MVARs in the EMS

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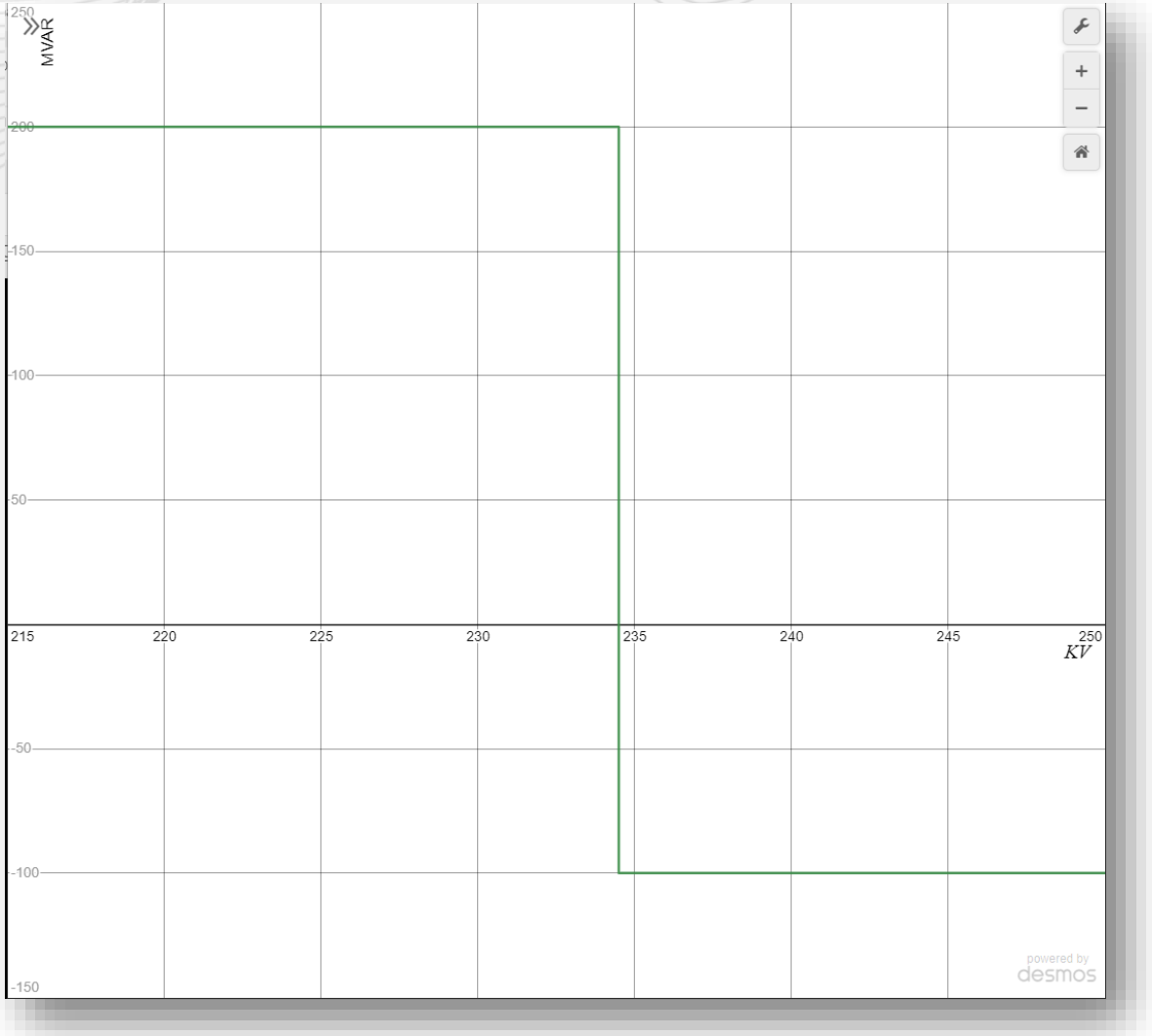
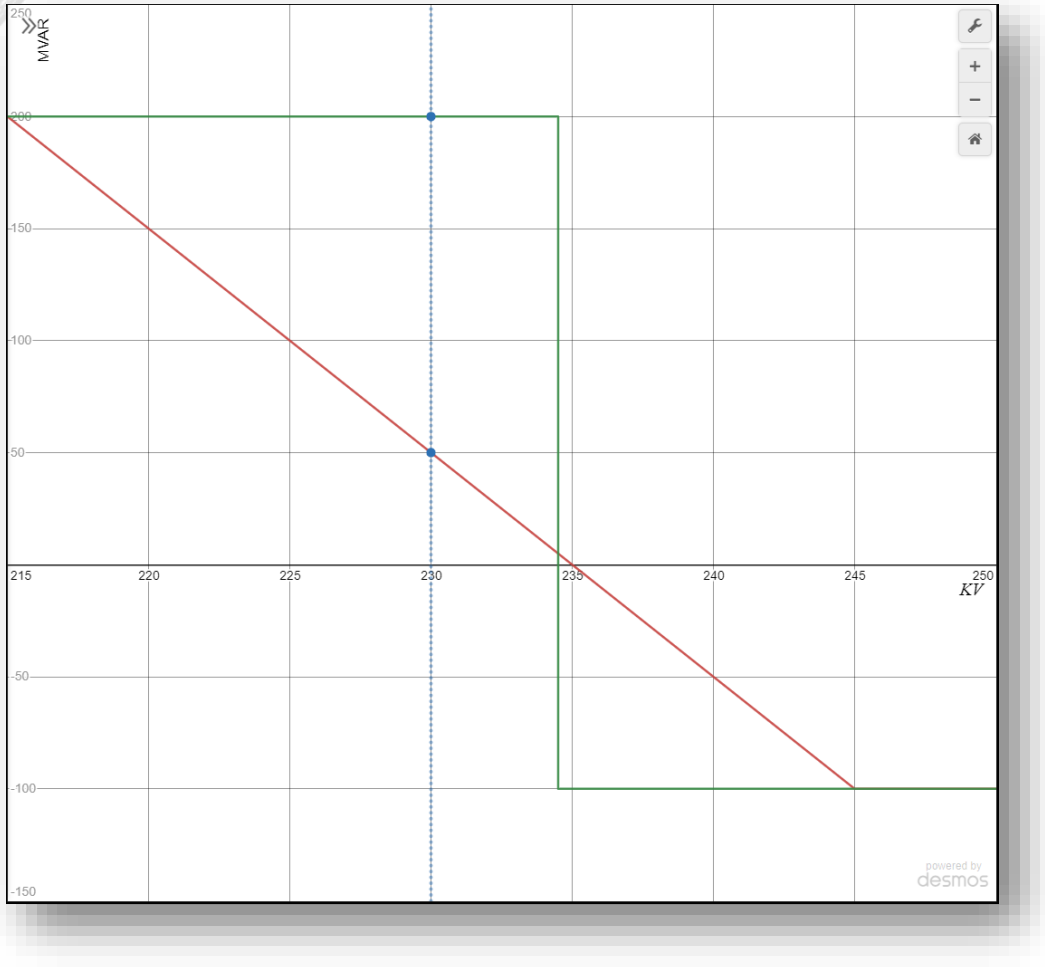
Voltage Regulation

- Regulating device where SE solved at 234.5 KV
- QMAX=200, QMIN=-100
- Notice the slopes
- Different MW outputs may shift QMIN/QMAX based on Dcurve but the slopes remain.



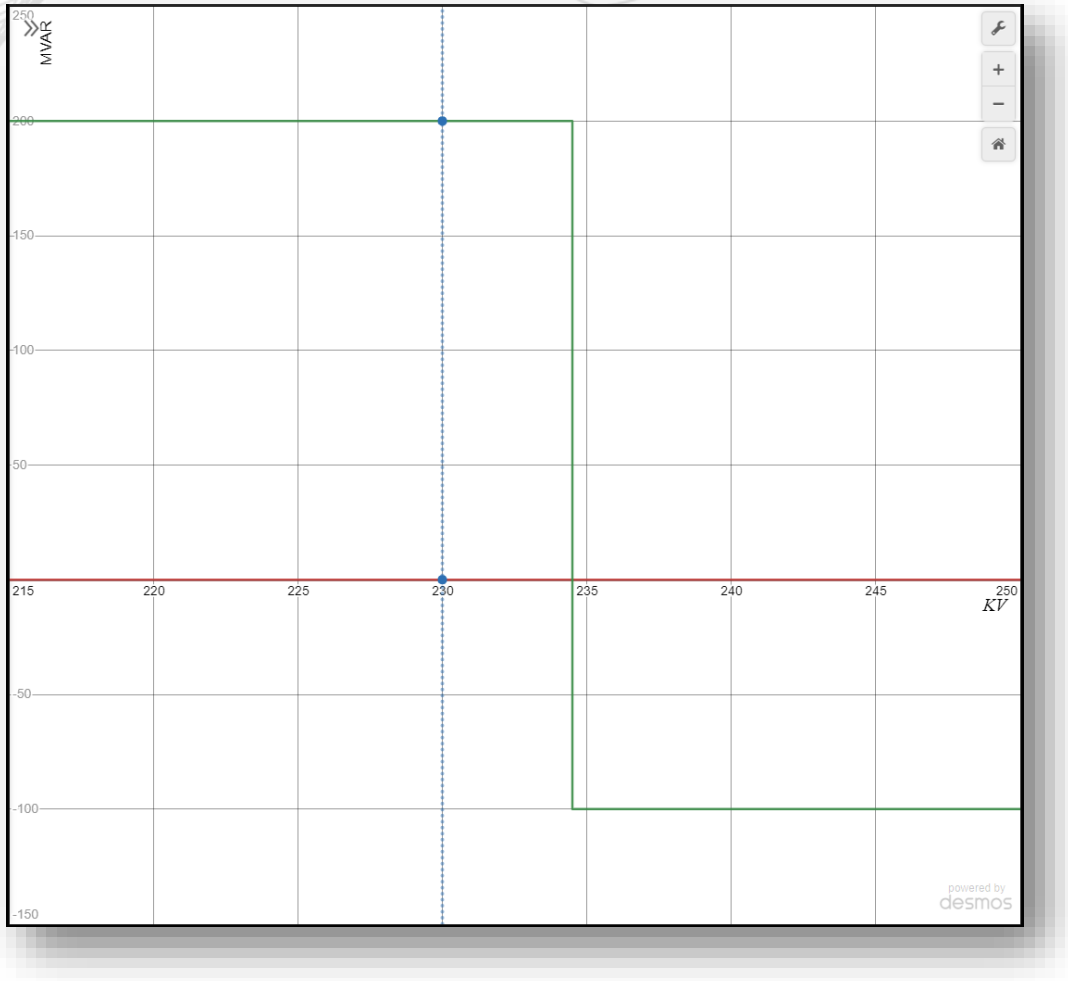
Sloped Response

- Red line shows a sloped response to voltage (base case 234.5 kv).
- Note the error at 230 KV (EMS assumes 200 MVAR, generator outputting just 50 MVAR)
- The steeper the slope, the more accurate the EMS simulation is at predicting generator performance.



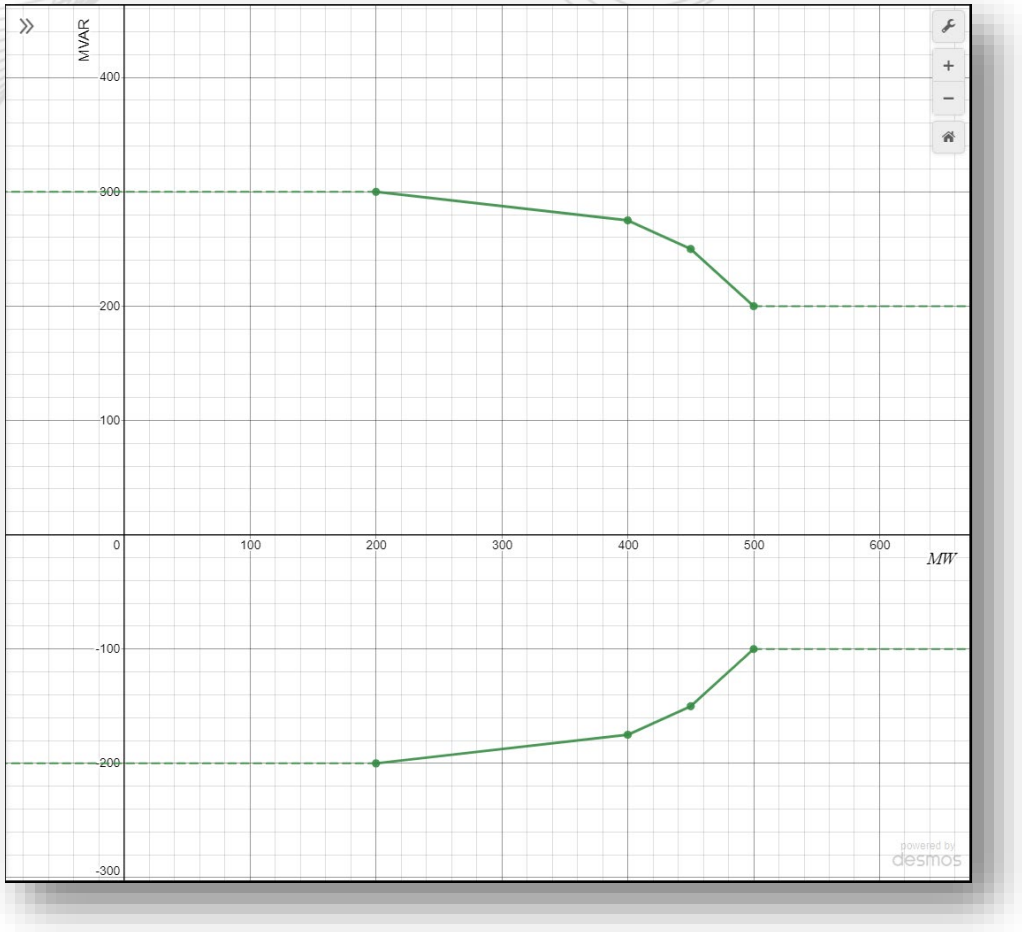
Power Factor “Regulation”

- If we define Regulation as controlling the high side voltage by adjusting MVAR output, power factor “regulation” is not really Regulation at all.
- QMAX and QMIN are only useful if they correctly simulate generator behavior.



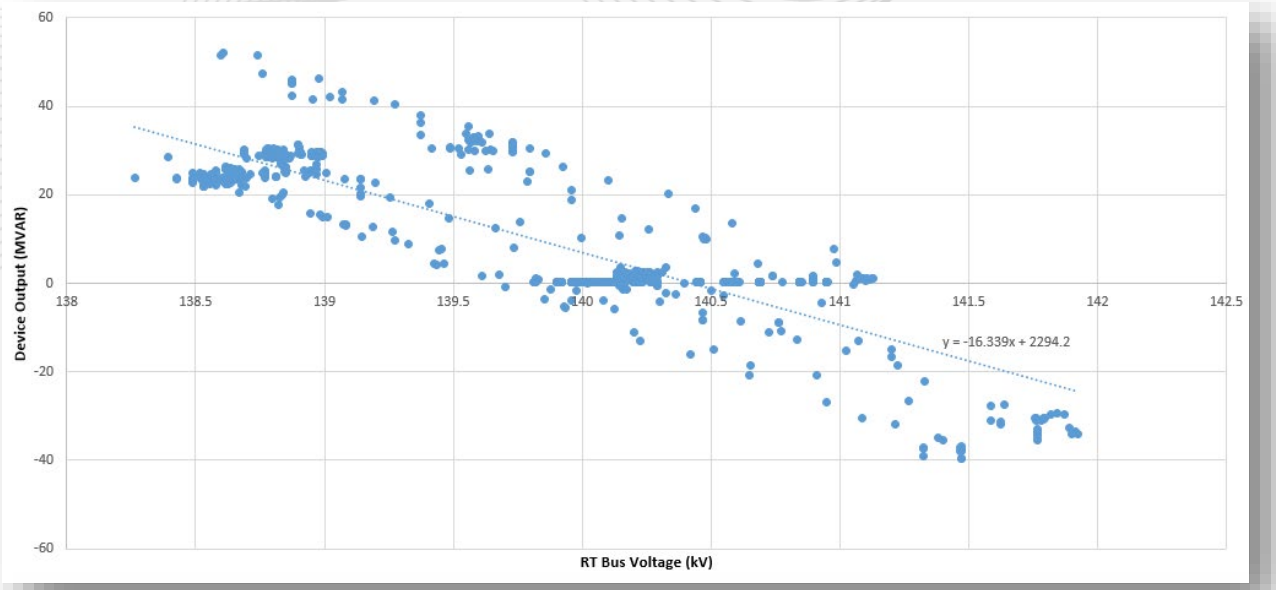
Dcurve Expansion

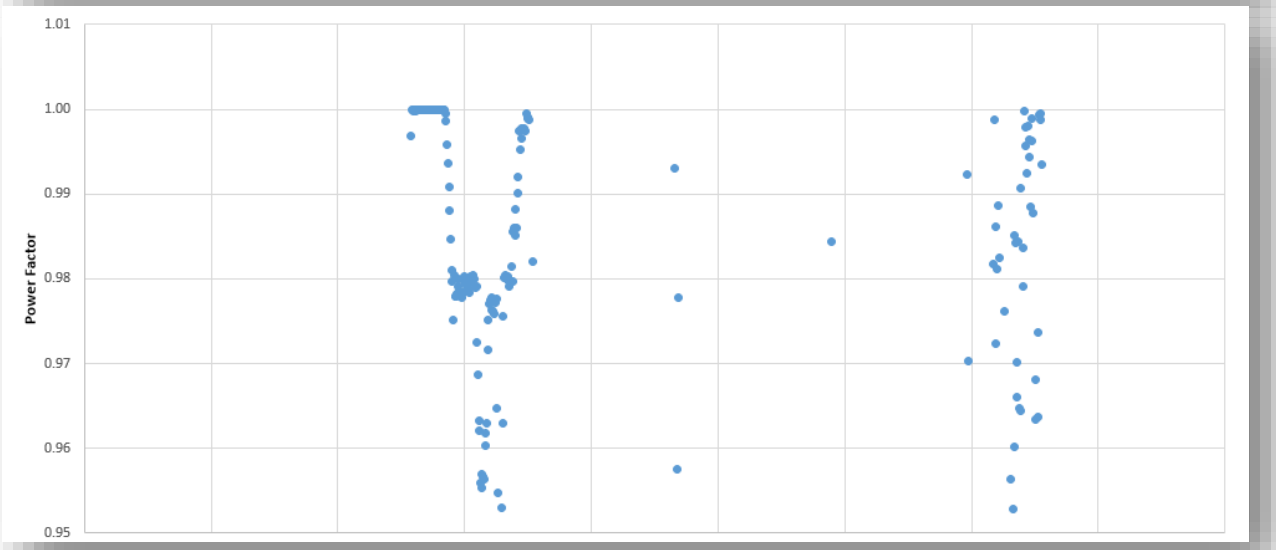
- Generator PMAX = 500 MW
- QMAX/QMIN at peak continue
- QMAX/QMIN at minimum continue (even negative MW values)
- Up to 8 different MW points (example shows 4)



Good Regulation

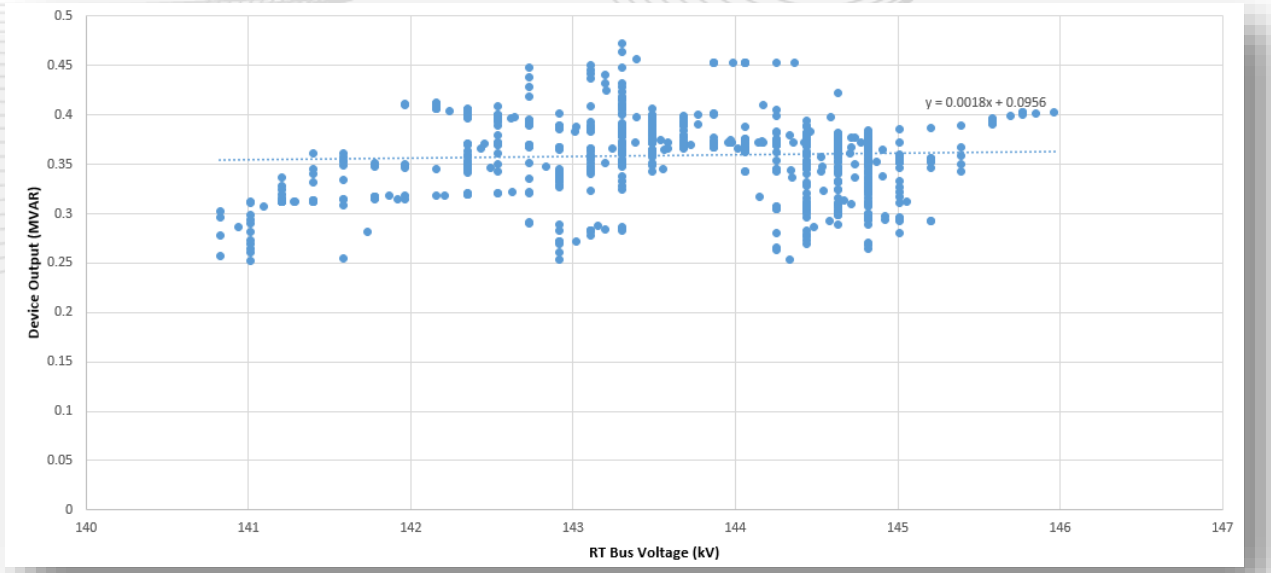
- Good regulation shows a strong correlation between system voltage and MVAR output.
- Power Factor will vary over time.

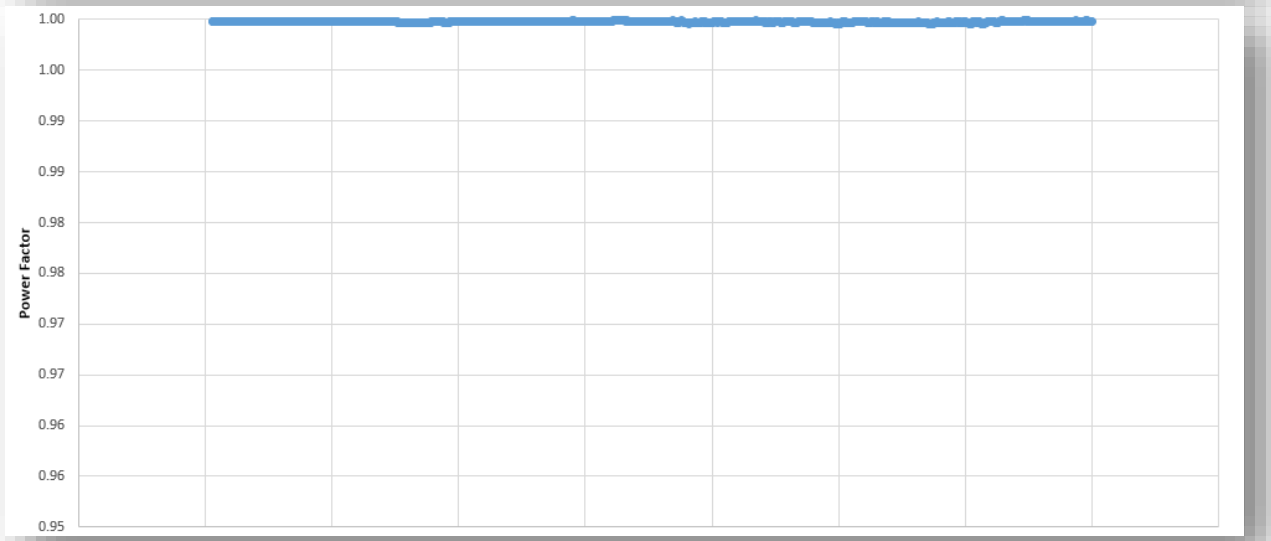




Bad Regulation

- Little correlation between voltage and MVAR output.
- Note the very stable power factor.
- Even with high system voltage, the generator is not consuming MVARs to it's rated capability.





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Distribution Connected MVAR's

- Generators that are connected at a high electrical distance from the closest BES bus have greatly reduced utility for direct voltage support of the BES as compared to an identical asset connected to the BES. Long lengths of lower voltage lines, distribution capacitor banks or other distribution devices, other distribution loads or assets, can all act to dissipate, consume and otherwise obfuscate the MVAR output of those generators as seen by the nearest BES bus. While PJM will often still obtain and parameterize the reactive capability of such units in EMS applications, this is done out more out of best practice than any immediate critical use of the data.

- Macro trends in the overall reactive loading of the distribution system is not unimportant or inconsequential. Overall, more MVAR production in distribution will lower the amount of MVARs pulled from or required from the BES, even if at a diminishing proportionality as more MVARS are consumed in distribution electrical distance than otherwise would be if delivered at the BES. But generators connected at high electrical distance will not be observable, in the sense that PJM will not be able to reliably verify the MVAR output as it impacts the BES, and will not be practically operable or dependable for BES voltage support since the POI output will largely dissipate before impacting the target BES areas of concern.

- BES voltages that PJM operates to will have significant impact on distribution voltages and operations. However that electrical relationship does no confer PJM with any direct observability of or role to secure distribution voltages, as EDCs have separate systems and methodologies to operate to their target voltages largely independent of PJM.