Transmission Planning Study

07/10/2023

Scope Overview

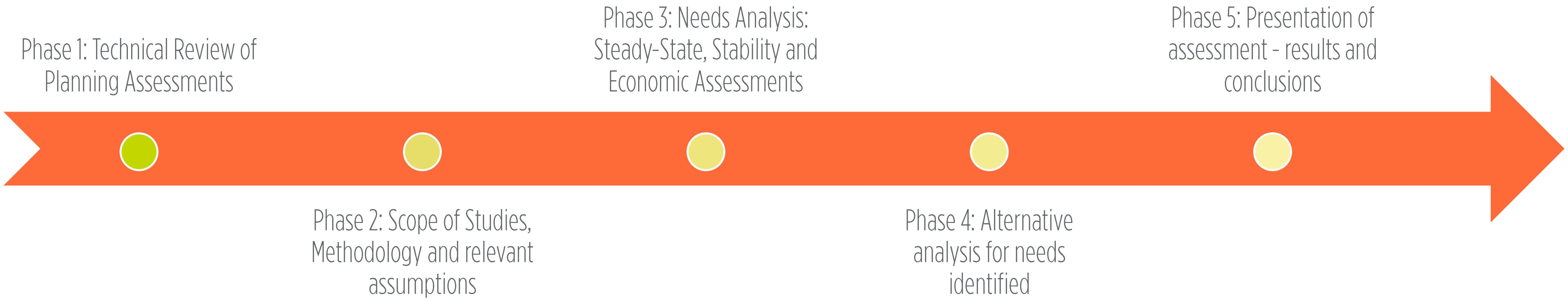
Objective:

Perform short-term and long-term integrated transmission planning assessment

- Assess Transmission and Distribution systems ability to support planned load increases and generation changes
- Resource Generation and Climate Protection Plan to 2030 (2030 Plan)
  - 100 percent carbon free by 2035 goal
- Study to identify Transmission Improvements
- Unit Retirements & Additions
  - Retirement of existing units as identified by the 2030 plan and other generating resources
- Risk Assessment and Resiliency improvement

Develop a plan that would help Austin Energy meet their short term and long-term objectives in a reliable, efficient and cost-effective manner

Outline of Study


Phase 1: Technical Review of Planning Assessments

Phase 2: Scope of Studies, Methodology and relevant assumptions

Phase 3: Needs Analysis: Steady-State, Stability and Economic Assessments

Phase 4: Alternative analysis for needs identified

Phase 5: Presentation of assessment - results and conclusions

- Review of existing assessment and understand the state of Austin Energy’s transmission system
- Study for potential transmission needs for Short-term and Long-term with the many anticipated changes (DG, EV, city plans etc.)
  - NERC Compliance evaluation
  - Compliance with ERCOT planning guide and Austin Energy planning criteria
  - Analysis in PSS/E and PSCAD software
  - Steady-State Analysis and Stability Analysis
- Arrive at solutions that fit short-term and long-term system needs

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Steady State & Stability Study Cases

Scenario	Description	Steady State Cases					Stability Cases			
		2023 WP	2024 SP	2026 HWLL *	2029 SP	2032 SP**	2024 SP	2025 HWLL	2028 SP	2032 SP***
Scenario 1	ERCOT Base Case	●	●	●	●	●	●	●	●	●
Scenario 2A	AE Decker Retirement (All 4 Units)	●	●	●	●	●	●	●	●	●
Scenario 2B	AE Sand Hill Retirement (All 8 Units)	●	●	●	●	●	●	●	●	●
Scenario 2	AE Generation Retirement (Decker and Sand Hill)	●	●	●	●	●	●	●	●	●
Scenario 3	Scenario 2 + External Gen Retirement	●	●	-	●	●	●	•	●	●
Scenario 4	Scenario 2 + AE high Load Growth	●	●	-	●	●	●	-	●	●
Scenario 5	Scenario 4 + AE High EV & DER	●	●	-	●	●	●	-	●	●
Scenario 6	Scenario 5 + High Solar in ERCOT	-	●	-	●	●	●	-	●	●
Scenario 7	Scenario 6 + Data Center Load	-	●	-	●	●	●	-	●	●
Scenario 8	Scenario 2 + High West to East Transfer in ERCOT	-	-	●	-	-	-	●	-	-
Sensitivity 1	Scenario 7 + Low Wind	-	●	-	●	●	●	-	●	●

WP: Winter Peak Load scenario
SP: Summer Peak Load scenario
HWLL: High Wind Light Load scenario

* 2026 HWLL case used instead of 2025 HWLL case
** 2032 SP case developed based on SSWG 2029 SP case
*** 2032 SP case developed based on DWG 2028 SP case

Case Summary – All Scenarios

Scenario	Description	Steady State Case Summary							
		2023 WP				2024 SP			
		AE		ERCOT Total		AE		ERCOT Total	
		Gen (MW)	Load (MW)	Gen (MW)	Load (MW)	Gen (MW)	Load (MW)	Gen (MW)	Load (MW)
Scenario 1	ERCOT Base Case	1,104	2,496	91,894	90,069	1,175	2,906	106,571	103,815
Scenario 2A	AE Decker Retirement (All 4 Units)	1,050	2,496	91,895	90,069	1,128	2,906	106,575	103,815
Scenario 2B	AE Sand Hill Retirement (All 8 Units)	635	2,496	91,919	90,069	750	2,906	106,613	103,815
Scenario 2	AE Generation Retirement (Decker and Sand Hill)	581	2,496	91,922	90,069	703	2,906	106,618	103,815
Scenario 3	Scenario 2 + External Gen Retirement	581	2,496	91,927	90,069	703	2,906	106,638	103,815
Scenario 4	Scenario 2 + AE high Load Growth	581	2,555	91,985	90,128	703	3,034	106,763	103,943
Scenario 5	Scenario 4 + AE High EV & DER	581	2,550	91,980	90,123	703	3,033	106,762	103,941
Scenario 6	Scenario 5 + High Solar in ERCOT	-	-	-	-	697	3,033	106,853	103,941
Scenario 7	Scenario 6 + Data Center Load	-	-	-	-	705	3,033	107,922	104,941
Scenario 8	Scenario 2 + High West to East Transfer in ERCOT	-	-	-	-	-	-	-	-
Sensitivity 1	Scenario 7 + Low Wind	-	-	-	-	750	3,033	107,716	104,941

WP: Winter Peak Load scenario
SP: Summer Peak Load scenario
HWLL: High Wind Light Load scenario

Case Summary – All Scenarios

Scenario	Steady State Case Summary											
	2026 HWLL				2029 SP				2032 SP			
	AE		ERCOT Total		AE		ERCOT Total		AE		ERCOT Total	
	Gen (MW)	Load (MW)	Gen (MW)	Load (MW)	Gen (MW)	Load (MW)	Gen (MW)	Load (MW)	Gen (MW)	Load (MW)	Gen (MW)	Load (MW)
Scenario 1	250	1,327	49,723	47,696	1,497	2,988	114,613	111,566	1,497	3,033	114,664	111,611
Scenario 2A	250	1,327	49,717	47,696	1,305	2,988	114,623	111,566	1,305	3,033	114,674	111,611
Scenario 2B	0	1,327	49,743	47,696	925	2,988	114,668	111,566	925	3,033	114,722	111,611
Scenario 2	0	1,327	49,743	47,696	733	2,988	114,680	111,566	733	3,033	114,732	111,611
Scenario 3	-	-	-	-	733	2,988	114,707	111,566	733	3,033	114,763	111,611
Scenario 4	-	-	-	-	733	3,405	115,157	111,982	733	3,669	115,464	112,246
Scenario 5	-	-	-	-	733	3,442	115,197	112,020	733	3,739	115,544	112,316
Scenario 6	-	-	-	-	729	3,442	115,328	112,020	730	3,739	115,686	112,316
Scenario 7	-	-	-	-	729	3,442	119,095	115,520	730	3,739	121,135	117,314
Scenario 8	0	1,327	49,996	47,696	-	-	-	-	-	-	-	-
Sensitivity 1	-	-	-	-	776	3,442	118,942	115,520	776	3,739	120,938	117,316

WP: Winter Peak Load scenario
SP: Summer Peak Load scenario
HWLL: High Wind Light Load scenario

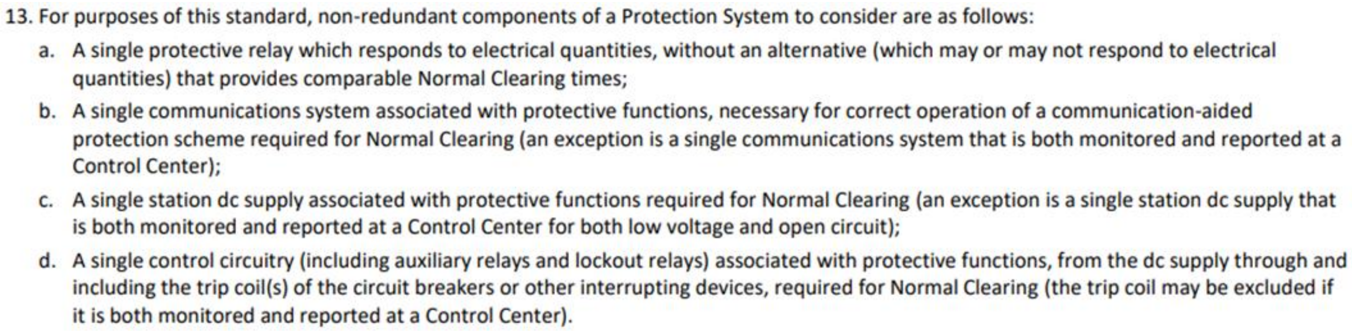
Reference Documents and Criteria

- NERC* TPL 001-4 and TPL 001-5
- ERCOT Planning Guide Section 4
- ERCOT Planning Guide Section 6.9
- Austin Energy Transmission Planning Criteria and Planning Guidelines

Transient Voltage Response	Category P1	Category P2 - P7
Time for voltage to recover to 0.9 p.u. after fault clearing	5 seconds	10 seconds
Power oscillation within the range of 0.2 to 2 Hz minimum decay	3%	3%

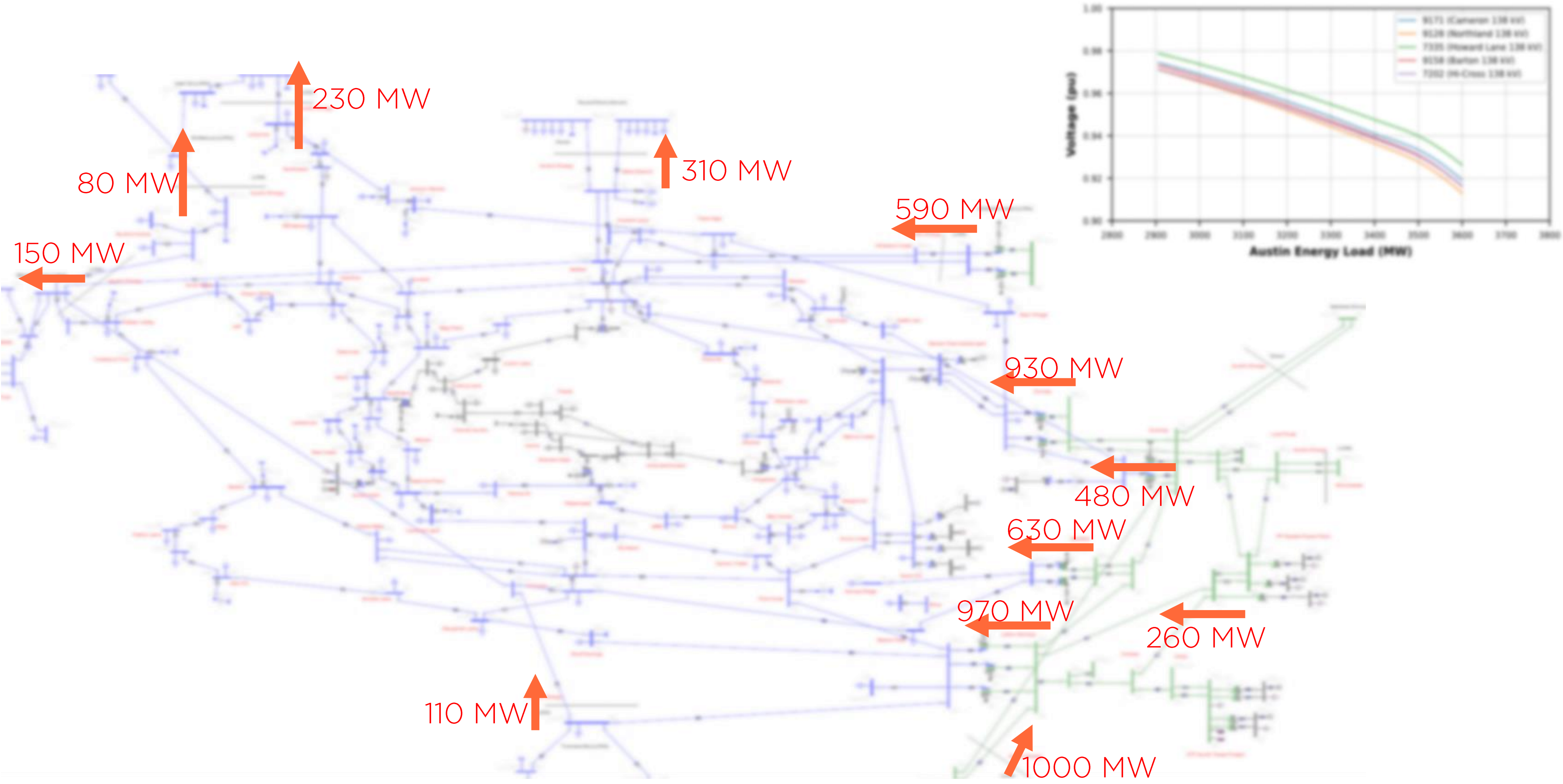
Voltage and Loading Performance or Manual Action	Category P0**	Category P1 & P2 & P7**	P3 to P6 and Extreme Events**
Transmission lines, autotransformers or other transmission equipment rating	Rate A	Rate B	Rate B
Substation bus voltages and equipment voltages	98-105% of nominal	95-105% of nominal	95-105% of nominal
Allow adjustment of autotransformer LTCs	Allowed	Allowed	Allowed
Redispatch on-line generation including adjustments to area interchange	Not Allowed	Not Allowed	Allowed
Dispatch the Fast-Start Gas Turbines	Not Allowed	Not Allowed	Allowed
Remove any single transmission line, autotransformer,or other transmission equipment loaded aboveits emergency rating	Not Allowed	Not Allowed	Allowed

*NERC: North American Electric Reliability Corporation
TPL 001-4 & TPL-001-5 : NERC Transmission System Planning Performance Requirements.
** P0-P7: NERC TPL Category of Contingency

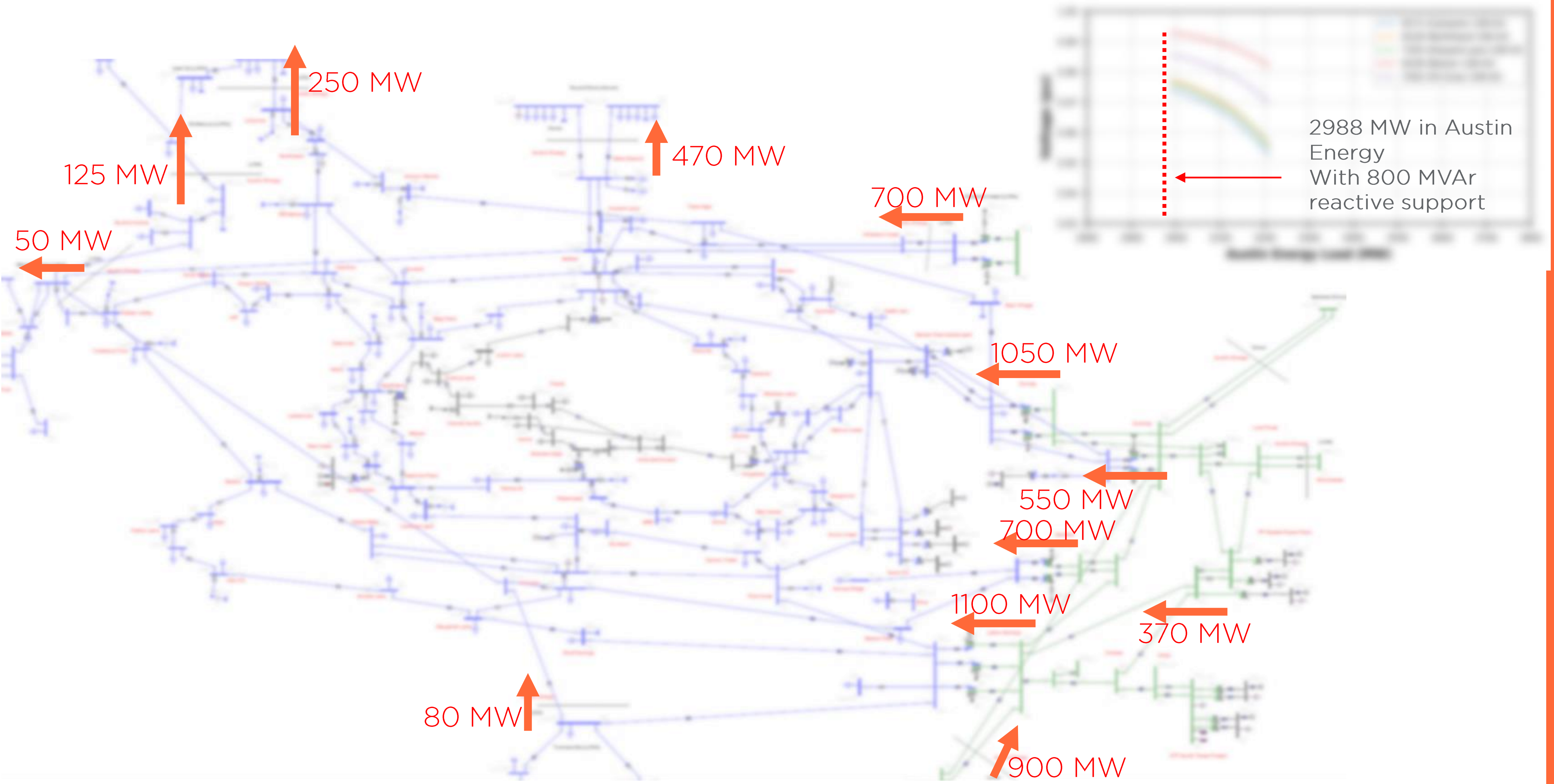


13. For purposes of this standard, non-redundant components of a Protection System to consider are as follows:
    a. A single protective relay which responds to electrical quantities, without an alternative (which may or may not respond to electrical quantities) that provides comparable Normal Clearing times;
    b. A single communications system associated with protective functions, necessary for correct operation of a communication-aided protection scheme required for Normal Clearing (an exception is a single communications system that is both monitored and reported at a Control Center);
    c. A single station dc supply associated with protective functions required for Normal Clearing (an exception is a single station dc supply that is both monitored and reported at a Control Center for both low voltage and open circuit);
    d. A single control circuitry (including auxiliary relays and lockout relays) associated with protective functions, from the dc supply through and including the trip coil(s) of the circuit breakers or other interrupting devices, required for Normal Clearing (the trip coil may be excluded if it is both monitored and reported at a Control Center).

Austin Energy System Overview (2024 SP, Scenario 2 - Gen Retirements)



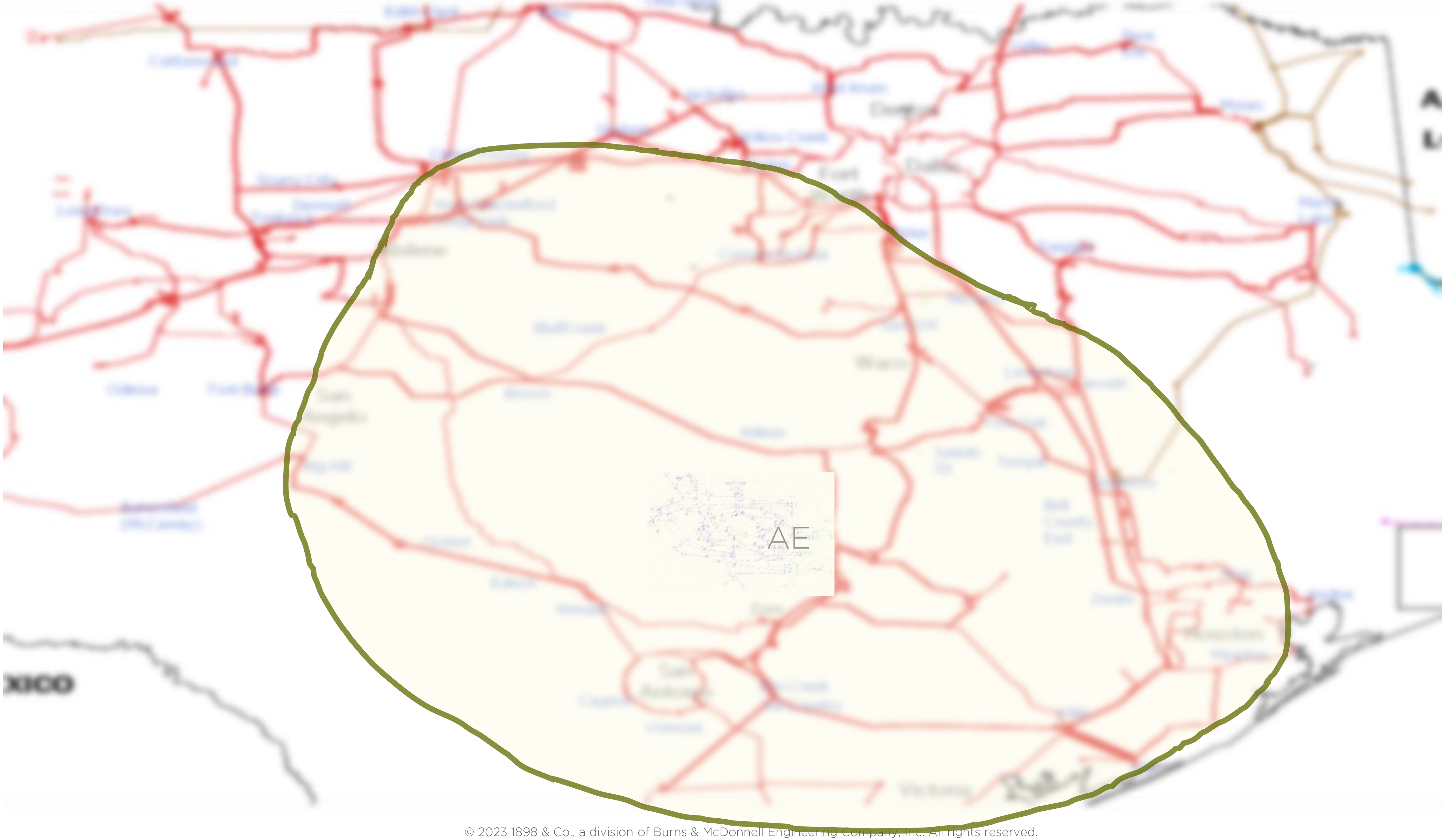
Austin Energy System Overview (2029 SP, Scenario 2 - Gen Retirements)



Key Observations

- Overall load in Austin Energy System is around 2900 MW (2024 Summer Peak)
- Good portion of loads are electrically distant from the sources i.e., generation or 345/138 kV substations
- The 2029 Decker and Sand Hill generation retirement scenario can be viewed as a large net load increase in the Austin Energy System that needs to be served from the external system. The system needs reactive power to maintain system voltages even without considering outages.
- In the same 2029 scenario, the whole of the ERCOT 245kV system (111.5 GW in the Summer Peak case), especially the transmission between Dallas-Austin-San Antonio, is fairly stressed from a voltage performance perspective.
- There are a few 138 kV lines with lower ratings on them compared to others.
- A few 345 kV lines around Austin Energy also have lower ratings on them.
- Though the system has a few Thermal constraints, the majority of system limits are due to voltage stability in the system following generation retirement.

Austin Energy and 10 Electrical Buses Away



Steady State Analysis

- NERC TPL-001-5 type analysis completed for the Austin Energy system.
  - Includes Contingency Analysis
  - Includes Stability Analysis
  - Voltage performance of the system assessed via
    - Power vs Voltage (PV) analysis (Voltages as a relation to Load being served)
    - Reactive Power vs Voltage (QV) analysis (Voltages as a relation to the Reactive Power available at a location)
- Cases assessed include:
  - Winter Peak (2023)
  - Summer Peak (2024, 2029, 2032)
  - High Wind Light Load (2026)

2024 Summer Peak Steady State Summary

Monitored Facility	Outage Label	Base Rate	Cont Rate	kVs	2024 Summer Peak Loading (% MVA)									
					Scen1	Scen2	Scen2a	Scen2b	Scen3	Scen4	Scen5	Scen6	Scen7	Sens1
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🟩	Line Loading less than 90 % of Emergency Rating
🟨	Line Loading between 90 – 100 % of Emergency Rating
🟥	Line Loading greater than 100% of Emergency Rating

2029 Summer Peak Steady State Summary

Monitored Facility	Outage Label	Base Rate	Cont Rate	kVs	2029 Summer Peak Loading (% MVA)									
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2032 Summer Peak Loading

Monitored Facility	Outage Label	Base Rate	Cont Rate	kVs	2032 Summer Peak Loading (%)									
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[redacted]	[redacted]	[redacted]	[redacted]	138	🟨	🟥	🟨	🟨	🟩	🟥	🟩	🟩	🟩	🟩
[redacted]	[redacted]	[redacted]	[redacted]	345/138	🟩	🟨	🟩	🟩	🟨	🟥	🟥	🟩	🟩	🟨
[redacted]	[redacted]	[redacted]	[redacted]	345/138	🟩	🟨	🟩	🟩	🟨	🟥	🟩	🟩	🟩	🟩

🟩 Line Loading less than 90 % of Emergency Rating
🟨 Line Loading between 90 – 100 % of Emergency Rating
🟥 Line Loading greater than 100% of Emergency Rating

Transient Stability Analysis

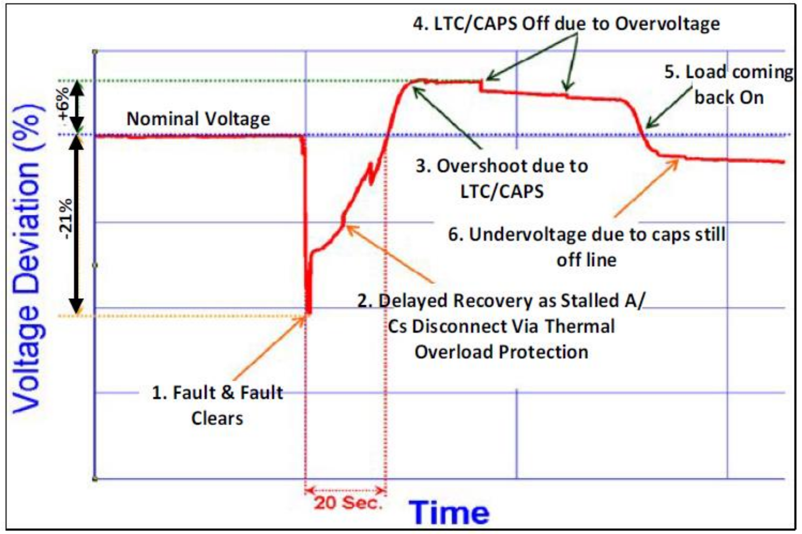
- Composite Load model Developed
  - Distribution Feeder review, Load type and amount
  - PSCAD model development vs Comparison with PSS/E
  - Utilizing this data in Transient Stability models
- NERC P1-P7 with Single Line and Three Line to Ground faults evaluated.
  - 2024, 2028 and 2032 cases and all scenarios evaluated.
  - 2025 High Wind Low Load case evaluated.
  - Checked for stability, Transient Voltage performance
  - Summary tables included in reports and weekly progress updates

	System Stress conditions	
Transient Voltage Response	Category P1	Category P2 - P7
Time for voltage to recover to 0.9 p.u. after fault clearing	5 seconds	10 seconds

Composite Load Model Development

Background:

- Fault-induced delayed voltage recovery (FIDVR) [1] due to the stalling of induction motors is common to utility distribution systems
  - Single-phase residential A/C motor (motor D) is the main driver for FIDVR [2]
  - Typical motor stalling voltage: <0.6 pu [2]
  - Typical motor stall duration: >5 cycles [2]
- FIDVR would not be captured correctly using static load model in PSS/E in transmission studies
- FIDVR in the distribution system would not be captured in the transmission system without a dynamic load model for the distribution system



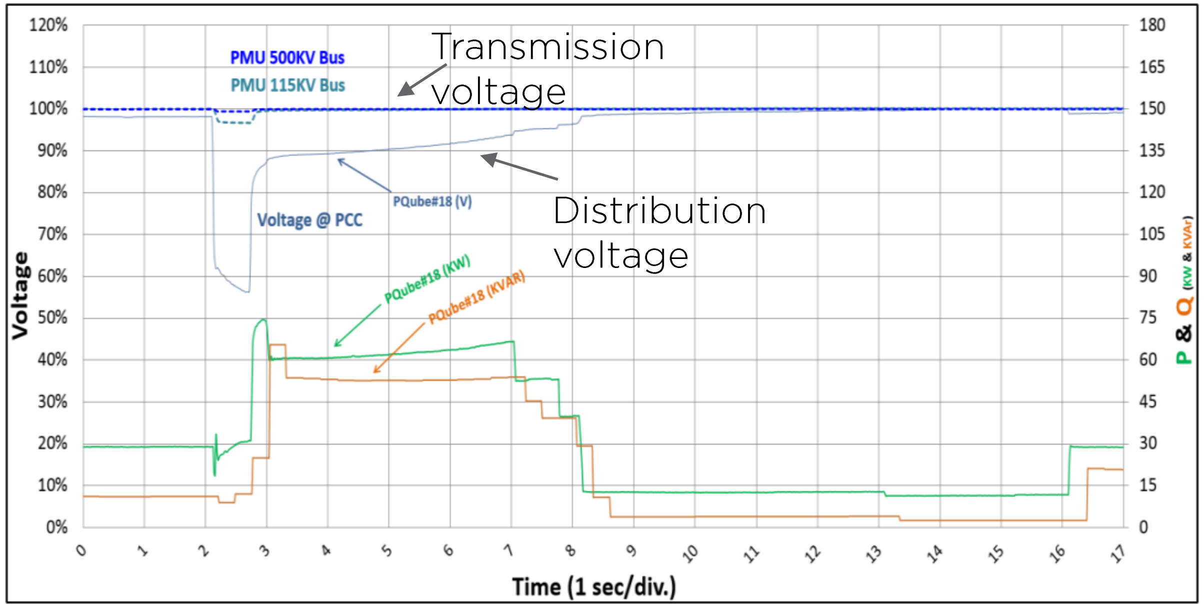
FIDVR event

[1] NERC Load Modeling Task Force, "Technical Reference Document on Dynamic Load Modeling," NERC, December 2016, [Online] Available: https://www.nerc.com/comm/PC/LoadModelingTaskForceDL/Dynamic%20Load%20Modeling%20Tech%20Ref%202016-11-14%20-%20FINAL.PDF
[2] S. Adhikari, J. Schoene, N. Gurung and A. Mogilevsky, "Fault Induced Delayed Voltage Recovery (FIDVR): Modeling and Guidelines," 2019 IEEE Power & Energy Society General Meeting (PESGM), 2019, pp. 1-5,

Composite Load Model Development

Goals:

- Develop a composite load model to represent the load characteristics of the distribution system
- To capture the potential FIDVR in the distribution system
- Use the developed composite load model to show the potential impact of distribution FIDVR on the transmission system



Southern California Edison FIDVR event [3]

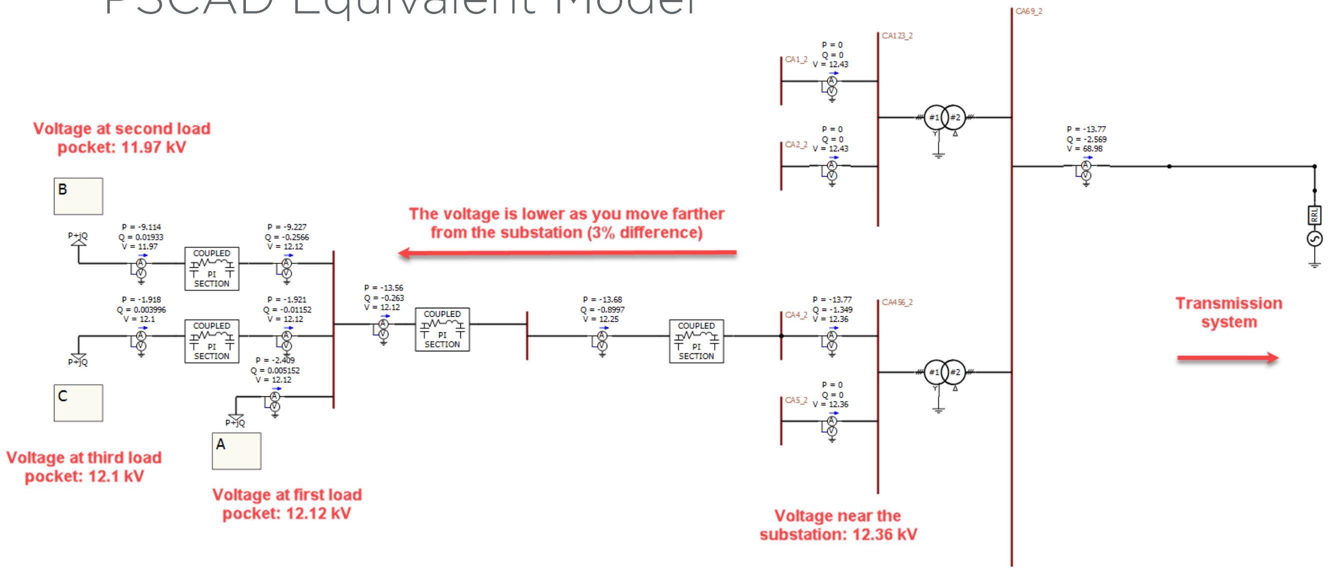
[3] Steven Robles, "2014 FIDVR Events Analysis on Valley Distribution Circuits", DER Laboratory, June 19, 2015. [Online]. Available: https://eta-publications.lbl.gov/sites/default/files/robles-2014-fidvr-events-analysis.pdf

PSCAD Feeder Model Development

Selected 10 low short-circuit ratio (SCR) substations (weak grid*) within AE system to develop and test the Composite load model.

Distribution Model in WindMil

PSCAD Equivalent Model



Voltage at second load pocket: 11.97 kV

The voltage is lower as you move farther from the substation (3% difference)

Transmission system

Voltage at third load pocket: 12.1 kV

Voltage at first load pocket: 12.12 kV

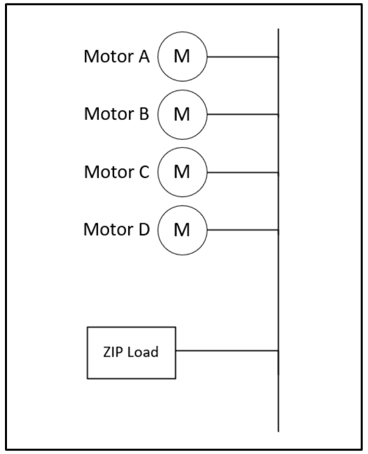
Voltage near the substation: 12.36 kV

* weak grid means that the voltage at the connecting point will be very sensitive to any variation of the load.

Composite Load Model Development

Load Component:

- 3-ph, 1-ph induction motors and ZIP load model was used with different % combinations to represent the residential, commercial and industrial loads
  - Motor A: 3-ph motor, such as compressors, typical size 5-25 HP
  - Motor B: 3-ph motor, such as fans, typical size 5-75 HP
  - Motor C: 3-ph motor, such as pumps, typical size 5-50 HP
  - Motor D: 1-ph motor, such as residential A/C, typical size 0.5-5 HP
  - ZIP load: constant impedance/current/power load
- Typical utility survey data is used to determine the % of each load component [3]



Dynamic Load Model module in PSCAD

Motor Characteristics:

- Typical motor characteristics (such as inertia and reactance) was used in PSCAD model

Residential Load Component	%	Load Type
Air Conditioner 1-ph	58.42	Motor D
Refriferator	6.28	Motor D
Fan	4.29	Motor D
Vaccum cleaner	2.25	Motor D
Lighting	15.2	Constant current
Power electronics	9.97	Constant power
Microven Oven	3.59	Constant impedance

Commercial Load Component	%	Load Type
Refrigerator	0.34	Motor A
Air Compressor 3-ph	23.81	Motor A
Fan	15.17	Motor B
Elevator	31.12	Motor C
Lighting	20.51	Constant current
Power electronics	9.05	Constant power

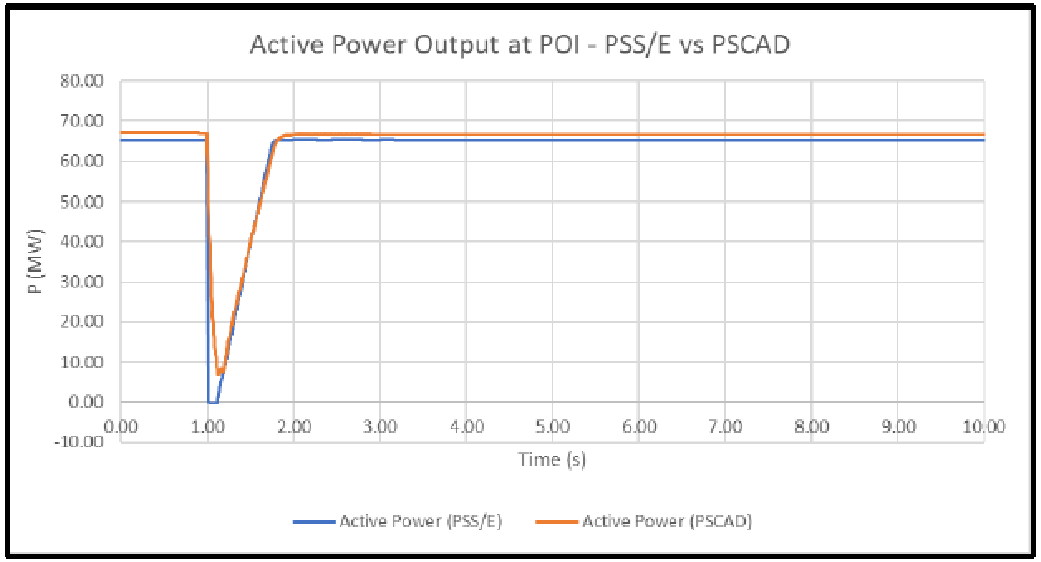
Industrial Load Component	%	Load Type
Air Conditioner 1-ph	0.4	Motor D
Air Compressor 3-ph	14.81	Motor A
Fan	1.66	Motor B
Elevator	75.55	Motor C
Lighting	7.36	Constant current
Power electronics	0.22	Constant power

[3] A. Bokhari *et al*., "Experimental Determination of the ZIP Coefficients for Modern Residential, Commercial, and Industrial Loads," in *IEEE Transactions on Power Delivery*, vol. 29, no. 3, pp. 1372-1381, June 2014

Composite Load Model Development

Develop PSS/E Composite Load Model:

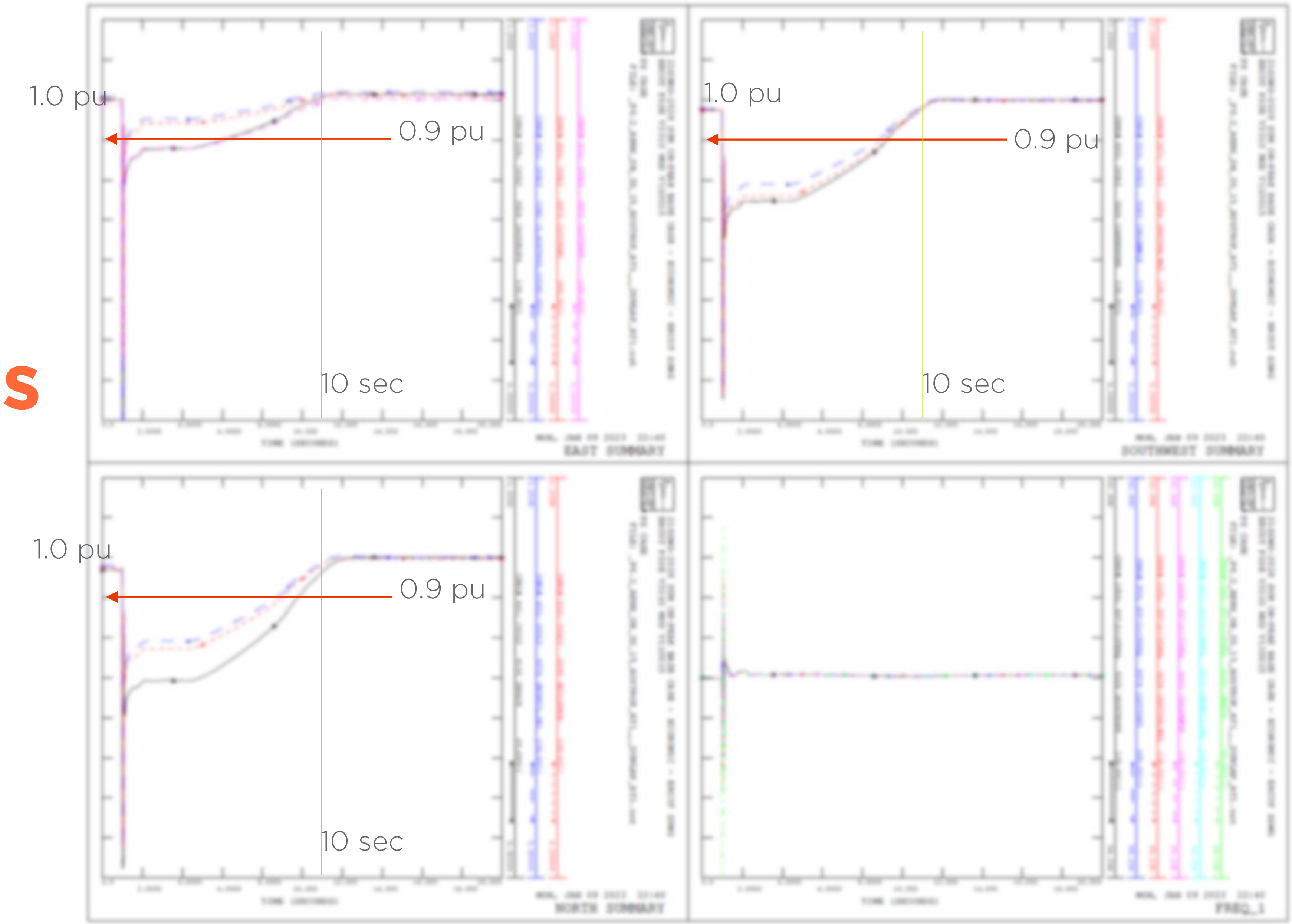
- Benchmark the PSS/E composite load model to the developed PSCAD model for each substation
- The composite load model were tested in the DWG case
- Equivalent external system (1 or 2 buses away) was created for PSCAD model testing
- Faults test at the POI and tuned the PSS/E model parameters to match the PSCAD responses



Benchmarking sample result

2024 Scenario 2

Sample Simulations for Study

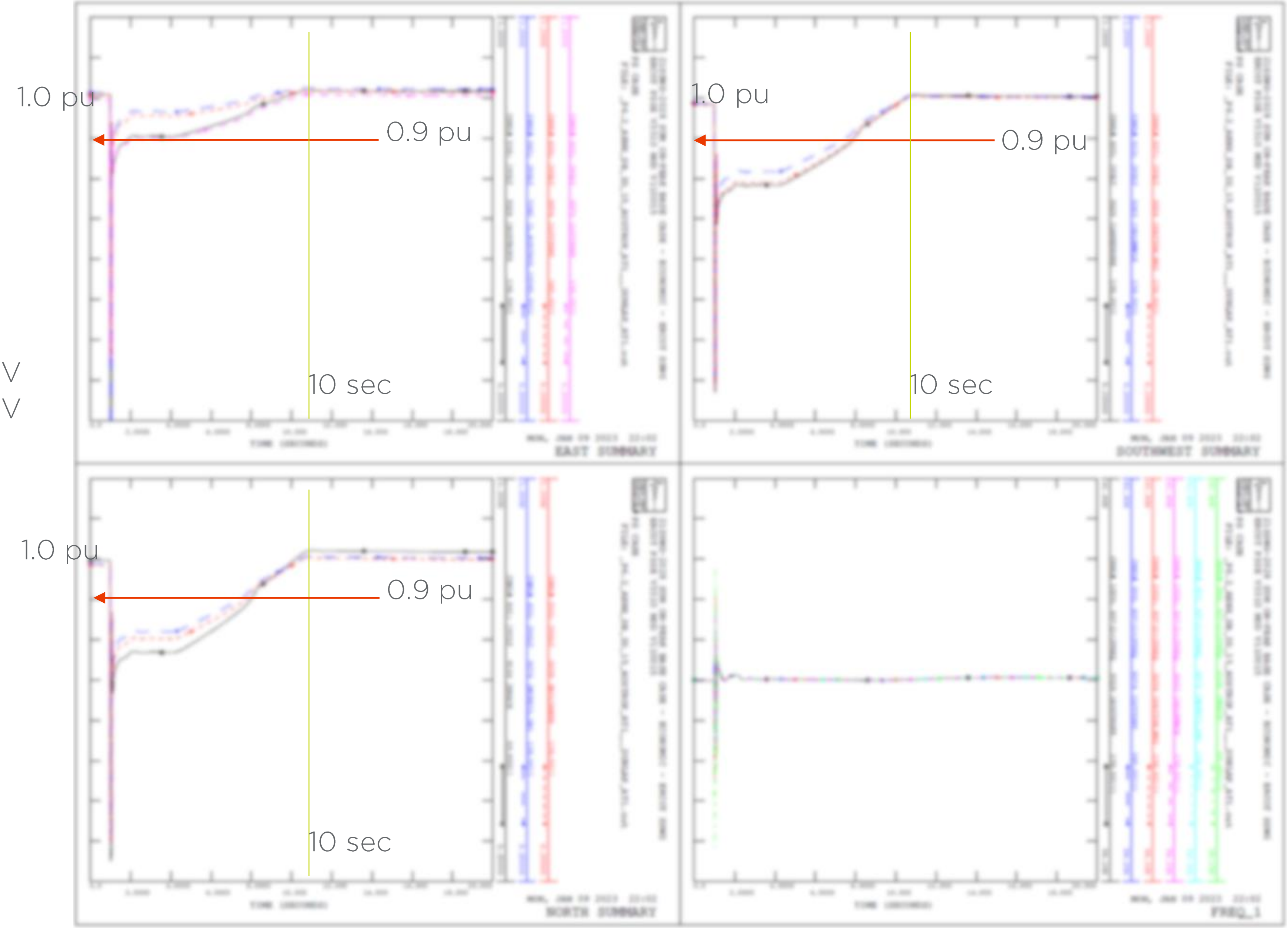


2028 Scenario 2

AE generation retirement
(Decker and Sand Hill)

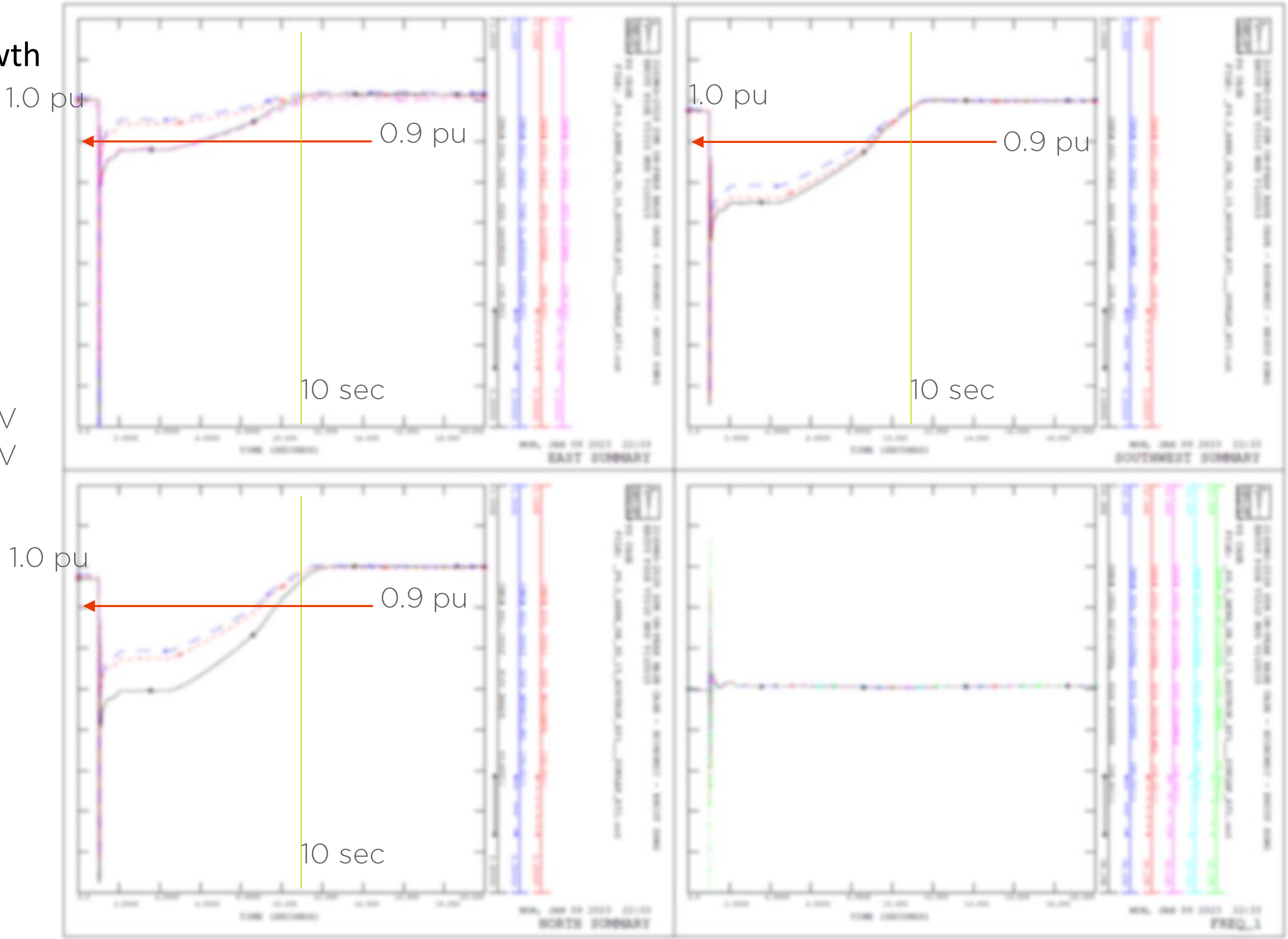
Sample - P6 outage of:

- Auto Transformer 345/138 kV
- Auto Transformer 345/138 kV



2028 Scenario 4

Scenario 2 + AE high load growth



Sample - P6 outage of:

- Auto Transformer 345/138 kV
- Auto Transformer 345/138 kV

Summary

- Conducted Steady State analysis on a range of cases to establish issues related to thermal overloads and voltages.
- Conducted detailed Transient Stability analysis on a variety of cases to identify outages that result in criteria violations.

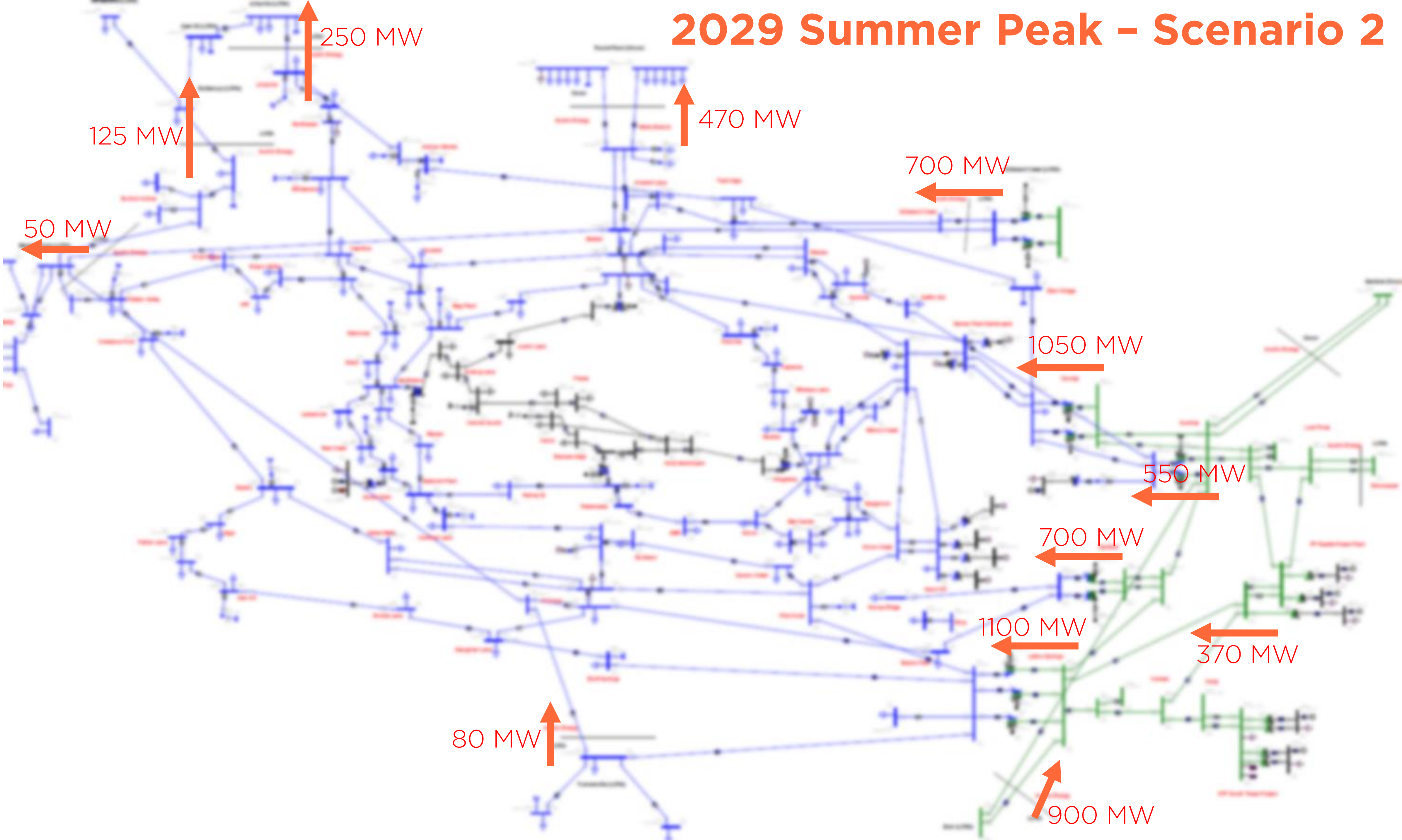
Proposed Mitigations Evaluated

1. A new 345 kV line from external system into Austin Energy 138 kV system via a new substation with a 345/138 kV auto transformer.
2. Conduct analysis to find which stations needed shunt capacitor banks and which stations need Dynamic reactive power (STATCOM) to provide voltage stability. Considering the need of reactive power in western part of Austin Energy system.
3. Assess placements and sizes of STATCOM and capacitor banks to achieve voltage stability, verifying with dynamic simulations
4. Replace the following 345/138 kV autotransformers:
    - Replace all existing 345/138 kV Auto Transformers to 1000 MVA and where applicable replace smaller 345/138 kV Auto Transformers with larger ones from existing stations.

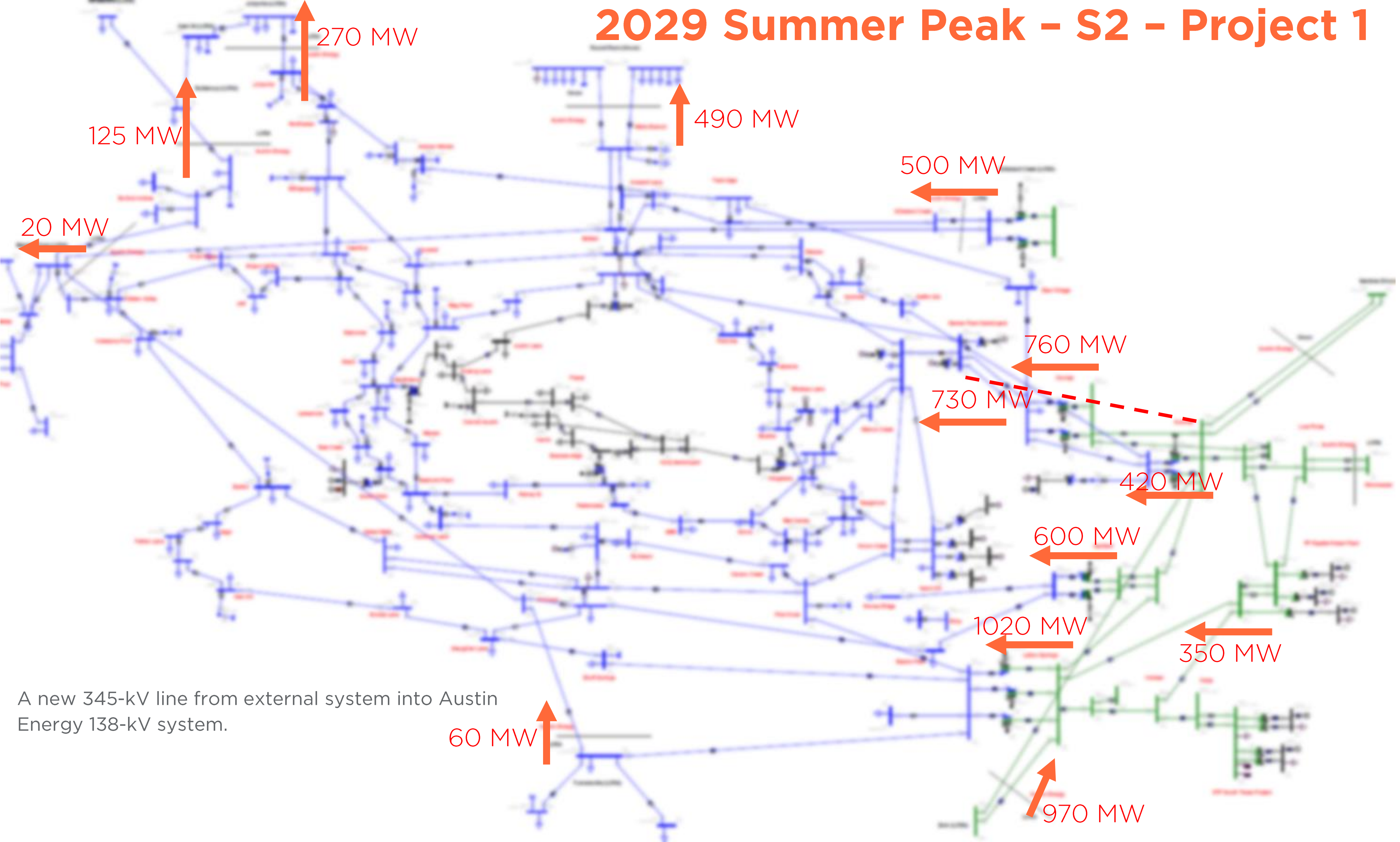
Proposed Mitigations Evaluated

5. Develop necessary 138 kV reinforcements to alleviate thermal overloads and consider changes for balancing the 138 kV system for better thermal performance and redundant operations.
6. Evaluate effectiveness of having tap changers on the 345 kV side of the 345/138 kV transformers. Currently all of the adjustable taps on AE autotransformers are on the low side.
7. Consider converting some 138 kV lines to 345 kV as a potential solution to improve reliability, balancing the load on the 345/138 kV autotransformers and improving operational redundancy.
8. Evaluate effectiveness of 200 MW Battery Energy Systems.

2029 Summer Peak – Scenario 2

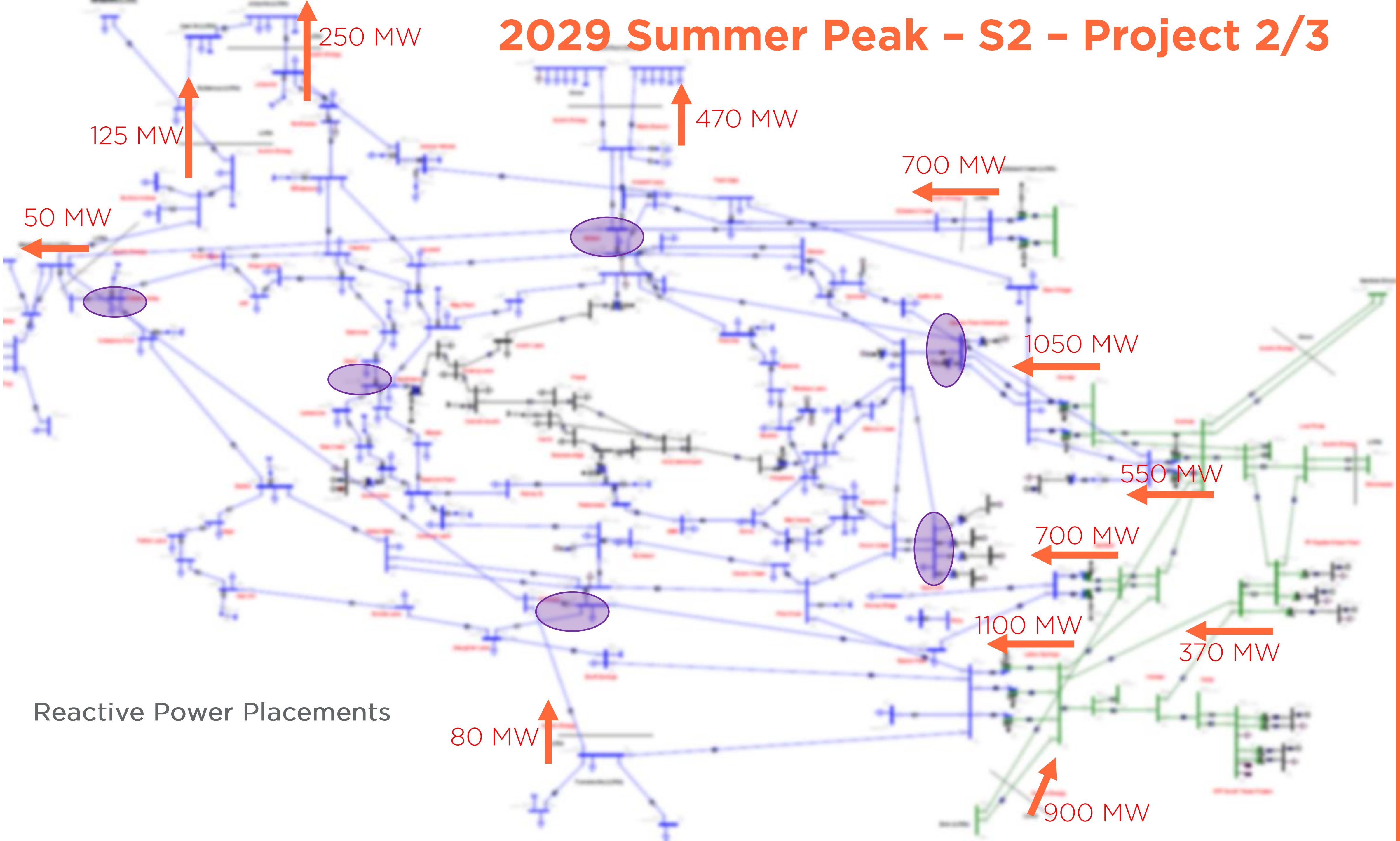


2029 Summer Peak – S2 – Project 1



A new 345-kV line from external system into Austin Energy 138-kV system.

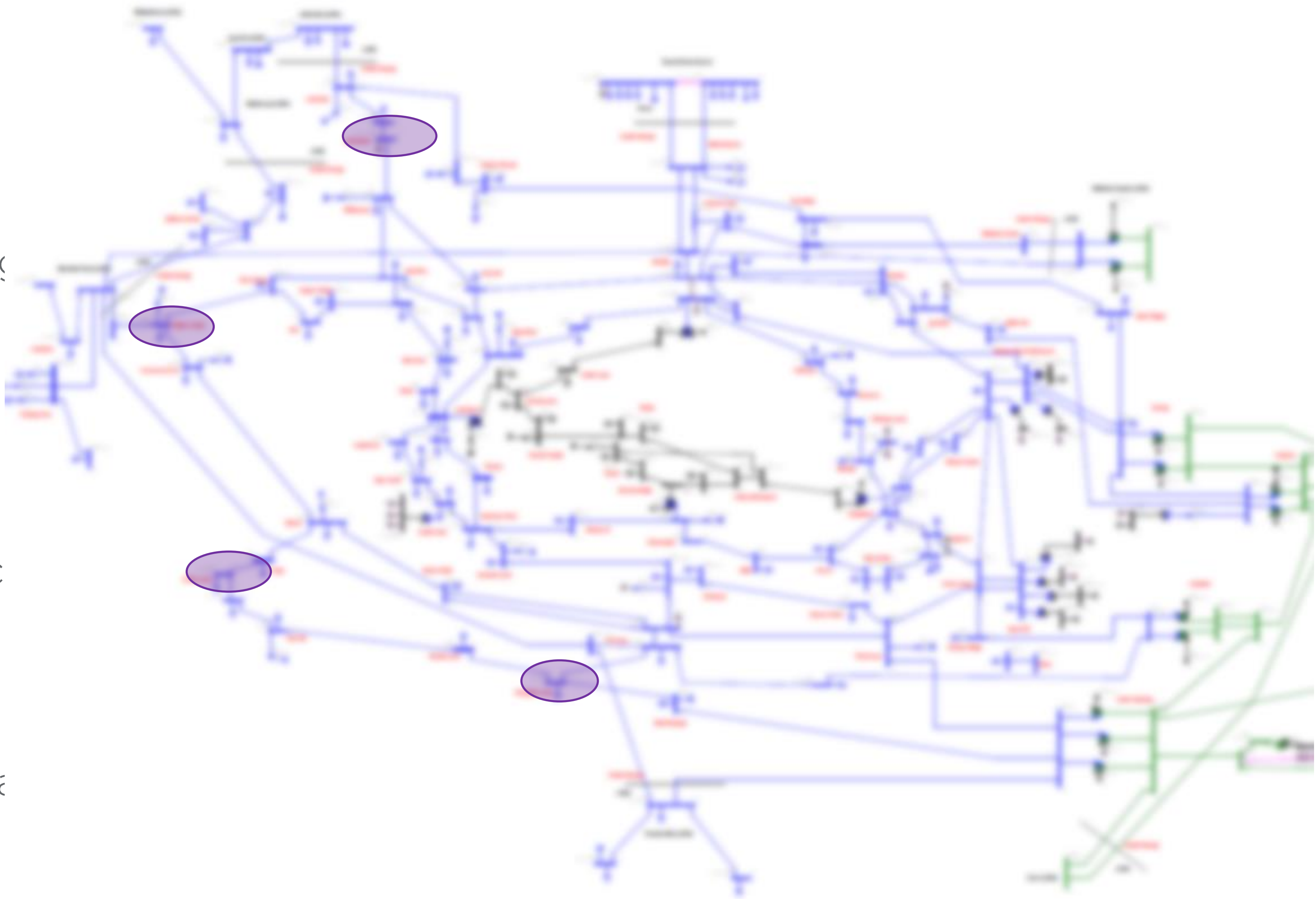
2029 Summer Peak – S2 – Project 2/3



Reactive Power Placements

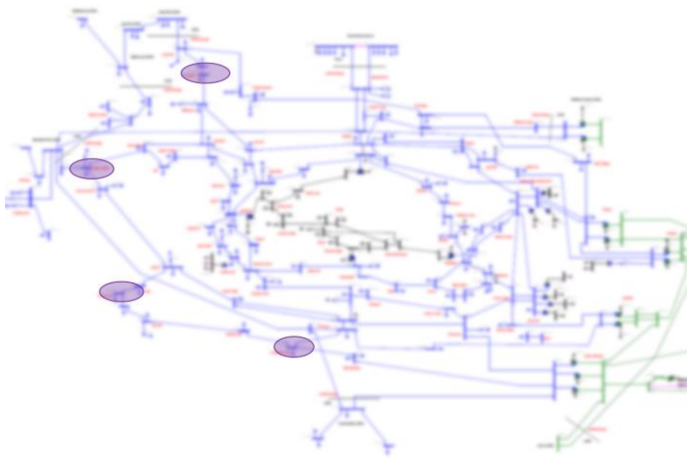
Reactive Power Analysis – Project 2/3

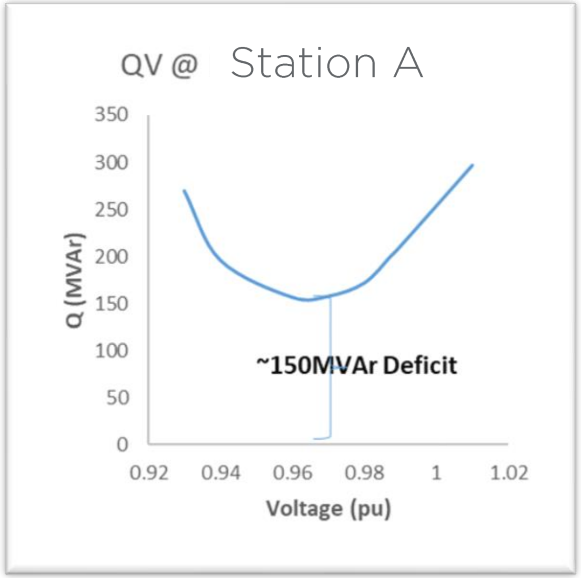
- Determine the load serving capability of Austin Energy System
- Stations with low voltag performance
- Assess:
  - Placements of reactive devices
  - Size of reactive devices
  - Static and dynamic reactive power support
- Test with proposed mitigation projects
- Validate with steady sta and dynamic analysis



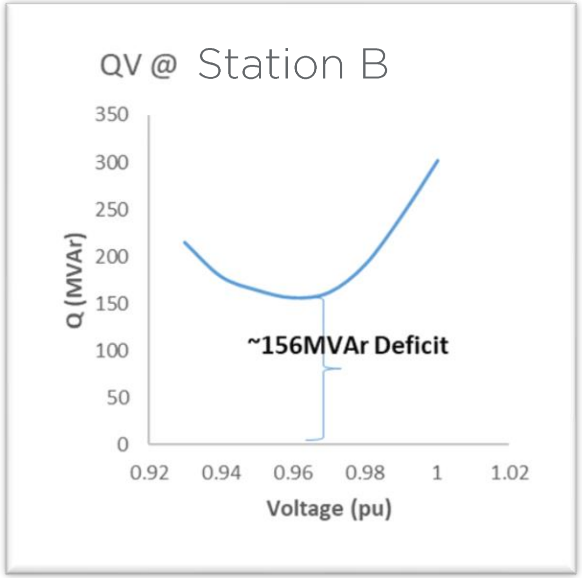
Reactive Power vs Voltage (QV) Analysis

- Identified Four Stations Requiring Reactive support on the base and study cases
    - Station A 138 kV
    - Station B 138 kV
    - Station C 138 kV
    - Station D 138 kV
- Most of the reactive support should be Dynamic

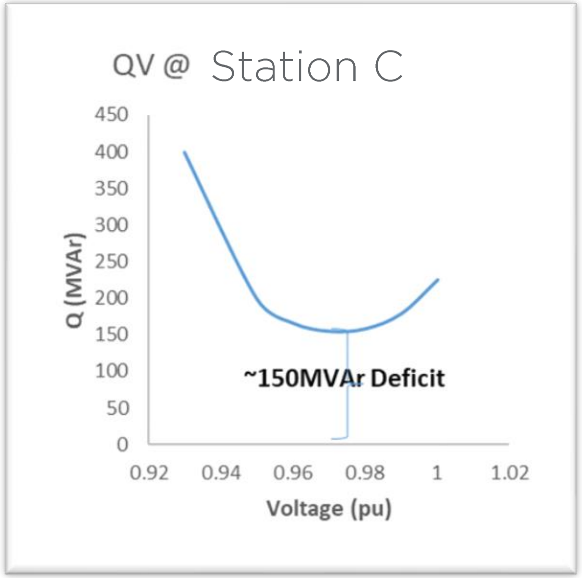




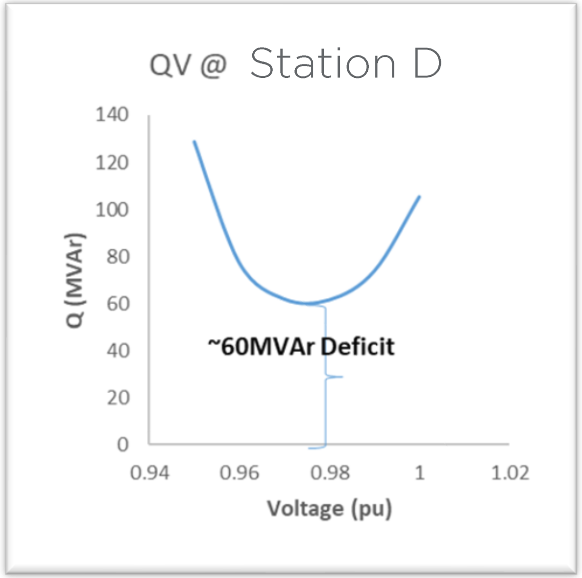
150 MVAr Deficit at Station A with:
200 MVAr @ Selected Four stations



156 MVAr Deficit at Station B with:
200 MVAr @ Selected Four stations

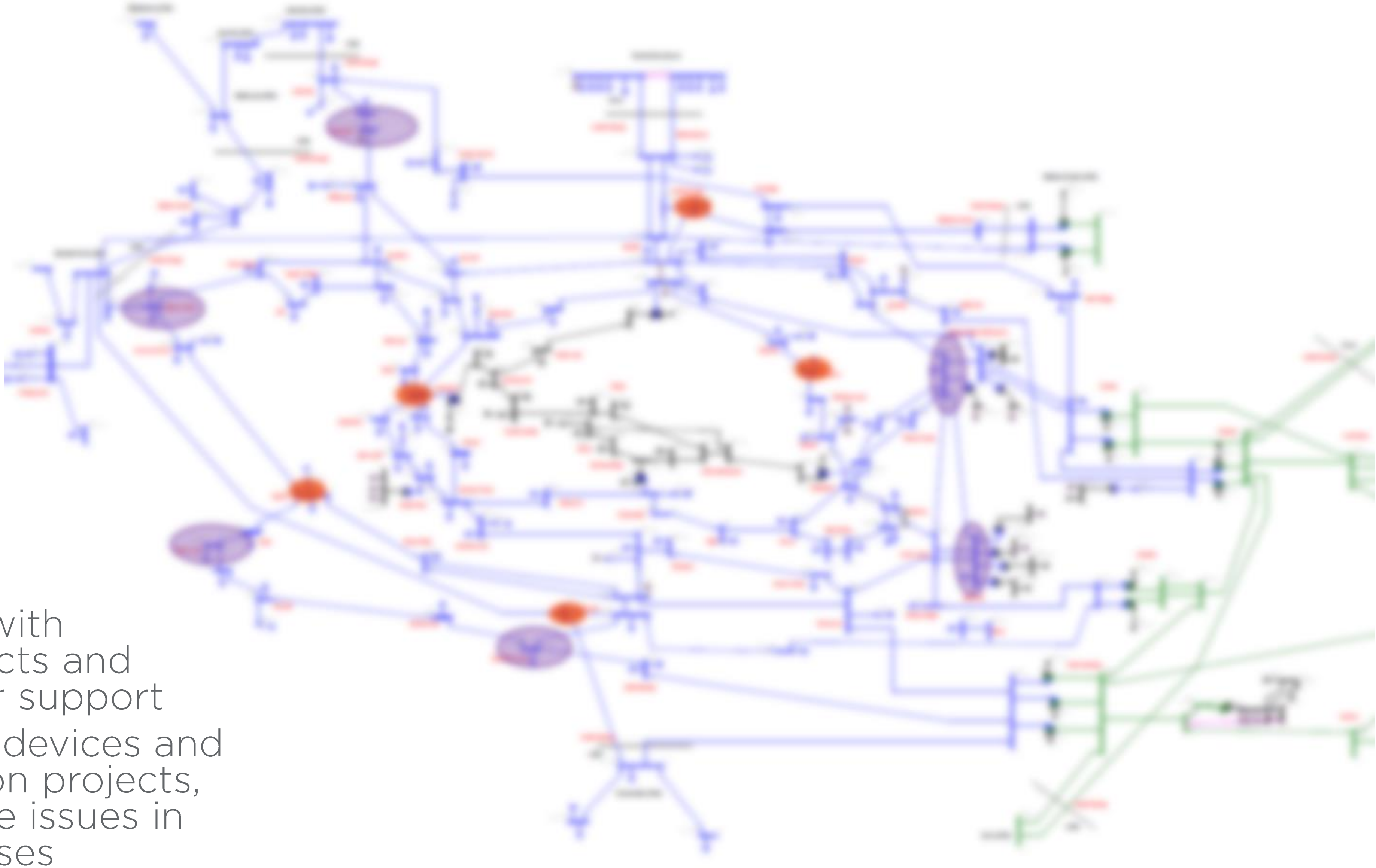


150 MVAr Deficit at Station C with:
200 MVAr @ Selected Four stations



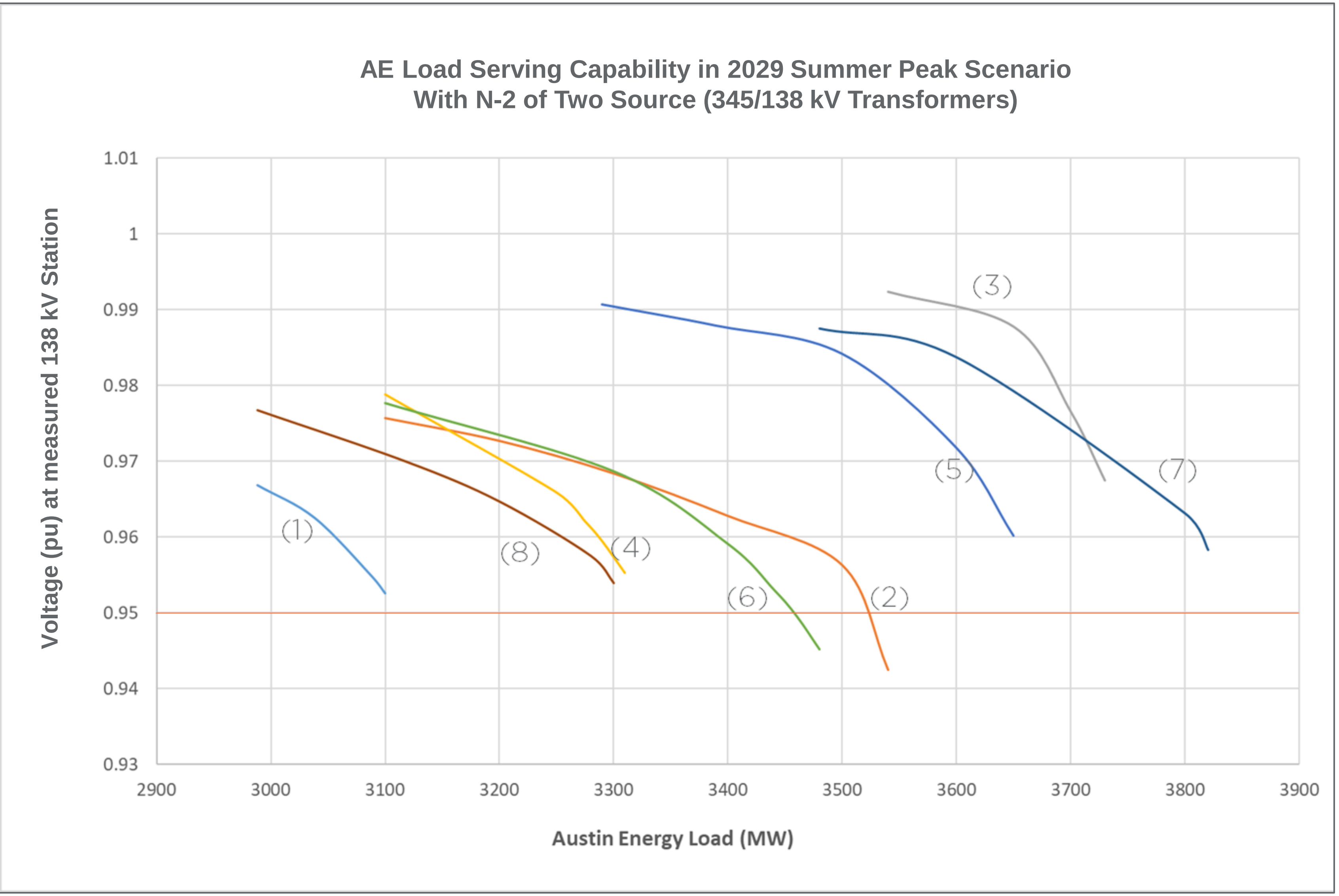
60 MVAr Deficit at Station D with:
200 MVAr @ Selected Four stations

Power Vs Voltage (PV) Analysis – Project 2/3



- Assessments with different projects and reactive power support
- With Reactive devices and other mitigation projects, the low voltage issues in the Central buses

Power vs Voltage (PV) Analysis 2029 Summer Peak Scenario



(1) 200 MVAr @ Selected Stations 138-kV

(2) 400 MVAr @ Selected Stations 138-kV

(3) 200 MVAr @ Selected Stations 138-kV
400 MVAr@ Sand Hill and Decker generating stations

(4) 200 MVAr @ Selected Stations 138-kV
New 345 kV connection into Austin Energy system

(5) 200 MVAr @ Selected Stations 138-kV
New 345 kV connection into Austin Energy system
200 MVAr @ Sand Hill and Decker generating stations

(6) 200 MVAr @ Selected Stations 138-kV
Converting 138 kV line to 345 kV: North and South

(7) 200 MVAr @ Selected Stations 138-kV
Converting 138 kV line to 345 kV: North and South
200 MVAr @ Sand Hill and Decker generating stations

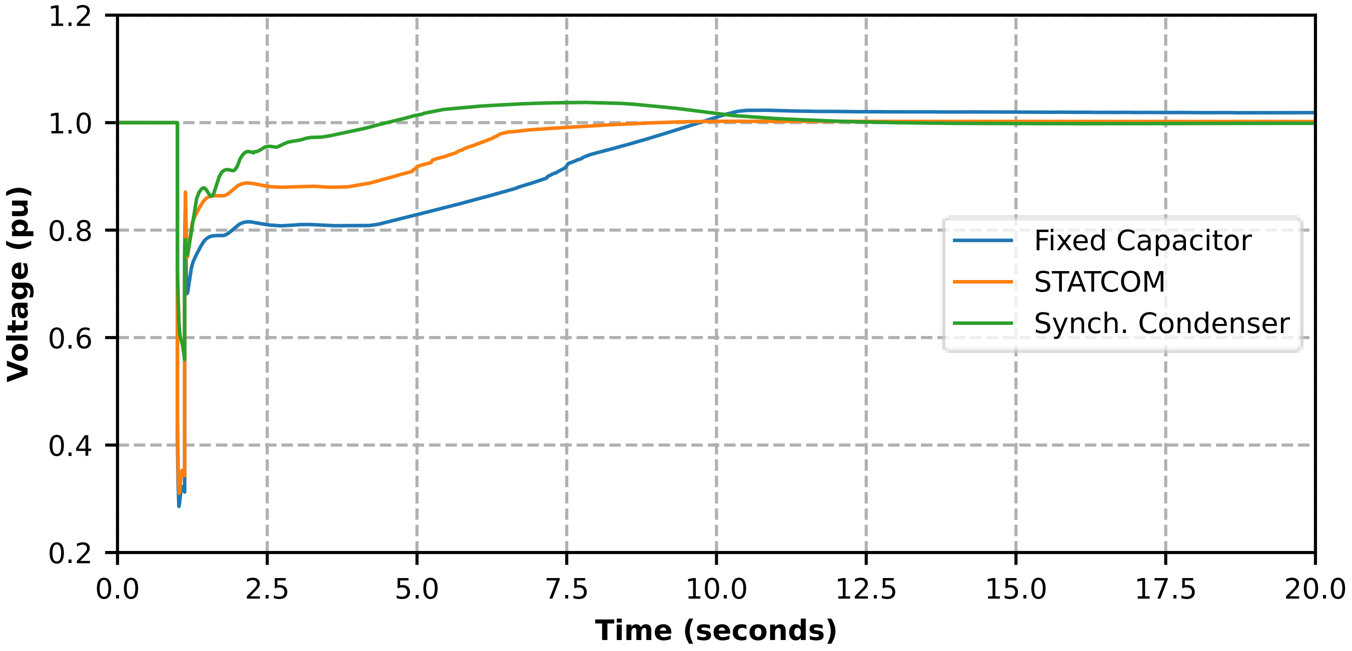
(8) 200 MVAr @ Selected Stations 138-kV
All Autotransformers Updated

Transient Stability Performance

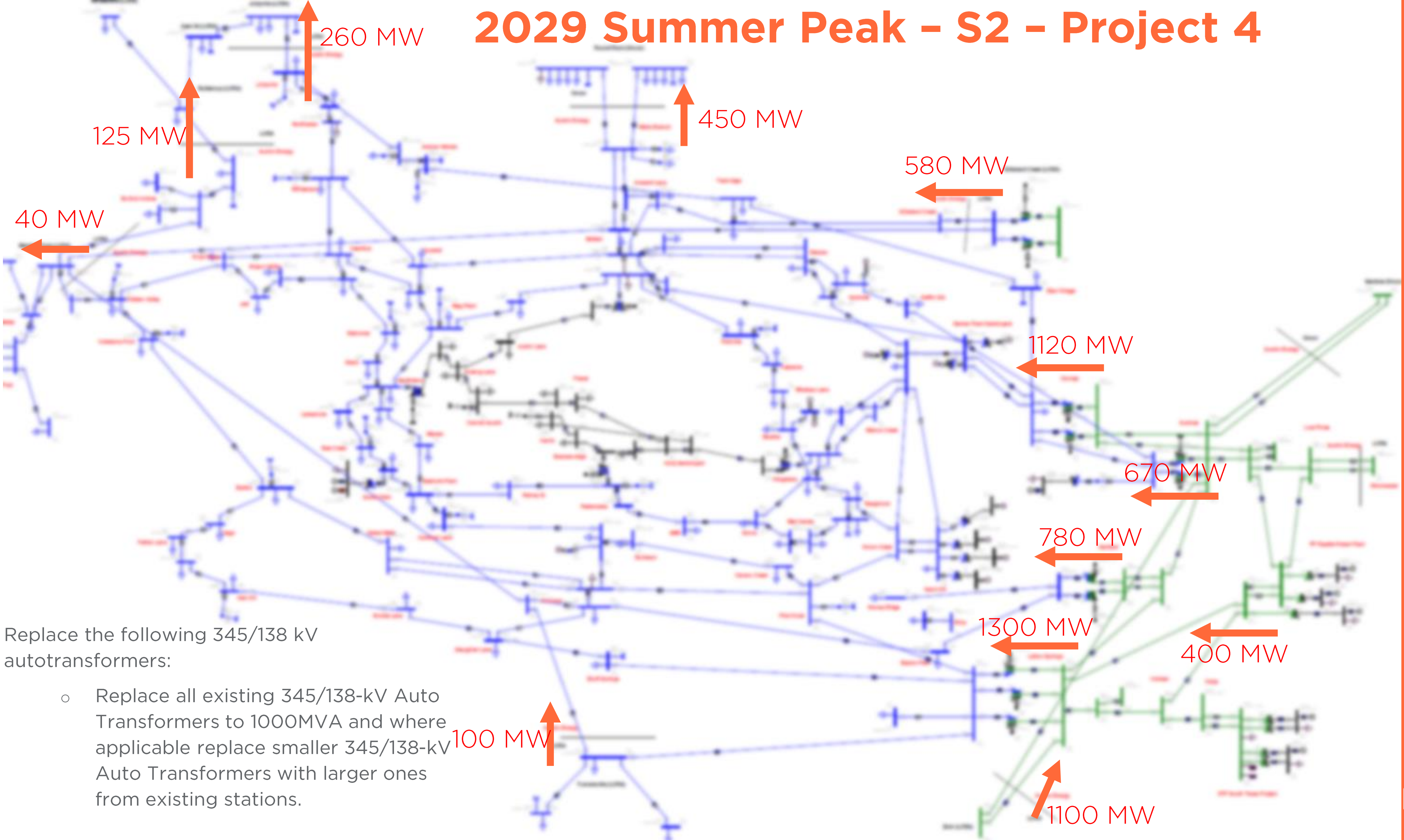
Reactive power needs tested with

- Fixed Capacitor Bank
- STATCOM
- Synchronous Condensers

P1.2 : 3 phase fault @ 345-kV station cleared after 5 cycles by tripping a 345-kV line.



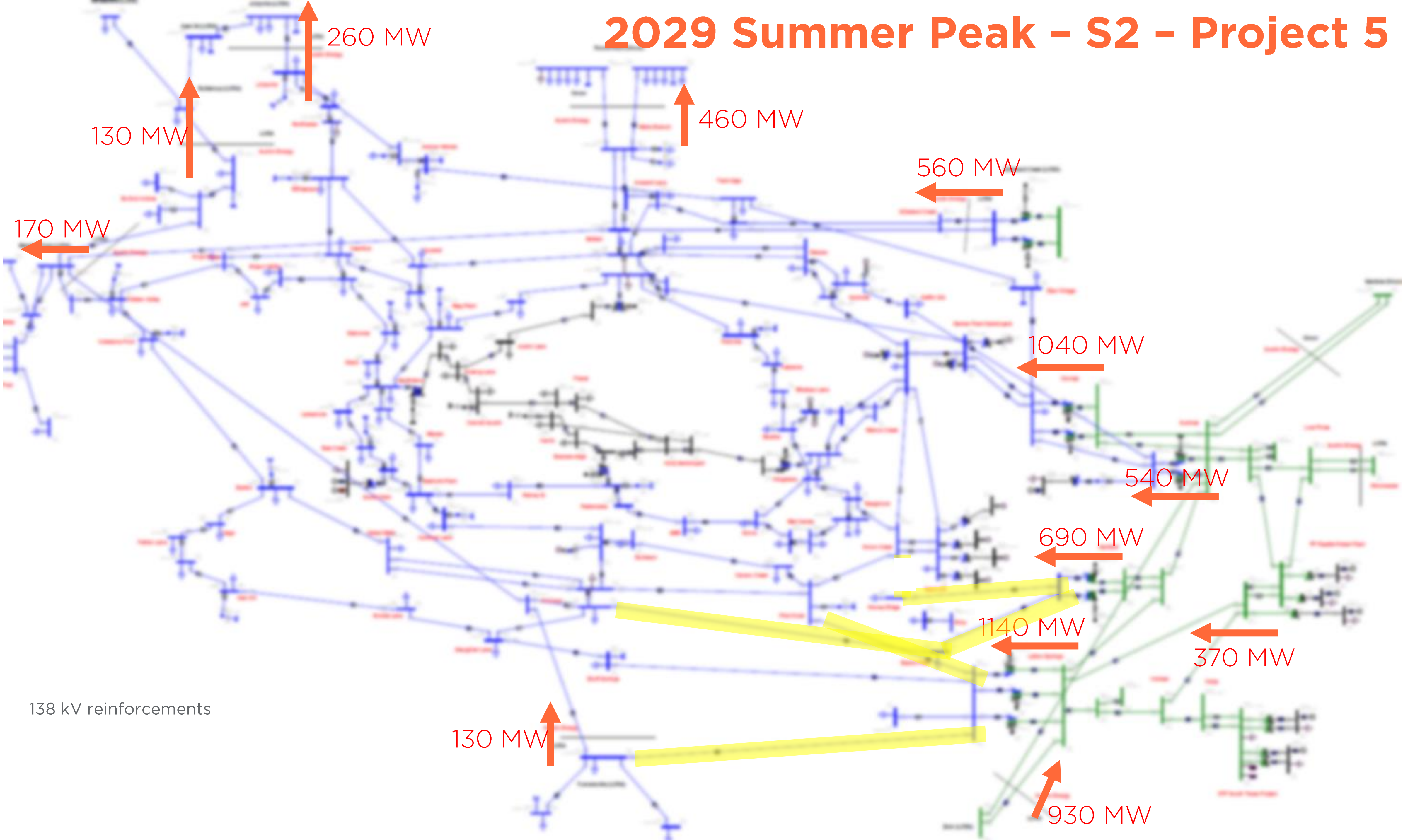
2029 Summer Peak – S2 – Project 4



Replace the following 345/138 kV autotransformers:

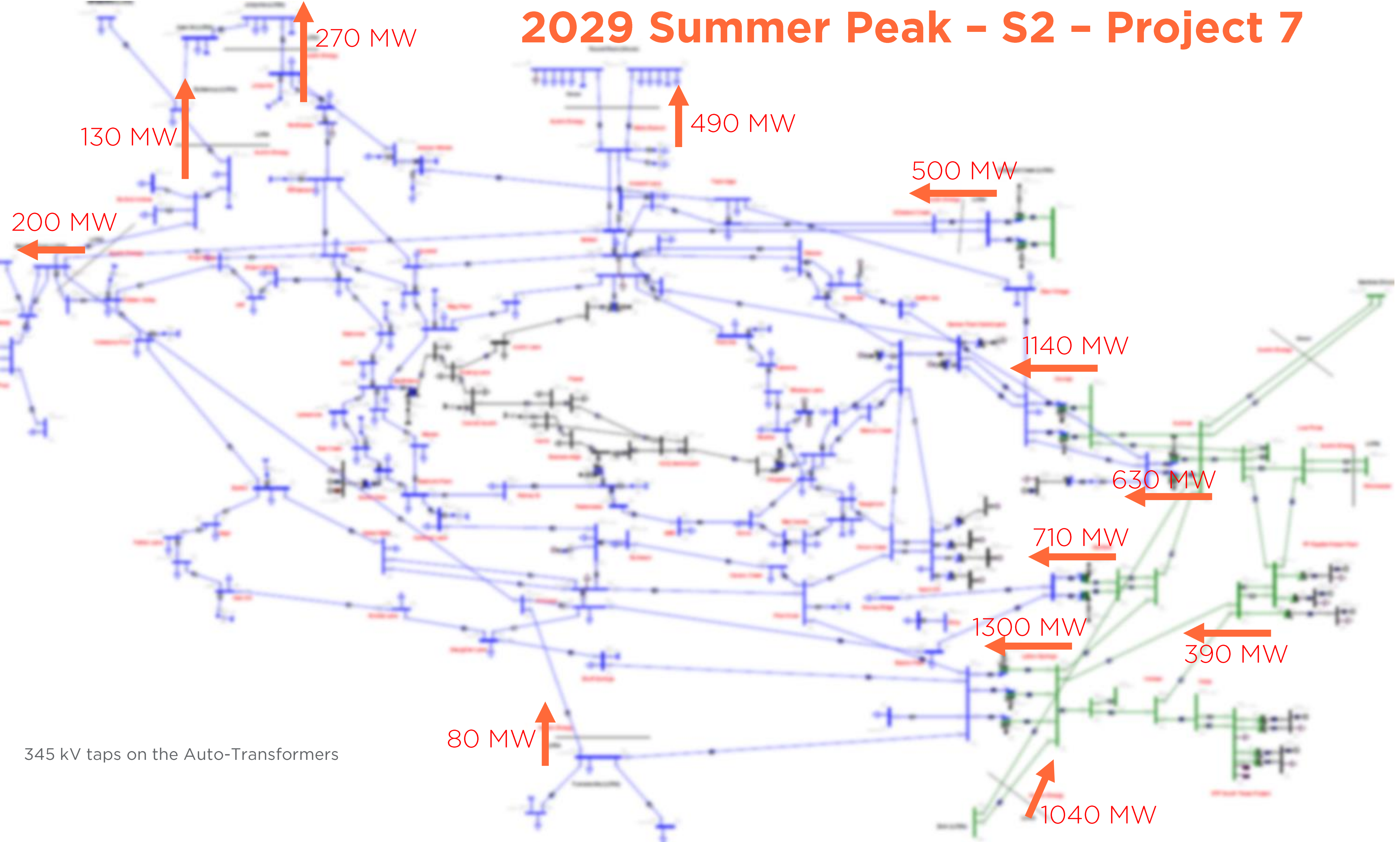
- Replace all existing 345/138-kV Auto Transformers to 1000MVA and where applicable replace smaller 345/138-kV Auto Transformers with larger ones from existing stations.

2029 Summer Peak – S2 – Project 5



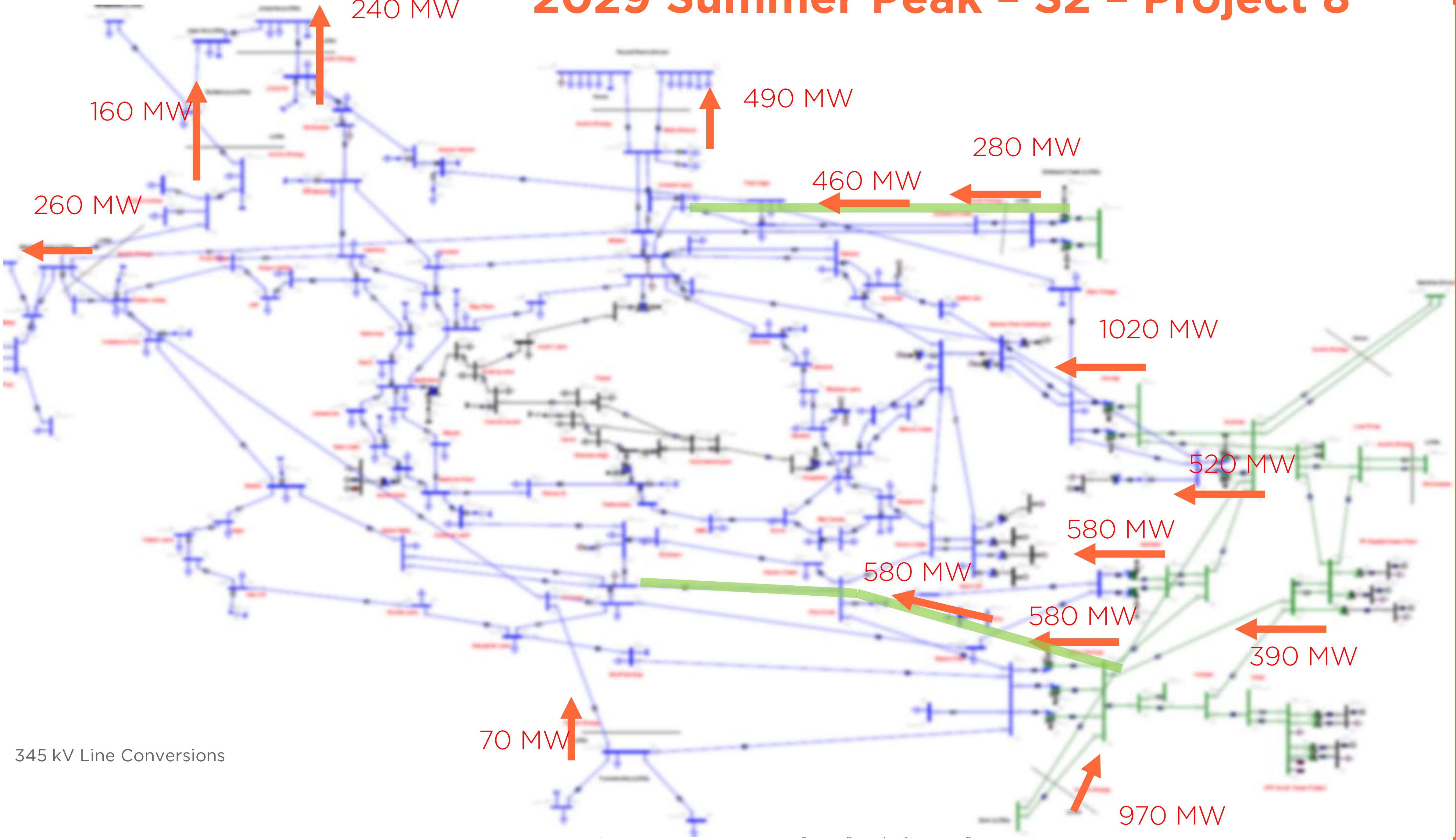
138 kV reinforcements

2029 Summer Peak – S2 – Project 7



345 kV taps on the Auto-Transformers

2029 Summer Peak – S2 – Project 8



345 kV Line Conversions

Thermal Summary of P1 Events
2029 Summer Peak – Scenarios 2/4

Contingency	Overloaded Element(s)	Project 1: New 345-kV source		Project 4: 1000 MVA Replacements		Project 5: Line Reinforcements 138 kV		Project 8: Line Conversions (138 to 345 kV) North and South	
		Scenario 2	Scenario 4	Scenario 2	Scenario 4	Scenario 2	Scenario 4	Scenario 2	Scenario 4
[redacted]	[redacted]	No Violation	No Violation	No Violation	Thermal Violation	Thermal Violation	Thermal Violation	Thermal Violation	Thermal Violation
[redacted]	[redacted]	No Violation	No Violation	No Violation	Thermal Violation	No Violation	Thermal Violation	No Violation	Thermal Violation
[redacted]	[redacted]	No Violation	No Violation	No Violation	No Violation	No Violation	Thermal Violation	No Violation	No Violation
[redacted]	[redacted]	No Violation	No Violation	Thermal Violation	Thermal Violation	No Violation	No Violation	Thermal Violation	Thermal Violation
[redacted]	[redacted]	No Violation	No Violation	No Violation	Thermal Violation	No Violation	No Violation	No Violation	No Violation
[redacted]	[redacted]	No Violation	No Violation	No Violation	Thermal Violation	No Violation	No Violation	No Violation	No Violation
[redacted]	[redacted]	No Violation	No Violation	Thermal Violation	Thermal Violation	No Violation	No Violation	No Violation	No Violation
[redacted]	[redacted]	No Violation	No Violation	Thermal Violation	Thermal Violation	Thermal Violation	Thermal Violation	Thermal Violation	Thermal Violation
[redacted]	[redacted]	No Violation	No Violation	Thermal Violation	Thermal Violation	Thermal Violation	Thermal Violation	Thermal Violation	Thermal Violation
[redacted]	[redacted]	No Violation	No Violation	No Violation	Thermal Violation	No Violation	No Violation	No Violation	Thermal Violation
[redacted]	[redacted]	No Violation	No Violation	No Violation	Thermal Violation	No Violation	No Violation	No Violation	Thermal Violation
[redacted]	[redacted]	No Violation	No Violation	Thermal Violation	Thermal Violation	No Violation	No Violation	No Violation	No Violation
[redacted]	[redacted]	No Violation	No Violation	No Violation	Thermal Violation	No Violation	No Violation	No Violation	No Violation

Thermal Summary of P2-P7 Events
2029 Summer Peak – Scenarios 2/4

Contingency	Cate-gory	Project 1: New 345-kV source		Project 4: 1000 MVA Replacements		Project 5: Line Reinforcements 138 kV		Project 8: Line Conversions North and South	
		Scenario 2	Scenario 4	Scenario 2	Scenario 4	Scenario 2	Scenario 4	Scenario 2	Scenario 4
[redacted]	[redacted]	No Violation	Thermal Violation	Thermal Violation	Thermal Violation	Thermal Violation	No Violation	Thermal Violation	No Violation
[redacted]	[redacted]	Thermal Violation	Thermal Violation	No Violation	No Violation	No Violation	No Violation	No Violation	Thermal Violation
[redacted]	[redacted]	Thermal Violation	No Violation	Thermal Violation	Thermal Violation	No Violation	No Violation	No Violation	No Violation
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Summary and Recommendation

Case	Project 1: New 345-kV Source	Project 2/3: Reactive Power Support Sizing and Placement	Project 4: Replacement of Transformers	Project 5: 138 kV Reinforcements	Project 7: Tap Changers	Project 8: 138 to 345 kV Conversion	Project 9: BESS Options
2029 Summer Peak Scenario 2	Improves the balancing of the system and reduces flows in the south portion of the system and provides a new 345 kV source at the north portion of the system	Effective and much needed after generation retirements especially in the 2029 summer scenarios.	Effective, still needs a few additional line rebuilds to move the additional power into the Austin Energy system. A phased approach coupled with rebuilds based on growth areas may be a viable alternative.	Effective, but does not add additional capacity to the overall Austin Energy System.	Not Effective	Generally, helps with outages, but has a few thermal overloads under contingencies. It is tough to permit and re-build 138 kV lines and requires substantial easements in dense portions of the city.	Not a viable option when Battery Energy Storage is modeled under charging scenario.

Summary and Recommendation

- Based on the analysis presented in the slides above, after generation retirements in 2029 summer case :
  - The system needs additional capacity to serve the load; Building a new 345 kV source into an existing 138 kV station or a similar type of project will help improve load serving capabilities.
  - The system will need approximately 800 MVAr of dynamic reactive support either at Sand Hill and Decker generating stations or at selected 138 kV stations. This will provide the necessary voltage support local to the loads and to meet Reliability criteria.
  - Where feasible, some 138 kV lines need to be reconductored to achieve better ratings to improve reliability.
- For the aggressive load growth scenarios, more reinforcements such as additional reactive support, additional 138 kV line rebuilds, auto transformer upgrades and new 345-kV lines into the system are needed.

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