IEAHYDRO
The International Energy Agency Technology Collaboration Programme on Hydropower

Assessing the Needs for Long Duration Stored Energy

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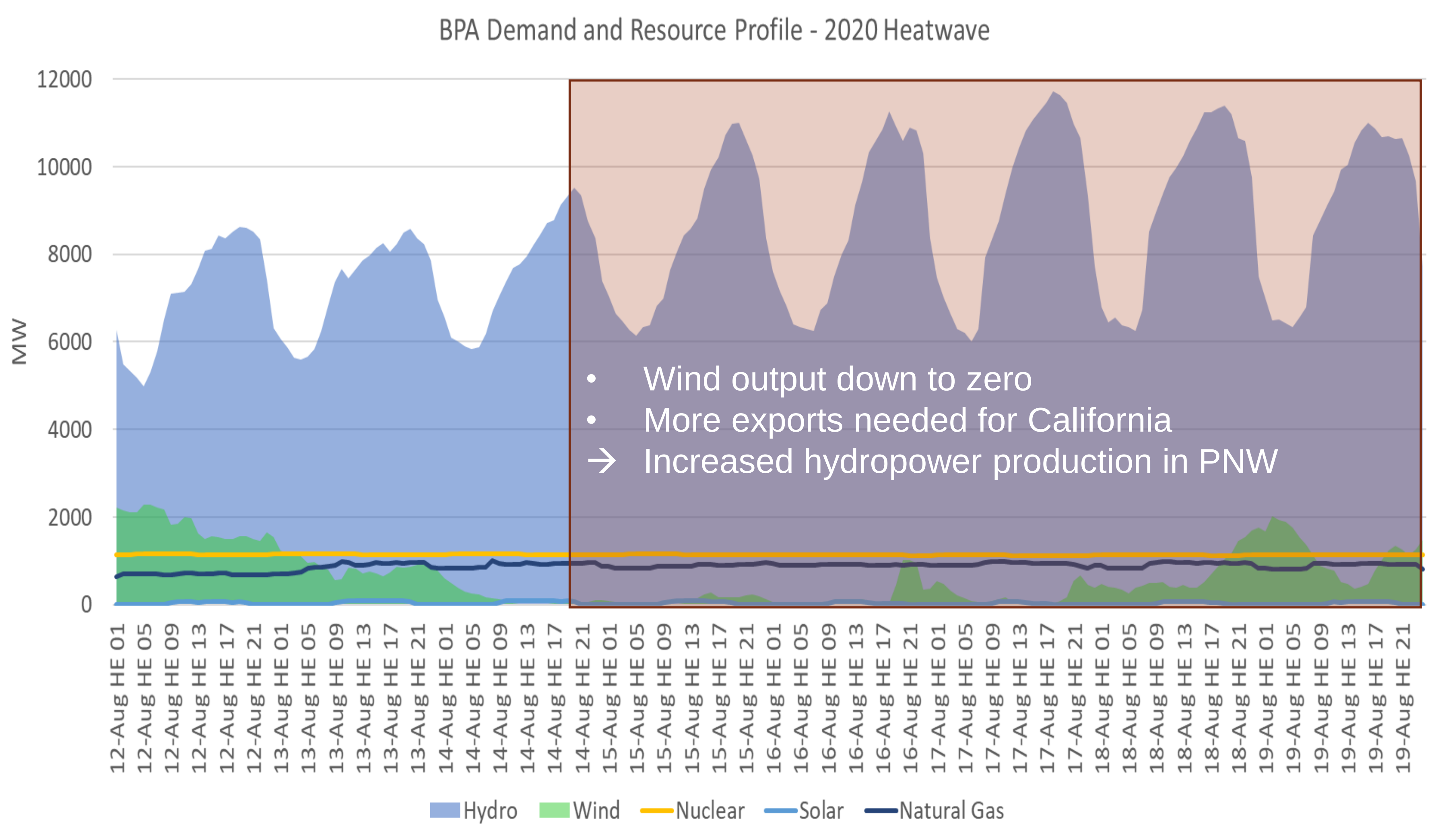
Overview

- Significant growth in deployment of energy storage: 4-6 hours duration
  - Business case is well established, although the market for services is thin
  - Grid services – capacity, ancillary services, and firm power
- Emerging but niche business cases: co-locate storage with conventional gen
  - Increase capacity and add flexibility – run-of-river hydro, nuclear, coal
  - Increase longevity and reduce wear/fatigue – storage can reduce start/stops
- Future need (nearer than we can imagine): Long Duration Stored Energy
  - Significant energy deficits from wind and solar energy droughts (“dunkelflaute” events)
    - Energy drought events likely to be exacerbated in an even higher RE future
  - Concurrently, significant amount of RE curtailment in several markets
- Policy, regulatory, and market initiatives
  - 90 plus PSH FERC licenses but why is nothing getting built?

Atypical weather events create energy shortfalls

- During the 2020 summer West Coast heatwave, California saw rolling blackouts
  - High demand in CA
  - Low CA/PNW wind output
- Pacific Northwest hydropower exports provided some relief
  - Sustained high generation during the heat wave, but
  - Exports limited by transmission availability



BPA's demand and generation profiles during the heatwave of August, 2020

Dunkelflaute – Energy drought definition

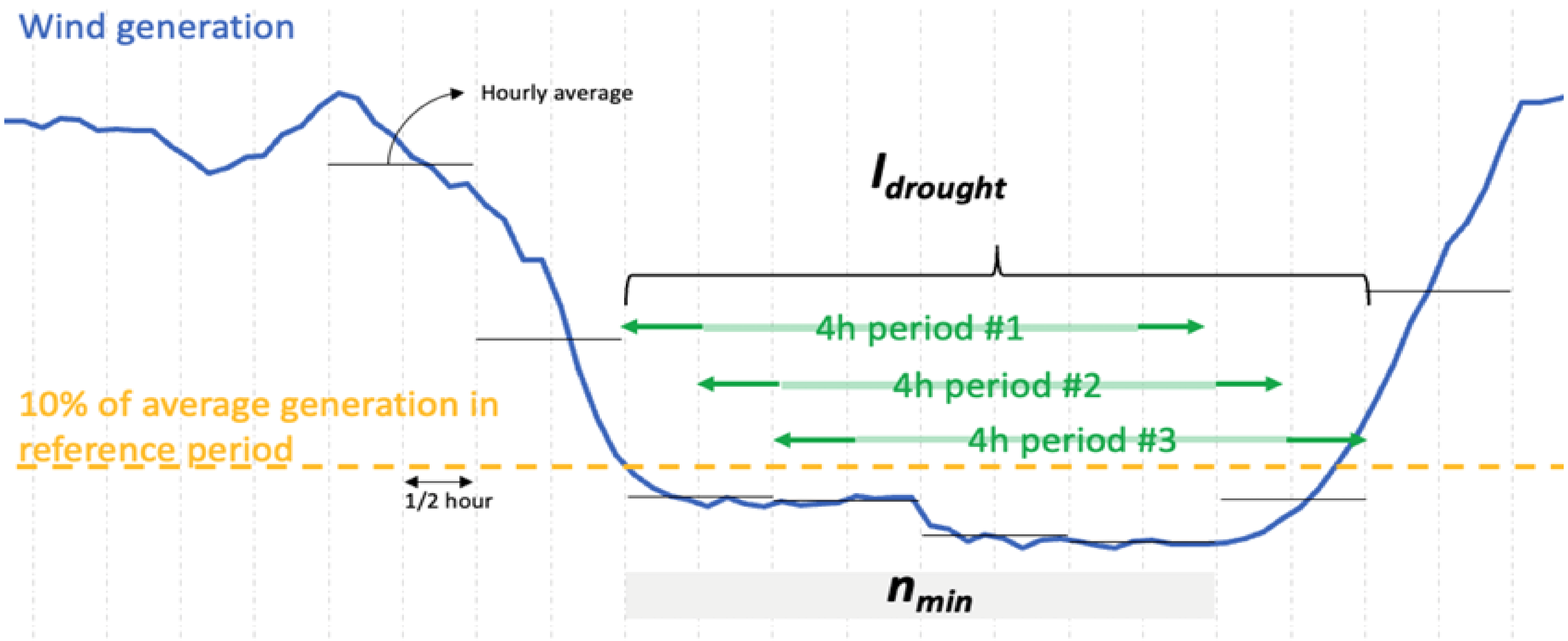


Figure 1. Graphical example illustrating a hypothetical wind drought scenario. The rolling period to evaluate the wind drought, n_{hours}, is 4 hours, the minimum duration to qualify as a wind drought, n_{min}, is 4 hours, and the length of the drought period, $l_{drought}$, is 5 hours.

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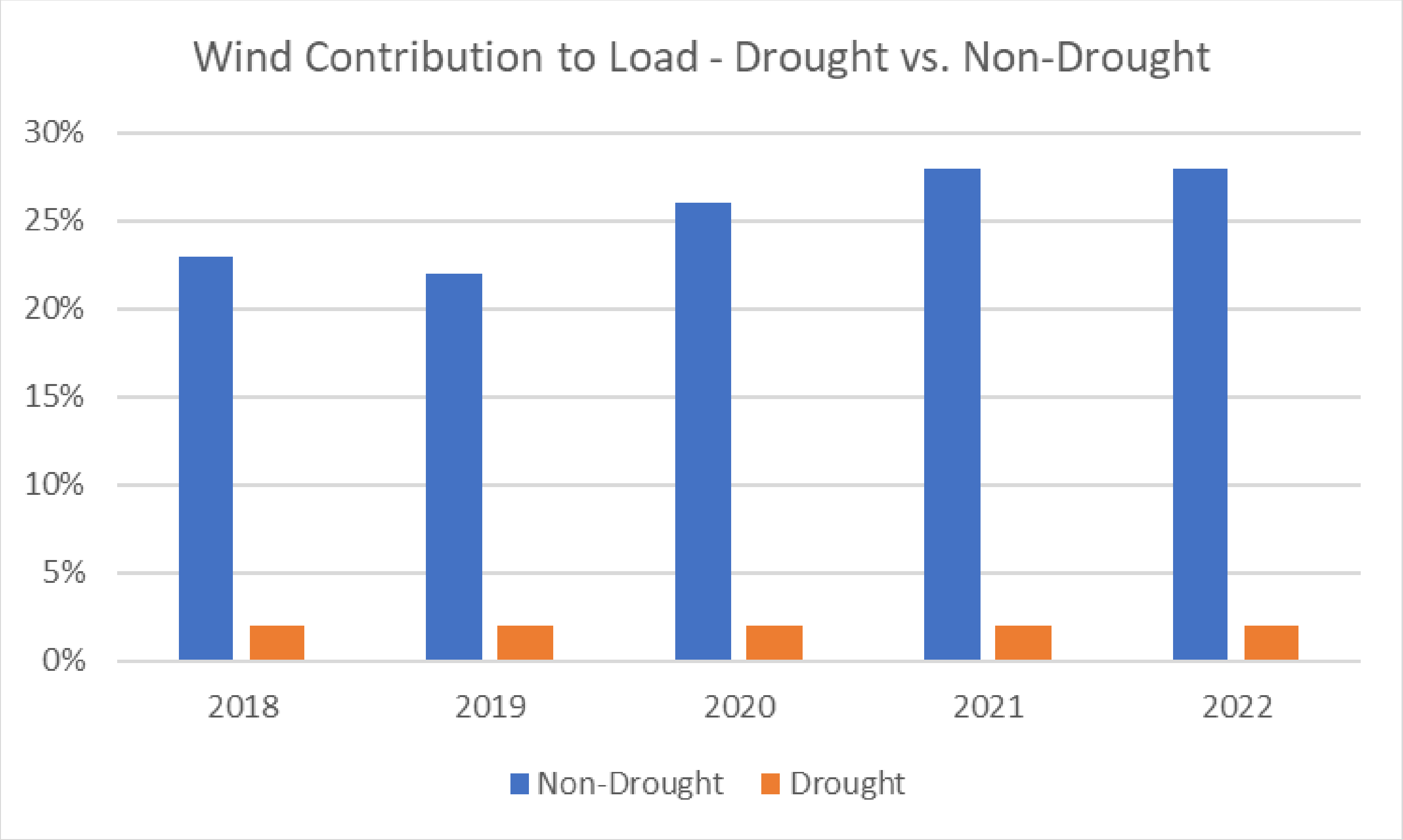
Need for long-duration stored energy

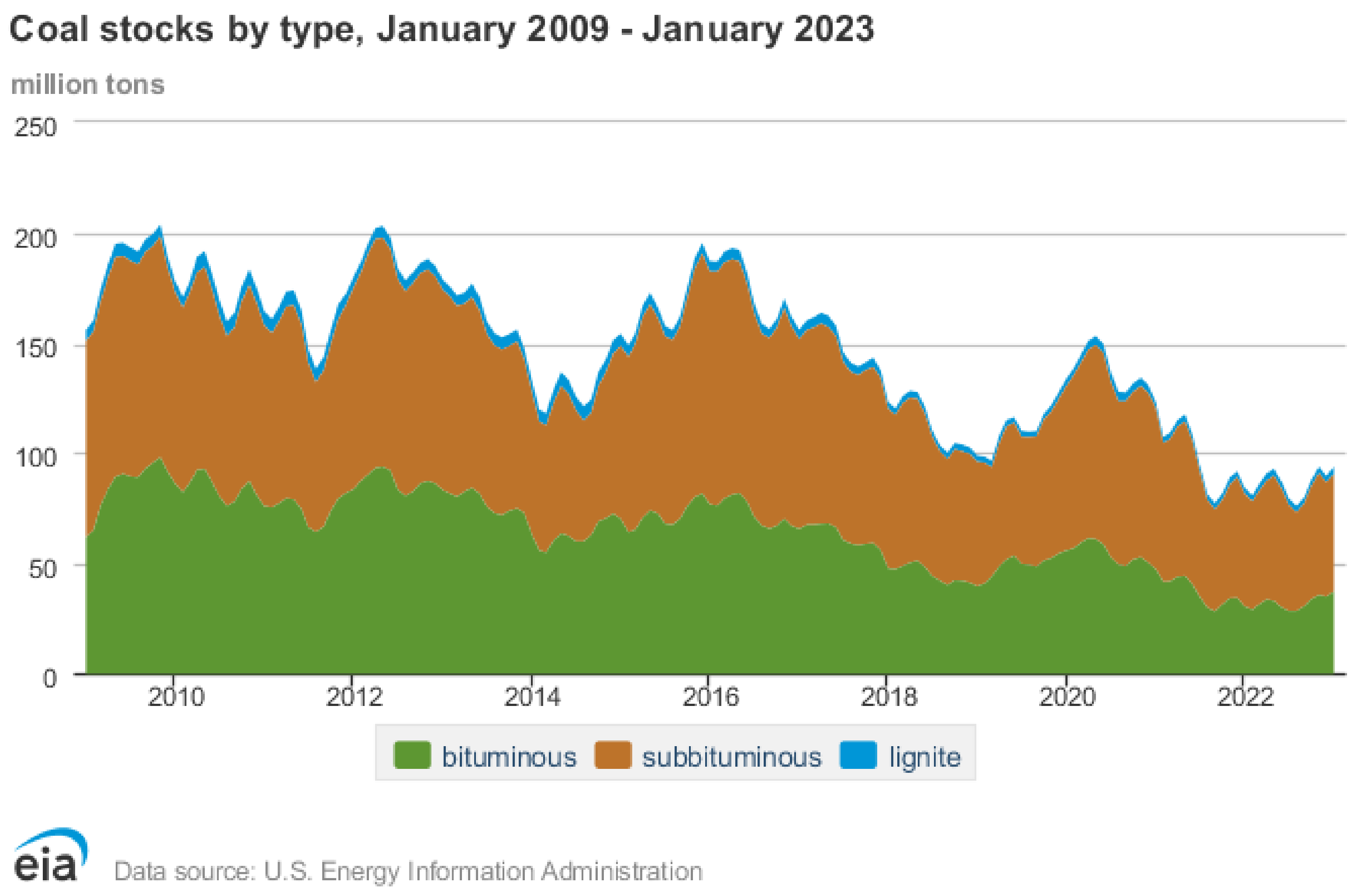
Renewable energy resources are prone to weather related energy droughts – *dunkelflaute* events



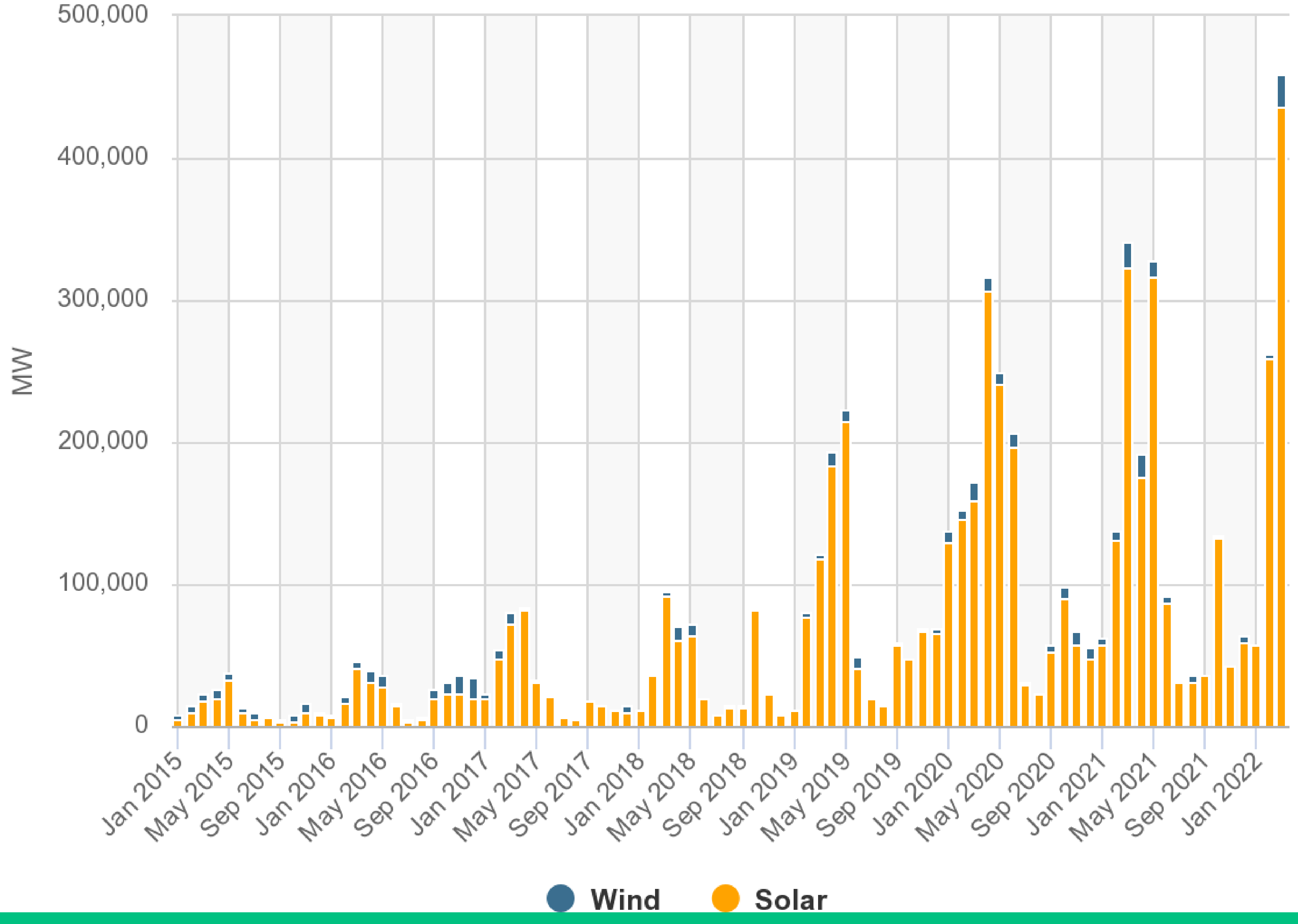
Wind	# of Events	Longest Event (# of Hrs.)	Energy Deficit (MWh)
USA – Texas (2018-2020)	82	15	145,853

ERCOT event corresponds to 10 plants @ 1000 MW capacity running for 15 hours straight

Conventional generation provide backup, currently



Other indicators of long-duration stored energy



There has been a steady increase in the amount of VRE curtailment in California (Source: CAISO)

Key takeaways

- Atypical weather is becoming more frequent, which leads to energy shortfalls, even though there's enough installed capacity.
- Systems are increasingly limited in energy, not capacity.
  - Current capacity-based definitions of resource adequacy fail to account for long-duration energy shortfalls.
  - Hence, resource adequacy assessments will have to be more energy (fuel) based as opposed to capacity based.
- Market, regulatory, and policy paradigms will need to evolve to make a viable business case going forward
  - Arbitrage and grid services-based remuneration will not be enough to make the business case, especially for LDES
  - Storage-as-a-service model is starting to emerge, which pays energy storage to store energy; e.g., Switzerland's Winter Reserve product
  - Alternative capacity market constructs are emerging that lay greater emphasis on available/stored energy; e.g., Colombia's capacity market construct

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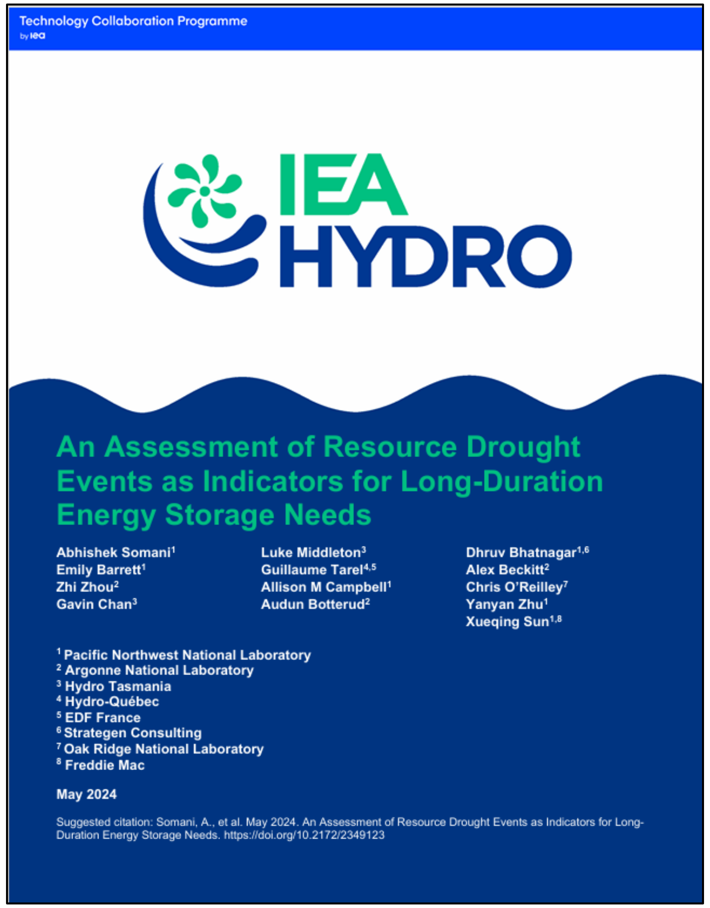

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An Assessment of Resource Drought Events as Indicators for Long-Duration Energy Storage Needs

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