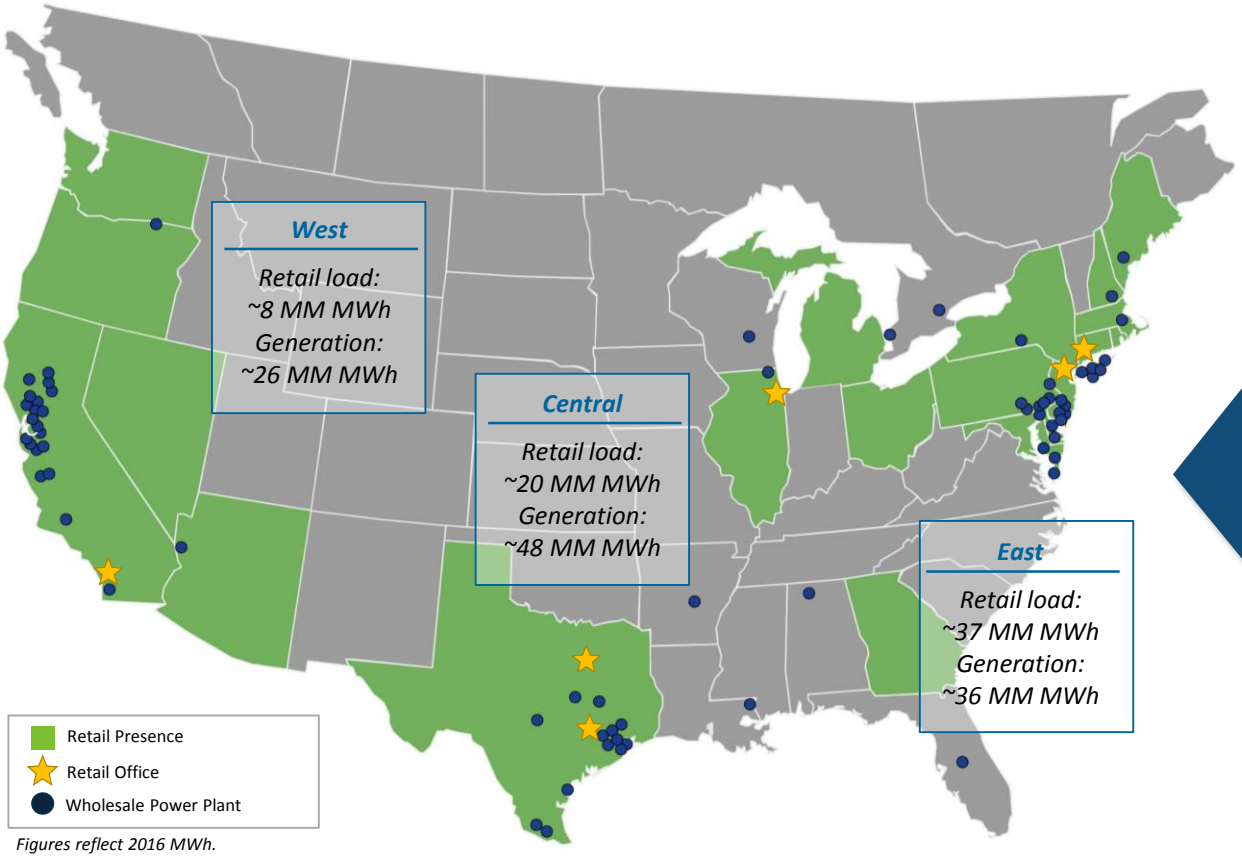
Gas/Renewable Integration & Energy Storage: Power Roundtable

2017 Gas/Electric Partnership Conference

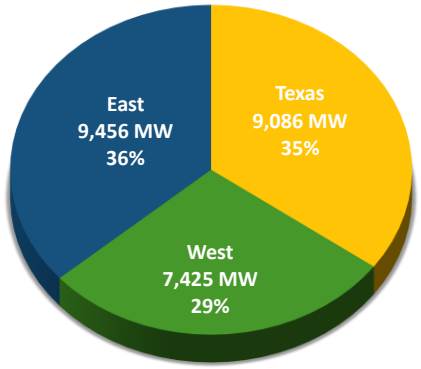
February 6-7, 2019

Calpine Corporation: Generation Owner/Operator and Retail Supplier with a National Portfolio of Generation and Load

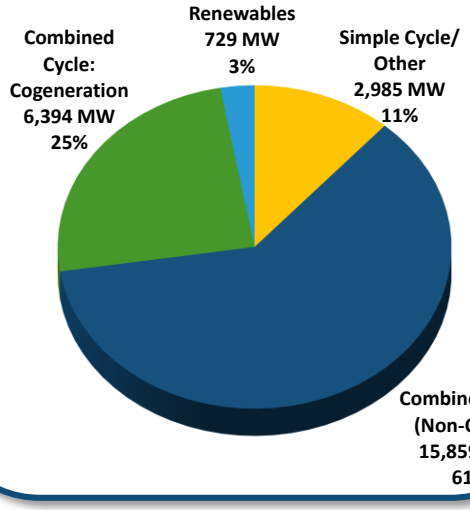


Figures reflect 2016 MWh.

Geographic Diversity



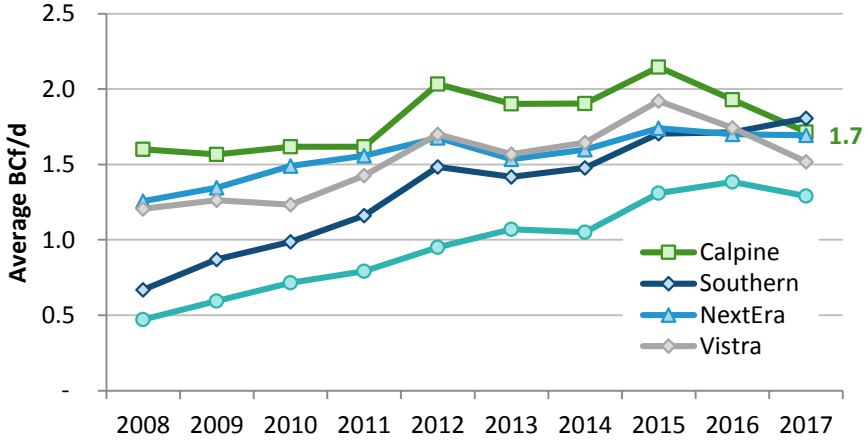
Dispatch Technology



- Geographically diversified portfolio: Scale in America's most competitive power markets
- Largest owner/operator of natural gas-fired generation in America
- Largest operator of combined heat and power (cogeneration) technology in America
- Largest geothermal power producer in America

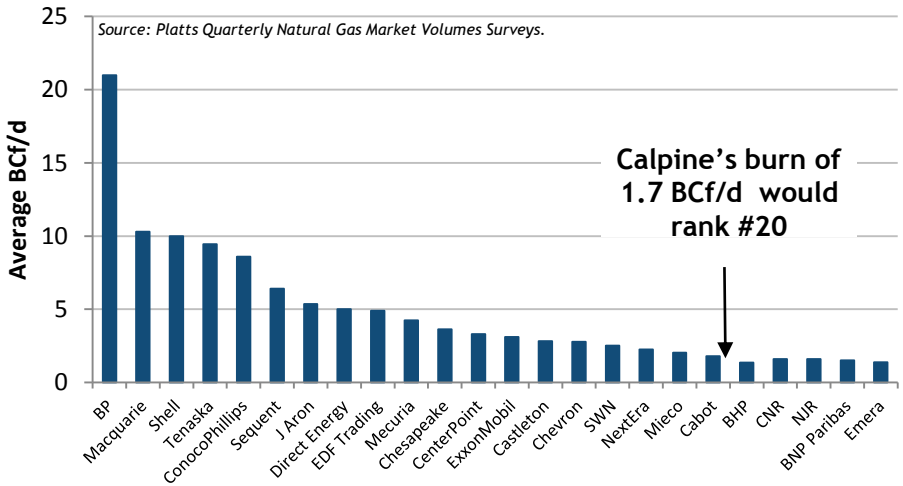
Calpine is one of the largest single consumers of natural gas in the US

Calpine has been the largest consumer of natural gas for power generation 9 of the last 10-years

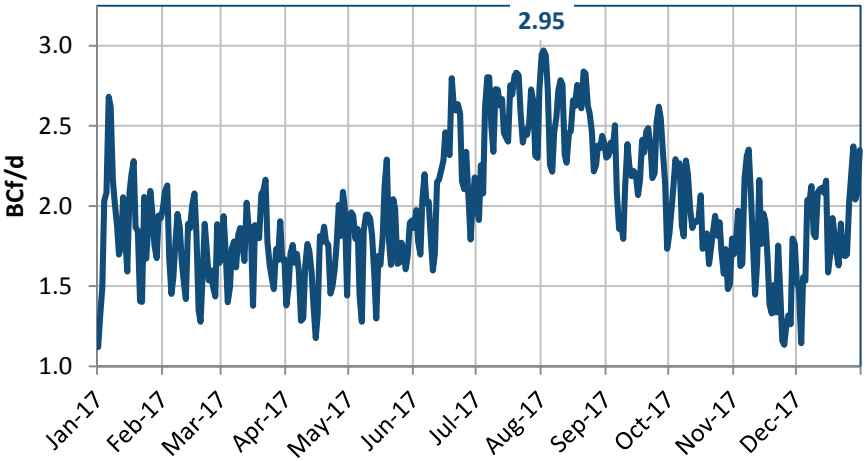


Source: EIA 923 data, Retrieved July 2018.

If Calpine Wholesale was classified as a natural gas marketer, it would rank #20 in 2017

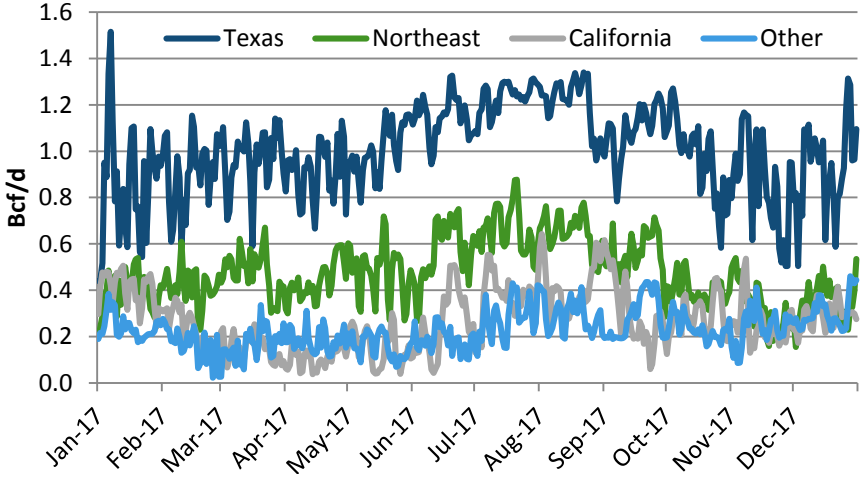


Calpine's 2017 (and 2018) peak daily natural gas burn approached 3.0 BCf/d



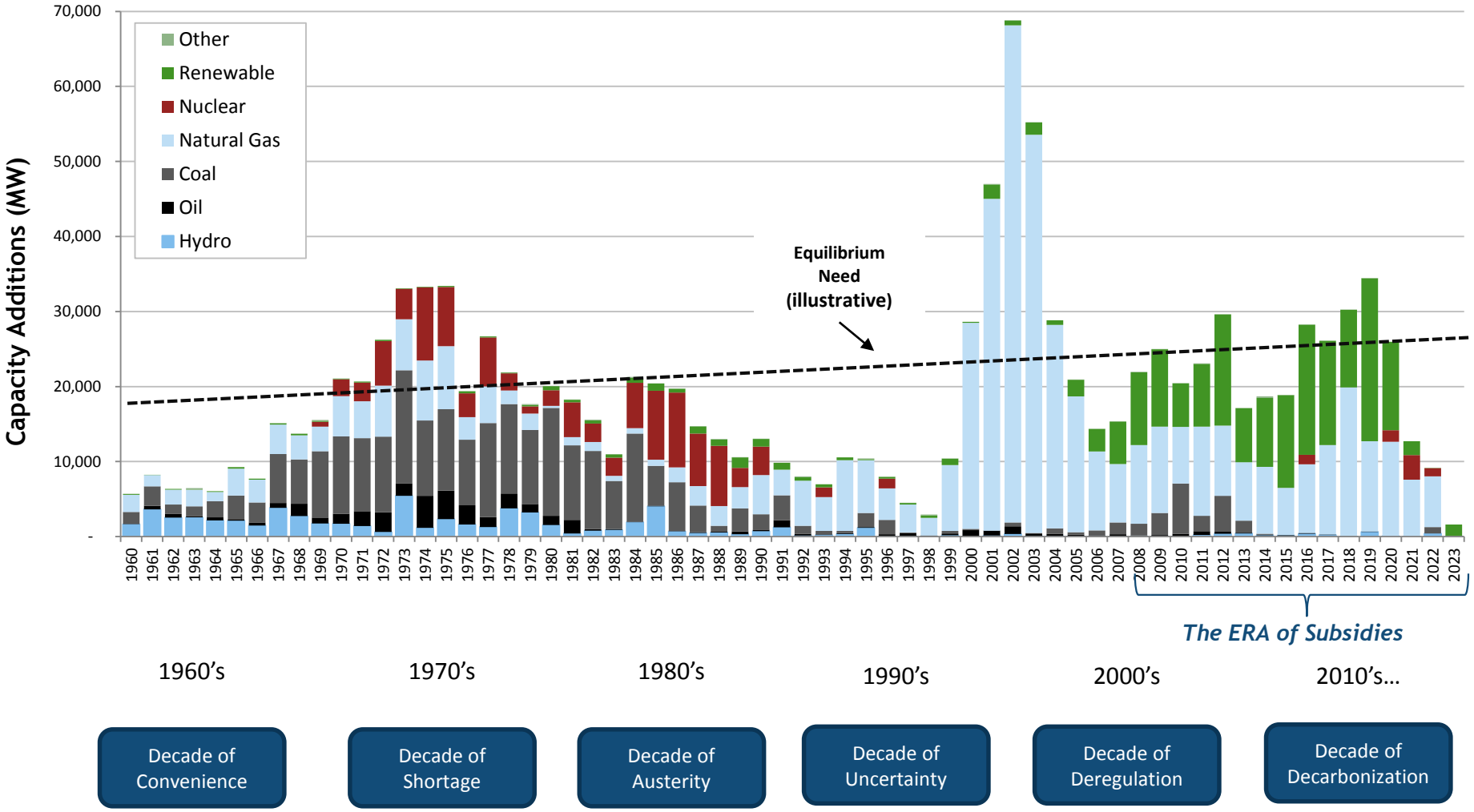
Source: EPA's 2017 CEMS data, Retrieved July 2018.

Calpine burns a significant amount of natural gas in Texas

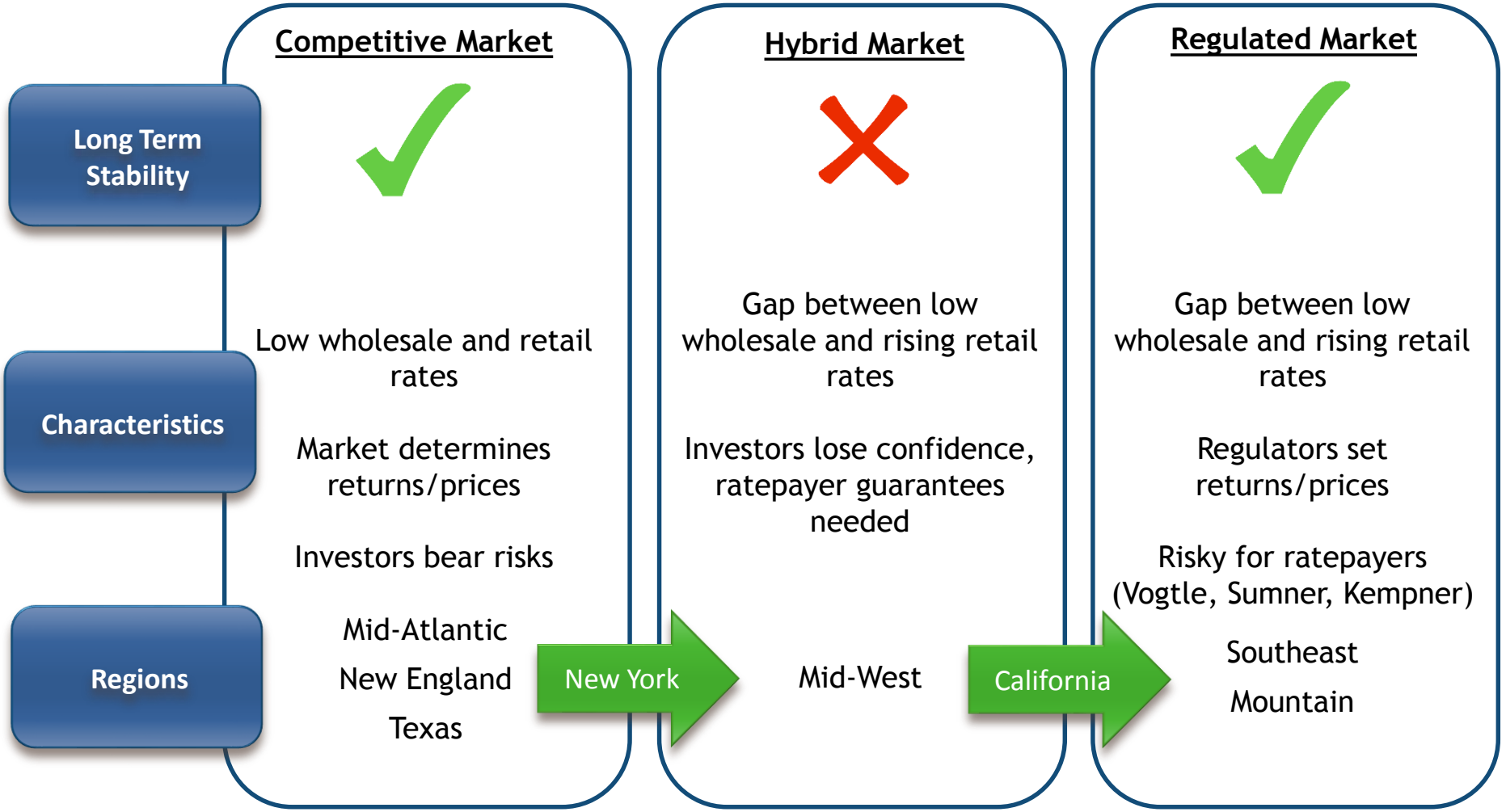


Source: EPA's 2017 CEMS data, Retrieved July 2018.

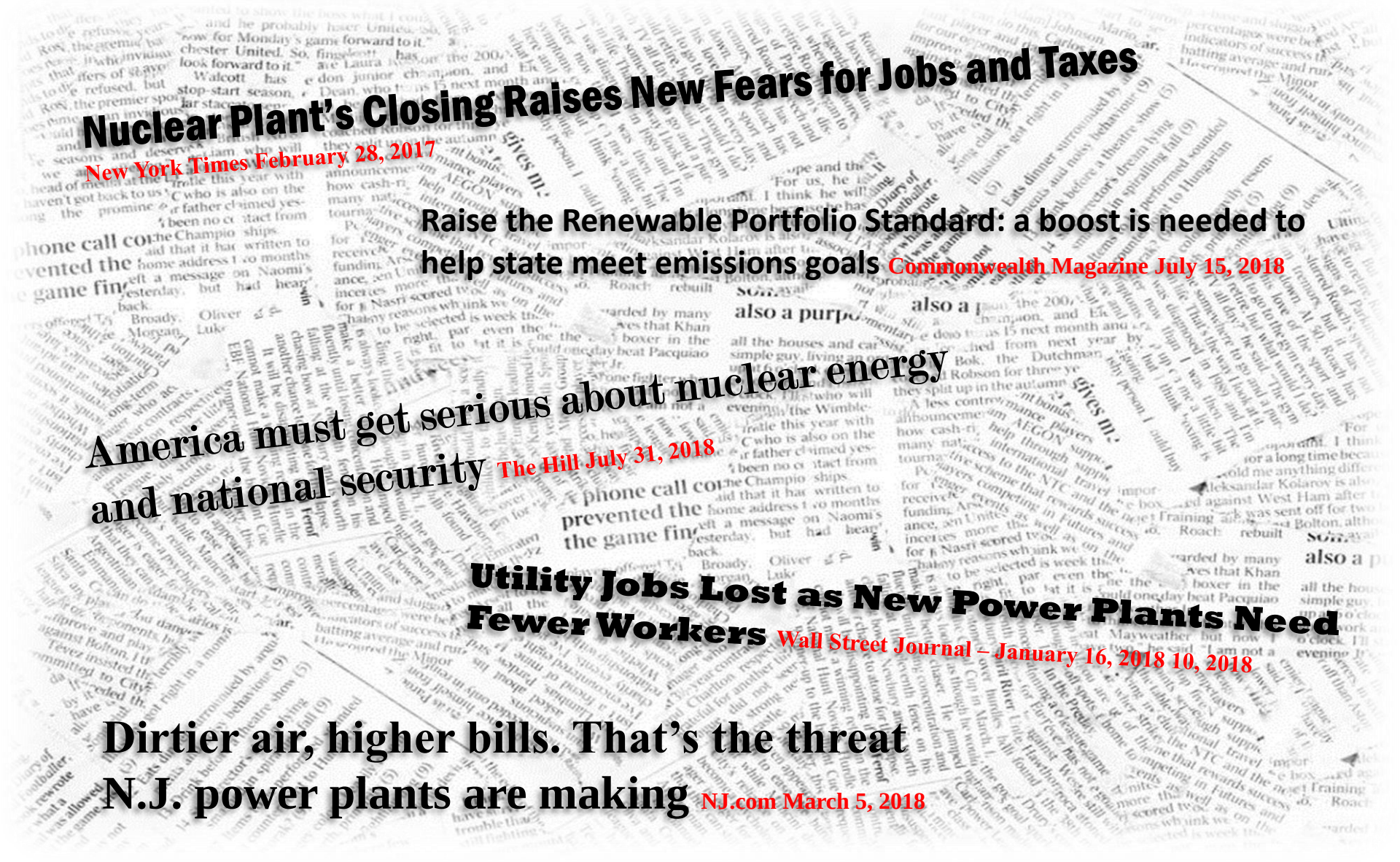
The latest transformation of the U.S. generation sector is focused on decarbonization



In the power generation sector there are currently three market structures, when ideally there should be two



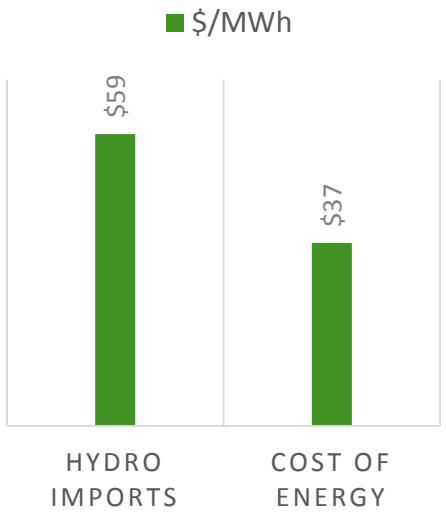
New capacity decisions are shift from the goal of lowest cost to policy makers picking winners and losers



Some current examples of how policy makers are making decisions about new capacity

Canadian Hydro Imports

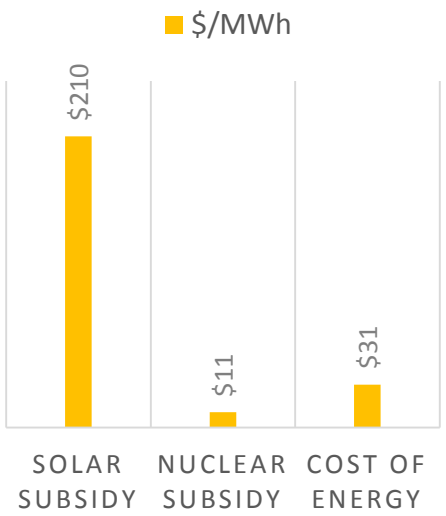
New England ISO redesigned part of their market to accommodate a State's preference to import hydro.



$557 MM/Year

New Jersey Nuclear and Solar Subsidies

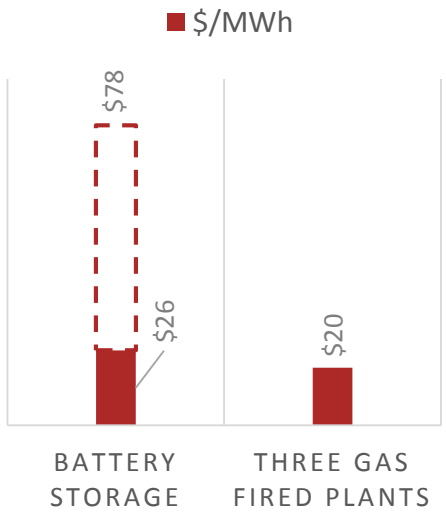
PJM ISO (Mid-Atlantic) awaiting FERC ruling to carve up existing market into subsidized vs. unsubsidized resources.



$300-$600 MM/Year

Metcalf Battery Replacement

California public utility commission required that a combined cycle and two peakers be replaced by lithium-ion batteries.

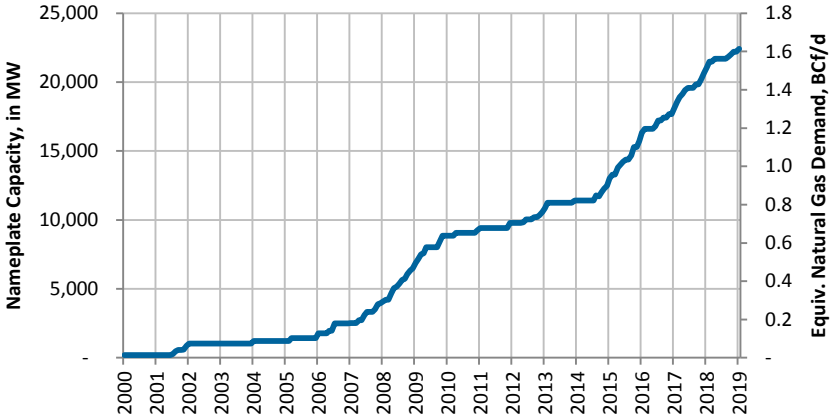


Est. $120 MM/Year

Sources: Hydro Cost- MassDoer. New England Annual Report 2017 Wholesale Cost of Energy. Nuclear and Solar Cost- New Jersey Senate Bill S2313. PJM Annual Report 2017 Wholesale Cost of Energy. Battery Storage Cost- CPUC. CAISO 2017 Annual Report 2017 Wholesale Cost of Energy.

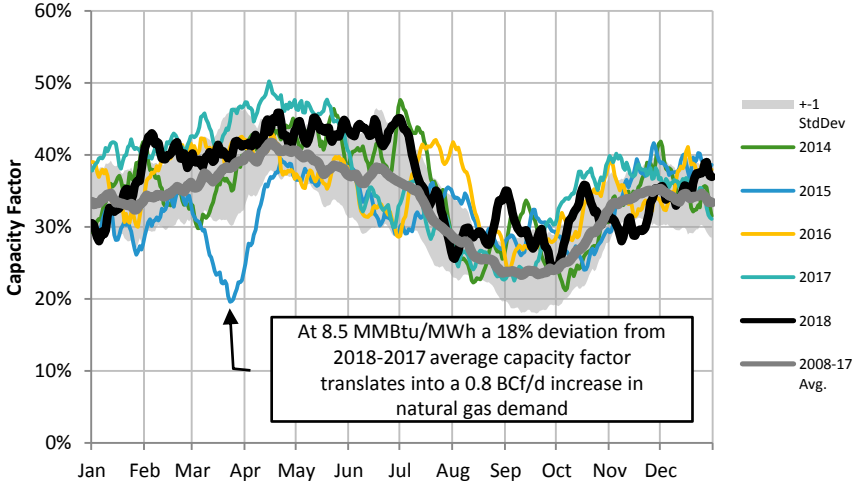
Heavily subsidized wind generation is reducing natural gas demand from power and increasing hourly demand volatility

Wind generation in ERCOT has increased significantly and is contributing to lower natural gas demand



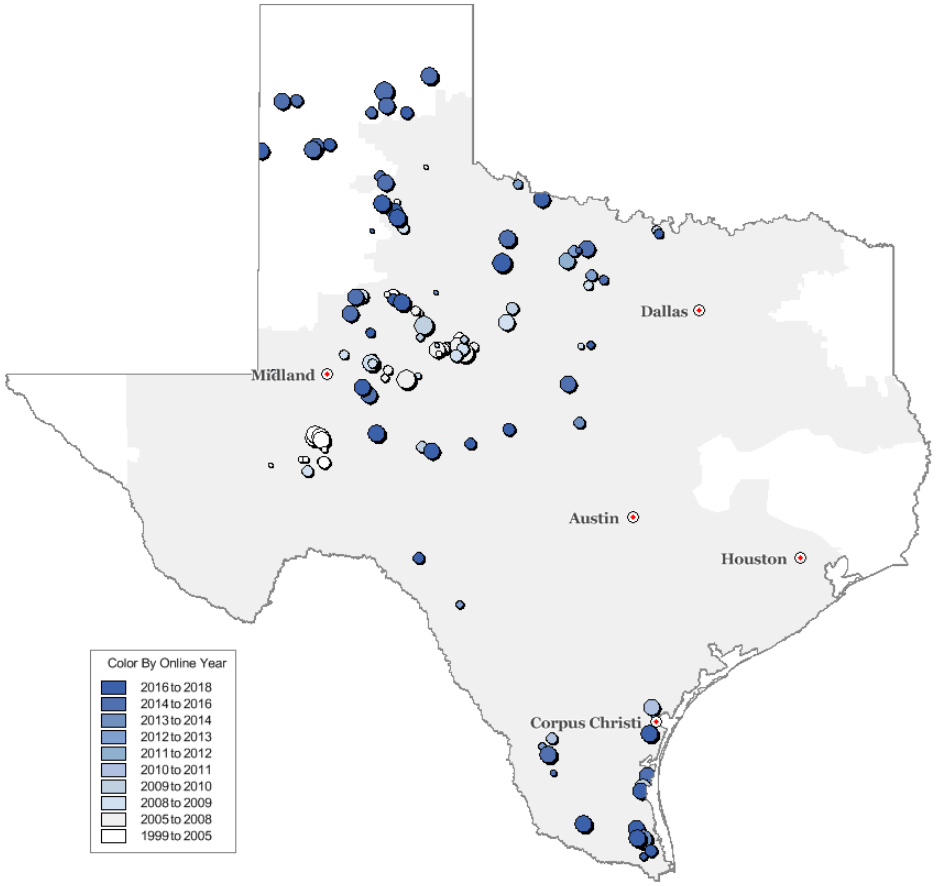
Note: Equivalent natural gas demand estimated assuming 8.5 MMBtu/MWh heat rate and a 35% capacity factor
Source: EIA via ABB/Energy Velocity and Company Analysis, Jan. 2019

Natural gas demand from power can swing wildly when its not windy



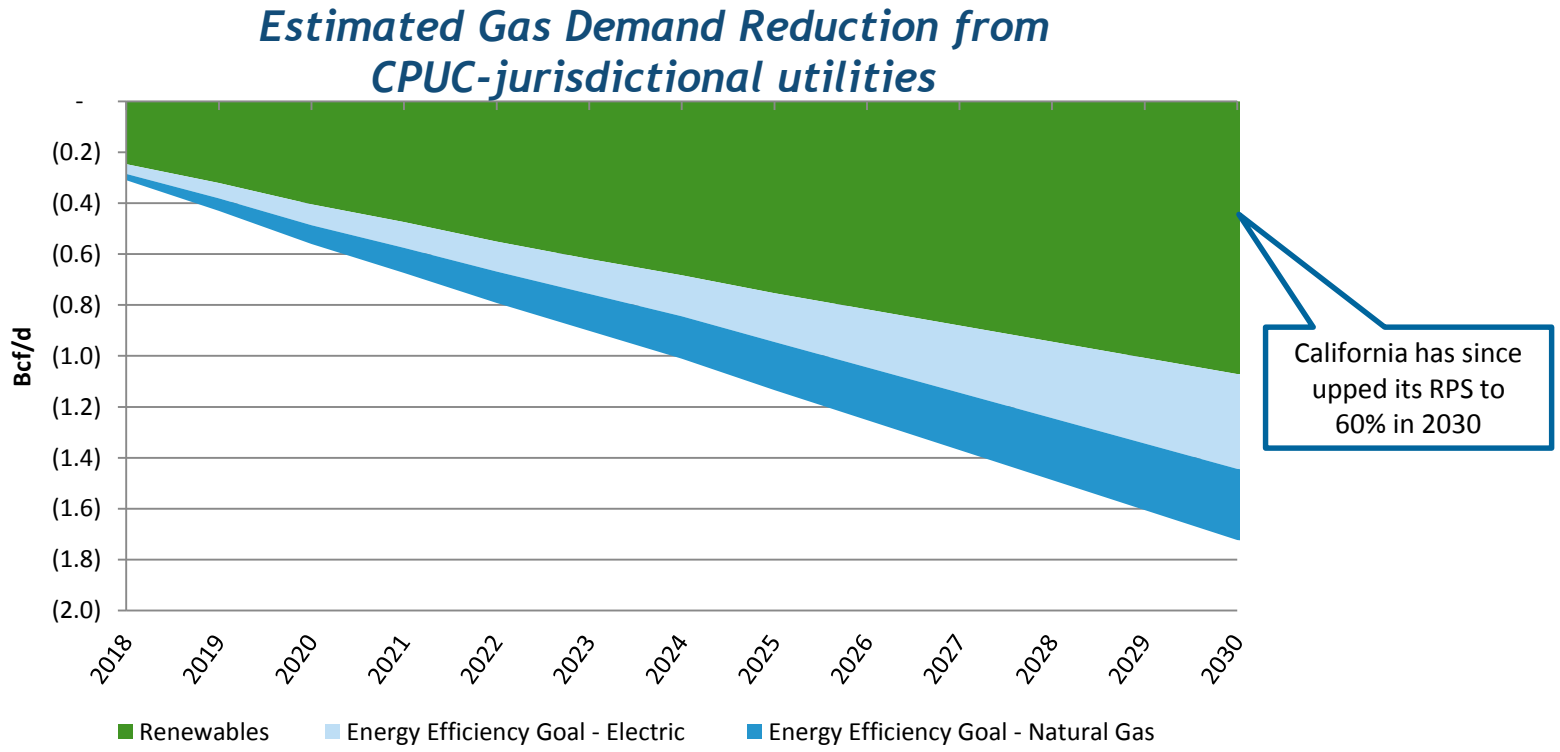
Source: ERCOT ISO and Company Analysis, Jan. 2019

In addition to subsidies, wind generation has required massive investment in the transmission grid funded by ratepayers in order to get electrons to markets



In 2015, the California legislature enacted legislation that will result in a reduction of natural gas demand

- **Clean Energy and Pollution Reduction Act (SB 350)** – requires the amount of electricity generated and sold to retail customers from eligible renewable resources be increased to 50% by December 31, 2030
- **Energy Efficiency Act (AB 802)** – aggressive state directives to increase the energy efficiency of buildings



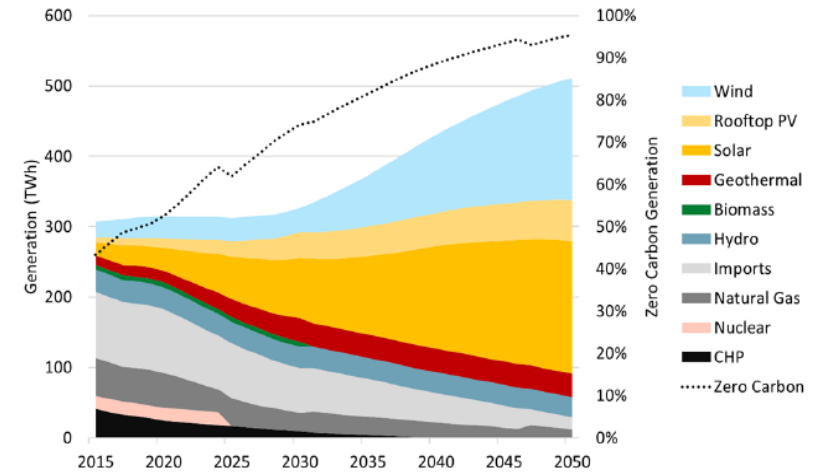
Source: 2018 California Gas Report. Prepared by the California Gas and Electric Utilities. Prepared in conjunction with the California Public Utilities Commission (CPUC)

Increases in renewable generation will reduce total natural gas demand an result in a increase in the daily and hourly load-forecast variance associated with operation of the natural gas-fueled electric generation system

While it is easy to speculate about the removal natural gas from the electric sector, it is much harder to do in reality

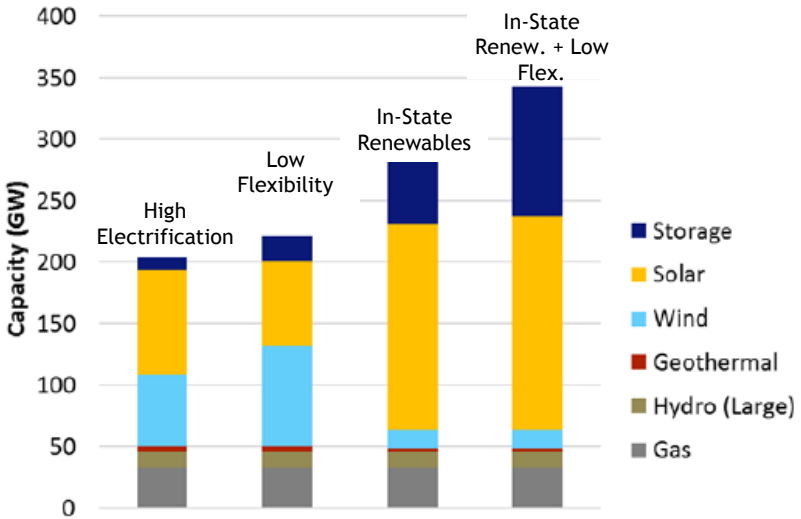
Carbon Reductions in Sectors Outside the Electric Sector Often Increase Electric Demand because the they Require Electrification (i.e. EVs)

Electric Generation by Fuel Type
(High Electrification Scenario)



Source: E3

2050 California Installed Nameplate Capacity



Source: E3

Notes: Graphs sourced from *Deep Decarbonization in a High Renewables Future*

Natural gas demand for power declines but natural gas generation capacity requirements remain stable because existing gas generation remains the cheapest option for multi-day weather events, i.e., multiple days where the wind doesn't blow and the sun doesn't shine. Compensation for gas generators will have to change.