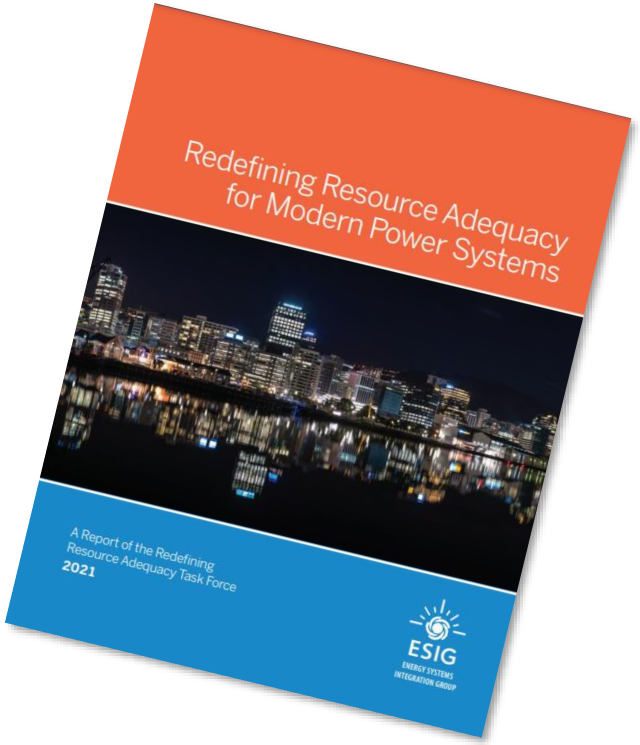
Redefining Resource Adequacy for Modern Power Systems

ESIG November Webinar | 11/16/2021

TELOS ENERGY

Acknowledgements



ESIG Whitepaper: Redefining Resource Adequacy for Modern Power Systems

ESIG Blog: Five Principles of Resource Adequacy for Modern Power Systems

ESIG Webinar: Redefining Resource Adequacy for Modern Power Systems

ESIG/GPST Policy Brief: The Intersection of Resource Adequacy and Public Policy

This project is supported by the Energy Systems Integration Group (ESIG), as part of the Redefining Resource Adequacy Task Force. The contents of this presentation are solely the responsibility of the authors and do not necessarily represent the official views of ESIG or its members

» **Next Steps:**

- CIGRE Paper on Evolving Metrics
- 2022 Topics

Agenda

1. Principles of Resource Adequacy
2. Gaps in Weather Modeling & Assumptions
3. Evolving Resource Adequacy Metrics
4. Pitfalls of Capacity Accreditation

A Tale of Two Reliability Events

California

August 14-15, 2020
Evening load shedding across two days

Texas

February 15-17, 2021
Continuous load shedding for 3+ Days

What can we learn from the California and Texas events?

- **Not all shortfalls are alike**… need to characterize size, frequency duration, and timing of events

- **Risk is shifting**… periods of concern longer occur during gross-peak load, need to look across an entire year of operation

- **Weather** is the single most important driver for resource adequacy…
  - Cross-disciplinary power systems and meteorological expertise is necessary
  - We need a North-American Weather Dataset for correlated wind, solar, and load
  - Climate trends should be considered
  - Correlated events are the issue!

- **Resource sharing** is critical, transmission is a capacity resource

Why is Resource Adequacy Broken?

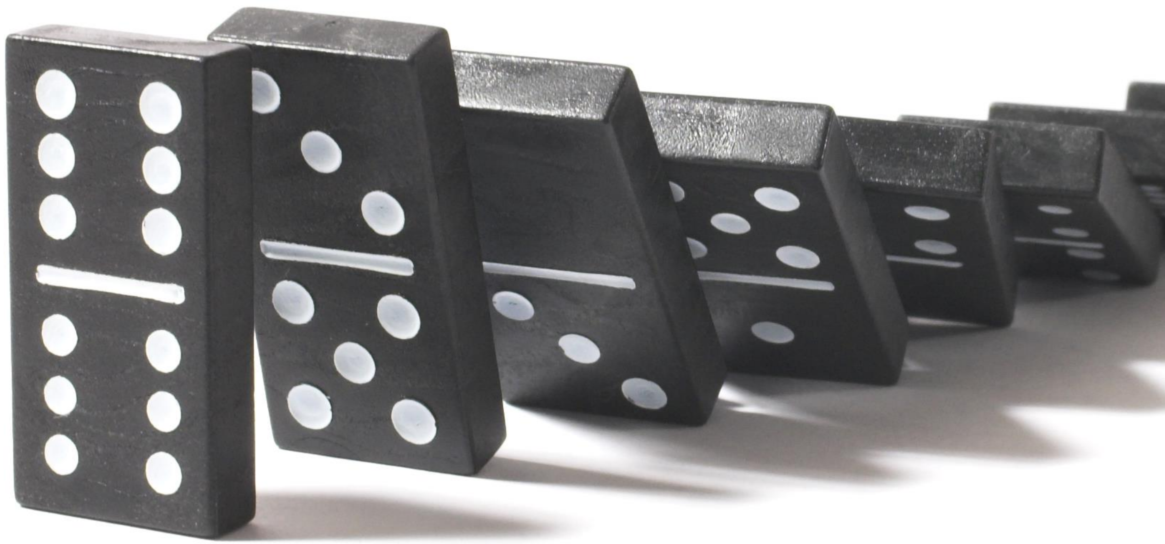
CHRONOLOGY + CORRELATION

CHRONOLOGY

- ✓ Variable Renewables
- ✓ Energy Storage
- ✓ Load Flexibility
- ✓ Hybrid resources

CORRELATION

- ✓ Weather
- ✓ Combined Outages
- ✓ Modular Technology
- ✓ Climate Trends



= fundamental need to rethink RA

Six principles of resource adequacy for modern power systems

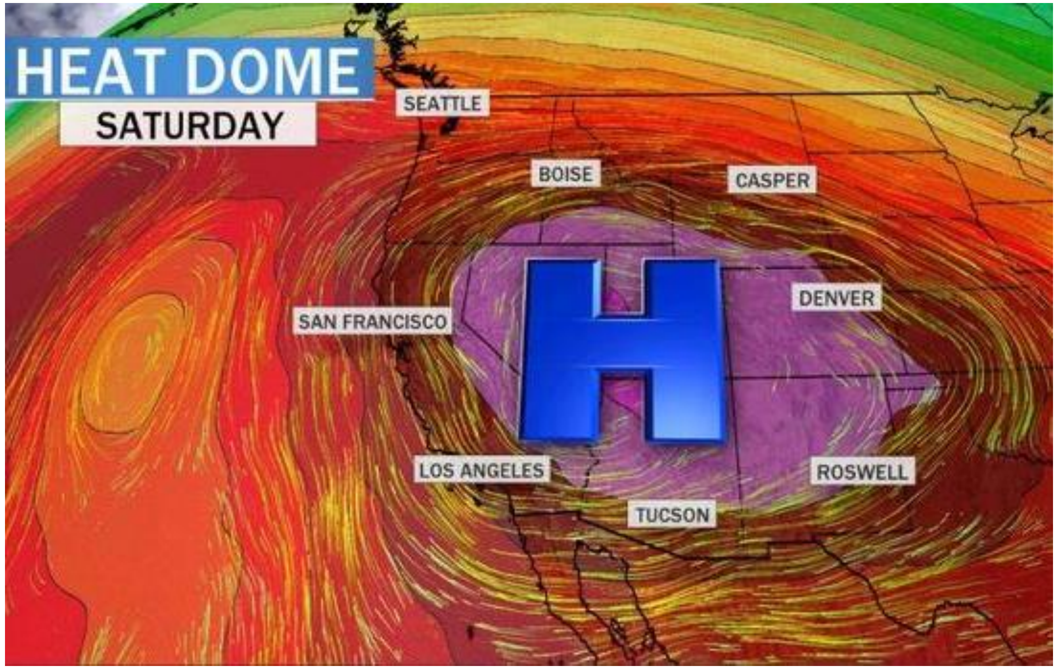
1. Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions
2. Chronological operations must be modeled across many weather years
3. There is no such thing as perfect capacity.
4. Load participation fundamentally changes the resource adequacy construct.
5. Neighboring grids and transmission are a key part of the RA challenge
6. Reliability criterion should not be arbitrary, but transparent and economic.

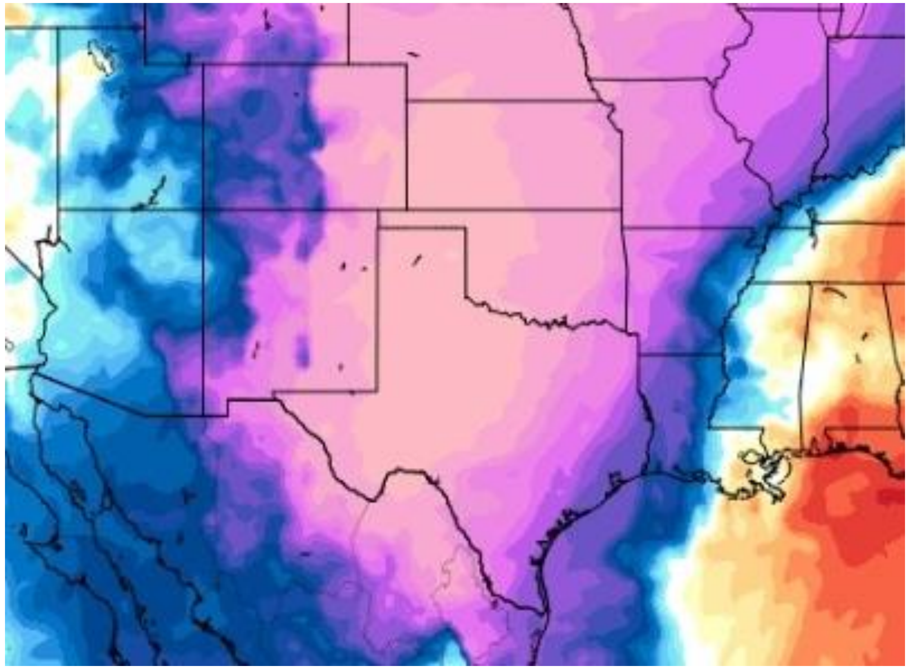
Weather Modeling for Resource Adequacy Modeling

Chronological operations must be modeled across many weather years

Chronological operations must be modeled across many weather years

- Historically, resource adequacy analysis had a relatively simple task: ensure there is enough capacity installed to meet **<u>peak</u>** load
- VRE and energy-limited resources are changing this construct
- Periods of risk are not necessarily periods of high load.
- All intervals matter for resource adequacy analysis
- Chronological operations and scheduling ensure energy storage and demand response will be around long enough, and can fully recharge, to get the system through reliability challenges





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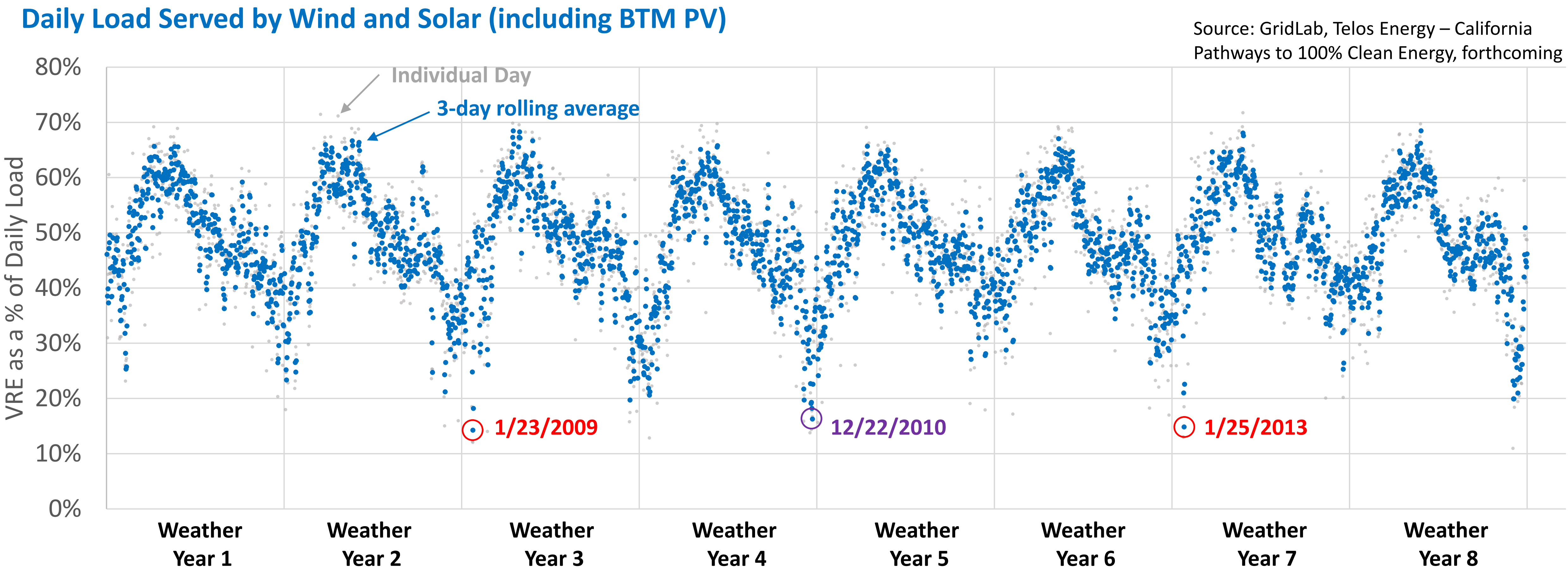
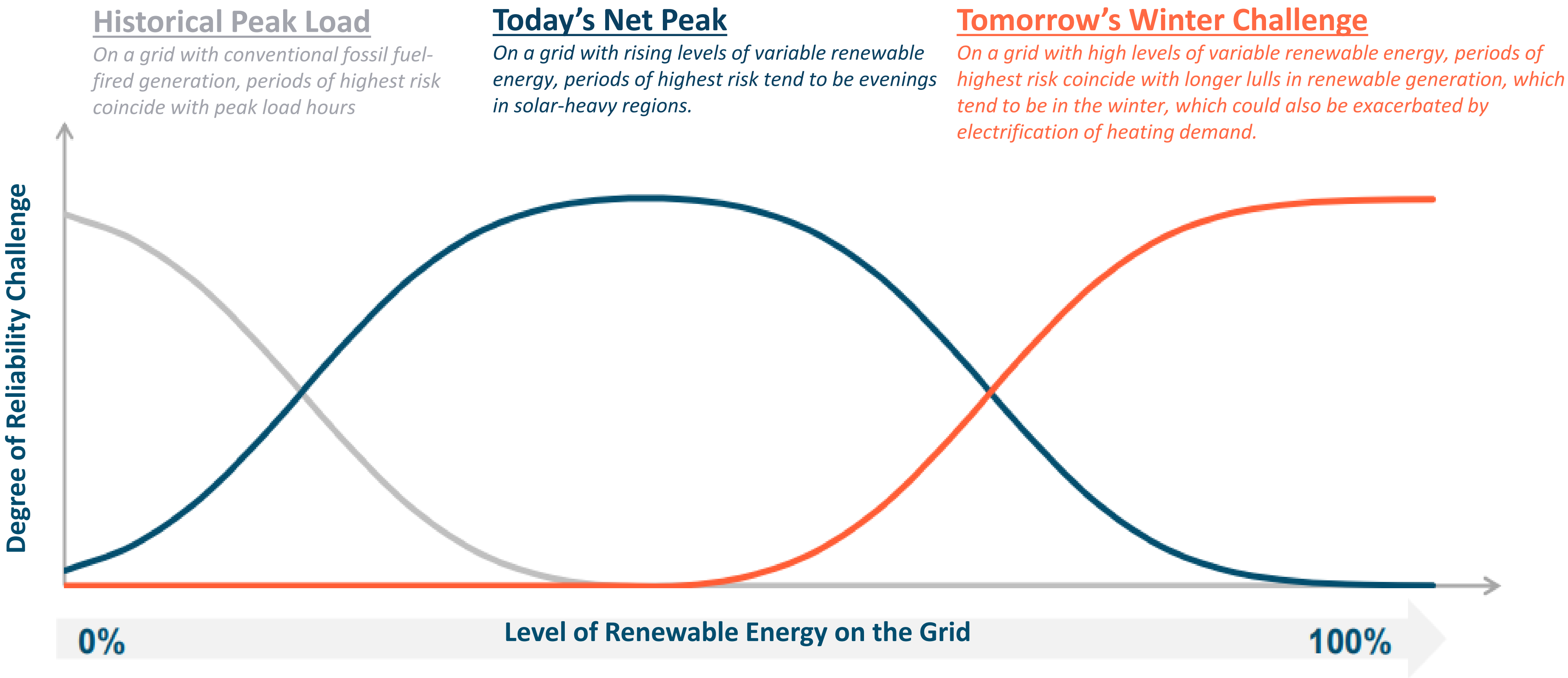
Identifying Multi-Day Low Wind & Solar Events



Dec. 16-23, 2010: Record-setting rain and snowfall across Southern CA (annual precipitation amounts were achieved in 7 days)

Evolving resource adequacy needs with decarbonization



Source: ESIG, adapted from E3, "ELCC Concepts and Considerations for Implementation," Prepared for August 30th, 2021 NYISO Installed Capacity Working Group.

Weather data modeling gaps…
dealing with imperfect data

The ideal dataset: time-synchronized weather dataset covering solar, wind, load, and temperature data across electric and gas sectors that includes a climate trends

Filling the Gaps: what do we do when we don't have data? Wide spectrum of approaches to fill the gaps. (bootstrapping, repeating data, guessing…)

Next Steps: we need a broad, national-scale weather dataset from a **consistent source** on *wind/solar/load/temperature*

Cross-disciplinary, inter-regional research and development is necessary

Power Industry's Weather Modeling Report Card

A- Solar Data

C+ Wind Data

B Load Data

D+ Temperature Data

F Gas-Electric Coordination

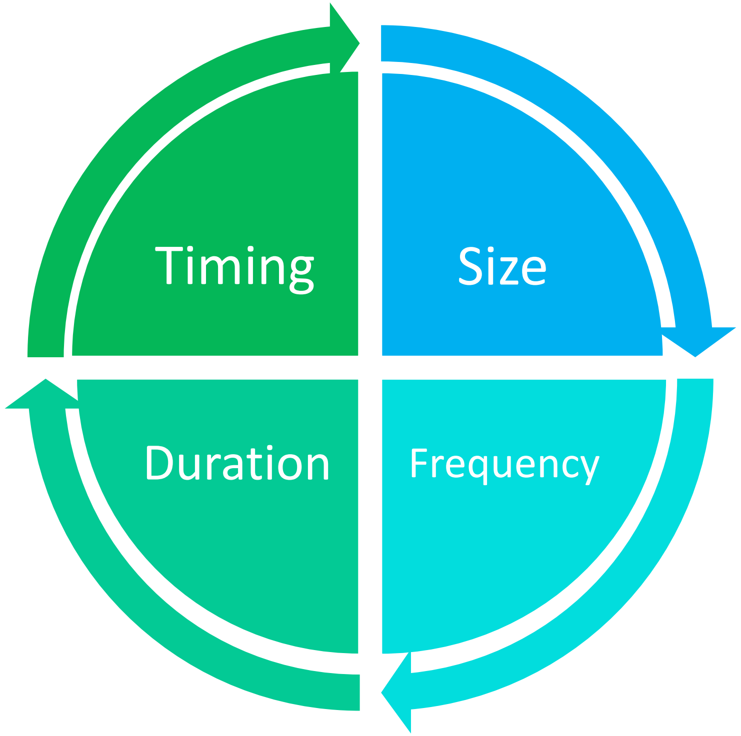
C- Climate Trends

Other Comments: Student does not work well with others. Interregional planning necessary

Resource Adequacy Metrics

Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions

Quantifying **size**, **frequency**, **duration**, and **timing** of capacity shortfalls is critical to finding the right resource solutions



Our metrics need to go further!

1. Place more emphasis on Expected Unserved Energy
2. Use a suite of reliability metrics, not just one
3. Move beyond expected values and consider tail events
4. Characterize size, frequency, duration, and timing of shortfall events

Event Characteristic	Metric Affected	California Aug 2020	Texas Feb 2021	Delta
Number of Days	LOLE	2 days	4 days	+200%
Number of Events	LOLEv	2 events	1 event	-50%
Number of Hours	LOLH	6 hours	71 hours	+1200%
Unserved Energy	EUE	2,700 MWh	990,000 MWh	+36,700%
Max Shortfall		1,072 MW	20,000+ MW	+1,766%

Our capacity resources are no longer "one size fits all"…

Storage and load flexibility can provide both power (MW) and energy (MWh) … how much is needed of each?

Larger Power Shortfalls (MW)

Larger Energy Shortfalls (MWh)

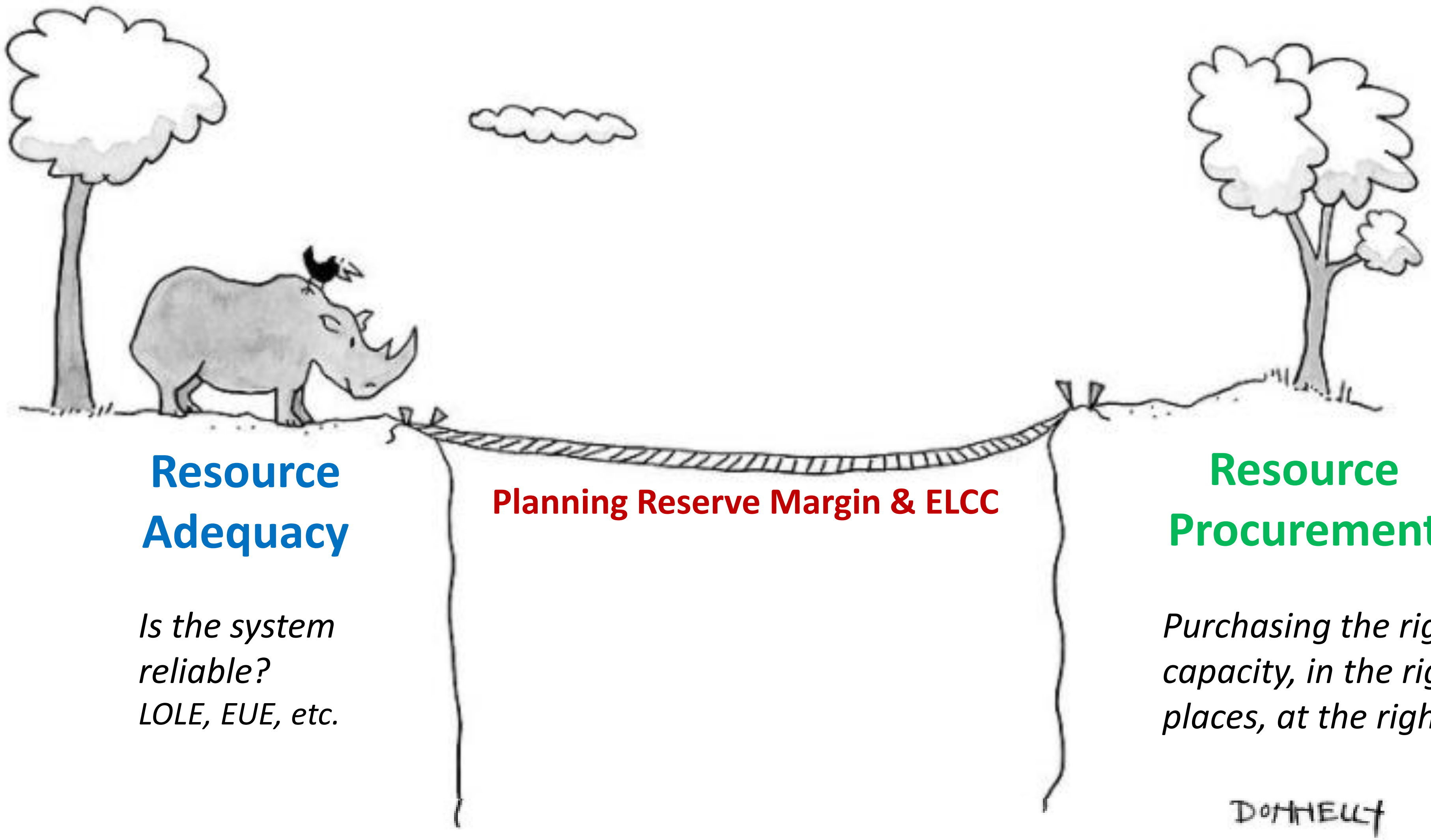
Energy (MWh)	Max Size (MW) 10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	>=200	Total
20	19.9%	14.4%	5.31%																		39.6%
40		0.70%	6.02%	6.11%	1.41%																14.2%
60			0.61%	2.34%	3.90%	1.60%	0.26%														8.7%
80			0.03%	0.58%	1.89%	2.18%	1.41%	0.16%													6.2%
100			0.03%	0.06%	0.64%	1.63%	1.66%	0.90%	0.06%	0.13%	0.06%										5.2%
120					0.06%	0.42%	1.12%	1.47%	0.67%	0.16%	0.10%	0.03%									4.0%
140							0.51%	1.02%	0.74%	0.35%	0.06%										2.7%
160						0.06%	0.32%	0.80%	0.42%	0.48%	0.19%	0.03%	0.03%								2.3%
180					0.03%		0.10%	0.35%	0.38%	0.42%	0.32%	0.06%	0.06%								1.7%
200							0.10%	0.29%	0.42%	0.51%	0.42%	0.32%	0.06%	0.03%	0.03%						2.2%
220						0.03%		0.06%	0.42%	0.16%	0.35%	0.26%	0.10%	0.03%							1.4%
240								0.06%	0.10%	0.16%	0.16%	0.29%	0.19%								1.0%
260								0.06%	0.03%	0.19%	0.35%	0.16%	0.29%	0.10%	0.19%		0.03%				1.4%
280							0.03%	0.03%	0.03%	0.03%	0.19%	0.19%	0.22%	0.10%	0.19%		0.03%				1.1%
300								0.03%		0.03%	0.16%	0.13%	0.13%	0.10%	0.03%						0.6%
320										0.10%	0.06%	0.06%	0.22%	0.10%	0.16%			0.03%			0.7%
340											0.03%	0.03%	0.16%	0.06%	0.16%	0.03%					0.5%
360											0.03%	0.10%	0.19%	0.06%	0.29%	0.03%	0.06%				0.8%
380												0.06%	0.03%	0.06%	0.13%	0.13%	0.16%				0.6%
400												0.06%	0.03%	0.16%		0.10%	0.06%	0.06%			0.5%
>400											0.16%	0.10%	0.22%	0.16%	0.35%	0.74%	0.32%	0.51%	0.42%	1.60%	4.6%
Total	19.9%	15.1%	12.0%	9.1%	7.9%	5.9%	5.5%	5.2%	3.3%	2.7%	2.7%	1.9%	2.0%	1.0%	1.5%	1.0%	0.7%	0.6%	0.4%	1.6%	100%

70% of events covered by 60 MW 2HR resource

85% of events covered by 100 MW 2HR resource

Capacity Accreditation

Translating resource adequacy to resource procurement



Resource Adequacy

Is the system reliable?
LOLE, EUE, etc.

Planning Reserve Margin & ELCC

Resource Procurement

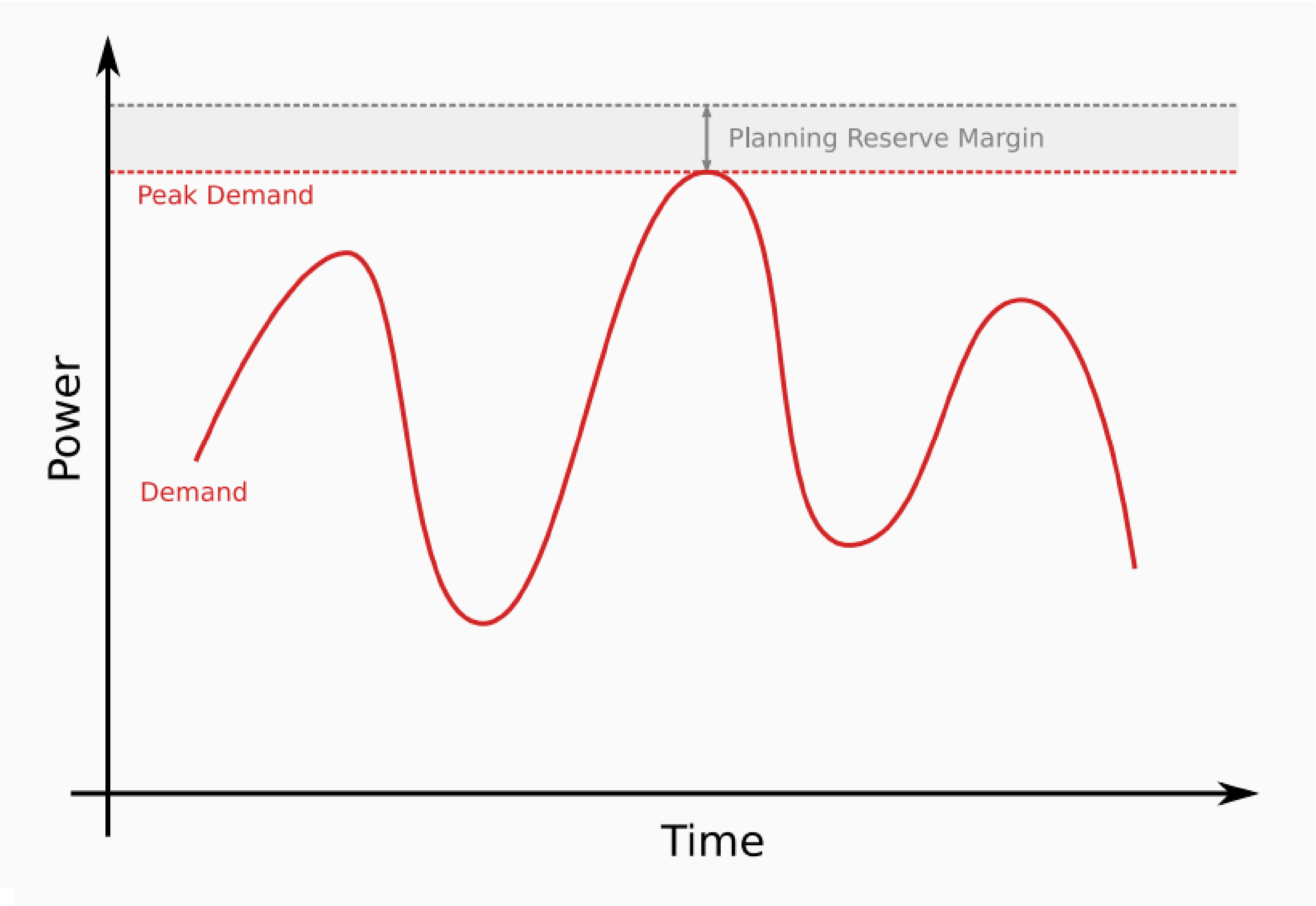
Purchasing the right capacity, in the right places, at the right time

"Go ahead. Nothing to worry about."

Source: Liza Donnelly, fineartamerica.com

PRM has outlived its usefulness for power system planning

- Risk is shifting to non-peak periods
- Relies on ELCC to remain credible (saturation and portfolio effects are increasingly difficult)
- Storage makes the system *energy* limited, not capacity limited
- Thermal units have correlated outages (UCAP based on FOR is not applicable)



More info: Gord Stephen, "Getting Past Capacity Credits, Better Deterministic Adequacy Analysis via Energy Reserve Margins," NERC Probabilistic Assessment Forum, Oct 6, 2021.

Challenges for ELCC in Long Term Planning & Procurement

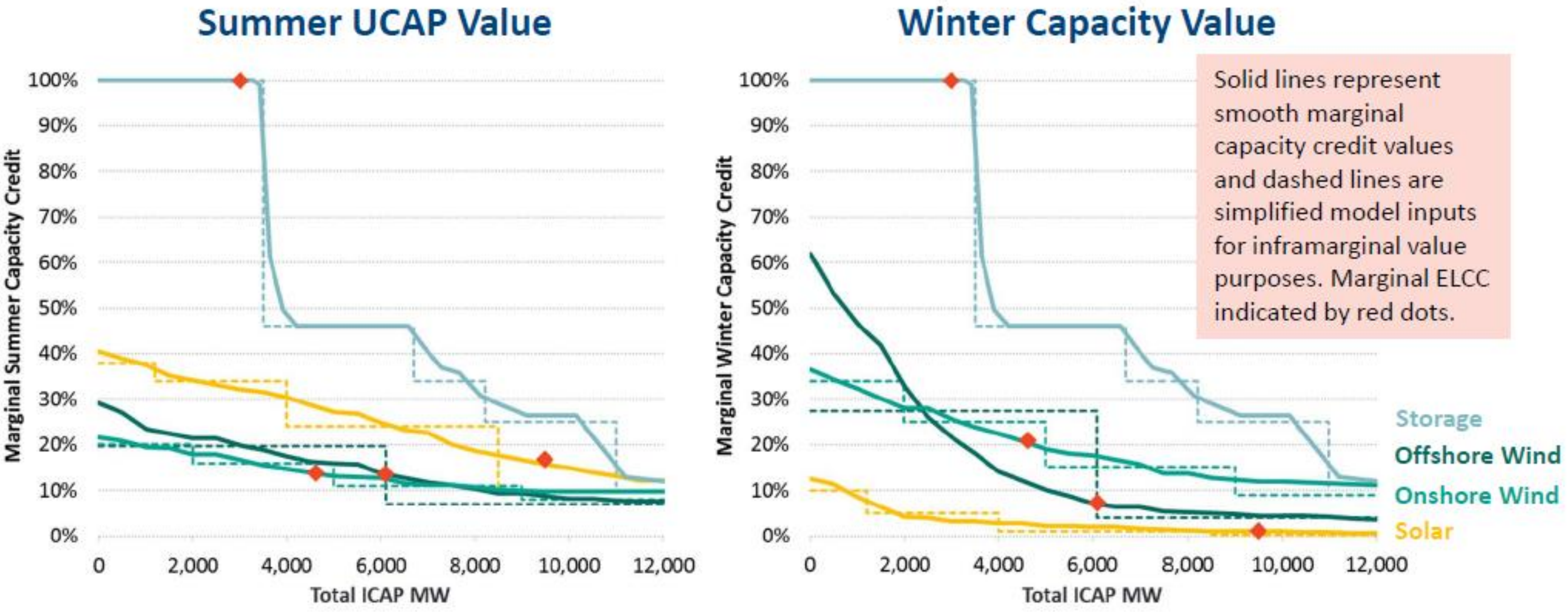
Saturation Effects

- ✓ Capacity value decreases as installations increase
- ✓ Reliability risk shifts to different time periods
- ✓ Duration requirements increase (peak periods become wider)
- ✓ Energy availability for charging

Portfolio Effects

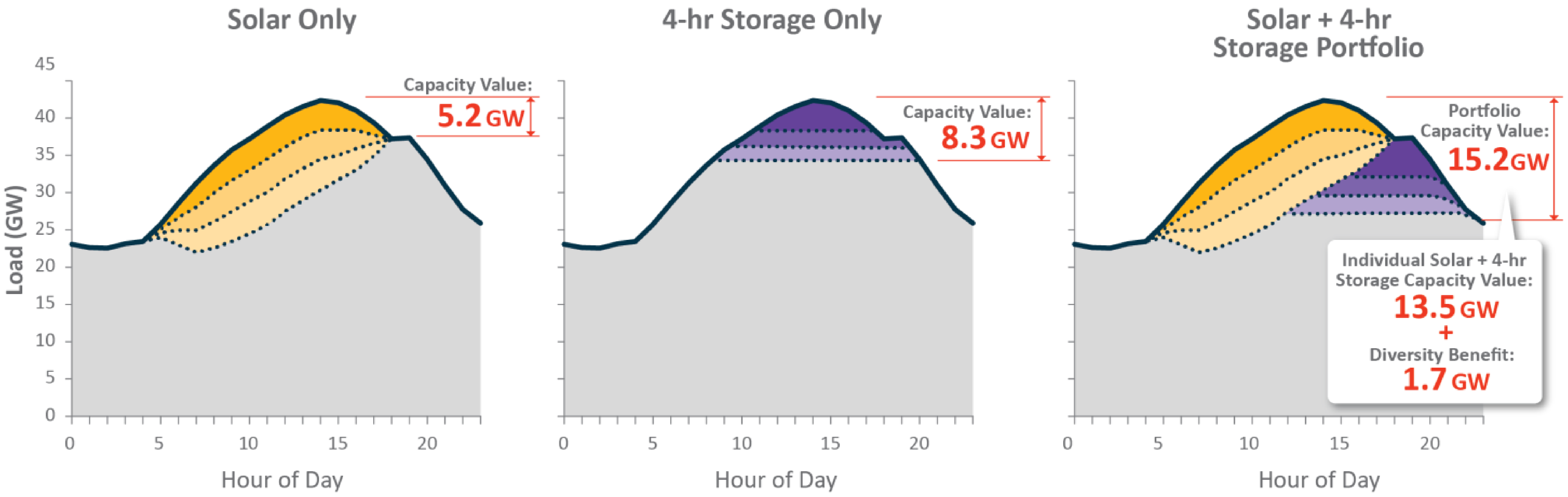
- ✓ Capacity value of one resource depends on penetration of another
- ✓ A resource reduces risk in some periods, shifting risk to others
- ✓ Net load profile changes over time

Saturation Effects



Source: Brattle, NYISO

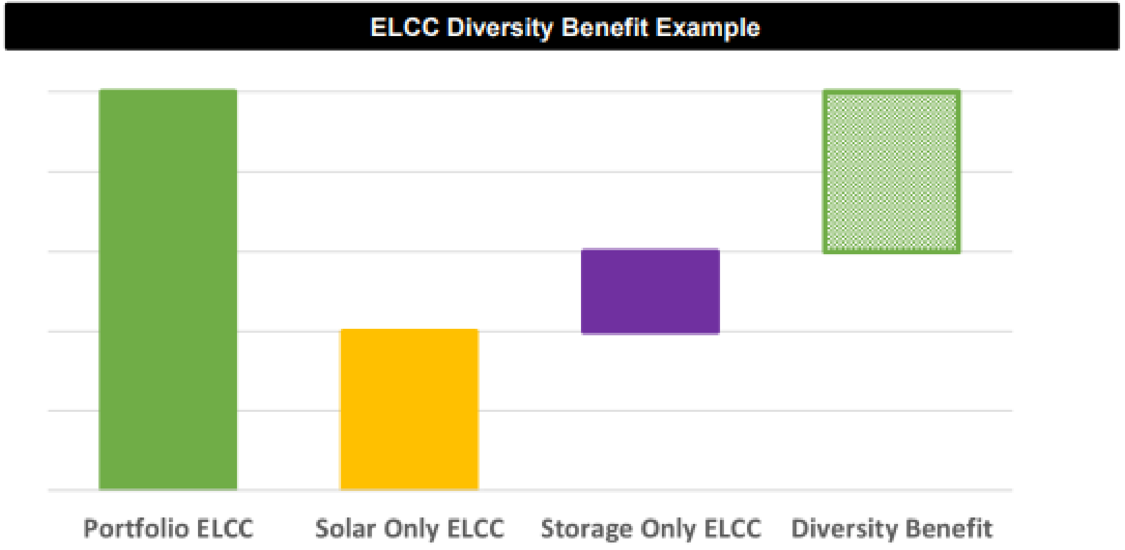
Portfolio Effects



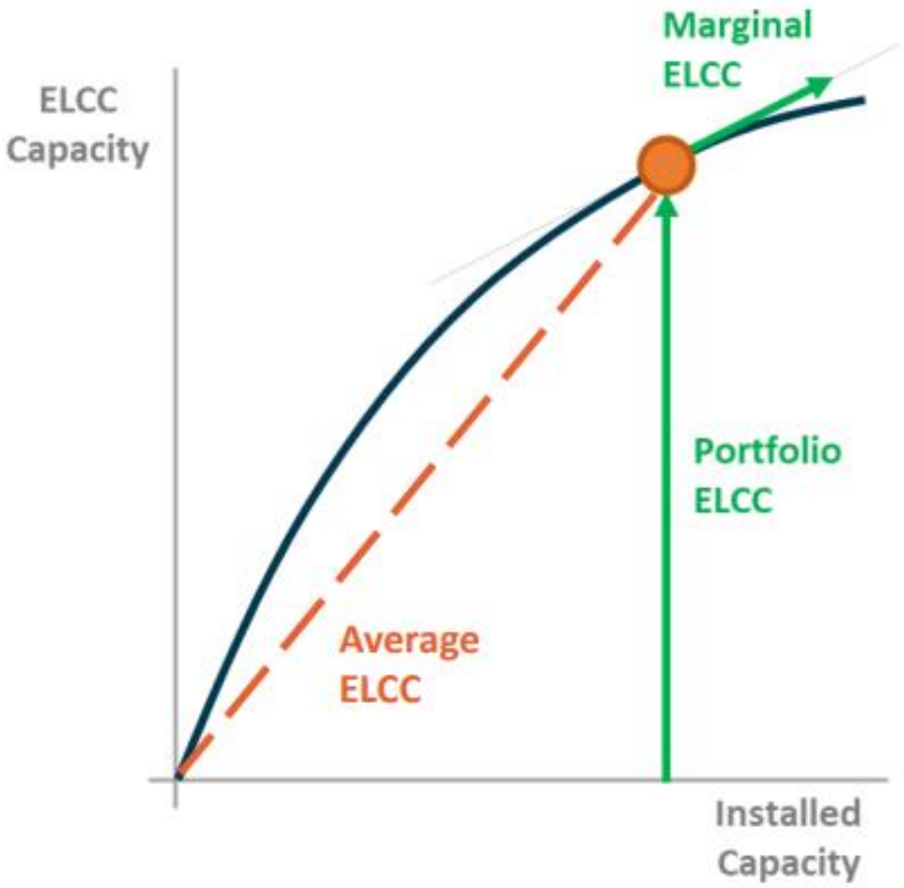
Source: E3

Average or Marginal ELCC?

The E3 Proposal for portfolio effects

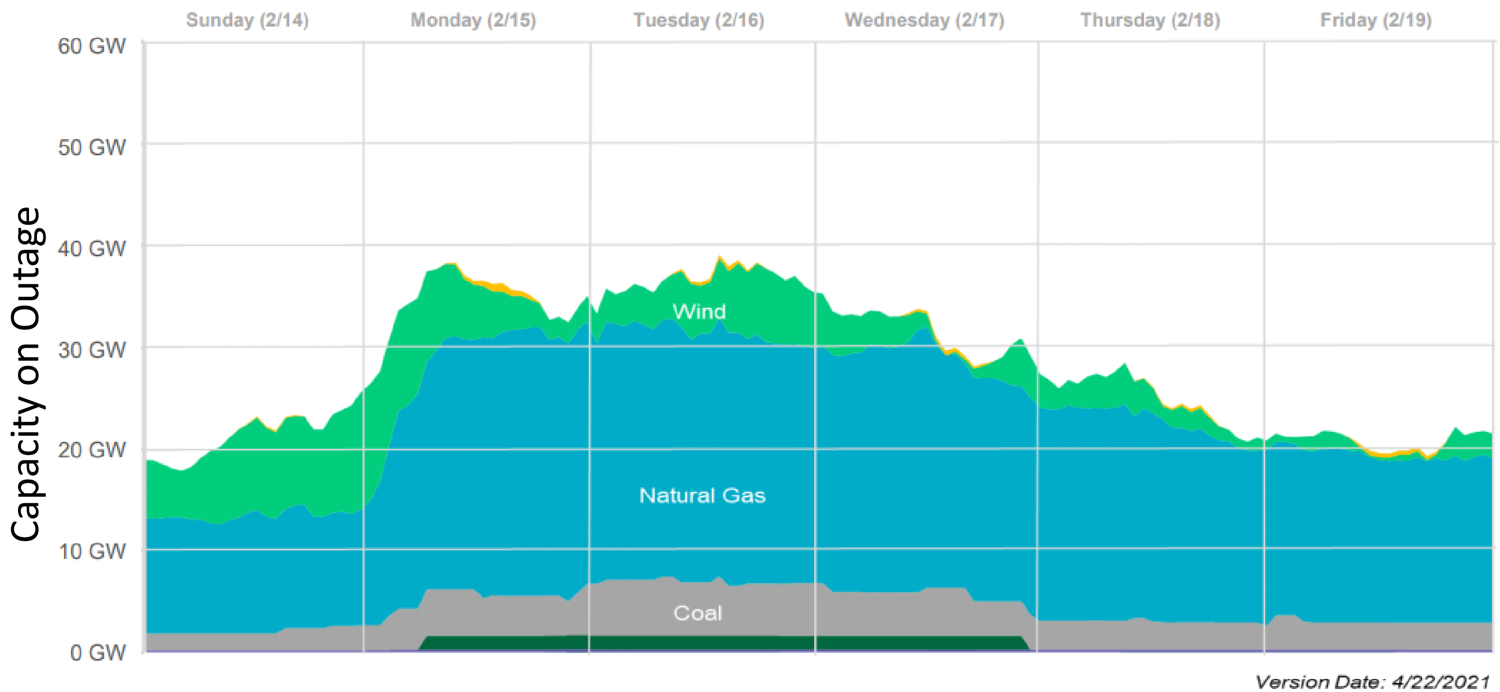


- **E3 developed the Delta Method as a way to ensure intuitive allocation of interactive effects**
  - PJM's application of the Delta Method was recently approved by FERC
  - Average ELCC of a given resources is its Marginal ELCC plus an allocation of the Diversity Benefit based on its contribution to it



Source: E3, [Capacity and Reliability Planning in the Era of Decarbonization]

There is no such thing as perfect capacity



Wind and solar MW values based on estimated lost output due to outages and derates from slides 15 and 16.

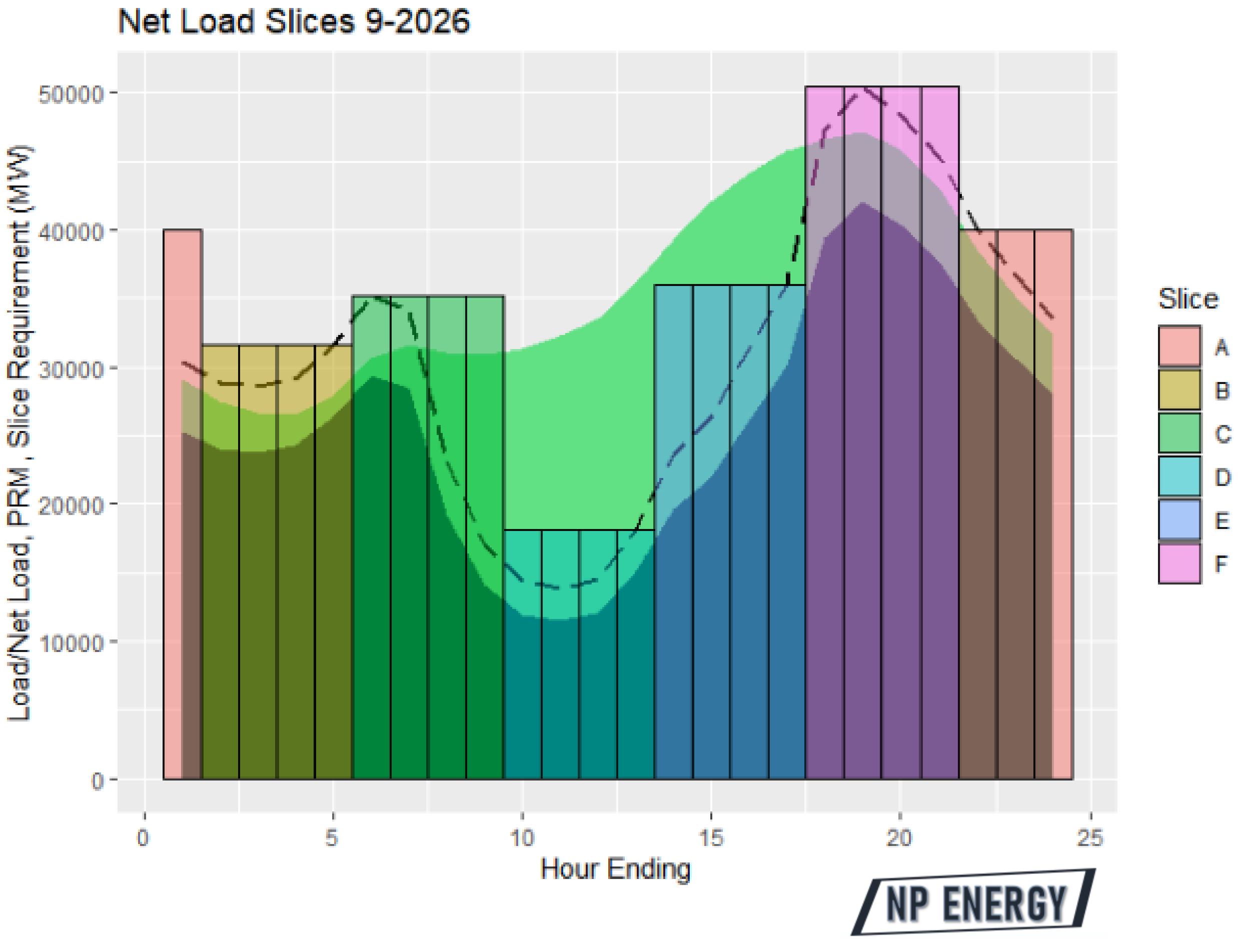
Sources:
[ERCOT Preliminary Report on Causes of Generator Outages and Derates For Operating Days February 14 – 19, 2021 Extreme Cold Weather Event]

+ Highly correlated outages, especially in extreme cold snaps
+ Ambient derates during extreme temperatures
+ Fuel supply risk and gas sector dependency

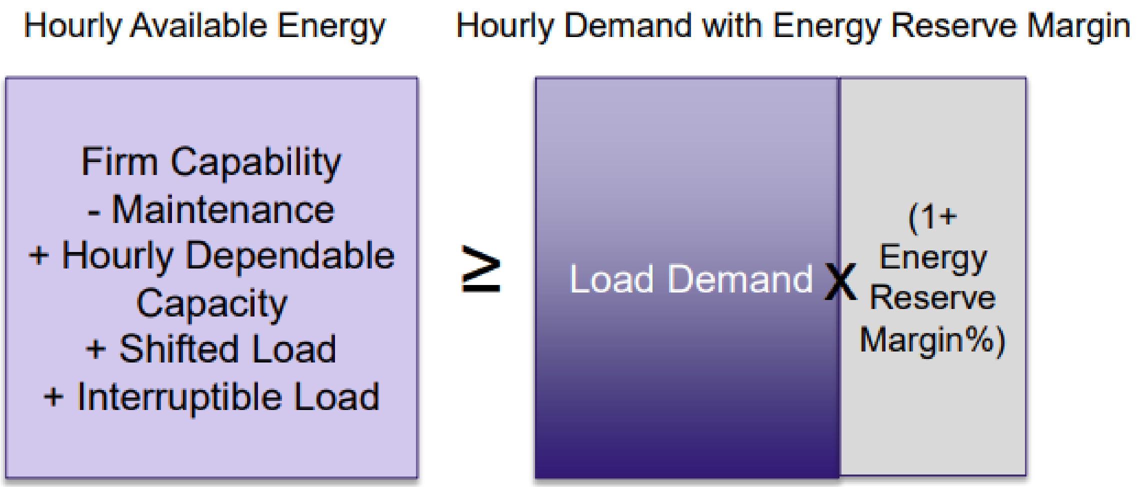
= Need to apply ELCC to other resource types to pick up on peak winter risk

Alternatives to the Planning Reserve Margin

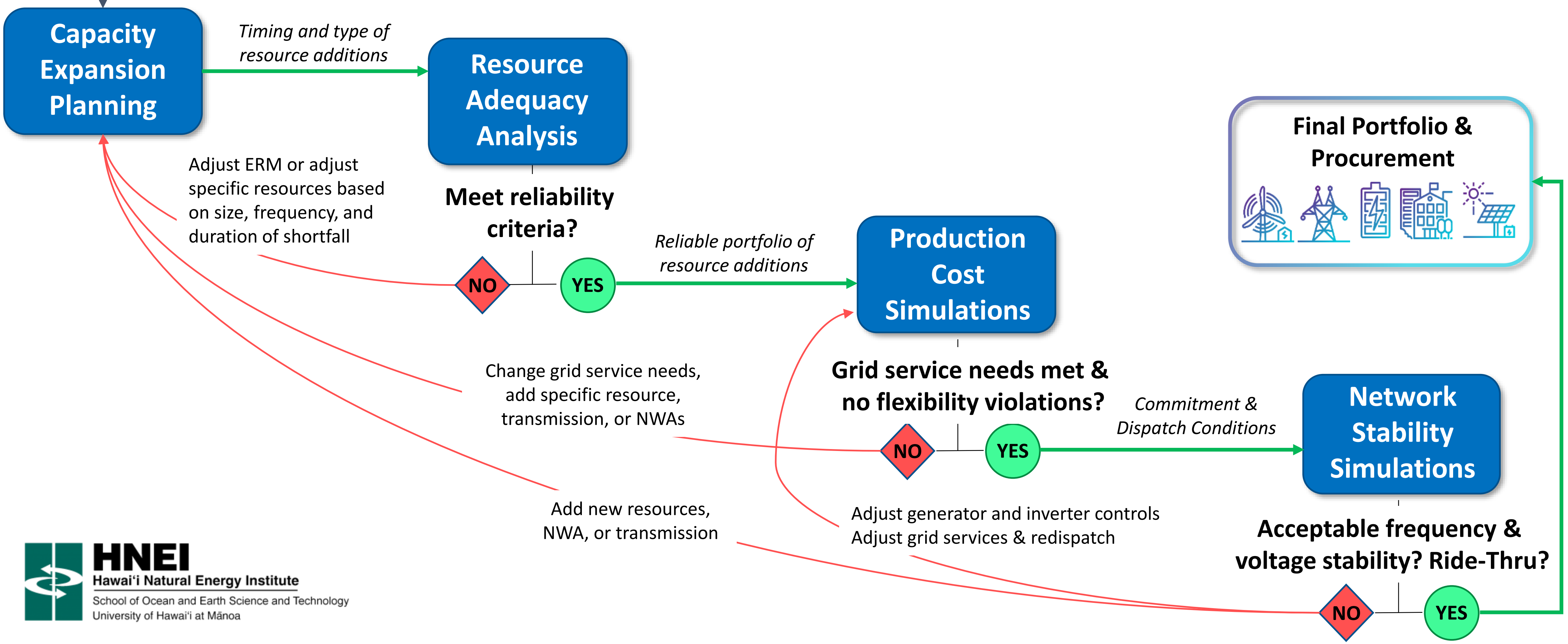
PG&E "Slice of Day"



HECO Energy Reserve Margin



PRM must be replaced with an iterative approach between capacity expansion planning *followed by* resource adequacy analysis to test the portfolio



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Next Steps for Resource Adequacy

- Calibration of New Metrics
- Best Practices for Weather Data
- Capacity Accreditation Alternatives

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Thank You!

Questions?

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