TVA's Use of Dispatchability Metrics in Its Scorecard

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1. INTRODUCTION

At the IRPWG Meeting Session 8 on June 19 and 20, TVA explained its approach to scoring various IRP scenarios and risk factors. Sierra Club and other stakeholders expressed strong concern over TVA's proposal to add a "flexibility" metric to its scorecard.

Our opposition rests on two central points: first, flexibility is a property that—absent any contribution to safety, reliability, and cost—has no inherent value to customers. Second, safety, reliability, and cost have *other* metrics that more correctly and completely measure each plan's relative value in those three areas.

1) **Safety and reliability** are so fundamental that TVA should screen out any plans in its IRP process that are unsafe or unreliable before they reach this stage of scoring, and we have every reason to believe that TVA already does exactly that.[1]
2) **The cost** of each plan is already measured by TVA with much greater accuracy via PVRR.

Flexibility, the property of being able to react to short-term events or changes in demand rapidly, has value where significant fluctuations in demand for fast-ramping dispatchable resources may pose challenges to system reliability. Under some scenarios, if non-dispatchable resources were to reach extremely large penetrations, TVA's planning models may not be able to account for the short-term fluctuations imposed by variable resources and changing load. But TVA is nowhere near approaching this level of concern. Even if non-dispatchable penetration were a concern, a simple flexibility metric such as the one considered by TVA would be insufficient to measure or mitigate this effect. Appropriate flexibility for meeting uncertain minute-to-minute demands are properly measured and modeled with a high resolution production cost model.[2] This type of modeling is fairly new in the U.S. power sector, and is currently limited to California and other areas with significant renewable energy penetration or targets.

Flexibility unto itself is not usefully measured as a scalar: simply being more flexible does not automatically translate to providing benefits to the utility or its ratepayers. TVA's system needs to be flexible enough to meet its reliability requirements, and no more. At this point in time, there is no reason to assume that TVA does not, or will not, meet its reliability obligations.

Since we can safely assume that the qualities of flexibility that make it valuable are already accounted for in TVA's process, including an explicit flexibility metric would not provide any additional, useful

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[1] Reliability: System Optimizer and other similar capacity expansion models solve to meet both energy and capacity requirements, taking into account minimum reserve requirements and available contributions to peak energy from various generation resources. Safety: There is no reason to believe that TVA (or any other utility) would allow resources that create unsafe conditions to operate.

[2] For example, see the Renewable Energy Flexibility (REFLEX) Model from E3, explained at https://ethree.com/public_projects/reflex.php, paper available at https://ethree.com/documents/reflex_paper9.pdf.

information to assess a plan's relative merits. In fact, including this metric could result in a plan with a *higher cost* scoring better than a *lower cost* plan with equivalent safety and reliability implications.

Even if one were to ignore this fundamental flaw, the metrics with which TVA proposes to measure "flexibility" also raise concerns, which are outlined in Section 2 of this memo. Section 3 recommends a more appropriate and standard method of assessing a resource plan's flexibility in terms of safety, reliability, and cost.

2. THE PROPOSED NON-DISPATCHABLE METRICS ARE UNHELPFUL

The metrics proposed by TVA to measure each plan's "flexibility" include:

- *Non-dispatchable energy ratio:* This is defined as the total energy produced by wind + solar + energy efficiency + nuclear, divided by the total sales in each year. [3]
- *% dispatchable capacity for load following:* This is defined as the percentage of fully dispatchable capacity available for load following, starting from peak to minimum load. [4]

These metrics do not measure a plan's flexibility so much as its *dispatchability*. This is problematic if one were truly trying to measure a plan's flexibility, because a dispatchable resource can be fairly inflexible (such as coal units), and a non-dispatchable resource can reduce the minimum amount of system flexibility needed for safe operation.

2.1. Dispatchable Is a Poor Proxy for Flexible

Dispatchability is not a binary attribute. No fossil-fueled unit can be dispatched if it is down for a planned or forced outage, and outage rates vary considerably across individual units. Coal units typically have minimum operating uptimes and downtimes that prevent the operator from altering the state of dispatch for a unit during a window of hours or more. Additionally, while all units have ramping limitations, steam units (coal, steam gas) tend to ramp very slowly[5] when compared to a combustion turbine or a dispatchable hydroelectric generation plant. All of these factors demonstrate that dispatchable units can have markedly different implications for fleet flexibility. That a unit is

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[3] TVA IRPWG Meeting Session 8 Slide Deck, June 19, 2014, p. 26.

[4] TVA IRPWG Meeting Session 8 Slide Deck, June 19, 2014, p. 26.

[5] For example, coal units in TVA's service territory take multiple hours to ramp from off to spinning (partial capacity), and even multiple hours to ramp from spinning to peak output. Reviewing hourly generation data submitted to EPA's Clean Air Markets Database (2013) indicates that Widows Creek, Gallatin, and Allen steam units (as examples) take 5-7 hours to ramp from zero to partial capacity (about 250 MW) and 2-3 hours to ramp from partial (250 MW) to full (450 MW). Paradise 3 takes up to 12 hours to ramp from zero to full capacity.

dispatchable does not, in itself, provide very useful information regarding that unit's contribution to system-wide flexibility or its ability to integrate intermittent generation.

2.2. Inflexible Is an Ineffective Proxy for Unreliable

Similarly, various inflexible resources contribute differently to system reliability. A non-dispatchable generator that produces output during times of high demand and not during times of low demand (e.g., solar, most residential and commercial EE)[6] is inflexible and non-dispatchable, but contributes to increased system reliability nonetheless because those resources reduce coincident peak – i.e., they tend to provide more power when the system operator seeks more power, and provide less power when the system operator seeks less. In contrast, a non-dispatchable generator that generally provides energy (or demand reduction) during times of low system demand does nothing to help the system meet peak load reliably and may—in conjunction with other relatively inflexible generators (run-of-river hydro, nuclear, coal, and perhaps wind)—make dispatch extremely challenging during times of low demand. A non-dispatchable generator that provides constant power helps the system meet peak load, but conversely can make system dispatch during times of low demand difficult: in periods of excess, some dispatchable generators must be ramped down. This type of situation occurred in Texas during 2012 and 2013, as coal units saw negative power prices during periods of generation excess and were unable to ramp down to meet reduced demand for fossil generation.

It is also important to consider that suites of relatively inflexible resources may, in concert, provide more reliability than when considered independently. To the extent that wind and solar power production are anti-correlated, the combination of the two provides benefits. Similarly, geographically diverse renewable energy programs dampen hourly and minute-to-minute variations, reducing the requirement for extensive flexible resources. Energy efficiency programs are often targeted to reduce peak load, potentially reducing the quantity of necessary dispatchable resources on the system. Energy efficiency programs can even be implemented to provide demand reduction at times when wind and solar tend to generate less power, synergistically reducing need for dispatchable resources even further. Simply put, measuring inflexibility as measured by TVA's proposed metric tells us (or TVA) very little about reliability.

2.3. The Proposal Undervalues Reservoir Hydro and Other Storage Methods

A 100 MW flexible generator (e.g., a CT) can adjust system generation by no more than 100 MW by going from off to generation at full capacity, or by going from full capacity to off. Each 100 MW of fast-ramping storage, on the other hand, can adjust system generation by more than 100 MW because its

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[6] An energy efficiency program that installed LED street lights in a system that peaks during daytime would not significantly improve reliability. On the other hand, an air conditioning efficiency program (or solar panels) in a summer peaking system likely would improve reliability because the associated demand reduction would be positively correlated with peaks in demand.

lowest output isn't 0 MW. When charging, the effective output of storage is a negative value.7 Whereas a CT or other fast-ramping fossil generator can provide capacity if there is insufficient generation on the system, it can't be used to mitigate a situation when too much generation is on the system. Storage, on the other hand, provides both additional capacity when there is insufficient generation and negative capacity when there is too much (avoiding curtailment of an intermittent or inflexible generator). Neither of the flexibility metrics proposed by TVA value storage capacity appropriately, because both metrics ignore the ability of storage to quickly change from generator to load. The Value of Flexible Generation Is Non-Linear

While flexible generation up to a certain point is valuable, the value of *additional* flexible generation depends greatly on the precise characteristics of the generators on the system already, the characteristics of load, and other resources like demand response. This means that, absent a careful analysis, a value such as *non-dispatchable energy ratio* or *% disposable capacity for load following* provides no useful information about reliability. For example, is a non-dispatchable energy ratio of 0.4 sufficient or insufficient? Without detailed analysis of the plan in question, there is no way to know.

While a minimum amount of flexibility is required, it is important to consider that the value of flexibility past that minimum threshold diminishes. This is because, at a certain point, additional flexibility is unnecessary to integrate the intermittent resources and meet inflexible demand already on the system. The incremental value of flexible generation is generally positive, but it decreases non-linearly as more flexible generation is added.

2.4. The Proposed Flexibility Metrics Do Not Meet TVA's Guiding Principles for Metrics

In the slide deck presented at the IRPWG Meeting Session 8, TVA details in four bullet points the guiding principles for metrics selected for use in the IRP study.[8]

The first bullet point states that "metrics must help distinguish between options." Neither of the proposed flexibility metrics helps to distinguish, because the metrics don't accurately measure a valuable characteristic of a resource plan (reliability or cost effectiveness).

The second bullet point states that "metrics must be able to show quantitative or qualitative differences between strategies as evaluated against scenarios." Again, the two proposed flexibility metrics do not show quantitative or qualitative differences because the numbers provided by the formulas don't inform decision makers about the implications on safety, reliability, or the economics of the plans being compared.

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[7] While many pumped hydro stations have symmetric charge and discharge power ratings, this need not be the case for all storage installations.

[8] TVA IRPWG Meeting Session 8 Slide Deck, June 19, 2014, p. 20.

The third bullet point requires that "metrics must be readily understood by the various IRP study stakeholder groups." While the formulas themselves can be readily understood, the *implications* of the values provided by the formulas cannot be readily understood because the calculated numbers can't be used to show that any plan is safer, more reliable, or less expensive than another plan.

Finally, while the two dispatchability metrics are "calculatable"—as required by the fourth bullet point—they are incorrectly calculating the contribution of storage and energy efficiency, as noted above.

3. Eliminating the Flexibility Metric

TVA seeks to provide safe, reliable power at low cost. Safety is listed first because it is the most important of the three criteria. Logic similarly demands that TVA should screen out any plans in its IRP process that are unsafe, and we have every reason to believe that TVA does exactly that. If a plan is unsafe, it shouldn't be proposed formally to be scored.

Reliability is also fundamental, and it would seem that the proposed flexibility category is attempting to provide some information about reliability. However, as discussed above, the flexibility metrics do not in fact provide useful information about reliability (a ubiquitous reliability standard is 1 day of outages in 10 years). Similar to safety, TVA should not include a plan that fails a reliability standard in the scorecard round.

Methods to determine the reliability of a plan exist, and include hourly dispatch modeling, maintaining adequate reserve requirements, and having sufficient ancillary service resources available. As noted earlier in this document, there are methods of formally quantifying flexibility requirements when system concerns are presented by the significant penetration of renewable energy, a level of penetration far in excess of that considered by TVA. If TVA's concern is that of reliability beyond that which can be solved by its current modeling system, the flexibility metric is an unsuitable analysis structure to answer that question.

TVA's PVRR (present value of revenue requirements) metric measures the overall cost of each plan, and is the appropriate measure of system cost (i.e., choosing a least-cost plan). If TVA quantified the value of flexibility (i.e., its salable properties, or ability to improve economic dispatch), such a measure could be included in the stream of net power costs that contribute to PVRR. However, TVA does not propose to include flexibility as a monetized value, instead measuring it independently through a proxy.

Finally, if TVA were to include the proposed flexibility metrics in its scorecard, it is possible that the lowest cost plan that meets TVA's safety and reliability requirements would score *lower* than a higher cost plan with equivalent safety and reliability implications, simply because it includes more resources that TVA considers "flexible."

For all of these reasons, we recommend that TVA not include either the proposed flexibility or a dispatchability metric in its scorecard.