Utilizing a BESS for Multi-Applications in a Distribution Grid

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Distribution Grid Solutions

10/18/2021

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Project Overview

- **Objective:** A one-day demonstration of the use of a BESS system for multiple grid support applications
  - Outage mitigation, peak-shaving, and voltage support
- **Methodology**: Use modeling software to create static BESS model and perform different studies
  - Software installation
  - Obtain system characteristics, create BESS model, run power system analysis, obtain simulation results
- **Goal**:
  - Understand the three grid-support applications
  - Familiarization with modeling and modeling software, model a DER component, and run analysis
  - Summarize the project in a presentation (final report out) and a conference paper (CIGRE 2021).

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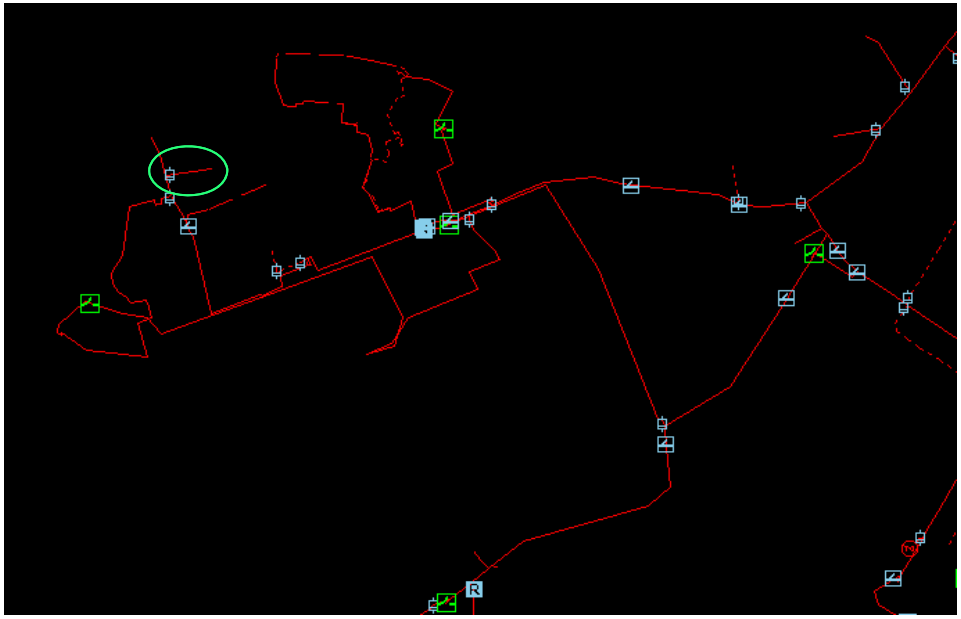
Site Information via Modeling Software

Entire Circuit with Substation

Zoomed in to area of interest



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Slide 3

CMM(TD-14 slides 3-7: i familiarize myself with synergi and the site location for this project, learning how to run different types of analysis and navigate synergi

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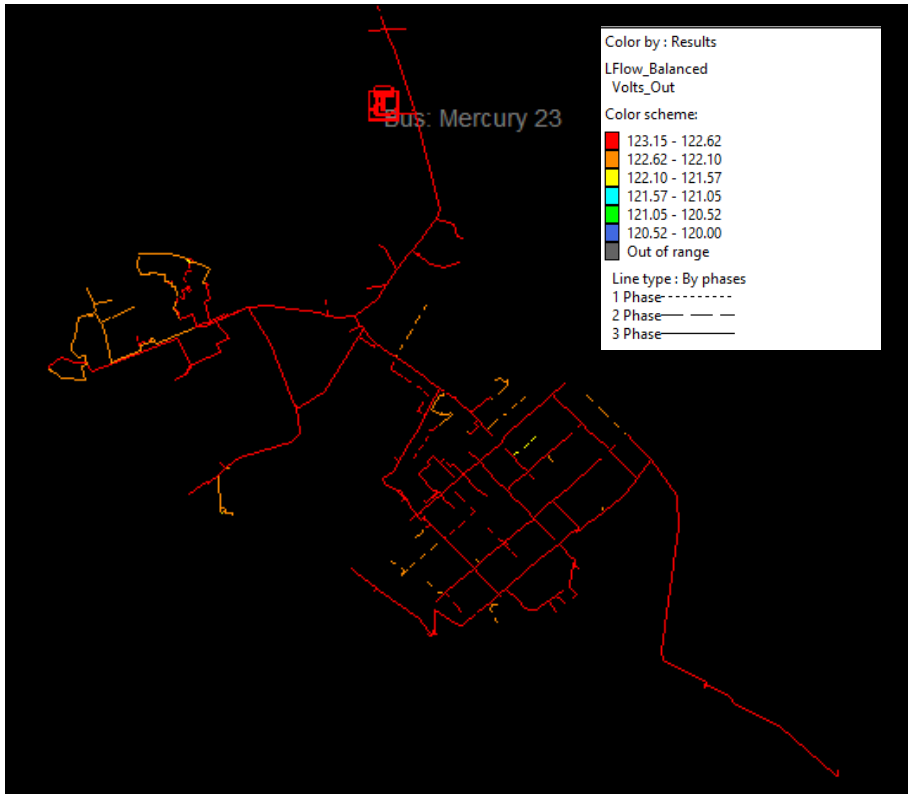
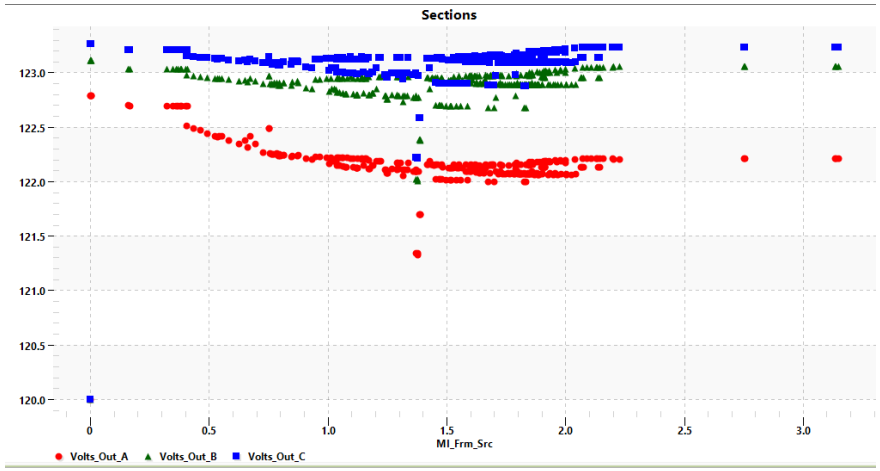
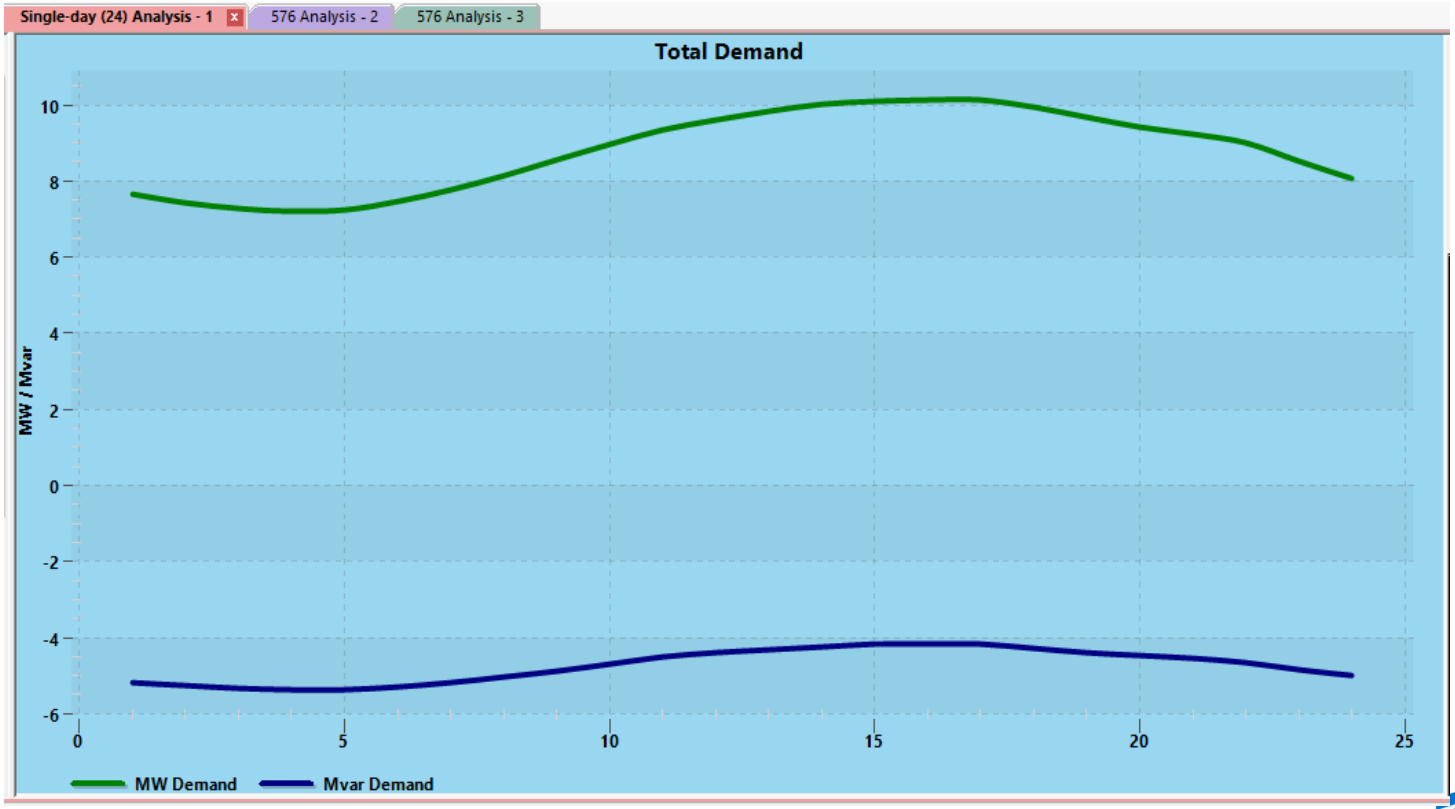
Running Power Flow Analysis



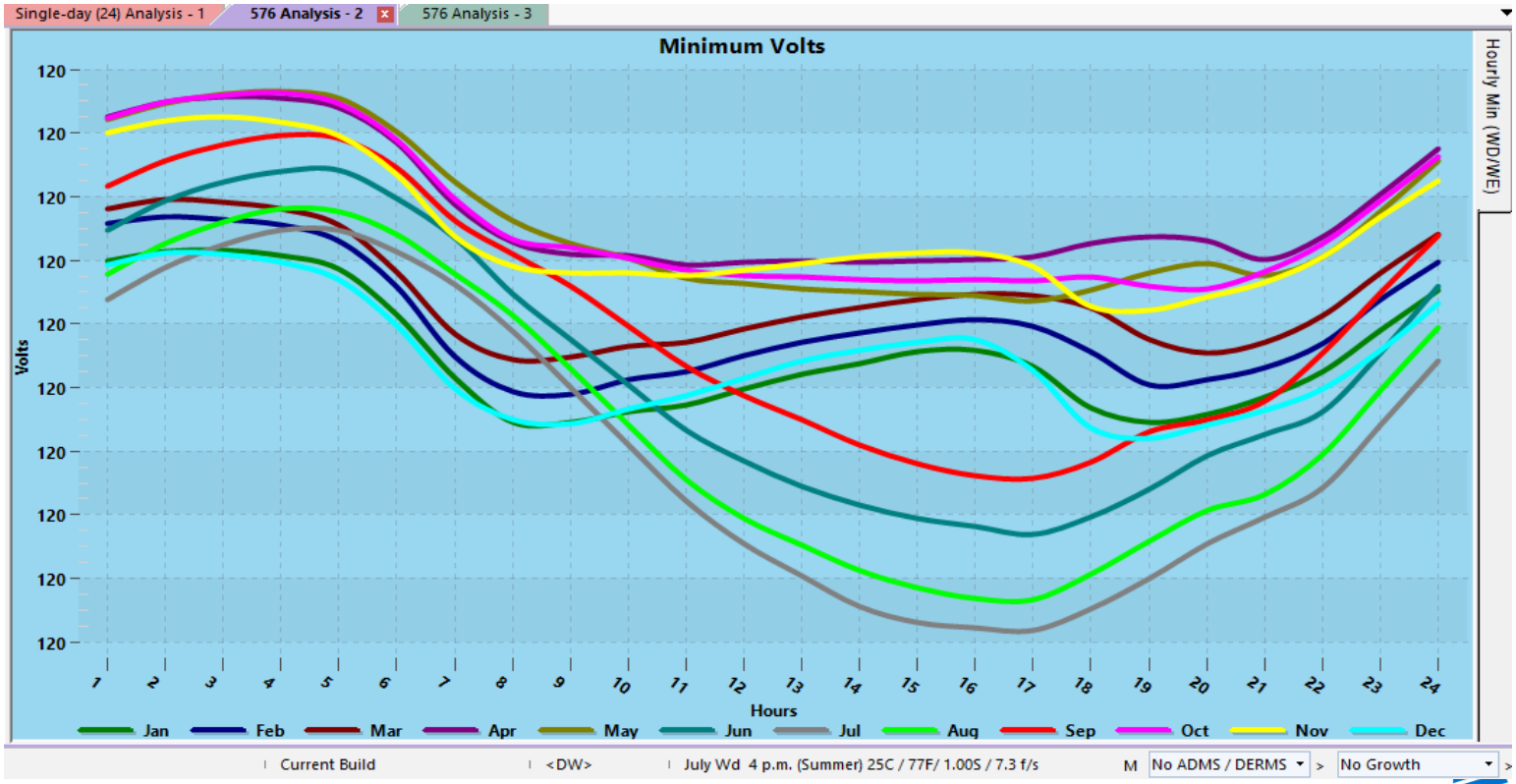


- Power flow results are obtained & voltage results are visualized.

24 (Single Day) Analysis



576 Analysis



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Add BESS Model To Circuit

- The battery was modeled two different ways for active and reactive power applications respectively.
  - Active power application: generator was used to model battery (Figure 1).
  - Reactive power application: a STATCOM model was used with a pre-defined inverter model with constant Q for constant reactive power output, since the battery model does not support this implementation (Figure 2).

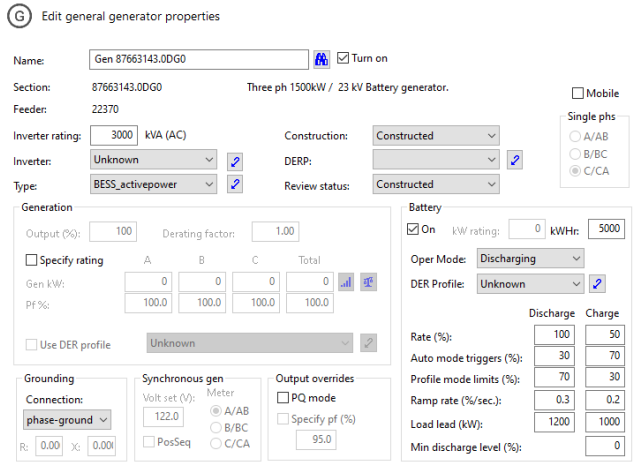

Figure 1: BESS Model

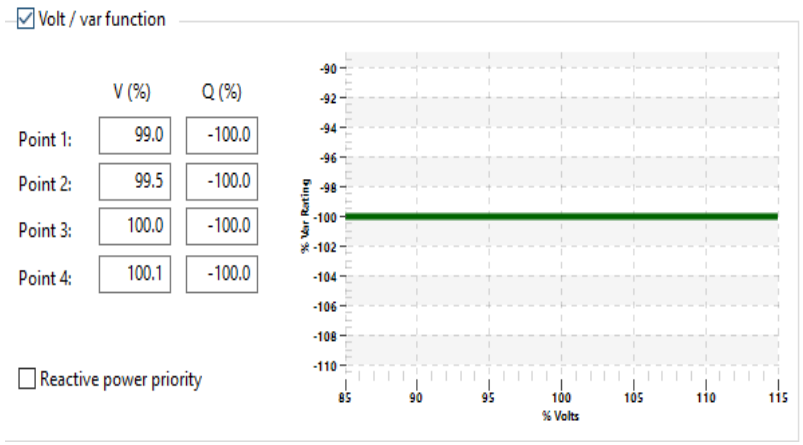

Figure 2: PV Inverter with volt/var function

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CMM(TD-11 replace with BESS model information screenshot and STATCON screenshot, showing the two ways the battery was modeled for active and reactive power
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CMM(TD-12 this shows at constant -100 absorbing reactive power, with a constant power output. this is to minic the reactive power support from the BESS, since the battery model given does not support this implementation
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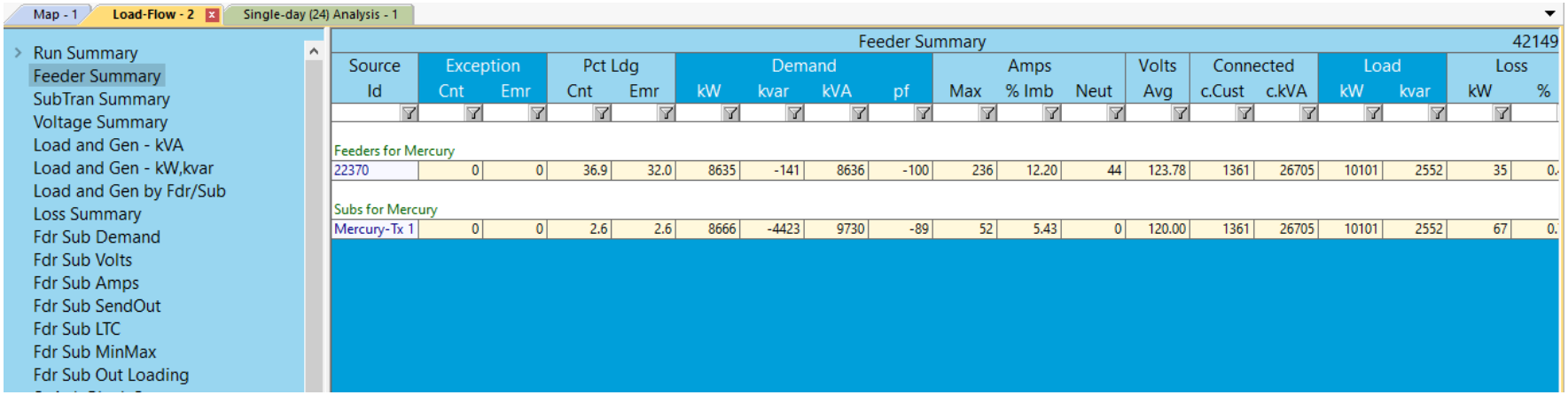
Active Power Application

- Active Power Application: Have the battery discharge during peak hours and charge during off-peak hours. This helps to shift peaking load on the substation transformer.
- Add a BESS and run power flow to validate that the model is working.✓



Feeder Summary 42149

Source Id	Exception Cnt	Exception Emr	Pct Ldg Cnt	Pct Ldg Emr	Demand kW	Demand kvar	Demand kVA	Demand pf	Amps Max	Amps % Imb	Amps Neut	Volts Avg	Connected c.Cust	Connected c.kVA	Load kW	Load kvar	Loss kW	Loss %
Feeders for Mercury																		
22370	0	0	36.9	32.0	8635	-141	8636	-100	236	12.20	44	123.78	1361	26705	10101	2552	35	0.
Subs for Mercury																		
Mercury-Tx 1	0	0	2.6	2.6	8666	-4423	9730	-89	52	5.43	0	120.00	1361	26705	10101	2552	67	0.

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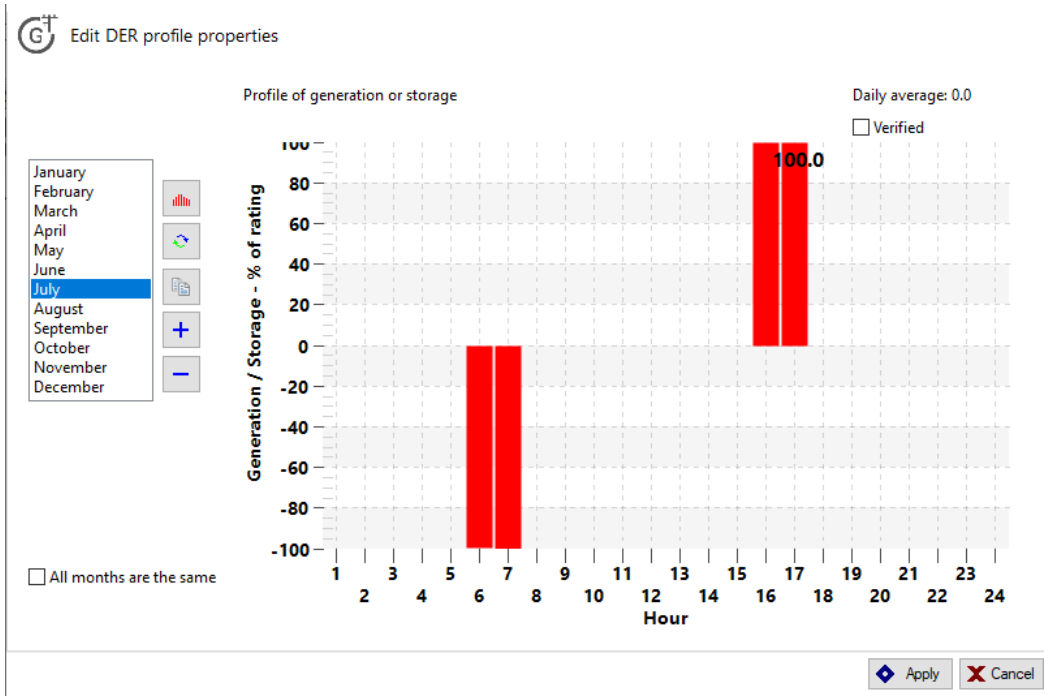
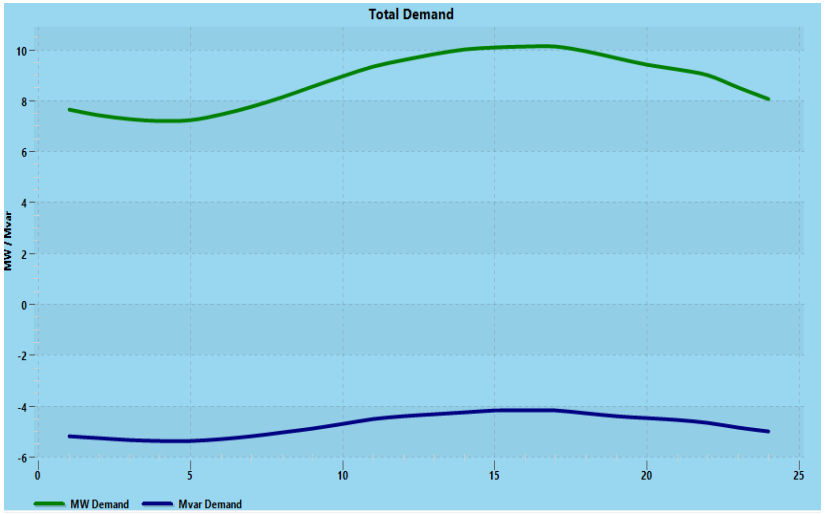
Discharging/Charging 1.5 MW for 2 hours during the peak & off-peak hours

- Peak Hours: 1500-1700
- Off-Peak Hours: 500-700
- Peak Month: July

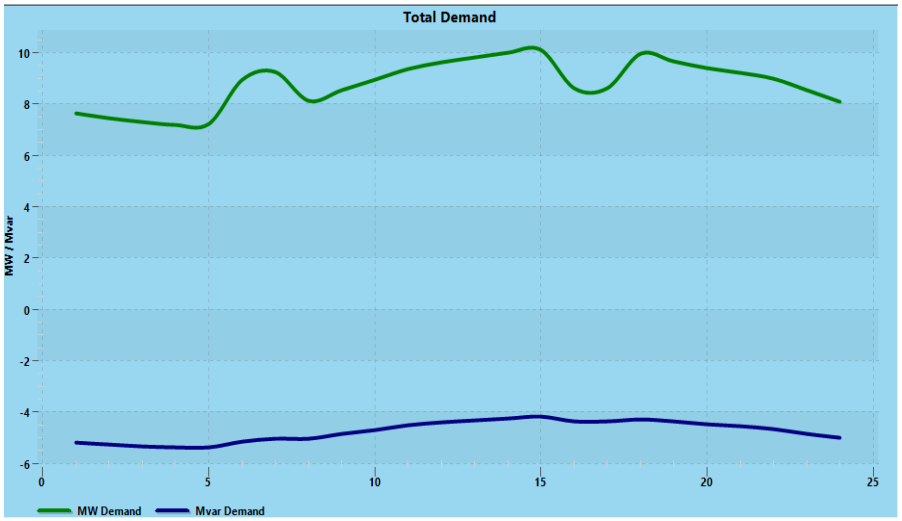


24-hour power flow analysis (Original case/BESS case)

Original Case:



BESS Case:



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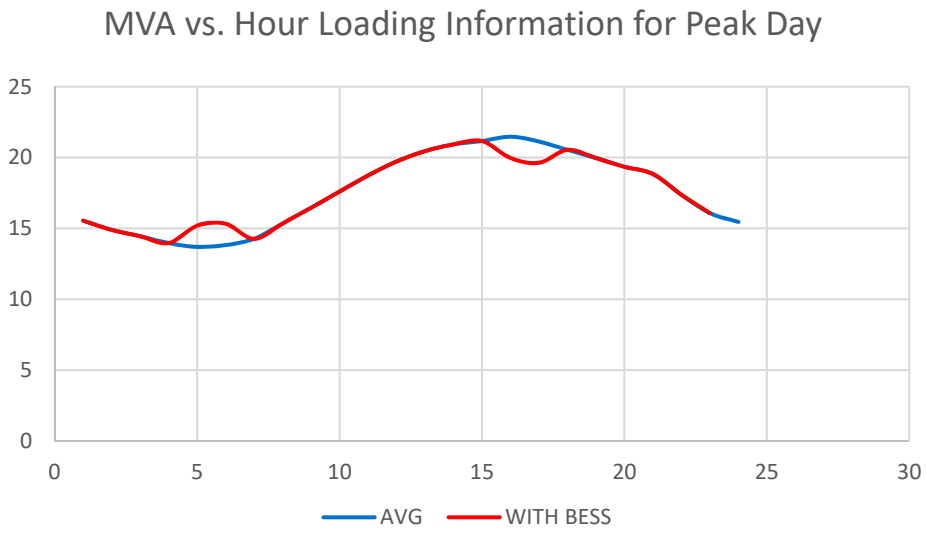
Using current 2021 peak day data from PI system

- Found peak day for Substation TX1 so far this year.
- Peak: 07/01/21 @ 1500-1600 -> AVG: 21.46673MVA
- Comparison of loading information with & without BESS.

2/23/2021 11:00	2/23/2021 12:00	NO DATA	NO DATA
7/1/2021 15:00	7/1/2021 16:00	21.46673	21.73316
7/1/2021 14:00	7/1/2021 15:00	21.16065	21.43362
7/1/2021 16:00	7/1/2021 17:00	21.1263	21.73316
7/1/2021 13:00	7/1/2021 14:00	20.93171	21.14001
7/13/2021 16:00	7/13/2021 17:00	20.82652	21.11919
7/13/2021 14:00	7/13/2021 15:00	20.79368	21.0238
6/29/2021 17:00	6/29/2021 18:00	20.78414	21.0402
6/29/2021 16:00	6/29/2021 17:00	20.75449	21.0402
6/30/2021 17:00	6/30/2021 18:00	20.72398	20.95376
7/13/2021 15:00	7/13/2021 16:00	20.72364	20.92893
7/13/2021 13:00	7/13/2021 14:00	20.63911	20.82403



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Reactive Power Application

- Modeled reactive power source and recorded voltage and transformer tap position at the BESS site and the substation.

Tap Setting (PU)	Substation Voltage [V]	Site Voltage [V]	LTC mode	LTC position	BESS Reactive Power Output
1	122.9	122.3	Auto	-6	0
0.995	123.5	123	Manual	-6	0
0.995	122.9	122.2	Manual	-6	1000
0.995	122.9	122.2	Auto	-6	1000
0.995	122.7	122.2	Auto	-7	0
1	122.9	122.3	Auto	-6	0
1.005	122.2	121.7	Manual	-6	0
1.005	122.8	122.5	Manual	-6	-1000
1.005	123.6	123.3	Auto	-5	-1000
1.005	123.1	122.5	Auto	-5	0

- In Case 1 where the battery is absorbing: we see that the LTC doesn't change its position to regulate the voltage when the battery is operating.
- Without the battery, the LTC reacts by changing from -6 to -7. This shows that the battery regulates the voltage and reduces the LTC tap position change.

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CMM(TD-13 use the Flex-STATCOM model for reactive power source

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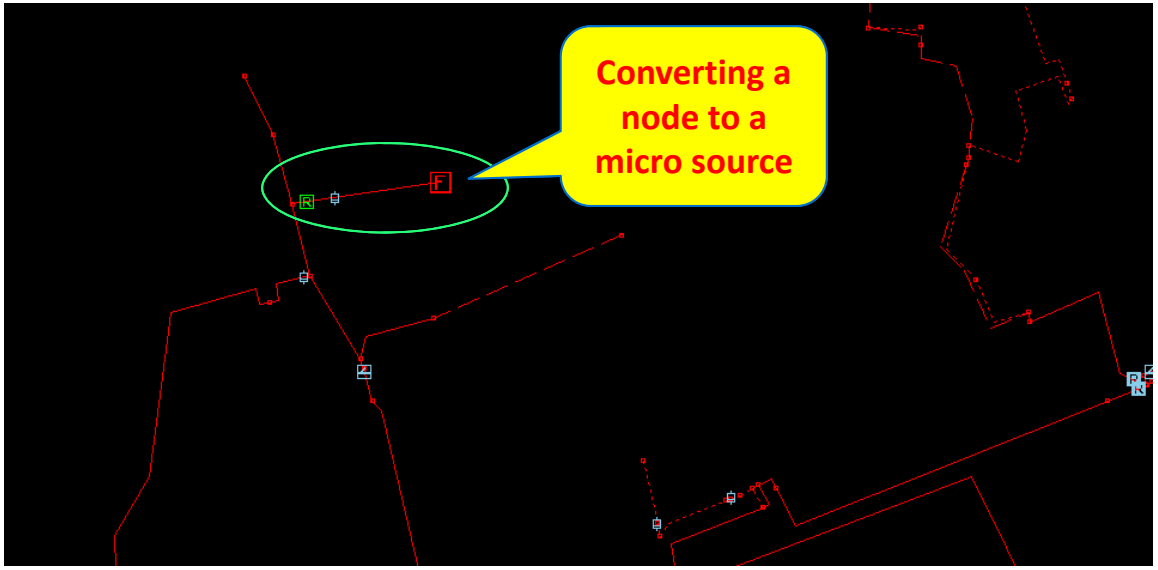
Islanding Mode Application: Outage Mitigation

- Serve as back up power generation. If the distribution system experiences an outage, the campus site can remain energized.
- Even though the recloser is open, so the building is disconnected from the main grid, the section still has power.



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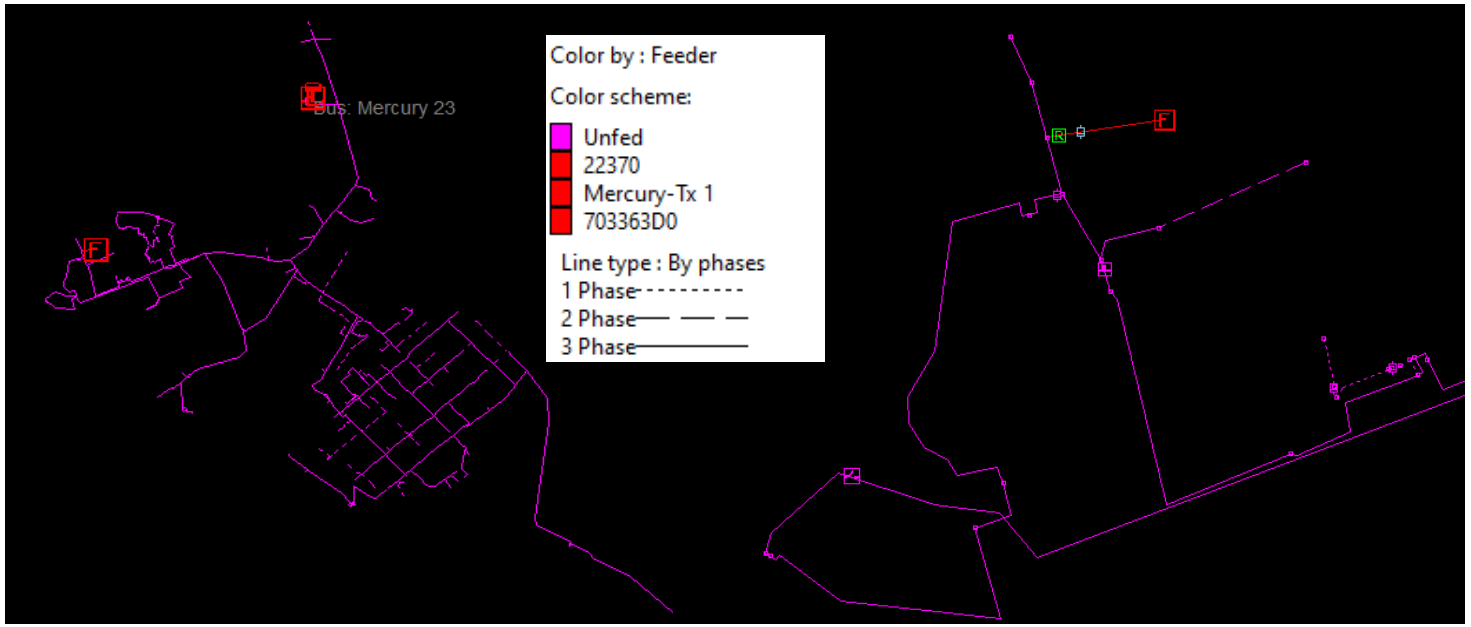
Islanding Mode Application: Outage Mitigation (cont.)

- Modeling a circuit outage by opening Breaker 22370 12. We see that the campus building is still energized.



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Islanding Mode Application: Outage Mitigation (cont.)

	Voltage at Building	Voltage at Breaker
No fault	123 V	123.7 V
Fault	123 V	0 (not energized)

- Constant voltage at the site location regardless of faults elsewhere on the circuit.
- The BESS could provide backup power generation when there is an outage.

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Results Summary / Conclusion

- **Objective:** A one-day demonstration of the use of a BESS system for multiple grid support applications. ✓
  - Outage mitigation, peak-shaving, and voltage support.
- **Methodology**: Use modeling software to create static BESS model and perform different studies.
  - Software installation. ✓
  - Obtain system characteristics, create BESS model, run power system analysis, obtain simulation results. ✓
- **Outcome**:
  - The content presented throughout this project can assist distribution system planners in better understanding of BESS, different ways to model a BESS, various grid support applications, and the potential value stacking strategy.
  - Future work includes value stacking strategy implementation and cost benefit calculation.

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Questions?

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