G-PST/ESIG Webinar Series: A Framework for Quantifying Supply and Demand for Grid Stability Services

Question	**Answer**
What types of planning tools are you using to develop this framework?	The planning tools used consist primarily of positive-sequence dynamic simulation (PSSE), steady-state analysis (TARA), and augmented specific application of EMT (PSCAD) and custom-developed analysis.
For Reactive Service, do you consider excitation system of sync. machine fast or slow in your category?	We consider the responses from synchronous machinery due specifically to the excitation system to be slow. While excitation systems themselves often respond very quickly in changing field voltage, the field current and additional reactive power from the stator typically take a few seconds to achieve their new response due to the significant rotor time constant of synchronous machines.
Could you please elaborate on the two variables of MW/d(delta) and MW/df?	First, my apologies - the intention is that these are delta(MW)/d(delta) and delta(MW)/df (the posted deck will be updated). For the delta(MW)/df, this metric captures the change in active power resulting from a change in frequency that occurs within the "Fast" timeframe, which we're considering to be within 1.0 seconds (similar to how FFR is typically defined today), and within the "Slow" timeframe, which we're considering to be within 16 seconds (typical governor or plant controller response timeframe). While the units looks like a frequency droop gain, it is more than that - it is the response that is actually achieved in the timeframe. On the delta(MW)/d(delta) metric, this is very analogous to the delta(MW)/df metric (because frequency is the derivative of delta) but is chosen to measure the response in the fastest timeframes, which will extract the inertial response when applied to synchronous machinery or the analogous response from an inverter with grid-forming controls.
Are you doing any work on how to price the supply and demand sides of the equation to incorporate these services into a market?	Pricing of services is not in scope of this effort. However, this is part of a broader effort led by the DoE with other scopes more focused on the markets and economics of grid services. We'll add a link to the project webpage here, once it becomes available. Stay tuned!

How do you make sure the pricing of the stability services is reasonable? The prices may skyrocket depending upon supply and demand.	The economic and market aspects raised here are valid but not in scope of this specific effort, which is focused on the technical aspects of stability and performance. However, this is part of a broader effort led by the DoE with other scopes more focused on the markets and economics of grid services. We'll add a link to the project webpage here, once it becomes available. Stay tuned!
Are you going to look at possibility to reduce largest contingency as a "provision of service"	Our analysis should provide insight into the specific locations or operating conditions where reducing the largest contingnecy could provide a benefit to the system. Depending on the magnitude of potential benefits, that would inform approaches for capturing the potential benefits. A "services" approach could be among these, but it is too soon to tell.
Will the framework consider potential [undesirable?] cross coupling between freq/volt magnitude perturbations to active/reactive power services	For this first phase, no, this work is not planning to cover the cross-coupling effects - we think the impact of these effects is secondary for most systems/regions. We do anticipate performing a variety of validation tests on the methods that could surface issues.
How many ISO/RTO planning groups are looking at this?	At changes needed to system services/requirements in general over recent years in the U.S.: ERCOT, MISO, PJM, SPP, CAISO can be named (but the least is not exhaustive) Specifically looking at new services/requirements needed when there are only a few synchronous machines online: ERCOT and HECO. More globaly National Grid in Great Britain, AEMO in Australia, Fingrid in Finland etc. Electrical island-type of grids or grids with weak areas pockets with high shares of IBRs are the first ones to start thinking about new services
What grid needs should be a mandatory requirement of connection, and what should be a commercial service, to be procured to some efficient minimum amount ?	While we are not specifically examining market or other procurement mechanisms, we expect to provide some guidence in this regard, based on our results. The temporal and spatial requirements that we surface will influence this along with other considerations (such as capital and operational costs to provide the service). In short, some services will be better suited to market procurement mechanisms than others.

Have I got this right? If resource provides high levels of fast reactive power support, it might not provide high levels of slow power support, and vice versa.	Providing fast and slow responses are not necessarily mutually exclusive. The best resources can provide high levels of support (both active and reactive) for all time-scales (provided they are operated with headroom to do so). One example of a specific technology that can provide fast, slow, and sustained responses for reactive and active power is a battery system with appropriately-configured grid-forming inverter technology.
Timeframe thresholds can be problematic. Eg, GFL providing very fast services can be unstable, but GFM is more likely to be stable. How to capture this?	This is a good point -- we absolutely agree. It is a necessary condition that the resource be able to provide a sufficiently stable response. A fast response that has excessive overshoot or low damping is not acceptable. Additional performance criteria must be applied to ensure that the response in any timeframe for any service is sufficiently stable. IEEE 2800 5.2.2 on Voltage control captures this well with the sentence "Stable and damped response shall take precedence over response time."
Does the framework allow to take system split scenarios into consideration on the demand side?	This framework considers the set of transmission contingencies and post-contingency viability as part of the demand for grid services. If a contingency could result in a system separation, then the demand for services in the resulting pieces of the system would reflect the need for those systems to be viable. That said, we're not contemplating separations due to cascading events and the system separation example is not planned for our demonstration phase. This is fertile ground for future work. For example, these methods might advise practice to manage system separations including definition of separtion interfaces that will tend to support viable subsystems.
This may be touched on later in the presentation, but where does the panel see a document like IEEE 2800 being used as the performance criteria for IBRs?	IEEE 2800 outlines capabilities with a range of performance that is specific to IBR technology, and more specifically, focused on grid-following (GFL) controls. The services we're defining are broader and some services have performance requirements that are beyond (faster) than what is called for in IEEE 2800. For instance, the voltage control range specified in IEEE 2800 is for a 1-30 sec response time, which falls in the "slow" timeframe as we're defining it. So an IEEE 2800 compliant IBR would likely satisfy some of the services (the slower ones) that we're defining. The fact that IEEE 2800 is silent on GFM IBR technology and that it does not explicitly cover the fast timeframes for services as we're defining them are related.

Will IBR have to offer these stability service with distributed controls for the response to fast enough?	While we are defining the services functionally and not specifying design elements, we see from a practical standpoint that achieving fast and stable responses drives equipment designers to locate the fast control functions at the inverter (in the inverter control system) to minimize signal/communications delays. However, a centralized (plant-level) controller with very low latency signal paths could potentially achieve an acceptable performance.
Are presently used planning tools able to deal with the locational analysis you are suggesting? and this 10-20-30 yrs out?	We certainly see opportunities for the enhancements of the transmission planning tools widely in use today for handling the locational aspects and the volume of data and cases capturing different futures and operating conditions in the 10+ year horizon. In the short-term, we are augmenting commercial tools with custom analysis to test out the proposed framework.
How does this framework align with legislation such as the PA community solar adder for grid services?	In general, DER have the capability to offer stability services like the ones we've presented. Conversely, legacy DER (for instance, those with improper ride-through settings) may constitute a demand for stability services because of their potential to exacerbate a prior contingency. At a glance, it appears that PA HB 1842 does not specifically address stability services, but I can't see a reason why the proposed framework would be in conflict with the pending legislation.