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PJM Staff Education/Analysis Request
RASTF KWA 2 & 5 Thermal Correlated Outage

June 15, 2022

Summary
Below are requested areas for further PJM analysis to "fully analyze the correlation of thermal outages during the peak times to ensure our modeling appropriately reflects those resources' reliability contribution to the grid." (October 14, 2021, PJM Board Letter).

Over the last 9 months, significant work has occurred and it appears that there is general consensus among stakeholders, PJM and IMM to make changes from the status quo. Several studies and solution concepts are already on the table. As PJM Board has highlighted, this is an urgent issue to address as the energy transition speeds up and PJM works to ensure reliability.

Important analysis has already occurred. In December 2021, PJM provided an analysis on areas of risk now on demand side.[1] In February, PJM stakeholders heard from Astrapé Consulting[2] [3] which provided a methodology to determine resource-type adjustments to EFORd to better account for outage correlation. Stakeholders have also heard from LS Power[4] with a concept to arrive primarily at a unit-specific adjustments to EFORd (also adopting the fleetwide asymmetry adjustment approach from Astrapé). Both Astrapé and LS Power highlighted research by Sinnott Murphy et al. PJM has conducted its own analysis identifying several areas of risk that are on the load side now. E3, on behalf of Calpine[5], and Enel[6] also presented viewpoints identifying needs for changes.

Unfortunately, most GADS data is not public and as a result, PJM has significantly greater ability than stakeholders in completing additional analyses.[7]

Therefore, we respectfully request PJM to perform analysis to support next steps. While these studies may not be necessary to move ahead with reforms, AEE believes they warrant discussion. AEE has highlighted below key questions that have come up during the stakeholder process. This analysis would

[1] https://www.pjm.com/-/media/committees-groups/task-forces/rastf/2021/20211217/20211217-item-04-education-reliability-risks-and-drivers-post-meeting.ashx
[2] https://www.pjm.com/-/media/committees-groups/task-forces/rastf/2022/20220228/item-4c---perspectives-on-reliability-risks-and-drivers---astrape.ashx
[3] https://www.astrape.com/?ddownload=9291
[4] https://www.pjm.com/-/media/committees-groups/task-forces/rastf/2022/20220526/item-08a---reliability-risks-and-drivers---ls-power.ashx
[5] https://www.pjm.com/-/media/committees-groups/task-forces/rastf/2022/20220411/item-2---e3-perspectives-on-capacity-market-reform.ashx
[6] https://www.pjm.com/-/media/committees-groups/task-forces/rastf/2022/20220228/item-4b---perspectives-on-reliability-risks-and-drivers---enel.ashx
[7] As a related activity, we would like PJM's feedback on whether PJM would support opening up GADS data access and if so, what is needed to accomplish this. Operational data from fossil generators that emit is available from EPA's publicly accessible database. Gas nomination data of natural gas facilities that interconnect to the interstate pipelines are available from various subscription services, and resource energy market offers are publicly available after a 90-day embargo period and anonymized. The benefits of releasing GADS data in an anonymous format after an appropriate embargo period (similar to energy market offers) would greatly outweigh the costs to an particular generator and would likely improve reliability through better sharing of data.

help stakeholders determine the proper accounting of each area of risk on the scale from fleet wide, to class, and to unit specific. This analysis would also support stakeholders to define class-types where relevant. The analysis would enable stakeholders to evaluate the problem and potential solutions more fully and integrate into education and CBIR activities.

We outline eight study question options. The first option is a broad study, while the additional options are focused. All build off of existing analysis. We are available to discuss the options and how to accomplish the goals of this analysis under a reasonable time frame. We recognize limitations in PJM staff time and resources, and important stakeholder timelines for developing alternatives to the status quo, which we do not want to delay significantly. We are open to further discussions to better determine how to prioritize activities. We appreciate PJM's timely response to this request.

Study Question Options

1. Conduct full expansion of Astrapé analysis to RTO level

Study Questions:

1. Astrapé observed that, unlike existing ELCC accreditation, thermal accreditation today is based on average outage rates and therefore does not account for outage variability or correlations. Astrapé shows that outages vary significantly during times of system tightness from expected average outages and necessitate more reserves than are assessed under the EFORd approach used today. Astrapé developed a methodology focusing on four areas of risk to isolate the impacts of variability and important correlations and thereby accredit thermal resources on a more accurate basis.
    a. What would be the outcome of applying this methodology to PJM's full thermal fleet across the RTO, rather than just PJM South and filling in gaps where Astrapé used public estimated data with PJM actual and up-to-date data?[8]

Requested PJM Analysis:

1. Undertake complete analysis described above.

2. Review of Outage Variability

Study Questions:

1. As one of four areas of risk, Astrapé identified that thermal accreditation today does not account for the variability in outages and pursuant reserve requirements that are needed to account for general variability/correlations. This is accounted for in existing renewable/storage ELCC metrics.
    a. What are the outcomes using the Astrapé methodology to assess Outage Variability de-rate on thermal resources on an RTO level?
    b. Given that the demand side now accounts for variability in outages, how would this change once outage variability is accounted for on the supply side?

[8] For instance, the link here looks to have the generic forced outage data. This is daily. We would request instead PJM use hourly and actual rather than forecast data. https://dataminer2.pjm.com/feed/gen_outages_by_type

Requested PJM Analysis:

1. Perform outage variability analysis per the Astrapé paper methodology pages 27-30.

2. Evaluate changes to how demand side accounts for variability in outages.

3. Review of Correlated Hot and Cold Weather Dependent Outages of Unlimited Resources

Study Questions:

1. Astrapé used Sinnott Murphy's findings on correlation between weather and forced outages to develop a weather-dependent de-rate factor by generation type.
    a. Single classes for generation types are broad and may not capture important intra-class distinctions. Can PJM assess the prudency of further intra-class distinctions and undertake related analysis of resource adequacy characteristics, including considering the impact of generator size, different technologies, and other salient criteria that can contribute to resource adequacy contributions and should be considered in informing possible subclasses?

Requested PJM Analysis:

1. Run statistics (average, 95% range) to determine the correlation between temperature and EFOR at specific temperature thresholds.
    a. Run this on EFOR as well, which only captures unit outages and not derates. This gives a clearer picture of binary performance vs. ambient derates.
    b. Perform statistical analysis comparing the distribution of system outages using uncorrelated random sampling to the historical distribution of system outages.[9]

2. Provide this data in aggregate and under buckets related to unit size, unit age, etc.

3. Run analysis with and without controlling for fuel availability.

4. Review of Fuel Availability Outages of Unlimited Resources

Study Questions:

1. Astrapé highlighted recent experiences that suggest under emergencies, ~10% of the gas fleet cannot obtain fuel. This raises questions such as whether and how units can effectively mitigate this risk partially (for instance, by obtaining firm fuel) or in whole?
    a. What is the scale and correlations of fuel related outages over the last 10 years in PJM?
    b. What portion of gas generation would be expected now or in the future to have fuel under specific weather events/temperatures due to constraints in gas delivery infrastructure?

[9]The link here looks to have the generic forced outage data. This is daily. We would request instead PJM use hourly and actual rather than forecast data. https://dataminer2.pjm.com/feed/gen_outages_by_type

c. Is there a distinction in outage profiles between resources that have firm and non-firm fuel contracts?
d. Is there a distinction in outage profiles between resources that have on-site fuel back up and do not?
e. Is there a distinction in outage profiles dependent on where the generation resource is located on the gas distribution system (such as behind an LDC), or on a main transmission pipeline lateral)?
f. Is there a distinction between resources that have DA energy schedules and are able to commit to timely gas day ahead nomination timelines and resources that are committed in the real time and may only nominate their gas intraday?

Requested PJM Analysis:

1. Run statistics (average, 95% range) to determine the correlation between fuel and EFOR at specific temperature thresholds.
    a. Perform statistical analysis comparing the distribution of system outages using uncorrelated random sampling to the historical distribution of system outages.

2. Provide this data in aggregate and under buckets related to unit size, unit age, etc.
    a. The specific GADS cause codes related to fuel supply issues:
        - 9130: "failure of fuel supplier to fulfill contractual obligations…due to physical fuel disruptions or operational impairments…"
        - 9131: "lack of fuel – due to contractual or tariff provisions that allow for service interruption…"
        - 9134: "fuel conservation"

3. Review of Common Mode Failure of Unlimited Resources

Study Questions:

1. Astrapé highlighted in its paper that some units share transformers and other facilities that can lead to correlated outages not accounted for today.
    a. What is the frequency of common mode failure?
    b. What are the trends over the last 10 years

Requested PJM Analysis:

1. Analyze the frequency of common mode failures by using GADS data and running a query of the same time period and cause code. This will assess the incidence of common mode failure

2. Review of Maintenance Outages of Unlimited Thermal Resources

Study Questions:

1. PJM explained in its analysis that PJM procures about 1,500 MW in the RRS to account for these. "The RRS, CETO, ELCC use most recent 5-year Equivalent Maintenance Outage Factor (EMOF) calculated using GADS data. A quarter (1/4) of the EMOF is added to the EFORd to create the EFORd of each unit; the remainder (3/4) is added to the EPOF" (KWA 2 Matrix)
    a. How is this 1,500 MW calculated?
    b. How is it shared across the PJM fleet? Is a single resource type responsible for it?

c. Is there a specific time period of maintenance outages that is responsible for requiring this 1,500 MW?

Requested PJM Analysis:

1. Analyze maintenance outages by month, resource type, and contribution to the RRS.

2. Investigate how and if maintenance outages reduce system reliability at all due to approval of multiple outages during periods that unexpectedly see higher system stress (demand/forced outages) than expected.
    a. For instance, in ERCOT there have been reports in May that planned outages are requested and approved for large amounts of thermal resources during the same periods which then see higher demand than expected, thus creating system stress events

3. Additional PJM analysis to fully analyze the study questions.

4. Review of Ambient Derates of Unlimited Thermal Resources

Study Questions:

1. PJM in its analysis identified 2,500 MW in RRS that must be procured due to ambient derates.
    a. How does this 2,500 MW figure get calculated and how does it interact with the ICAP calculation?[10]
    b. How are these 2,500 MW distributed by resource type?
    c. On a unit level, what is the appropriate additional de-rate to EFORd to account for ambient derates?
    d. Since ambient de-rates presumably occur during periods of system stress and are correlated across the system, has analysis been performed to quantify the impact on thermal resources' capacity contribution?

Requested PJM Analysis:

1. Analyze ambient derates to fully analyze the study questions.

2. Review Planned Outages of Unlimited Thermal Resources

Study Questions:

1. For ELCC resources, planned outages are part of their accreditation, while for Unlimited Thermal Resources, planned outages do not contribute to accreditation. PJM explained in its December analysis that the impact today on the RTO reliability requirement is currently 0 MW UCAP, but the impact on the reliability requirement of modeled LDAs that have risk spread-out across

[10] "ICAP is also the capability of the generating unit at the expected time of the PJM Summer Peak. This is also referred to as the "rated capability" or "rated ICAP." Rated capability or rated ICAP is determined by adjusting the generators capability for generator site conditions coincident with the dates and times of the last 15 years PJM summer peaks. Generator site conditions coincident with the last 15 years' PJM summer peaks are also known as summer conditions." §1.2 PJM Manual 21

seasons is greater than 0. Concepts such as Equivalent Availability Factor aim to account for Planned Outages in Accreditation, something that the IMM has highlighted, in particular.

a. What is the impact of Planned Outages on the RRS within modelled LDAs today and how does that affect overall capacity procurement by affecting CETO etc.?
b. What is the impact of Planned Outages in the future based on expected changes in supply mix/demand across the RTO and within LDAs?
c. Please share descriptive statistics on Planned Outages in the PJM fleet in terms of average duration, frequency, seasonality, and overall quantity by asset type, asset age, etc.

Requested PJM Analysis:

1. Analyze Planned Outages fully to analyze the study questions.