Increasing DER Hosting Capacity with Tie-Point Controllers

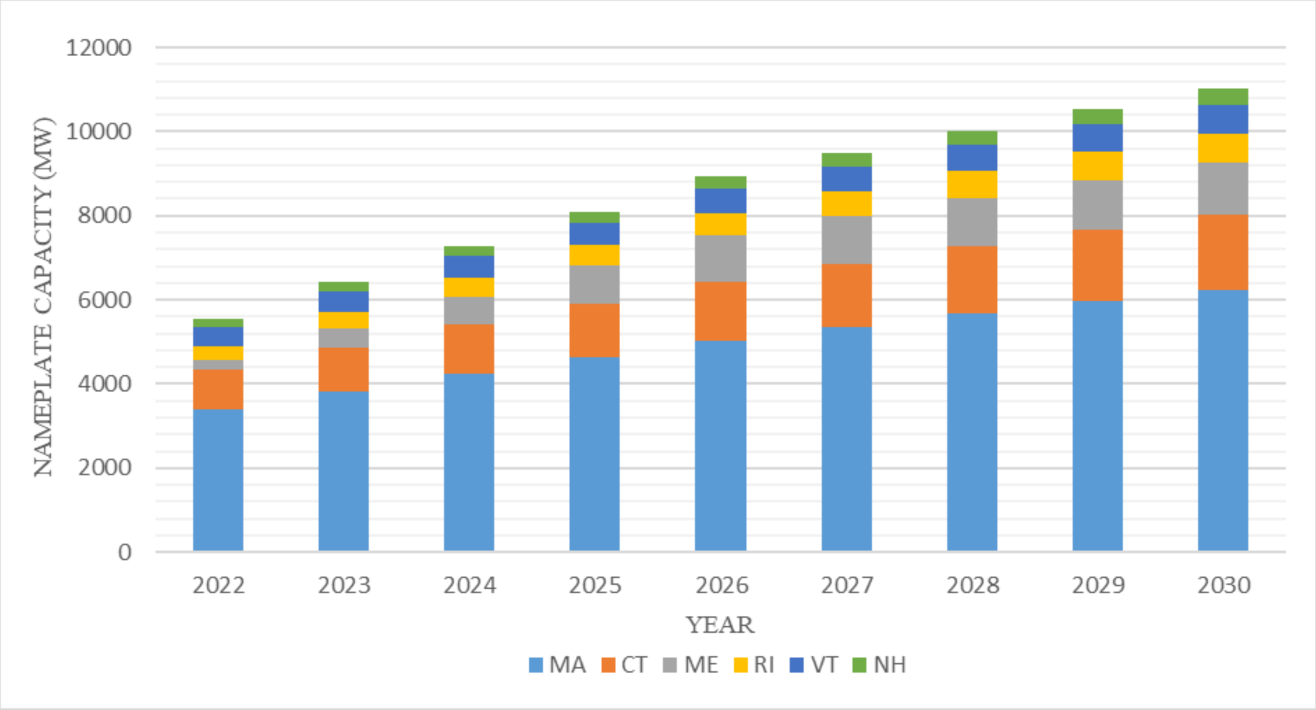
CIGRE 2022 Grid of the Future Symposium

Presentation Overview

- DER Hosting Capacity
- Tie-Point Controllers
- Device Modeling
- Use Case
- Conclusion

DER Hosting Capacity Challenge

- Rapid growth of distributed energy resources (DER) is presenting Hosting Capacity challenges for developers and utilities.
- ISO New England (ISO-NE) forecasts PV penetration to double by the end of 2030, increasing from 5.5 GW to 11.0 GW.



Hosting Capacity Constraints and Solutions

- Common Hosting Capacity Constraints
  - Overvoltage Conditions
  - Thermal Overloads
  - Volt/Var Device Miscoordination
  - Protection Miscoordination

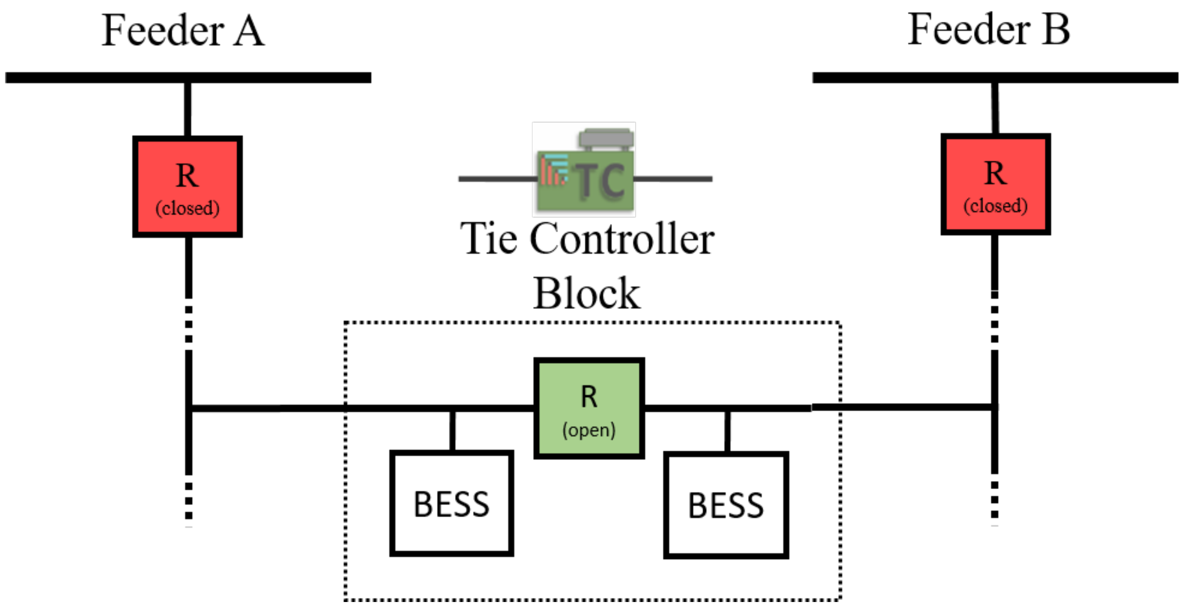
- Methods for Increasing Hosting Capacity
  - Grid Reinforcements
  - Voltage Regulation Adjustments
  - Smart Inverter Control
  - Dynamic Reactive Devices

Tie-Point Controllers

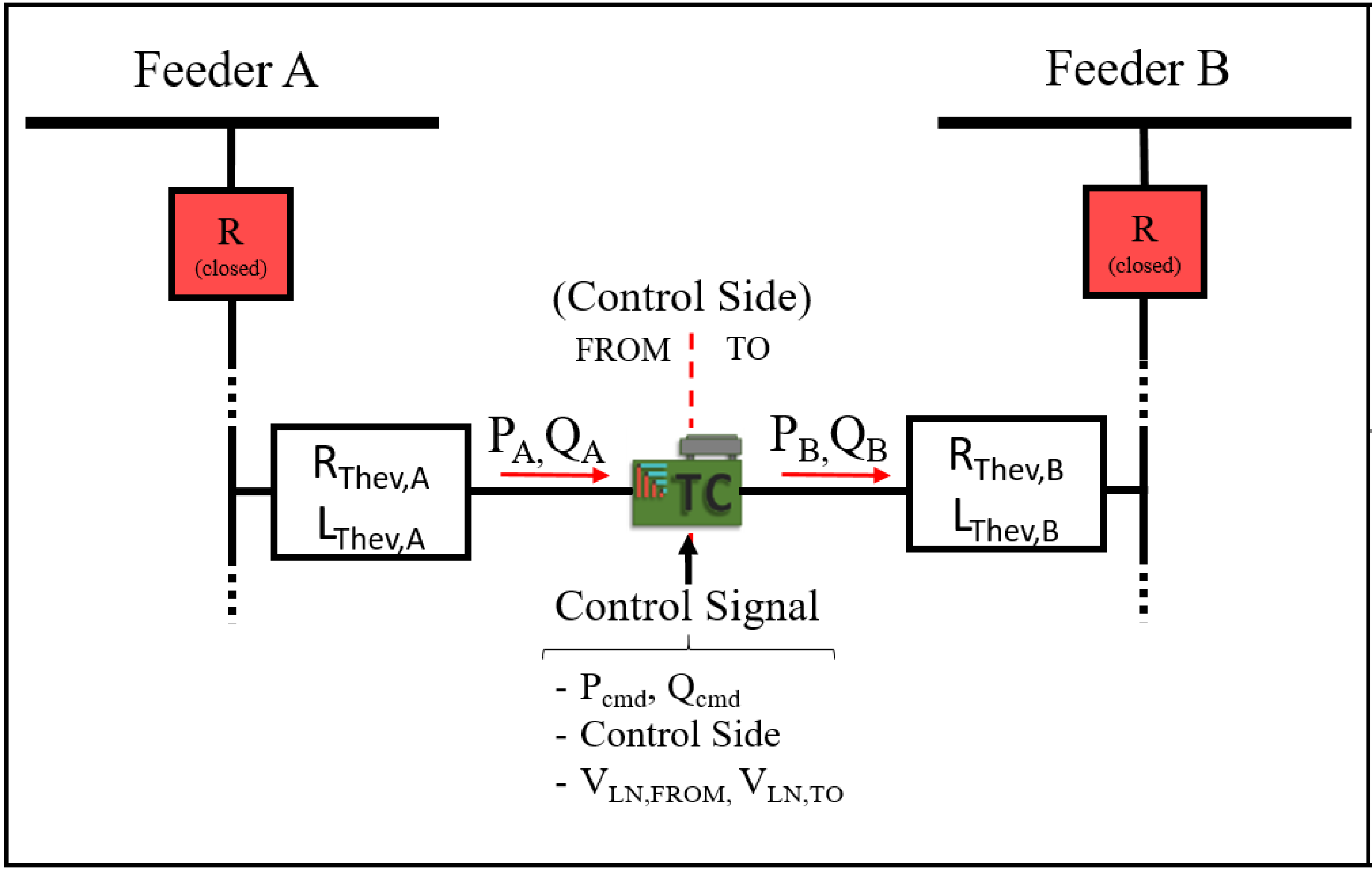
- Tie-Point Controllers, sometimes referred to as Soft Normally-Open Points (SNOPs), are power electronic devices installed at normally-open points between medium voltage systems that allow for real and reactive (Watts, Vars) power to be transferred across a normally-open point.
- The ability to dynamically "push and pull" real and reactive power across a normally-open point allows Tie-Point Controllers to leverage available capacity on adjacent systems, which can increase both load and generation hosting capacities.
- Controlling real and reactive power allows Tie-Point Controllers to help ameliorate both voltage and thermal violations that frequently limit DER hosting capacity.

Tie-Point Controller Model

- Eaton's CYME software does not currently have a built-in Tie-Point Controller model, so the device functionality must be modeled using existing architecture accompanied by custom programming scripts.
- Battery energy storage systems (BESS) were placed on either side of a normally-open (N.O.) point to emulate the Tie-Point Controller functionality.



Tie-Point Controller I/O's



Inputs:

- P_{cmd}, Q_{cmd}
- Control Side
- $R_{Thev,A}$, $L_{Thev,A}$
- $R_{Thev,B}$, $L_{Thev,B}$
- $V_{LN,FROM}$, $V_{LN,TO}$

Outputs:

- P_A, Q_A
- P_B, Q_B

Case Study

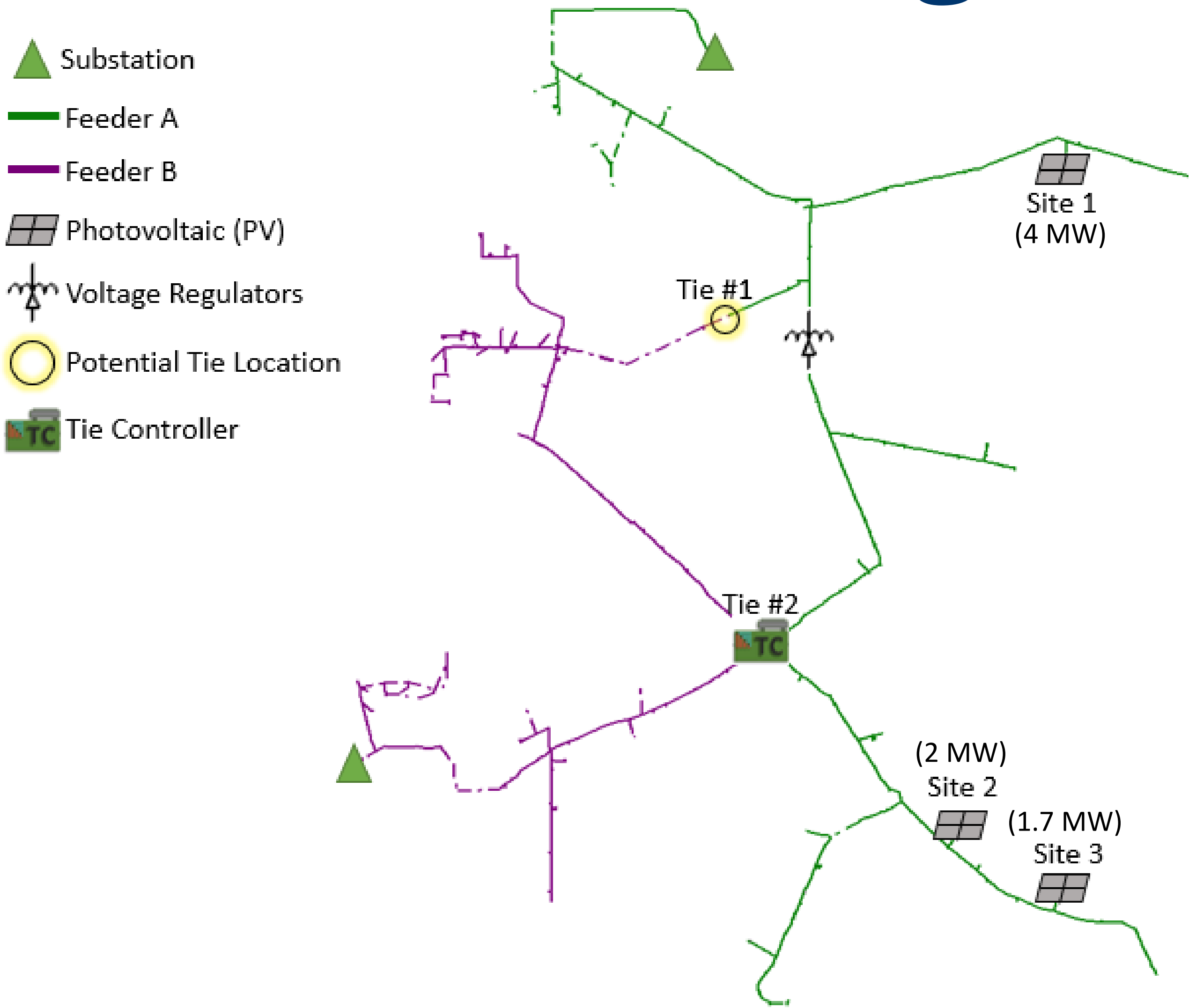
- A DER Hosting Capacity (HC) study was performed on a radial 12.5 kV circuit (Feeder A). Feeder A was located next to an adjacent 12.5 kV circuit (Feeder B); however, the circuits were served from two different substations.
- Feeder A, which is served by a 115/12.5 kV substation, is 30° out of phase with Feeder B, which is served by a 34.5/12.5 kV substation.
- The study focused on improving HC on Feeder A by leveraging available HC on Feeder B.

System Overview

- Three commercial PV sites were evaluated as DER interconnecting to Feeder A:
  - Site 1: 4 MW
  - Site 2: 2 MW
  - Site 3: 1.7 MW
- Feeder B did not have any DER interconnections.
- The following table summarizes the peak and light daytime loading assumptions as well as the amount of nameplate DER on each circuit.

Circuit	Peak Load	Light Load	Nameplate DER
Feeder A	6.6 MW	1.7 MW	7.7 MW
Feeder B	5.0 MW	1.3 MW	0 MW

System Overview (One-Line Diagram)



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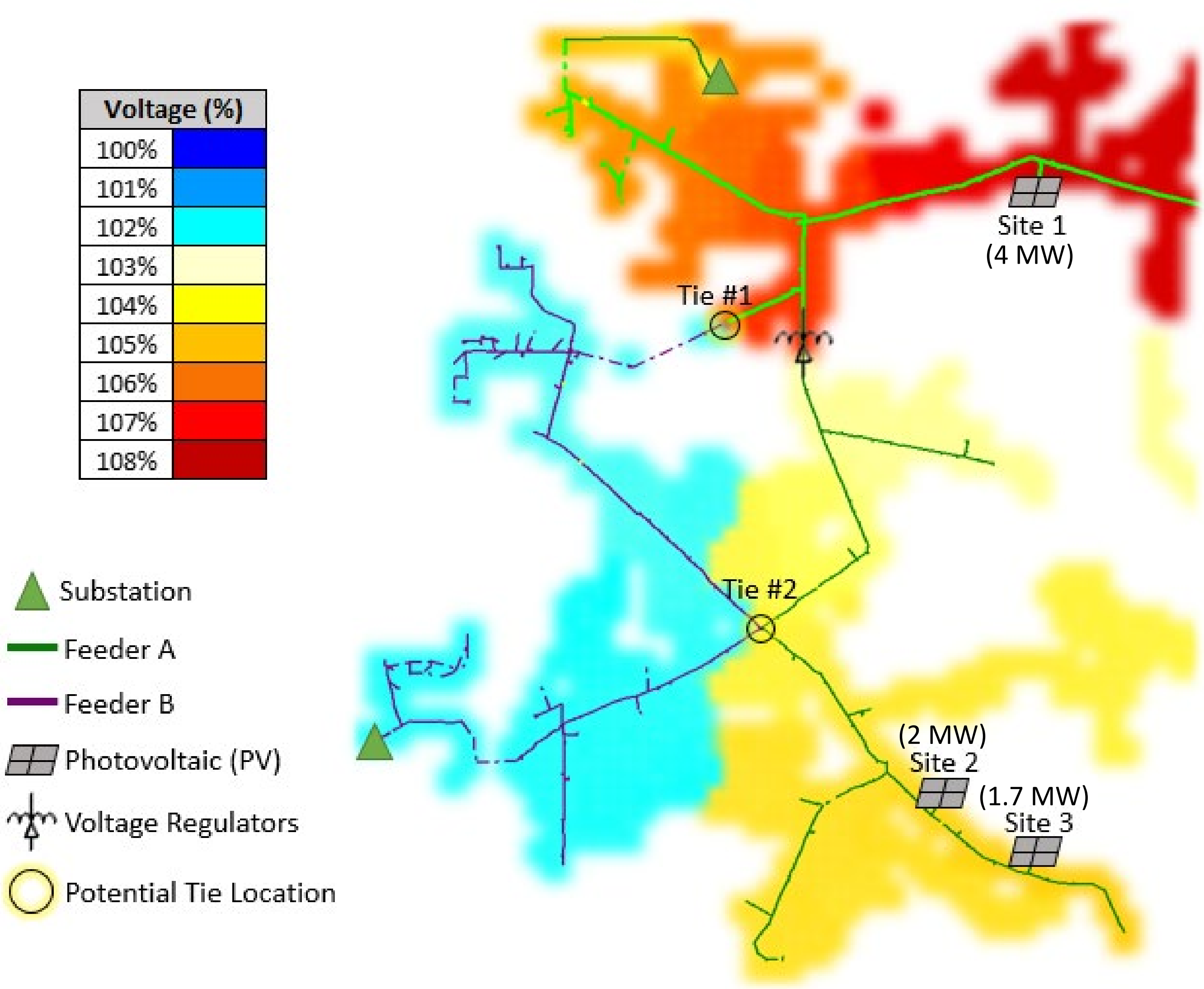
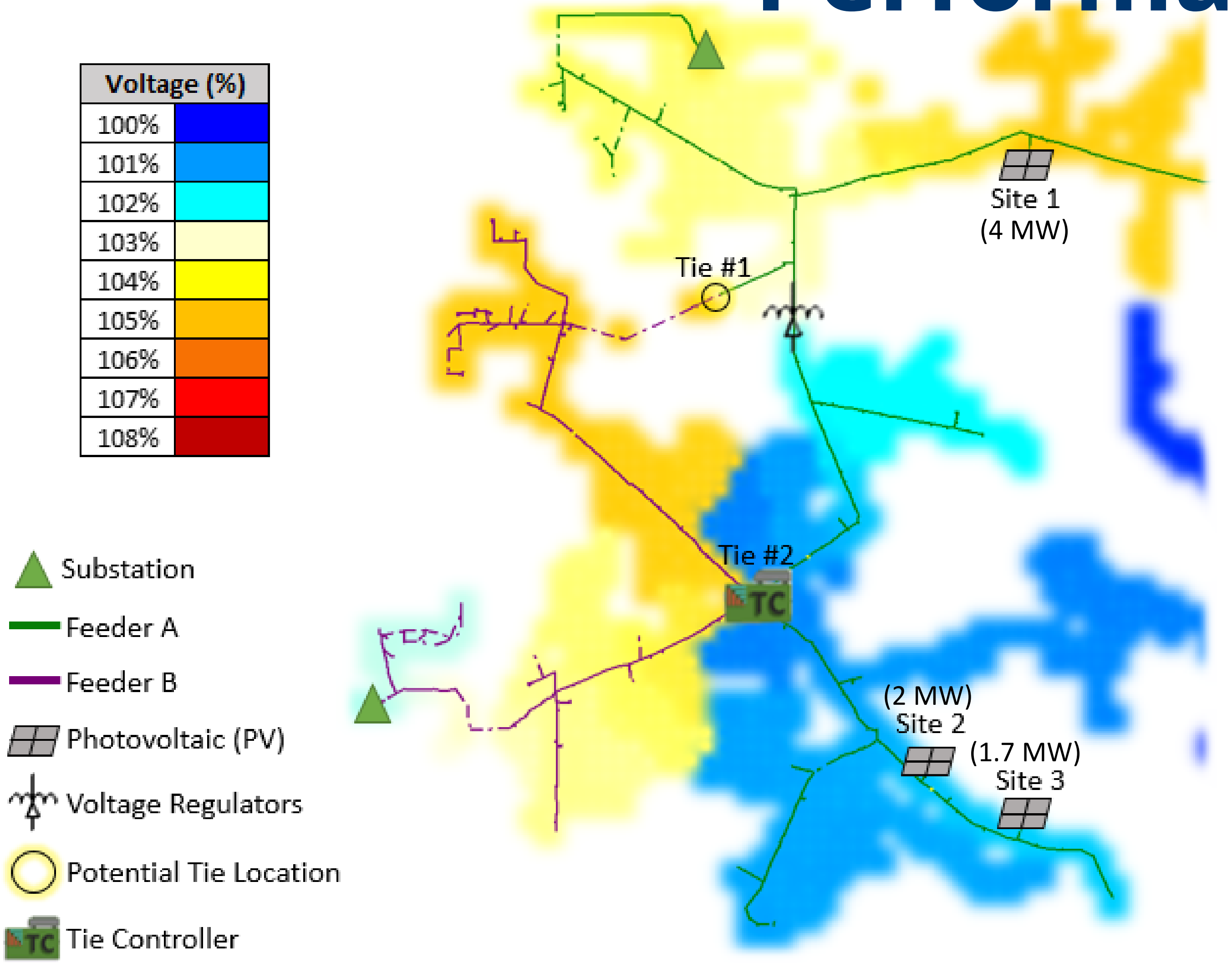
Existing System Performance



- Voltages as high as 108% were observed near the 4 MW PV at Site 1.
- Feeders A and B were not thermally limited.
- To determine hosting capacity, DER was uniformed scaled down until all high voltages were resolved.
- The existing system DER hosting capacity was approximately 1.1 MW.

Post Tie-Point Controller System Performance



- The Tie-Point Controller was used to transfer 5 MW and 2.5 MVAR from Feeder A to Feeder B.
- All high voltage violations were resolved.
- Feeders A and B were not thermally limited.
- Satisfactory voltage levels were maintained on both feeders with 100% of nameplate DER (7.7 MW) connected.

Results Table

Circuit	Evaluation	Parameter	Existing System	With Tie-Point Controller
Feeder A	Voltage Levels (% of Nominal)	Highest	107.8%	104.9%
		Lowest	103.4%	100.3%
	Key Thermal Element Loading (% of Max)	Feeder A Substation Transformer	10.3%	5.2%
		Main Line Conductor*	77.4%	25.5%
Feeder B	Voltage Levels (% of Nominal)	Highest	102.4%	104.8%
		Lowest	102.1%	102.7%
	Key Thermal Element Loading (% of Max)	Feeder B Substation Transformer	19.9%	14.2%
		Main Line Conductor*	12.2%	38.3%

*The most limiting section of conductor in-line with the Tie-Point Controller was selected to show device impact.

Conclusions

- Tie-Point Controller efficacy is dependent upon the location of the device in the distribution system, where the DER(s) are located relative to the device, how the device is controlled, and the available capacity on adjacent systems.
- The case study showed a 567% (6.6 MW) increase in DER hosting capacity.
- The flexibility to dynamically shift real and reactive power across SNOPs can be an effective tool in remediating voltage and thermal constraints that limit Hosting Capacity. Thus, while Tie-Point Controller efficacy is dependent upon the application scenario, the device could be a valuable tool for the distribution system engineer’s toolbox.

Questions?