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MA-TSRG National Grid Advanced PV Facilities Update

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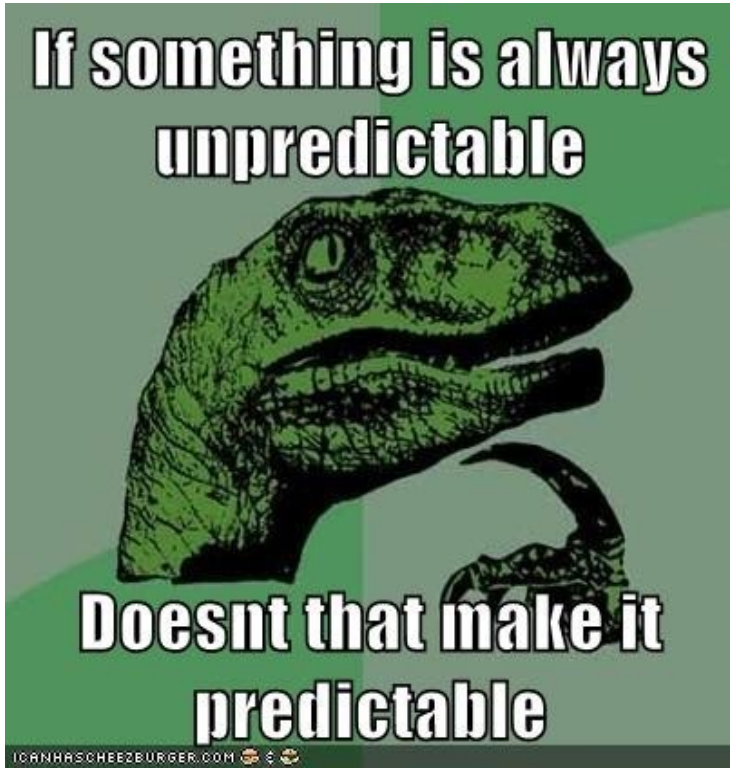
06.24.2020

National Grid's Solar and Storage Program

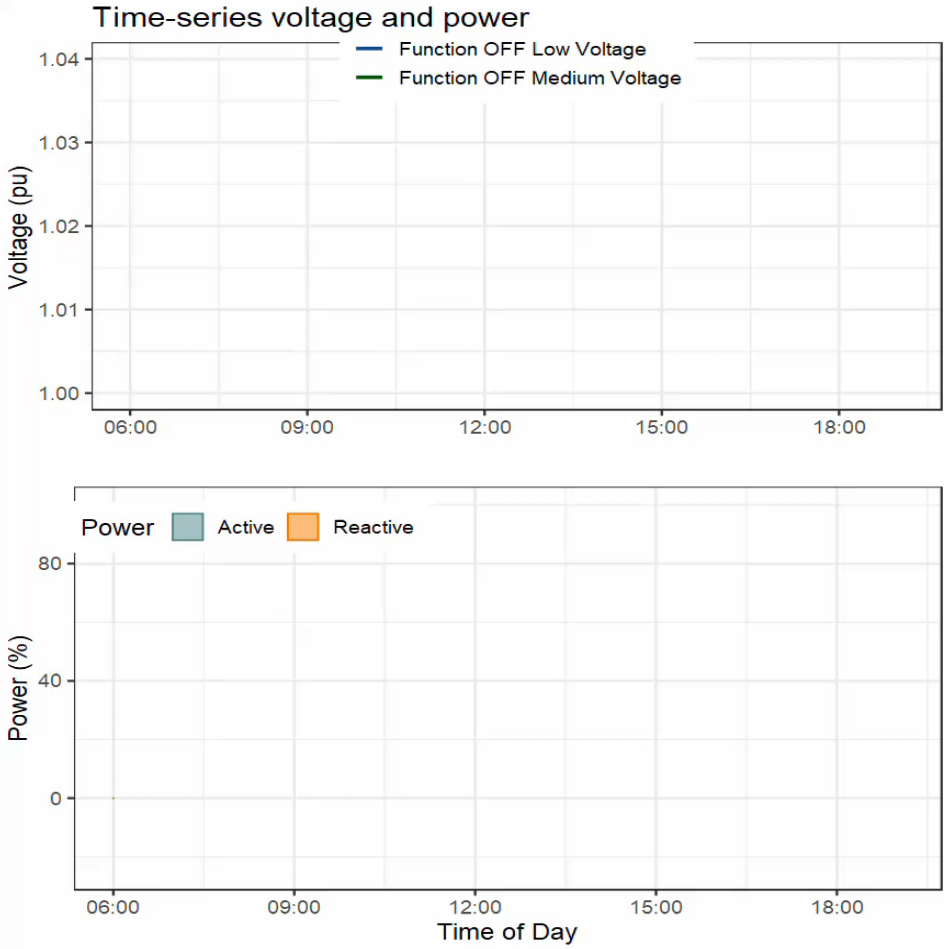
Goal: Move from interconnecting DER to integrating it. Reduce customer interconnection cost and time.

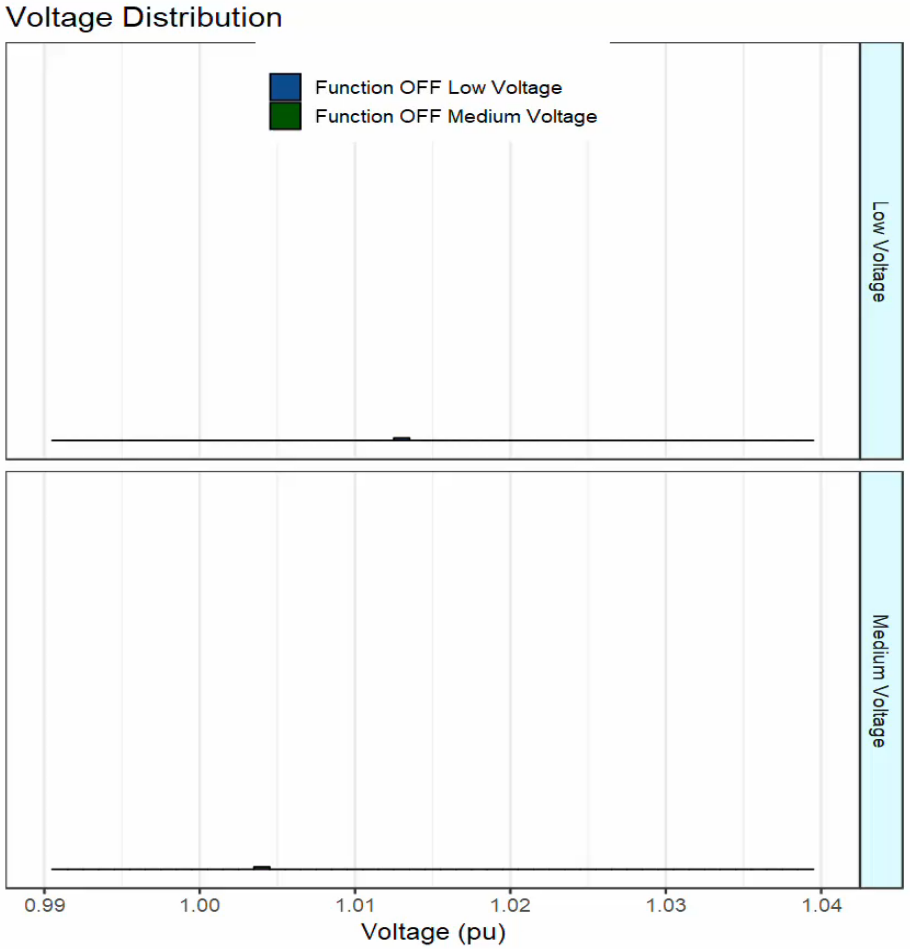


Promising Technologies We are Exploring

Key Areas of Research in the program	Partner	Share updates
Increasing Hosting Capacity-Interim Report	EPRI	Offered Q2, 2018
DC Arc flash study	EPRI	Offered Q3, 2018
Increasing Hosting Capacity-Smart Inverters	EPRI	Offered Q2, 2019
PV +Storage+ Load Management systems	Fraunhofer	Offered Q4, 2019
Field Performance Assessment of Advanced Grid Support Functions.	EPRI	Q2, 2020
Can DER be used to resolve Transmission Issues?	EPRI	Q3, 2020
Risk of Islanding of Smart Inverters	NPPT	Q4, 2020
Distribution Resource Open Management Optimization System (DROMOS)	Sandia	Q1, 2021

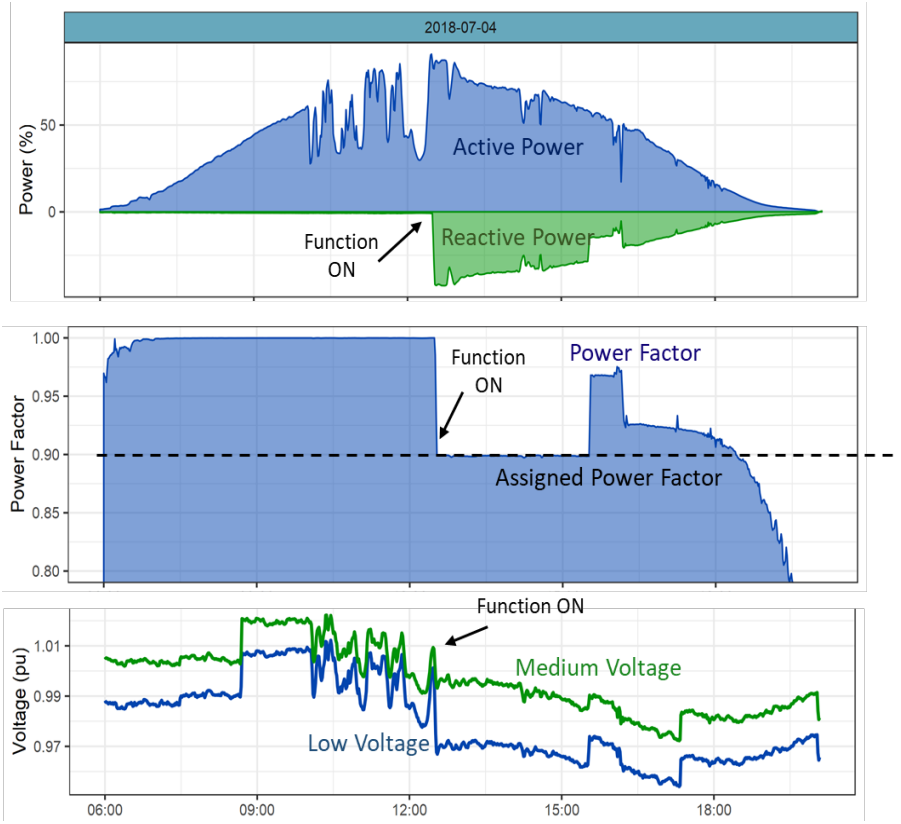
Jog Our Memory





Which Function is the Best

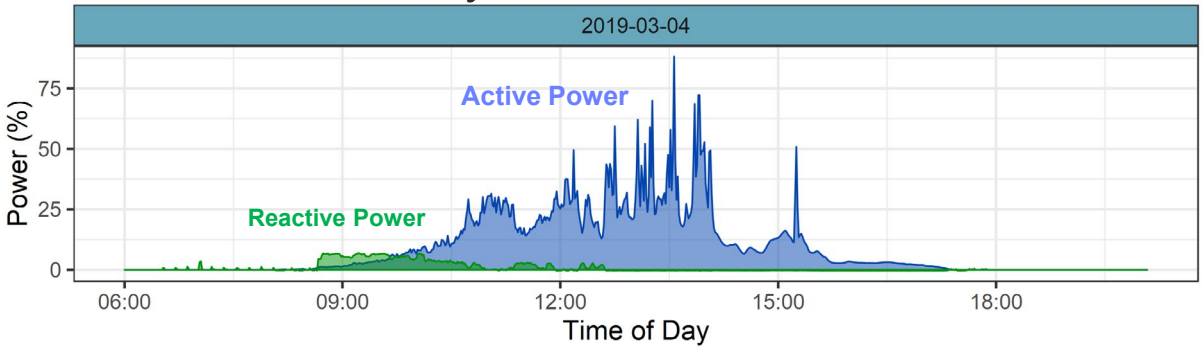
- There is approximately 16MW of Solar on the feeder that the Blossom site is located at.
- To resolve voltage issues all sites on the feeder were asked to accept a constant PF of 0.97 Absorbing.
- Constant PF is a standard solution utilities use to resolve high voltage issues.
- One of its drawbacks is that sites are absorbing VARs at times they don't need to.

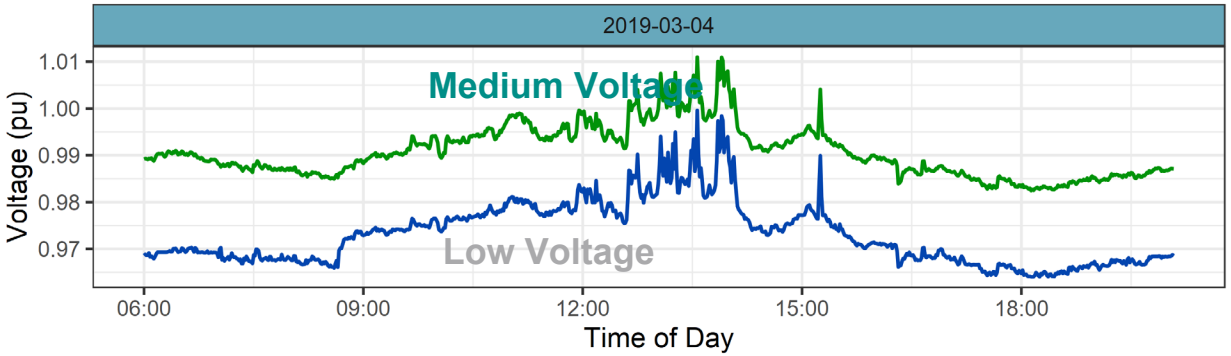


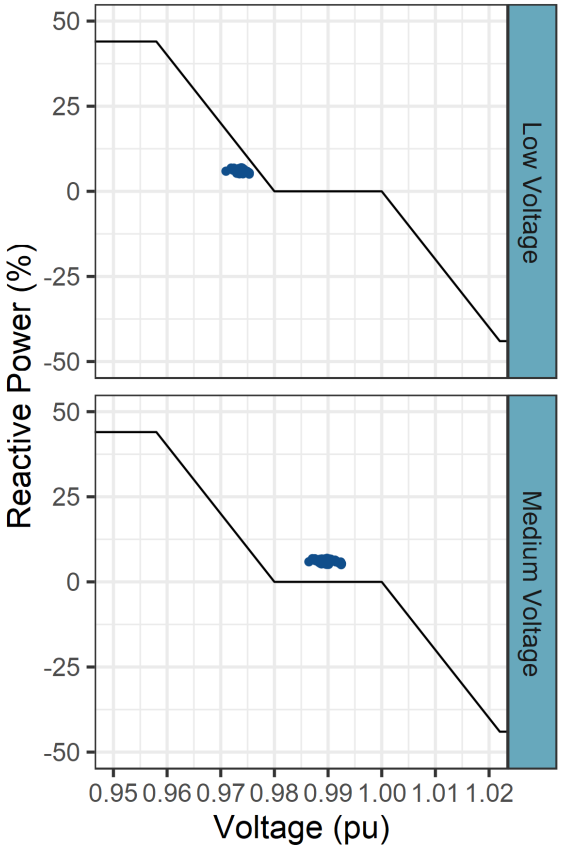
Power factor function example at Blossom, 2MW

Blossom-with Volt/VAR

- Site injects VARs to adjust for neighboring sites a few hours a day







Ideal Function Selection Criteria

- NREL has identified six “Power Quality” conditions to evaluate various reactive power functions according to. Among them, Voltage Violations, Control Device Operation and Energy Lose.
  https://www.nrel.gov/docs/fy17osti/67600.pdf

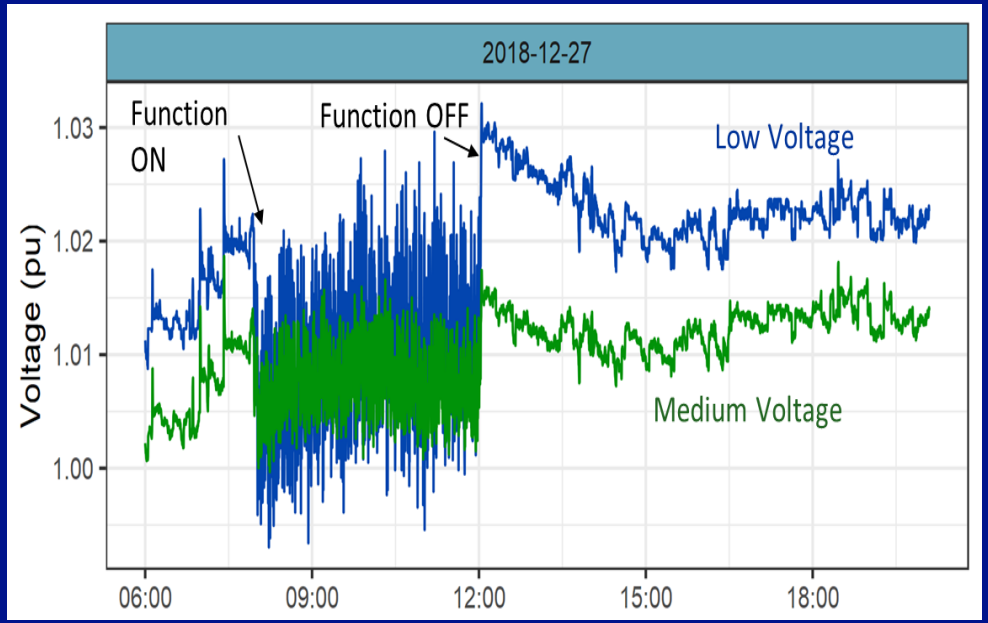
- Results of EPRI analysis (DVanZandt@epri.com), assuming all factors are equally important shows Volt/VAR as the highest scoring reactive power mode on a 10 point index.

- We will likely need to look into this in more detail as part of our IEEE 1547-2018 adoption plans.

	PQS
NoPV	9.471921393
unityPF	9.126760457
voltvar	9.18178633
PF	9.064427956
wattvar	9.062350585
wattpf	8.909044462

Image Courtesy of EPRI

Voltage Oscillations Challenges



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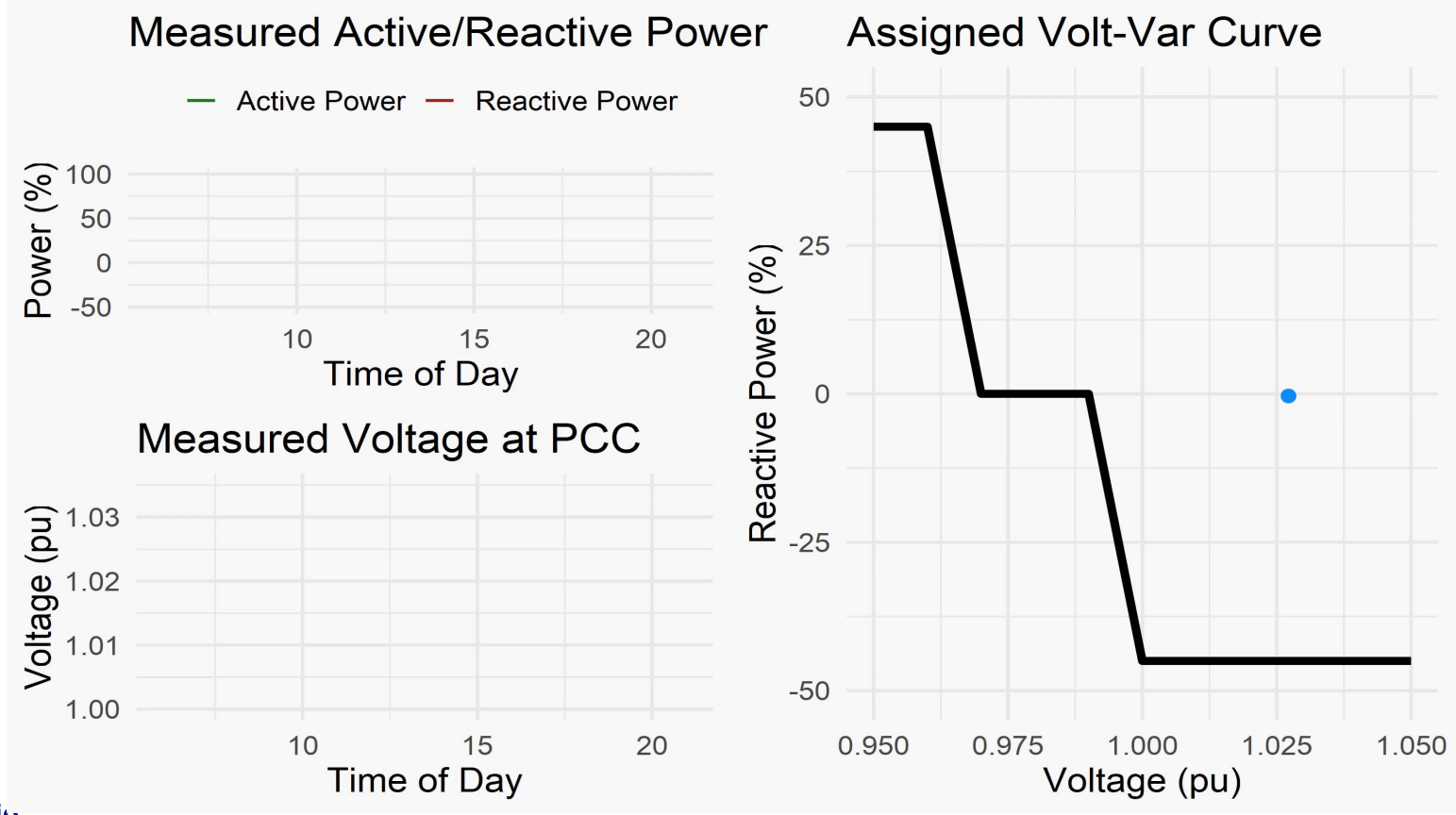
Voltage Oscillation Challenge



Voltage Oscillation Challenge

Several Factors play into oscillations:

1- Steepness of the Volt/VAR curve, steep curves are more effective at reducing voltage variability, however are more likely to result in oscillations.

2- Delays in voltage measurements (t_m) and delays in processing time (t_d).

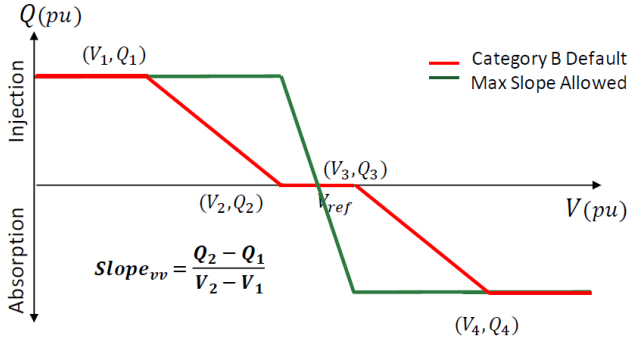
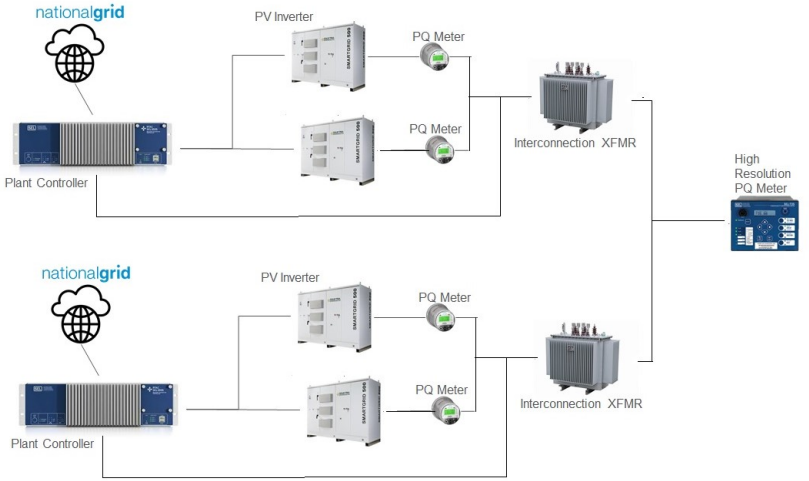


Image Courtesy of EPRI



Plant Control Scheme, 2MW Blossom

Voltage Oscillation Challenge

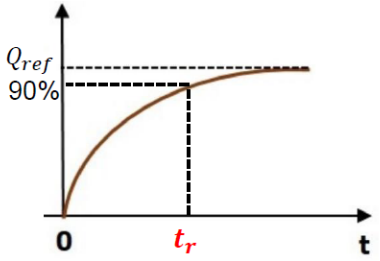


Illustration of Open Loop Response Time

3- Response Time (t_r), time needed to for reactive power to change to 90% of new setting.

4- Measured time must be smaller than response time $t_m << t_r$

5-System Stiffness.

6-Site Location, sites at the end the feeder are more likely to cause oscillations.

Utilities may contact Aminul Huque (mhuque@epri.com) to learn more on modeling to prevent oscillations.

Site testing, especially for sites with plant controllers will likely be needed for early stages of IEEE 1547-2018 adoption.

What's Next?

National Grid hosts IEEE PES at Shirley, MA site

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National Grid Future Work-MA

- **Multiple Smart Inverters on the same feeder:**

  Do smart inverters on the same feeder fight?

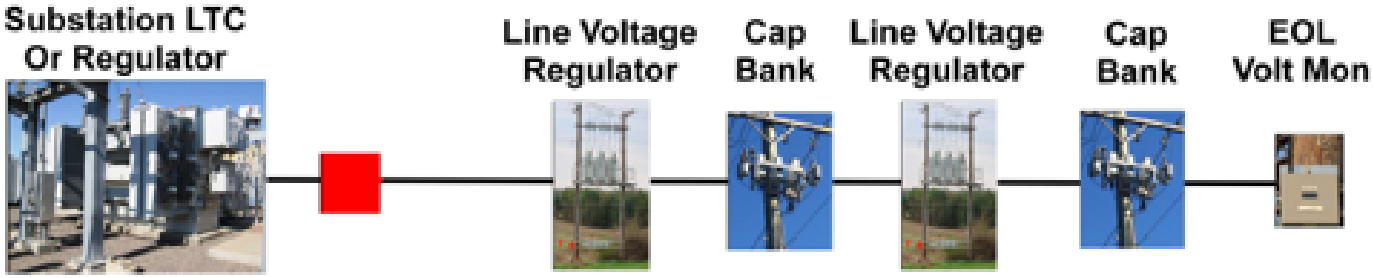
  Is there an effective and efficient way to model smart inverters on the same feeder?

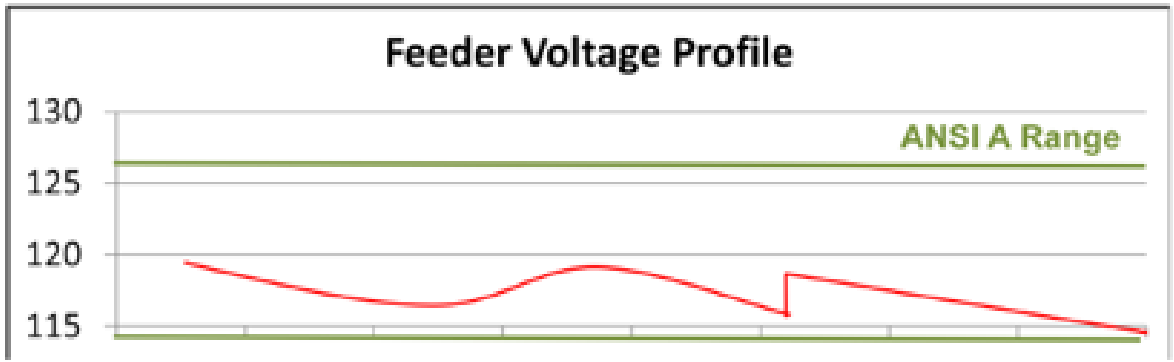
  Would each site need unique settings or would a generic curve suffice?

  How will the autonomous smart inverters interact with grid devices?

National Grid Future Work-NY

With NYSERDA we are looking to add Smart Inverter into our VVO scheme.





MA leading the way in Solar and Storage

Distributed Energy Conference- 2020 Power Game Changer Award

References

- Field Performance Assessment of Advanced Grid Support Functions Implemented via Plant Controllers: National Grid Solar Phase II Program Report https://www.epri.com/research/products/000000003002019417?src=mail
- Recommended Smart Inverter Settings for Grid Support and Test Plan: Interim Report

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- Smart Grid Ready PV Inverters with Utility Communication

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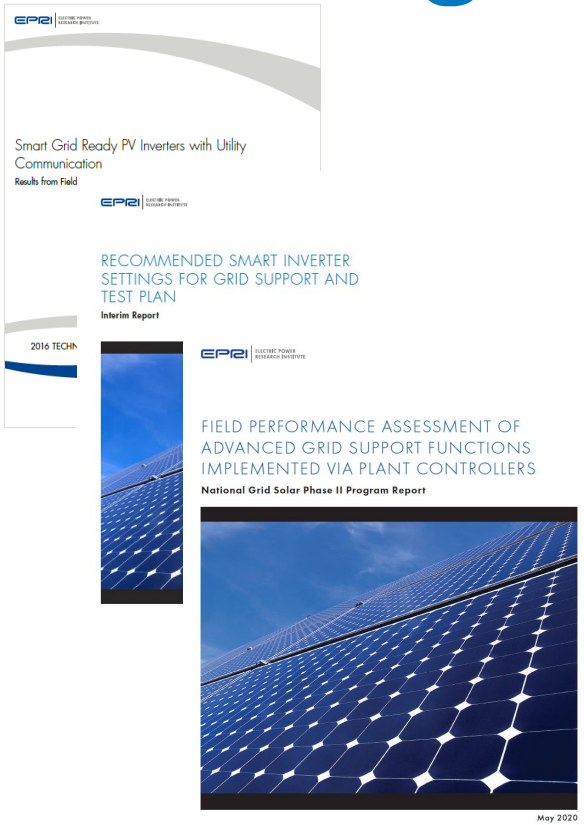

Follow Up Discussions

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