G-PST/ESIG Webinar Series: Use of Probabilistic Resource Adequacy Methods	
Question	**Answer**
Of all data inputs, which data types were hardest to develop for RA models? e.g. correlated weather, renewable, and load data, climate scenarios, resources	While each cae study had different challenges, incorporating correlated weather outage data into the models was challenging for many, other than the few that already had data avaialble. If as an industry we could develop time series for correlated wind,solar and load data, as well as temperature-dependent outage curves by unit type for each region this would be very helpful. We will provide guidance oon how to gather and develop the data in final reports comign this summer (keep an eye on www.epri.com/resource-adequacy), but also think there's a strong need to develop such datasets across industry.
How can we improve LOLE and accreditation to better capture the correlated outage risk of thermal resources?	Including temperature-dependent outage risk in our models, and increased probability of natural gas insufficiencies in certain regions, potentially driven by temperature thresholds, will be important to improve adequacy analysis, and by extension any accreditation metric such as ELCC which is calculated from the probabilistic resource adequacy model. These correlated outages can be represented in the models used, and then results should reflect the risks due to this behavior.
Do you believe you have adequate time serial weather, load, renewable data, and outage data to populate your models?	Obtaining adequate data is always a challenge in any resource adequacy analysis. Some of the case studies used a 40 year weather synchronized dataset for their base case, but some where more limited based on available data. The different case studies focused on this question of data adequacy in varying ways. For example, the ERCOT case study analysed the impact on results of using varying number of historical weather years. In contrast, the Northeast case study was more limited in the number of correlated weather years obtained, but spent some time analysizing the impact of climate change and energy efficiency and electrification on this data.
If a capacity market is linked with multiple reliability targets, would it significantly increase the complexity of capacity accreditation?	This depends on the implementation. If the metrics were linked in some way, it may increase complexity. However, if each was independently assessed, it may not make as much of a difference, for example setting the ELCC based on the binding constraint in any simulation. Brining in secondary metrics may require different consideration of how resources would contribute to adequacy.

How do you model the climate impact that could be different from historical weather patterns and increased electrification (load side-scale, speed, and timing)?	Climate change impacts weren't considered in the base case results for any of the case studies, however they are considered as a sensitivity for the Northeast case study, where changes to load and load behavior were also considered. Preliminary results for this analysis show a limited impact for climate change within the 8-10 year forecast horizon considered, with changes in resource mix being the primary driver, and changes to load also mattering more. However, this impact is anticipated to become more significant when considering scenarios several decades in the future, and this is a key focus of the EPRI Climate READi initiative, which is ongoing.
In terms of data, what is the biggiest gap we have?	We identified several gaps. Load forecasting is a big data gap currently - it has a very significant impact on results, and we need to better understand how electrification and climate change will influence it. Winter storm Elliot was a good example of the work we still have to do around better forecasting load during extreme weather events. Data to support improved load forecasting will support RA analysis in the future. We will publish a report on key gaps in the summer.
is LOLE < 0.1 really the right level of reliability? I've often interpreted the ODITY metric as actually a "one EVENT in ten year" metric, so LOLE < (0.1/24)	The one day in ten years metric currently enforced in much of the US is a criterion that has been in place for many decades, and has often been interpreted as one event in ten years - though the lenght of the even is not necessarily one hour. The comment here illustrates how there are also different ways to interpret, depending on whether you consider and event, an hour, or days with an event. We have written about this in a document we published on metrics (www.epri.com/resource-adequacy). Even were we to decide a specific way to calculate, there is a likely need to add additional metrics and analysis, as discussed during the presentation, and revisit criteria. The reliability criteria selected should be set based on consumer's risk tolerance, and as such may vary from one region to the next.
How do you cope with random distribution of unserved energy between modelled zones?	How unserved energy is distributed across zones when it is not contained to a single zone is something that is done differently across the various tools, and so is approached slightly differently from one case study to another - Some of the work done for the MISO case study evaluates the impact of varying unserved energy distributions across zones on final results and will be discussed in the final reports.

How do you decide whether an event is Category 5,4 etc. in the Severity Scale?	The severity scale currently proposes a category 4 event if load shedding is below 10% of load, and a category 5 event if load shedding is above 10% of load - or below 10% but for a sustained amount of time. This is still in proposal stage and we are open to other ideas - in fact, based on existing discussions with project members, we are likely to make changes in coming months before the fist version is published.
Regarding the case study on long duration energy storage, what's the duration of the storage you are considering - are you modelling 8760h horizons here?	The Western Interconnection case study considers long-duration specifically. One of the portfolios evaluted contains multi-week energy storage, and work has been done to analyse the impact of varying optimization windows on results. We model 8760 hours for multiple weather years and outage draws within that optimization
Do you feel correlated outage risk of thermal resources is a first, second, or third order concern?	As many systems see increased risk in winter periods, correlated outage risk is becoming a top concern. However, this is not the case across all systems and dependent on the weather patterns, capacity buildout, and pipeline infrastructure present in the region. IN our case studies, we saw a variety of impacts, but in all cases there is some impact from correlated outages of thermal resources. Looking further into the future, we may become less dependent on these resources, but while we still do, the correlated outages is a big issue that needs to be considered in tools and processes going forward. We'll be making some specific recommendations and providing tools to support this in coming months (watch www.epri.com/resource-adequacy)
How do you envision these recommendations leading to change in actual capacity accreditation?	This project focuses on resource adequacy analysis and risk metrics, and doesn't touch on capacity accreditation too much. However, the capacity accreditation values you will get through an ELCC-type analysis are very dependent on the model used. As such, we expect this analysis will allow for more accurate capacity accreditation values. For example, improved modeling of thermal outages during extreme weather would allow for better calculation of the capacity and energy contribution of such resources. We are currently working on this topic in a different project which will build on the improved modeling, metrics and tools from this effort.
What does NEUE stand for?	Normalized expected unserved energy. This corresponds to the total amount of loss of load (in MWh) as a percentage of total system demand - sometimes calculated in parts per million, since that number is so small

Better deployment of storage would lead to higher contribution during times of most need. How important is storage management/modeling to accreditation?	The ERCOT case study investigated the impact of varying storage dispatching strategies to various risk metrics. Those findings show that the storage dispatch strategy modeled has an impact on LOLE, and so on ELCC by extension. Previous EPRI work has similar conclusions (https://gridops.epri.com/Adequacy)
To what degree does this analysis incorporate correlated outages of thermal resources?	Correlated outages of thermal resources were not incorporated into base case results, but were studied in sensitivities for many of the case studies - this allows us to understand what impact correlated thermal outage modeling has on system results. Final results will be published in coming months.
How different do you think the results would be if you used the same model across all case studies?	The various sensitivity runs we've analyzed showcase the sensitivity of results to varying model, data and tool options. As such, comparison across case studies should be done keeping this fact in mind - results can't be compared directly, but general trends can be identified. This brings an important point up about RA analysis in general - as well as the aspects currently getting highlighted such as how ELCC is calculated, it is important to understand the underlying tools, data and assumptions made. Those can have a significant impact on results that is often not considered.
Do you have any specific criteria for the EUE as in the LOLE<0.1?	No, we don't have any specific EUE criteria. These should be set on a system-by-system basis, based on the risk tolerance of the consumer. We will provide a set of results across different regions that may help identify where the criteria should be set.
Is there a need to run these types of RA analyses more frequently given the (seemingly) more rapid changes in system conditions? Maybe on a rolling basis?	Running RA analyses more frequently can be helpful to more rapidly identify adequacy impacts due to changing system conditions. Additionally, running RA analyses for different timescales will allow for differing levels of details to be incorporated (For example, a near-term RA analysis that isn't run for a full-year horizon may be able to incorporate operating constraints which a longer analysis wouldn't have the computational bandwidth to accomodate). This has to be balanced with complexity and run time of the models.
Have you considered the cost of the resources that would be required to mitigate those very unlikely but high impact tail events?	We haven't explicitly considered the cost of resources to mitigate these events in our case study analyses, but do recognize the need for an understanding of the cost of extra reliability when setting adequacy criteria - these shouldn't be decoupled from economics, as they are currently.

How difficult do you anticipate driving regulatory and market related change as a result of these insights will be with regulators and govt departments?	Changing the way we run adequacy analyses is a big task that will take time. However, we are already seeing changes in several regions. More and more systems are starting to consider correlated outage risk in their analyses, for example, and tools are increasingly adding functionality to calculate a wider array of risk metrics. As a first step, we'd suggest reporting several risk metrics, even if still planning for a 0.1 days/year system. This would allow reglators, executives and government departments to become more comfortable with alternative risk metrics.
What is PJM-10 degree? comparing with PJM	The curves were developed for the PJM region (by CMU- S. Murphy), where generators are expected to be better equipped for cold weather. To account for this difference, these curves were shifted 10 degrees to the right in the ERCOT case study to illustrate how outages may change. Ideally, one would perform the same analysis for ERCTO as PJM, and we are building tools to do so with a project in ISO-NE, but the data wasn't available in time for that study.
How do your analyses handle the issue of weather-correlated limits on imports from adjacent regions?	This was handled differently depending on the case study. Some case studies were modeled as islanded systems, and imports were not considered. Larger case studies (such as the Western Interconnect case study and the Northeast case study) modeled a number of balancing areas or ISOs, and modeled the flows between regions. So a weather event would be seen across multiple regions, and exports would get adjusted according to each region's availability (with priority being given to meeting in-region demand)
Do you think that the approaches used in these case studies (and the amount of data required) are possible to implement in low and medium-income countries?	The reports published as part of this initiative will provide "standard-advanced-best in class" recommendations across the different parts of the resource adequacy process. We will also be sharing a "materiality index" worksheet which will help planners identify key areas to focus their time and resources for maximum impact. We have worked with low and mdeium-income countries in this area in the past, and many are using some version of the tools discussed here; data availability varies but we can work to ensure they can use the tools to greatest extent possible.
What is the difference between LOLE and LOLH?	LOLE (in days/year, as it is generally used in the US) corresponds to the expected number of loss of load days in a year, whereas LOLH corresponds to the expected number of loss of load hours in a year. LOLE could also calculated number of events per year (sometimes denoted LOLEv)

What's your suggestion of best way to include renewables in RA?	Care should be taken to use correlated weather datasets with a sufficient number of weather years to include statistically relevant events. Often, there is insuffient weather data available, or it is available from different sources, which complicates this implementation. More information on data recommendations will be provided in the upcoming data deliverable for this project.