Provisional Interconnection Study Report for PI-2024-17

1/06/2025

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1.0 Executive Summary

The PI-2024-17 project is a Provisional Interconnection Service (PIS)[1] request for 107.53 MW Solar Photovoltaic (PV) Generating Facility with a Point of Interconnection (POI) at the Mirasol 230 kV switching station. The maximum output will be controlled via power plant controller not to exceed 100 MW. PI-2024-17 is the Provisional Interconnection Service request as associated with Generation Interconnection Request 5RSC-2024-04 in the 5RSC cluster.

The total estimated cost of the PSCo transmission system improvements required for PI-2024-17 to qualify for Provisional Interconnection Service is estimated to be $7.039 million (Table 13 and Table 14).

The initial maximum permissible output of PI-2024-17 Generating Facility is 0 MW at the Point of Interconnection. In addition, due to the nature of the network violations determined in the Short Circuit analysis (see Sec. 5.4), the inverters may not be connected to the grid. The maximum permissible output of the Generating Facility in the PLGIA[2] will be reviewed quarterly and updated, if there are changes to the system conditions assumed in this analysis.

Security: PI-2024-17 is a request for Energy Resource Interconnection Service (ERIS). For ERIS requests, security shall estimate the risk associated with the Network Upgrades and the Interconnection Facilities and is assumed to be a minimum of $5 million.

The Interconnection Customer assumes all risk and liabilities with respect to changes between the PLGIA and the LGIA[3], including changes in output limits and Interconnection Facilities, Network Upgrades, Distribution Upgrades, and/or System Protection Facilities cost responsibility.

The Provisional Interconnection Service in and of itself does not convey transmission service.

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[1] **Provisional Interconnection Service (PIS)** shall mean an Interconnection Service provided by Transmission Provider associated with interconnecting the Interconnection Customer's Generating Facility to Transmission Provider's Transmission System and enabling that Transmission System to receive electric energy and capacity from the Generating Facility at the Point of Interconnection, pursuant to the terms of the Provisional Large Generator Interconnection Agreement and, if applicable, the Tariff.

[2] **Provisional Large Generator Interconnection Agreement (PLGIA)** shall mean the interconnection agreement for Provisional Interconnection Service established between Transmission Provider and/or the Transmission Owner and the Interconnection Customer. The pro forma agreement is provided in Appendix 8 and takes the form of the Large Generator Interconnection Agreement, modified for provisional purposes.

[3] **Large Generator Interconnection Agreement (LGIA)** shall mean the form of interconnection agreement applicable to an Interconnection Request pertaining to a Large Generating Facility that is included in the Transmission Provider's Tariff.

2.0 Introduction

PI-2024-17 is the PI Service request for a 107.53 MW Solar Photovoltaic (PV) Generating Facility located in Pueblo County, Colorado. The Study will evaluate the impacts on the PSCo transmission system and Affected Systems by modeling the Generating Facility at the nameplate amount minus any losses for the interconnection facilities.

- The POI of this project is at the Mirasol 230 kV switching station.
- The COD requested to be studied for PI-2024-17 is June 1, 2028.

The geographical location of the transmission system near the POI is shown in Figure 1. Note an approximation was used to overlay the new Colorado's Power Pathway onto the current one-line diagram.

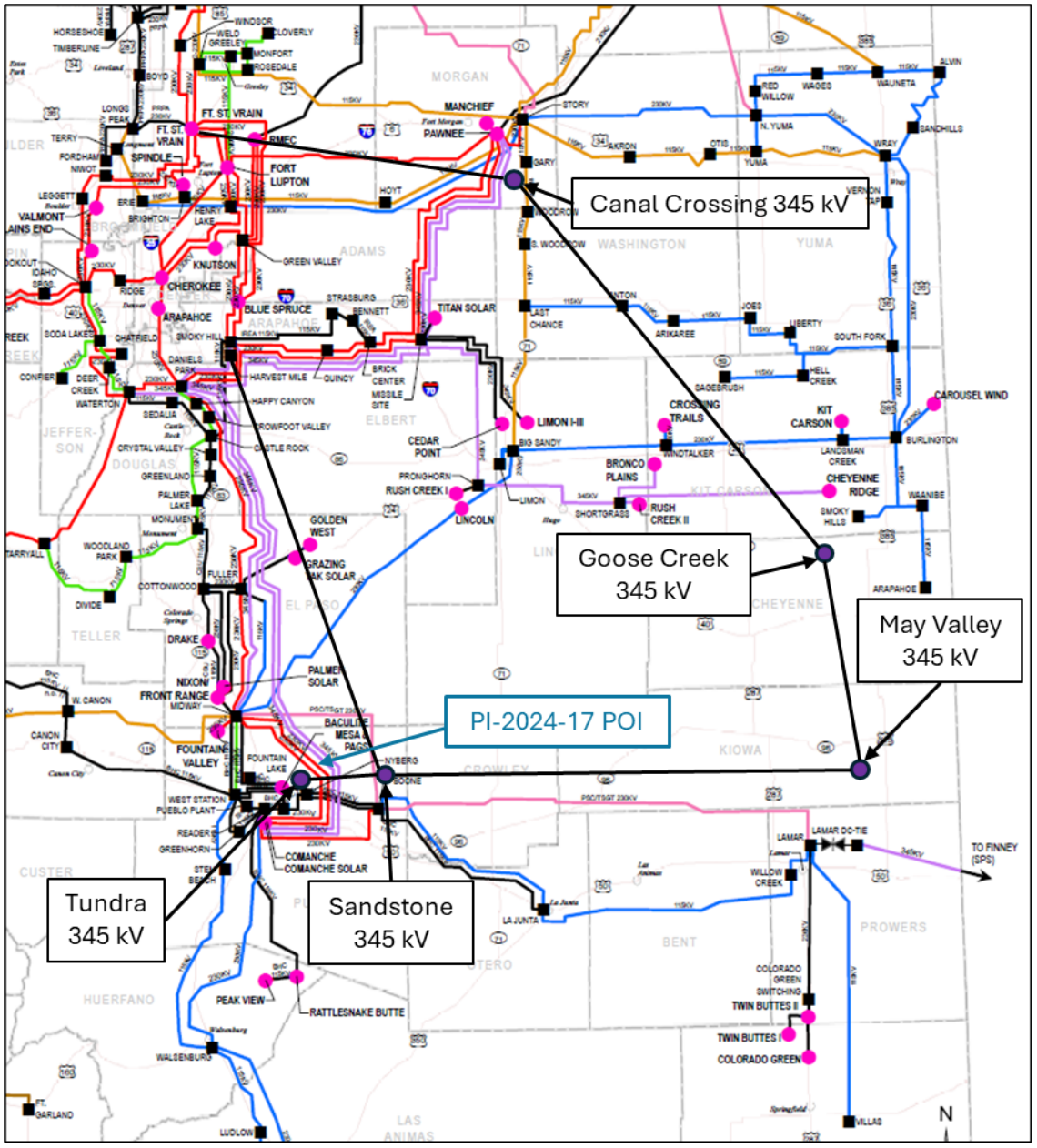

Figure 1: Approximate Point of Interconnection of PI-2024-17

3.0 Study Scope

The purpose of this study is to determine the impacts to the PSCo transmission system and the Affected Systems from interconnecting PI-2024-17 for Provisional Interconnection Service. Consistent with the assumption in the study agreement, PI-2024-17 selected Energy Resource Interconnection Service (ERIS)[4].

The scope of this report includes voltage and reactive capability evaluation, steady state (thermal and voltage) analysis, transient stability analysis, short-circuit analysis, and cost estimates for Interconnection Facilities and Station Network Upgrades. The study also identifies the estimated Security[5] and Contingent Facilities associated with the Provisional Interconnection Service.

3.1 Steady-State Criteria

The following Criteria are used for the reliability analysis of the PSCo system and Affected Systems:

P0—System Intact conditions:

Thermal Loading: <=100% of the normal facility rating

Voltage range: 0.95 to 1.05 per unit

P1 & P2-1—Single Contingencies:

Thermal Loading: <=100% Normal facility rating

Voltage range: 0.90 to 1.10 per unit

Voltage deviation: <=8% of pre-contingency voltage

P2 (except P2-1), P4, P5 & P7—Multiple Contingencies:

Thermal Loading: <=100% Emergency facility rating

Voltage range: 0.90 to 1.10 per unit

Voltage deviation: <=8% of pre-contingency voltage

[4] **Energy Resource Interconnection Service** shall mean an Interconnection Service that allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission system to be eligible to deliver the Generating Facility's electric output using the existing firm and non-firm capabilities of the Transmission Provider's Transmission System on an as available basis.

[5] **Security** estimates the risk associated with the Network Upgrades and Interconnection Facilities that could be identified in the corresponding LGIA.

3.2 Transient Stability Criteria

The transient voltage stability criteria are as follows:

a. Following fault clearing, the voltage shall recover to 80% of the pre-contingency voltage within 20 seconds of the initiating event for all P1 through P7 events for each applicable Bulk Electric System (BES) bus serving load.
b. Following fault clearing and voltage recovery above 80%, voltage at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds, for all P1 through P7 events.
c. For Contingencies without a fault (P2.1 category event), voltage dips at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds.

The transient angular stability criteria are as follows:

a. P1—No generating unit shall pull out of synchronism. A generator being disconnected from the system by fault clearing action or by a special Protection System is not considered an angular instability.
b. P2–P7—One or more generators may pull out of synchronism, provided the resulting apparent impedance swings shall not result in the tripping of any other generation facilities.
c. P1–P7—The relative rotor angle (power) oscillations are characterized by positive damping (i.e., amplitude reduction of successive peaks) > 5% within 30 seconds.

3.3 Breaker Duty Analysis Criteria

Fault Current after PI addition should not exceed 100% of the Breaker Duty rating. PSCo can only perform breaker duty analysis on the PSCo system. Before the PI goes in-service the Affected Systems may choose to perform a breaker duty analysis to identify breaker duty violations on their system.

3.4 Study Methodology

For PSCo and non-PSCo owned facilities, thermal violations attributed to the request include all new facility overloads with a thermal loading >100% and increased by 1% or more from the benchmark case overload post the Generator Interconnection Request (GIR) addition.

The voltage violations assigned to the request include new voltage violations which resulted in a further variation of 0.01 per unit.

Since the request is for Provisional Interconnection Service, if thermal or voltage violations are seen, the maximum permissible Provisional Interconnection Service before violations is identified. For voltage violations caused by reactive power deficiency at the POI, voltage upgrades are identified.

The Provisional Interconnection Service request should meet the transient stability criteria stated in Section 3.2. If the addition of the GIR causes any violations, the maximum permissible Provisional Interconnection Service before violations is identified.

3.5 Contingency Analysis

The transmission system on which steady state contingency analysis is run includes the WECC designated Area 70 and selected zones in Area 73, as appropriate. Contingencies performed were provided by PSCo.

The transient stability analysis is performed for the following worst-case contingencies shown in Table 1.

Table 1 – Transient Stability Contingencies

Ref. No.	Fault Location	Outage(s)	Clearing Time (Cycles)
1	-	Flat Run	-
2	PI-2024-17 Gen	PI-2024-17 Generation and Load	4
3	Mirasol 230 kV (LoTC 79)	Comanche – Mirasol 230 kV ckt 1 GI-2020-10 Generation	4
4	Mirasol 230 kV (LoTC 102)	Midway PS – Mirasol 230 kV ckt 1	4
5	Mirasol 230 kV (LoTC 103)	Mirasol – Thunderwolf 230 kV ckt 1 Thunderwolf Generation	4
6	Midway PS 230 kV (LoTC 28)	Midway PS – Fuller 230 kV ckt 1	4
7	Midway PS 230 kV (LoTC 78)	Comanche – Midway PS 230 kV ckt 1	4
8	Midway PS 230 kV (LoTC 69)	Boone – Midway PS 230 kV ckt 1	4

Ref. No.	Fault Location	Outage(s)	Clearing Time (Cycles)
9	Mirasol 230 kV (BF 096a)	Midway PS – Mirasol 230 kV ckt 1 Comanche – Mirasol 230 kV ckt 1 Mirasol – Thunderwolf 230 kV ckt 1 GI-2020-10 Generation Thunderwolf Generation	17
10	Mirasol 230 kV (BF 094c)	Midway PS – Mirasol 230 kV ckt 1 Midway PS – Fountain Valley Gen. 230 kV ckt 1 Fountain Valley Generation and Load	17
11	Mirasol 230 kV (Lines 5411, 55255)	Midway PS – Mirasol 230 kV ckt 1 Comanche – Midway PS 230 kV ckt 1	4
12	Mirasol 230 kV (Lines 5413, 5408)	Comanche – Mirasol 230 kV ckt 1 Comanche – Huckleberry 230 kV ckt 1 Huckleberry – Walsenburg 230 kV ckt 1 GI-2020-10 Generation	4

3.6 Study Area

The Southern Colorado study area includes WECC designated zone 704. As described in Section 3.11 of the BPM, this pocket is comprised of South-central Colorado and Southeast Colorado transmission system. Below is the current generation in the Southern Colorado study area:

- Comanche: Golden West Wind at Fuller, Fountain Valley Gas at Midway, Comanche Coal, Community Solar at Comanche, Mirasol, Tundra.
- Lamar: Colorado Green Wind, Twin Buttes Wind, DC Tie.

4.0 Base Case Modeling Assumptions

The 2029HS2a WECC case released on May 8, 2023, has been modified to represent a 2028 heavy summer loading condition and it was selected as the Starting Case. The Base Case was created from the Starting Case by including the following modeling changes, shown in Table 2.

Table 2 – Planned Transmission Projects Included in the 2028HS Base Case

Project Description	ISD	Added (Included), Removed (Excluded)
Leetsdale – Monroe L5283 uprate to 796 MVA	2026	Added
Cherokee – Federal Heights – Broomfield line uprate to 398 MVA	2026	Added
Daniels Park – Prairie – Greenwood L5111 uprate to 916 MVA	2026	Added
Arapahoe – Greenwood L5709 uprate to 956 MVA	2027	Added
New Arapahoe 230/115 kV transformer #6	2027	Added
Monroe – Elati – Denver Terminal line uprate to 796 MVA	2027	Added
Leetsdale – Harrison L9955 uprate to 378 MVA	2027	Added
Spruce – High Point 230 kV line uprate to 741.4 MVA	TBD	Added

Additionally, the following segments of the Colorado Power Pathway (CPP) were included in the Base Case:

- Segment #1: Fort St. Vrain – Canal Crossing 345 kV Double Circuit
- Segment #2: Canal Crossing – Goose Creek 345 kV Double Circuit
- Segment #3: Goose Creek – May Valley 345 kV Double Circuit
- Segment #4: May Valley – Sandstone – Tundra 345 kV Double Circuit
- Segment #5: Sandstone – Harvest Mile 345 kV Double Circuit

The Base Case model includes the existing PSCo generation resources and all Affected Systems' existing resources. While the higher-queued NRIS requests were dispatched at 100%, the higher-queued ERIS requests were modeled offline.

4.1 Benchmark Case Modeling

The Benchmark Case was created from the Base Case (2028HS) described in Section 4.0 by changing the study pocket generation dispatch to reflect heavy generation in the Southern Colorado study pocket. This was accomplished by adopting the stressed generation dispatch

given in Table 3. Additionally, 4050 MW of Native Load Priority (NLP) was modeled, as shown in Table 4.

Table 3 – Generation Dispatch to Create the Southern Colorado Benchmark Case (MW is Gross Capacity)

Ref. No.	Generator Bus No.	Bus Name	Base kV	ID	Status	Pgen (MW)	Max Power (MW)
1	70120	COMAN_2	24.00	C2	1	365.00	365.00
2	70577	FTNVL1&2	13.80	G1	1	35.40	40.00
3	70577	FTNVL1&2	13.80	G2	1	35.40	40.00
4	70578	FTNVL3&4	13.80	G3	1	35.40	40.00
5	70578	FTNVL3&4	13.80	G4	1	35.40	40.00
6	70579	FTNVL5&6	13.80	G5	1	35.40	40.00
7	70579	FTNVL5&6	13.80	G6	1	35.40	40.00
8	70777	COMAN_3	27.00	C3	1	804.90	804.90
9	70934	COMAN_S1	0.42	S1	1	102.00	120.00
10	70017	SI_GEN 0	0.60	1	1	15.10	30.10
11	70878	BIGHORN_S	0.63	S1	1	210.38	247.50
12	70756	NEPTUNE_B1	0.48	B1	1	106.25	125.00
13	70758	NEPTUNE_S1	0.66	S1	1	212.93	250.50
14	70761	THNDWLF_B1	0.48	B1	1	85.00	100.00
15	70763	THNDWLF_S1	0.66	S1	1	170.00	200.00
16	70859	SUN_MTN_S1	0.66	S1	1	172.30	202.70
17	700142	GI_2020_10	0.63	S1	1	103.70	154.10
18	700146	GI_2020_10	0.63	S2	1	103.70	154.10
19	70256	CO_GRN_W	0.58	W2	1	64.80	81.00
20	70708	CO_GRN_E	0.58	W1	1	64.80	81.00
21	70704	TBI_GEN	0.58	W1	1	60.00	75.00
22	70663	GLDNWST_W1	0.69	W1	1	199.52	249.40
23	70010	TBII_GEN	0.69	W	1	62.40	78.00
24	700119	REPL_21_1	0.66	S1	1	75.00	121.20
25	700120	REPL_21_1	0.66	S2	1	75.00	121.20
26	700121	REPL_21_1	0.66	S3	1	75.00	121.20
27	70725	SPANPKS2_GEN	0.60	PV	1	20.20	40.20
28	70994	SP_GEN	0.62	PV	1	50.20	100.20
34	700172	GI_2014_6	0.63	S	1	100.20	100.90
Total (MW)						**3510.76**	**4163.20**

Table 4 – NLP Generation Included

Generator Bus Number	Name	ID	Status	Pgen (MW)
700043	24_14_B	B	1	192.30
700057	24_13_W2	W2	1	143.30
700060	24_13_W3	W3	1	143.30
700063	24_13_W4	W4	1	122.90
700067	24_13_W1	W1	1	143.30
700076	24_12_W1	W1	1	109.20
700077	24_12_W2	W2	1	122.90
700078	24_12_W3	W3	1	109.20
700079	24_9_W1	W1	1	116.00
700082	24_9_W2	W2	1	122.90
700085	24_9_W3	W3	1	102.40
700088	24_9_W4	W4	1	116.00
700095	24_18_W	W	1	235.80
700182	24_28_W	W	1	389.20
700196	24_19_W1	W1	1	419.80
700226	24_6_S	S	1	336.40
700232	24_22_S	S	1	384.90
700235	24_26_S1	S1	1	116.00
700237	24_26_B1	B1	1	76.60
700239	24_26_S2	S2	1	116.00
700241	24_26_B2	B2	1	76.60
700244	24_27_B1	B1	1	82.90
700245	24_27_B2	B2	1	79.30
700246	24_27_S1	S1	1	96.80
700247	24_27_S2	S2	1	96.80
Total (MW)				**4050.80**

4.2 Study Case Modeling

A Study Case was created from the Benchmark Case by turning on the PI-2024-17 generation. The additional 100 MW of net output from PI-2024-17 at the POI was balanced against PSCo generation outside of the southern Colorado study pocket.

4.3 Short-Circuit Modeling

This request is for the Interconnection of a 107.53 MW Solar PV Generating Facility (PI-2024-17) to the Mirasol 230 kV switching station. The net output shall not exceed 100 MW at the POI.

All connected generating facilities were assumed capable of producing maximum fault current. As such, all generation was modeled at full capacity, whether NRIS or ERIS is requested. Generation is modeled as a separate generating resource in CAPE and included at full capacity in the short circuit study, regardless of any limitations to the output that would be imposed otherwise.

5.0 Provisional Interconnection Service Analysis

5.1 Voltage and Reactive Power Capability Evaluation

Per Section 4.1.1.1 of the BPM, the following voltage regulation and reactive power capability requirements are applicable to non-synchronous generators:

- Xcel Energy's OATT requires all non-synchronous generator Interconnection Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the high side of the generator substation. Furthermore, Xcel Energy requires every Generating Facility to have dynamic voltage control capability to assist in maintaining the POI voltage schedule specified by the Transmission Operator.
- It is the responsibility of the Interconnection Customer to determine the type (switched shunt capacitors and/or switched shunt reactors, etc.), the size (Mvar), and the locations (on the Interconnection Customer's facility) of any additional static reactive power compensation needed within the generating plant in order to have adequate reactive capability to meet the +/- 0.95 power factor at the high side of the main step-up transformer.
- It is the responsibility of the Interconnection Customer to compensate their generation tie-line to ensure minimal reactive power flow under no load conditions.

Per Section 4.1.1.2 in the BPM, the following voltage regulation and reactive power capability requirements are applicable to synchronous generators:

- Xcel Energy's OATT requires all synchronous Generator Interconnection Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the POI.
- The reactive power analysis performed in this report is an indicator of the reactive power requirements at the POI and the capability of the generator to meet those requirements. The Interconnection Customer is required to demonstrate to the satisfaction of PSCo Transmission Operations prior to the commercial in-service date of the generating plant that it can safely and reliably operate within the required power factor and the regulating voltage of the POI.

Per Section 4.4.1 in the BPM, the following steps shall be followed to perform the reactive power capability evaluation for synchronous generators:

a. The reactive power evaluation of the Synchronous generators is done by dispatching the generator at Pmax and changing the POI voltage till Qmax and Qmin are reached.
b. This step is repeated for Pmin.
c. The POI voltage and power factor for the two evaluations are noted. If the POI power factor of 0.95 is reached and the POI voltage stays under the voltage guidance values noted (1-1.04 p.u. for the 230 kV system, 1-1.05 for the 345kV system and 1-1.03 for 115 kV system), the GIR is considered to meet reactive power requirements. If not, additional dynamic reactive support would be identified.

All proposed reactive devices in customer provided models are switched favorably to provide appropriate reactive compensation in each test, therefore identified deficiencies are in addition to any proposed reactive compensation.

All summary tables representing GIRs' Voltage and Reactive Power Capability tests adhere to the following color formatting representing the different aspects of the tests:

- Values highlighted in red indicate a failed reactive power requirement.
- Voltages outside of 0.95 – 1.05 p.u. are highlighted in yellow to provide additional information.

The PI-2024-17 GIR is modeled as follows:

PV Generator: Pgen = 101.80 MW, Pmin = 0.0 MW, Qmax = 35.4 Mvar, Qmin= -35.4 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for PI-2024-17 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for PI-2024-17 are summarized in Table 4.

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Table 5 – Reactive Power Capability Evaluation for PI-2024-17

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
101.8	23.7	35.4	-35.4	1.034	100.2	33.2	1.037	0.9493	100.2	33.5	1.037	0.9487
101.8	-28.0	35.4	-35.4	1.026	100.2	-33.8	1.031	-0.9475	100.2	-33.7	1.031	-0.9478
0.0	0.5	35.4	-35.4	1.034	-1.0	1.1	1.034	-0.6727	-1.0	1.4	1.034	-0.5812

5.2 Steady-State Analysis

Contingency analysis was performed on the Southern Colorado study pocket using the Study Case model. The results obtained for the analysis are summarized below:

- System Intact analysis showed the following thermal violations in Table 6. No System Intact voltage violations attributable to PI-2024-17 were observed.
    - Note all System Intact violations are alleviated via the redispatch, which is shown in Table 7. The loading obtained with the re-dispatched units is shown in the last column of Table 6. None of the System Intact overloads are attributed to the Study GIR.
- Single Contingency analysis showed the following thermal violations in Table 8. No Single Contingency voltage violations attributable to PI-2024-17 were observed.
    - Note all Single Contingency violations are alleviated via the redispatch, which is shown in Table 7. The loading obtained with the re-dispatched units is shown in the last column of Table 8. None of the Single Contingency overloads are attributed to the Study GIR.
    - The Single Contingency analysis presented three divergent contingencies, as shown in Table 9. All contingencies are divergent in both Benchmark and Study Cases. Therefore, the divergence is not attributed to PI-2024-17.
- Multiple Contingency analysis showed the following thermal violations in Table 10. No Multiple Contingency voltage violations attributable to PI-2024-17 were observed. Per TPL-001-5, multiple contingency violations are mitigated using system adjustments, including generation redispatch (includes GIRs under study) and/or operator actions. None of the multiple contingency overloads are attributed to the Study GIR.
    - Note one P7 contingencies was divergent as shown in Table 11. Multiple contingency issues are resolved using system adjustments, including generation redispatch (includes GIRs under study) and/or operator actions. Therefore, they are not attributable to the study GIR.

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Table 6 – System Intact Overloads

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)	Re-dispatched Study Case Loading (%)
1	Foxrun (73414) - Flying Horse N2 115 kV CKT 1	Base Case	115	73	142	103.99	106.94	2.95	46.48
2	Flying Horse S (73576) - Kettle Creek N (73711) 115 kV CKT 1	Base Case	115	73	162	103.59	106.20	2.61	52.74
3	Cottonwood N (73391) - Kettle Creek S (73410) 115 kV CKT 1	Base Case	115	73	162	102.88	104.73	1.85	68.12

Table 7 – Generation Dispatch to Resolve System Intact and Single Contingency Overloads

Bus No.	Bus Name	Base kV	ID	Original Pgen (MW)	Modified status	Modified Pgen (MW)
70069	CABCRKA	13.8	HA	138.0	1	169.5
70070	CABCRKB	13.8	HB	138.0	1	162.0
70106	CHEROK4	22.0	G4	220.0	1	308.0
70147	CHEROKEE7	18.0	ST	219.0	1	232.0
70120	COMAN_2	24.00	C2	365.0	0	0.0
70408	ST.VR_4	18.00	G4	0.0	1	115.1
70409	ST.VRAIN	22.00	ST	0.0	1	317.8
70562	SPRUCE1	18.00	G1	0.0	1	136.5
70563	SPRUCE2	18.00	G2	0.0	1	135.5
70591	RMEC3	23.0	ST	110.0	1	192.3
70593	SPNDLE1	18.00	G1	0.0	1	143.1
70594	SPNDLE2	18.00	G2	0.0	1	140.6
70756	NEPTUNE_B1	0.48	B1	106.3	1	-112.9
70758	NEPTUNE_S1	0.66	S1	212.9	0	0.0
70761	THNDWLF_B1	0.48	B1	85.0	1	-50.0
70763	THNDWLF_S1	0.66	S1	170.0	0	0.0

Bus No.	Bus Name	Base kV	ID	Original Pgen (MW)	Modified status	Modified Pgen (MW)
70777	COMAN_3	27.00	C3	804.9	0	0.0
70817	MTNBRZ_W2	0.69	W2	2.1	1	13.8
70818	MTNBRZ_W1	0.69	W1	23.7	1	157.9
70823	CEDARCK_1A	34.50	W1	33.0	1	220.0
70824	CEDARCK_1B	34.50	W2	12.0	1	80.0
70825	CEDAR2_W1	0.66	W1	18.8	1	125.0
70826	CEDAR2_W2	0.69	W2	15.1	1	100.8
70827	CEDAR2_W3	0.69	W3	3.8	1	25.0
70859	SUN_MTN_S1	0.66	S1	172.3	0	0.0
70878	BIGHORN_S	0.63	S1	210.4	0	0.0
70934	COMAN_S1	0.42	S1	102.0	0	0.0
70950	ST.VR_5	18.00	G5	0.0	1	156.2
70951	ST.VR_6	18.00	G6	0.0	1	154.5

Table 8 – Single Contingency Overloads

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)	Re-dispatched Study Case Loading (%)
1	Poncha W (77642) - Smelter (70394) 115 kV CKT 1	W Canon (73551) - Ponchabr (79054) 230 kV CKT 1	115	70	60	180.44	184.21	3.77	93.20
2	Cttnwd N (73391) - Kettleck S (73410) 115 kV CKT 1	Briargate S (73389) - Briargate N (73710) 115 kV CKT 1	115	73	162	169.28	171.94	2.66	119.99*
3	Ft St Vrain (70410/70916) 230/345 kV transformer T8	Ft St Vrain (70410/70916) 230/345 kV transformer T7	230/345	70	560	164.28	165.36	1.08	98.98

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)	Re-dispatched Study Case Loading (%)
4	Ft St Vrain (70410/70916) 230/345 kV transformer T7	Ft St Vrain (70410/70916) 230/345 kV transformer T8	230/345	70	560	164.28	165.36	1.08	98.98
5	Foxrun (73414) - Flyhorse N2 (73738) 115 kV CKT 1	Vollmert (72413) - Fuller (73481) 115 kV CKT 1	115	73	142	158.80	162.49	3.69	87.15
6	W.Canon (70550) - Hogback115 (71025) 115 kV CKT 1	Midwaybr (73413) - Hambone Tap (73638) 230 kV CKT 1	115	70	120	156.50	159.25	2.75	91.37
7	Smelter (70394) - W.Canon (70550) 115 kV CKT 1	W Canon (73551) - Ponchabr (79054) 230 kV CKT 1	115	70	73	152.82	155.92	3.10	80.92
8	Flyhorse S (73576) - Kettleck N (73711) 115 kV CKT 1	Vollmert (72413) - Fuller (73481) 115 kV CKT 1	115	73	162	151.66	154.92	3.26	88.30
9	Ftn Vly (70193) - Midwaybr (73412) 115 kV CKT 1	Midway Ps (70286) - Midwaybr (73413) 230 kV CKT 1	115	70/73	179	123.67	126.80	3.13	49.37
10	Briargate N (73710) - Kettleck N (73711) 115 kV CKT 1	Cttnwd N (73391) - Kettleck S (73410) 115 kV CKT 1	115	73	186	118.83	120.85	2.02	81.03
11	Smoky Hl (70396) - Powhaton (70532) 230 kV CKT 1	Smoky Hl (70396) - Spruce (70528) 230 kV CKT 1	230	70	740	116.24	118.28	2.04	31.81
12	Smoky Hl (70396) - Spruce (70528) 230 kV CKT 1	Smoky Hl (70396) - Powhaton (70532) 230 kV CKT 1	230	70	740	115.37	117.42	2.05	30.78
13	Kelker E (73408) - Templton (73422) 115 kV CKT 1	Kelker E (73408) - Rockisld (73420) 115 kV CKT 1	115	73	131	115.11	116.42	1.31	90.88
14	Smoky Hl (70396) - Harvest Mi (70596) 230 kV CKT 1	LoTC_151: Harvest Mile - Smoky Hill 345 kV CKT 2	230	70	956	114.69	116.86	2.17	56.91

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)	Re-dispatched Study Case Loading (%)
15	Comanche (70122) - Gi 2020 10 (700139) 230 kV CKT 1	Midway Ps (70286) - Mirasol (70652) 230 kV CKT 1	230	70	478	112.48	132.77	20.29	71.08
16	Spruce (70528) - Powhaton (70532) 230 kV CKT 1	Smoky Hl (70396) - Spruce (70528) 230 kV CKT 1	230	70	717	111.17	113.29	2.12	23.45
17	Kelker E (73408) - Rockisld (73420) 115 kV CKT 1	Kelker E (73408) - Templton (73422) 115 kV CKT 1	115	73	162	110.54	111.66	1.12	90.15
18	Vollmert (72413) - Fuller (73481) 115 kV CKT 1	Flyhorse S (73576) - Kettleck N (73711) 115 kV CKT 1	115	73	173	109.24	111.22	1.98	71.17
19	Desrtcov (70449) - W.Staton (70456) 115 kV CKT 1	Midway Ps (70286) - Midwaybr (73413) 230 kV CKT 1	115	70	221	108.29	110.84	2.55	47.96
20	Palmer Lk (70308) - Foxrun (73414) 115 kV CKT 1	Daniel Pk (70139) - Fuller (73477) 230 kV CKT 1	115	70/73	156	108.06	112.02	3.96	33.06
21	Midway Ps (70286) - Fuller (73477) 230 kV CKT 1	Midway Ps (70286) - Midwaybr (73413) 230 kV CKT 1	230	70/73	478	107.92	111.19	3.27	47.34
22	Gray Street (70208) - Lakewood 1 (70251) 115 kV CKT 1	Gray Street (70208) - Lakewood 2 (70252) 115 kV CKT 2	115	70	111	107.27	108.43	1.16	61.83
23	Puebplnt (70339) - Reader (70352) 115 kV CKT 1	Greenhrn (70004) - Reader (70352) 115 kV CKT 1	115	70	160	107.05	108.67	1.62	57.97
24	Midway Ps (70286) - Mirasol (70652) 230 kV CKT 1	Comanche (70122) - Gi 2020 10 (700139) 230 kV CKT 1	230	70	505	107.02	127.27	20.25	66.88
25	Portland (70330) - Skala (70390) 115 kV CKT 1	N Penrose (71024) - Trk Crk Poi (71032) 115 kV CKT 1	115	70	110	106.98	108.42	1.44	70.66
26	Smoky Hl (70599/70396) 345/230 kV transformer T4	Smoky Hl (70396) - Harvest Mi (70596) 230 kV CKT 1	345/230	70	560	105.84	107.10	1.26	68.30

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)	Re-dispatched Study Case Loading (%)
27	Smoky Hl (70599/70396) 345/230 kV transformer T6	Smoky Hl (70396) - Harvest Mi (70596) 230 kV CKT 1	345/230	70	560	105.84	107.10	1.26	68.30
28	Smoky Hl (70599/70396) 345/230 kV transformer T5	Smoky Hl (70396) - Harvest Mi (70596) 230 kV CKT 1	345/230	70	560	105.84	107.10	1.26	68.30
29	Vollmert (72413) - Blk Sqmv (73460) 115 kV CKT 1	Flyhorse S (73576) - Kettleck N (73711) 115 kV CKT 1	115	73	173	104.01	105.97	1.96	66.05
30	Midway Ps (70286) - Midwaybr (73413) 230 kV CKT 1	Midway Ps (70286) - Fuller (73477) 230 kV CKT 1	230	70/73	637	103.19	106.72	3.53	36.90
31	Daniel Pk (70139) - Prairie 3 (70323) 230 kV CKT 2	Daniel Pk (70139) - Prairie 1 (70331) 230 kV CKT 1	230	70	916	102.20	104.24	2.04	61.43
32	Briargate S (73389) - Cttnwd S (73393) 115 kV CKT 1	Cttnwd N (73391) - Kettleck S (73410) 115 kV CKT 1	115	73	150	101.75	104.07	2.32	58.89
33	Daniel Pk (70139) - Prairie 1 (70331) 230 kV CKT 1	Daniel Pk (70139) - Prairie 3 (70323) 230 kV CKT 2	230	70	916	101.56	103.57	2.01	61.24
34	Ftn Vly (70193) - Desrtcov (70449) 115 kV CKT 1	Midway Ps (70286) - Midwaybr (73413) 230 kV CKT 1	115	70	221	100.75	103.29	2.54	40.57
35	Daniel Pk (70139) - Fuller (73477) 230 kV CKT 1	Midway Ps (70465) - Waterton (70466) 345 kV CKT 1	230	70/73	478	100.53	103.87	3.34	35.93
36	W.Canon (70550/73551) 115/230 kV transformer T1	Midwaybr (73413) - Hambone Tap (73638) 230 kV CKT 1	115/230	70/73	100	98.98	100.93	1.95	50.72
37	Midwaybr (73412) - Rancho (73416) 115 kV CKT 1	LoTC_28: Midway - Fuller 230 kV CKT 1	115	73	119	98.56	100.14	1.58	66.54

Table 9 – Diverged Single Contingencies

Ref. No.	Diverged Contingency	Contingency Description	Benchmark Case	Study Case
1	PLANT: 79016 CRAIG 2 22.0 73 790	Loss of generation 79016 CRAIG 2	Diverged	Diverged
2	PLANT:700182 24_28_W 0.69 70 706	Loss of generation 700182 24_28_W	Diverged	Diverged
3	12181 GLDSTNPS 230 70990 VALENT 230 1 1	GLDSTNPS (12181) - VALENT (70990) 230 kV CKT 1	Diverged	Diverged

Table 10 – Multiple Contingency Overloads

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
1	East 1 (70162) - East 2 (70171) 115 kV CKT 1	P7_149: Lines 5177, 5171, 5277	115	70	119.5	215.09	220.55	5.46
2	Foxrun (73414) - Flyhorse N2 (73738) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	73	157	171.93	177.15	5.22
3	Ftn Vly (70193) - Midwaybr (73412) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70/73	179	166.49	171.08	4.59
4	Flyhorse S (73576) - Kettleck N (73711) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	73	180	160.94	165.51	4.57
5	W.Canon (70550) - Hogback115 (71025) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	120	159.46	162.49	3.03
6	Palmer Lk (70308) - Foxrun (73414) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	70/73	162	145.85	150.83	4.98
7	Desrtcov (70449) - W.Staton (70456) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	221	143.15	146.89	3.74

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
8	Midway PS (70286) - Midway BR (73413) 230 kV CKT 1	P7_130: Lines 5129, 7051	230	70/73	637	141.79	146.34	4.55
9	Smoky Hl (70396) - Harvest Mi (70596) 230 kV CKT 1	P7_137: Lines 7081, 7087	230	70	956	137.49	139.94	2.45
10	Cttnwd N (73391) - Kettleck S (73410) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	73	180	135.49	138.58	3.09
11	Ftn Vly (70193) - Desrtcov (70449) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	221	135.44	139.16	3.72
12	East 2 (70171) - Smoky Hl N (70395) 115 kV CKT 1	P7_149: Lines 5177, 5171, 5277	115	70	120	129.83	132.72	2.89
13	Puebplnt (70339) - Reader (70352) 115 kV CKT 1	P7_53: Lines 5411, 55255	115	70	160	123.11	126.46	3.35
14	Daniel Pk (70139) - Fuller (73477) 230 kV CKT 1	P7_51: Lines 5415, 5411	230	70/73	478	122.26	126.54	4.28
15	Clark (70112) - Jordan (70241) 230 kV CKT 1	P7_58: Lines 5707, 5111	230	70	364	119.71	122.00	2.29
16	Poncha W (77642) - Smelter (70394) 115 kV CKT 1	BF_133a: Spruce 5180 Stuck	115	70	60	117.85	120.00	2.15
17	Arapahoe (70038) - Santa Fe (70527) 230 kV CKT 1	BF_064c: Greenwood Bus Tie	230	70	556	114.38	117.22	2.84
18	Boone (70061) - Pi 2024 15 (700015) 230 kV CKT 1	P7_53: Lines 5411, 55255	230	70	319	113.74	117.16	3.42
19	Midway Ps (70286) - Pi 2024 15 (700015) 230 kV CKT 1	P7_53: Lines 5411, 55255	230	70	319	113.71	117.13	3.42
20	Monaco 12 (70481) - Sullivan 2 (70365) 230 kV CKT 1	BF_004a: Arapahoe 230 kV Bus	230	70	445	113.48	116.69	3.21
21	Spruce (70528) - Powhaton (70532) 230 kV CKT 1	BF_129r: Smoky Hill 5177 Stuck	230	70	717	111.51	113.63	2.12
22	Daniel Pk (70139) - Santa Fe (70527) 230 kV CKT 1	BF_064c: Greenwood Bus Tie	230	70	637	109.46	111.92	2.46

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
23	Daniel Pk (70139) - Marcy (70278) 230 kV CKT 1	P7_65: Lines 5109, 7051	230	70	478	109.30	110.55	1.25
24	Midwaybr (73412) - Rancho (73416) 115 kV CKT 1	P7_130: Lines 5129, 7051	115	73	119	109.19	111.05	1.86
25	Littlet1 (70263) - Waterton (70463) 115 kV CKT 1	BF_004a: Arapahoe 230 kV Bus	115	70	174	109.07	110.97	1.90
26	Smoky Hl N (70395/99185) 115/230 kV transformer T1	P7_149: Lines 5177, 5171, 5277	115/230	70	144.2	108.81	110.44	1.63
27	Smoky Hl (70396) - Powhaton (70532) 230 kV CKT 1	BF_129r: Smoky Hill 5177 Stuck	230	70	797	108.24	110.14	1.90
28	Hydepark (70236) - Puebplnt (70339) 115 kV CKT 1	P7_53: Lines 5411, 55255	115	70	159	108.08	111.43	3.35
29	East 2 (70171) - Smoky Hl N (70395) 115 kV CKT 2	P7_149: Lines 5177, 5171, 5277	115	70	145	107.45	109.84	2.39
30	Lamar Swyd (70254) - Lamar C2 (70255) 230 kV CKT 1	P7_51: Lines 5415, 5411	230	70	239	103.90	105.64	1.74
31	Midway Ps (70285) - W.Staton (70456) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	87	103.40	105.66	2.26
32	Denver Tm (70149) - Lacombe (70324) 230 kV CKT 1	P7_148: Lines 5177, 5171	230	70	568	102.75	106.12	3.37
33	Smelter (70394) - W.Canon (70550) 115 kV CKT 1	BF_133a: Spruce 5180 Stuck	115	70	73	101.60	103.37	1.77
34	Smoky Hl (70396) - Spruce (70528) 230 kV CKT 1	BF_129q: Smoky Hill 5171 Stuck	230	70	813	101.29	103.15	1.86
35	Daniel Pk (70139) - Prairie 3 (70323) 230 kV CKT 2	BF_064b: Greenwood Bus 1	230	70	916	100.08	102.23	2.15
36	Portland (70330) - Skala (70390) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	110	100.08	102.05	1.97
37	Daniel Pk (70139) - Prairie 1 (70331) 230 kV CKT 1	BF_045s: Daniels Park 5707	230	70	916	99.97	102.02	2.05

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
38	Chatfld (70100) - Waterton (70464) 230 kV CKT 1	BF_064c: Greenwood Bus Tie	230	70	553	99.10	101.32	2.22
39	Midway Ps (70286) - Fuller (73477) 230 kV CKT 1	BF_094e: Midway WAPA 230 kV bus	230	70/73	478	98.86	101.94	3.08
40	W.Canon (70550/73551) 115/230 kV transformer T1	BF_094d: Midway 5120 Stuck	115/230	70/73	100	98.85	100.95	2.10
41	Monaco 12 (70481) - Gree Sr (70105) 230 kV CKT 1	BF_004a: Arapahoe 230 kV Bus	230	70	553	98.31	100.88	2.57
42	Greenwood 2 (70189) - Gree Sr (70105) 230 kV CKT 2	BF_004a: Arapahoe 230 kV Bus	230	70	553	98.31	100.88	2.57
43	Comanche (70122) - Gi 2020 10 (700139) 230 kV CKT 1	P7_53: Lines 5411, 55255	230	70	559	96.75	114.08	17.33

Table 11 – Diverged Multiple Contingency

Diverged Contingency	Contingency Description	Benchmark Case	Study Case
P7_55	Lines: 7015, 7017	Diverged	Diverged

5.3 Transient Stability Results

The following results were obtained for the disturbances analyzed:

- ✓ No machines lost synchronism with the system.
- ✓ No transient voltage drop violations were observed.
- ✓ Machine rotor angles displayed positive damping.

The results of the contingency analysis are shown in Table 12. The transient stability plots are shown in Appendix A in Section 10.0 of this report.

Table 12 – Transient Stability Analysis Results

Ref. No.	Fault Location	Outage(s)	Clearing Time (Cycles)	Post-Fault Voltage Recovery	Angular Stability
1	-	Flat Run	-	Stable	Stable
2	PI-2024-17 Gen	PI-2024-17 Generation and Load	4	Stable	Stable
3	Mirasol 230 kV (LoTC 79)	Comanche – Mirasol 230 kV ckt 1 GI-2020-10 Generation	4	Stable	Stable
4	Mirasol 230 kV (LoTC 102)	Midway PS – Mirasol 230 kV ckt 1	4	Stable	Stable
5	Mirasol 230 kV (LoTC 103)	Mirasol – Thunderwolf 230 kV ckt 1 Thunderwolf Generation	4	Stable	Stable
6	Midway PS 230 kV (LoTC 28)	Midway PS – Fuller 230 kV ckt 1	4	Stable	Stable
7	Midway PS 230 kV (LoTC 78)	Comanche – Midway PS 230 kV ckt 1	4	Stable	Stable
8	Midway PS 230 kV (LoTC 69)	Boone – Midway PS 230 kV ckt 1	4	Stable	Stable
9	Mirasol 230 kV (BF 096a)	Midway PS – Mirasol 230 kV ckt 1 Comanche – Mirasol 230 kV ckt 1 Mirasol – Thunderwolf 230 kV ckt 1 GI-2020-10 Generation Thunderwolf Generation	17	Stable	Stable
10	Mirasol 230 kV (BF 094c)	Midway PS – Mirasol 230 kV ckt 1 Midway PS – Fountain Valley Gen. 230 kV ckt 1 Fountain Valley Generation and Load	17	Stable	Stable
11	Mirasol 230 kV (Lines 5411, 55255)	Midway PS – Mirasol 230 kV ckt 1 Comanche – Midway PS 230 kV ckt 1	4	Stable	Stable
12	Mirasol 230 kV (Lines 5413, 5408)	Comanche – Mirasol 230 kV ckt 1 Comanche – Huckleberry 230 kV ckt 1 Huckleberry – Walsenburg 230 kV ckt 1 GI-2020-10 Generation	4	Stable	Stable

5.4 Short-Circuit and Breaker Duty Analysis Results

A study was completed to determine whether any over-dutied breakers resulted when several Provisional Interconnections (PIs) were added to the PSCo transmission system in the order of their Commercial Operation Date (COD). If the addition of the interconnection resulted in a requirement that one or more breakers be replaced in the PSCo transmission system, it was considered that that customer would not be able to connect under a provisional interconnection agreement and it was removed from the study.

Taken into consideration were any existing plans for breaker replacement by PSCo. Breakers that had already been assigned to projects were not considered as needing replacement by the interconnection customer.

The Short Circuit study on the PSCo transmission system has identified one circuit breaker that became over-dutied because of adding the PI-2024-17. The over-dutied breaker does not have a project initiated for its replacement and will require Network Upgrades. The fault currents at the POI for can be made available upon request by the Customer.

5.5 Affected Systems

The study did not identify any impacts to Affected Systems.

5.6 Summary of Provisional Interconnection Analysis

All system intact and single contingency thermal violations were alleviated through generation redispatch. The initial maximum permissible output of the Provisional Interconnection Service request is at 0 MW due to an over-dutied breaker. The maximum permissible output of the Generating Facility in the PLGIA will be reviewed quarterly and updated, if there are changes to the system conditions assumed in this analysis.

6.0 Cost Estimates

The total estimated cost of the required Upgrades for PI-2024-17 to interconnect for Provisional Interconnection Service at Mirasol 230 kV switching station is **$7.039 million**.

- **Cost of Transmission Provider's Interconnection Facilities (TPIF) is $2.922 million** (Table 13)
- **Cost of Station Network Upgrades is $4.117 million** (Table 14)
- **Cost of System Network Upgrades is $0**

The list of improvements required to accommodate the Provisional Interconnection Service of PI-2024-17 are given in Table 13, and Table 14.

Table 13 – Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (Million)
PSCo's Mirasol 230 kV switching station	Interconnection of 5RSC-2024-04 (PI-2024-17) at the Mirasol 230 kV switching station. The new equipment includes: • (1) 230 kV single bay dead end structure • (1) 230 kV 3-phase arrester • (1) 230 kV 3000 A disconnect switch • (1) 230 kV 3-phase CT for metering • (1) 230 kV 3-phase CCVT for metering • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying	$2.457
PSCo's Mirasol 230 kV switching station	Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead end structure, 3 conductors, insulators, hardware, jumpers and labor.	$0.465
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$2.922**

Table 14 – Station Network Upgrades

Element	Description	Cost Est. (Million)
PSCo's Mirasol 230 kV switching station	Interconnection of 5RSC-2024-04 (PI-2024-17) at the Mirasol 230 kV switching station. The new equipment includes: • (1) 230 kV single bay dead end structure • (1) 230 kV 3000 A circuit breaker • (5) 230 kV 3000 A disconnect switches • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$3.733
PSCo's Mirasol 230 kV switching station	Install required communication in the EEE at the Mirasol 230 kV switching station	$0.284
PSCo's Mirasol 230 kV switching station	Siting and Land Rights permitting, no land purchase costs included	$0.100
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$4.117**

PSCo has developed cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of PI-2024-17 for Provisional Interconnection Service. The estimated costs provided in this report are based upon the following assumptions:

- The estimated costs are in 2024 dollars with escalation and contingencies applied.
- Allowances for Funds Used During Construction (AFUDC) is not included.
- The estimated costs include all applicable labor and overheads associated with the siting, engineering, design, and construction of these new PSCo facilities.
- The estimated costs do not include the cost for any Customer owned equipment and associated design and engineering.
- Labor is estimated for straight time only—no overtime included.
- PSCo (or its Contractor) will perform all construction, wiring, testing, and commissioning for PSCo owned and maintained facilities.

The customer requirements include:

- Customer will install two (2) redundant fiber optic circuits (one primary circuit with a redundant backup) into the Transmission Provider's substation as part of its interconnection facilities construction scope.

- Power Quality Metering (PQM) will be required on the Customer's generation tie-line terminating into the POI.
- The Customer will be required to design, procure, install, own, operate and maintain a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer substation. PSCo will be provided with indications, readings, and data from the LF/AGC RTU.
- The Interconnection Customer will comply with the Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW, as amended from time to time, and available at: XEL-POL-Transmission Interconnection Guideline Greater 20MW

6.1 Schedule

This section provides proposed milestones for the interconnection of PI-2024-17 to the Transmission Provider's Transmission System. The customer requested back-feed date (In-Service Date for Transmission Provider's Interconnection Facilities and Station Network Upgrades required for interconnection) for the Provisional Interconnection Service is October 1, 2027. This is attainable by the Transmission Provider, based upon the current schedule developed for this interconnection request. The Transmission Provider proposes the milestones provided below in Table 15.

Table 15 – Proposed Milestones for PI-2024-17

Milestone	Responsible Party	Estimated Completion Date
PLGIA Execution	Interconnection Customer and Transmission Provider	March 2025
In-Service Date for Transmission Provider Interconnection Facilities and Station Network Upgrades required for interconnection	Transmission Provider	October 1, 2027
In-Service Date & Energization of Interconnection Customer's Interconnection Facilities	Interconnection Customer	October 1, 2027
Initial Synchronization Date	Interconnection Customer	December 1, 2027
Begin trial operation & testing	Interconnection Customer and Transmission Provider	February 1, 2028
Commercial Operation Date	Interconnection Customer	June 1, 2028

Some schedule elements are outside of the Transmission Provider's control and could impact the overall schedule. The following schedule assumptions provide the basis for the schedule milestones:

- Construction permitting (if required) for new facilities will be completed within 12 months of PLGIA execution.
- The Transmission Provider is currently experiencing continued increases to material lead times which could impact the schedule milestones. The schedule milestones are based upon material lead times known at this time.
- Availability of line outages to interconnect new facilities to the transmission system.
- A Certificate of Public Convenience and Necessity (CPCN) may be required for the construction of the Interconnection Facilities and Station Network Upgrades. The expected time to obtain a CPCN approval is 18 months, which could impact the start of construction for the interconnection facilities.

7.0 Summary of Provisional Interconnection Service Analysis

The total estimated cost of the PSCo transmission system improvements required for PI-2024-17 to qualify for Provisional Interconnection Service would be **$7.039 million**.

The initial maximum permissible output of PI-2024-17 Generating Facility is 0 MW at the Point of Interconnection. In addition, due to the nature of the network violations determined in the Short Circuit analysis, the inverters may not be connected to the grid. The maximum permissible output of the Generating Facility in the PLGIA[6] will be reviewed quarterly and updated, if there are changes to the system conditions assumed in this analysis.

Security: PI-2024-17 is a request for Energy Resource Interconnection Service (ERIS). For ERIS requests, security shall estimate the risk associated with the Network Upgrades and the Interconnection Facilities and is assumed to be a minimum of $5 million.

The Provisional Interconnection Service in and of itself does not convey transmission service.

[6] **Provisional Large Generator Interconnection Agreement (PLGIA)** shall mean the interconnection agreement for Provisional Interconnection Service established between Transmission Provider and/or the Transmission Owner and the Interconnection Customer. The pro forma agreement is provided in Appendix 8 and takes the form of the Large Generator Interconnection Agreement, modified for provisional purposes.

8.0 Contingent Facilities

The Contingent Facilities identified for PI-2024-17 include the TPIF and Station Network Upgrades identified in Table 13 and Table 14, respectively.

9.0 Preliminary One-Line Diagram and General Arrangement for PI-2024-17

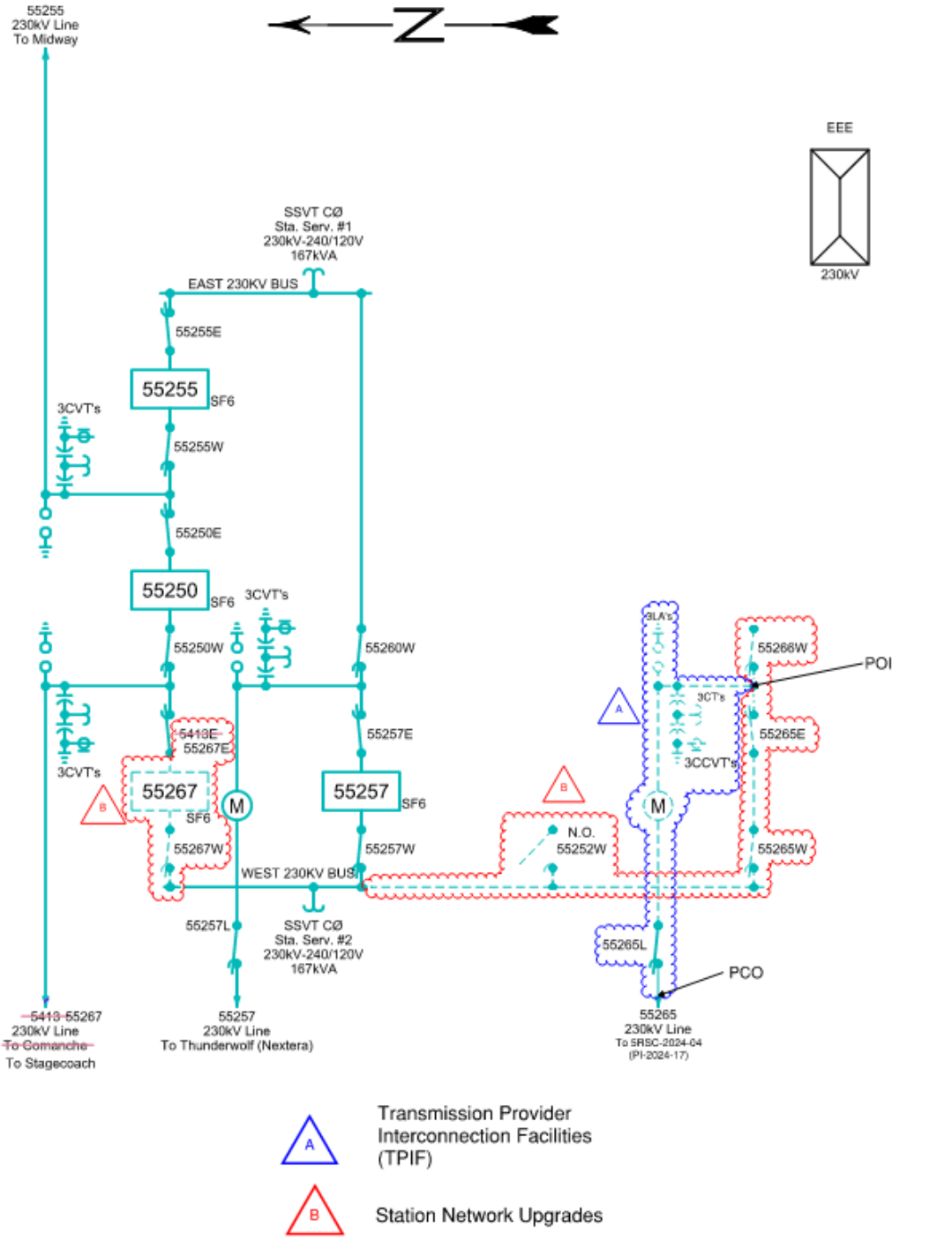


Figure 2: Preliminary One-Line for PI-2024-17 at the Mirasol 230 kV Switching Station

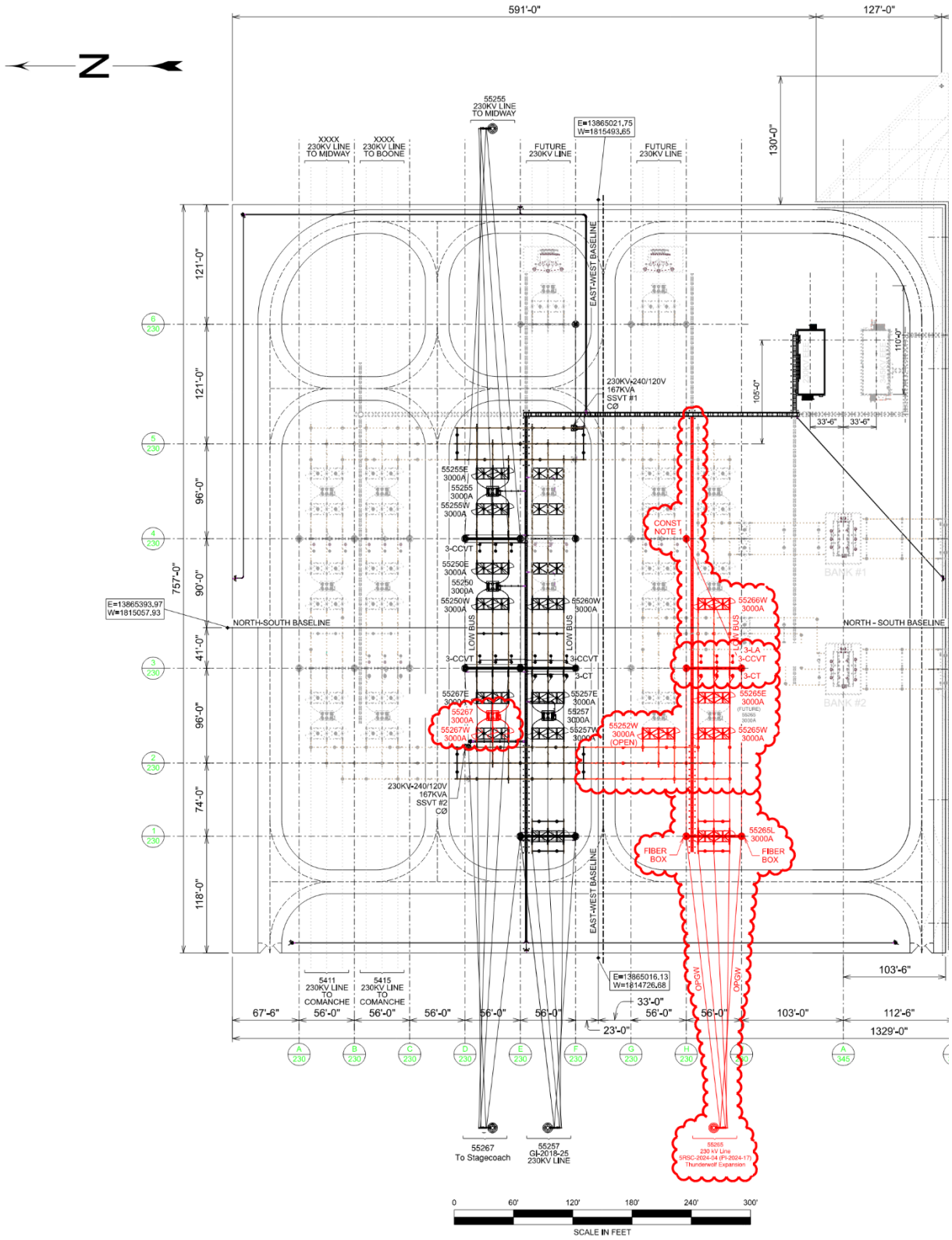
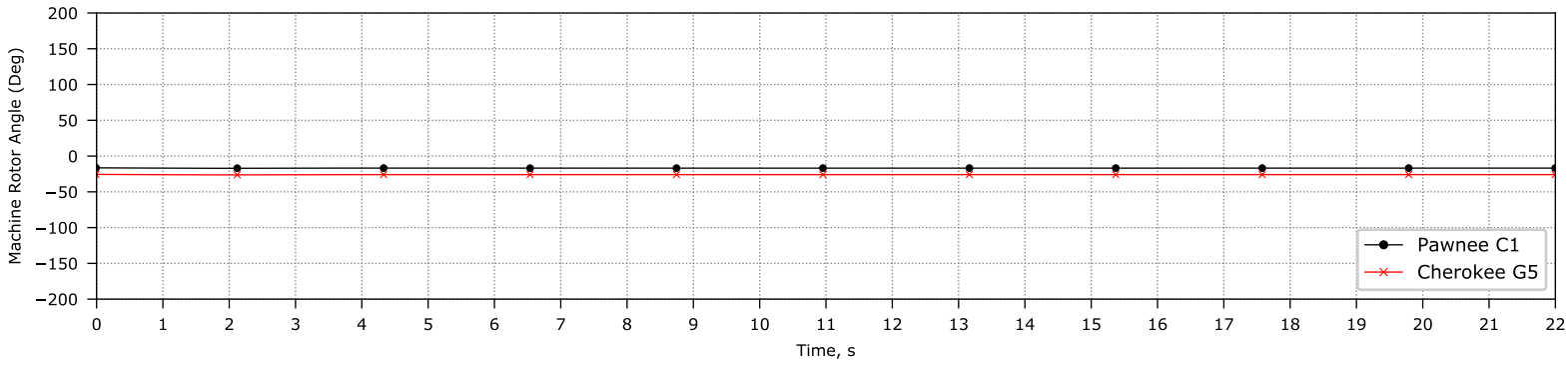


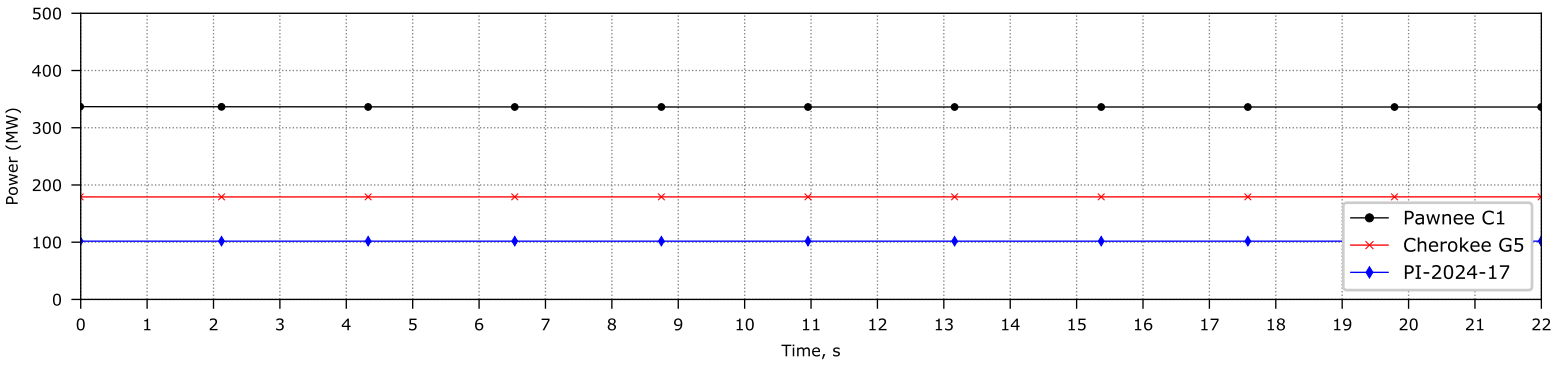
Figure 3: Preliminary General Arrangement for PI-2024-17 at the Mirasol 230 kV Switching Station

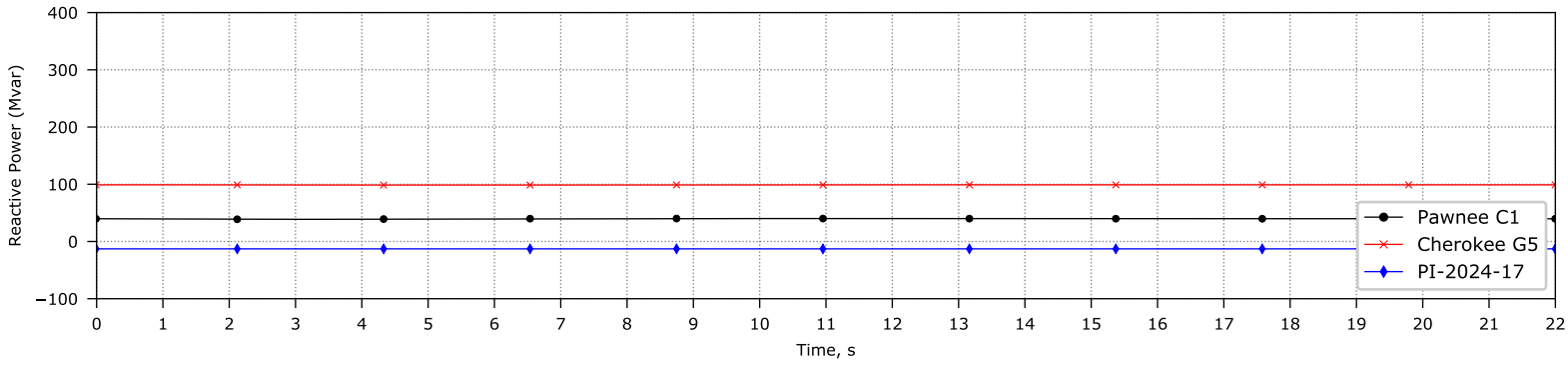
10.0 Appendices

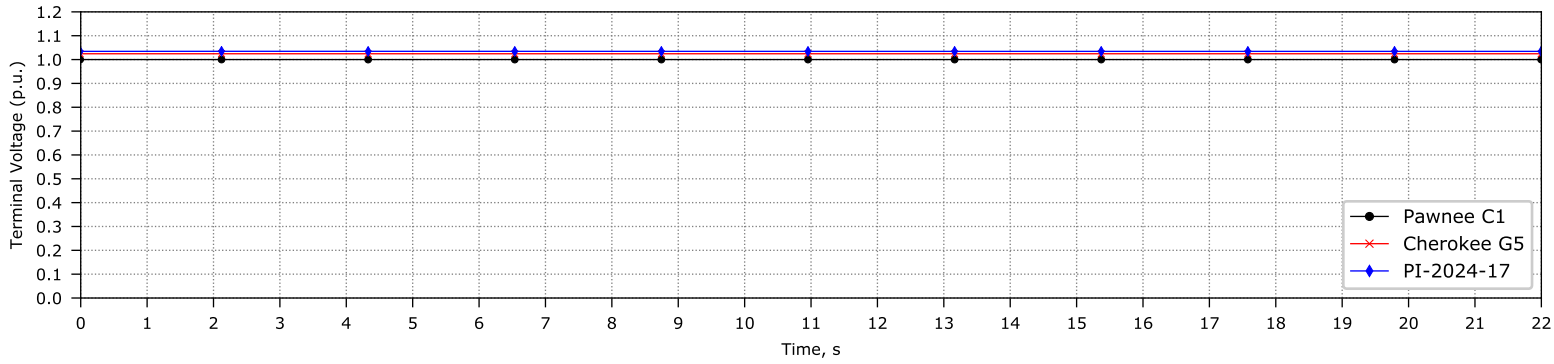
Appendix A: Transient Stability Plots	PI-2024-17_Transient Stability Plots.pdf

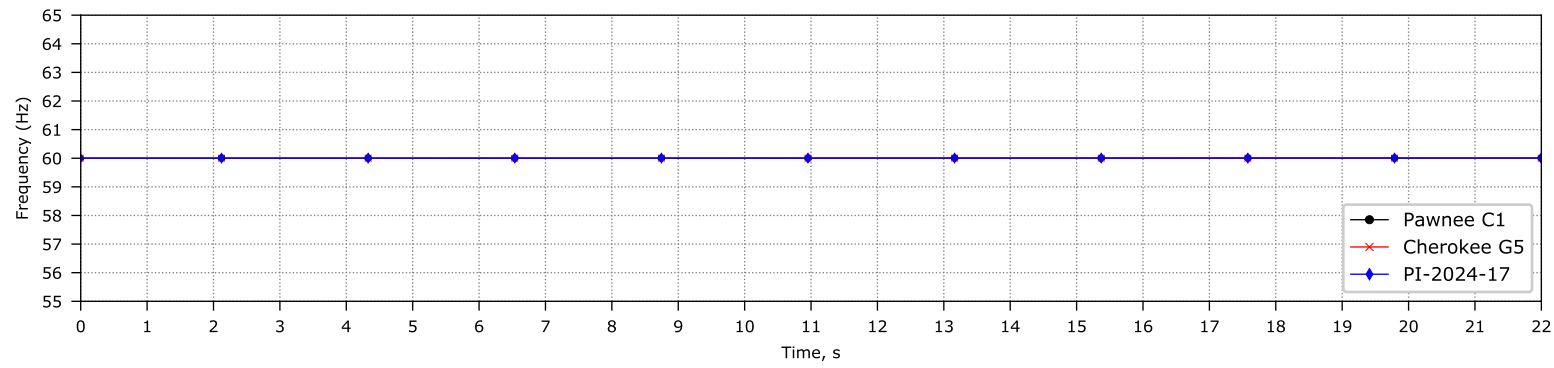
Flat Run

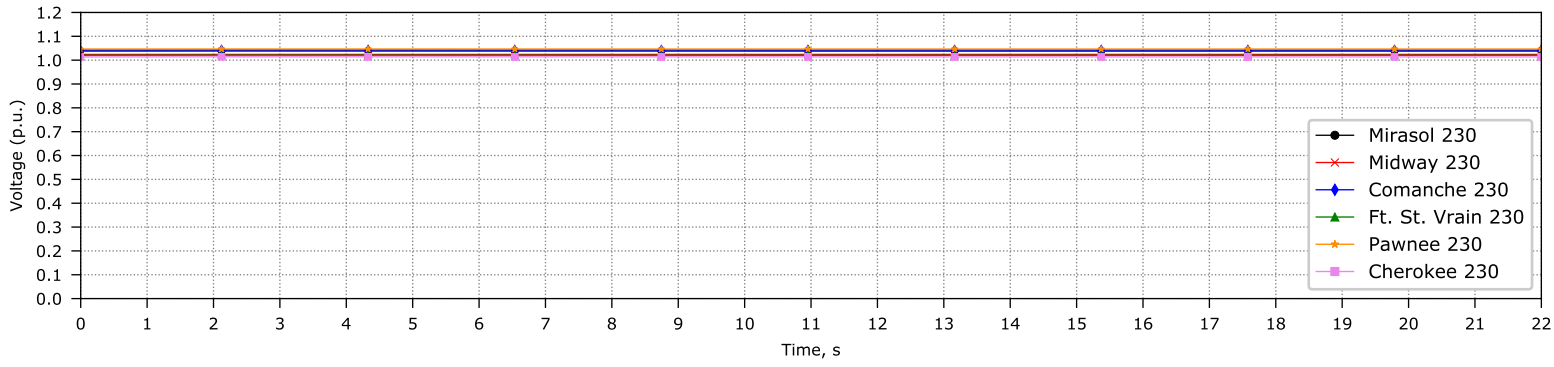

Machine Rotor Angle (Deg)
Time, s
Pawnee C1
Cherokee G5


Power (MW)
Time, s
Pawnee C1
Cherokee G5
PI-2024-17

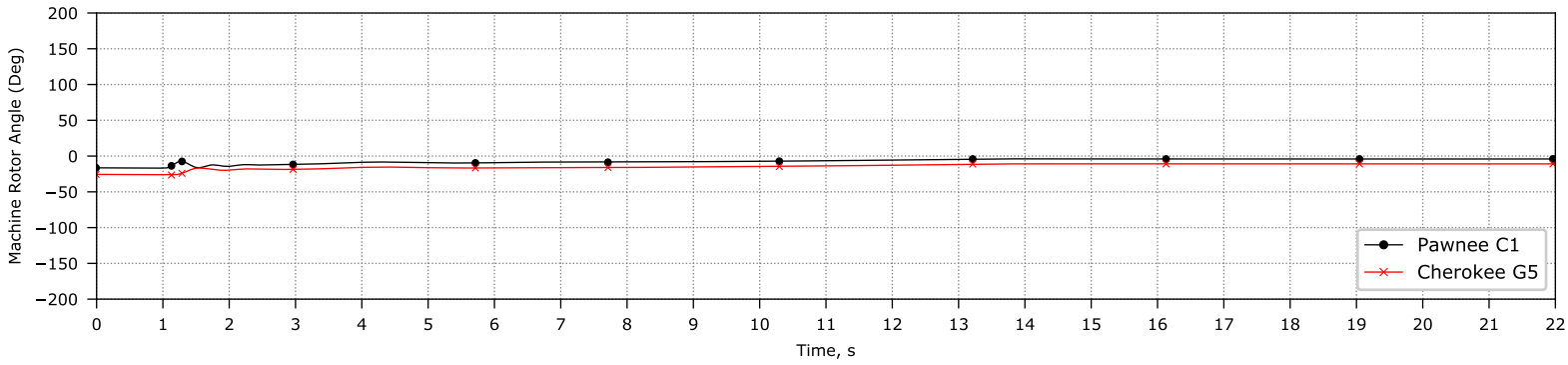

Reactive Power (Mvar)
Time, s
Pawnee C1
Cherokee G5
PI-2024-17

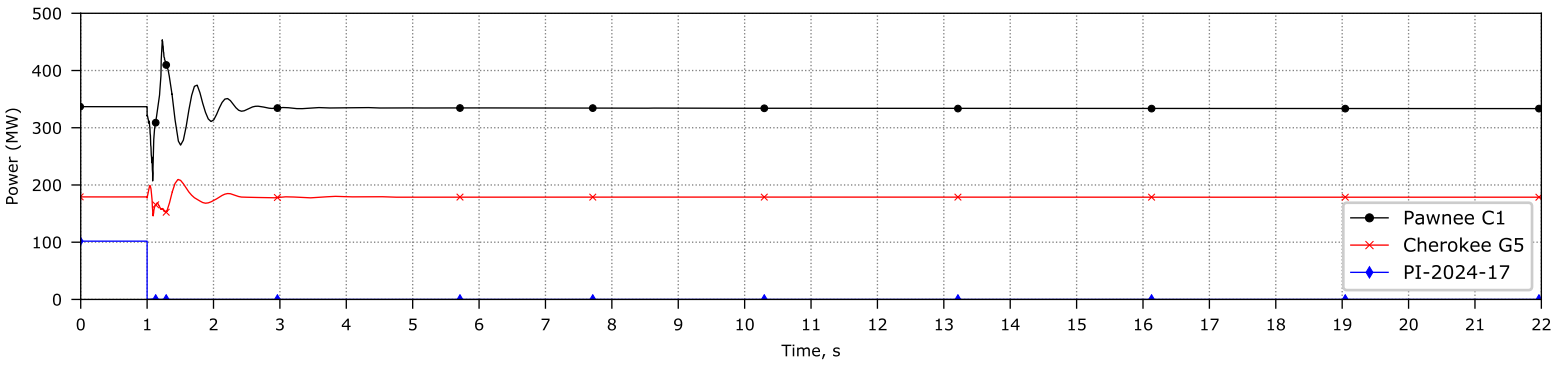

Terminal Voltage (p.u.)
Time, s
Pawnee C1
Cherokee G5
PI-2024-17

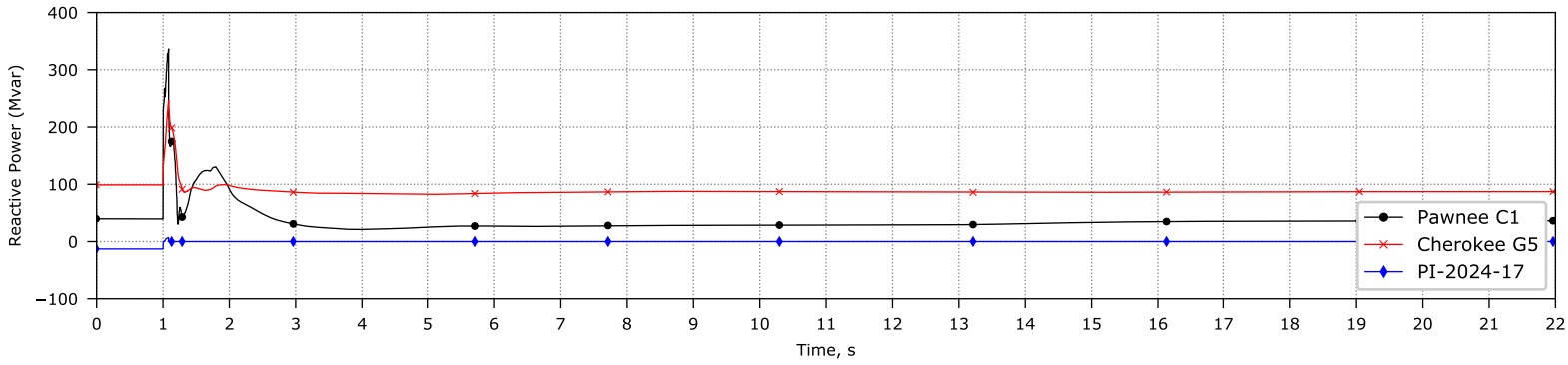

Frequency (Hz)
Time, s
Pawnee C1
Cherokee G5
PI-2024-17

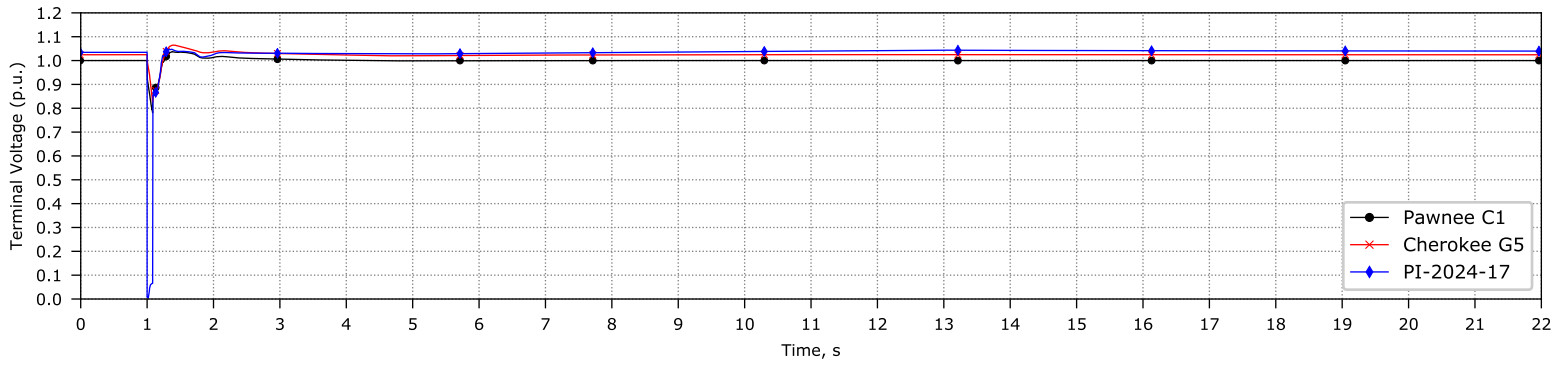

Voltage (p.u.)
Time, s
Mirasol 230
Midway 230
Comanche 230
Ft. St. Vrain 230
Pawnee 230
Cherokee 230

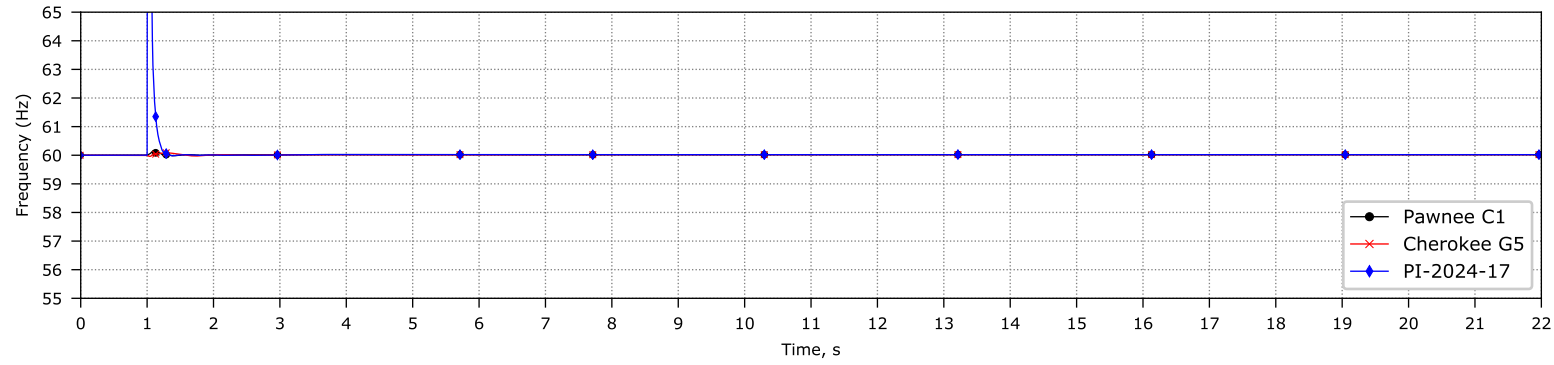
PI-2024-17_Gen

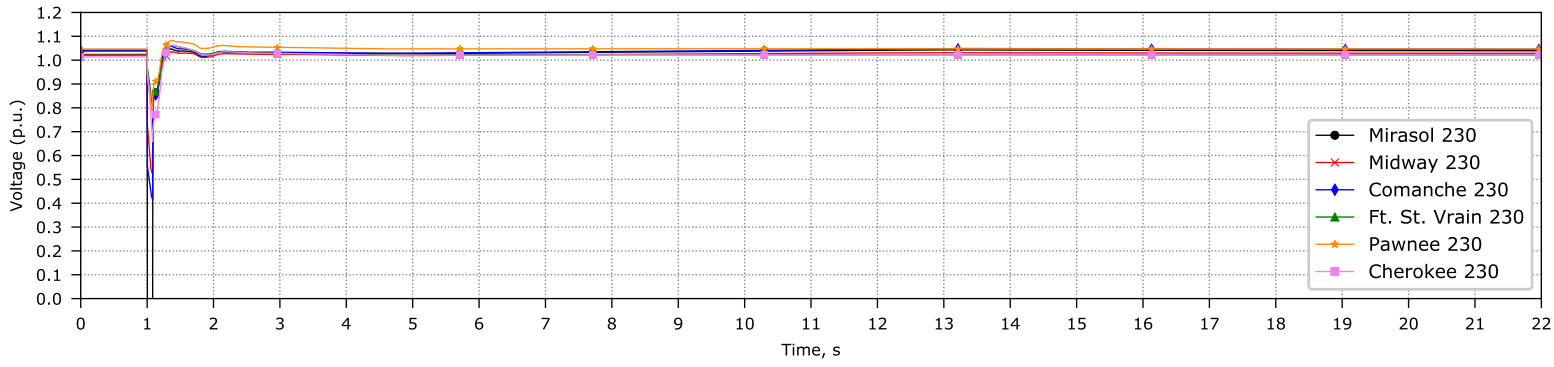




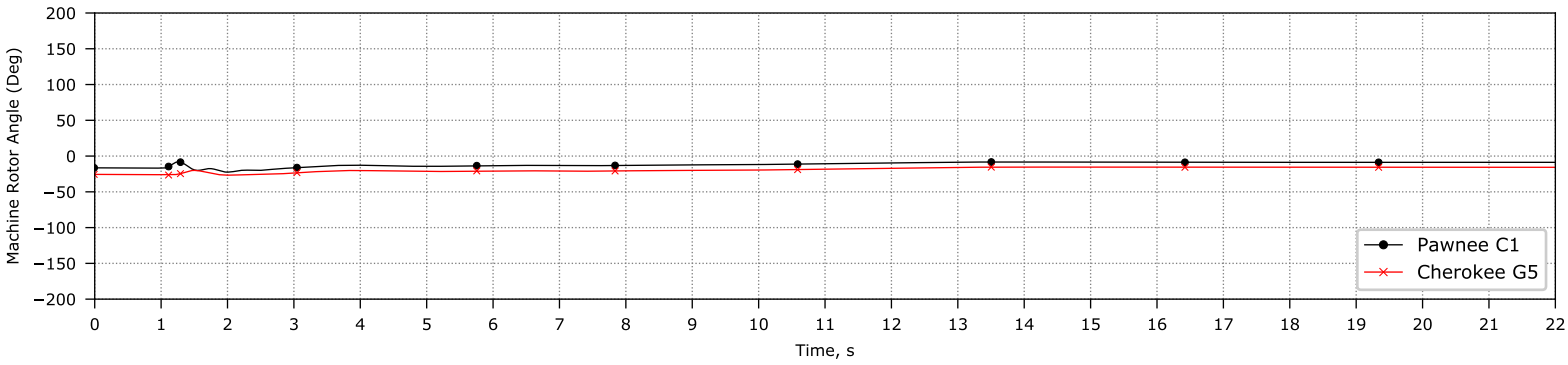


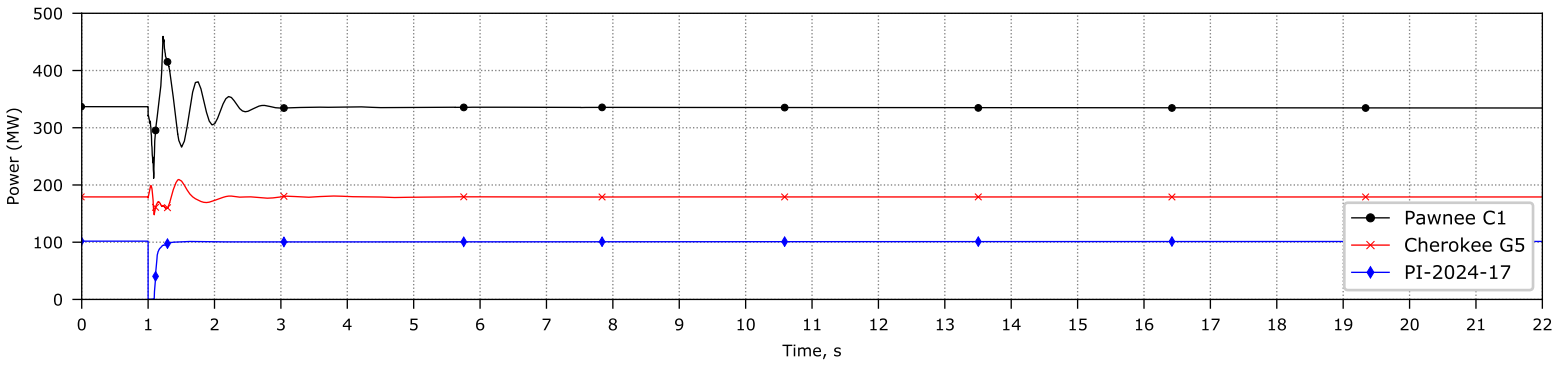


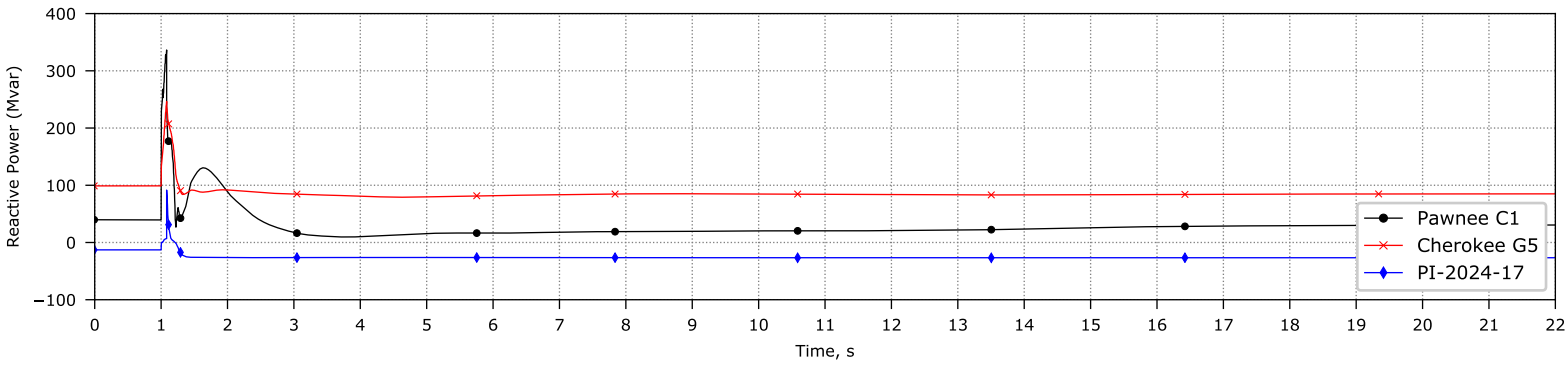


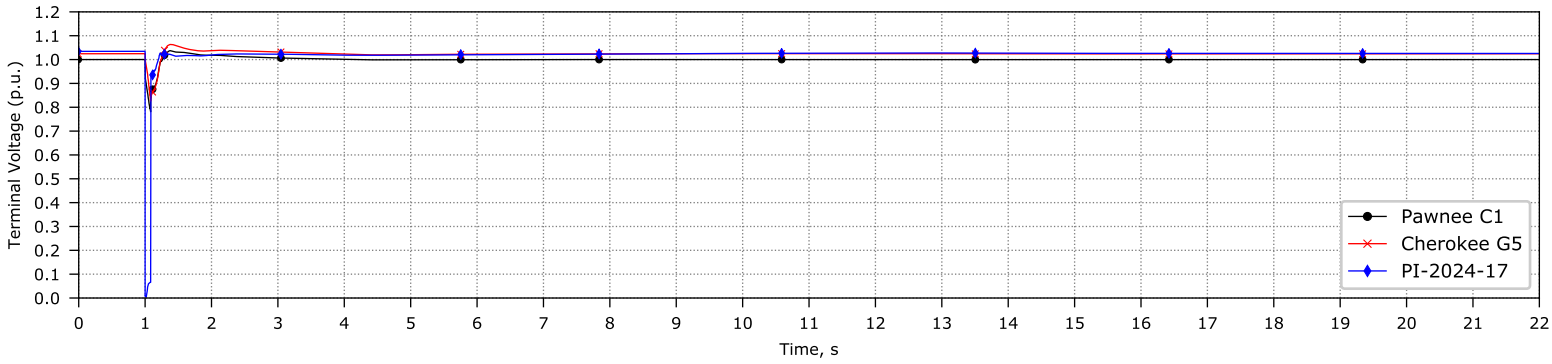


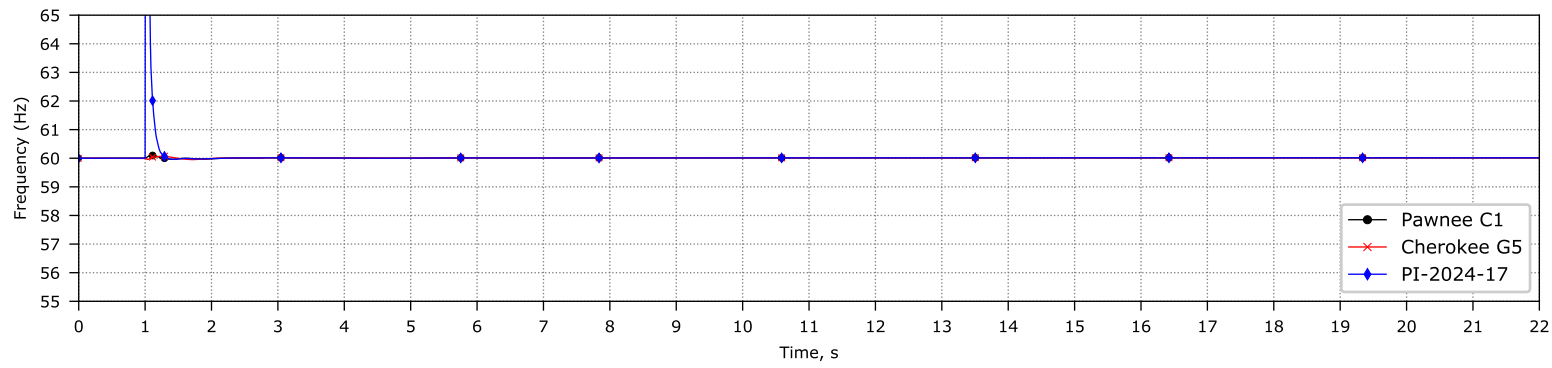
Comanche_Mirasol_230kV (LoTC 79)

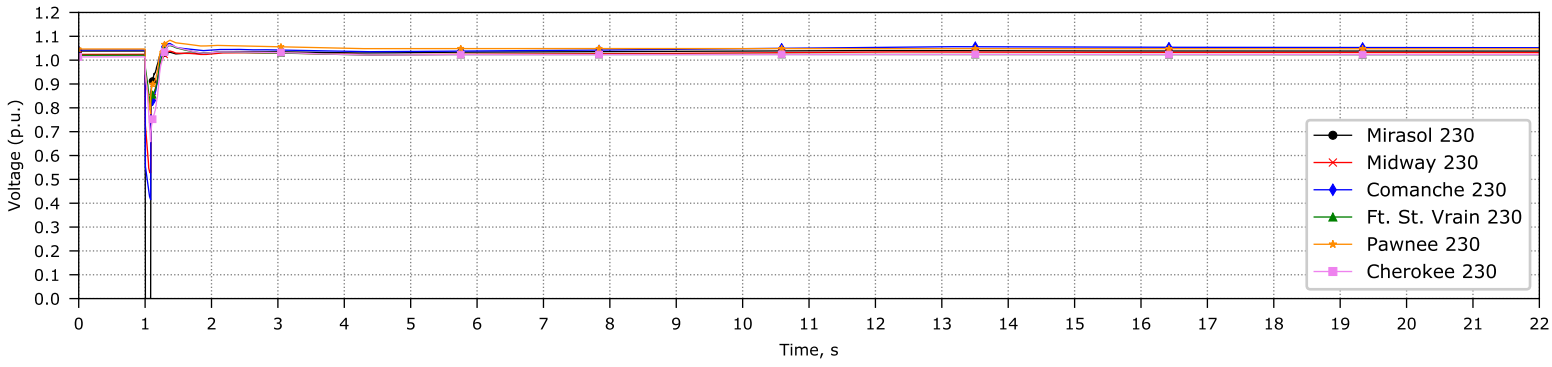




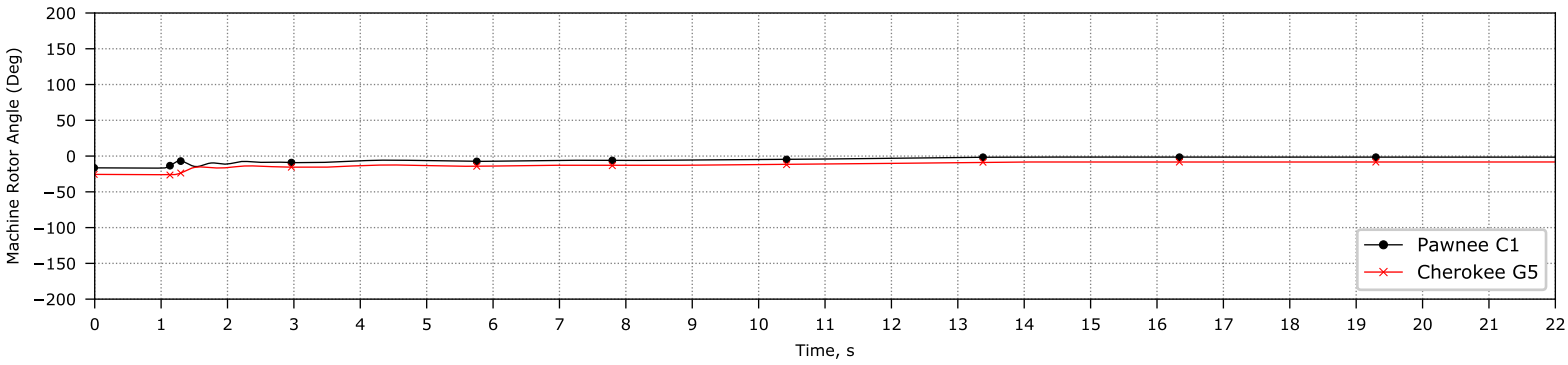


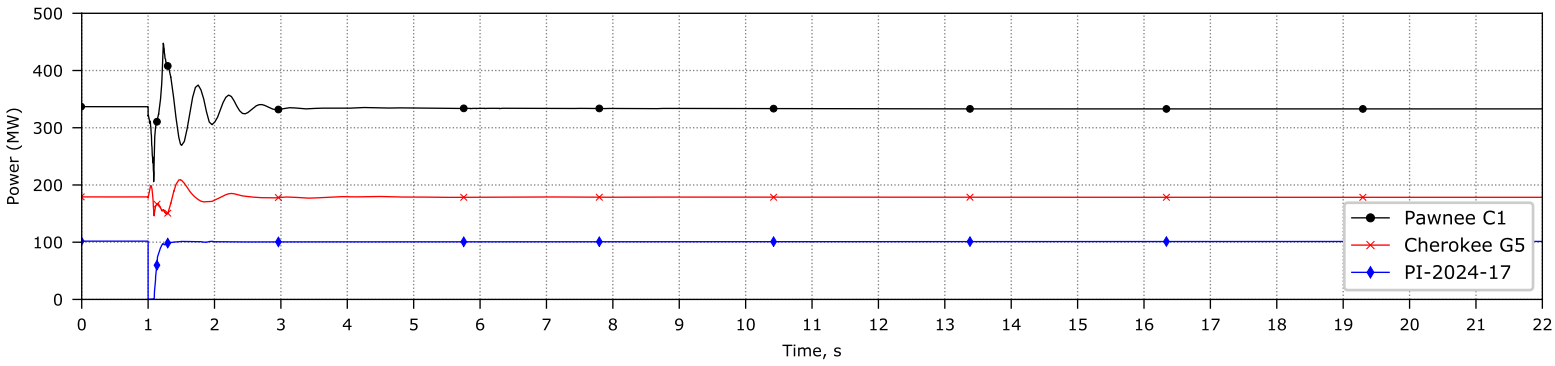


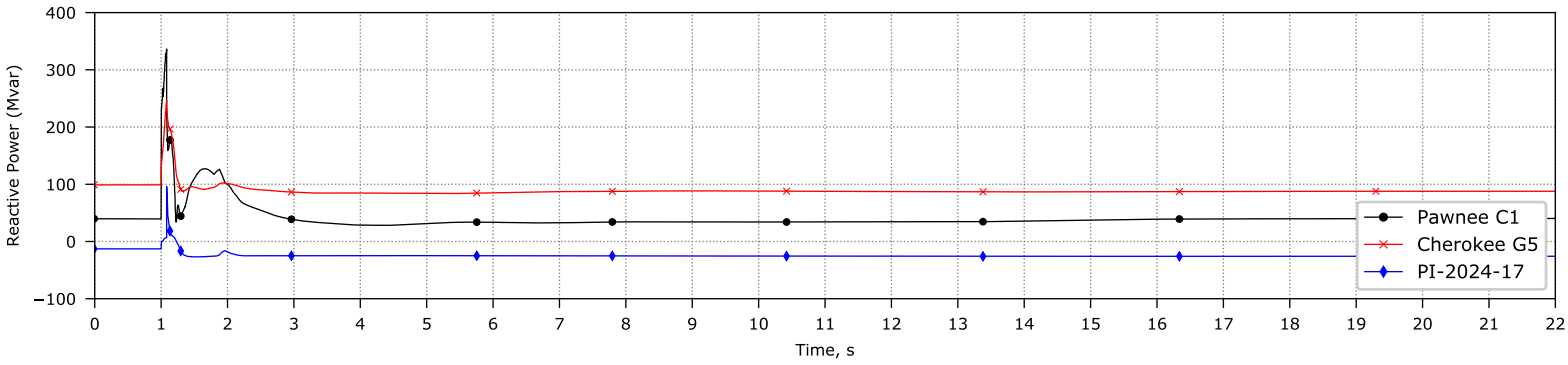


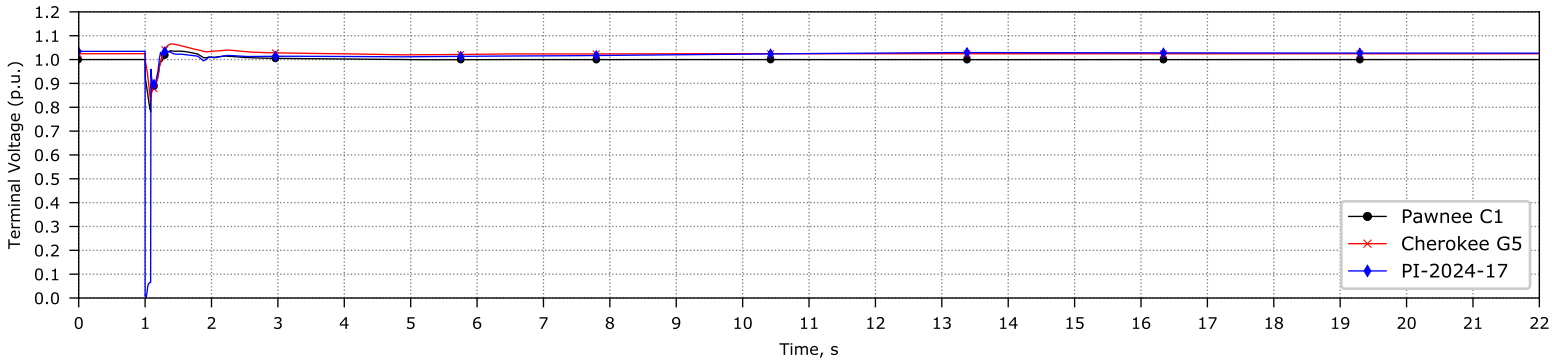


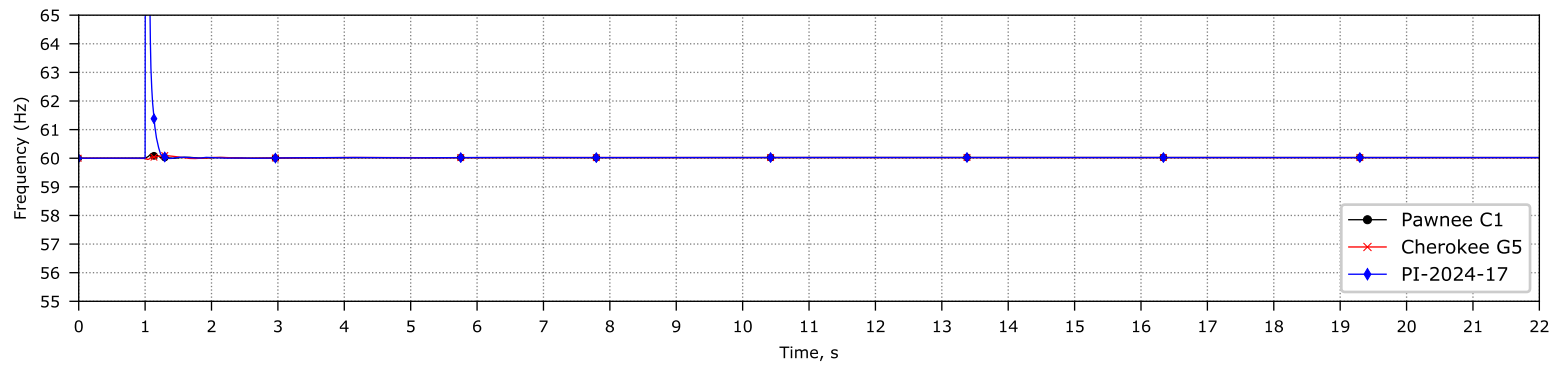
Midway_Mirasol_230kV (LoTC 102)

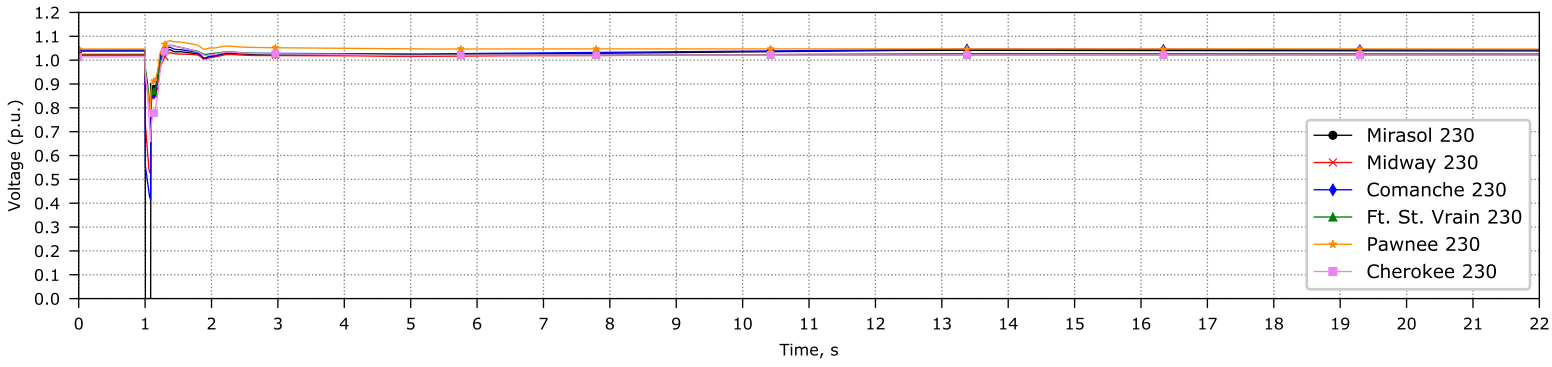




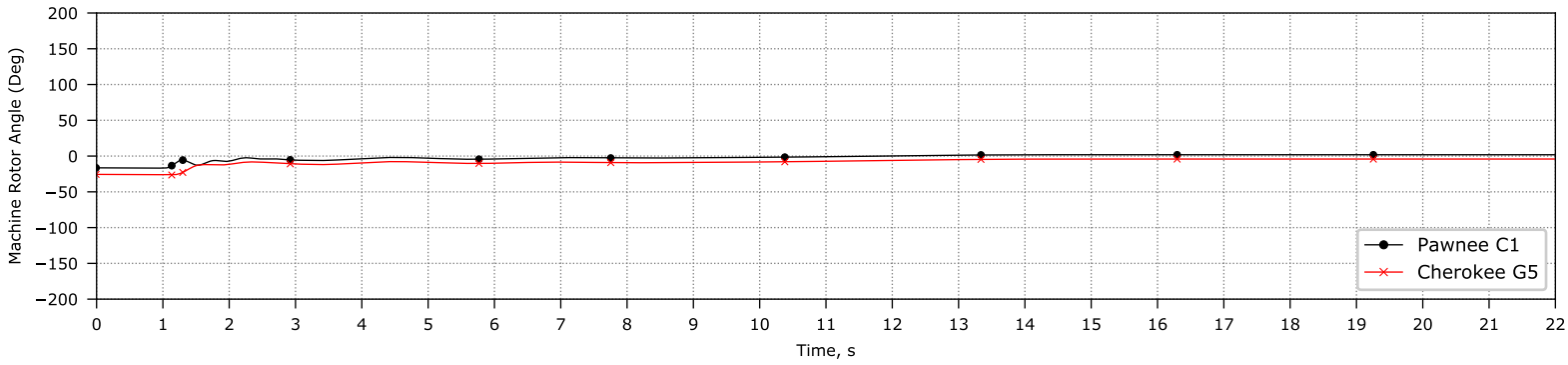


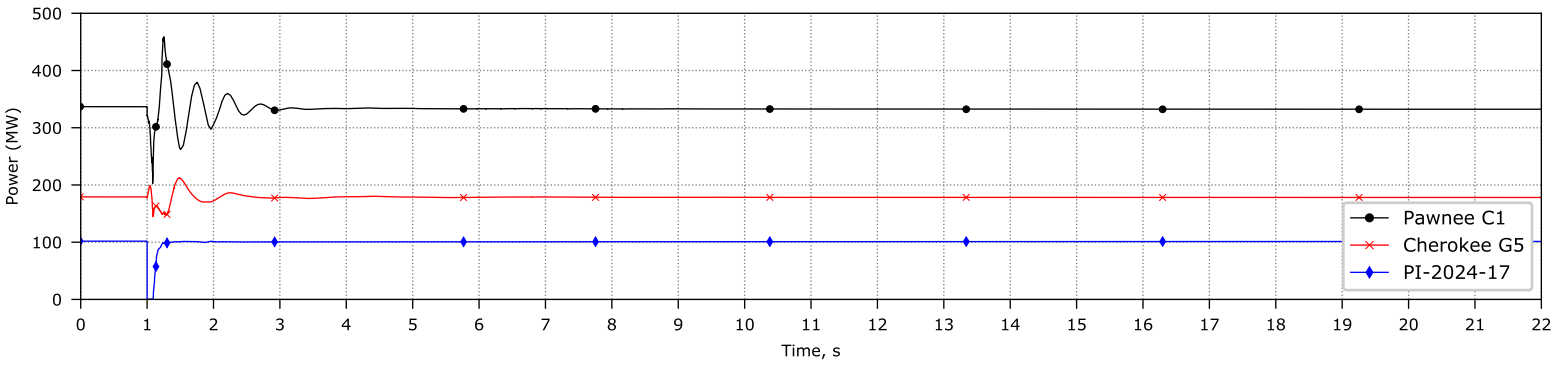


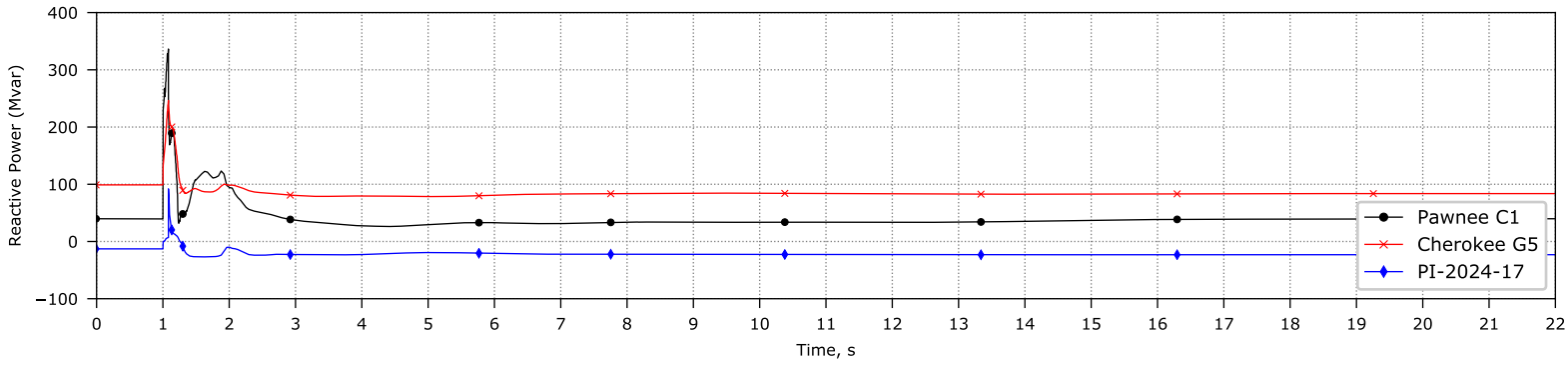


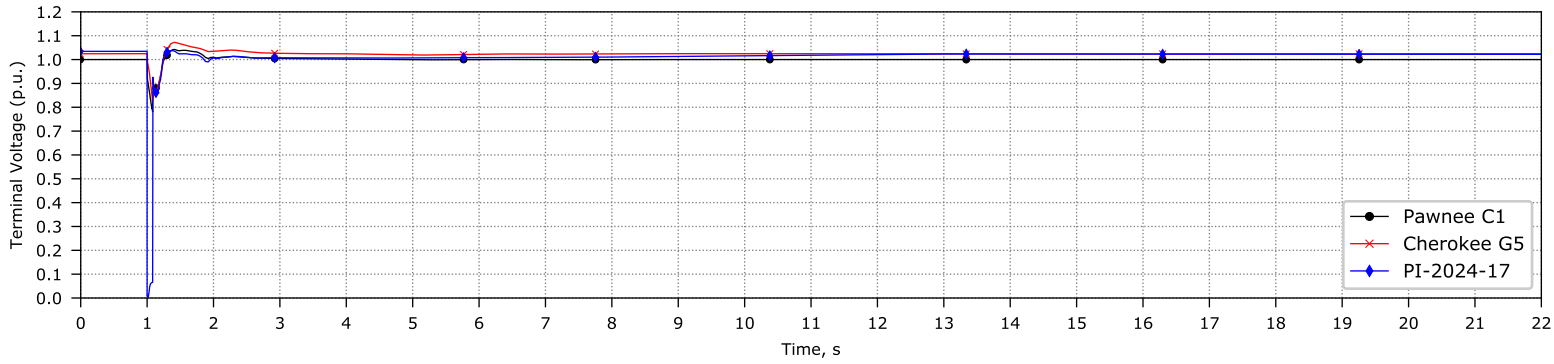


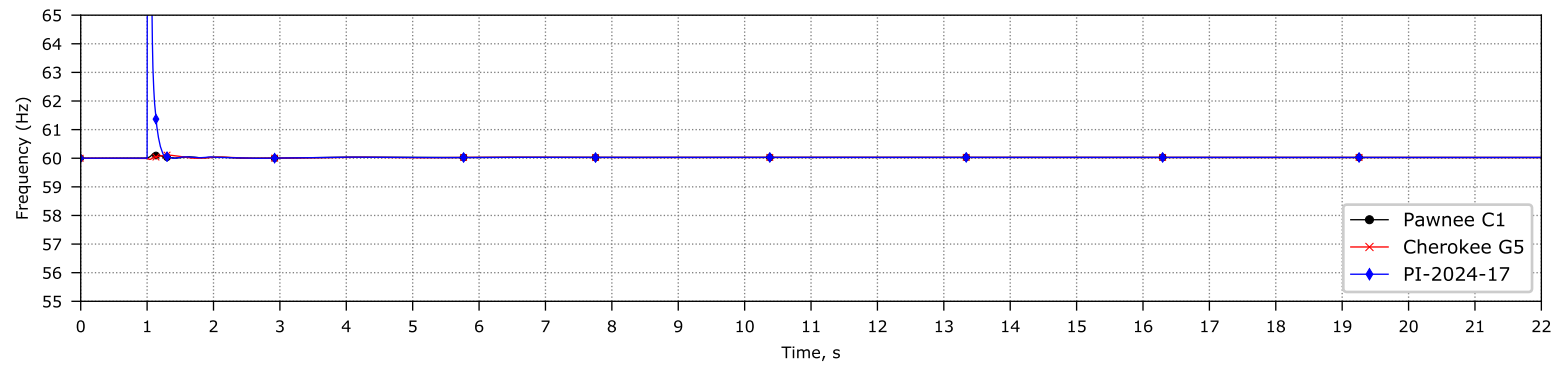
Mirasol_Thunderwolf-Gen_230kV (LoTC 103)

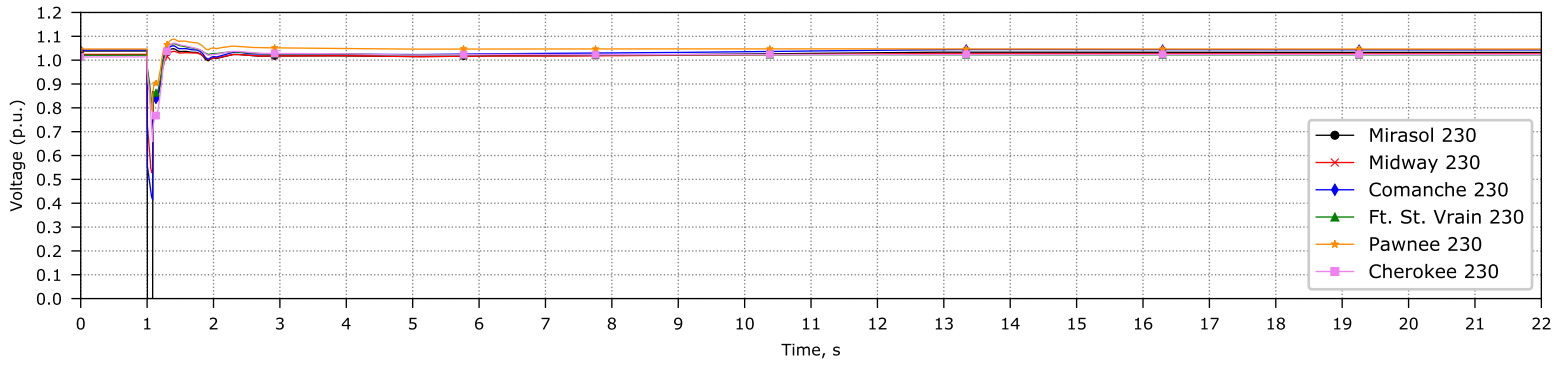




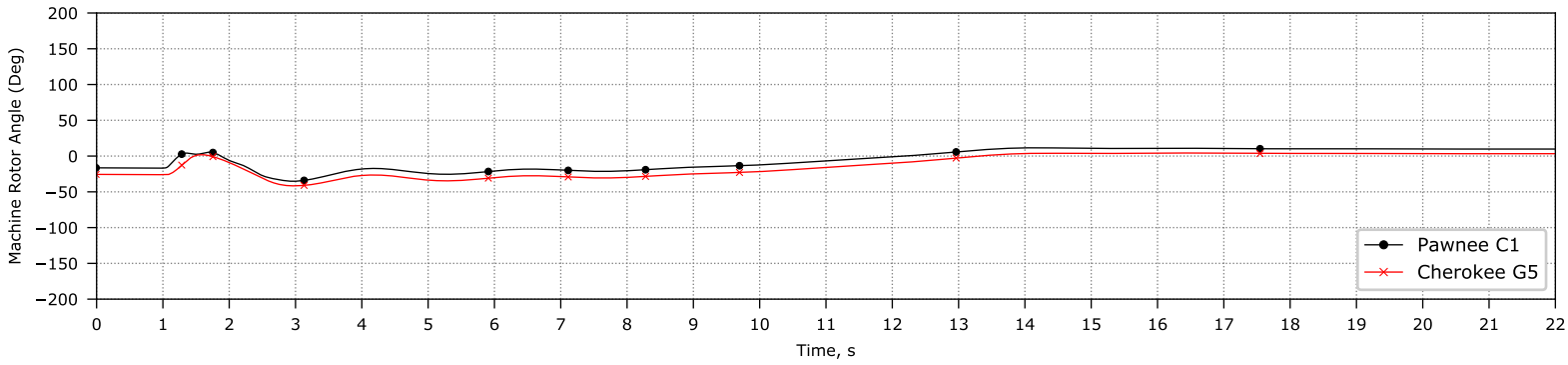


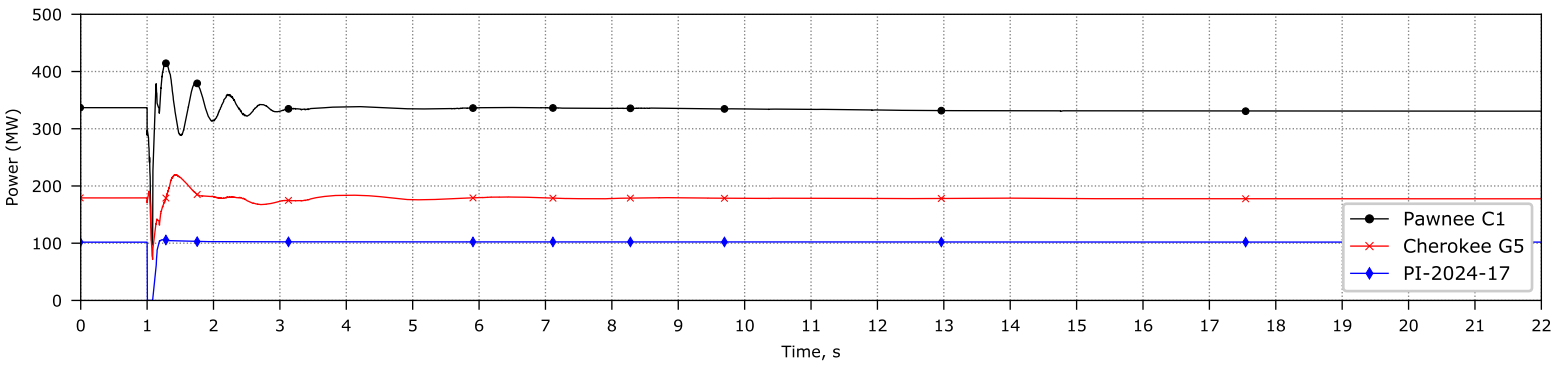


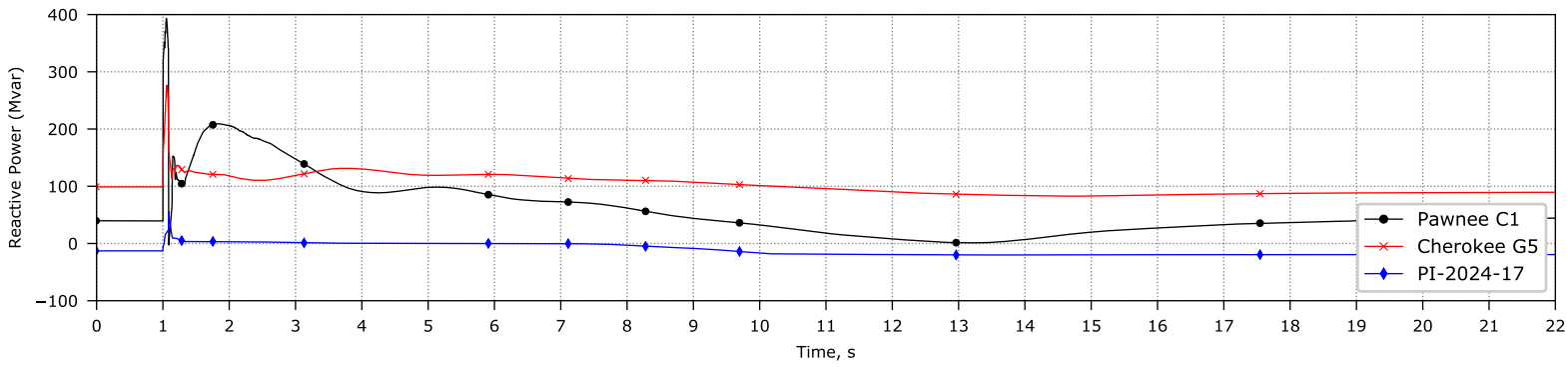


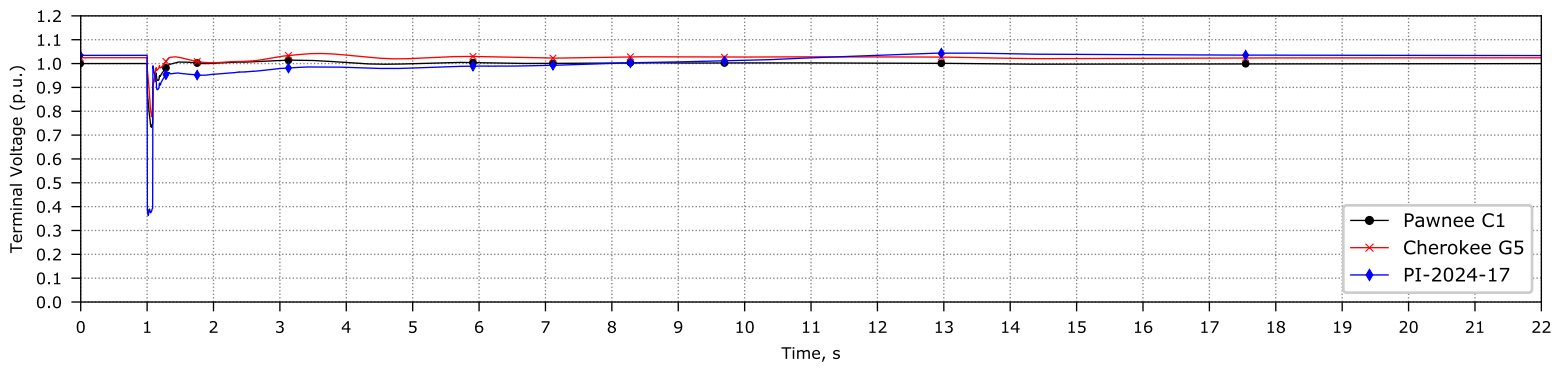


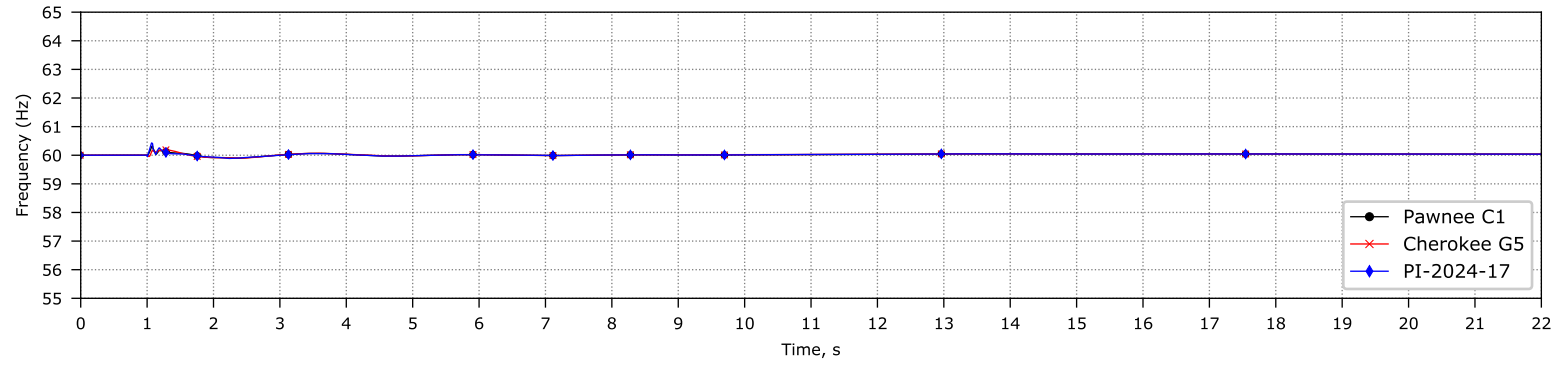
Midway_Fuller_230kV (LoTC 28)

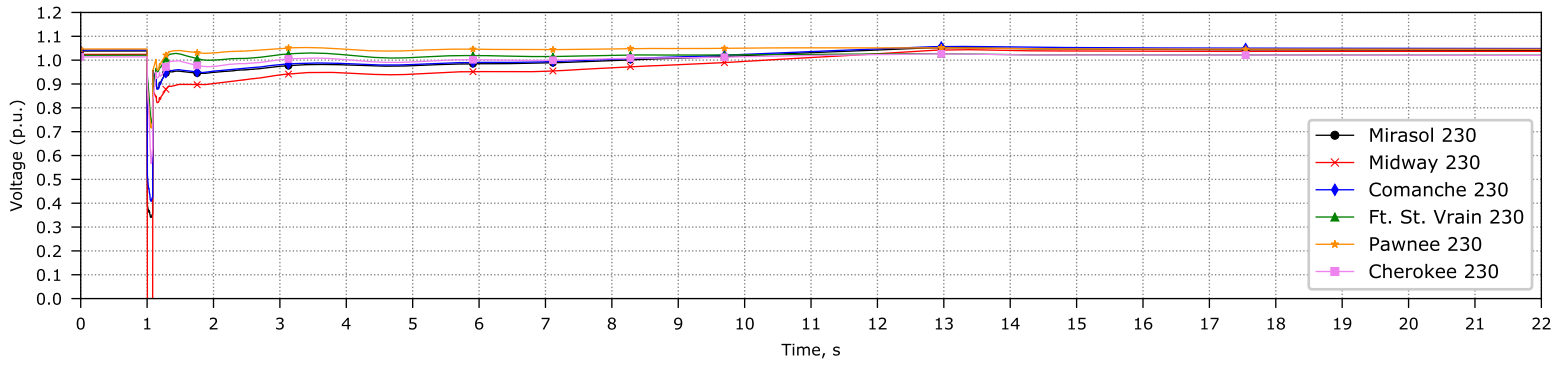




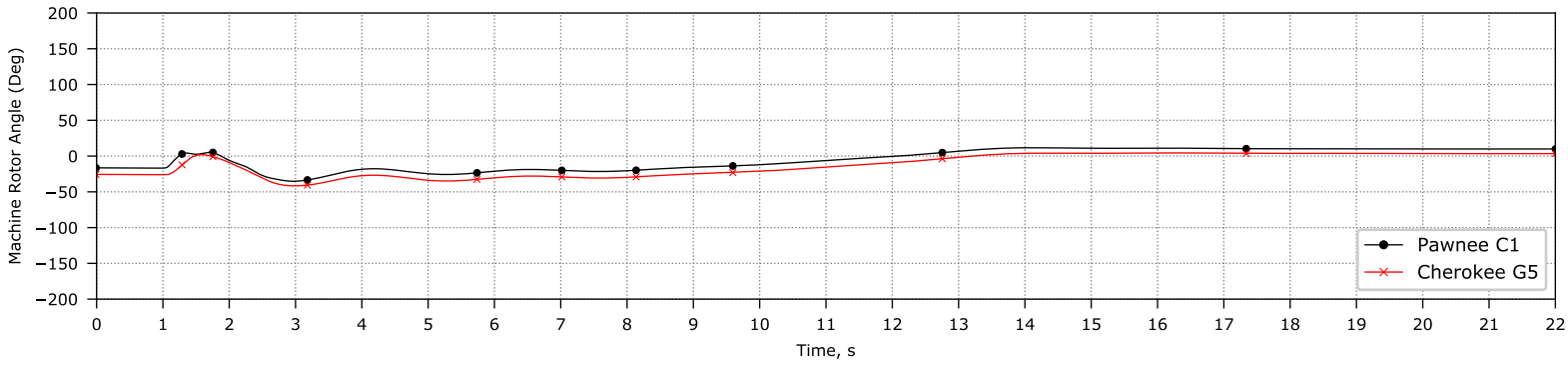


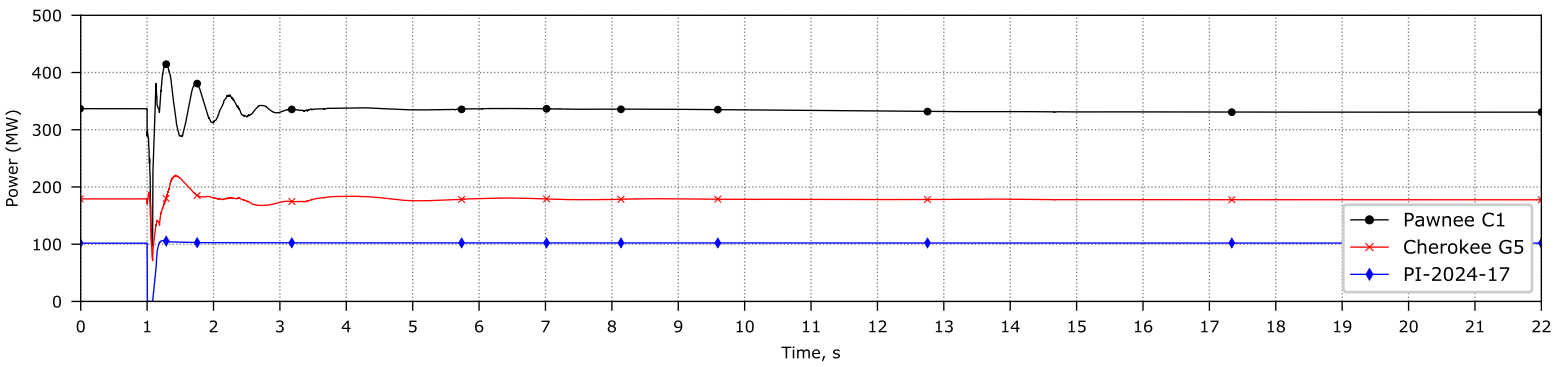


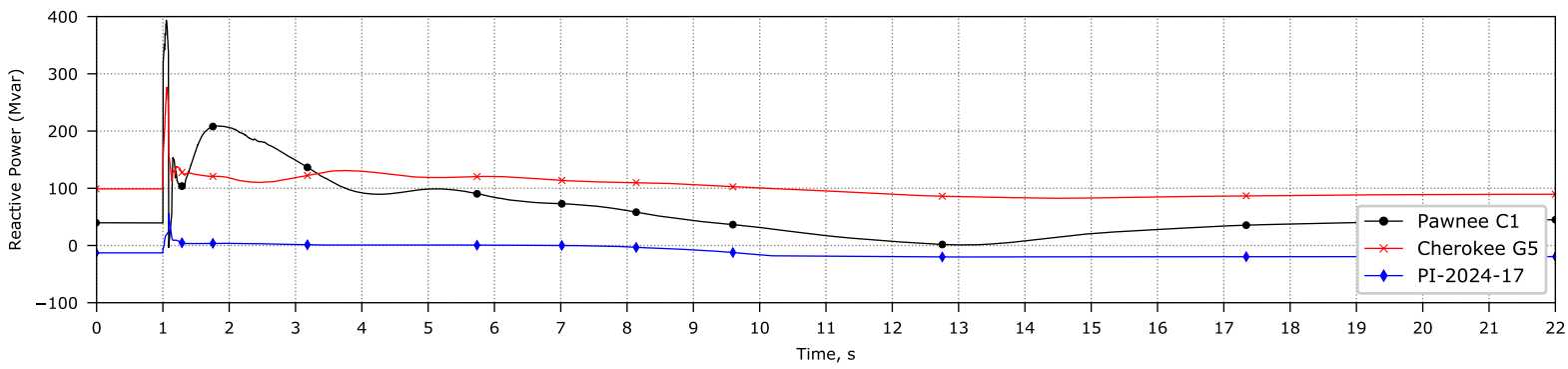


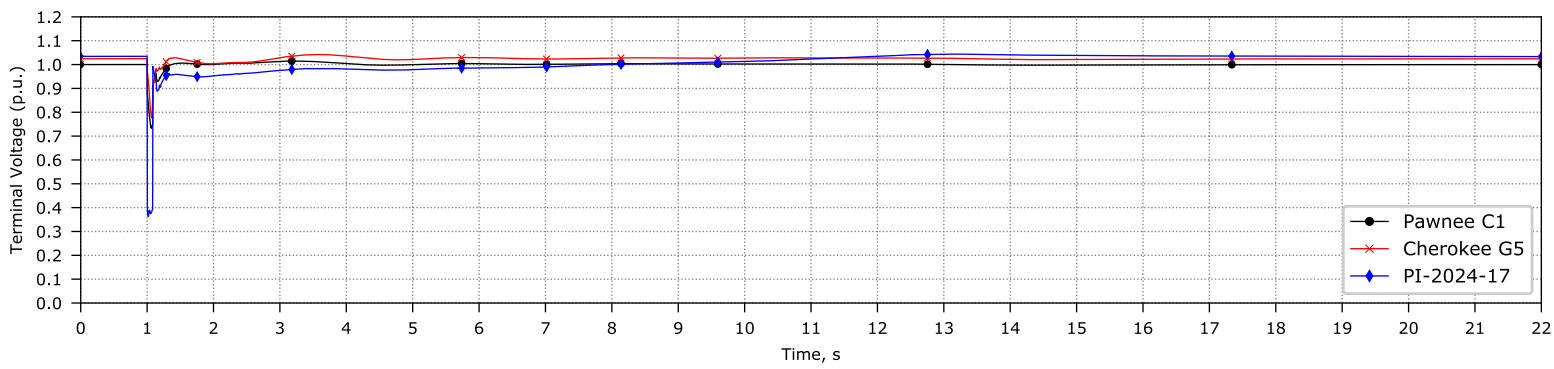


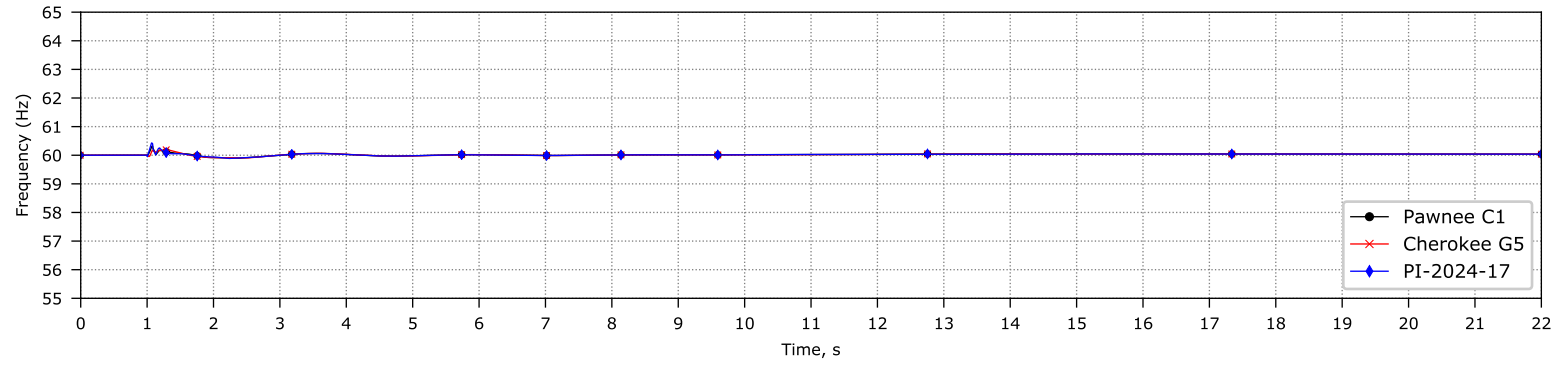
Comanche_Midway_230kV (LoTC 78)

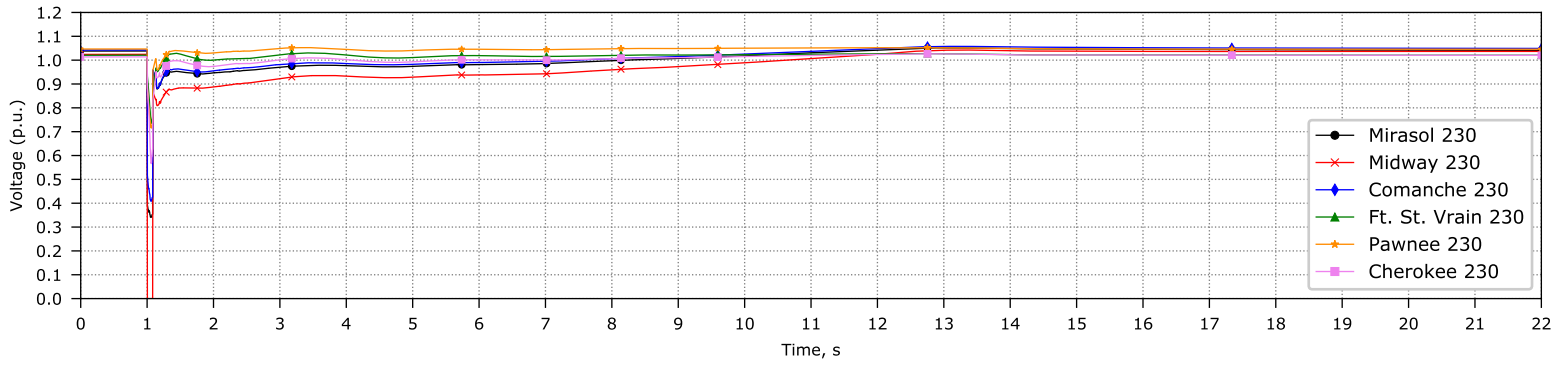




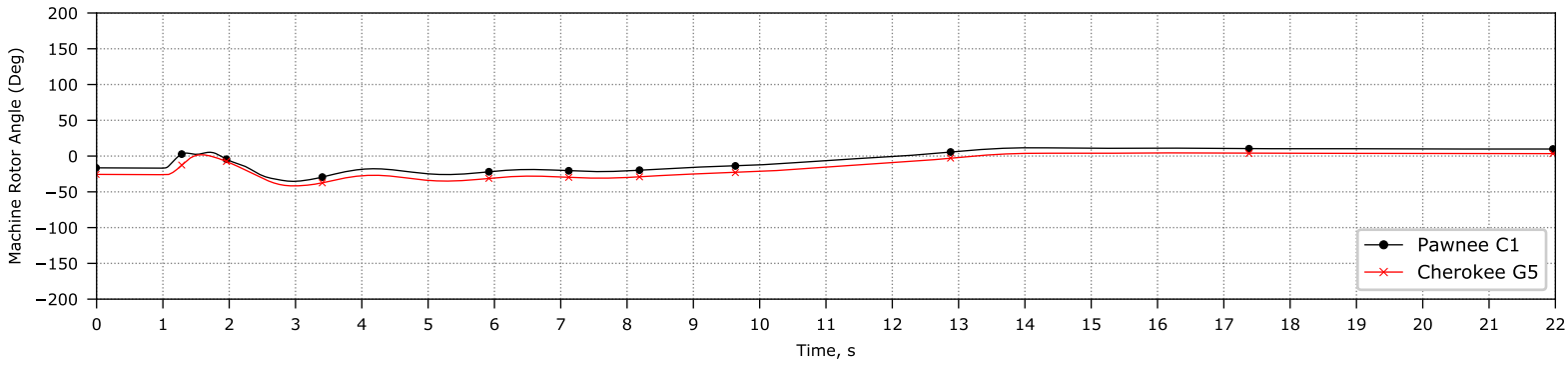


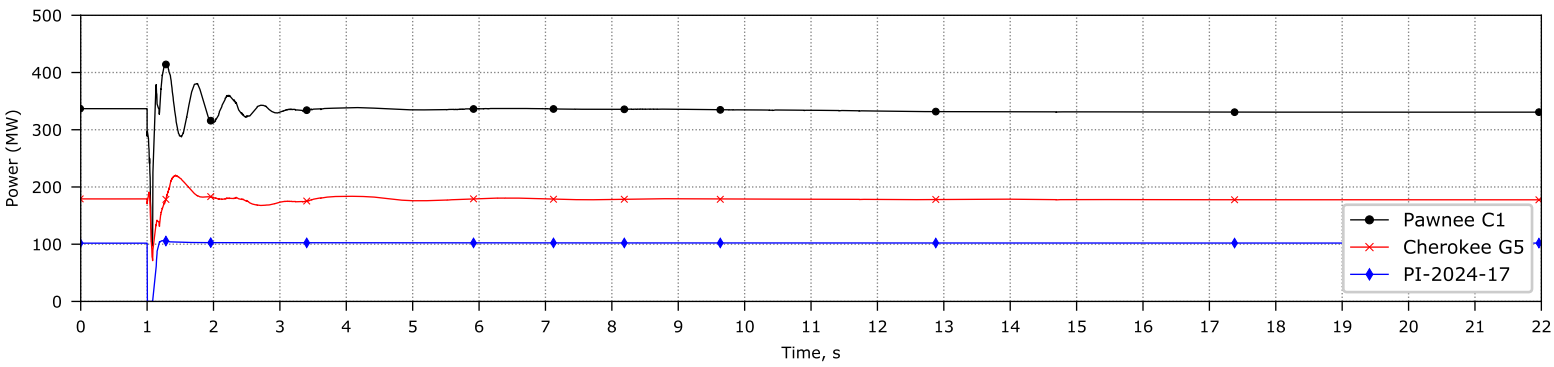


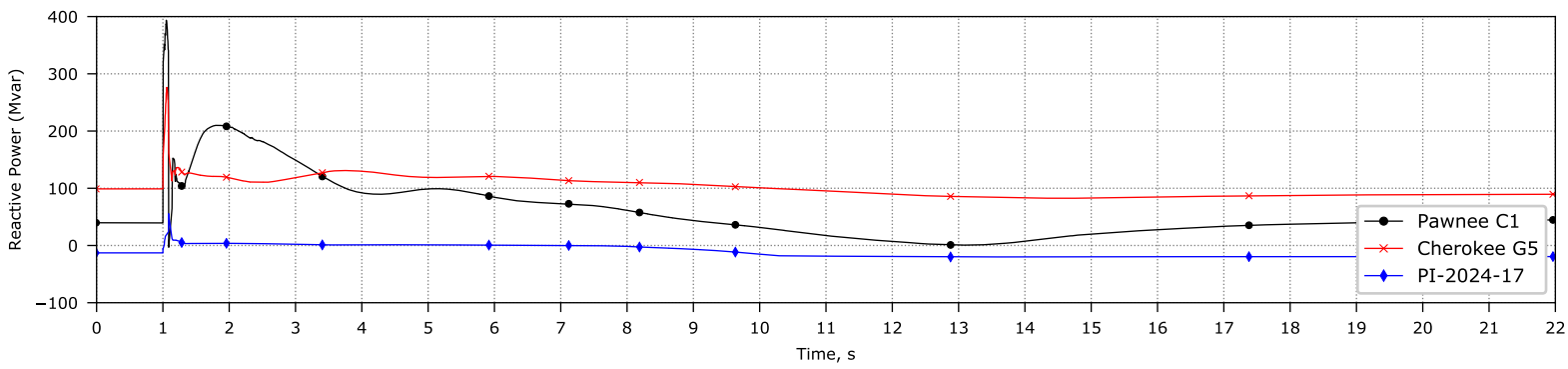


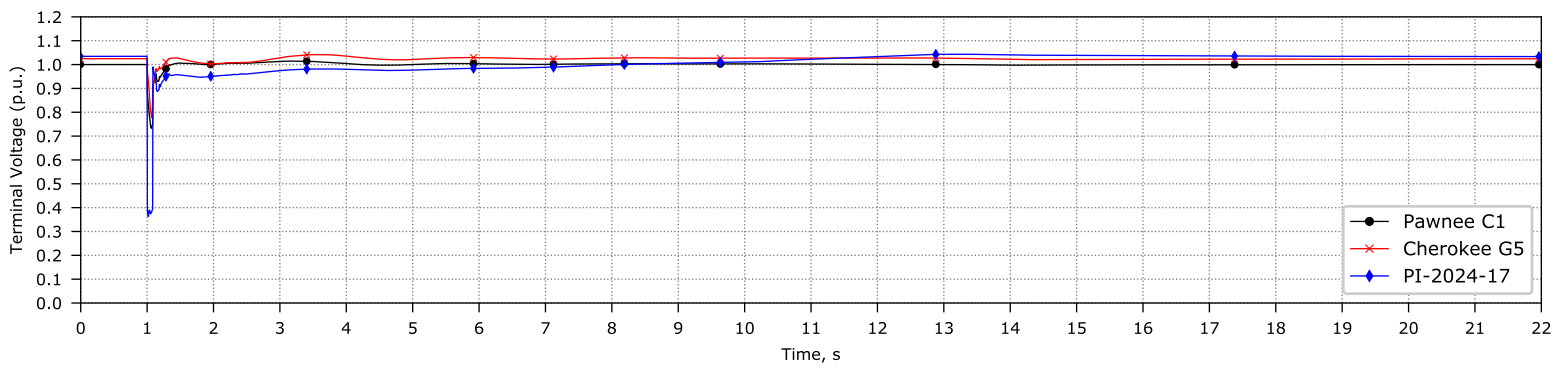


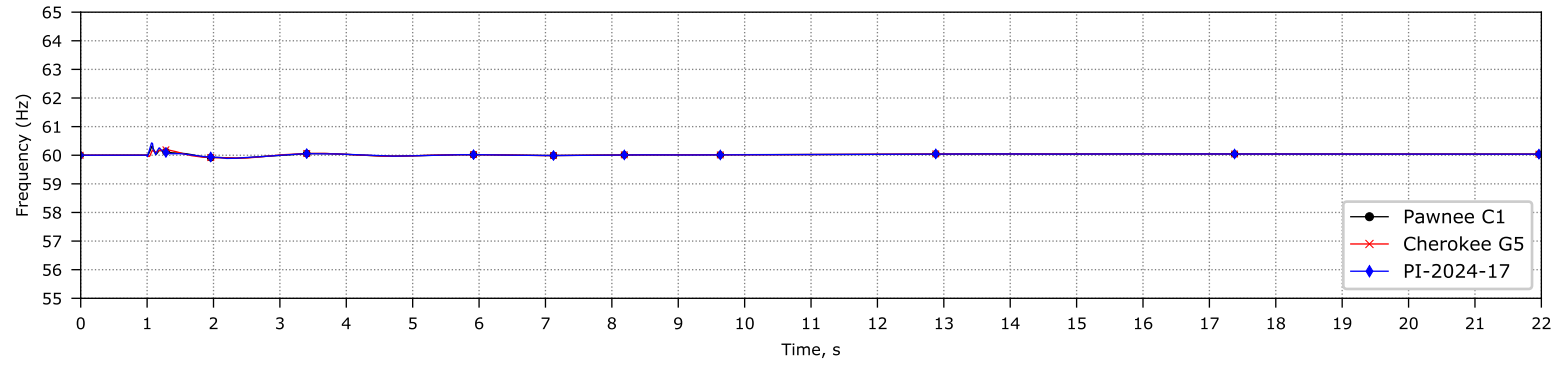
Boone_Midway_230kV (LoTC 69)

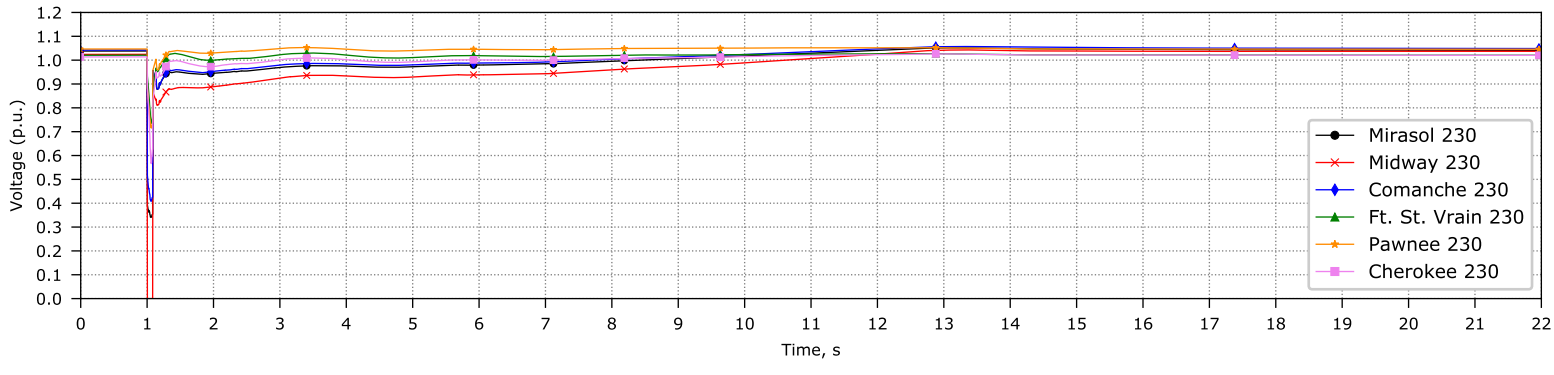




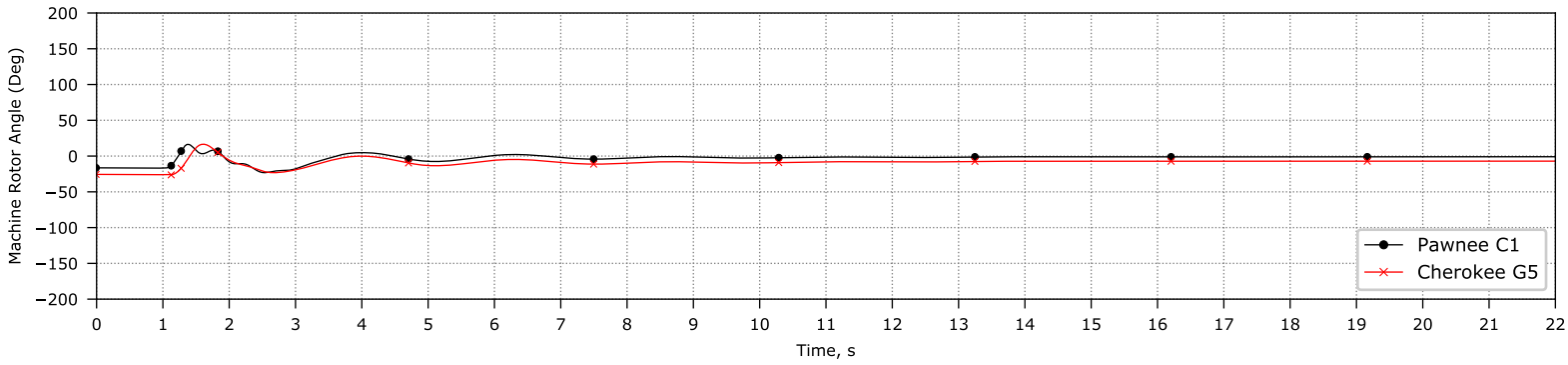


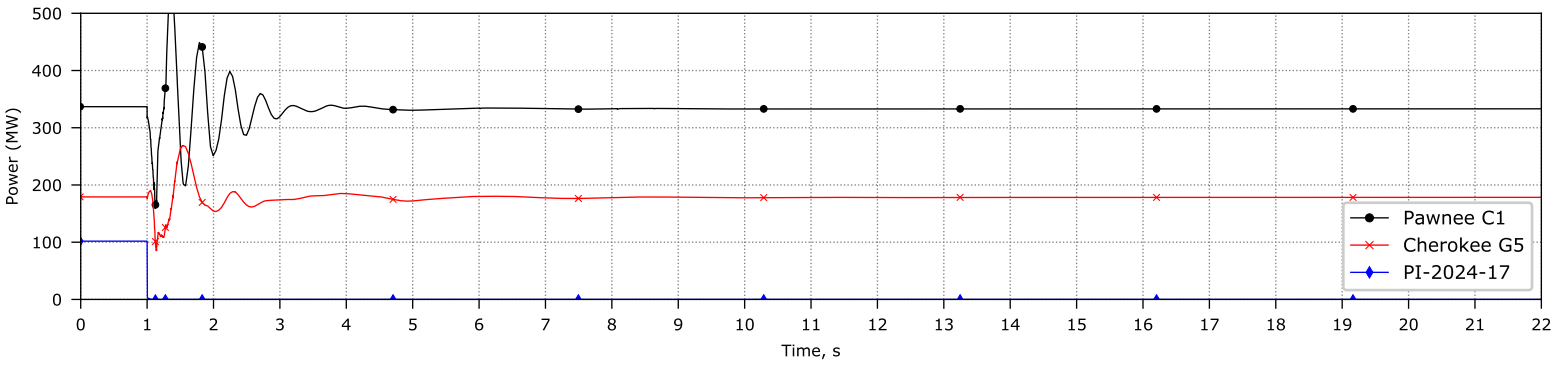


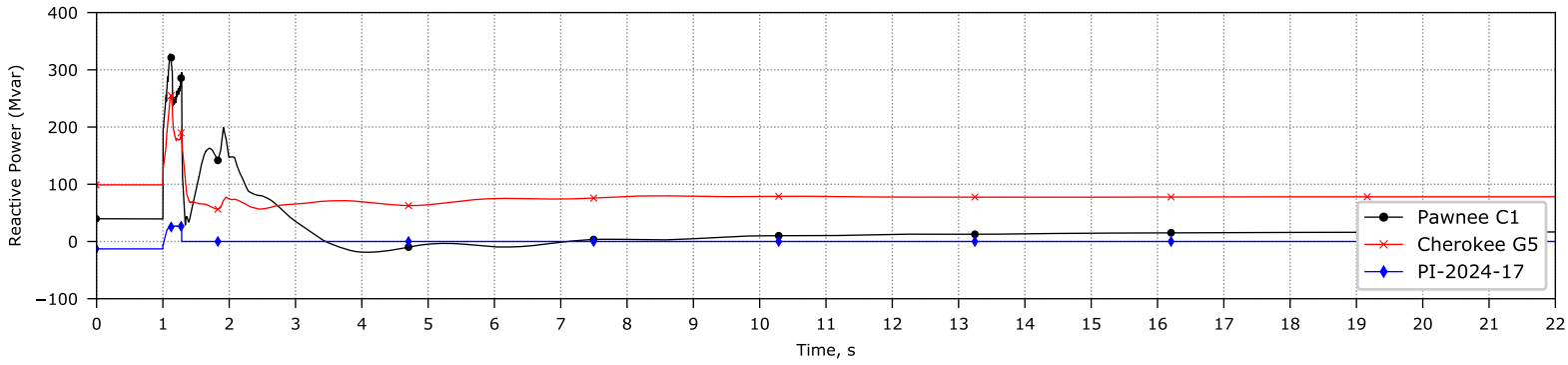


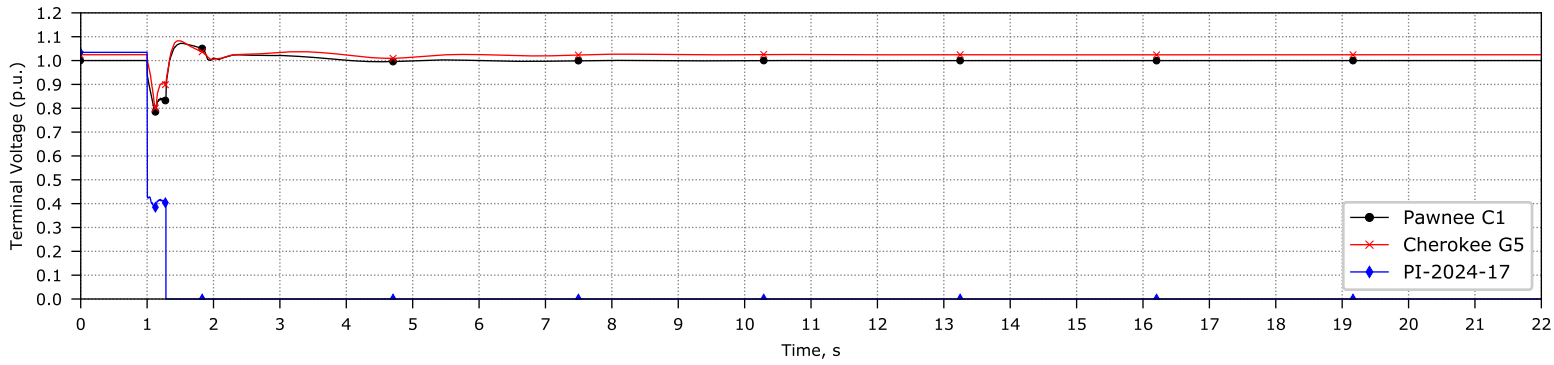


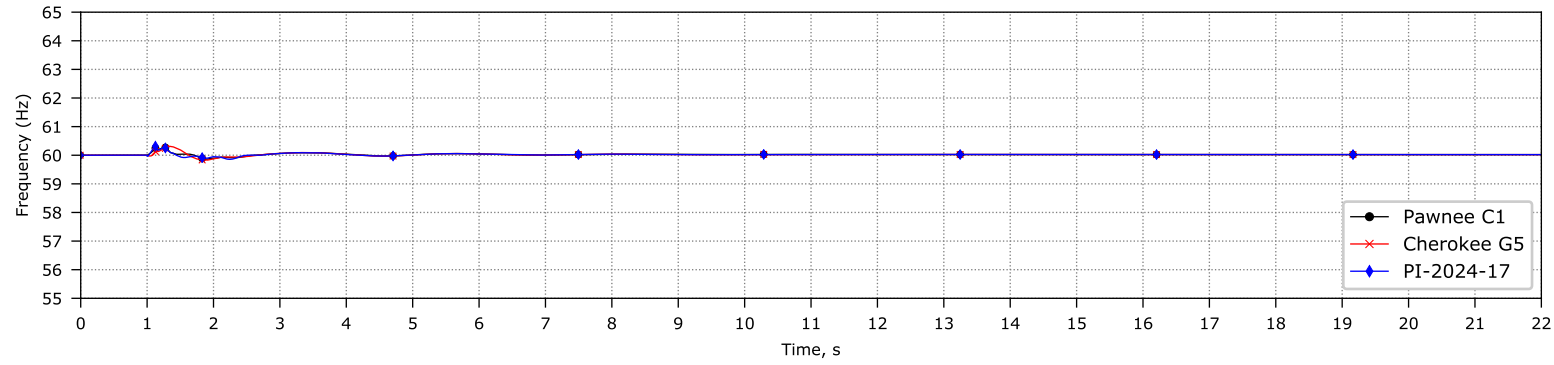
Mirasol_230kV (BF_096a)

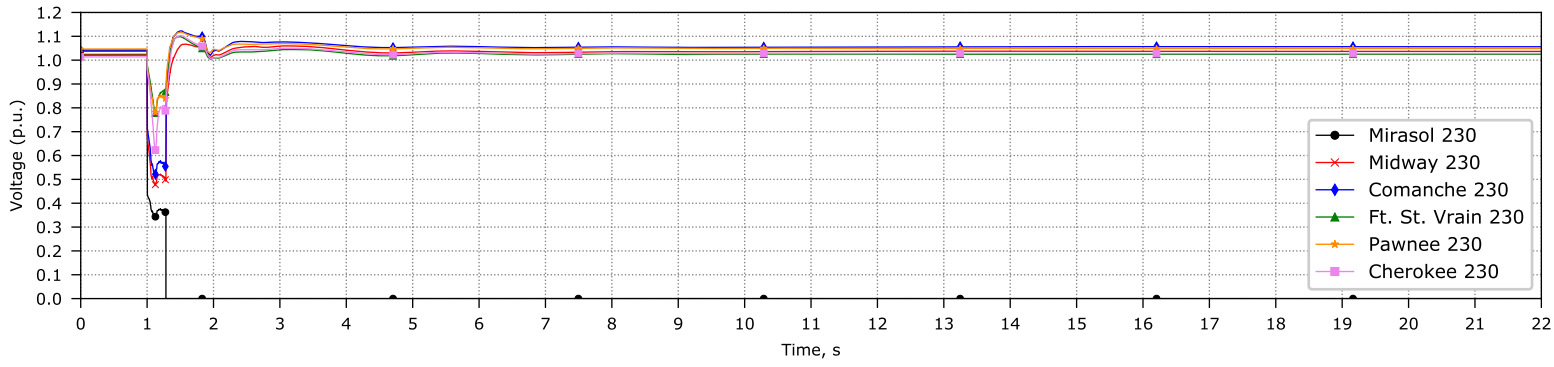




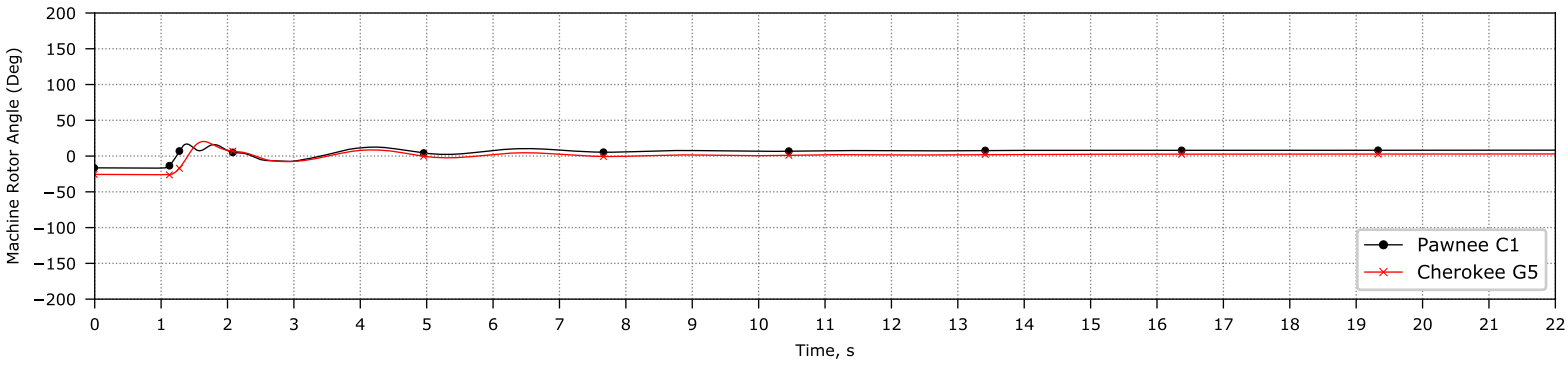


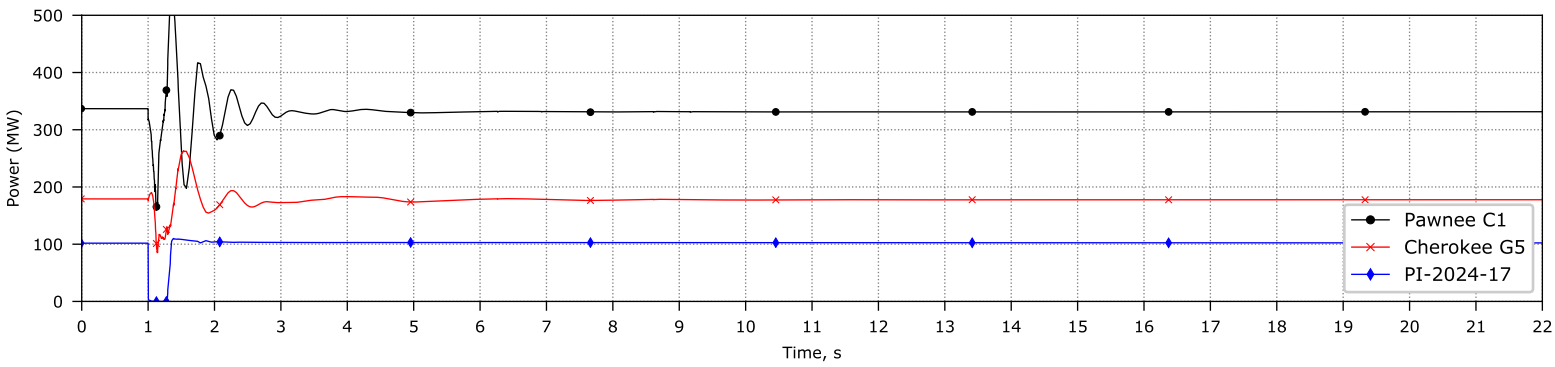


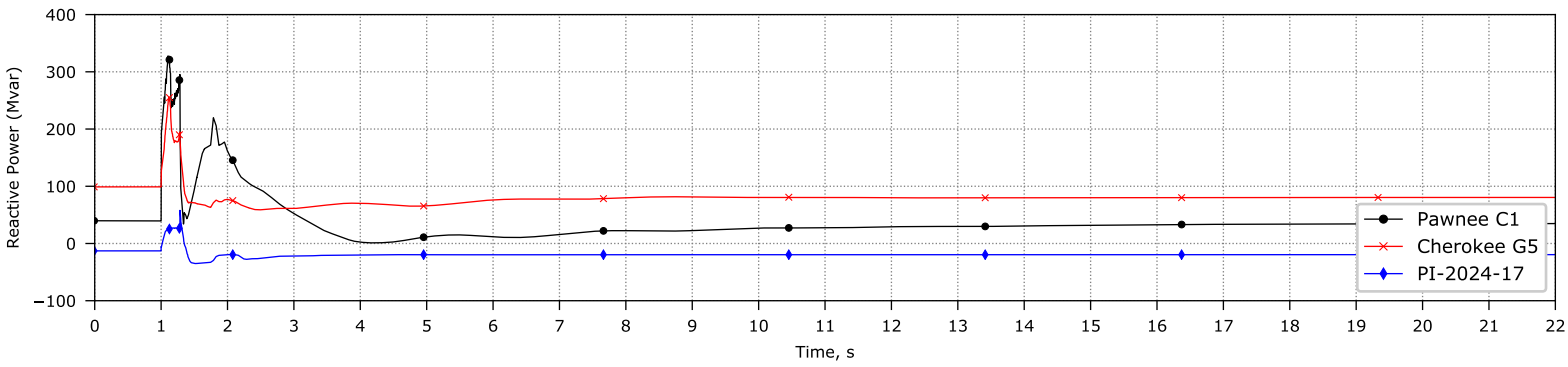


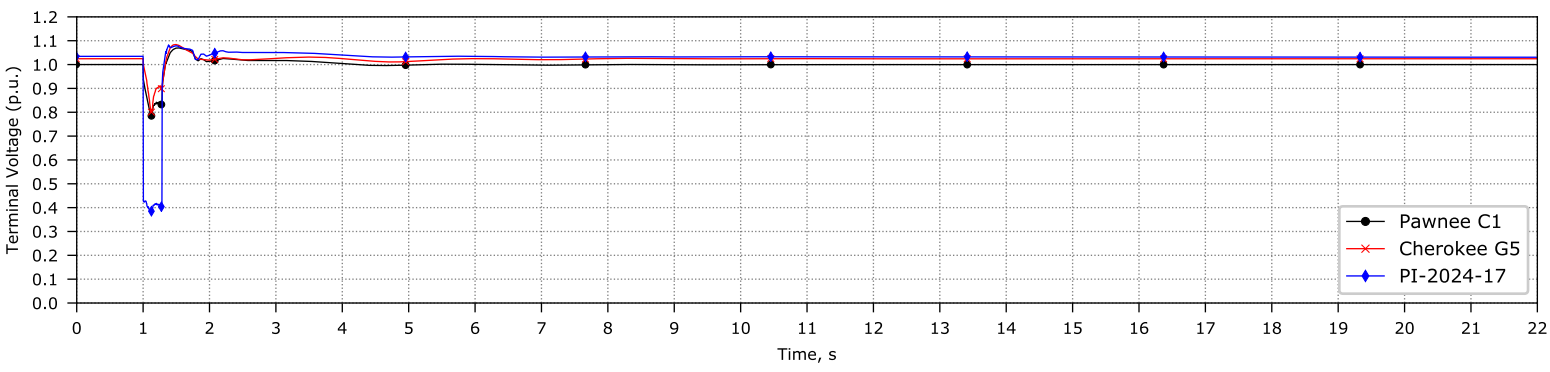


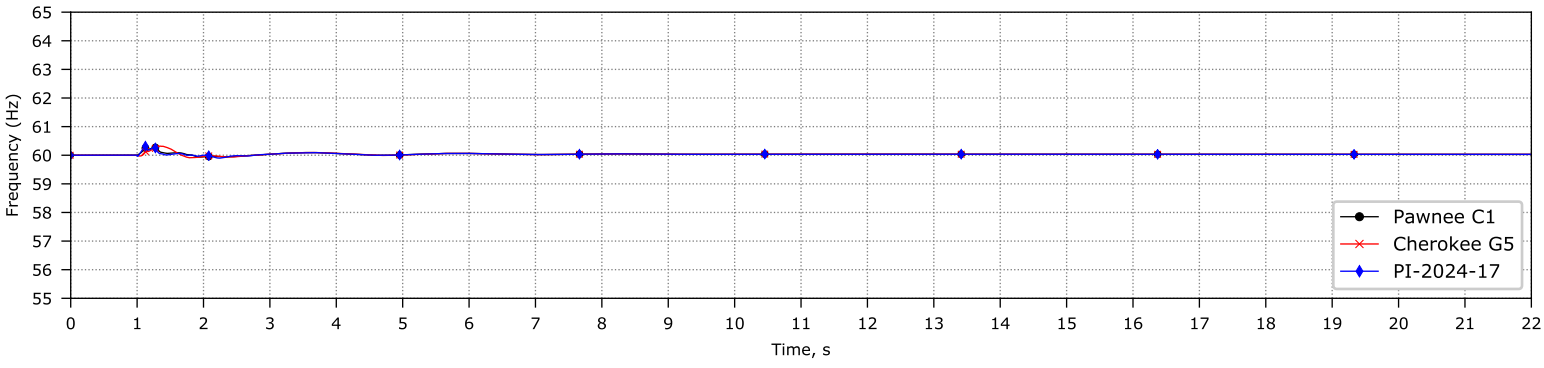
Midway-PS_Mirasol_230kV (BF_094c)

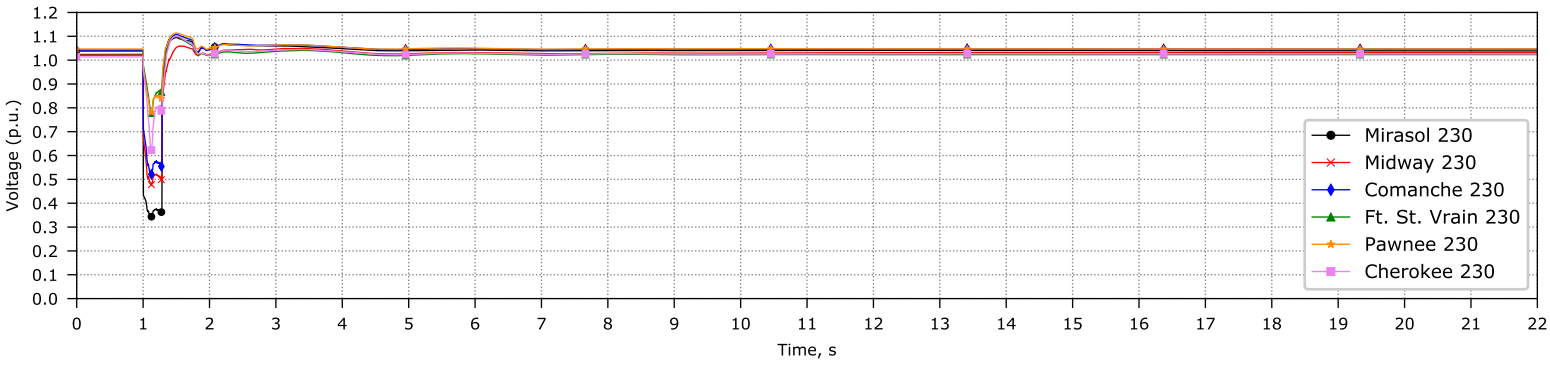




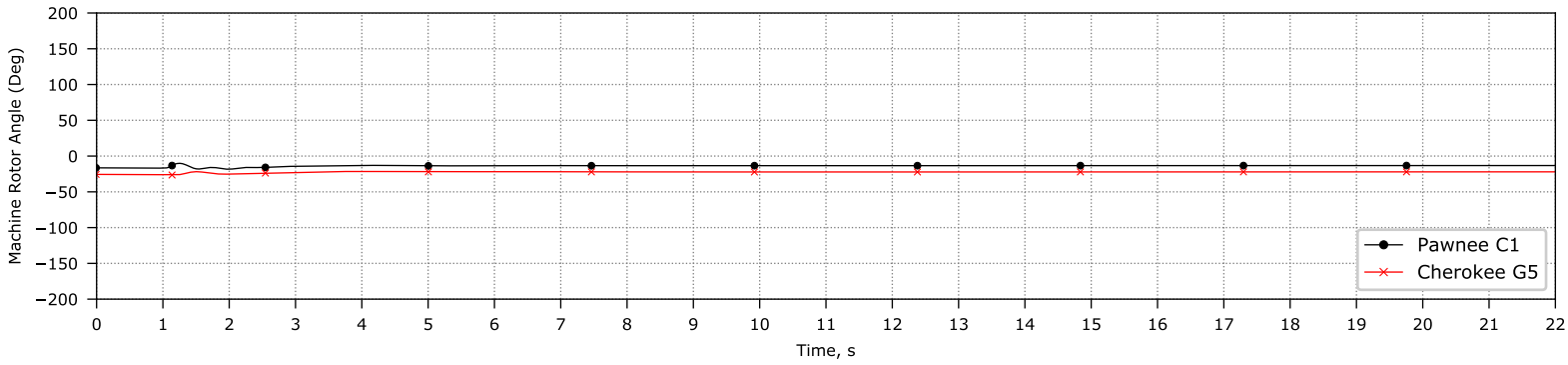


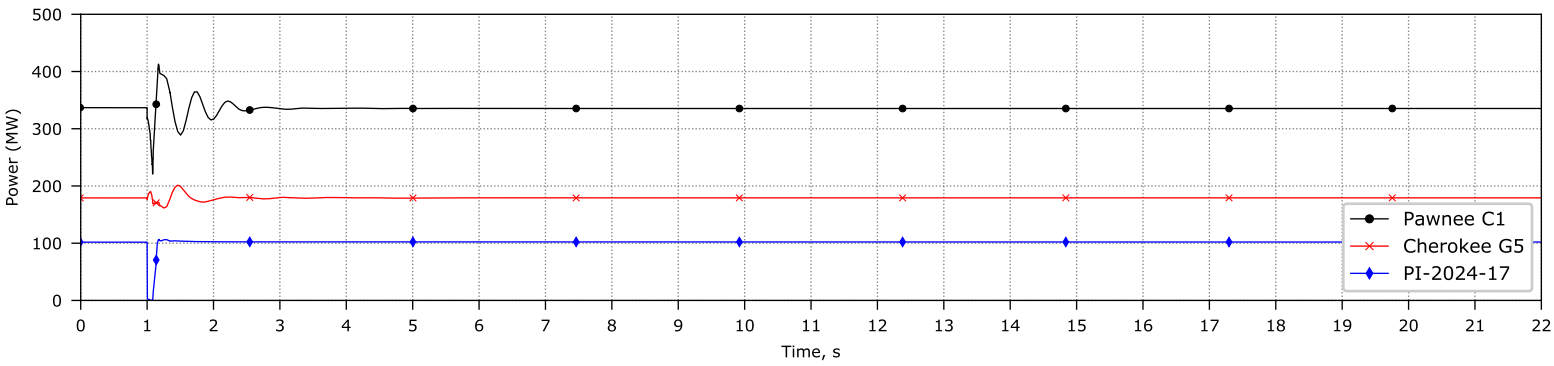


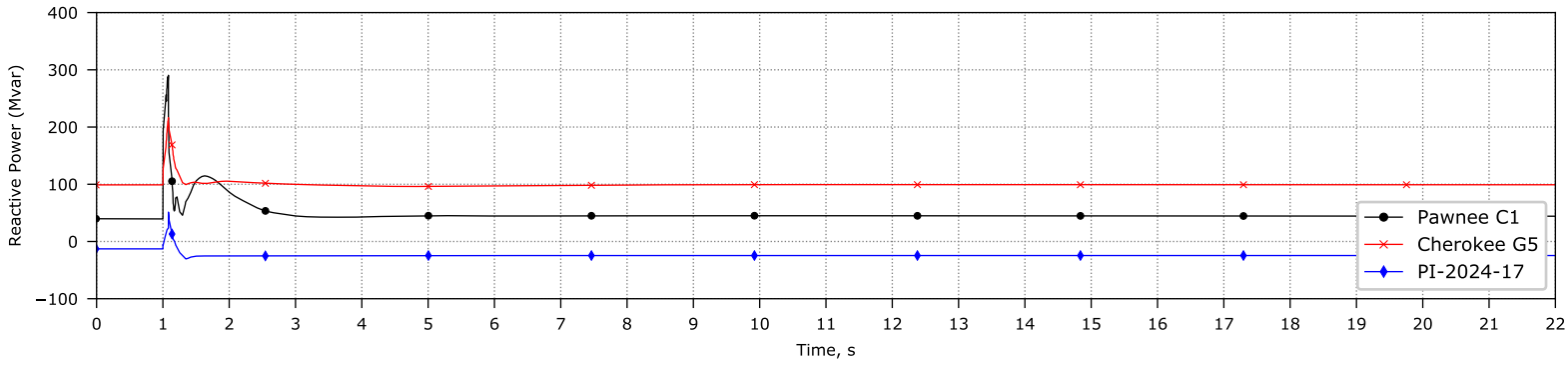


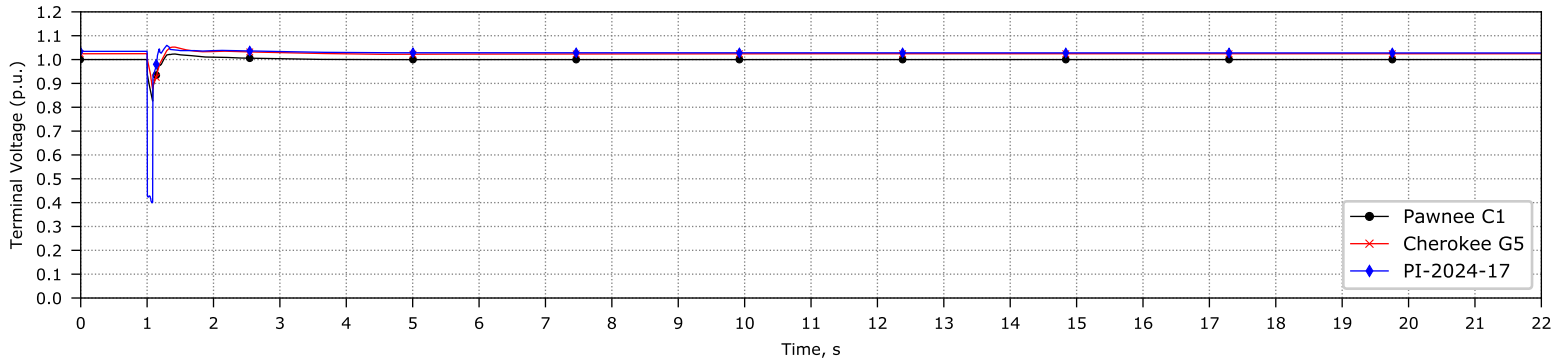


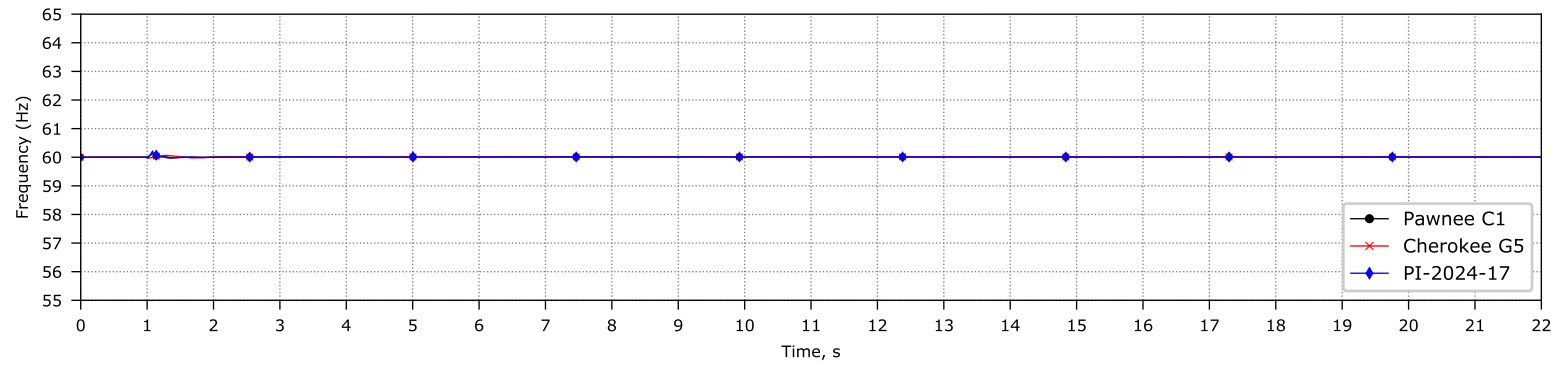
Comanche_Midway_Mirasol_230kV (Lines 5411, 55255)

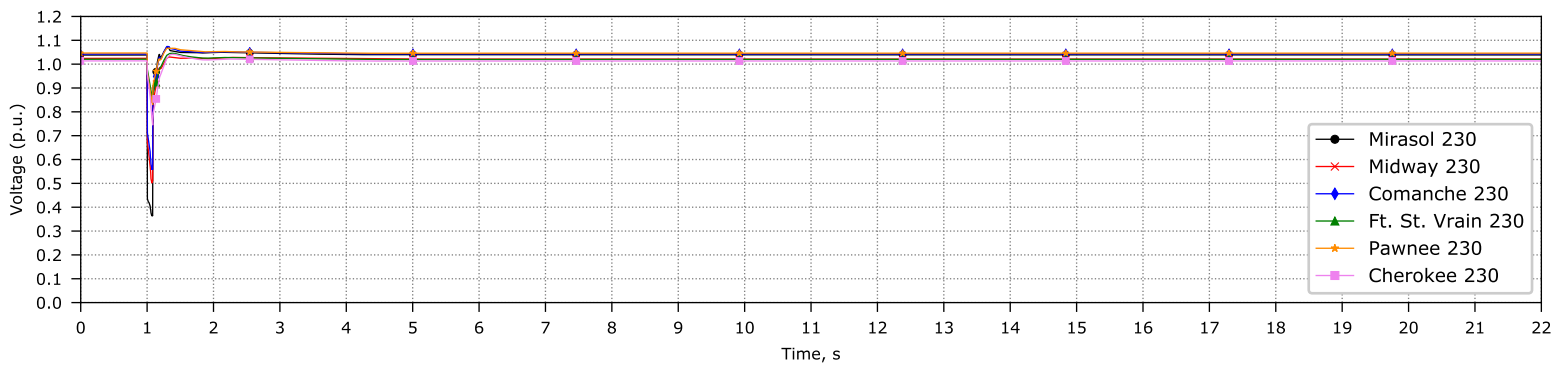












Comanche_Mirasol_Huckleberry_230kV (Lines 5413, 5408)