Energy storage: Opportunities and the potential role of long-duration storage in the U.S. power grid

Presentation to NARUC
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Overview

- What are the main roles of energy storage for the grid?
- What values and services should we focus on?

  …and not focus on…
- When might we transition to longer duration storage?

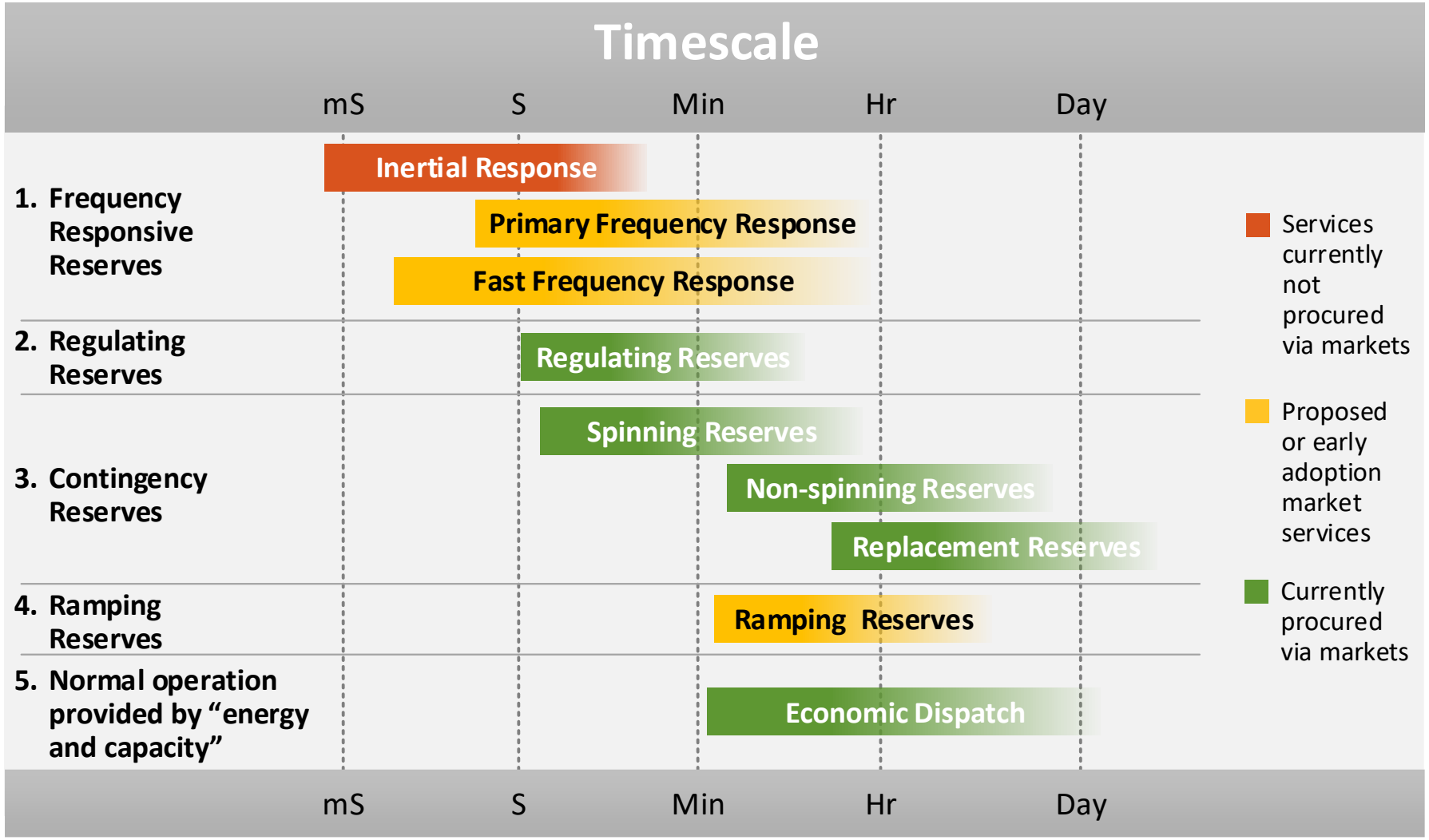
Recent Storage Installations

Year	Power (MW)	Weighted Avg. Duration (Hours)	Notes
2010-2014	208	0.7	Total power capacity includes 42 MW of PHS completed in 2012, but the duration average does include this plant
2015	155	0.5	
2016	198	1.3	
2017	122	2.2	
2018	222	2.3	
2019	170	2.7	
2020	491	1.2	Data dominated by a single 250 MW 1-hr plant
2021	3,252	2.6	99.9% of capacity listed as Li-Ion
2022	4,168	2.5	99.7% of capacity listed as Li-Ion.
Total	8,945	2.4	

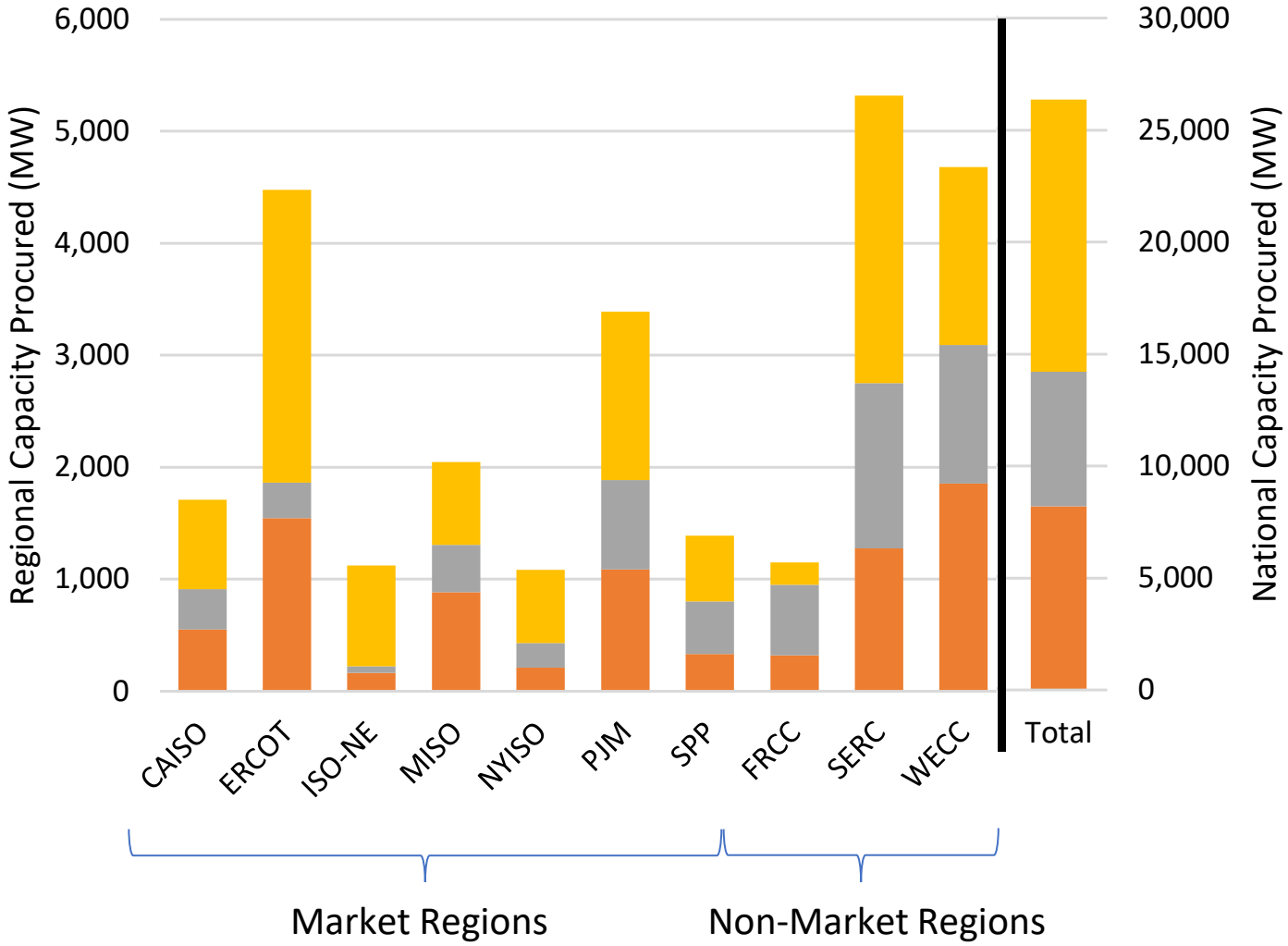
The average duration of plants completed in 2021 and 2022 is about 2.6 hours, with 2,850 MW of batteries with exactly four hours. Less than 7% of total capacity has a duration that exceeds 4 hours.

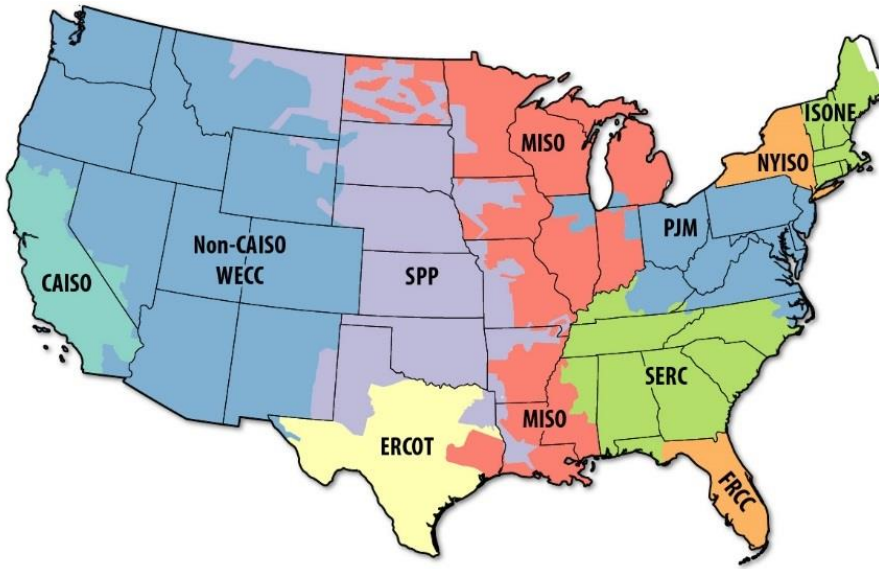
BUT WHY???

What Services to Consider?

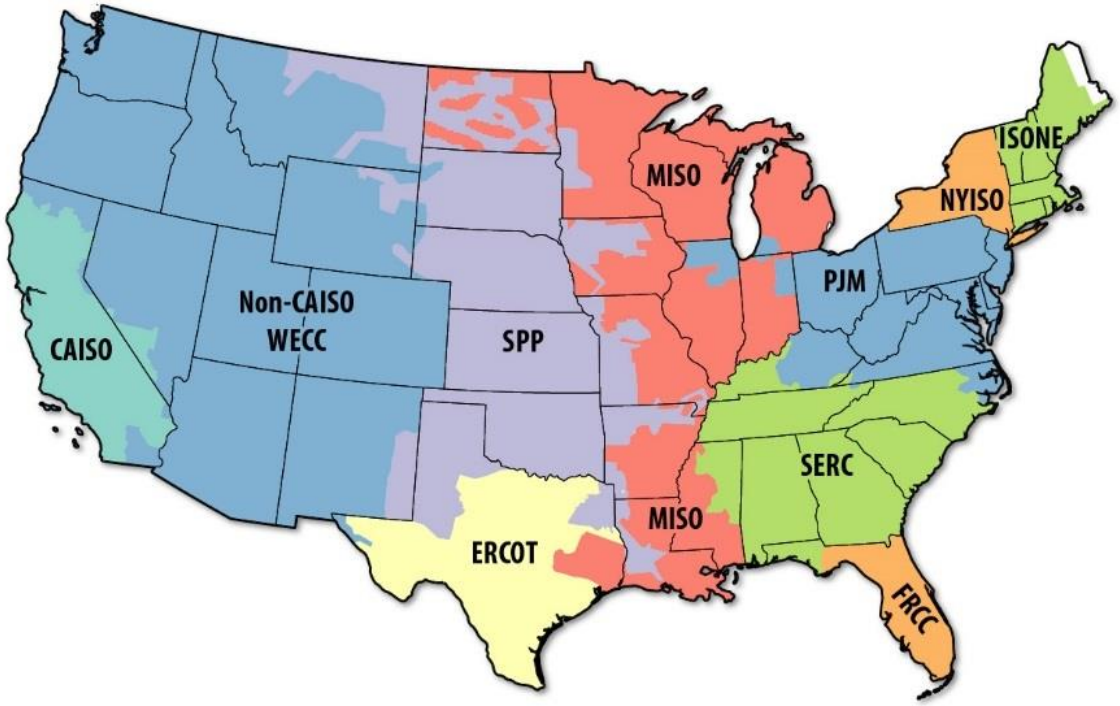


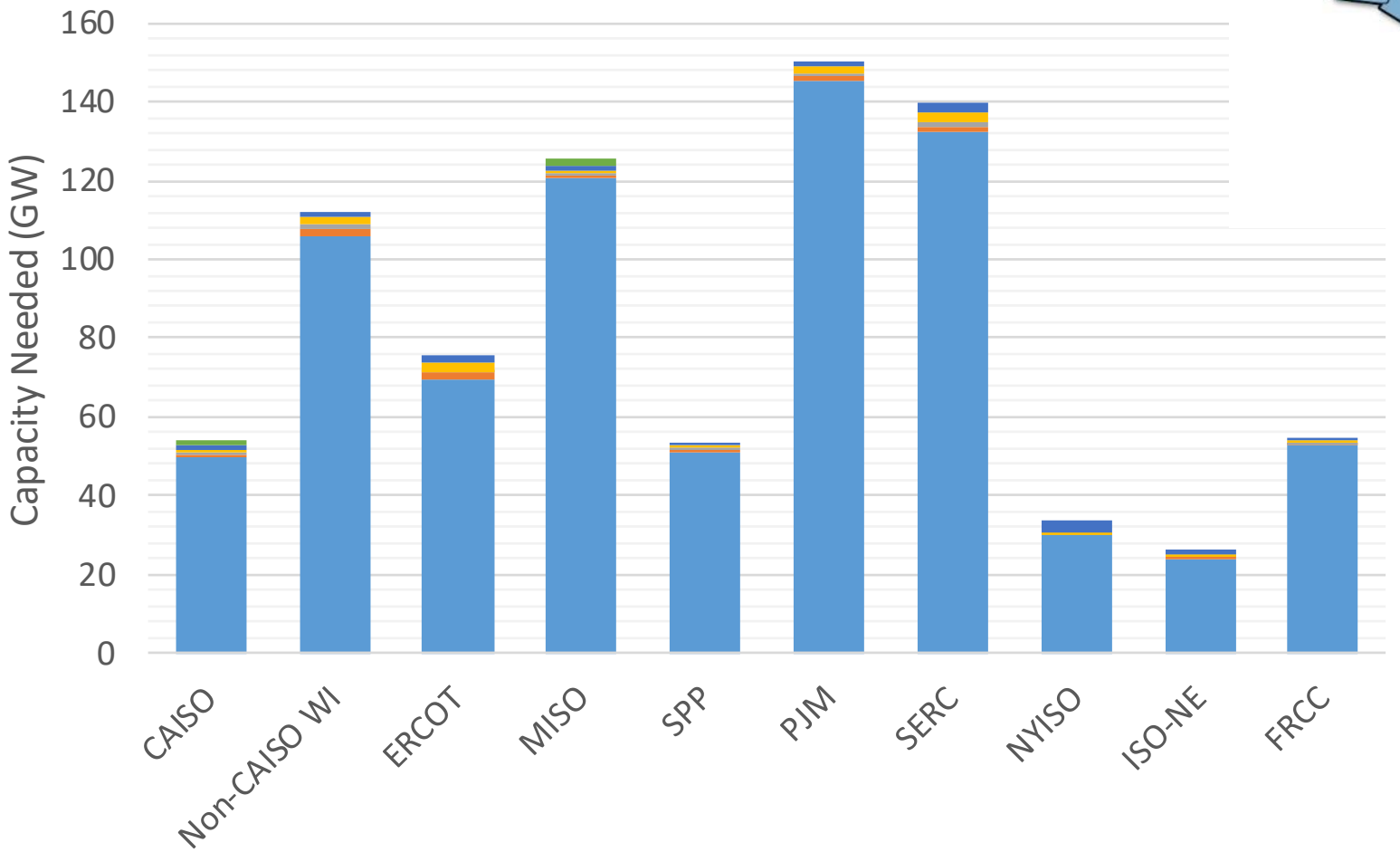
Operating reserves have been an important entry point for shorter duration storage





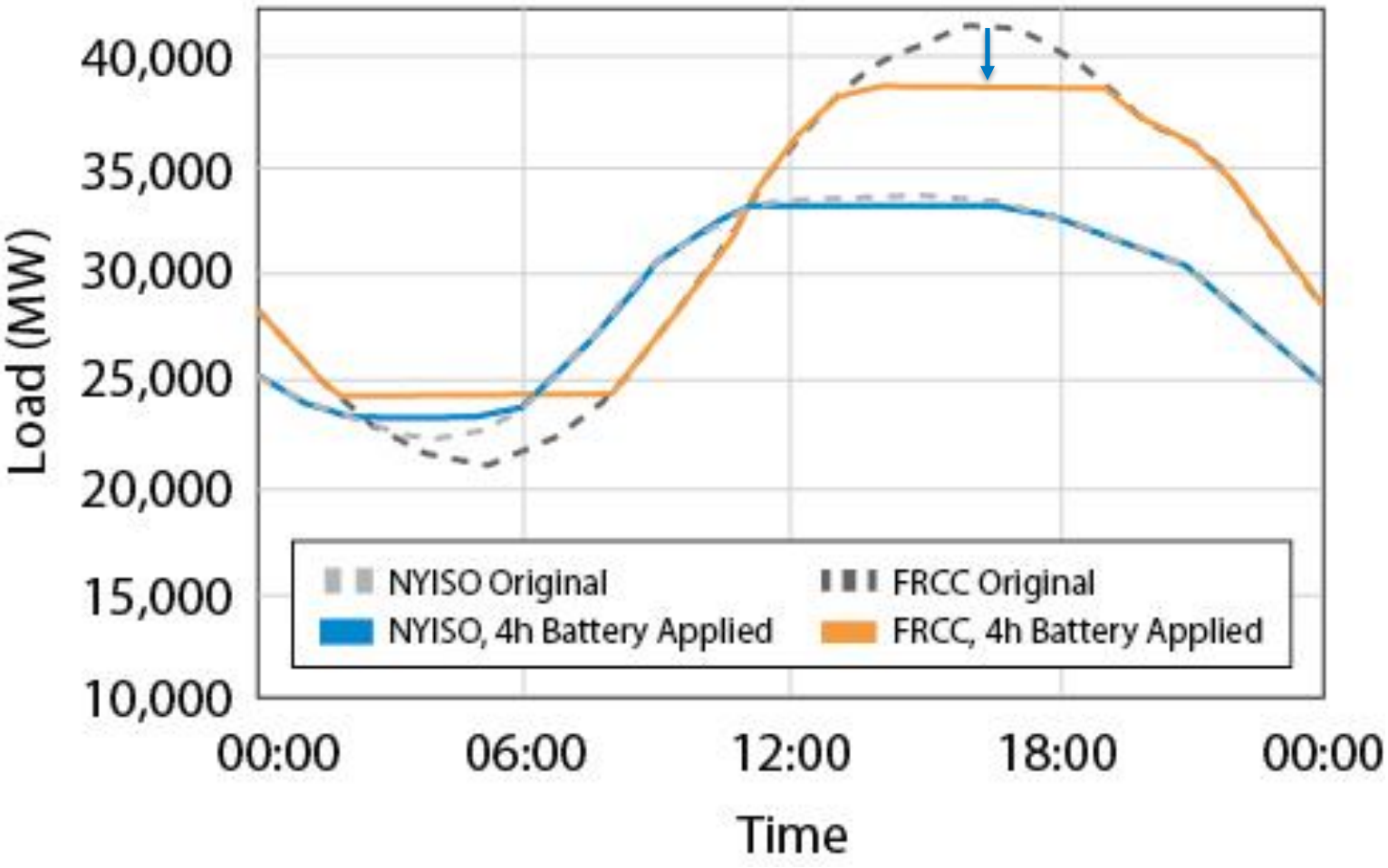
Focus of Storage is Shifting to Peaking/Firm Capacity





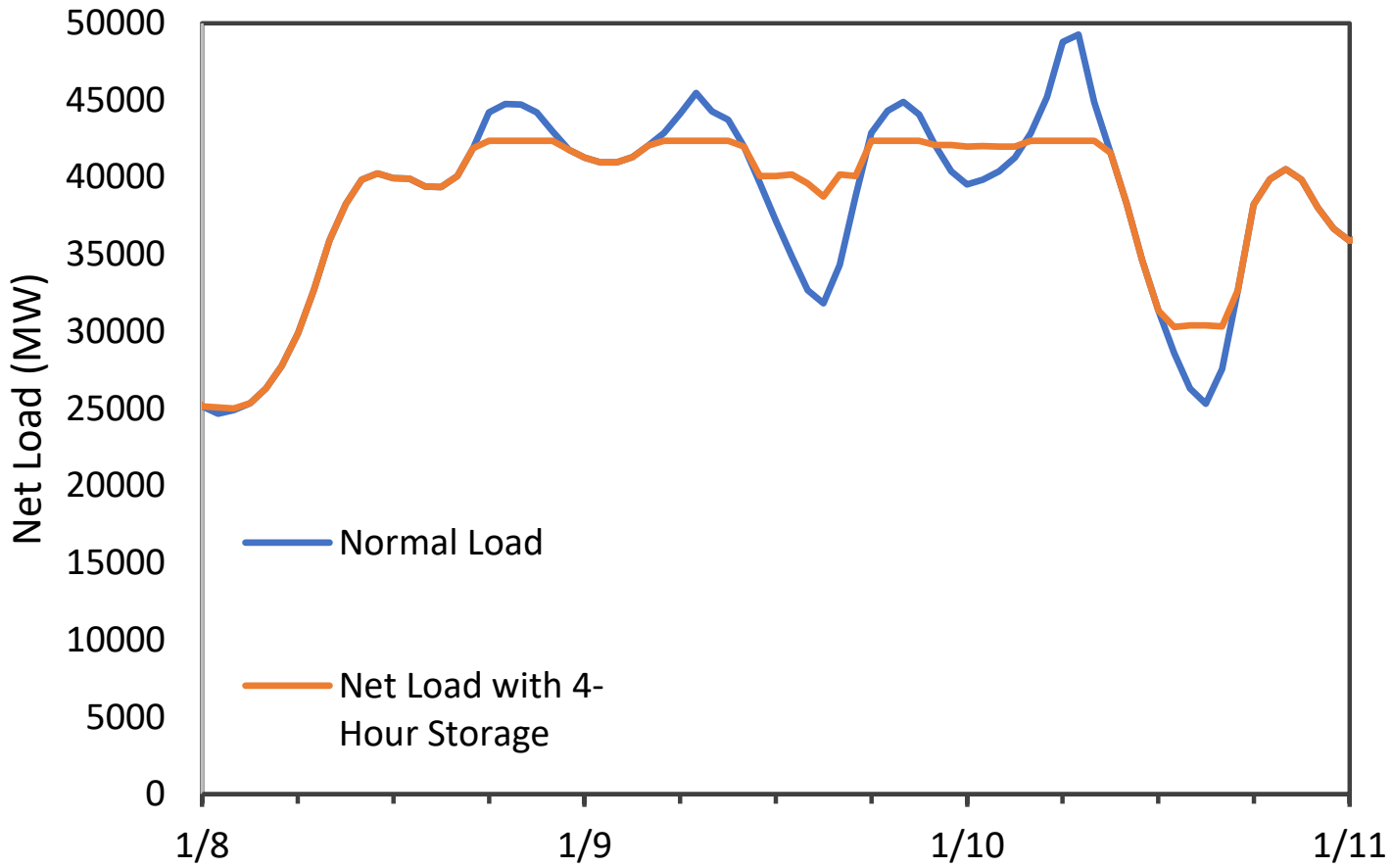
Storage Clipping the Summer Peak and Providing Firm Capacity

Storage can replace conventional peaking capacity



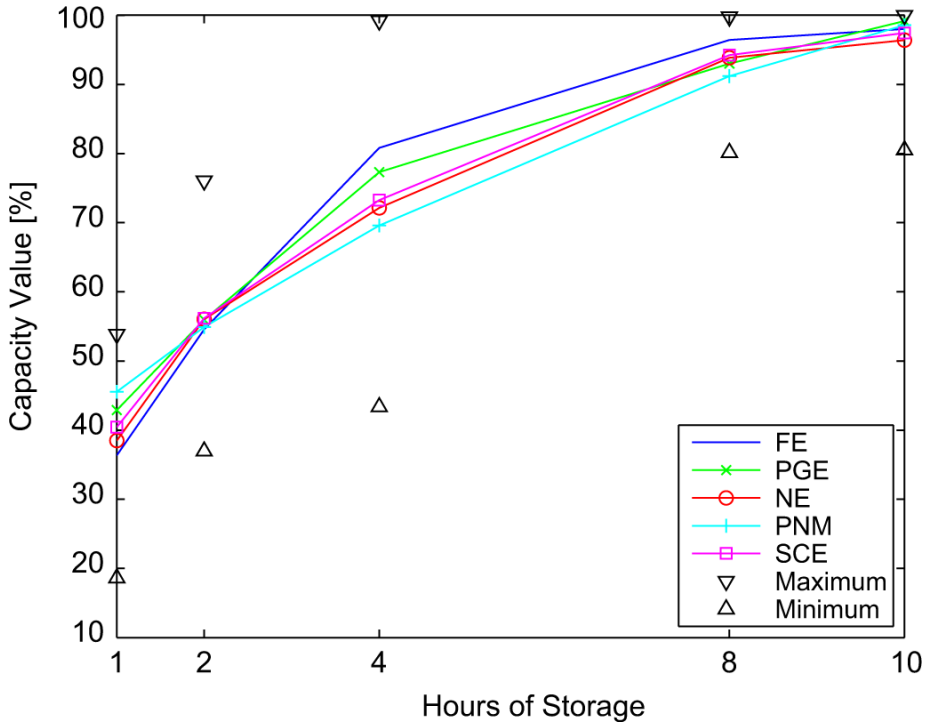
Storage Works during Winter Peaks As Well

Florida (many warm states can have significant winter peaks)



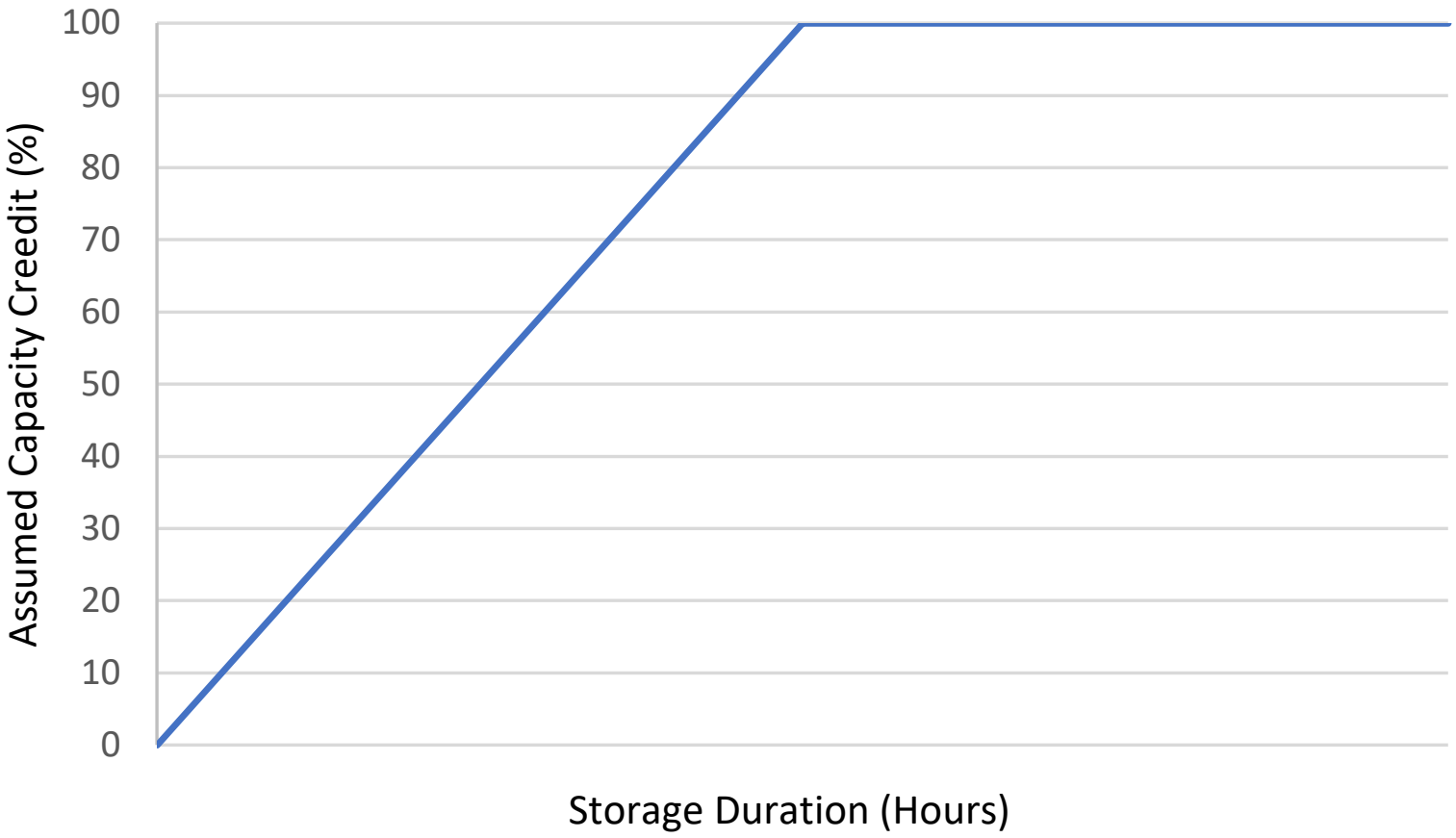
The Value of Capacity Depends on Capacity Credit

- Fraction of nameplate that can reliably serve load
- Capacity credit of storage varies as a function of duration



The math gets really tricky out here.

Many Markets Do This Instead…

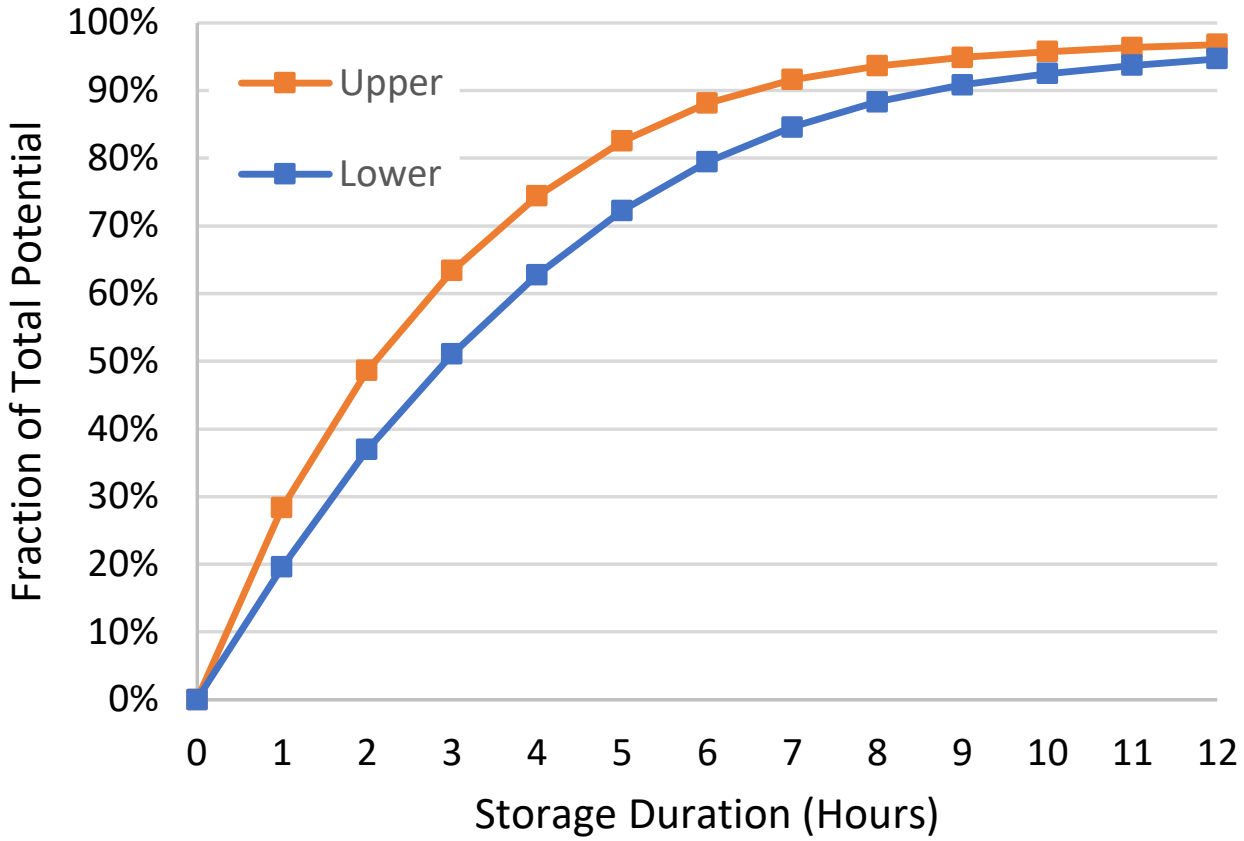


Market Operator	Duration Minimum (hours)
ISO-NE	2
CAISO	4
NYISO	4
SPP	4
MISO	4
PJM	~~10~~ (ELCC based)

Many regions have implemented a 4-hour requirement for resource adequacy

So the marginal value of adding a fifth hour is **zero**.

Energy Shifting Value

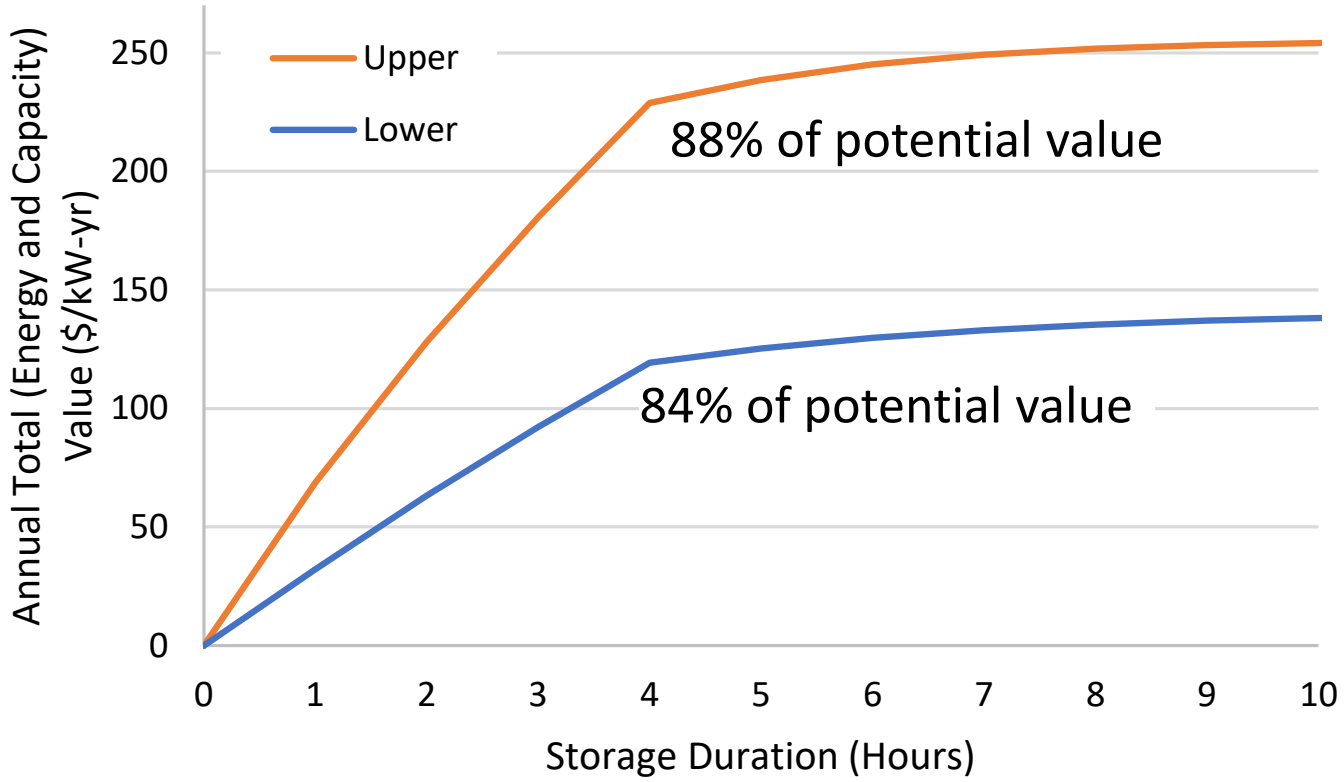


Example of the total value of energy time-shifting using a range of wholesale market prices

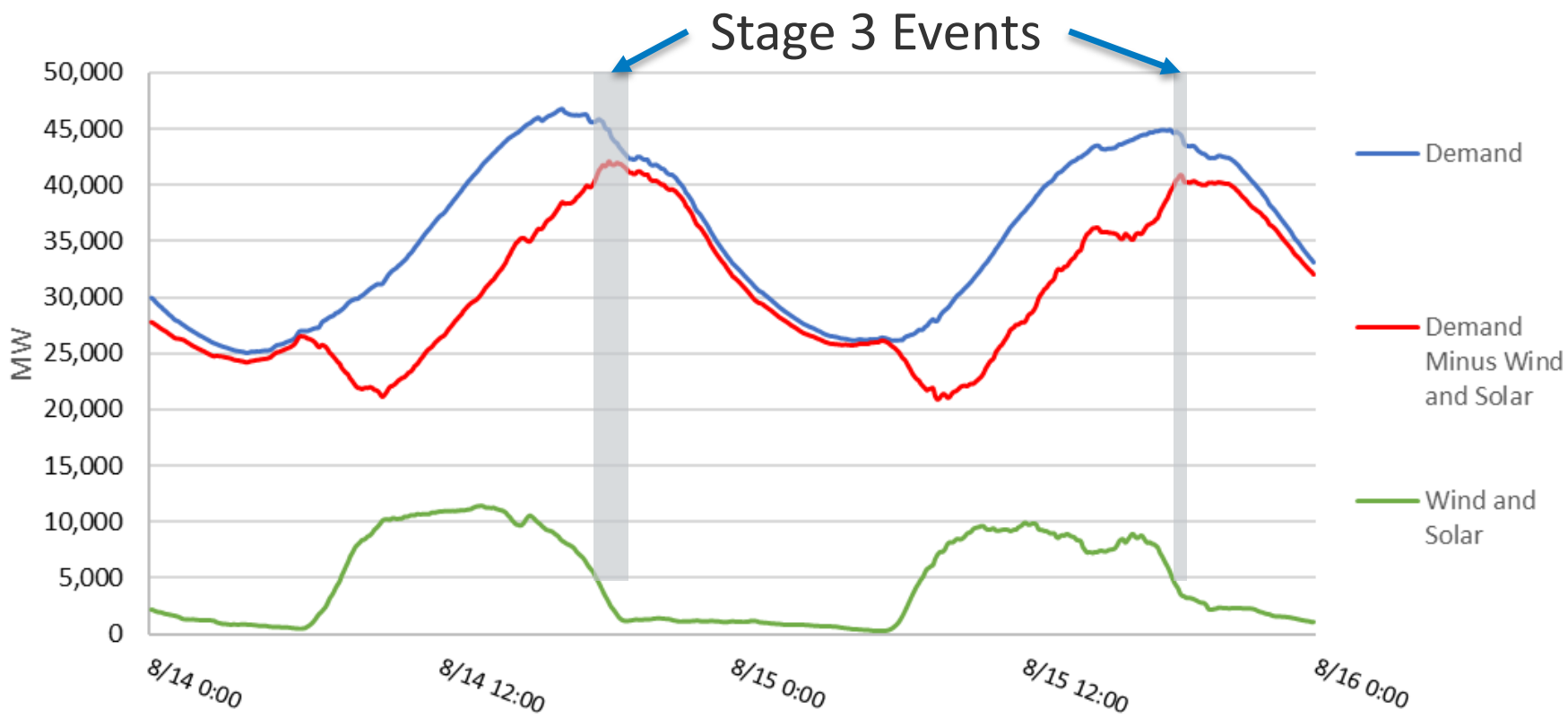
Bottom line

- Four hour storage captures most of the value in locations with a four-hour capacity rule

In market regions, you basically can not get paid for long duration storage

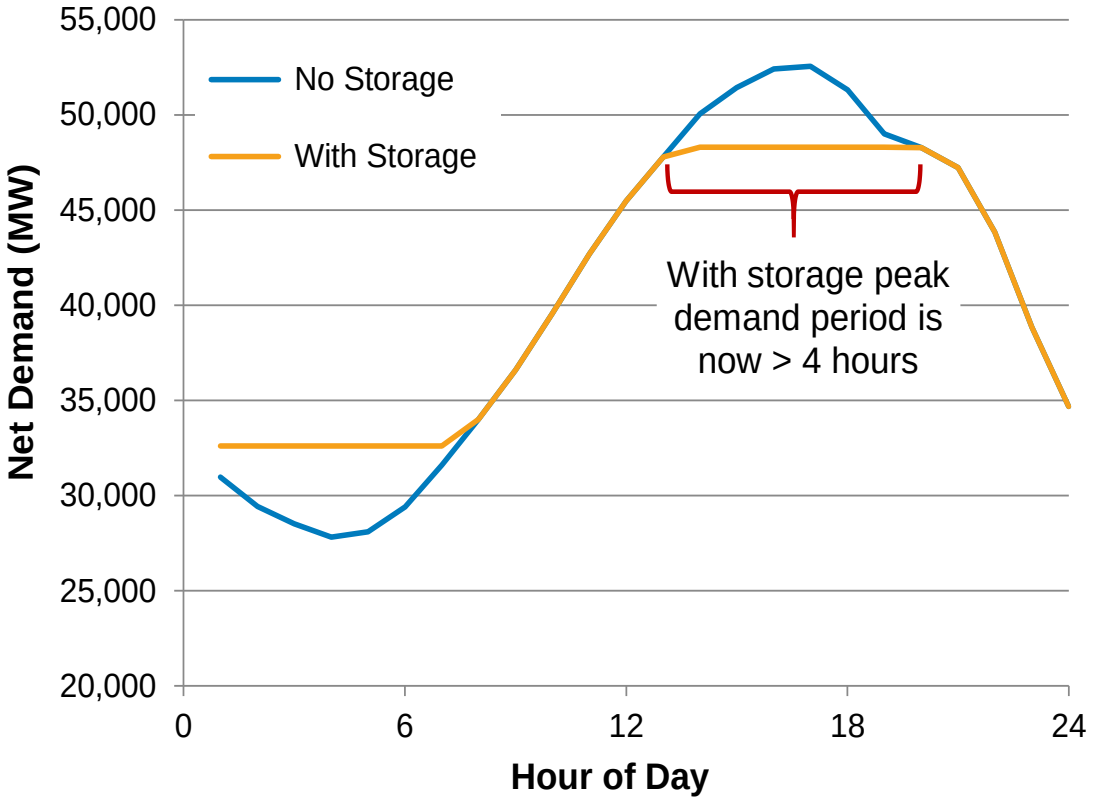


And Four Hours Should be Enough For Now….

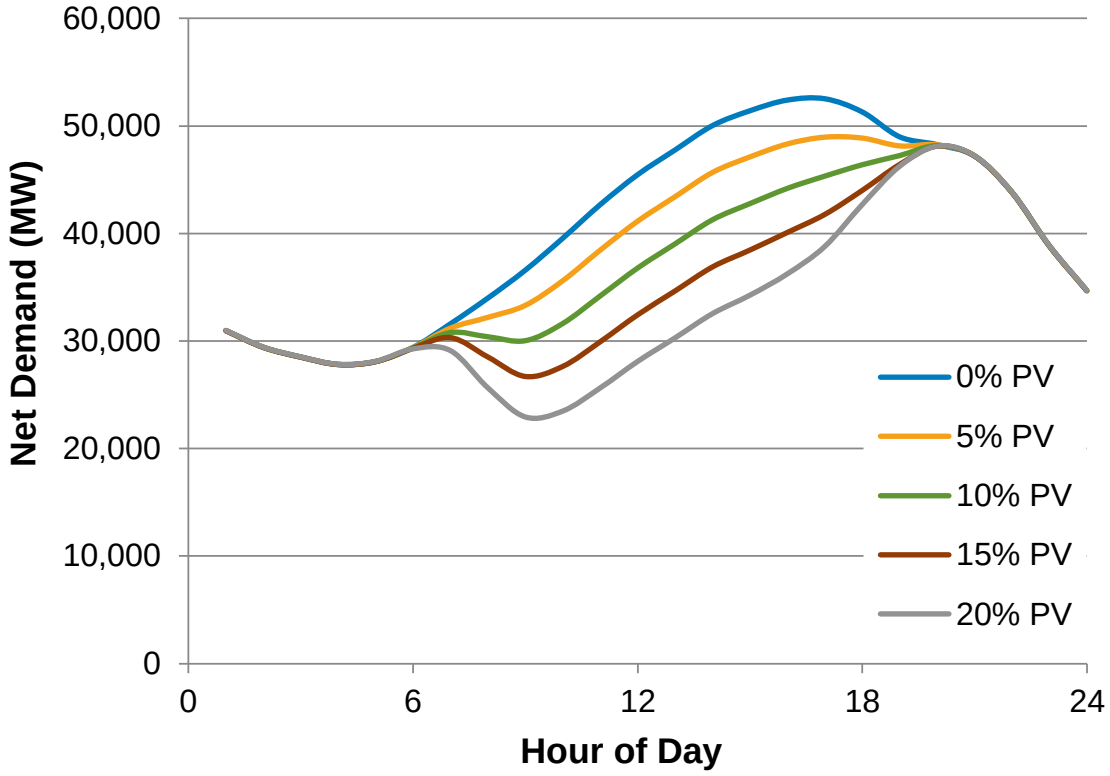


CAISO 2020 outages could have been addressed with 2.5 hours of storage

Transition to Longer Duration? Not so fast….

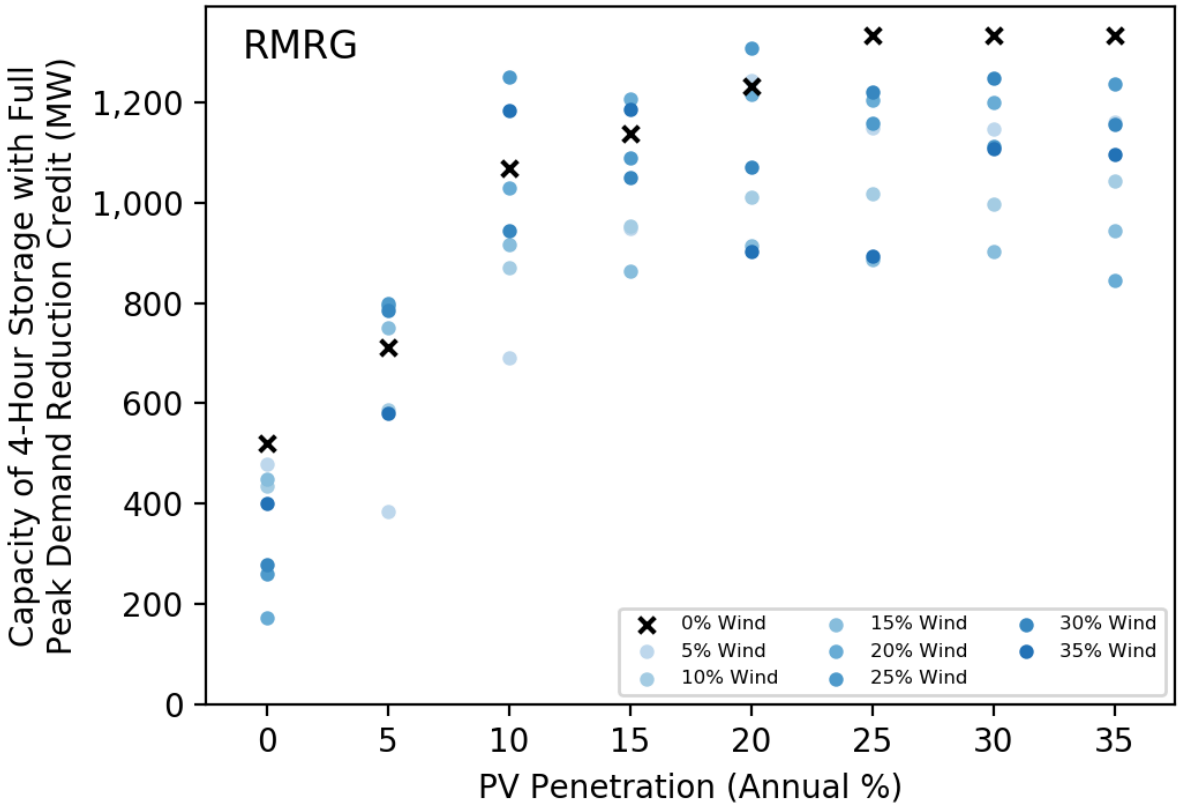


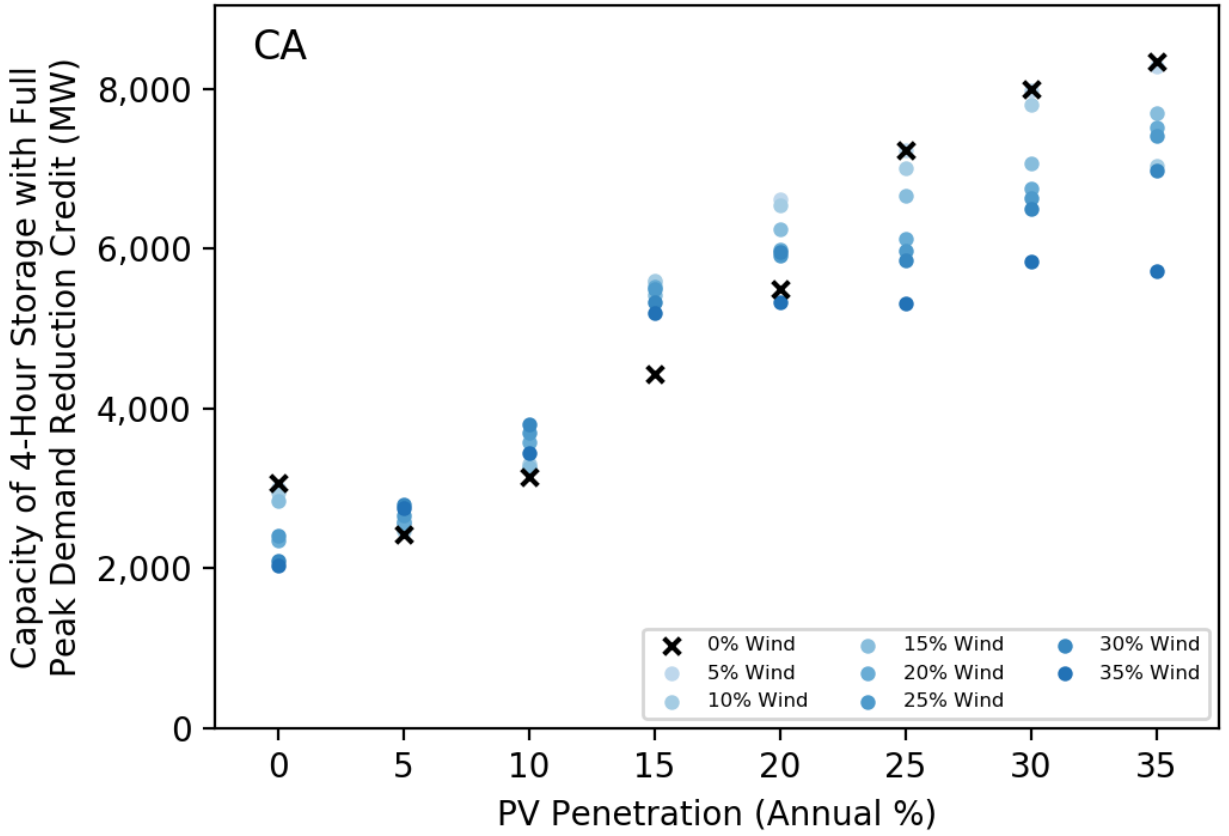
Simulated impact of increased 4-hour storage deployment on net load shape



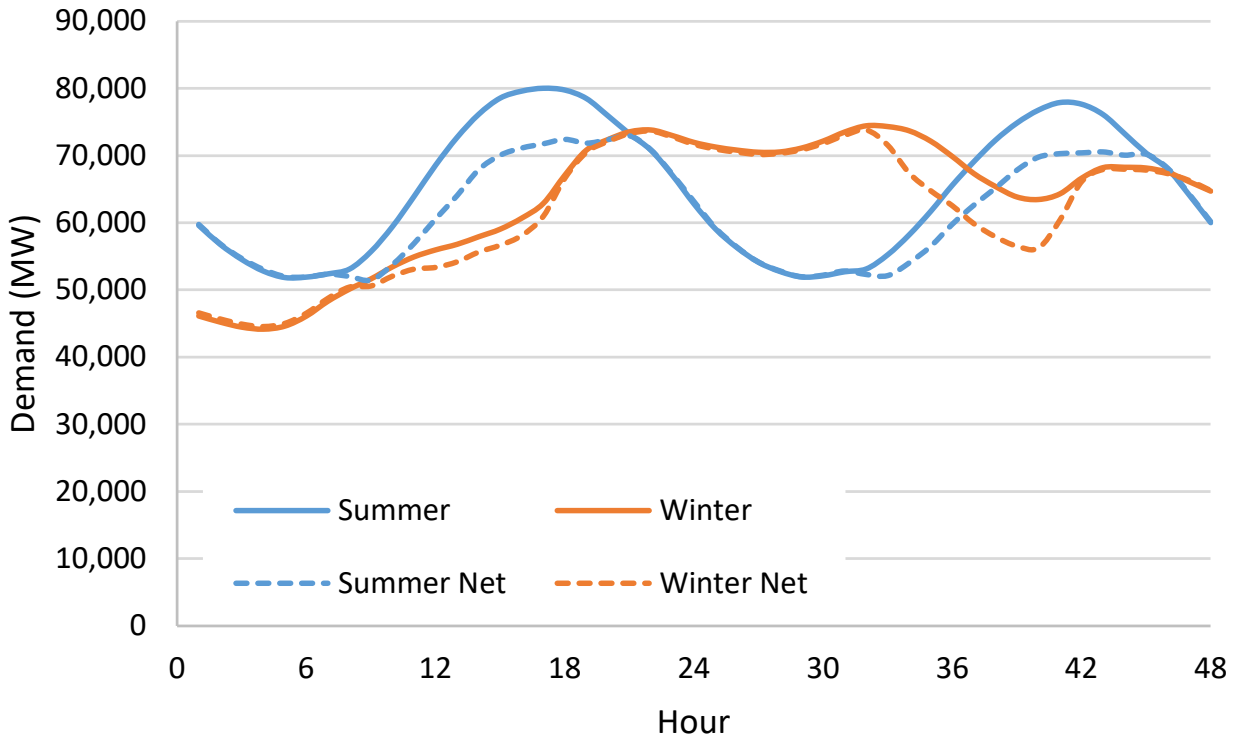
PV increases opportunities for 4-hour storage as peaking capacity – California Example

But Eventual Saturation of 4-Hour Storage

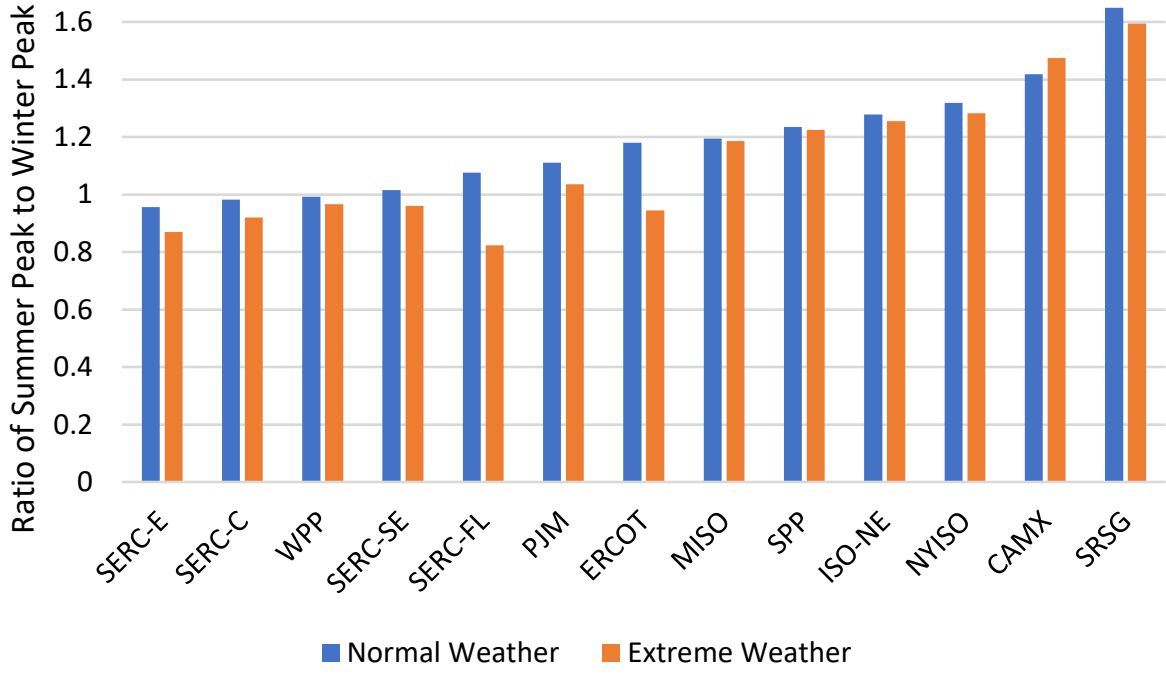




Transition to Longer Winter Peaks

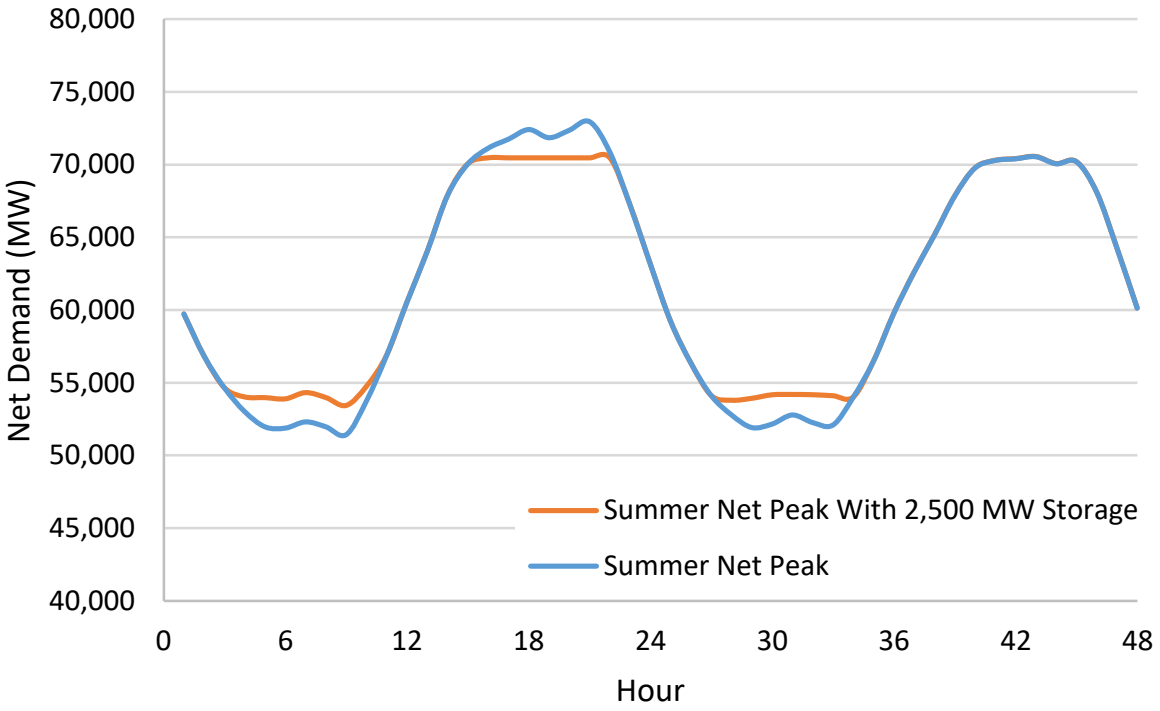


2022 ERCOT load data – net winter peak with the impact of PV

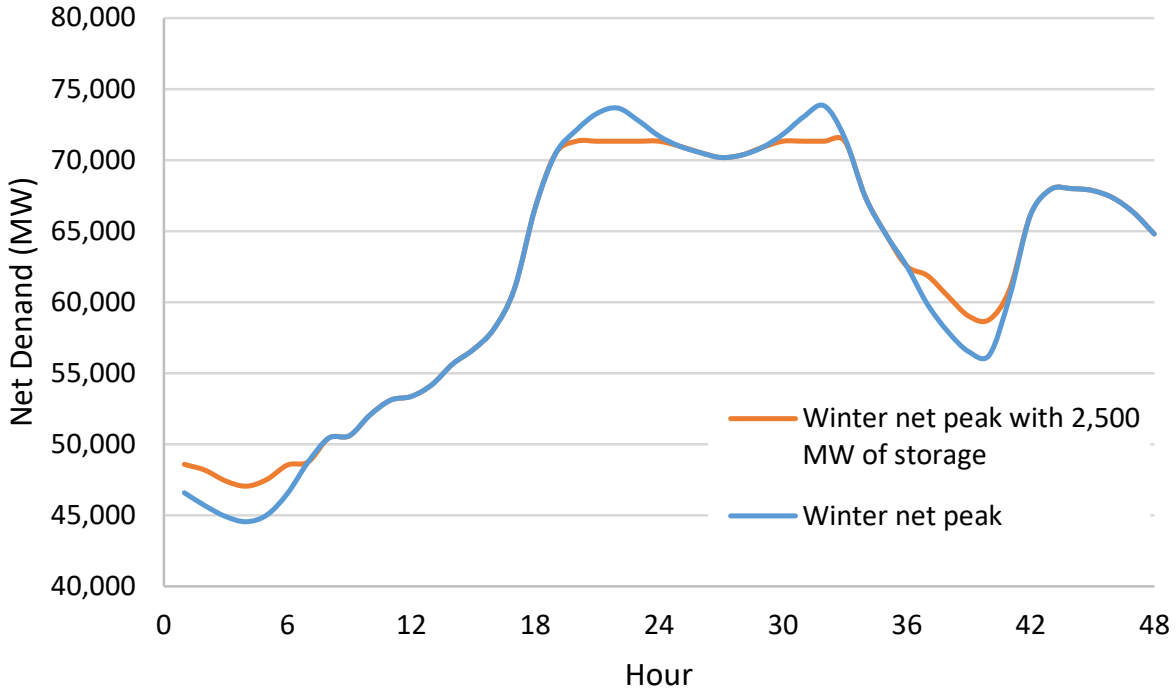


The Southeast is now winter peaking !?

Flatter, longer peaks with addition of modest amount of storage



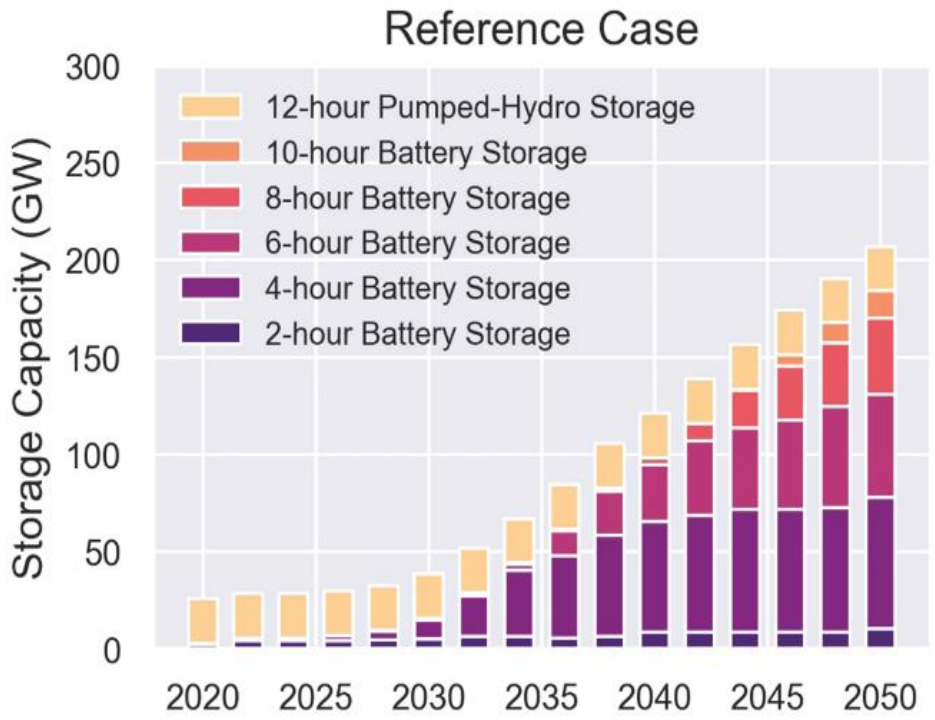
Summer peaks are still narrow…

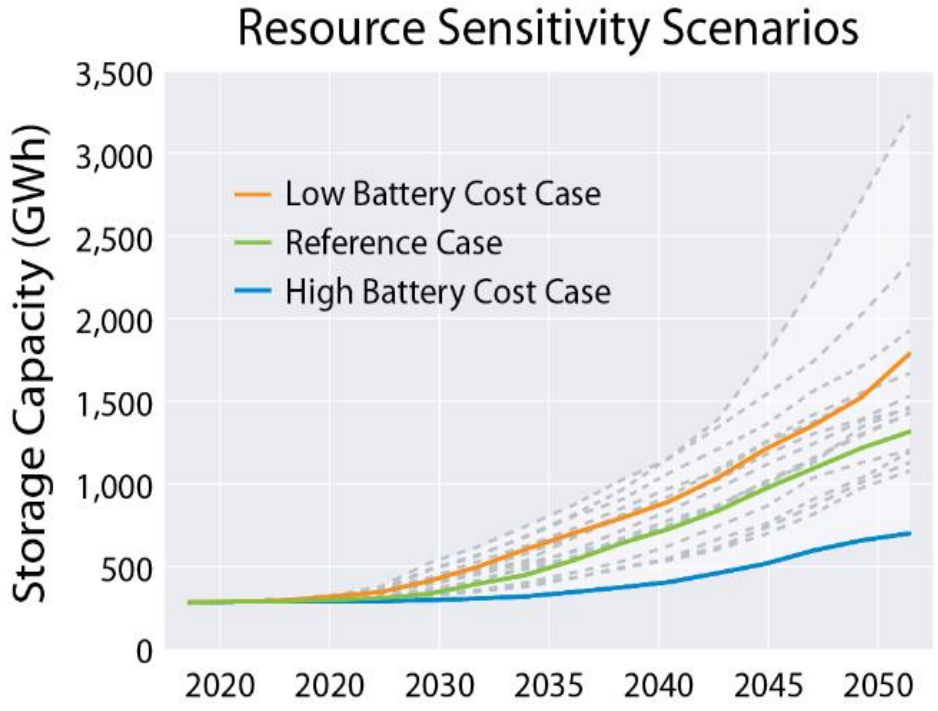


Winter peaks can be 8+ hours long

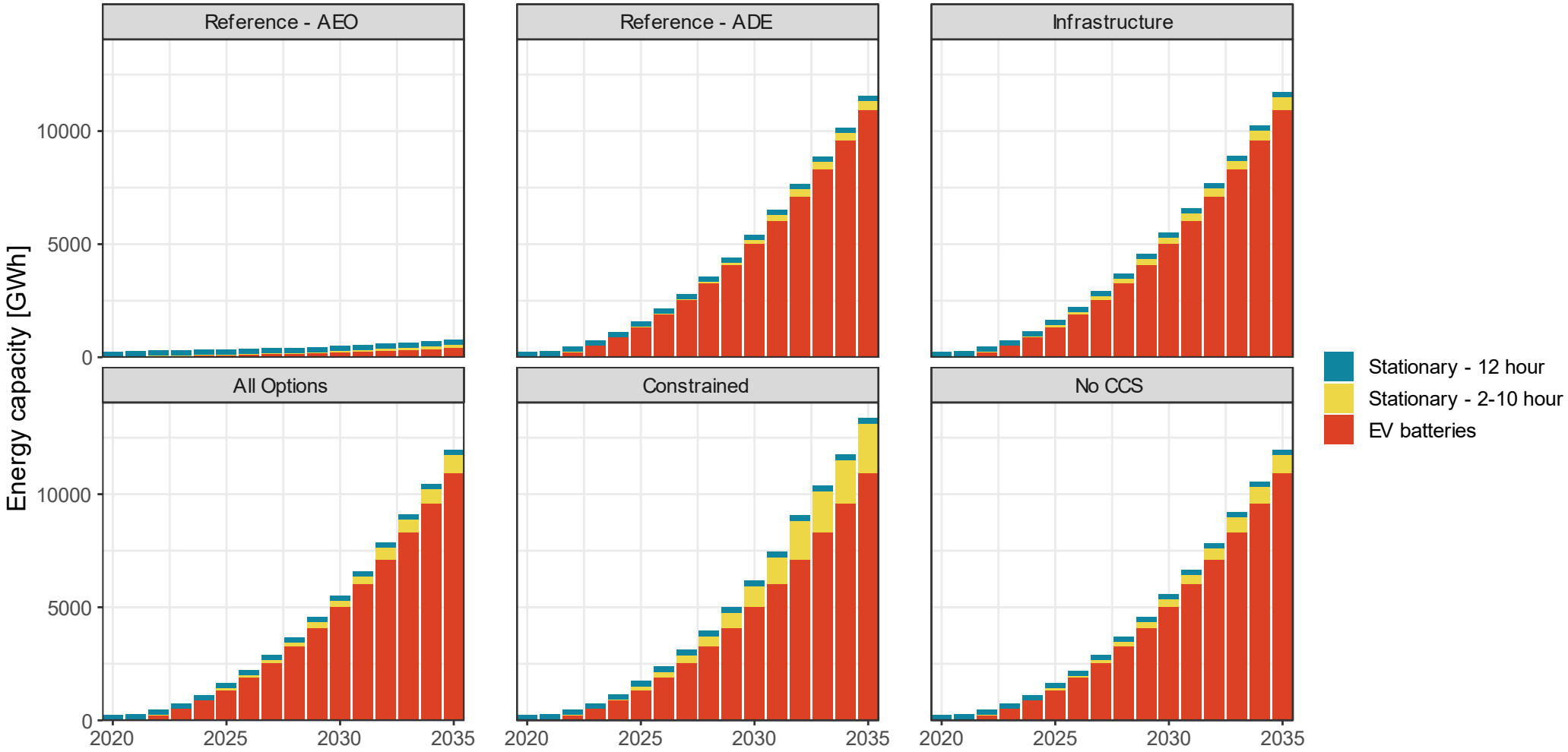
Transition to Longer Durations…

- 100–650 GW in 2050, or 5X today's capacity in a BAU scenario…
- Driven by storage costs, natural gas prices, renewable energy cost





Actual storage capacity driven by electric vehicles



Conclusions

- Storage is increasingly competitive as a source of firm capacity
- Much of the benefits of storage can be achieved with durations of 4 hours in summer peaking systems
- Transition to durations beyond 4 hours will be driven largely by a shift to winter peaks

Thank you

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