

UH Energy
2021 Texas Spring Energy Forum

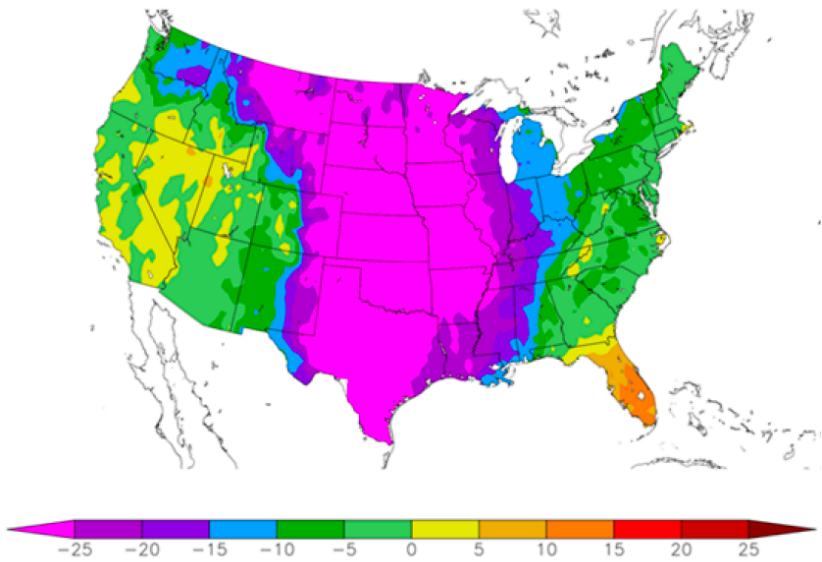
Green Power Supply in Texas
(plus, a recap of the freeze event)

MARCH 2021

Apex·CAES

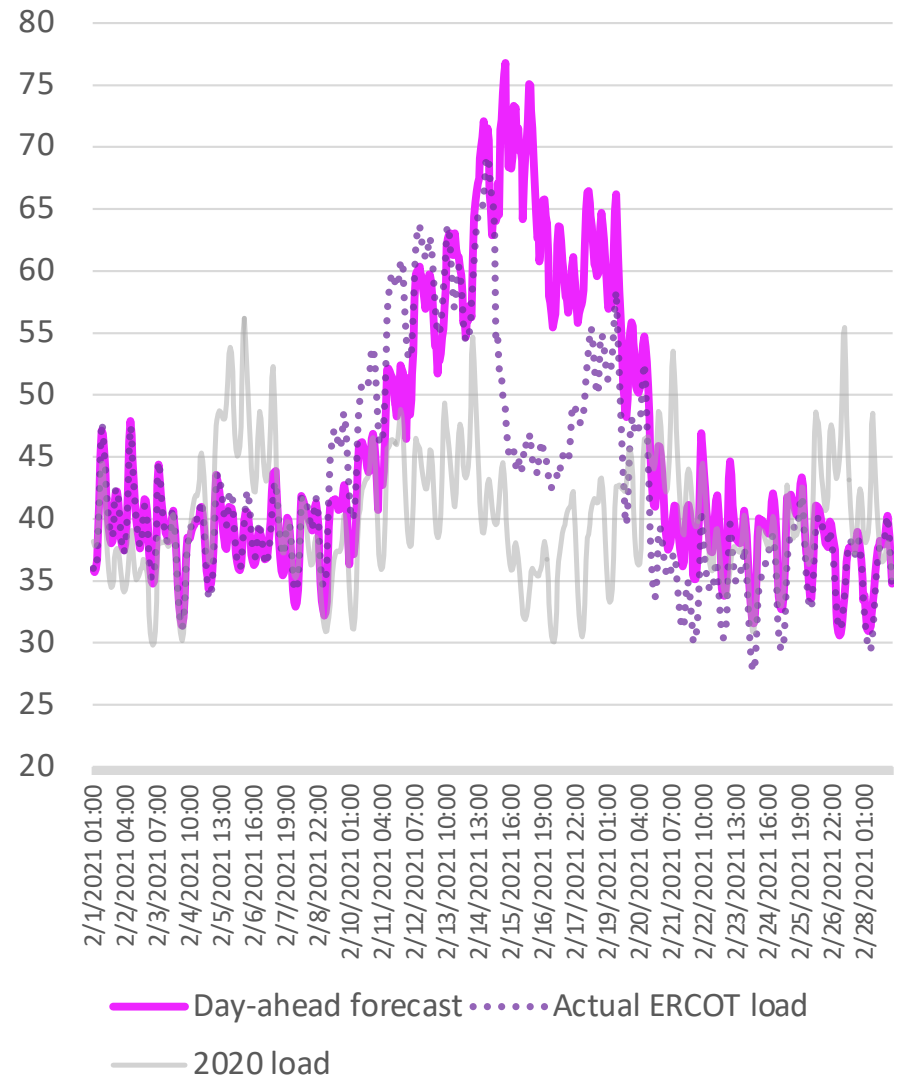
PRELIMINARY REVIEW OF THE FEBRUARY 2021 WINTER FREEZE - DEMAND

Departure from normal temperature



- Record low temperatures for largest cities in Texas – cold temperatures persisted for >3 days
- Record high winter power demand projected at 77 GW (but for involuntary load sheds)
- Summer 2019 & 2020 peak loads reached 74 GW without an involuntary loss of load

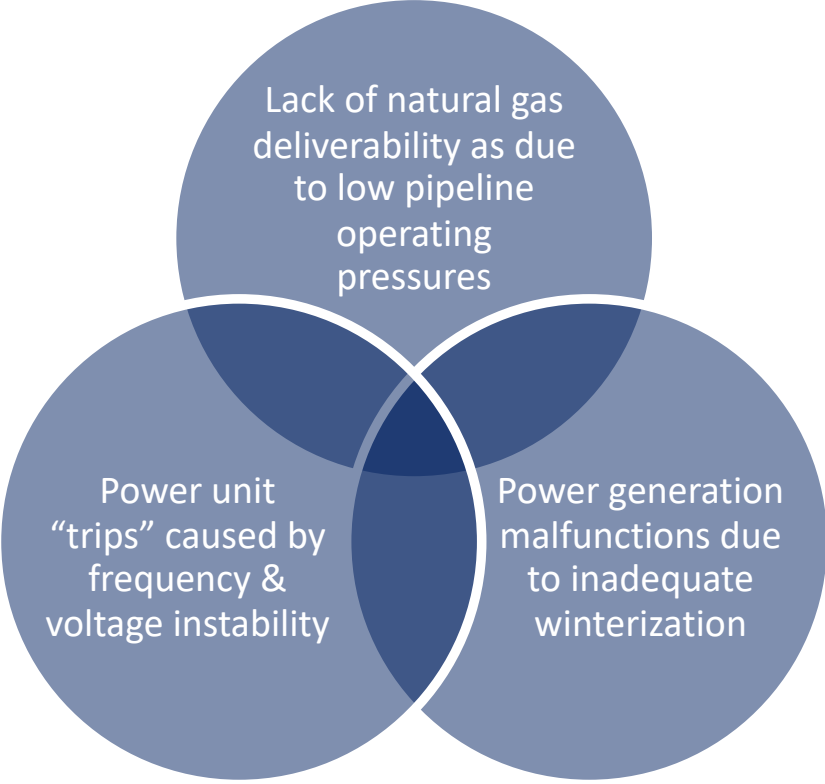
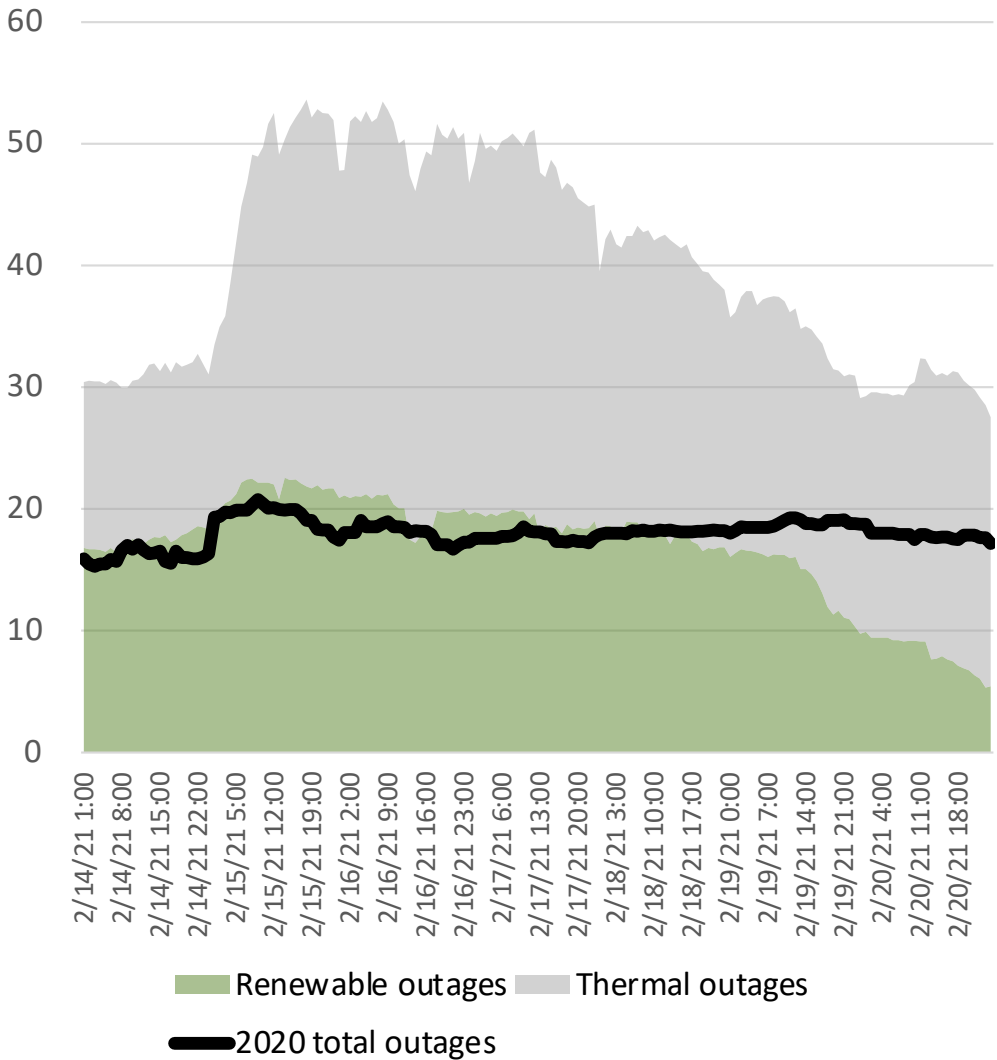
ERCOT hourly loads, GW



Sources: NOAA; ERCOT

PRELIMINARY REVIEW OF THE FEBRUARY 2021 WINTER FREEZE – SUPPLY

ERCOT power generation losses, GW



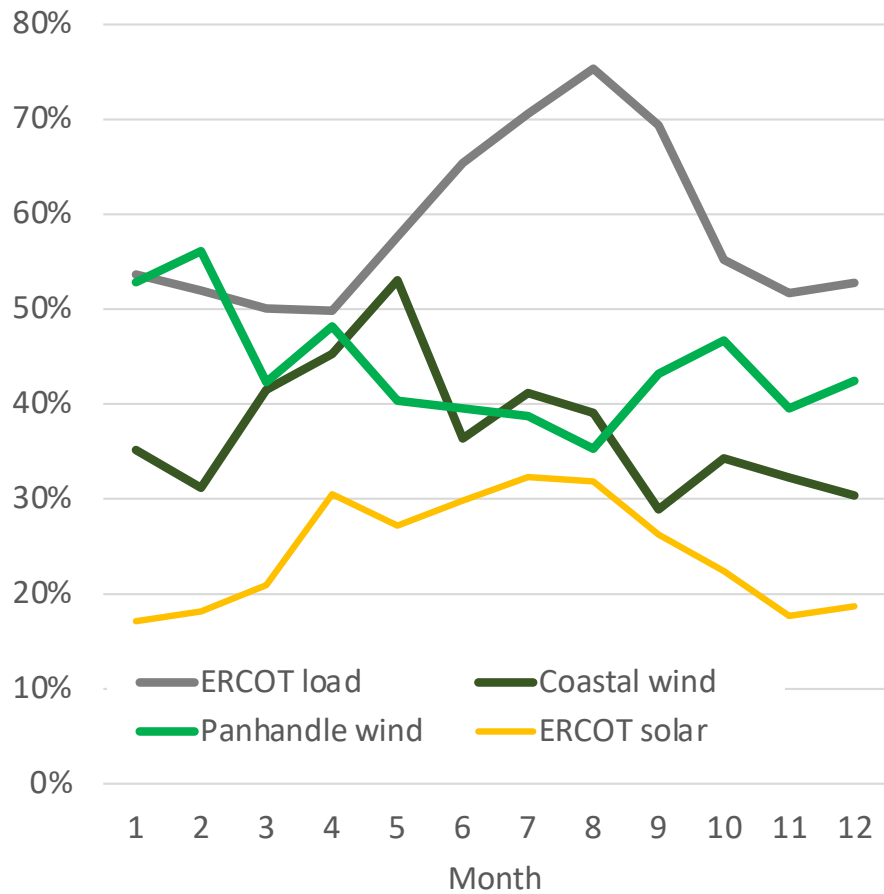
\$9,000/MWh price cap intended to act as an incentive/penalty for power plant performance, but no power price level could overcome these outages in real-time

Sources: ERCOT
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 @ApexCAES on Twitter

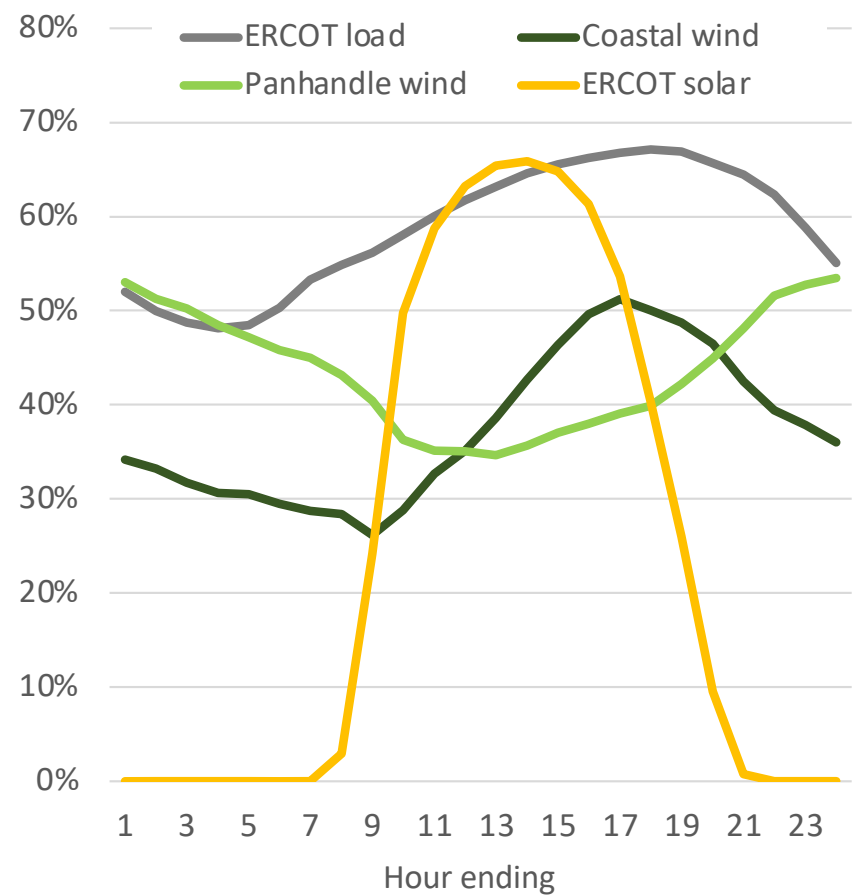
PROCURING GREEN SUPPLY IN ERCOT

- Renewable Energy Credits (REC) from existing wind/solar resources
- “Dedicated RECs with additionality” from new wind/solar resource
- CO2 offsets from a domestic or international program (e.g., forestry, land fill gas capture) or CO2 “allowances” programs

Monthly capacity factor of load and renewable resources*



Diurnal capacity factor of load and renewable resources*

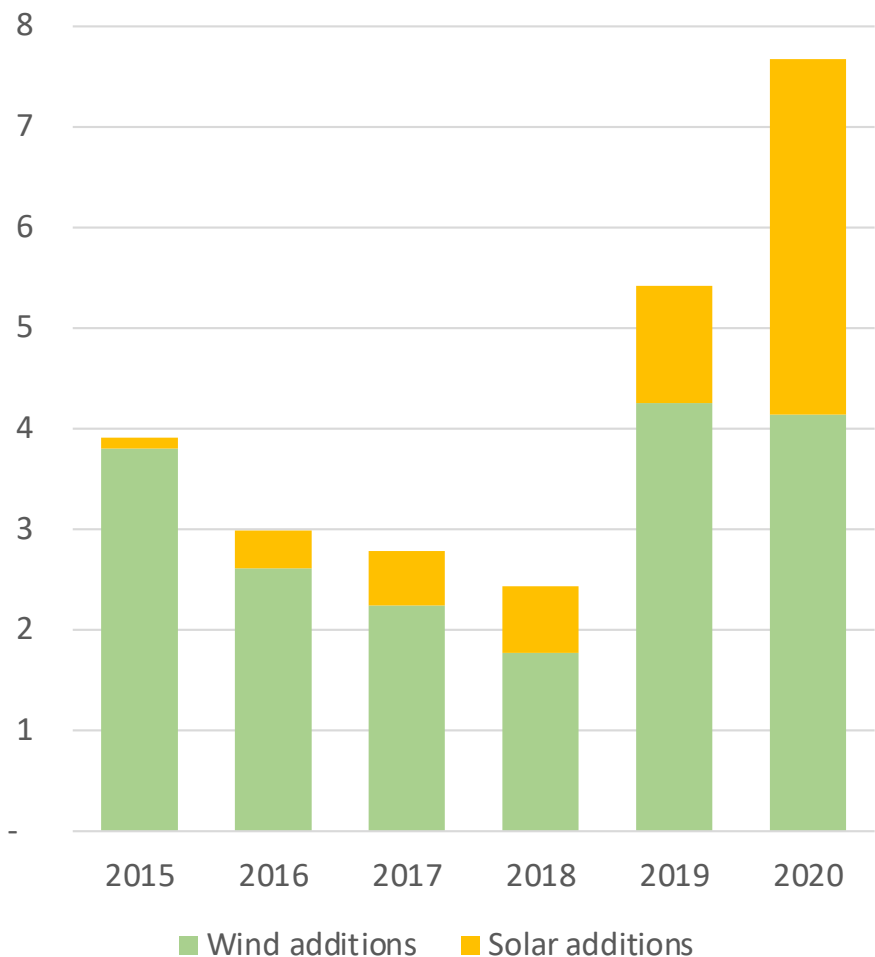


* 2019 hourly actual capacity factors

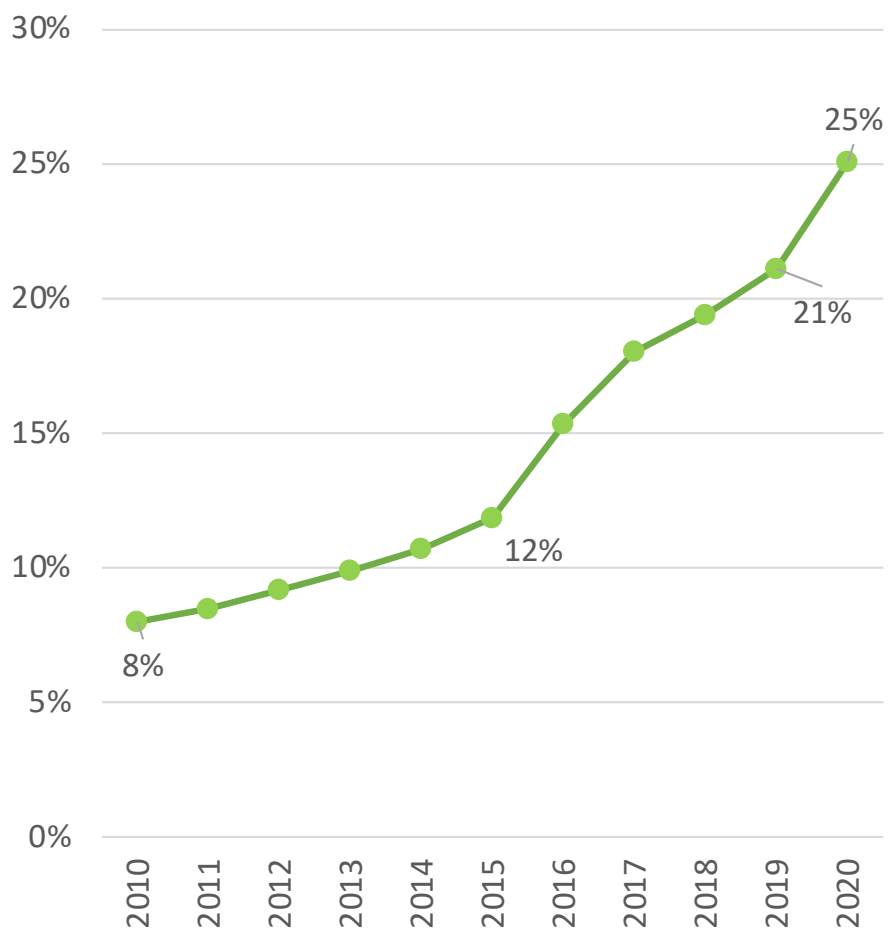
Sources: ERCOT 2019 Generation by Fuel Type Reports; ERCOT 60-day SCED data for selected wind resources

ERCOT RENEWABLE ADDITIONS ARE BOOMING

2015-2020 ERCOT renewable additions, GW per year

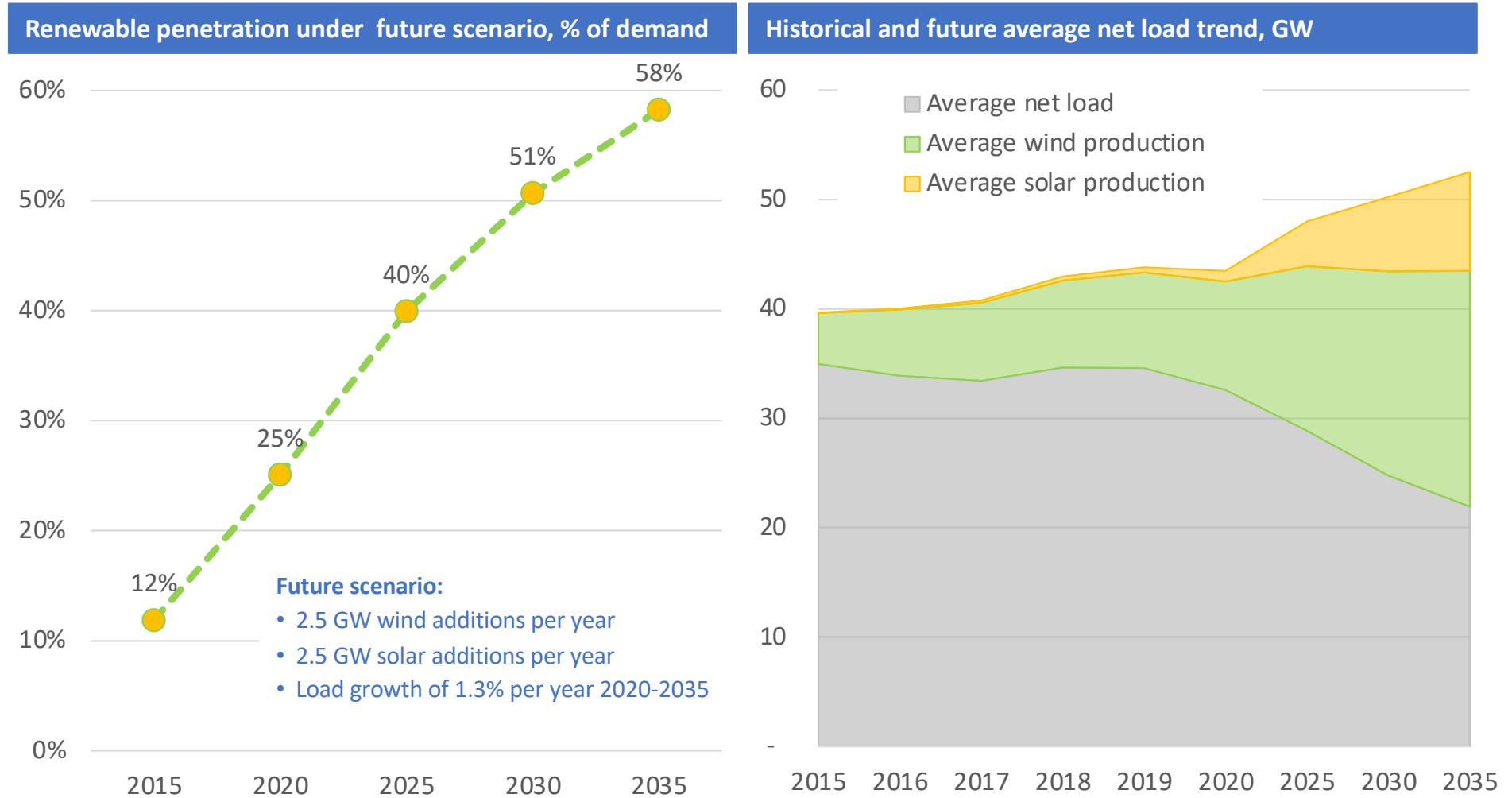


2011-2019 renewable penetration, % share of total supply



Sources: ERCOT Generation by Fuel Type reports 2010-2020; ERCOT Generation Interconnection Status report December 31, 2020

GROWING RENEWABLE PENETRATION SHRINKS AVERAGE THERMAL PRODUCTION

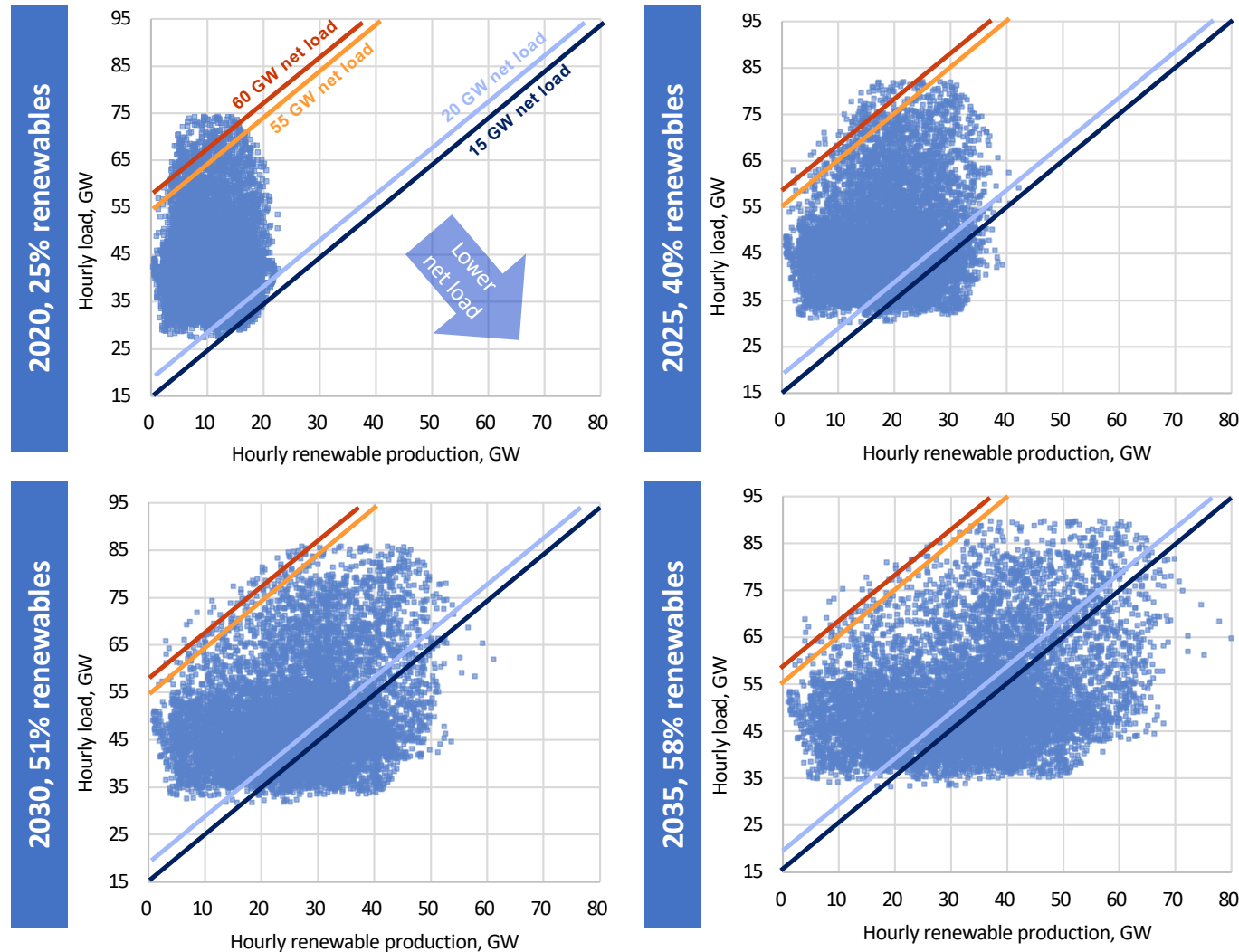


Sources: ERCOT Generation by Fuel Type Reports 2015-2020; ERCOT Native Load reports 2015-2020; ERCOT Hourly Most Recent Short Term Wind Power Forecasts for 2020; ERCOT Long Term Load Forecast December 2020

2025-2035 based on 2020 load and renewable production patterns (wind production based on hour-ahead forecast); assumes 2.5 GW/ year of wind additions and 2.5 GW/year of solar additions and ERCOT projected load growth

CONTINUED GROWTH IN RENEWABLES RESULTS IN EXTREME NET LOAD VARIABILITY

Load distribution grows some while renewable distribution grows enormously



- The variability of net load is a function of the combined variability of demand and renewable production
- The hourly variability in wind and solar production, relative to average production, is far greater than the variability of demand
- Thus, strong growth in renewable production creates a wider range of net load outcomes

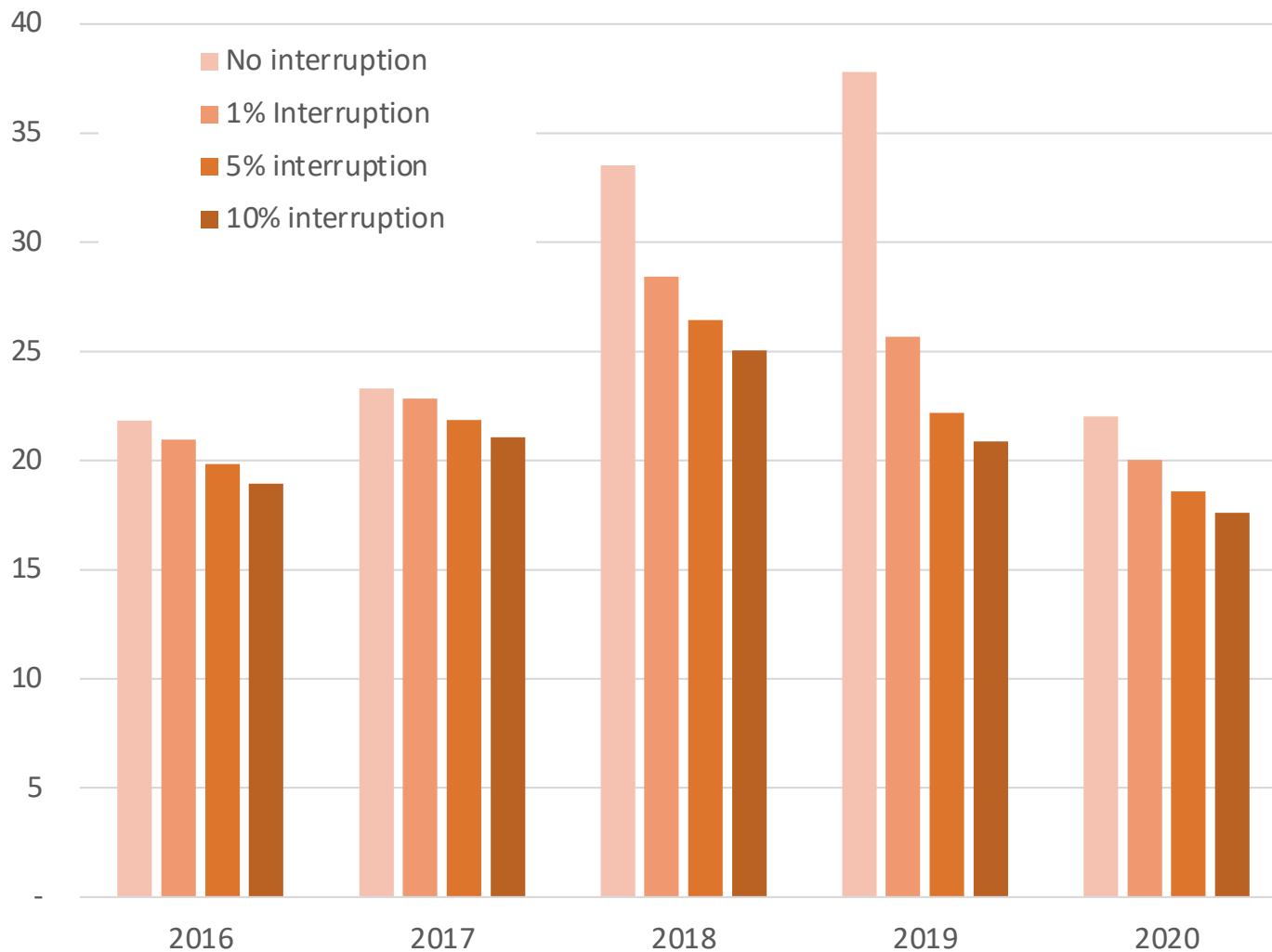
- Three key market changes emerge:
 - ① Rapidly increasing frequency of renewable curtailment with near \$0/MWh pricing
 - ② Magnitude of peak net load is largely unchanged as solar production shifts scarcity pricing to the post-sundown hours
 - ③ Larger hour-to-hour net load ramps increase price volatility

Sources: ERCOT Generation by Fuel Type Reports 2015-2020; ERCOT Native Load reports 2015-2020; ERCOT Hourly Most Recent Short Term Wind Power Forecasts for 2020; ERCOT Long Term Load Forecast December 2020

2025-2035 based on 2020 load and renewable production patterns (wind production based on hour-ahead forecast); assumes 2.5 GW/ year of wind additions and 2.5 GW/year of solar additions and ERCOT projected load growth

VALUE OF DEMAND FLEXIBILITY IS HIGH AND LIKELY TO GROW WITH INCREASING RENEWABLE PENETRATION

2016-2020 average hourly North Hub prices under various supply interruption levels, \$/MWh

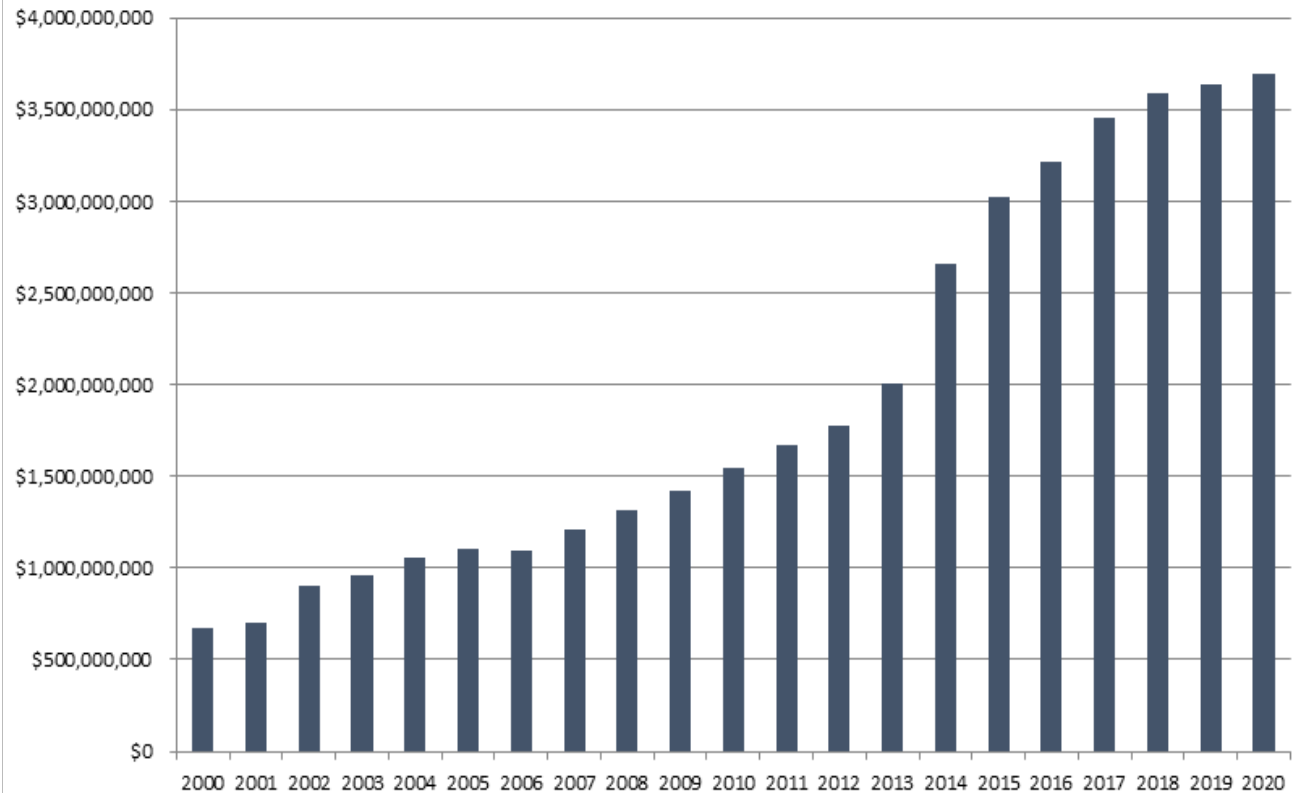


- 10% demand interruption flexibility would save...
 - \$2 to 17/MWh
 - 10 to 45%
- 1% demand interruption flexibility would save...
 - \$0.50 to 12/MWh
 - 2 to 32%
- Demand flexibility also creates additional cost savings:
 - Congestion
 - Ancillary Services
 - Transmission

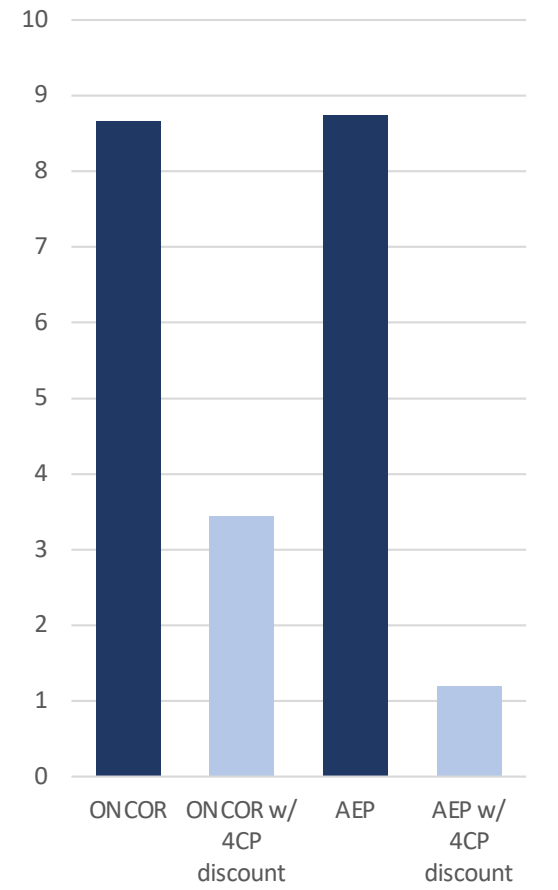
Sources: ERCOT day-ahead prices 2016-2020

RISING TRANSMISSION COSTS CAN BE REDUCED BY AVOIDING "4CP" HOURS

ERCOT annual transmission costs



Transmission-level service with and without 4CP*



- 4CP discount varies by transmission owner
- 60% to 90% of transmission charge can be avoided by interrupting load on the 4 highest load hours in each summer month (i.e., 16 hours of 4CP hours) – June, July, August, and September

* Represent "transmission Service" for high load factor customer

Sources: NRG

PROCURING GREEN SUPPLY IN ERCOT – ADDITIONAL CONSIDERATIONS

Power supply contracting considerations

1. Best long-term pricing available from new wind/solar resources, but requires 10 to 15-year contract at fixed-price and uncertain delivery volumes hour-to-hour
2. Risk management for over/under supply from renewable resource versus demand profile
3. Congestion risk between supply node and Load Zone
4. Interconnection at transmission or distribution level – 4CP discount is large (\$5-7/MWh) but requires demand flexibility and transmission interconnection
5. Ancillary Services hedge (\$1 to 2/MWh)
6. Qualified Scheduling Entity and Retail Electric Provider services or costs (\$1 to 5/MWh)
7. Credit support (e.g., Parent Guarantee, Letter of Credit, cash collateral)
8. Bundle new renewable supply with retail services/hedges (e.g., NRG Renewable Select)