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Impacts of Renewable and Storage Technologies on Resource Adequacy

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What is resource adequacy?

Ensuring sufficient resources exist to supply power and energy requirements at a future time and location, with a certain probability/tolerance of failing to do so

	Regions	Metric	Target Value
Probabilistic Method	Southwest Power Pool	LOLH	2.4 hours/year
	ISOs/RTOs: PJM, MISO,[a] NYISO, ISO-NE, ERCOT[b] NERC[c] regions: Midcontinent Area Power Pool, some SERC entities (e.g., Duke Energy Carolinas, Progress Energy Carolinas, Entergy), Florida Reliability Coordinating Council APS[d]	LOLE	1 day/10 years
	BPA[e]	LOLP	5%[i]
PRM Method	CAISO[f]	PRM	15%
	SCE&G[g]	PRM	12%–18%
	PNM[h]	PRM	13%

[a] Midcontinent ISO
[b] Electric Reliability Council of Texas
[c] North American Electric Reliability Corporation
[d] Arizona Public Service (part of the Federal Energy Regulatory Commission (FERC)'s Southwest region)
[e] Bonneville Power Administration (part of FERC's Northwest region)
[f] California ISO
[g] South Carolina Electric and Gas (part of NERC's SERC region)
[h] Public Service Company of New Mexico (part of FERC's Southwest region)
[i] This LOLP of 5% reflects the probability that the region would experience a significant power shortage no more than once in 20 years (NWPP 2008).

Consists of two parts:

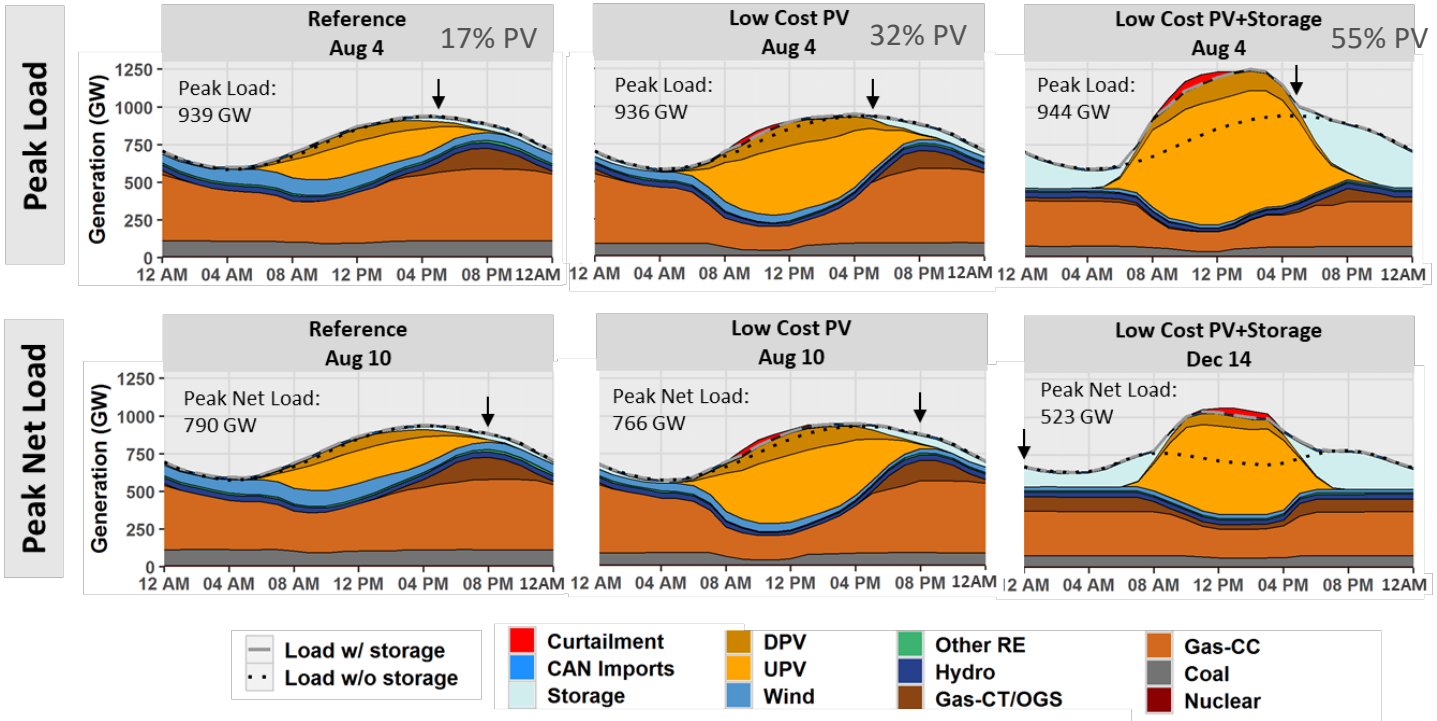
1) **System-wide target** (e.g., 1d/10yr LOLE, 15% PRM, etc.)
2) **Resource contribution to that target** (e.g., capacity credit, outages)

Different metrics and methods are used for each; probabilistic-based approaches are recommended

Source: Milligan et al. "Wholesale electricity market design with increasing levels of renewable generation: Revenue sufficiency and long-term reliability" (2016). https://doi.org/10.1016/j.tej.2016.02.005

Move over peak load day…

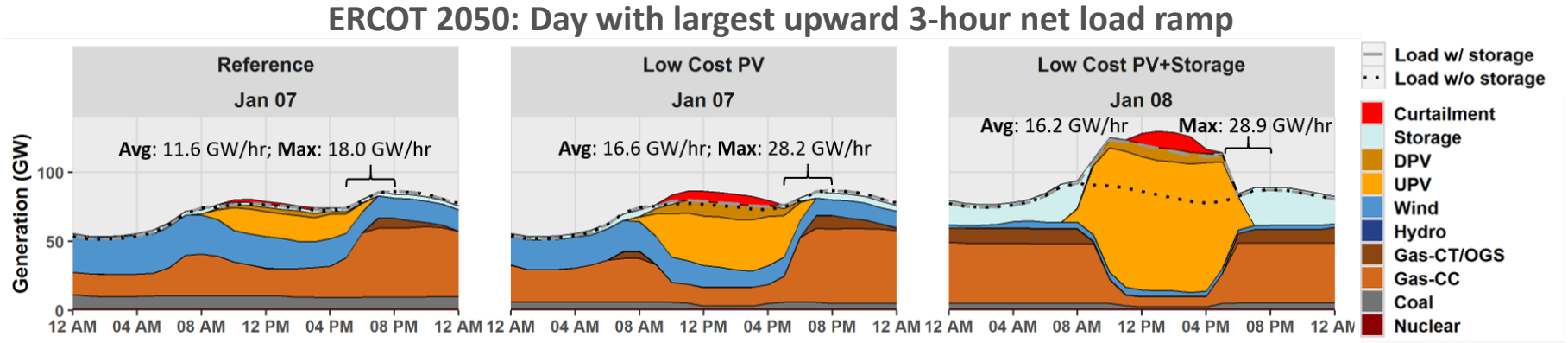
It's all about peak *net* load ("all hours matter")



Nationwide 2050 peak load and net load days

Source: Frew, et al. "Sunny with a Chance of Curtailment: Operating the US Grid with Very High Levels of Solar Photovoltaics" (2019). www.sciencedirect.com/science/article/pii/S2589004219303967

Does resource adequacy = capacity-only adequacy?

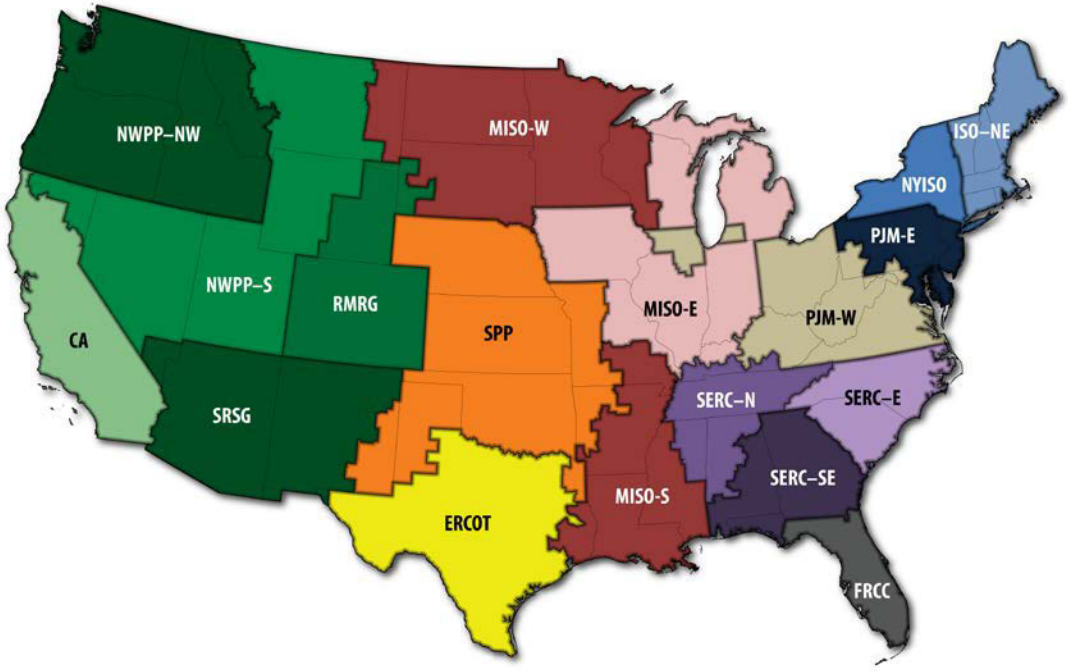


With more renewables, system conditions other than peaks can be increasingly important

Source: Frew, et al. "Sunny with a Chance of Curtailment: Operating the US Grid with Very High Levels of Solar Photovoltaics" (2019). www.sciencedirect.com/science/article/pii/S2589004219303967

Weather year matters

Region	"Binding" Weather Year
CA	2012
ERCOT	2012
FRCC	2009
ISO-NE	2013
MISO-E	2009
MISO-S	2011
MISO-W	2013
NWPP-NW	2013
NWPP-S	2011
NYISO	2011
PJM-E	2013
PJM-W	2013
RMRG	2008
SERC-E	2007
SERC-N	2011
SERC-SE	2008
SPP	2011
SRSG	2010



Source: Denholm et al., "The potential for battery energy storage to provide peaking capacity in the United States" (2019). https://www.nrel.gov/docs/fy19osti/74184.pdf

ReEDS: https://www.nrel.gov/analysis/reeds/

PRAS: https://nrel.github.io/PRAS

Thank You

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