Study Committee C6

Active Distribution Systems and Distributed Energy Resources

Paper ID 10524

Smart Inverter Functions to Increase PV Hosting Capacity - A Case Study of New York Distribution Circuits

Shammya SAHA, Jouni PEPPANEN, Devin VAN ZANDT, Matthew RYLANDER

Electric Power Research Institute, USA

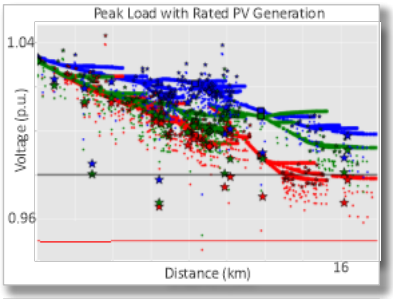
This Paper Presents

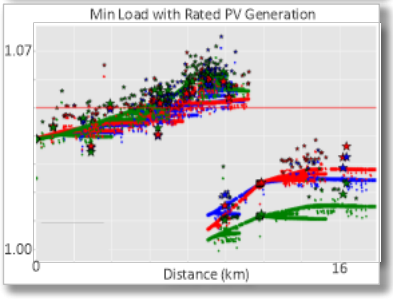
- Key findings from a project assessing the techno-economic impact and value of SI functions
- Approach for coordinating SI functions with conventional VRE

Motivation

- Conventional voltage regulation equipment (VRE) include on-load tap changers (LTCs), voltage regulators, and capacitor banks
- VRE local control settings are typically tuned for conservative worst-case conditions
- Smart inverter (SI) functions (e.g., constant power factor, Volt-var and Volt-watt) can mitigate DER voltage impacts
- Distribution planners/engineers need to understand:
  - The technical and economic impact and value of SI functions
  - How to effectively coordinate SI functions with conventional VRE

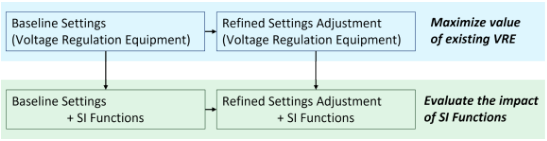
Increasing Complexity



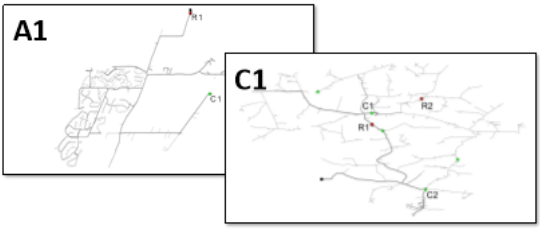


Hosting Capacity for Comparison

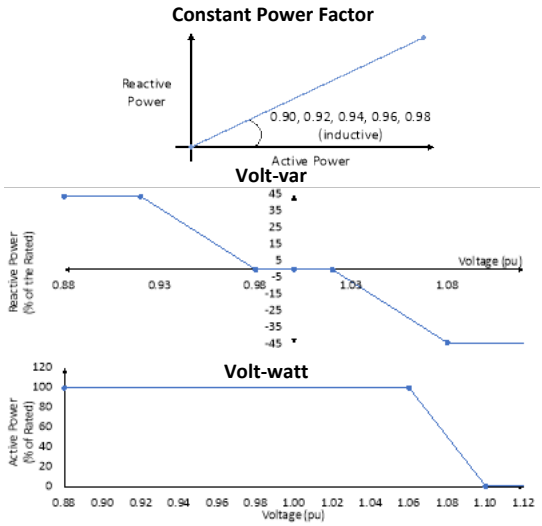
- Annual hourly (8760) quasi steady time series hosting capacity (HC) method for detailed assessment
- Specific scenario of >1000-kW & >100-kW scale PV, locations chosen by static hosting capacity analysis



Two Distribution Circuits Analyzed



Analyzed Smart Inverter Functions



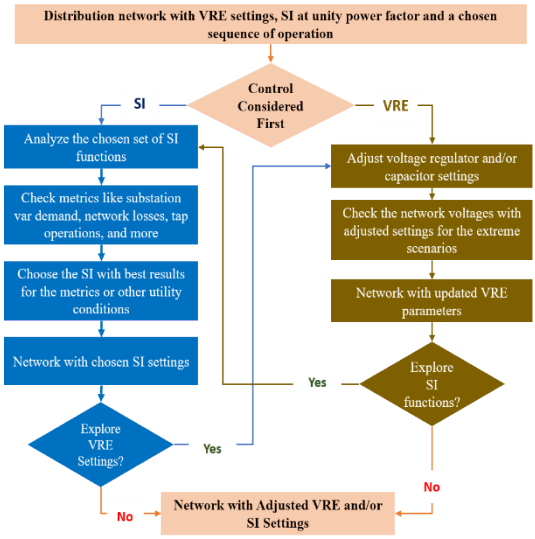
Study Committee C6

Active Distribution Systems and Distributed Energy Resources

Paper ID 10524

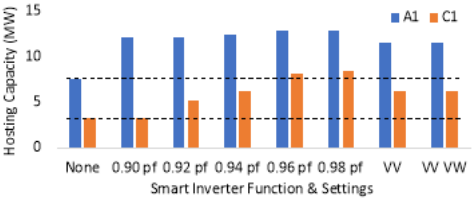
Smart Inverter Functions to Increase PV Hosting Capacity - A Case Study of New York Distribution Circuits

Coordination of VRE & SI Controls



Baseline Settings & Smart Inverters

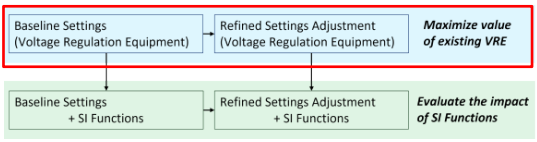
- SI functions increased the hosting capacity
- Limited impacts on regulator & capacitor operations



Refined Settings & Smart Inverters

- Properly coordinated VRE and SI functions further increased the hosting capacity slightly
- VRE settings & SI functions are mainly effective in addressing voltage constraints (not thermal or other DER impacts)
- Important to evaluate impacts on VRE operations & circuit reactive power consumption

Baseline vs. Refined Settings – No SI



- Refined settings increased the hosting capacity
- Potential impacts on regulator & cap operations

Circuit	VRE Settings Applied	Hosting Capacity (MW)	Voltage Regulator Tapping Count	Cap Switching Count
A1	Baseline	7.6	200	12
	Refined 1	9.6	500	13
	Refined 2	12.9	2,900	232
C1	Baseline	3.3	1,800	11
	Refined 3	3.6	1,500	26

Circuit	VRE Settings Applied	Smart Inverter Function	Hosting Capacity (MW)
A1	Baseline	None	7.6
	Refined 4	VV	13.2
	Refined 5	VV	12.9
	Baseline	0.96 pf	12.9
	Baseline	0.98 pf	12.9
C1	Baseline	None	3.3
	Baseline	0.98 pf	8.6
	Refined 6	None	3.6
	Refined 7	0.98 pf	9.2

Conclusion

- When properly coordinated, conventional VRE or SI functions *alone* can integrate higher DER penetration levels
- When coordinated *jointly*, conventional VRE and SI functions can integrate even higher DER penetration levels
- Next to hosting capacity, it is recommended to consider impacts to VRE operations, reactive power consumption, etc.