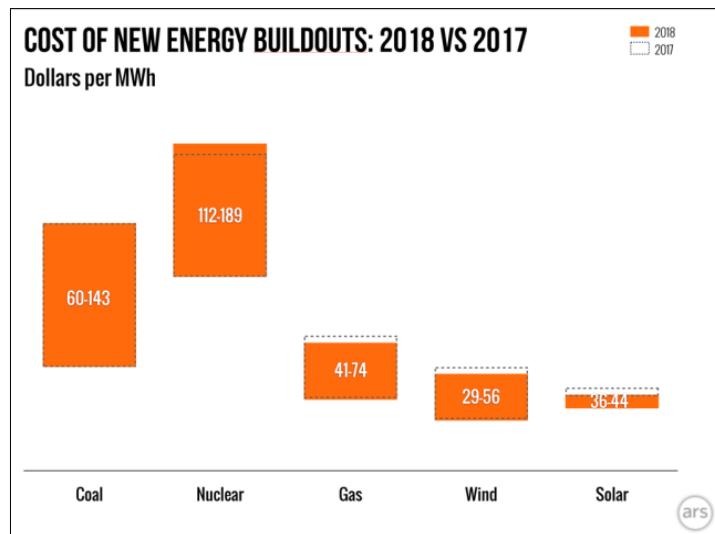
Lazard also released a [separate report quantifying the cost of storage](#) (PDF). Energy storage included grid-scale lithium-ion batteries as well as vanadium and zinc flow batteries, lead-acid batteries, and advanced lead batteries. Lazard breaks these down further by market: batteries selling storage wholesale have different revenue streams than batteries connected to utility-grade solar or commercial standalone batteries that are not controlled by a utility.

More details are in the two reports hyperlinked above, and in the attached Further Reading source article.

Study Method: Lazard surveys energy buildouts that occurred in the previous year and divides the estimated cost of building and operating the plant, including fuel cost estimates, by the amount of energy a particular plant is expected to produce in its lifetime. This is useful because a nuclear power plant might cost billions to build, but it would have a vastly longer life and higher output than, say, a field of solar panels.

By breaking costs down on a per-megawatt-hour basis, it becomes easier to compare sources of electricity.

Figure 4, Cost of New Energy Buildouts, Source: Lazard



Further Reading:

- Ars Technica, [Cost of wind and solar fall below cost of coal and gas](#), November 12 2018

GE supplying first US hybrid renewables project – While hybrid systems have been started outside the US in the past three years¹, GE Renewable Energy has been awarded the contract to supply components to the US's first commercial wind-solar hybrid project developed by Juhl Energy. The 2.5 MW community site in Minnesota will comprise a single GE 2.0-116 turbine and a 0.5 MW solar PV system. Bank of America is providing financial support for the project and has agreed to buy the Renewable Energy Certificates generated from the project. GE said it will incorporate the solar element of the project into the wind turbine's converter "increasing system net capacity by 3-4% and annual energy production by up to 10%", the manufacturer claimed. The site is expected to be online by the end of 2018.

Further Reading:

- Wind Power Monthly (and others), [GE supplying first US hybrid Renewables Project](#), November 22, 2018

PG&E will replace three gas generators with storage – In a significant example of how batteries can take the place of fossil fuel generation on the power grid, the California Public Utilities Commission (CPUC) on November 8 [approved four energy storage projects](#) for Pacific Gas & Electric (PG&E) to replace retiring gas generators, including two batteries that would be the largest in the world.

¹ EPS: [World's First Hybrid Wind-Solar-Storage Project Set for Australia](#), and, [Battery storage systems being integrated with gas turbines for reliability](#)

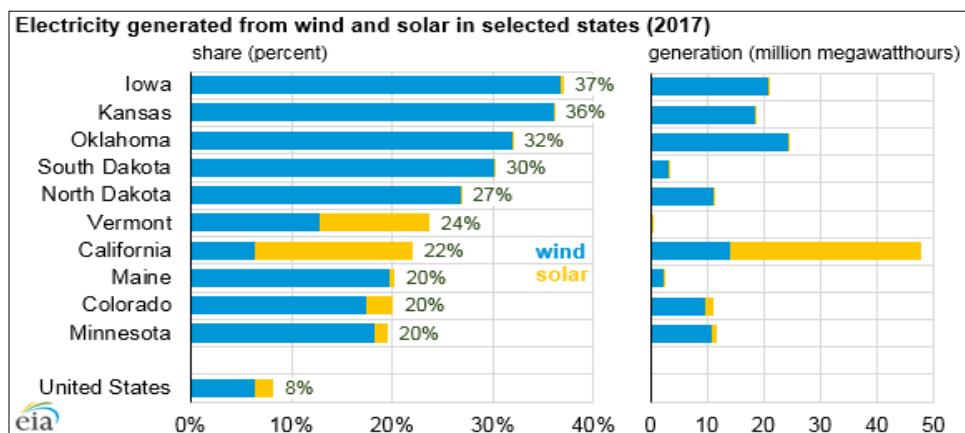
The CPUC granted approval for a total of 567.5 MW / 2,270 MWh of storage, including a 300 MW / 1,200 MWh project from Vistra Energy and a 182.5 MW / 730 MWh project from Tesla that the utility would own. Those batteries, once completed, would be the two largest in service. The CPUC directed PG&E to purchase the storage in January instead of approving new ratepayer-funded contracts for three gas plants in PG&E's service area. Analysts told Utility Dive the cost of the batteries is likely cheaper than continuing to operate the plants.

Further Reading:

- Utility Dive, [Storage will replace 3 California gas plants as PG&E nabs approval for world's largest batteries](#), November 9 2018

Ten states have at least 20% wind and solar generation - Wind and solar electric generation, including small-scale solar photovoltaics, reached or exceeded 20% of total generation in 10 states in 2017. During some months in 2017, wind accounted for more than 50% of in-state electricity generation in Iowa and Kansas, and solar accounted for more than 20% of in-state electricity generation in California. Total annual generation from wind and solar in the United States in 2017 reached 8% for the year, and peaked at 11% in April. In the Western Interconnection, California and Colorado made the top ten.

Figure 5, Selected States Wind and Solar Generation, Source: EIA



Further Reading:

- Energy Information Agency Today in Energy, [Combined wind and solar made up at least 20% of electric generation in 10 states in 2017](#), October 11 2018

Idaho approves wind projects - The Idaho Public Utilities Commission approved three new wind projects to be located in Wyoming, granting Rocky Mountain Power (RMP) the final approval it needed to move ahead with parts of its Energy Vision 2020 plan. Regulators approved the wind facilities, which have a total generating capacity of 1,150 MW, along with associated transmission facilities and a rate-making treatment, capping costs at \$2 billion. Large consumers opposed the project, saying the company is unnecessarily taking on risk because it could continue to make power purchases, referred to as uncommitted front office transactions (FOTs). The PUC determined, however, that building new generation would demonstrably lower customer costs.

Further Reading:

- Utility Dive, [Idaho approves \\$2 billion, 1,150 MW in wind projects](#), July 31 2018

Wind producers shifting spending to operations and maintenance - The North American wind industry will reach a turning point in three years when the industry begins to spend more on operations and maintenance than it spends on installing new wind turbines. The shift is a result of the billions of dollars companies have already spent to build massive wind farms across the windiest landscapes, benefiting from federal tax cuts in the United States and Canada to encourage renewable energy development, according to a study by [IHS Markit](#). Now, companies are spending more money than ever before on operations and maintenance to keep the older turbines running and productive.

The North American wind turbine fleet is aging with the average age rising from seven years today to 14 years in 2030, according to the study. As the turbines age, they cost more to maintain, which has become a new growth opportunity for companies eager to expand into that part of the wind industry.

Further Reading:

- Houston Chronicle, [Wind energy reaching turning point as turbines age](#), September 10 2018

Xcel on renewables vs. fossil – Xcel's chief planner in an interview noted "...we can buy new renewables cheaper than existing fossil fuels". He goes on to say that in many areas, the incremental cost of renewable generation is currently less than the embedded cost of the existing generation. "That is a very important part of this transition. If we can buy a new resource at a lower cost than the existing resource, that is going to advance the transition. This is exactly the market we have seen over the last few years. That market has been supported by declines in renewable prices and progressive tax policies that are set to expire over the next few years.

The market is moving faster than the traditional utility process moves, both in terms of what customers want and in terms of the technology options. Customers traditionally have not been as interested in our processes as they are now. The interview article has further insight into Xcel's business model and future thinking.

Further Reading:

- GreenTech Media, [We Can Buy New Renewables Cheaper Than Existing Fossil Fuels](#), September 11 2018

Xcel's Colorado green energy plan approved - The Colorado Public Utilities Commission has approved a \$2.5 billion plan by Xcel Energy to close coal-fired power plants and add a hefty dose of wind and solar generation so 55 percent of the utility's electricity will come from clean energy by 2026. For Xcel, switching from coal-fired electricity to wind and solar will save customers about \$200 million by 2054. Xcel will add 1,110 MW of wind power, 700 MW of photovoltaic solar and 275 MW of energy storage tied to solar projects. The utility also will buy 383 MW of existing natural gas turbines as backup.

Further Reading:

- Colorado Springs Gazette, [Xcel gets green light from Colorado for \\$2.5 billion clean energy plan](#), September 9 2018

Xcel will use BTM solar to support steel mill expansion – Xcel Energy Colorado filed an agreement Thursday to [build a customer-sited 240 MW solar plant](#) on the property of EVRAZ Rocky Mountain Steel. The landmark behind-the-meter (BTM) construction is part of a 22-year power purchase agreement, meant to allow the steel mill to expand operations in the state while the utility retires 660 MW of coal-fired generation in the surrounding area. The Colorado Public Utilities Commission will have to approve the deal. Xcel included the net metered solar facility in its [Colorado Energy Plan Portfolio \(CEPP\)](#). The steelmaker gets more than the benefits of a large net-metered solar system by locking in electricity prices through 2041 with Xcel, but customers statewide will also see benefits from the deal. EVRAZ's move to renewable energy through this new solar project in combination with their ability to interrupt quickly will lower cost for other customers. The solar project is the largest behind-the-meter development made by a utility, [according to PV Magazine](#). The project will be made along with developing 700 MW of new solar generation that Xcel Colorado proposed to buy in its 2018 CEPP.

Further Reading:

- Utility Dive, [Xcel strikes deal for 240 MW of BTM solar to support steel mill expansion](#), August 20 2018

Montana developer plans hybrid project – A renewable energy developer [filed with the Montana Public Service Commission](#) (PSC) this month to build 320 MW of wind and 160 MW/640 MWh of battery storage spread over four separate projects in the state. Caithness Beaver Creek wants to develop the four 80 MW wind projects and 40 MW/160 MWh batteries as qualifying facilities (QFs) under the Public Utility Regulatory Policy Act (PURPA) after negotiations over capacity payments broke down with Northwestern Energy, Montana's largest utility. PURPA requires utilities to purchase power from independent generators at the utility avoided cost rate.

Caithness wants its projects to receive energy payments of \$31.33/MWh for heavy load hours and \$29.5/MWh for light load hours, in addition to capacity payments of \$81.45/MWh during on-peak hours and a \$0.58/MWh payment for ancillary services. Montana regulators must issue a decision on contract terms by February 2019. The Caithness project filing highlights the growing competitiveness of battery-paired renewable energy with traditional generators, as well as the complex negotiations in determining what to pay the new resources.

Further Reading:

- Utility Dive, [Montana developer eyes PURPA contracts for 320 MW of wind, 640 MWh of storage](#), August 21 2018

Studies across the country are beginning to show just how much excess gas generation exists in the US that can be shuttered without impacting reliability, as illustrated in the following two studies.

CAISO could lose 28 gas plants and keep the lights on - In a report released on August 9, The Union of Concern Scientists said their analysis showed that California could retire 28 natural gas plants without impacting electricity reliability. In order to meet the California Public Utilities Commission's (CPUC) target to reduce carbon to 42 million metric tons (MMT) by 2030 in the most economical way possible, the UCS model chose not to build any new gas plants to replace less efficient combined-cycle gas turbines.

The California Independent System Operator (CAISO) market currently has 89 gas plants, but not all of them are providing local capacity requirements. The 28 plants selected by the model were "dead weight," providing system capacity that other resources could "easily" supply, said Laura Wisland, the report's author.

Further Reading:

- Utility Dive, [CAISO could lose 28 gas plants and keep the lights on](#), August 8 2018
- Union of Concerned Scientists, [Turning Down the Gas in California](#), August 9 2018

FirstEnergy can shut 4 GW of fossil plants without harming reliability - PJM Interconnection has completed a 30-day reliability study of FirstEnergy Solutions' (FES) proposed coal and diesel plant retirements, concluding the shutdowns can proceed without impacting the grid's reliability. FES wants to [mothball four fossil fuel plants](#) in Pennsylvania and Ohio in 2021 and 2022, amounting to 4 GW of coal capacity. Earlier this year, the grid operator concluded FES could [shut down three nuclear plants without threatening reliability](#). Because the deactivations are planned several years into the future, PJM said it would have time to make system upgrades to account for any impact. The operator also said it is working on a study of extended outages associated with potential fuel disruptions, and would incorporate into that analysis FES' new closures.

Further Reading:

- Utility Dive, [PJM: FirstEnergy can shut 4 GW of fossil plants without harming reliability](#), October 2 2018

Renewable generation pushing wholesale prices down – Some past studies examining power markets in the eastern US have shown that baseload resources are retiring because of low natural gas prices, not an influx of renewable generation. However, increasing renewable energy generation appears to be responsible for the majority of price declines in California's wholesale power market over the last five years, according to [a new report](#) from the Energy Institute at Haas School of Business (UC Berkeley). The report, which in part examined the effect of increased utility-scale solar capacity on the market, also finds higher levels of solar

penetration do not uniformly lower power prices, but makes them lower during the day and higher during non-daylight hours. That uneven price distribution disproportionately affects baseload generation, such as coal, nuclear and even highly efficient combined-cycle gas turbines, making those resources less economic while bolstering less efficient and higher cost flexible gas turbines.

Further Reading:

- Utility Dive, [Renewables push CAISO prices lower, threaten inflexible generation](#), August 28 2018
- Haas Business School, [The Impacts Of Renewable Energy On Wholesale Power Markets](#), August 2018

Green Mountain Power helps customer go off grid - Green Mountain Power is one of the most commonly cited companies when the movement toward a more customer-centric view of energy services is discussed. However, an examination of what the company does shows that it is using some fairly standard tools; primarily starting with a customer energy audit. This approach allows for only the most cost-effective products and services to be offered to customers. Green Mountain also manages its distribution system expansion costs closely so that new energy options also work well with its ongoing operations.

Further Reading:

- Green Mountain Power, [GMP Empowers Customers to go Off Grid](#), Webpage, 2018

Implications for Reliability: We see enhanced opportunities in recent developments in the area of utility-scale power developments to improve electric system reliability. New technological options and approaches to service are increasing power supply and service company choices.

Changes in State and Federal Electric System Reliability Standards and Regulations

Federal, State and Provincial agencies directly set rules and standards that the power industry must follow to meet electric system reliability. Issues like climate change, cyber-security risks, and improved system resilience (in response to damaging climate events or physical attacks) are becoming increasingly important as they impact electric system reliability, and will likely lead to increased costs for electric power infrastructure. A clear understanding of these developments and how they may play out in the longer term is important for understanding the evolution of electric reliability. Additionally, as increasing amounts of variable generation resources are integrated into the system and relied upon in maintaining and assuring bulk electric system reliability, the dynamics of assuring system reliability may change in comparison to what is required in traditional utility systems.

Faceoff over the Public Utility Regulatory Policies Act (PURPA) at FERC – Newly filed comments in FERC's PURPA review docket could help shape how the commission reforms its implementation of the 1970s law, the first to open up power generation to competition. PURPA was meant to reduce oil dependence and increase electric reliability by forcing utilities to buy renewable electricity from independent providers at or below their avoided cost for other generation. Recent comments filed by environmental organizations and state utility regulators highlight the divergent perspectives over how the Federal Energy Regulatory Commission (FERC) should reform its implementation of the Public Utility Regulatory Policies Act (PURPA), a 1978 law that compels utilities to purchase power from small renewable generators.

"PURPA has outlived its usefulness because utilities have ample access to renewable resources outside the law, the [National Association of Regulatory Utility Commissioners \(NARUC\)](#) wrote. FERC should create a "yardstick" that would allow utilities — even those not in wholesale power markets — to prove they should be exempt from PURPA's requirements." [Eight renewable energy and environmental groups argued](#) PURPA is still essential to the growth of wind and solar, particularly in Midwestern and Southeast states that are not part of wholesale power markets. The comments come as utilities push FERC to [move forward on its long-dormant review of PURPA](#).

Further Reading:

- Utility Dive, [States, greens face off over PURPA implementation at FERC](#), October 24 2018

California wants to reduce gas generation and maintain reliability - The state relies on natural gas for reliability, but won't reach its 100% zero emissions goal without looking to alternatives. When California's lawmakers mandated 60% renewables by 2030 and targeted zero emissions by 2045 [in Senate Bill 100](#), passed in September, they took on never-before-answered questions about reliability. One of those questions is how to keep the lights on without natural gas at the most supply-constrained times and places. Instead of a capacity market, which many systems use to meet these spikes, California imposes a [resource adequacy \(RA\) requirement](#) on load-serving entities (LSEs) that adds 15% extra generation to their portfolios.

The natural gas generation that dominates today's RA supply cannot be part of a 100% emissions-free future. With its investor-owned utilities (IOUs) [on track to reach 50% renewables by 2020](#), policymakers want to move natural gas out of the RA mix, despite resistance from natural gas interests. "The fight in commission proceedings over natural gas is where the transition to a zero-carbon grid will happen," according to former utility executive Jim Caldwell, technical director for the [Center for Energy Efficiency and Renewable Technologies \(CEERT\)](#). "*We know where it will end, but not how to get there* ". (Italics ours)

Further Reading:

- Utility Dive, [California strives to nix its natural gas habit without letting the lights go out](#), October 15 2018

Western regionalization plan B – Western utility leaders' political push to expand California's grid system into a regional power market was dismissed in the state's most recent 2018 legislative session, but now those leaders are looking toward a different market. California lawmakers in August rejected [Assembly Bill 813](#), which would have expanded the California Independent System Operator (CAISO) by including other Western

state representatives into its governance. California lawmakers, concerned this might compromise the state's clean energy goals, [froze the bill in committee](#).

And yet, policymakers and utility leaders in California, Washington, Oregon, Nevada and Arizona remain committed to developing some kind of regional cooperation and are discussing an expansion of CAISO's real-time [energy imbalance market](#) (EIM) to its day-ahead operations. The group of leaders from power companies and regulators is still optimistic about building more regional cooperation to manage power cost and increase system reliability.

Further Reading:

- Utility Dive, [Utilities take an interim step to expand the grid](#), October 30 2018

Pacific Gas & Electric (PG&E) to invest in new energy storage projects with CPUC approval - PG&E filed Advice Letter 5322-E on June 29, 2018, requesting California Public Utilities Commission (CPUC) approval of three capacity contracts and one purchase agreement for four projects totaling 567.5 megawatts (MWs) in capacity. These four projects resulted from a solicitation authorized by Commission Resolution E-4909, launched by PG&E on February 28, 2018. Pursuant to the capacity agreements, PG&E will purchase all capacity attributes from the Hummingbird Energy Storage LLC, mNOC, and Dynegy energy storage projects. Pursuant to the engineering, procurement and construction (EPC) agreement with Tesla, PG&E will own the energy storage project. This Resolution approves these four agreements. PG&E's execution of the agreements is consistent with the objectives and directives of Commission Resolution E-4909, as well as the Energy Storage Procurement Framework and Design Program, approved by the Commission in Decision (D.)13-10-040.

Further Reading:

- California Public Utilities Commission, [PG&E Filing](#), November 8 2018

Group will advance data standards - LO3 Energy recently announced it will work with the Energy Web Foundation (EWF) to advance the development of data standards and the systems architecture for an open-source, blockchain-based, distributed energy resources trading and management platform. The results should help rationalize a nascent market and technological ecosystem that has been undergoing rapid fragmentation and diversification.

A small but growing number of proprietary, blockchain-based distributed energy transaction systems have emerged over the course of recent years in response to the fast-growing deployment of distributed solar and other renewable energy resources. Developing industry-wide standards for data, exchanges of data, and peer-to-peer, distributed energy transaction processing and management would provide the technical common ground and rules needed for distinct platforms to communicate and interact with one another seamlessly and securely, thereby serving as a catalyst for further development and growth of distributed renewable energy capacity worldwide.

Further Reading:

- Solar Magazine, [Building the Foundation for the Grid Edge-Centered Renewable Energy Web of the Future](#), August 21 2018

The potential role of big data analytics in power grid evolution - This report suggests that the path toward power companies getting immediate and widespread cost savings or new customer offerings will take time and lot of investment in learning how to use those systems. The author notes that "...while sensors give operators the insights they need to make better decisions and automate swift, intelligent responses to real-time conditions, they also generate large amounts of data." Imaging and camera related sensors produce frame rates-sampling frequencies of 30 to 60 frames per second (fps). One imaging camera can generate up to 500,000 bytes per scan, at 60 fps, resulting in 27 million bytes per second.

With all the sensors that can be located in a substation, including continuous online thermal imaging and security/perimeter monitoring, which is the most data-intensive, there can be up to 5 Gigabits per second of data streaming out of the substation. That is, if the configuration allows all data gathered to be sent outside

the substation. This is where big data can introduce new levels of complexity, including the need to move data around safely and securely."

Further Reading:

- Utility Products, [Big Data = Big Challenges for Big Substations](#), Vol 17, Issue 10, 2018

Implications for Reliability: In general, we see developments in Federal and State Regulations of electric systems reliability improving conditions in which reliability risks can be addressed and reduced. For example, the encouraging management of data systems and standards, and adoption and integration of storage continues Developments are positive that support resource adequacy such as support for new sources of power supply at both Federal and State levels.

Evolution of the Impacts of Climate Change and Environmental Issues on Electric Power Service

Addressing climate change is a central issue in the evolution of electric power supply systems in the US, Canada, and the world. Other environmental issues like air and water quality and land use are also important. Policies set by governmental agencies will influence electric supply and demand choices for all customers, and the cost of power will be impacted by those policies. How customers see and value climate and environmental issues will impact future legislation placed on the power industry.

Election Day impacts on climate policy - Here are the states that put climate change front and center on Election Day.

1. **New Mexico:** Newly elected Governor Michelle Lujan Grisham wants to turn oil-soaked New Mexico into [an environmental leader](#).
2. **Colorado:** Governor-elect Jared Polis has a big plan to shift his state to [100 percent renewable energy by 2040](#). If successful, it would be [the most aggressive state-level environmental policy in the country](#).
3. Illinois: Newly elected Governor J.B. Pritzker is all about the renewables. He wants to commit to [25 percent clean energy by 2025](#), significantly bumping up the state's previous target of 15 percent.
4. New York: Governor Andrew Cuomo, now working with a flipped state senate, has some extra room to make good on his environmental promises this term. He's [got plans](#) to put the state on a path to 50 percent renewables by 2030 - a bill he's been trying to pass for a while now.
5. Maine: Janet Mills, Maine's first female governor, wants to slash the state's emissions 80 percent by 2030.

Further Reading:

- The Grist, [Midterms may spur climate policy in these states](#), November 12 2018

Climate change and the 75% problem – A recent post by Bill Gates serves as a reminder that Climate Change, or Global Warming if you will, is not just a problem for electricity generation, which is what most people think of when asked about reducing greenhouse gas emissions. He breaks the emitters into percentages.

- Electricity..... 25%
- Agriculture..... 24%
- Manufacturing....21%
- Transportation.... 14%
- Buildings..... 6%
- The final 10% is a sixth, miscellaneous category that includes things like the energy it takes to extract oil and gas.)

The post goes on to talk about possible solutions and mitigations for the other 75% of emissions sources.

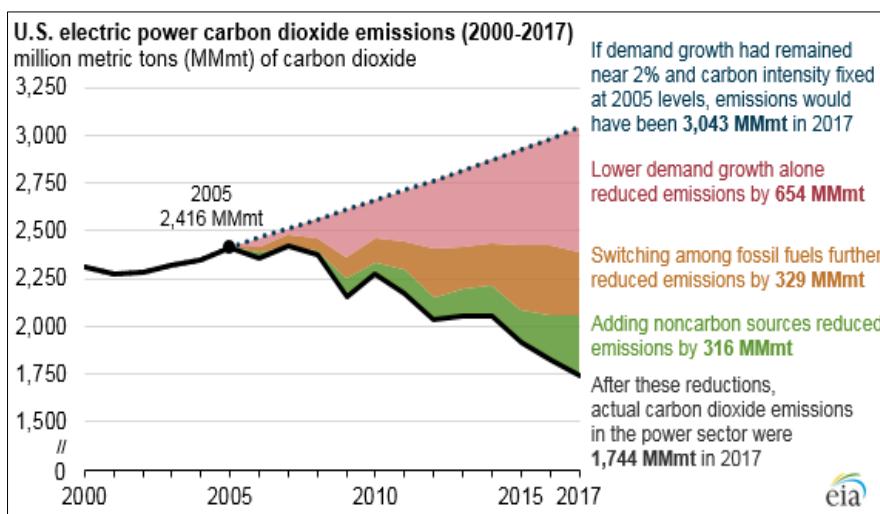
Further Reading:

- Gates Notes, [My energy plan for fighting climate change](#), October 17 2018

US power generation CO2 emissions continue decline - US electric power sector carbon dioxide emissions (CO2) have declined 28% since 2005 because of slower electricity demand growth and changes in the mix of fuels used to generate electricity.

EIA has calculated that CO2 emissions from the electric power sector totaled 1,744 million metric tons (MMt) in 2017, the lowest level since 1987.

Figure 6, US electric Power CO₂ Emissions 2000 -2017,
Source: EIA



Further Reading:

- Energy Information Administration Today in Energy, [US carbon emissions down 28%](#), October 29 2018
- Energy Information Administration, [U.S. Energy-Related Carbon Dioxide Emissions to 2017](#), September 25 2018

Western states and provinces have experienced massive wildfires over the recent past, and by all indications and projections, will see more and even more intense wildfires in the future. In California, utilities have been identified as a primary cause of some of the most devastating fires. The state and its utilities are scrambling to come to grips with how to respond, and their efforts may be an indicator of how other states and provinces may act in the future.

California approves bill limiting utility liability for wildfires - California state legislators advanced a number of policy priorities impacting utilities, working right up to midnight on Friday, when the 2018 legislative session ended. A number of bills were approved; including a bill that Gov. Brown voiced strong support for to address costly utility wildfire liability, which passed with amendments.

PG&E Cuts power to prevent wildfires – In a first, Pacific Gas & Electric cut off electric service to nearly 60,000 people on Sunday in a new attempt to prevent wildfires across Northern California service area during high winds and dry conditions after the National Weather Service a Red Flag Warning for the region, cautioning of extreme risk of wildfires due to low humidity and winds reaching above 50 miles per hour. High winds can cause power lines to come into contact with vegetation, igniting fires. PG&E lines were found responsible for 16 fires last year and California lawmakers passed wildfire liability protections for utilities this summer after PG&E warned that fire costs could force it into bankruptcy or reorganization.

PG&E defends power outages - Pacific Gas & Electric (PG&E) told the California Public Utilities Commission last week that while [its October decision](#) to cut power to 60,000 customers during a three-day windstorm that heightened the potential for wildfires was a "last resort" decision, such actions can also help keep customers and communities safe. PG&E cut power to customers in the North Bay and in the Sierra Foothills from Oct. 14 to Oct. 17, citing "weather and wildfire-risk conditions." It was the first time the utility used the technique, known as a Public Safety Power Shutoff (PSPS). Wildfires have become a significant issue for electric utilities, both in terms of safety and liability. State regulators are [moving swiftly to review fire mitigation plans](#) ahead of the 2019 wildfire season.

Further Reading:

- Utility Dive, [California approves bill to limit utility liability for wildfires, but not CAISO expansion](#), September 4 2018

- Utility Dive, [In a first, PG&E cuts power to 60,000 to prevent wildfires during windstorm](#), October 15 2018
- Utility Dive, [PG&E defends planned outages as 'last resort' tool to prevent wildfires](#), November 5 2018

Western power utilities (and their customers) may face another problem as they deal with extreme weather events, especially wildfires, as liabilities and cost of replacing infrastructure may affect their cost of capital. Not only could sources of capital demand higher interest rates, but no doubt, utilities would expect ratepayers to shoulder most of the increased costs.

Wildfires threaten California renewable goals - California's ambitious drive to combat climate change may hinge on the fate of its biggest utility owner since PG&E's credit status is 'material' to the state's climate-change goals, and climate change is making wildfires more common in California. The embattled PG&E Corp. would face higher borrowing costs if its credit rating falls to junk following California's deadliest and most destructive wildfire. That could affect the state's green-energy strategy, potentially making solar farms more expensive and threatening investment needed to support wider use of electric vehicles, said Michael Wara, a senior research scholar at Stanford University.

"California has big ambitions," James Berger, a Los Angeles-based lawyer at Norton Rose Fulbright LLP, said in an interview. "PG&E obviously has a big role to play. That's one of the reasons the legislature will want to make sure they don't file for bankruptcy."

Further Reading:

- Bloomberg, [Wildfires Are Threatening California's Renewables Strategy](#), November 16 2018

Two major climate change studies were published this fall, one from the US and one from the UN. The US report, issued by 11 federal agencies, outlines the impact of climate change on the US economy, while the UN report notes that climate change accelerating, and that impacts will be felt much earlier than originally thought.

US Climate Report Warns of Damaged Environment and Shrinking Economy - A major scientific report issued by 13 federal agencies on November 23 presents the starker warnings to date of the consequences of climate change for the United States, predicting that if significant steps are not taken to rein in global warming, the damage will knock as much as 10 percent off the size of the American economy by century's end.

The report, which was mandated by Congress and made public by the White House, is notable not only for the precision of its calculations and bluntness of its conclusions, but also because its findings are directly at odds with President Trump's agenda of environmental deregulation, which he asserts will spur economic growth.

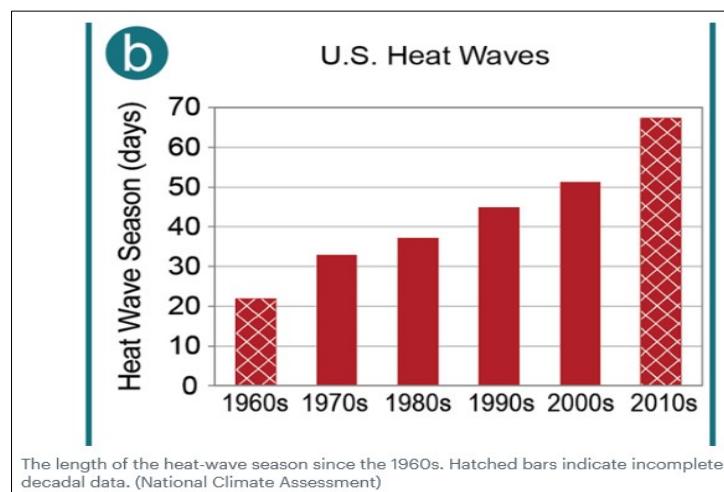
In direct language, [the 1,656-page assessment](#) lays out the devastating effects of a changing climate on the economy, health and environment, including record wildfires in California, crop failures in the Midwest and crumbling infrastructure in the South. Going forward, American exports and supply chains could be disrupted, agricultural yields could fall to 1980s levels by midcentury and fire season could spread to the Southeast, the report finds.

The *Atlantic* notes three significant conclusions from the report, summarized in the following figures.

1. Extreme hot weather is getting more common and cold weather rarer.

Figure 7, US Heat Waves, Source, National Climate Assessment

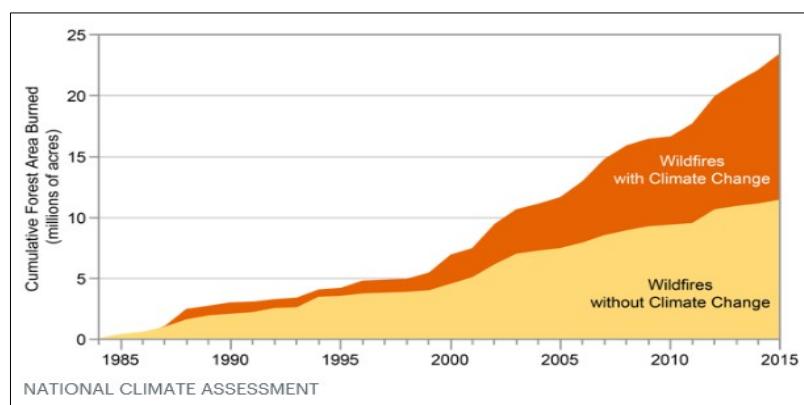
In its first chapter, the National Climate Assessment reports that the heat-wave season has expanded by more than 40 days since the 1960s. In the bleakest scenario of unchecked climate change, Phoenix could have as many as 150 days per year above 100 degrees Fahrenheit by the end of the century.



2. Climate change has doubled the devastation from wildfires in the Southwest.

Figure 8, Forest Acres Burned 1995-2015, Source: National Climate Assessment

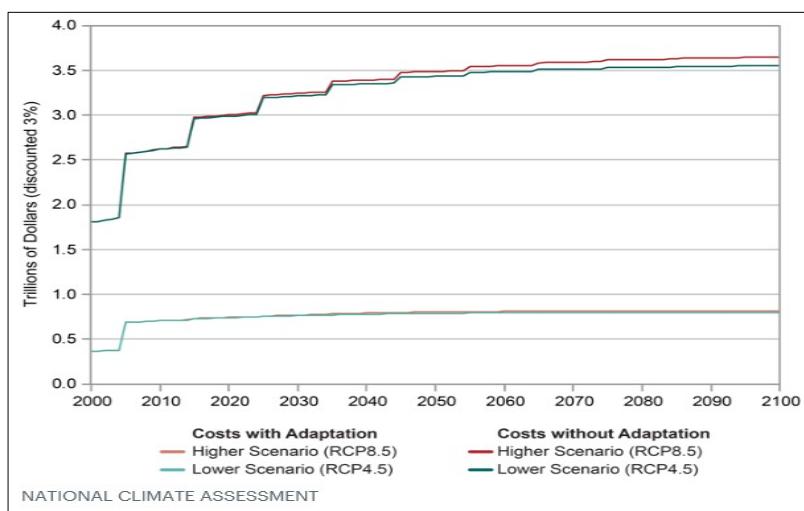
According to the report, human-caused climate change has heated and dried out the American Southwest, leading to deaths, enormous costs, and lingering health consequences.



3. Rising sea levels will necessitate mass migrations, and coastal cities aren't doing enough.

Figure 9, Sea Level Rise, Actual and Projected, 2000-2100, Source, National Climate Assessment

The report's chapter on the coastal effects of climate change warns that sea-level rise alone could force tens of millions of people to move from their homes within the next century.



Further Reading

- The Atlantic, [Three most chilling parts of the 2018 climate assessment](#), November 26 2018

US energy, transportation sectors not prepared for climate change - The US energy and transportation sectors are unprepared for the impacts of climate change they are helping to cause, according to a new federal report that warns of "longer and more frequent power interruptions." US infrastructure is threatened by higher temperatures, stronger storms, increased flooding, and longer, more intense droughts, according to the [Fourth National Climate Assessment](#). While locational effects differ, "all regions will be affected by climate change," the authors conclude.

One sector especially vulnerable is energy infrastructure. In the Southeast US, scientists estimated that rising sea levels will expose 69 power plants to storm surge from Category 1 hurricanes, and 291 plants to surge from Category 5 storms. If sea levels rise more than three feet, a moderate estimate by the end of the century, the report also warns that dozens of power plants currently not at risk for 100-year floods would be put under threat. "This would put an additional cumulative total of 25 gigawatts (GW) of operating or proposed power capacities at risk," scientists wrote. In Delaware and Florida, the number of flood-vulnerable plants would double, while it would more than triple in Texas.

Further Reading:

- National Climate Assessment, [2018 Assessment](#), November 2018
- The New York Times, [U.S. Climate Report Warns of Damaged Environment and Shrinking Economy](#), November 23 2018
- The Atlantic, [Three most chilling parts of the 2018 climate assessment](#), November 26 2018
- Utility Dive, [Federal climate report: US energy, transportation sectors not prepared for warming](#), November 26 2018

Americans are politically divided over climate change – Americans continue to be of different minds about climate change, but there's broader consensus around some of the solutions. New data from the [Yale Program on Climate Change Communication](#) – in partnership with Utah State University and the University of California, Santa Barbara – show how Americans across the country view climate and energy policies.

- Percentage of adults who support requiring utilities to produce 20 percent of electricity from renewable sources = 63%
- Percentage of adults who support rebates for people who purchase energy-efficient vehicles or solar panels = 82%
- Percentage of adults who support expanding offshore drilling for oil and natural gas = 49%
- Percentage of adults who support drilling for oil in the Arctic National Wildlife Refuge = 32%
- Percentage of adults who support requiring fossil fuel companies to pay a carbon tax and using the money to reduce other taxes, such as income tax = 68%

Further Reading:

- The New York Times, [Where Americans \(Mostly\) Agree on Climate Change Policies, in Five Maps](#), November 1 2018

Climate change impacts worse than expected, global report warns - The Intergovernmental Panel on Climate Change says the world is headed for painful problems sooner than expected, as emissions keep rising. While not breaking any new ground with new studies, [the new report](#) released on October 7 re-examined over 6,000 previous studies, and *found that climate change is accelerating, and the effects will worsen much sooner than originally thought* (italics ours). The report further notes that the impacts and costs of 2.7 degrees Fahrenheit (1.5 degrees Celsius) of global warming will be far greater than originally expected. In a significant change from past reports, this is the first time the IPCC has focused on preventing, and more importantly, mediating and adapting to the effects described in the report.

The past decade has seen an astonishing run of record-breaking [storms](#), forest fires, droughts, [coral bleaching](#), heat waves, and floods around the world with just 1.8 degrees Fahrenheit (1.0 degrees Celsius) of global warming [[See: Hidden Costs of Climate Change Running Hundreds of Billions a Year](#)]. But much of many of those effects will come much sooner and will get substantially worse with 2.7 degrees Fahrenheit of warming

and far worse at 3.6 degrees Fahrenheit (2 degrees Celsius), according to the IPCC's examination of more than 6,000 studies.

The IPCC also reported that 2.7 degrees Fahrenheit could be reached in as little as 11 years - and almost certainly within 20 years without major cuts in carbon dioxide (CO₂) emissions. Even if such cuts were to begin immediately it would only delay, and not prevent, 2.7 degrees Fahrenheit of global warming. *The report puts WECC's Scenario 5: Energy, Water and Climate Change squarely within this timeframe.*

We recommend that WECC continue to develop and refine Scenario 5 by updating it – including the study case metrics and parameters - within the context of both the US and UN studies with accelerating global warming and more intense effects happening much sooner than previously anticipated.

Further reading – In light of the impact of this report on Scenario 5, we have chosen to list all of the more significant articles on the IPCC report, and all of the articles and reports noted below have detailed analysis and diverse insights on the report:

- The UN International Panel on Climate Change, [Special Report: Global Warming of 1.5 °C](#), October 2018
- The New York Times, Major Climate Report Describes a Strong Risk of Crisis as Early as 2040, October 7 2018
- The Atlantic, [How to Understand the UN's Dire New Climate Report](#), October 9 2018
- The National Geographic, [Climate change impacts worse than expected, global report warns](#), October 7 2018
- Associated Press, [UN report on global warming carries life-or-death warning](#), October 8 2018
- Reuters, [Rapid, unprecedented change needed to halt global warming](#) - U.N., October 7 2018
- The Smithsonian, [The World Was Just Issued 12-Year Ultimatum On Climate Change](#), October 8 2018
- Forbes, [It's Misleading To Say We Only Have 12 Years To Avert Dangerous Climate Change](#), October 8 2018
- New York Magazine, [UN Says Climate Genocide Is Coming. It's Actually Worse Than That](#), October 10 2018

The cost of climate change - There's \$500 trillion of wealth on planet Earth, give or take: Maybe \$230 trillion in land and property, \$200 trillion in debt and \$70 trillion in equity. All of that wealth comes, ultimately, from the planet, and the climate. Specifically, it has come from a stable climate. William Nordhaus points out in his 2013 book "The Climate Casino" that "the last 7,000 years have been the most stable climatic period in more than 100,000 years." The last 7,000 years have also seen the rise of civilization and the creation of that \$500 trillion in wealth. This is not a coincidence.

Nordhaus won the Nobel Prize this week (October 14), in an announcement that coincided with the release of a hugely important UN Intergovernmental Panel on Climate Change report on what will happen to the world when it gets 1.5°C, or 2.7°F, warmer than pre-industrial levels. The report puts the cost of a 1.5°C increase at \$54 trillion, in today's money. That number comes from research that also says that a 2.0°C increase will cause \$69 trillion of damage, and a 3.7°C increase will cause a stunning \$551 trillion in damage.

Where things stand: Human civilization has reached the very end of reaping the dividends from a stable climate. Compared to recent decades, the world in 2100 will have a 13% reduction in crop yields (and those crops will also be less nutritious); it will also have 2.8 billion more people at risk from drought in any given month. Preventing extreme global warming will be neither cheap nor easy.

Further Reading:

- Axios, [The cost of climate change](#), October 2018

Trump Administration's Low Cost on Carbon Emissions - How much economic damage will global warming cause? That's one of the key questions embedded in the Trump administration's recent proposals to weaken Obama-era regulations on greenhouse gas emissions from both [vehicles](#) and [power plants](#). When federal

agencies calculate the costs and benefits of climate regulations, they use a figure called the “social cost of carbon,” an estimate of the harm caused by releasing more carbon dioxide into the atmosphere and increasing global warming.

In its rollback proposals, the Trump administration [argued](#) that each ton of carbon dioxide emitted by a car or a coal plant in 2020 would only cause around \$1 to \$7 in economic damages. That’s far lower than the Obama administration’s central estimate, which, after adjusting for inflation, argued that same ton of carbon dioxide [would cause roughly \\$50 in total damages](#).

Climate-heating greenhouse gases at record levels - Carbon dioxide, methane, and nitrous oxide are far above pre-industrial levels. The main greenhouse gas emissions driving climate change have all reached record levels, the UN’s meteorology experts have reported. Carbon dioxide, methane, and nitrous oxide are now far above pre-industrial levels, with no sign of a reversal of the upward trend, a [World Meteorological Organization \(WMO\) report](#) says. “The last time the Earth experienced a comparable concentration of CO₂ was 3-5m years ago, when the temperature was 2-3C warmer and sea level was 10-20 meters higher than now,” said the WMO secretary-general, Petteri Taalas. “The science is clear. Without rapid cuts in CO₂ and other greenhouse gases, climate change will have increasingly destructive and irreversible impacts on life on Earth. The window of opportunity for action is almost closed.”

Further Reading:

- The Guardian, [Climate-heating greenhouse gases at record levels, says UN](#), November 22 2018
- World Meteorological Organization, [WMO Greenhouse Gas Bulletin \(GHG Bulletin\)-No. 14](#), 2018

Greenhouse gas emissions are accelerating - Greenhouse gas emissions worldwide are growing at an accelerating pace this year, Researchers said on December 5, putting the world on track to face some of the most severe consequences of global warming sooner than expected.

Scientists described the quickening rate of carbon dioxide emissions in stark terms, comparing it to a “speeding freight train” and laying part of the blame on an unexpected surge in the appetite for oil as people around the world not only buy more cars but also drive them farther than in the past — more than offsetting any gains from the spread of electric vehicles.

“We’ve seen oil use go up five years in a row,” said Rob Jackson, a professor of earth system science at Stanford and an author of [one of two studies](#) published Wednesday. “That’s really surprising.”

2014-2017: Despite modest growth in the world economy, CO₂ emissions from fossil fuel combustion, cement production and other industrial processes remained relatively stable from 2014 to 2016. This brought optimism to climate policy discussions, indicating that global GHG emissions might show signs of peaking. However, preliminary estimates of global CO₂ emissions from fossil fuels, industry, and cement for 2017 suggest an increase of 1.2 percent. The main drivers of the increase are higher gross domestic product (GDP) growth (about 3.7 percent) and slower declines in energy, and especially carbon, intensity, compared with the 2014–2016 period. The 2017 increase leaves considerable uncertainty as to whether the 2014–2016 slowdown was driven primarily by short-term economic factors. (Source: [UN Emissions Gap Report 2018](#))

2018: Worldwide, carbon emissions are expected to increase by 2.7 percent in 2018, [according to research](#), which was published by the [Global Carbon Project](#), a group of 100 scientists from more than 50 academic and research institutions and one of the few organizations to comprehensively examine global emissions numbers. Emissions rose 1.6 percent last year, the researchers said, ending a three-year plateau.

Further Reading:

- The United Nations, [The Emissions Gap](#), November 2018
- The New York Times, [Greenhouse Gas Emissions Accelerate Like a ‘Speeding Freight Train’ in 2018](#), December 5 2018
- The Global Climate Project, [Global Carbon Project 2018](#), December 5 2018

Scientists at National Academies takes a hard look at how to remove carbon from the air directly - Carbon dioxide removal (CDR) techniques that aim to remove and sequester excess carbon from the atmosphere have been identified as an important part of the portfolio of responses to climate change. These approaches have been garnering new attention as the international community has identified lower thresholds for global temperature increases, which can only be accomplished with net negative carbon emissions to the atmosphere. However, many of these CDR technologies are not yet viable in terms of cost and scalability, and any potential risks that deployment of these techniques would entail are not fully understood. This study aims to develop a detailed research and development agenda needed to assess the benefits, risks, and sustainable scale potential for carbon dioxide removal and sequestration approaches; and increase their commercial viability.

Further Reading:

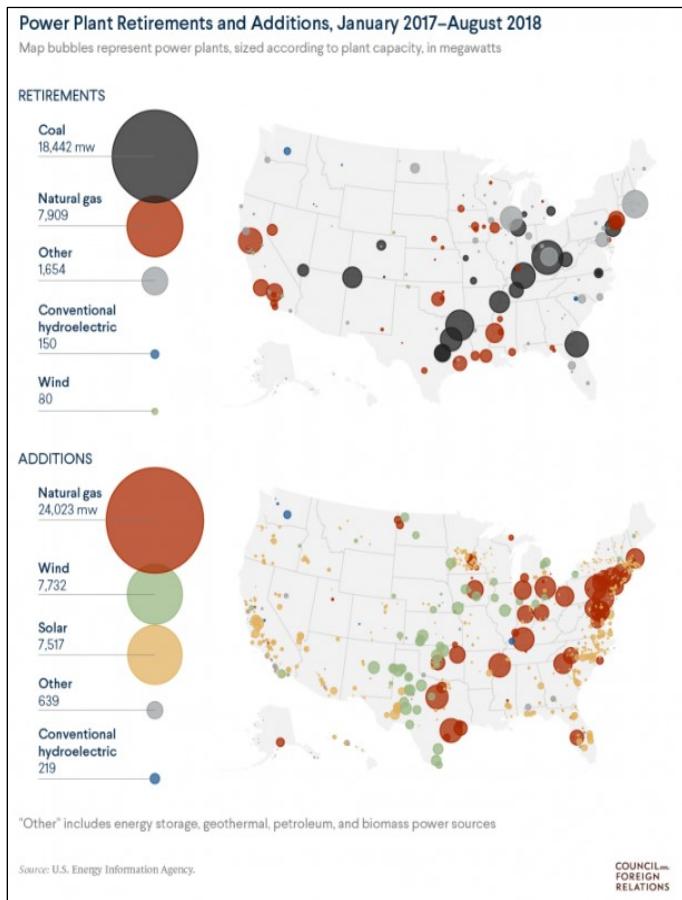
- National Academies Press, [Negative Emissions Technologies and Reliable Sequestration](#), October 2018 (note: Four-page report summary is free)

Implications for Reliability: Due to widespread and varied impacts of potential climate change events, we see recent developments in this area presenting significant risks to electric reliability in all four of the key areas of concern. Climate-related events can destroy and disable power systems so that resource adequacy, operational, infrastructure, and system stability risks can emerge

Evolution of Fuel Markets in the Electric Power Sector

All electric power generation requires a fuel source. Historically coal, natural gas, oil, and nuclear fuel have been dominant (sunlight, wind and water are not traditionally thought of as "fuel" though they serve similar purposes). It is therefore critical to understand the role of fuels in the power sector, particularly natural gas, including the transportation infrastructure (including pipelines and storage). How and at what levels these fuels will be used as the power system evolves will be central to how electric reliability will be met.

Figure 10, Power Plant Retirements and Additions, January 2017-August 2018, Source: S&P Global



Despite efforts from the Trump Administration to support the coal industry, basic economics and state regulations are driving a continuing trend of reduced usage of coal-fired generation plants in the US.

Coal plant retirements double in 2018 - In 2018, 14.3 gigawatts (GW) of coal-fired capacity was retired, up from 7 GW retired in 2017. That constitutes the second-biggest year for coal-fired capacity retirement since 2015, according to new research from S&P Global Market Intelligence. In 2015, 14.7 GW of coal-fired capacity was retired.

Although the data is from January 2017 through August 2018, figure 9 provides a good illustration of the order of magnitude of this continuing trend, where it is concentrated, and new additions to generation can be seen.

S&P Global says that an additional 23.1 GW of coal plant capacity has been announced to be retired between 2019 and 2024, for a total of 71.9 GW of retirements or planned retirements between 2014 and 2024. S&P's analysis shows about 245.6 GW of current operating coal plant capacity in the US.

Further Reading:

- Ars Technica, [Coal plant closures double in 2018](#), November 29 2018
- S&P Global, [Coal plant closings double in Trump's 2nd year despite 'end of war on coal'](#), November 28 2018

Two in five coal plants are running at a loss - And according to a new report from financial think tank Carbon Tracker, the situation will not improve for the out-of-favor fuel: by 2030, new wind and solar will be cheaper than almost all existing coal plants, according to the report. The firm says it analyzed the profitability of 6,685 coal plants worldwide, and published the results in a new "[coal power economics portal](#)" to help develop "economically rational plans to close coal plants and to understand the financial risk if they continue to operate." Globally, coal plants represent \$267 billion in stranded asset risk, and the United States could save \$78 billion by closing plants in line with the Paris climate accord, according to the firm's analysis.

Further Reading:

- Utility Dive, [42% of global coal capacity now unprofitable](#), November 30 2018

PacifiCorp released economic study of its coal plants – PacifiCorp revealed that 13 of its 22 coal units are [more expensive than alternative options](#), such as clean energy, when discussing its coal fleet as part of a two-day public stakeholder meeting in December. The Berkshire Hathaway subsidiary used unit-by-unit analysis to calculate a net benefit or cost for taking the coal units offline by 2022, showing nearly 60% of the retirements would lead to savings. But the utility says more analysis is needed before any shutdown decisions are made. The announcement is on par with analysis from the environmental group Sierra Club, which noted in a June report that [wind energy was a cheaper replacement](#) option for 20 of 22 PacifiCorp coal plants.

PacifiCorp's analysis of potential retirements is not final and more updates are expected on the company's coal fleet assessment at an integrated resource process (IRP) stakeholder meeting on January 24 2019.

PacifiCorp's announcement is not an official step toward early coal plant retirement, but it is part of a larger trend of economic analysis showing the difficulties of coal generation in competing with cheaper natural gas and renewable energy. PacifiCorp's analysis showed 13 units at plants in Montana, Colorado, and Wyoming were more expensive to operate than replacement options.

While closing coal plants early could save money, it would result in capacity shortfalls. PacifiCorp sees addressing that challenge as a next step in the process and industry analysts have a number of ideas on how to do so, such as securitization. PacifiCorp's analysis not only provides critical economic justification for the growing [transition away from coal](#), but also addresses legitimate questions of reliability costs and modeling that more utilities may be able to take example from as coal retirements continue.

Further Reading:

- Utility Dive, [As analyses point to more coal shutdowns, replacement questions rise](#), December 13 2018
- Utility Dive, [PacifiCorp shows 60% of its coal units are uneconomic](#), December 5 2018

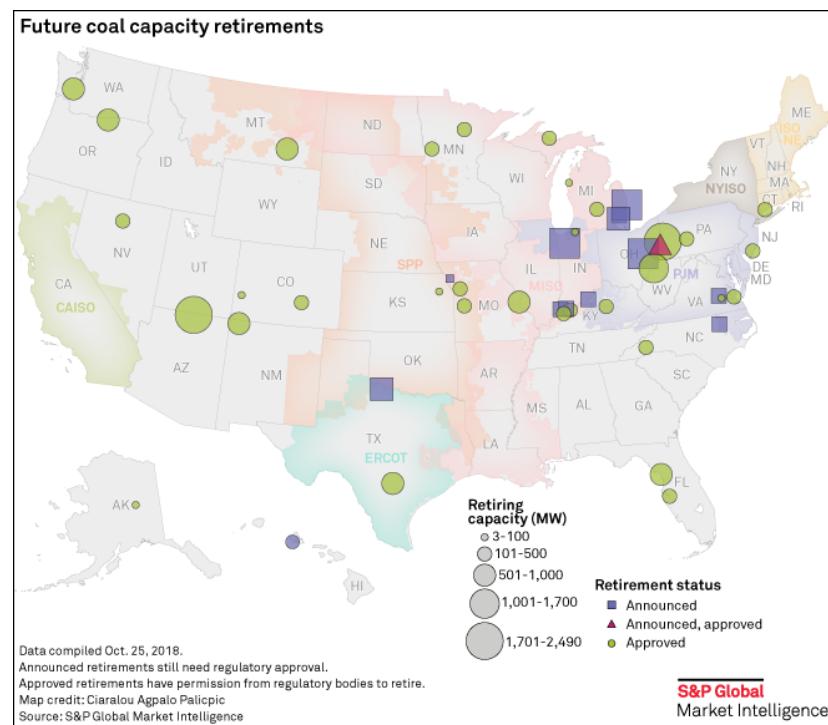
S&P Global's November report cited above provides details of current and projected coal retirements for the US.

Figure 11, Coal Retirements by ISO, 2014-2024 in MW, Source: S&P Global

ISO region	Coal retirements by ISO through 2024 (MW)												Total
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		
CAISO	168	29	0	0	0	0	0	0	0	0	0	0	196
ERCOT	140	0	0	0	5,203	0	650	0	0	0	0	0	5,993
ISO-NE	296	0	0	1,056	0	0	0	385	0	0	0	0	1,737
MISO	224	1,220	4,064	396	2,343	671	257	138	900	3,683	580	14,476	
NYISO	0	0	421	0	0	0	0	0	0	0	0	0	421
PJM	2,127	7,323	356	1,986	3,095	450	1,936	2,490	3,330	0	0	0	23,092
SPP	38	335	1,180	573	850	97	0	0	0	0	0	0	3,074
Outside ISO/RTO	1,506	5,868	2,163	3,026	2,809	3,163	1,663	395	2,066	0	0	0	22,658
Total	4,497	14,774	8,185	7,037	14,301	4,381	4,506	3,408	6,296	3,683	580	71,647	

Data compiled Nov. 2, 2018.
Includes completed retirements, and future retirements that have either been announced or received regulatory approval.
Source: S&P Global Market Intelligence

Figure 12, Future Coal Retirements by Region, Source: S&P Global



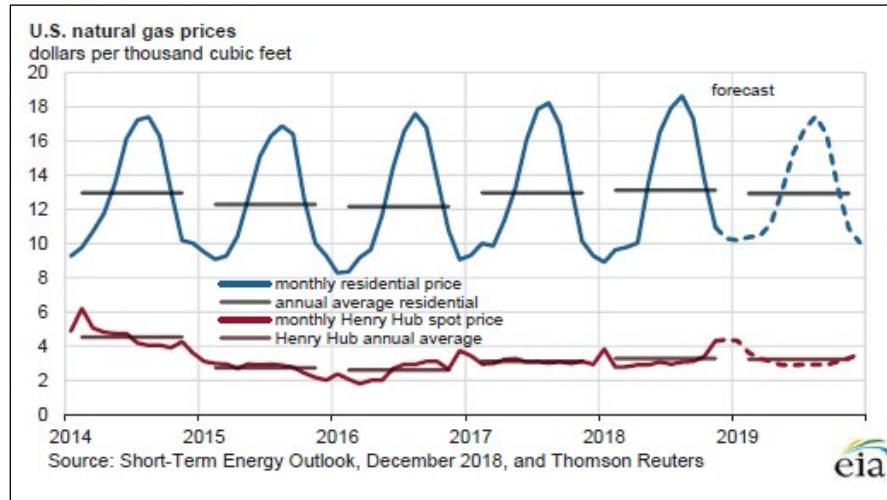
Natural gas prices forecasted lower in 2019 - Despite low inventory levels, EIA expects strong growth in US natural gas production to put downward pressure on prices in 2019. EIA expects Henry Hub natural gas spot prices to average \$3.11/MMBtu in 2019, down 6 cents from the 2018 average and down from a forecast average price of \$3.88/MMBtu in the fourth quarter of 2018

EIA forecasts that dry natural gas production will average 83.3 billion cubic feet per day (Bcf/d) in 2018, up 8.5 Bcf/d from 2017. Both the level and volume growth of natural gas production in 2018 would establish new records. EIA expects natural gas production will continue to rise in 2019 to an average of 90.0 Bcf/d.

Figure 12, US Natural Gas Prices, Actual and Forecast, 2014-2020, Source: EIA

Further Reading:

- Energy Information Administration, [Short-term energy outlook](#), December 11 2018



The United States is becoming more electrified - The National Renewable Energy Laboratory (NREL) is looking at the impacts of shifting non-electric sources of energy to electricity at the point of final consumption. NREL's multi-year "Electrification Futures Study: A Technical Evaluation of the Impacts of an Electrified US Energy System", studied contiguous US energy systems, including transportation, residential and commercial

buildings, and industry. Their focus for the latest version of the [report \(PDF here\)](#) examines what electrification will look like at 2050, as well as different potential transition models. *The report found that widespread electrification could increase electricity use to 38 percent of energy consumption in a high adoption scenario, with up to 1.6 percent compound annual growth rates* (italics ours).

"By exploring the impact of electrification on how much, when, and where electricity is used, the demand-side scenarios presented here lay the foundation for future reports on the US power system evolution and operations, as well as key costs and impacts of electrification," said NREL's Trieu Mai, principal investigator for the Electrification Futures Study (EFS).

Further Reading:

- Daily Energy Insider, [NREL analyzes impact of future where electricity powers greater part of US economy](#), July 30 2018
- National Renewable Energy Laboratory, [Electrification Futures Study](#), June 2018

While oil is not a primary fuel for electric power in the US, natural gas is a major co-product of oil production, so we follow long-term developments in the oil sector.

The US is now a net oil exporter – during the week of November 26, the US became a net exporter of oil [for the first time on record](#), the result of a fracking boom which has sparked massive increases in drilling and slashed reliance on foreign energy sources. The Department of Energy reported the US exported a net 211K bbl/day for the week through Nov. 30, the first time ever dating back to the DoE's creation in 1973, as crude exports jumped to a weekly record of more than 3.2M bbl/day.

Petroleum exports until recently were dominated by products such as gasoline and diesel, but that has changed since the US shale revolution that has sped up drilling and extraction of oil, helping raise overall US production to a record 11.7M bbl/day. The DoE data comes as OPEC adjourned a meeting without announcing an agreement to cut production as it tries to cope with falling prices due in part to the surge in US output.

Further Reading:

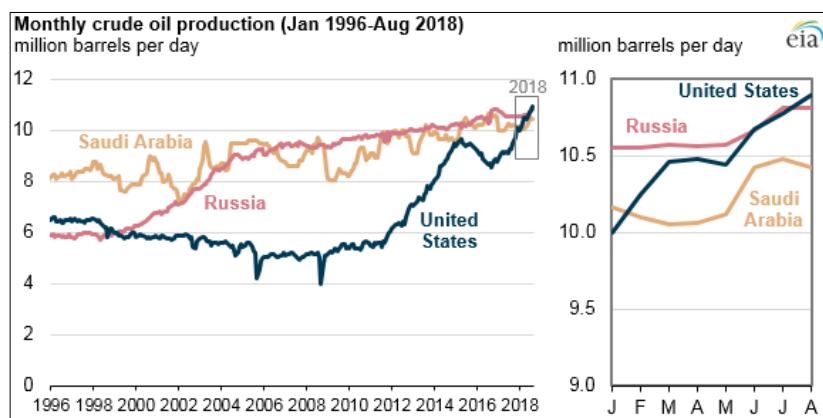
- Seeking Alpha, [U.S. now a net oil exporter for first time on record](#), December 6 2018

US world's largest crude producer - The United States likely surpassed Russia and Saudi Arabia to become the world's largest crude oil producer earlier this year, based on preliminary estimates in EIA's *Short-Term Energy Outlook* (STEO).

In February, US crude oil production exceeded that of Saudi Arabia for the first time in more than two decades. In June and August, the United States surpassed Russia in crude oil production for the first time since February 1999.

Figure 13, Monthly Crude Production, January 1996-August 2018, Source: EIA

Although EIA does not publish crude oil production forecasts for Russia and Saudi Arabia in the STEO, EIA expects that US crude oil production will continue to exceed Russian and Saudi Arabian crude oil production for the remaining months of 2018 and through 2019.



Further Reading:

- Energy Information Administration Today in Energy, [The United States is now the largest global crude oil producer](#), September 12 2018

The geopolitics of the global oil market continue to shift - With the increase in oil and gas production in the US over the last several years, the geopolitical considerations that impact oil prices have become even more complex with US political leaders wanting low oil prices to stave off any impact on economic growth, but also needing reasonably good oil prices to keep job-creating oil and gas development going. Predicting short-term variation in prices is just as difficult as it has been in the past in light of the many global suppliers and their varied political and economic interests.

Further Reading:

- The New York Times, [What's Happening to the Price of Oil?](#), November 20 2018
- The Economist, [Turbulent times: Measuring real-time shifts in a volatile oil market](#), 2018 (note: requires registration to download)

Implications for Reliability: In general, recent and short-term movement in the evolution of fuel markets in the power sector do not present any new emerging risks for any of the categories of electric reliability. In particular, domestic natural gas resources serving the power sector continue to be abundant, thus enhancing the ability to add resources to address reliability concerns.

Shifts in the Cost of Capital and Financial Markets

Power industry assets are capital intensive investments and cost a lot of money, and often necessitate long-term borrowing and debt. Thus, the cost of capital is an essential component in the cost of the electric power supply generation, transmission, and distribution, and can influence the choice and use of supply options. Tax incentives and financial structuring of securities can also have significant influences on option choices. As supply options are determined based on costs, there will be implications for meeting electric reliability standards based on the energy supply assets financed and built.

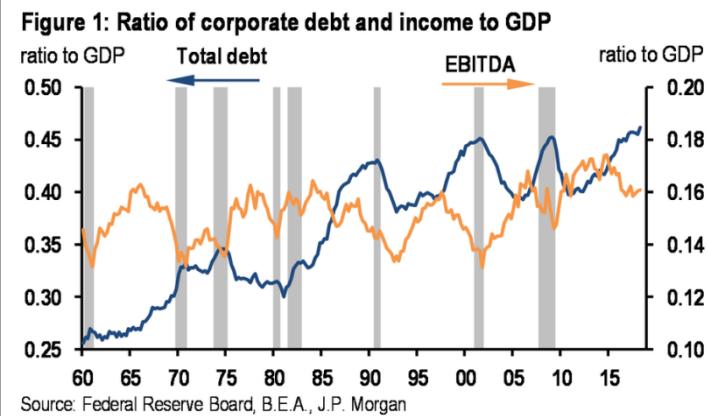
Fed officials hint at looming policy shift – Even as the Federal Reserve raised rates by a quarter point again on December 19 in the face of mounting criticism by President Trump – the ninth increase since December 2015 - Federal Reserve policymakers, who until recently had been [so bullish on the US economy](#) as to forecast interest rate hikes into 2020, are starting to temper their optimism about growth – and thus the likely amount of [additional interest rate hikes](#) that will be needed. A chorus of Fed officials has pointed to a shift in their policy stance from one of gradual, predictable interest rate hikes to a time where the Fed policymakers' next move starts [coming into question](#). Going into 2019, it is unclear when the Fed will see inflation as at the “neutral point”, and just how many, if any, rate hikes will occur in 2019

Further Reading:

- Forbes, [Fed Officials Keep Hinting At Looming Policy Shift](#), November 28 2018

Figure 14, Ratio of Corporate Debt and Income to GDP, Source, the US Federal Reserve

Leveraged lending is US economy's 'ticking time bomb' - A surge in US corporate debt presents a 'key vulnerability in the economy. US corporate debt levels have again surpassed their pre-crisis peaks of \$6 trillion, raising widespread concern that, [as the Federal Reserve raises interest rates](#) some firms could run into financial trouble.



"We think corporate debt is a key vulnerability," JP Morgan economists Jesse Edgerton and Devwrat Vegad wrote in a research note, saying that the corporate bond market was likely not big enough for a crash there to have consequences as widespread as the US housing meltdown of 2006-2008.

On a similar note, Sen. Elizabeth Warren, D-Mass., urged regulators this week to take action against banks issuing leveraged loans, warning that the practice could lead to a repeat of the 2008 financial crisis. In the letter, Warren questioned regulators on what their agencies' plans are to address what she describes as "growing risks" in the leveraged lending market as well as proposed changes to rules governing the Collateralized Loan Obligation (CLO) market, the largest buyers of leveraged loans. She requested responses by December 11. "I am concerned that the large leveraged lending market exhibits many of the characteristics of the pre-2008 subprime mortgage market," Warren wrote. "These loans are generally poorly underwritten and include few protections for lenders and investors," she wrote. "Many of the loans are securitized and sold to investors, spreading the risk of default throughout the system and allowing the loan originators to pass the risk of poor underwriting on to investors." The US leveraged loan market is worth \$1.1 trillion, according to [Reuters](#).

Further Reading:

- Forbes, [A Surge In U.S. Corporate Debt Presents a 'Key Vulnerability In The Economy](#), November 14 2018
- Reuters, [Senator Warren presses regulators on leveraged lending](#), November 15 2018

- Fox News, [Leveraged lending is US economy's 'ticking time bomb'](#), November 15 2018

Zombie companies - When a company cannot make enough money to cover even the interest on its loans (let alone the underlying principal) it is close to bankruptcy. But companies can stagger along for years — like zombies — as long as banks with low lending standards continue to extend them credit. In the US, the situation is even worse, according to data from the [Bank for International Settlements](#) (BIS) published this month. More than 16% of all American companies are zombies. Twenty years ago, in the late 1980s, the zombie problem was negligible, according to BIS senior economist Ryan Banerjee; only 2% of firms were zombies. BIS's data covers all companies in Australia, Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. BIS is often described as the central banks' central bank.

Further Reading:

- Business Insider, [The 'zombie' problem](#), October 29 2018

Global Economic Growth

Global Growth Cools - Only a few months ago, the world's fortunes appeared increasingly robust. For the first time since the wealth-destroying agony of the global financial crisis, every major economy was growing in unison. The global economy is now palpably weakening, even as most countries are still grappling with the damage from that last downturn. Many nations are mired in stagnation or sliding that way. Oil prices are falling and factory orders are diminishing, reflecting slackening demand for goods. Companies are warning of disappointing profits, sending stock markets into a frenetic bout of selling that reinforces the slowdown.

Germany and Japan have both contracted in recent months, while China is slowing more than experts anticipated. Even the United States, the world's largest economy, and oft-trumpeted standout performer, is expected to decelerate next year as the stimulative effects of President Trump's \$1.5 trillion tax cut wear off, leaving huge public debts.

The reasons for this turn run from rising interest rates delivered by the Federal Reserve and other central banks to the unfolding trade war unleashed by the Trump administration. The likelihood that Britain's tortuous exit (BREXIT) from the European Union will damage trade across the English Channel has discouraged investment.

Further Reading:

- The New York Times, [Global Growth Cools, Leaving Scars of '08 Unhealed](#), December 1 2018

The world economy is beginning to sour - The world's third- and fourth-largest economies are shrinking. The European Union is battling with the UK and Italy over Brexit and a deficit-boosting budget, respectively. Traders are reeling from a plummet in oil prices that sent shockwaves through the stock market.

In Japan, GDP fell 0.3% in the third quarter, after increasing 0.8% in the three months to June. At an annualized rate, [it contracted by 1.2%](#), with activity severely curtailed by natural disasters.

Germany is feeling the effects of the trade war. GDP in Europe's largest economy fell in the third quarter, the first contraction since the start of 2015. Growth declined by 0.2%, more than economists projected and the most since 2014, substantiating fears about a global economic slowdown.

Britain BREXIT bickers: Before even seeing the details of the agreement, many prominent Brexiteers have pledged to vote against it (see BREXIT update above and in the Wild Cards section below). Meanwhile, pro-EU members of May's government spent last night at a rally in support of holding a second referendum on EU membership. And the DUP, the Northern Irish party supporting May's slim majority in parliament, have expressed reservations.

Italy's populist, anti-establishment government is standing its ground against the EU. Rome has decided to [not revise its budget](#) that projects a deficit next year of 2.4% of GDP and 1.5% economic growth. The budget

would cut taxes, introduce a universal basic income, and lower the retirement age. Italy's plan breaks EU rules on "excessive deficits," which could result in fines and other penalties.

Further Reading:

- Quartz, [The world economy is looking awfully shaky all of a sudden](#), November 14 2018

Eurozone GDP growth rate confirmed at four-year low - The eurozone economy grew at its slowest pace in four years in the third quarter of 2018, while employment growth also eased during the period, data released on Wednesday showed. Eurozone gross domestic product (GDP) rose by 0.2 percent in the July-Sept period, European statistics agency Eurostat reported, confirming its earlier preliminary flash estimate from October 30. This was the slowest rate of economic growth since the second quarter of 2014. The economy of Germany, the eurozone's largest, contracted by 0.2 percent, France's was 0.4 percent stronger, while Italy's was unchanged in the quarter.

Eurostat also confirmed that the year-on-year GDP growth rate was 1.7 percent, the lowest level since the fourth quarter of 2014.

Further Reading:

- Reuters, [Eurozone GDP growth rate confirmed at four-year low](#), November 14 2018

Fault Lines in the Global Economy - At a time when the world's major central banks are winding down their many years of ultra-easy monetary policies, global asset and credit markets remain very buoyant. They remain so even though a number of important fault lines in the global economy have appeared in plain sight, which could cause major financial market turbulence within the next 12 months as the world's central banks proceed with normalizing their monetary policies. Among the more dangerous of these fault lines is Italy, the eurozone's third-largest economy and the world's third-largest sovereign bond market with a public debt of almost \$3 trillion. This makes the Italian economy too big to fail for the Euro to survive. Yet it also makes it too big to save by its European partners if markets were to turn decisively against that country.

Further Reading:

- Inside Sources, [Fault Lines in the Global Economy](#), August 6 2018

Central Banks Aren't Ready - The global economy is looking shaky and the economics chief at the Bank for International Settlements says central banks may be powerless if it all goes awry.

Claudio Borio, a long-time critic of loose monetary policy, used the Bank of International Settlements' (BIS) latest Quarterly Review to highlight again that central bankers were overburdened after the [global financial crisis](#). He said side effects are inevitable, including market turmoil such as that seen in emerging markets in response to Federal Reserve tightening and dollar appreciation. Given their depleted firepower, it also means that policymakers are unprepared for the next downturn. "*With interest rates still unusually low and central banks' balance sheets still bloated as never before, there is little left in the medicine chest to nurse the patient back to health or care for him in case of a relapse* (italics ours). Moreover, the political and social backlash against globalization and multilateralism adds to the fever."

Further Reading:

- Bloomberg, [The Global Economy Is Vulnerable and Central Banks Aren't Ready](#), September 23 2018

Implications for Reliability: We see no new emerging issue in capital markets that raises significant risk to electric reliability in any of the key categories. Continued low cost and abundant sources of capital exist for the power industry for development with sound credit quality. Economic growth in the WECC area is in line with national trends and in some States slightly ahead.

Economic growth within the Western Interconnection

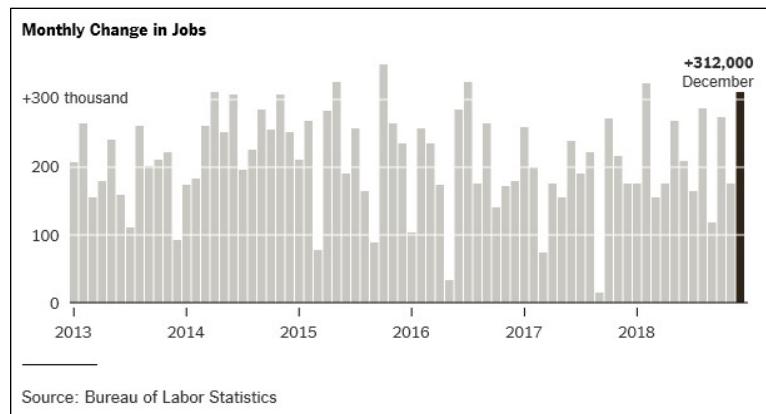
Economic growth is a prime driver in electricity demand growth and thus the need for additional power supplies. Economic growth is determined by a wide range of local, regional and national factors that play out differently in the states and provinces in the Western Interconnection. The different forms and levels of economic growth which vary across the Western Interconnection contribute to varied energy policy responses (prime examples being varied policies in support of renewable energy portfolio standards and addressing climate change). In this way, variations in economic growth can impact what actions and investments are made to assure and sustain electric reliability in the Western Interconnection.

End of Year Economic Indicators, US and Canada

December US Jobs Report - In the last couple of months, as stocks swayed and concern over the prospect of a recession ensued, the labor market was relatively steady. And December's numbers ended the year with a flourish. And the unemployment rate seems to have risen for good reasons - more people are being drawn into the job market, perhaps because of higher wages.

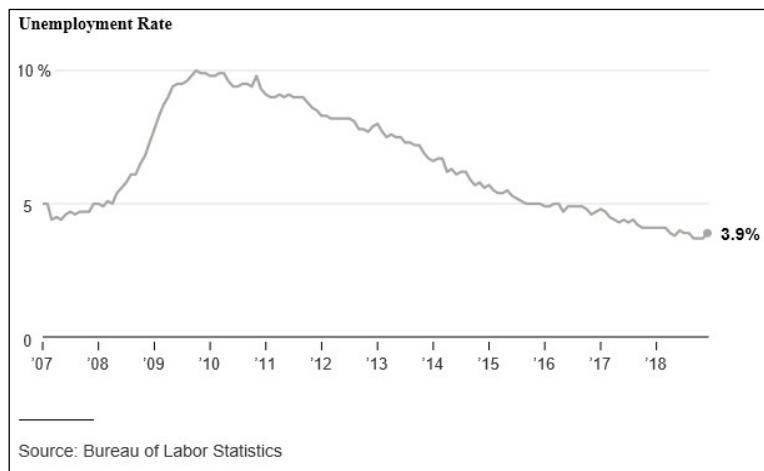
The labor force grew by a healthy 419,000 people last month. Overall, employers added more jobs in 2018 than they did in 2017, at a monthly average of 220,000. But last year was unique, because Congress passed a big corporate tax cut that essentially bathed a sizzling economy in lighter fluid. Optimism among consumers and businesses soared. Manufacturers and builders kept hiring despite trade tensions and a slowdown in the housing market.

Figure 15, Monthly Changes in Jobs, New York Times, Source: US Bureau of Labor Statistics



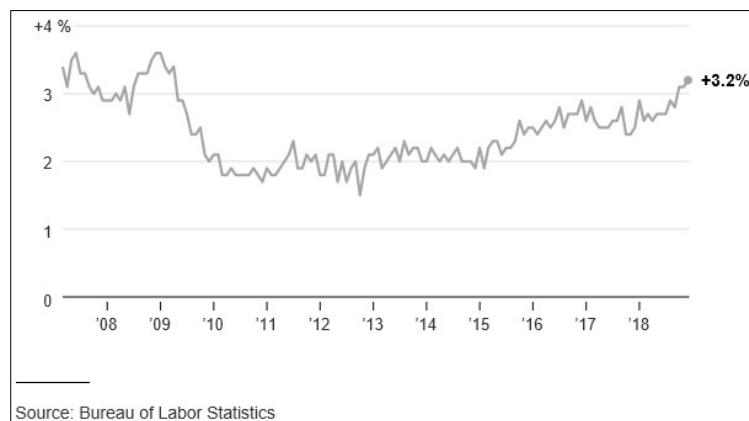
The unemployment rate grew to 3.9% from November's 3.7%.

Figure 16 US Unemployment Rate, New York Times, Source: US Bureau of Labor Statistics



Average hourly wages grew by 3.2% from a year ago.

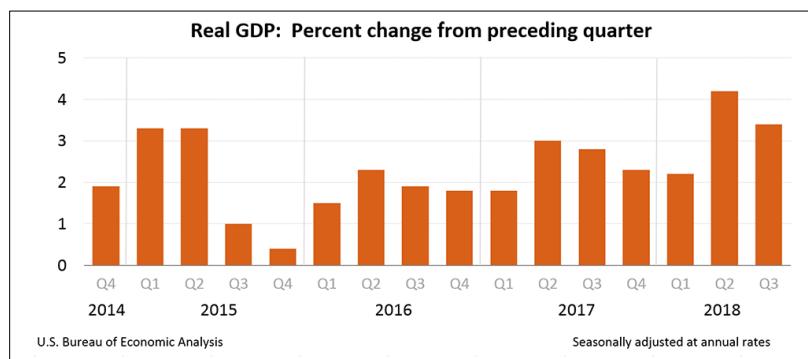
Figure 17 Average Hourly Wage Rate, New York Times, Source: US Bureau of Labor Statistics



Final GDP numbers for the US were not available for this report, however, here is a snapshot of the third quarter of 2018, and final numbers will be noted in our next report. Real gross domestic product (GDP) increased 3.4 percent in the third quarter of 2018, according to the "third" estimate released by the Bureau of Economic Analysis. The growth rate was revised down 0.1 percentage point from the "second" estimate released in November. In the second quarter, real GDP increased 4.2 percent.

Figure 18, US Real GDP, Q1 2014 – Q3 2018, Source: US Bureau of Economic Analysis

Final US 2018 GDP numbers will be noted in our next report if available.

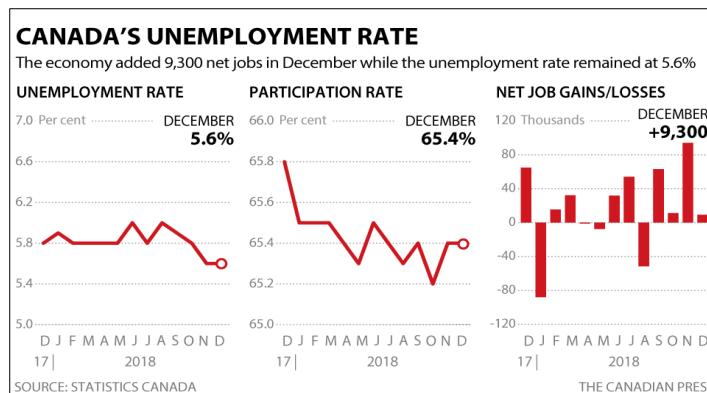


Further reading:

- The New York Times, [December 2018 Jobs Report](#), January 4 2019
- US Bureau of Economic Analysis, [3Q 2018 GDP](#), December 21 2019

December Canada jobs report - Canada's Unemployment still at a 43-year low in December, but wages barely budged. For the second straight month, the jobless rate was at its lowest level since Statistics Canada started measuring comparable data in January 1976. Economists had expected the addition of 5,500 jobs and an unemployment rate of 5.7 percent.

Figure 19, Canada's Unemployment Rate, Source: Statistics Canada



But even in a tightened job market, the latest labor force survey shows wage growth delivered another weak reading in December of 1.49 percent, which is well below inflation. Year-over-year average hourly wage growth for permanent employees was 1.46 percent in November – and it has decelerated steadily since its May peak of 3.9 percent. Economists highlighted other less-than-stellar details from the December report noting that all of the job creation came from the part-time sector, with full-time job employment declining 19,000. Net employment among salaried workers fell by 37,000 during the month, with all the gains coming from self-employment.

Employment in Alberta fell by 17,000 in December, as losses in full-time work outweighed gains in part-time work. On a trend-cycle basis, overall employment in the province has been increasing since June 2016. In December, the unemployment rate in Alberta was little changed at 6.4%.

In 2018, employment in British Columbia increased by 44,000, almost entirely in full-time work. Employment grew by 1.8%, double the national average, while the unemployment rate edged down to 4.4%, still the lowest among the provinces. Employment gains were spread across several industries, led by professional, scientific and technical services. At the same time, declines were recorded in finance, insurance, real estate, rental and leasing.

As with the US, final GDP numbers for Canada were not available for this report; however, here are the numbers for the third quarter of 2018. The Canadian economy grew 0.5 percent quarter-on-quarter in the third quarter of 2018, following a 0.7 percent expansion in the previous period. The slowdown was mainly due to lower household spending. Expressed as an annualized rate, the GDP advanced 2.0 percent, easing from a 2.9 percent growth in the second quarter and in line with market expectations. GDP Growth Rate in Canada averaged 0.79 percent from 1961 until 2018, reaching an all-time high of 3.10 percent in the fourth quarter of 1963 and a record low of -2.30 percent in the first quarter of 2009.

Further reading:

- Global News Canada, [Canada December Jobs Report](#), January 4 2019
- Statistics Canada, [The Daily Quotidian Labor Force Survey](#), January 4 2019

Other Economic Events

FED watching for economic weakness - Jerome H. Powell, the Federal Reserve chairman, said on Friday January 4, that low inflation would allow the Fed to be “patient” in considering whether to continue raising its benchmark interest rate, giving the central bank more time to assess whether economic growth is slowing and helping to calm jittery financial markets. Mr. Powell’s message on Friday, delivered at an economics conference in Atlanta, was that the Fed is withholding judgment on the health of the economy. He said he believed it remained healthy, but he also sought to reassure investors that policymakers were watching closely for signs of weakness and were not in a rush to raise rates again. “If we ever came to the conclusion that any aspect of our plans” was causing a problem, Powell said, “we wouldn’t hesitate to change it.”

Further Reading:

- The New York Times, [Powell Says a ‘Patient’ Fed Is Watching for Signs of Economic Weakness](#), January 4 2019

General Motors’ (GM) plant closures are a warning sign for US economy - The carmaker said on November 26 that it plans to idle five factories in North America and cut about 14,000 jobs. GM said the cost cuts were necessary because new-car sales had slowed and consumers have shunned smaller vehicles in favor of pickups and SUVs (the factories are producing compact cars). And the move frees up money to invest in technologies like electric and autonomous vehicles. But the cuts underscore that the current economic boom is nearly a decade old, manufacturing growth may have peaked, and President Trump’s recent economic stimulus may prove short-lived. They also highlight how carmakers are suffering from Mr. Trump’s trade fight, which raised the costs of steel and aluminum. US automakers are selling fewer vehicles in China, too.

Further reading:

- The New York Times, [G.M.’s Cuts Spell Trouble for the Economy](#), November 27 2018

Worsening income equality - US household incomes grew in 2017, yet inequality worsened over the period. The income of a median US household rose for a third straight year in 2017 as solid economic growth helped put more people into full-time jobs. But income inequality also worsened as the wealthiest Americans enjoyed even larger pay increases. At the same time, the data underscores the lasting damage the Great Recession did to the majority of American families. US households are still earning essentially the same that they did in 2007 just before the Great Recession. And their inflation-adjusted median income remains slightly below the record in 1999 of \$62,000.

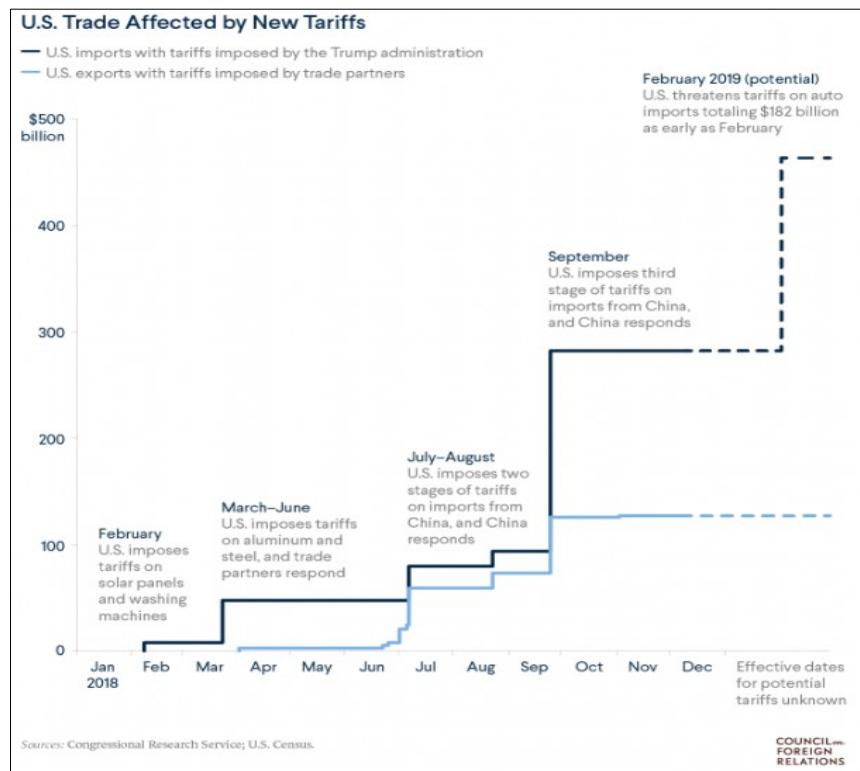
Further Reading:

- US News & World Report, [US Household Incomes Grew in 2017, Yet Inequality Worsens](#), September 12 2018
- The Daily Mail, [Median US household incomes grew for third straight year in 2017](#), September 12 2018

The trade war heated up in 2018 - This was the year that President Donald J. Trump delivered on his threats of a trade war. The United States imposed duties of 10 percent or higher on nearly \$300 billion in imports in 2018, the largest tariff increase since the 1930s. Foreign governments retaliated with their own tariffs against nearly \$150 billion in US exports.

The new taxes still affect just 10 percent of US imports, but that could grow substantially in 2019. Mr. Trump has threatened tariffs on nearly \$200 billion in imports of autos and auto parts, as well as on the remainder of Chinese imports.

Figure 20, US Trade Affected by Tariffs, Source: [Council on Foreign Relations](#)



Implications for Reliability: At this time, economic indicators in the Western Interconnection are showing a stable and growing economy, even within an environment of increasing uncertainty, and do not indicate an emerging threat to power system reliability.

Worldwide developments in the electric power industry

There are tremendous forces of change impacting the electric power industry worldwide, and we are seeing an acceleration of these changes driven by technology, policy choices, (e.g., addressing climate change), economics, and public demand. Many of those changes may influence or directly impact choices and changes in the US and, specifically, in the Western Interconnection power systems.

Honda reveals fluoride battery breakthrough - Honda Research Institute has announced new breakthrough battery chemistry developed in collaboration with Caltech and NASA JPL researchers. The technology, which was detailed in a newly published study, has a better eco-footprint while enabling the use of higher energy density materials in comparison to existing battery tech.

Honda says the new technology sidesteps fluoride-based battery technology temperature limitations. The team successfully demonstrated the operation of fluoride-ion based energy cells at room temperature, opening the door for high energy-density batteries that better meet the high capacity needs of modern technology. Even better, the [researchers say](#) that unlike popularly used lithium-ion batteries, which are known to be volatile, fluoride-ion batteries are safer without the risk of overheating. As well, this battery technology is better for the environment due to the lower environmental impact of its source materials. Batteries created with the chemistry may have up to 10 times the high energy density of lithium-ion batteries, according to [the study](#). Despite the upsides, this type of battery hasn't replaced lithium-ion due to its temperature limitations, until now, it has required temperatures above 302 F degrees to work properly. Researchers with Honda, NASA, and Caltech overcame this limitation and developed a fluoride-ion cell that can operate at room temperature. The team achieved this using a fluoride-conducting liquid electrolyte that has high ionic conductivity, as well as a wide operating voltage. Such technology may one day be behind batteries that power everything from consumer gadgets to electric vehicles.

Further Reading:

- Slash Gear, [Honda reveals fluoride battery breakthrough for next-gen power storage](#), December 6 2018

Fossil Fuels Won't Go Away - Fossil fuels would still make up 77 percent of global energy demand in a carbon-constrained future, according to Wood Mackenzie.

It's the year 2040, and all new vehicle sales in the United States, the European Union and China are electric. Coal demand has cratered, renewable energy use has skyrocketed and energy storage has been deployed at a massive scale to complement renewables growth. But even so, keeping global warming under 2 degrees Celsius remains out of reach. This is according to Wood Mackenzie's (WoodMac) updated alternative energy outlook, [Carbon-constrained scenario 2018: Navigating a challenging path to lower global emissions](#).

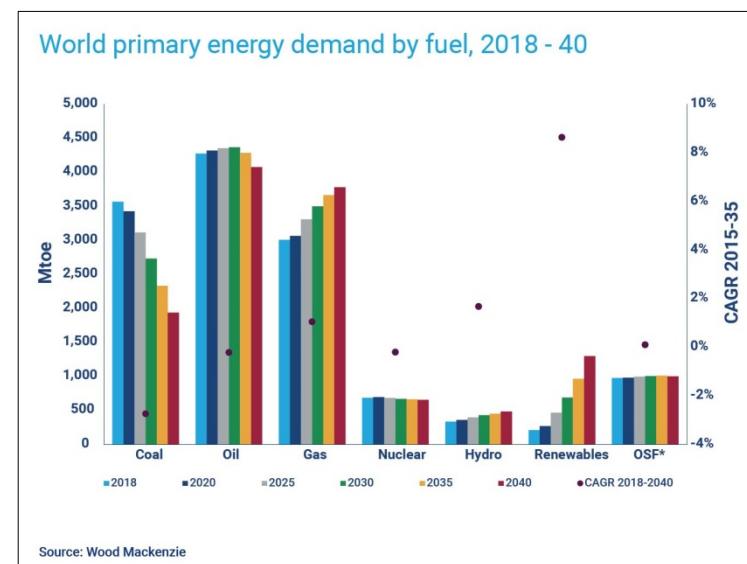
The report explores how commodity demand and carbon emissions would respond to accelerated deployment of low-carbon power and transport sector technologies, and finds that fossil fuels would still make up the vast majority of global energy demand.

"Fossil fuel use will not disappear any time soon," said David Brown, senior analyst at Wood Mackenzie. "Our scenario envisages fossil fuels having a 77 percent share of global energy demand — versus 79 percent in our base case — as major markets such as China and the EU reach similar levels of fossil fuel shares."

Fossil fuels won't go away in a carbon-constrained world, but the energy landscape will change dramatically.

Figure 21, Worldwide Energy Demand by Fuel, 2018-2040, Source: Wood Mackenzie

Under WoodMac's base-case scenario, oil demand peaks in 2036. Under the accelerated Decarbonization scenario, oil demand peaks five years earlier, in 2031, as the impact of EVs becomes unmistakable.



Further Reading:

- GreenTech Media, [Fossil Fuels Won't Go Away, Even if the Energy Transition Accelerates](#), December 3 2018
- Utility Dive, [Even in a carbon-constrained world, fossil fuels remain dominant](#), December 4 2018,

Negative power prices around the world - In many places around the world where wind and solar energy are increasingly available and abundant (for example many sunny and windy days), power companies are wrestling with power production that exceeds demand. To deal with this in the most cost-effective manner some power companies are selling power at negative rates. This is especially true in Germany, Belgium, Australia, and in the US in California and Texas. There is some concern that as wind energy installation expands that negative prices during low demand periods will become more common. How regulators will view this in different locales is uncertain.

Further Reading:

- Bloomberg, [Power Worth Less Than Zero Spreads as Green Energy Floods the Grid](#), August 5 2018

A Look at US power generation trends - To give the public a well-grounded look at power generation trends, the New York Times produced a state by state look at how generation sources have shifted since 2000. It showed the following strong trends: much wider use of natural gas as coal-fired power declined; growth in wind generation as a major source of power in many states, strong growth in solar from a small base; and a decline in nuclear power with plant closures. However, the US power sector was still producing too much CO₂ to greatly reduce its impact on climate change.

Further Reading:

- The New York Times, [How Does Your State Make Electricity?](#) December 24 2018

Implications for Reliability: Worldwide developments in the power sector suggest that the wide range of options for meeting electric reliability will continue to expand. Resource options are abundant. Continued technological innovation suggests that operational, infrastructure, and system stability risks will be manageable at current or improved levels.

WILD CARDS AND OUTLIERS

Over our past reports, two Wild Cards have consistently been of concern: Cybersecurity and BREXIT. At this time, BREXIT (Britain's exit from the European Union) has not been resolved, and it is increasingly unclear whether there will be a new vote, if Parliament will accept Prime Minister Theresa May's exit proposal, or some other action will occur.

Further Reading:

- The Guardian (UK), [Brexit: May faces possible defeat as MPs debate no-deal amendment to finance bill](#), January 7 2018 (Note: This is a live update of current BREXIT events)

Cyber-security risks in the electric power infrastructure of the nation

Russian hackers continue probing the US Grid - At the CyberwarCon forum in Washington, DC on November 28, researchers from threat intelligence firm FireEye noted that while the US grid is relatively well-defended and difficult to hit with a full-scale cyber-attack, Russian actors have nonetheless continued to benefit from their ongoing vetting campaign. In the wake of the massive 2003 Northeastern blackout, utilities implemented resilience and defense standards known as the North American Electric Reliability Corporation Critical Infrastructure Protection requirements, more digestibly referred to as NERC CIP. These created minimum baselines for defending against and dealing with natural disasters, but also promoted best practices for network defense, including two-factor authentication, network segmentation, data storage protection, and strict access controls for both network owners and third-parties. All of these protections combined have hardened electricity generation and transmission systems against attack.

But not all segments of the grid are held to those standards. Distribution entities, which often subcontract with larger organizations to deliver power locally, often lack adequate resources and defenses. And while hackers may have a harder time fully compromising more formidable targets, they can still achieve many of their goals through persistent probing of softer targets.

Further Reading:

- Wired, [Russian Hackers Haven't Stopped Probing the US Power Grid](#), November 26 2018

New research on IoT devices - At the USENIX Security Symposium, Princeton University's Department of Electrical Engineering presented research that showed that if Wi-Fi-based high-wattage appliances become common, they could conceivably be used to manipulate electrical demand over a wide area - potentially [causing local blackouts and even cascading failures of regional electrical grids](#). The research used models of real-world power grids to simulate the effects of a "MaDIoT" (Manipulation of Demand Internet of Things) attack. It found that even swings in power usage that would be within the normal range of appliances such as air conditioners, ovens, and electric heating systems connected to "smart home" systems would be enough to cause fluctuations in demand that could trigger grid failures.

Further Reading:

- Ars Technical, [Just say no: Wi-Fi-enabled appliance botnet could bring power grid to its knees](#), August 17 2018

California governor signs country's first IoT security law - The law mandates that any maker of an Internet-connected, or "smart," device ensure the gadget has "reasonable" security features that "protect the device and any information contained therein from unauthorized access, destruction, use, modification, or disclosure." In June, [California passed a data-privacy law that some have called the country's toughest](#). It includes stopping the collection and sale of personal data upon request from consumers.

The new IoT rule, however, has garnered mixed reviews. Some observers say the law, which will go into effect on Jan. 1, 2020, is vague, and doesn't go far enough in its protections. Others, however, say the California rule will focus attention on the issue of IoT security because the state's size effectively sets standards that will be followed throughout the country.

Further Reading:

- Security Week, [California IoT Cybersecurity Bill Signed into Law](#), October 1 2018

Implications for Reliability: Cybersecurity is an increasing threat and risk to power systems operations and reliability worldwide, and US power systems continue to be a top target of state-sponsored and rogue hackers. We consider cybersecurity both a near-term and long-term reliability threat to the Western Interconnection.