G-PST/ESIG Webinar Series: Probabilistic Resource Adequacy Methods	
Question	**Answer**
How strong are the correlations you're seeing between various gen types' output and weather? Can you describes some of these trends?	Very strong, particularly during winter extreme cold events. Forced outages of thermal units are much higher, load is high, solar resource availability is low, wind can also be low. Fuel supply on the gas network can also be limited. Summer also has correlation, but less pronounced and more often captured in RA studies.
If you could change the metric of assessment (1 in 10 years), what would that be ?	As the system transitions to be more *energy* constrained rather than just capacity constrained, a metric that quantifies unserved energy (not just events) becomes more important. So something like Expected Unserved Energy (EUE) would be my preference. But it could also be a dual metric, like LOLE and EUE, or an LOLP that ensures the worst case is within a certain range. Regardless of the new criterion, an economic component is also important because reliability and economics are naturally interconnected.
Do you know of any studies on the correlation between load and solar and wind output. And the impact of mismatching load and production data on RAA	I don't know of any off the top of my head that quantify this specifically, but best practice is to use correlated wind, solar, load (and temperature for thermal) data.
what improvements do you think can be made in these long term high resolution forecasts for load?	Increased use of bottoms-up load forecasts by layer rather than use econometric models that extrapolate based on recent trends. Increased electrification will change not only the magnitude of load growth, but just as importantly the underlying shape. The other suggestion is to create weather-year specific chronological load forecasts, rather than just a P50/P10/P90
Were production cost modeling methods used in the "redefining RA" report?	Yes, I would characterize it as production-cost lite, so using a Linear Optimization, no min up/down constraints, etc. So less granular than a full production cost simulation, but enough cost information to schedule energy limited resources.
Is use of representative days/weeks consistent with the recommendation for chronology and multiple weather years?	I think this is sufficient for capacity expansion modeling, provided that the representative days/weeks are selected carefully. For resource adequacy modeling it is, in my opinion, insufficient. We really need many weather years of full 8760 chronological data.
What level of validation is typically performed on both the actual and synthetic weather data?	Short answer, not enough. Longer answer, there is a lot of information on the NREL NSRDB and Wind Toolkit sites. In places where the ISO has developed their own data (e.g. ERCOT, ISONE), there is also a lot of documentation.

A challenge: really incorporate T/D networks in reliability analysis. But adding load-flow/transient simulations to RA makes it likely intractable. Ideas ?	Agreed. On distribution, I'm not convinced that needs to feed back to the RA modeling. On transmission, I think (for now) we're still stuck with working with the transmission planning team to identify interfaces and transmission constrained zones (with temporal limits) that can be modeled for RA. A short-term improvement would be to add interface limits that have a probability associated with it to correspond to transmission outages.
Are there any analysis out there that account for duration of thermal generation outages?	Good question. Another reason we need to have a publicly available version of granular (anonymized) GADs data - so we can get a better handle on repair time distributions for forced outages
Would there be any reasonable way to incorporate demand response into these models?	Yes. Typically modeled as a
A text message sent in California reduced load on the system by 2,600MW in minutes. What part can demand side management play in improving resource adequacy?	We covered this as one of the six main principles for the Redefining RA whitepaper. I am always careful in defining RA as "ensuring enough *resources* to meet load" where resources include both supply side capacity, as well as demand-side flexibility. However, I don't think we should count emergency text-messages as a resource, because it is relying on uncompensated, unquantified support from ratepayers. It's great to get their response when it is needed, but it's a blunt instrument. We should have actual programs that pay for this type of participation.
Is the gas system considered in any of this RA analysis?	Not in the analysis I shared, but it is increasingly important and being done in ISONE and other places. I would still characterize most of this work in its infancy. Most of the time the analysis is conducted to determine how much of an affect gas disruptions could have, rather than cross-sector modeling which is needed.
How are the TSOs are modelling High Impact Load Probability events within their resource adequacy analysis?	Right now, in most places, these events get averaged in with the rest of the weather data. I typically advocate for separate "what if" stress testing of specific events to understand the impacts because probabilities can be very difficult (or impossible) to assign.
do you characterize uncertainty in available capacity for thermal units? (temperature driven impacts)	Yes, I think this question came in before the section devoted to this question.
Slide#15. It's interesting that the loss of load event is shifting from short event to long event. What region is this study for?	ERCOT, but I have seen this type of relationship in many systems with high renewables and storage - thus requiring us to move past just LOLE metrics that count the number (but not size) of events
Do you have some recommendation for current studies analyzing the impact from flexible EVs, HPs and other flexible devices on adequacy?	I think this is generally a focus area of analysis over the coming year(s). Ensuring we treat load flexibility as a resource is essential. While this was always true, electrification affords a new type of resource that can be much more flexible.

What is the time scale for evaluating the resource's adequacies? How is the granularity of different reserve services taken care?	In my opinion, the timescale for RA analysis should be hourly. "Capacity" should be considered a grid service, along with all of the other ancillary services like regulation reserve, spinning reserve, ramping reserves, PFR, FFR, inertia, etc. While we need to plan for all of those grid services, they don't all have to be reflected in RA studies.
Can you explain the difference between regional capacity sharing and acquiring capacity through a capacity market like in PJM?	The capacity markets in the ISO/RTO footprints is part of the interregional capacity sharing I was referring to. This was a large reason for the pooling of resources in an ISO/RTO to begin with. I believe many of these benefits could be applied to the Western US and Southeastern US without needing a full ISO capacity market through the use of capacity sharing. In addition, there are also benefits of interregional capacity sharing even between ISO/RTOs due to load diversity and wind/solar diversity.
How the spatial relation between different vRES is modeled in the studies?	Each individual plant should have its own production profile that is based on the same underlying weather assumptions as the rest of the system.
Can you describe the modeling process that is used to estimate the capacity value of transmission? Does this work within a market as well (between zones)?	Two options. 1) assess new transmission with an ELCC calculation similar to wind/solar/storage etc. To do this you would evaluate the system without the new transmission, calculate LOLE (or other metric), add the transmission which will reduce LOLE, and then add load back to see how much you can add to get back to the starting point LOLE. This will give you an ELCC to compare to other resources. 2) calculate the capacity requirement (i.e. planning reserve margin) with and without the transmission resource to determine how much less capacity can be procured altogether. The first assigns the value to the individual resource, while the latter assigns the value to the system.
CAISO has proposed a UCAP that based on performance only during tight supply conditions. Does looking at hours of highest LOLP bring UCAP closer to ELCC?	Yes. We have found average capacity factor during tight margin hours (unserved energy hours) to align closely with ELCC, as long as the tight margin hours are updated regularly to align with the underlying risk hours in the RA assessment. Personally I think this approach should be used for all resources instead of ELCC.
ISO-NE's reliability study showed a strong dependence on how battery storage is deployed wrt lolp. how do you model generator behavior in market. Game theory?	This is one reason to move to an EUE metric instead of LOLE/LOLP, because the latter can change significantly based on storage dispatch and utilization, but EUE is the same. This is also the reason why I prefer using an average generation during risk hours approach rather than ELCC.
Are there tools that do this kind of chronological RA assessment well? Or is most of this work done manually?	Most production cost tools can be adapted in some way to do this type of chronological Monte Carlo RA assessments.