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## **Continuation of major trends**

Natural gas demand has been growing, while production has been growing even more Prices continue the downward trend, though the pace has slowed

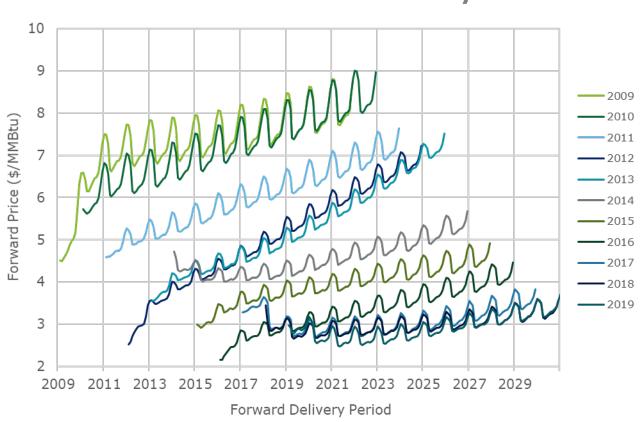
The Energy Information Administration (EIA) reported average total dry gas production of 92 billion cubic feet per day (Bcf/d), an increase from reported

- •83 Bcf/d in 2018
- 75 Bcf/d in 2017

The natural gas forward price curve has been in general decline for over a decade

- Comparing forward curves from late January for the past dozen years
  - 2020 forwards in 2019 are:
    - Almost 75% lower than in 2009
    - Almost 50% lower than in 2014
  - Mild front-end backwardation seen in the last few years has essentially disappeared

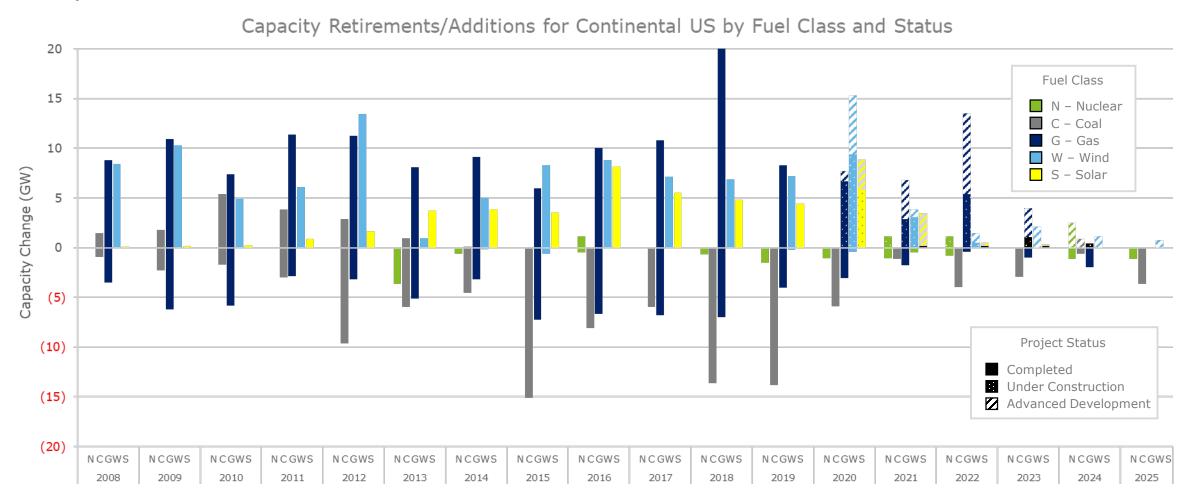
## Historical Henry Hub Forward Curves Observed in Late January



Source: Total Dry Gas Production from EIA Short-Term Energy Outlook (STEO), January 14, 2020; Henry Hub forward prices from S&P Global Market Intelligence, accessed January 30, 2020; chart compiled by Deloitte

### Changes to capacity have also been shifting

Nuclear and coal capacity have retired while new capacity shifted to primarily gas, wind, and solar



Source: : S&P Global Market Intelligence unit capacity data, accessed January 30, 2020; chart compiled by Deloitte

### Renewable Portfolio standards have expanded to Clean Energy Standards Target levels have increased in several states as well

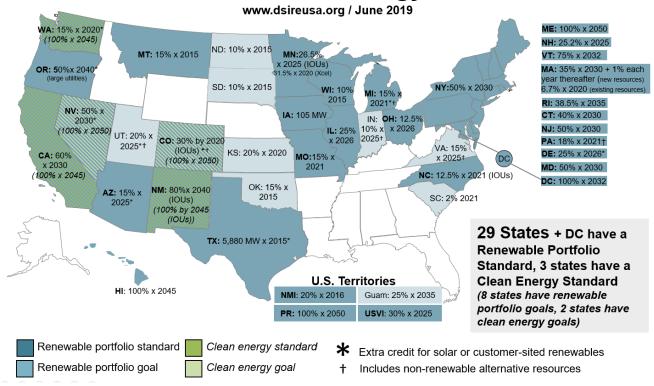
- Besides Hawaii's 100% renewable portfolio standard (RPS), several other states have adopted by law or are considering 100% clean energy standard (CES) or variations, including:
  - California (SB100, September 10, 2018)
  - New Mexico (SB489, March 22, 2019)
  - Nevada (SB358, April 22, 2019)
  - Washington (SB5116, May 7, 2019)
- Wind and solar resources have been expected to be the primary sources of qualifying energy, and the expectation remains going forward
- While federal tax credits are scheduled to phase out, RPS and CES are expected to provide continued incentives in some states







### Renewable & Clean Energy Standards



Source: Renewable & Clean Energy Standards graphic from DSIRE by N.C. Clean Energy Technology Center, funded by US Department of Energy, <a href="https://s3.amazonaws.com/ncsolarcen-prod/wp-content/uploads/2019/07/RPS-CES-June2019.pptx">https://s3.amazonaws.com/ncsolarcen-prod/wp-content/uploads/2019/07/RPS-CES-June2019.pptx</a>; California SB100, <a href="https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill\_id=201720180SB100">https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill\_id=201720180SB100</a>; New Mexico SB 489, <a href="https://www.nmlegis.gov/Legislation/Legislation/Chamber=S&LegType=B&LegNo=489&year=19">https://www.nmlegis.gov/Legislation/Legislation/Chamber=S&LegType=B&LegNo=489&year=19</a>; Nevada SB358, <a href="https://www.leg.state.nv.us/App/NELIS/REL/80th2019/Bill/6651/Overview">https://www.leg.state.nv.us/App/NELIS/REL/80th2019/Bill/6651/Overview</a>; Washington SB5116, <a href="https://www.news.ntml.gov/https://www.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/https://www.news.ntml.gov/ht

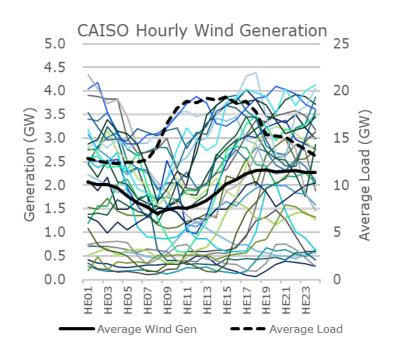
# Generation profiles Renewables and gas generation

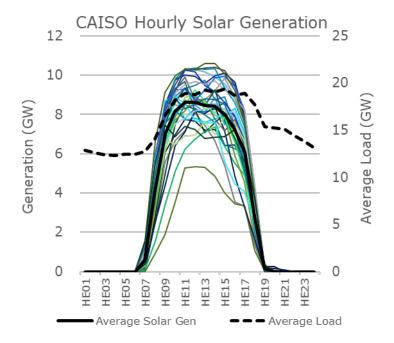
### Generation patterns can differ widely by technology

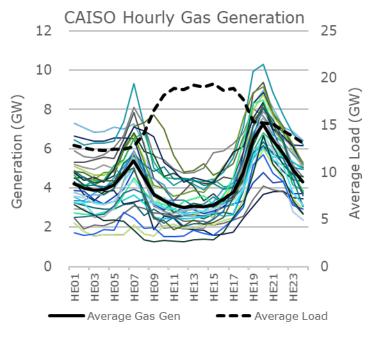
Renewable sources such as wind and solar typically have profiles that differ from the underlying system demand

Comparing the daily generation in California Independent System Operator (CAISO) from March 16, 2019 to April 15, 2019 for wind, solar, and gas sources shows qualitatively different profiles

- Wind can be highly variable and does not generally follow the load profile
- Solar more closely aligns with load than wind, but solar often declines earlier in the day than demand
- · Gas is frequently the marginal supply, balancing the system, and following the residual load







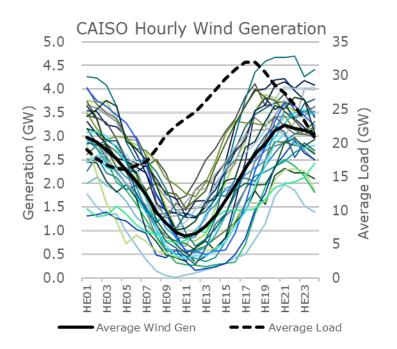
Source: Generation data from Energy Information Administration (EIA) Hourly Electric Grid Monitor (Beta), <a href="https://www.eia.gov/beta/electricity/gridmonitor">https://www.eia.gov/beta/electricity/gridmonitor</a>, accessed January 30, 2020; charts compiled by Deloitte

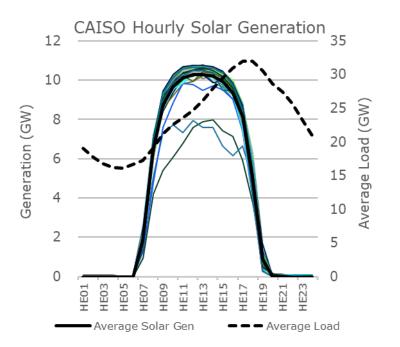
### Generation patterns can also differ by season

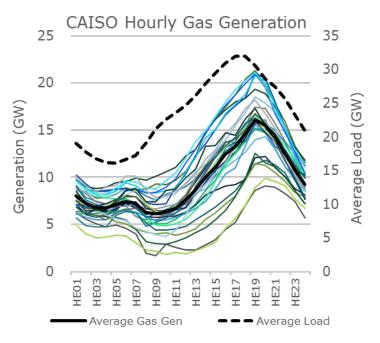
Renewable sources such as wind and solar typically have profiles that can change throughout the year while load also changes in magnitude and shape

Comparing the daily generation in CAISO for August 2019 from wind, solar, and gas sources illustrates seasonal changes in profiles

- Wind is variable in summer but less so than in spring
- Solar is also less variable in summer than spring and declines while load is still peaking
- Gas faces a larger range due to higher overall load, though late-day ramp is less dramatic than in spring







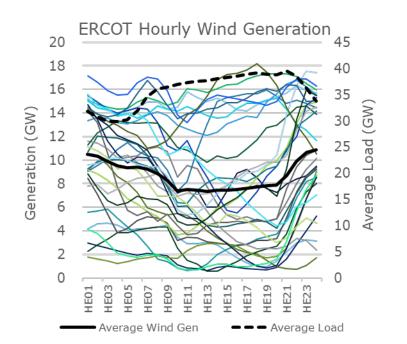
Source: Generation data from Energy Information Administration (EIA) Hourly Electric Grid Monitor (Beta), <a href="https://www.eia.gov/beta/electricity/gridmonitor">https://www.eia.gov/beta/electricity/gridmonitor</a>, accessed January 30, 2020; charts compiled by Deloitte

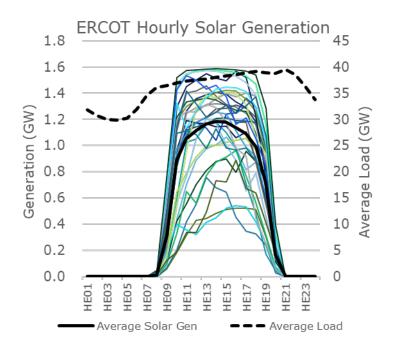
### Generation patterns can also differ by geography

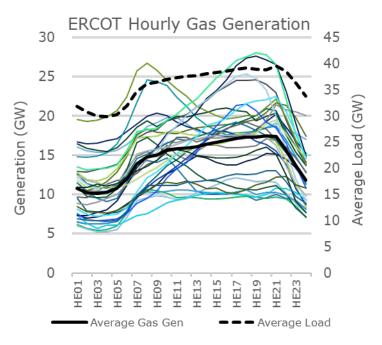
Electric Reliability Council of Texas (ERCOT) displays differences in generation profiles when compared to CAISO

Comparing the daily generation in ERCOT from March 16, 2019 to April 15, 2019 for wind, solar, and gas sources shows wide variation from day to day

- Wind varies widely and does not generally follow the load profile
- Solar capacity is relatively low in ERCOT, though growth is expected and should increase its influence
- Gas faces a range of generation levels resulting from wide wind variation relative to lower seasonal loads



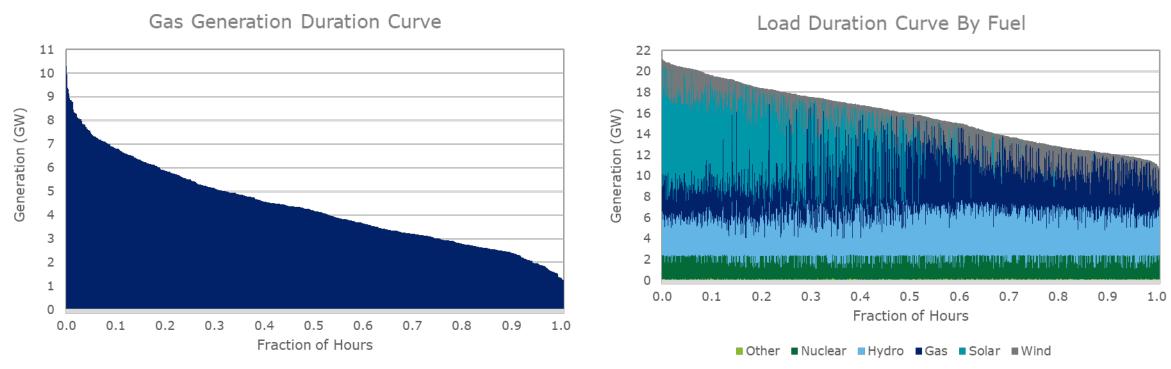




Source: Generation data from Energy Information Administration (EIA) Hourly Electric Grid Monitor (Beta), <a href="https://www.eia.gov/beta/electricity/gridmonitor">https://www.eia.gov/beta/electricity/gridmonitor</a>, accessed January 30, 2020; charts compiled by Deloitte

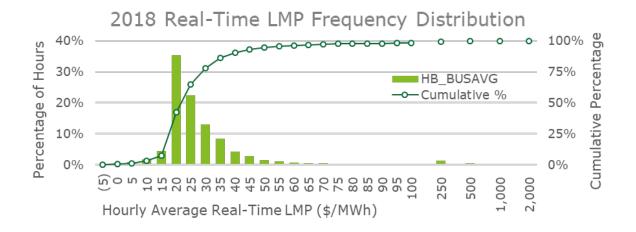
### Generation and load duration curves suggest value of gas flexibility

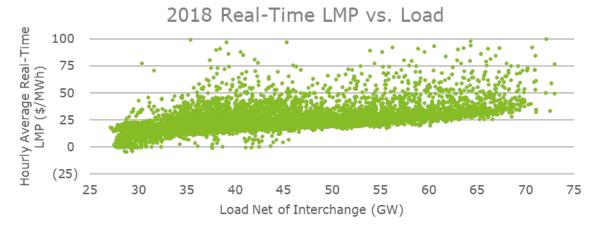
- Gas generation during high output periods are well above baseload level during spring in CAISO
- Load duration curve shows gas generation levels vary widely across system net load levels
  - High correlation of solar generation and load concentrate gas generations in mid- to low-load periods



Source: Generation data from Energy Information Administration (EIA) Hourly Electric Grid Monitor (Beta), https://www.eia.gov/beta/electricity/gridmonitor, accessed January 30, 2020; charts compiled by Deloitte

Relatively low energy prices attributed to high penetration of wind generation in ERCOT With the largest installed base of wind capacity of any state and relatively low cost natural gas, power prices have trended lower in Texas





- In 2018, of the 8,760 hourly average real-time locational marginal prices (LMPs) for settlement point HB\_BUSAVG:
  - 65% were at or below \$25/MWh
  - Less than 2% were above \$100/MWh
- Many hours of high load were still served at relatively low energy prices.
- Many generator were uneconomic to operate with such low energy prices, and over 4 GW of coal capacity retired in 2018.
- Price spikes experienced in 2019 may lead the market to prices that are high enough to support baseload gas generation
  - Expected increases in renewable generation may continue to limit power prices during most hours

Source: Price and load data from ERCOT: Historical RTM Load Zone and Hub Prices report for 2018; 2018 ERCOT Hourly Load Data report;; charts compiled by Deloitte

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