Generator Reactive Performance

Daniel Moscovitz, EMS Support
Darrell Frogg, Generation

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Categories

There are many reasons Generators do not provide as many VARs as possible at all times. Compensation needs to align with ensuring generator VAR capability delivers useful voltage response.

We will discuss:

1) Machine Capability vs ISA
2) ISA vs Tested D-curve
3) Tested D-curve vs actual Voltage response

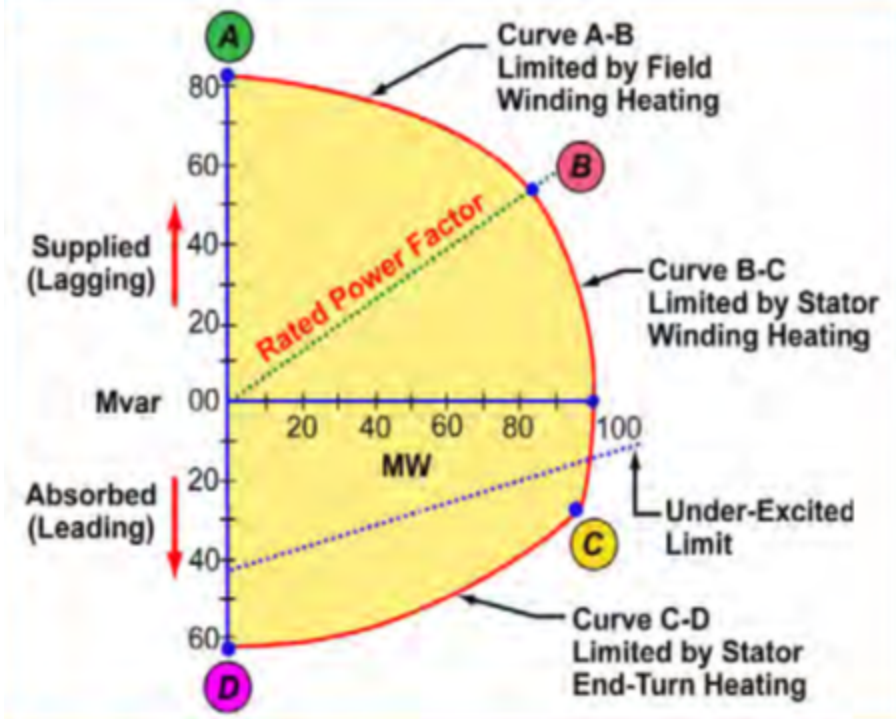
ISA

- No requirement to “provide all reactive capability the plant can at all times”
- 0.95 leading and lagging not universal
- POI, high side, low side, net/gross
- Capacitors are sometimes used to meet reactive requirements
- There may not be a VAR requirement in the ISA at all

Machine VS ISA

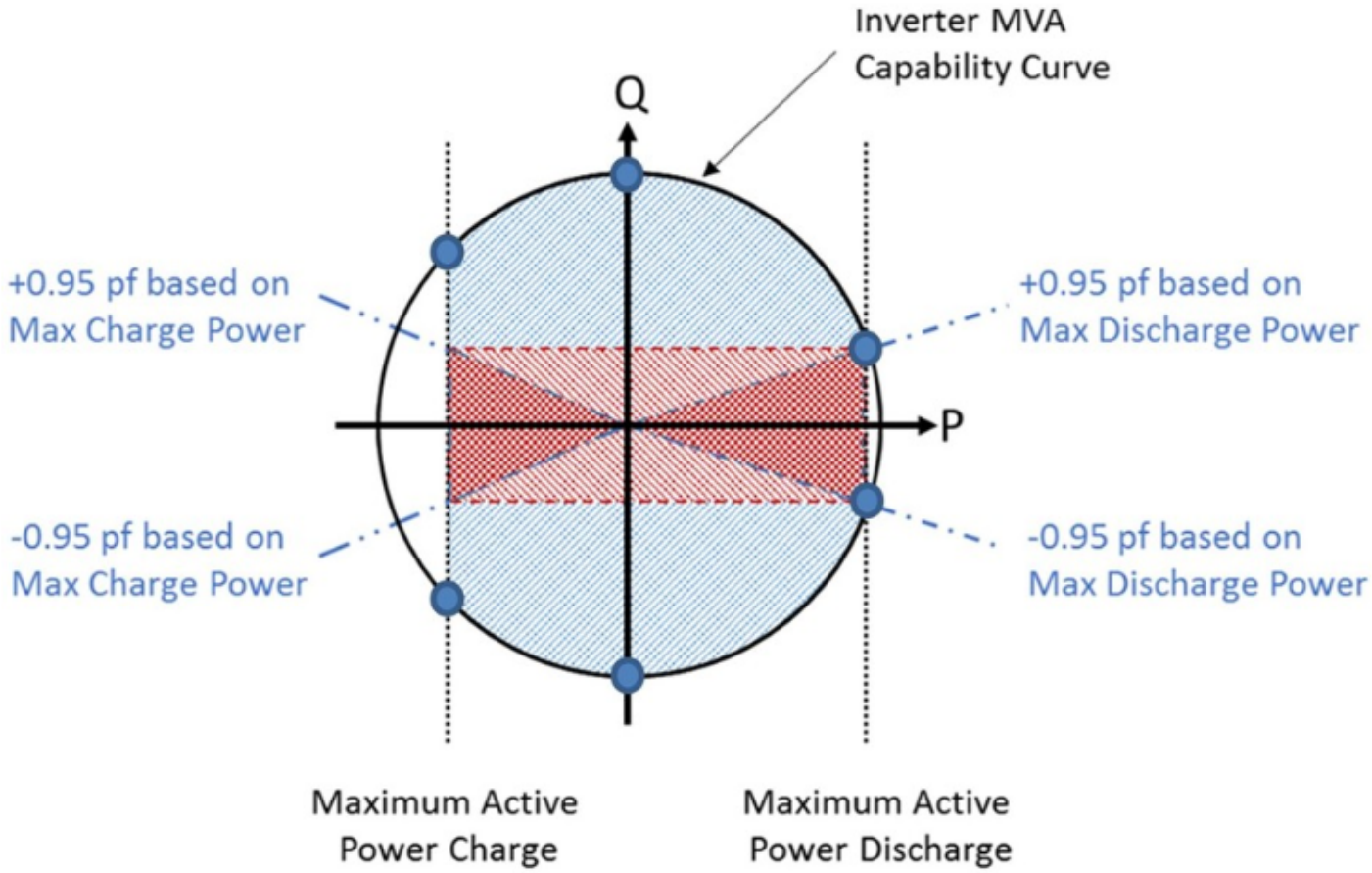
- D-curve is generally low side gross, not high side net
- Under-Excited Limit often the bound / non-symmetrical curve
- Response below PMIN is generally cut off.

- Line B shows lagging only power factor “ISA requirement”

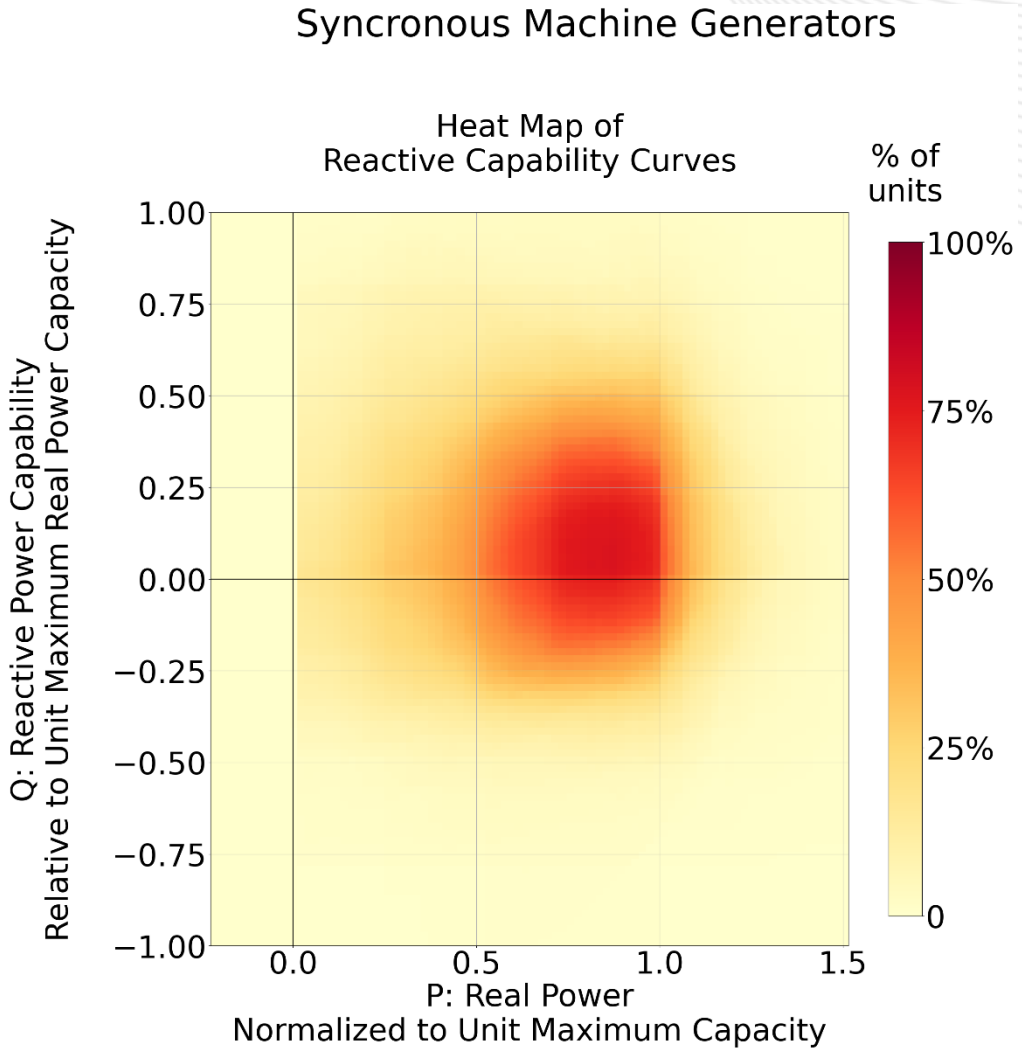


Inverter Capability vs ISA

- “D-curve” of a battery shown
- Blue is machine capability
- Dark Red is ISA requirement
- Operating in the blue costs active power (MW)

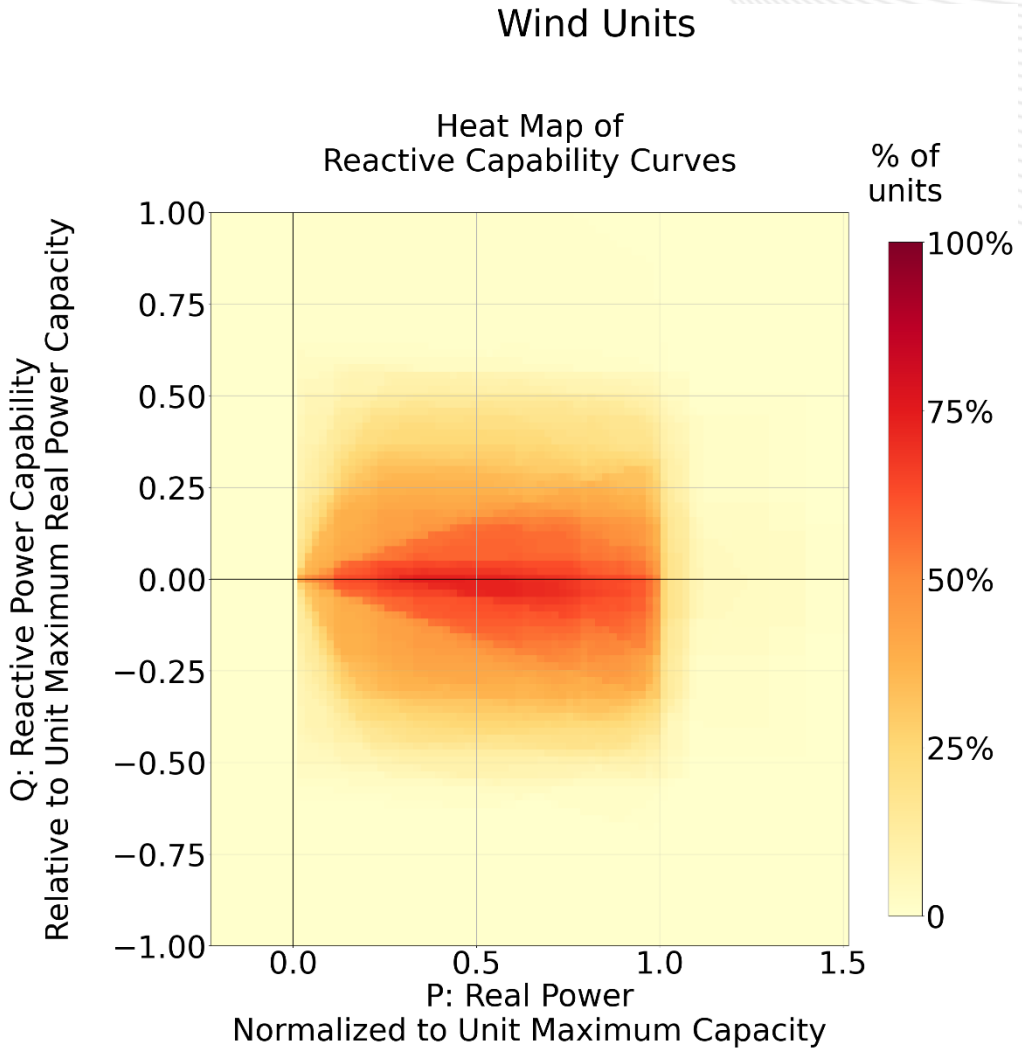


Tested D-curve: Syncronous



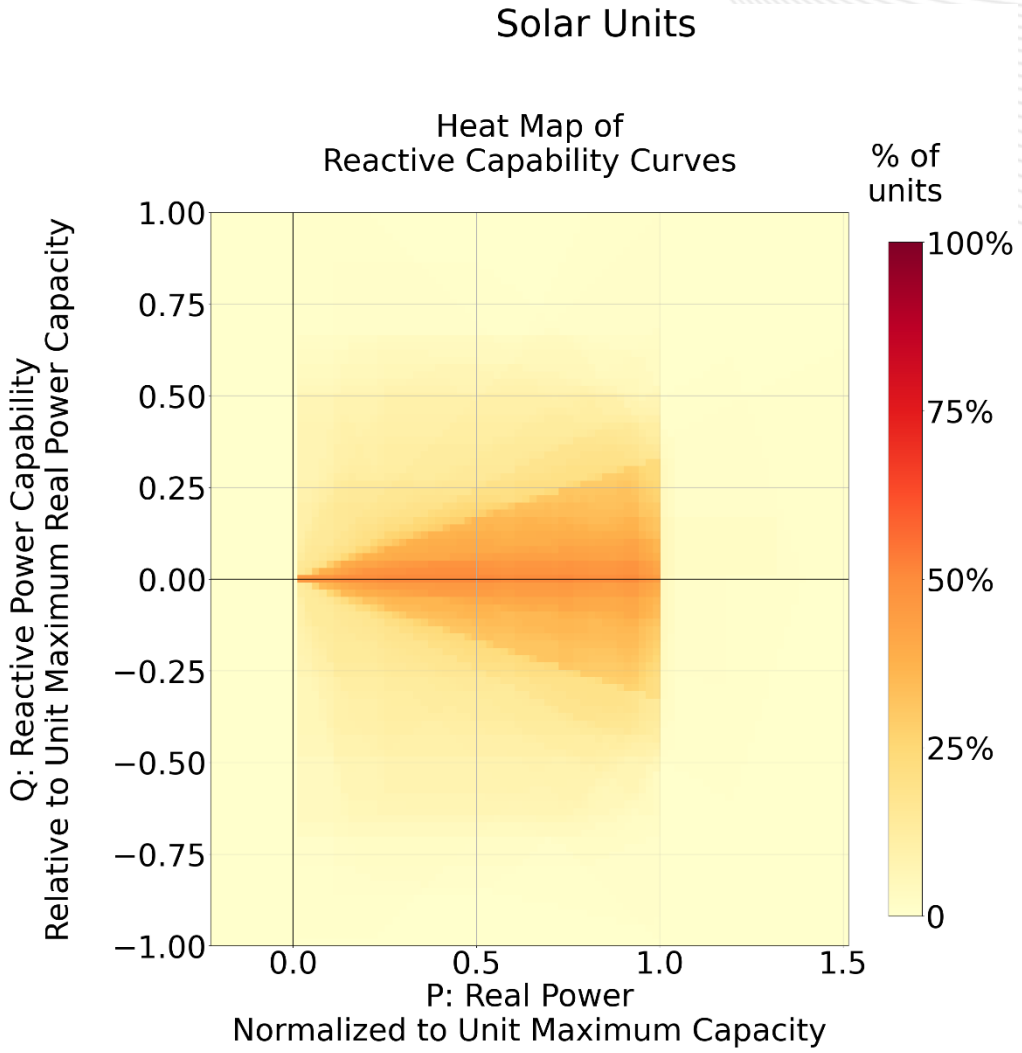
- Classic D shape
- Lowering Generator's MW increases VAR capability
- Lagging Bias
- Not PF based

Tested D-curve: Wind



- Useful over a wider MW range
- Generally holds peak MVAR capability across MW range
- Note PF line, increasingly “restrictive” on newer installations.

Tested D-curve: Solar

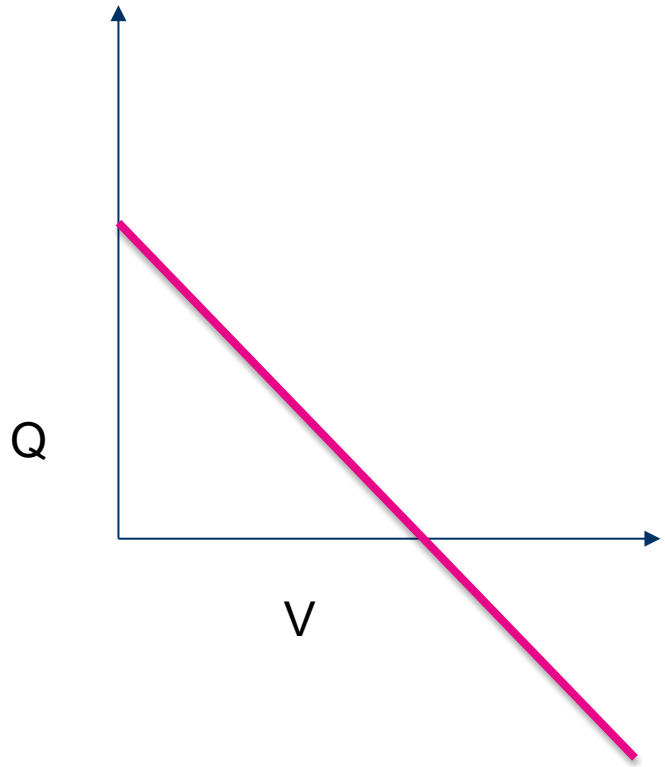


- Most installations have no VAR requirements (light color)
- Machine Capability all but invisible
- ISA PF shape

Voltage Regulation

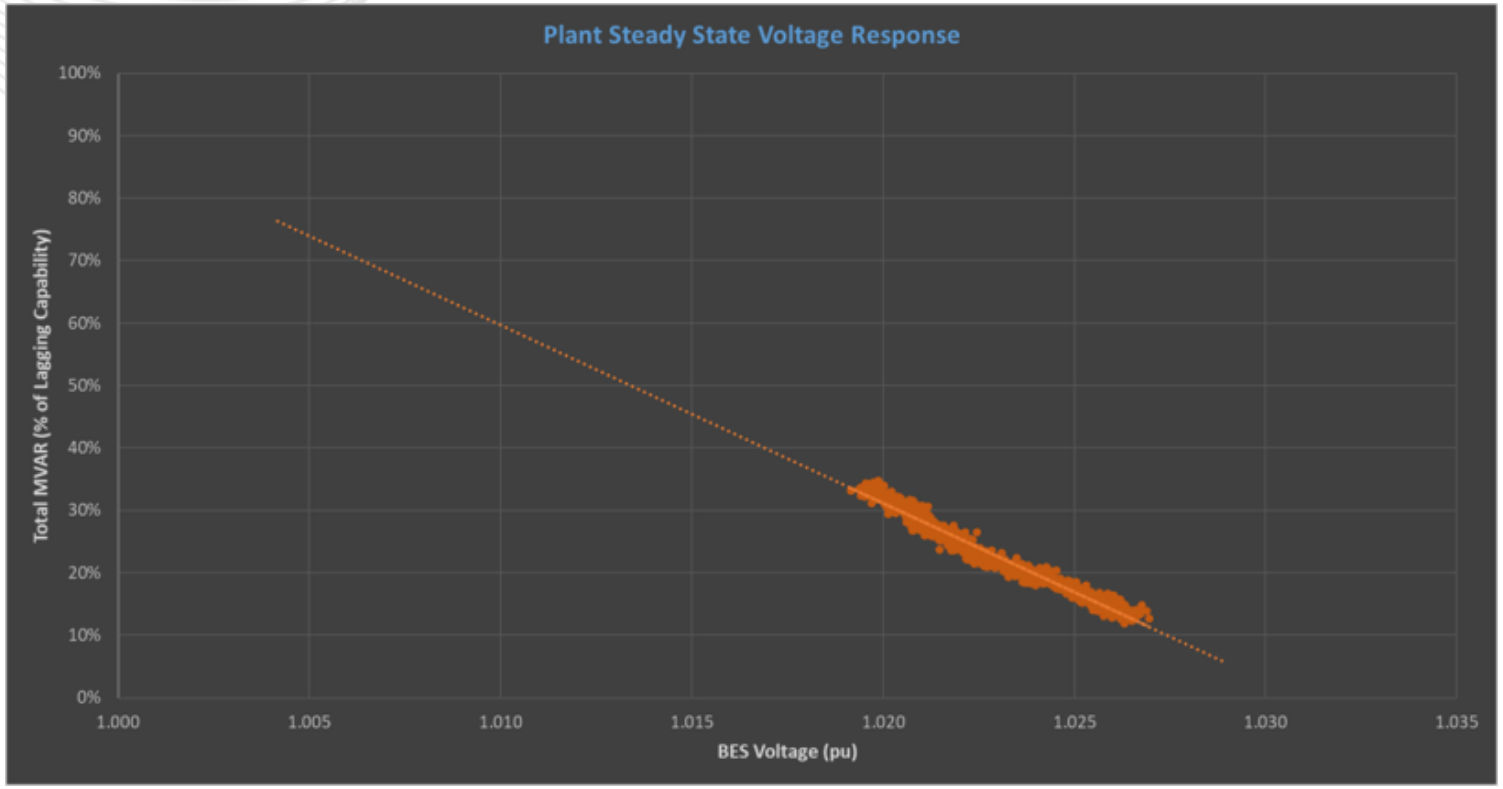
- Example is similar X00 MW sized BES generators
- Both have similar voltage schedules
- Both have similar MVAR capability (D-curve)
- Both have AVR's
- Both have ISA requirements
- 8 hours of data points captured

We expect something like:



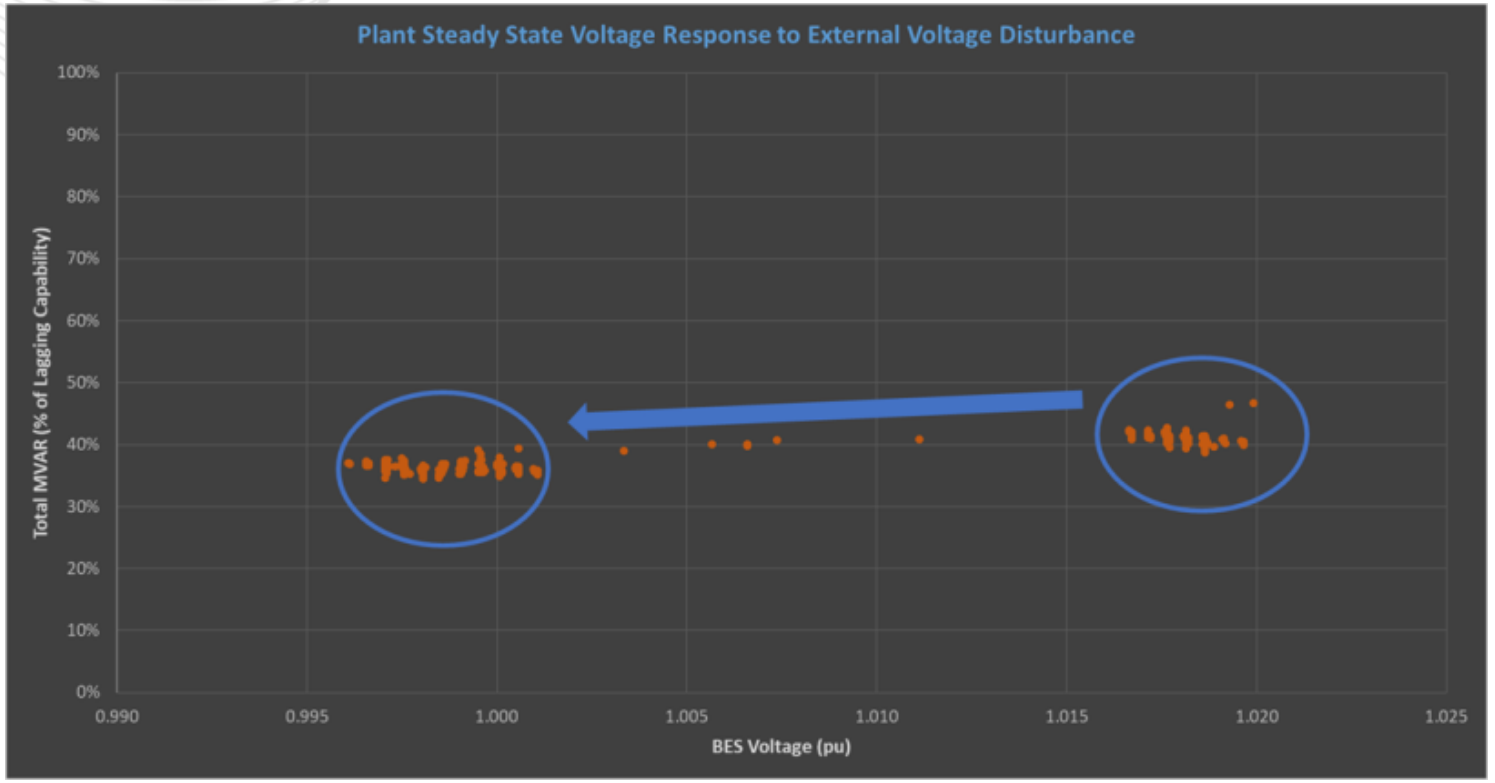
“Good” regulation

- VAR output is clearly Voltage dependent
- Slope is not steep but looks reasonable relative to 0.95 to 1.05 p.u. voltage limits
- System is not stressed in this time window



DCURVE vs Response

- VAR output is independent of voltage (slight reverse correlation)
- 0.99 to 1.02 show no response. Similar in more strenuous times
- PJM should model voltage response of this generator by AVR=off



Generator vs. same sized Capacitor

Generator Pros:

- Variable output
- No V^2 losses
- Provides Dynamic VAR response post contingency*

*GSU's result in significant reactive impedance to the larger grid.

Generator Cons:

- Capacity Factor
- Indirect control (GO vs TO)
- Conflict of interest: paid for MW which reduces MVAR output
- Not always prioritizing VAR output (not in "testing mode")
- Droop
- Performance!

Contact

Presenters:

Daniel Moscovitz,

daniel.moscovitz@pjm.com

Darrell Frogg,

darrell.frogg@pjm.com

Generator Reactive Performance

Member Hotline

(610) 666 – 8980

(866) 400 – 8980

custsvc@pjm.com