Provisional Interconnection Study Report for PI-2024-14

8/25/2025

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1.0 Executive Summary

The PI-2024-14 project is a Provisional Interconnection Service (PIS)[1] request for 250 MW Battery Energy Storage System (BESS) with a Point of Interconnection (POI) at the Goose Creek 345 kV switching station. The maximum output will be controlled via power plant controller not to exceed 250 MW at the POI. PI-2024-14 is the Provisional Interconnection Service request as associated with Generation Interconnection Request 5RSC-2024-10 in the 5RSC cluster.

The total estimated cost of the PSCo transmission system improvements required for PI-2024-14 to qualify for Provisional Interconnection Service is estimated to be $8.118 million (Table 11 and Table 12).

The initial maximum permissible output of PI-2024-14 Generating Facility is 250 MW in Discharging mode at the POI and 250 MW in Grid Charging mode at the POI. 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-2024-14 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 $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-2024-14 is the Provisional Interconnection Service for a 250 MW Battery Energy Storage System (net output located in Cheyenne 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 Goose Creek 345 kV switching station.
- The COD requested to be studied for PI-2024-14 is May 1, 2027.

The geographical location of the transmission system near the POI is shown in Figure 1.

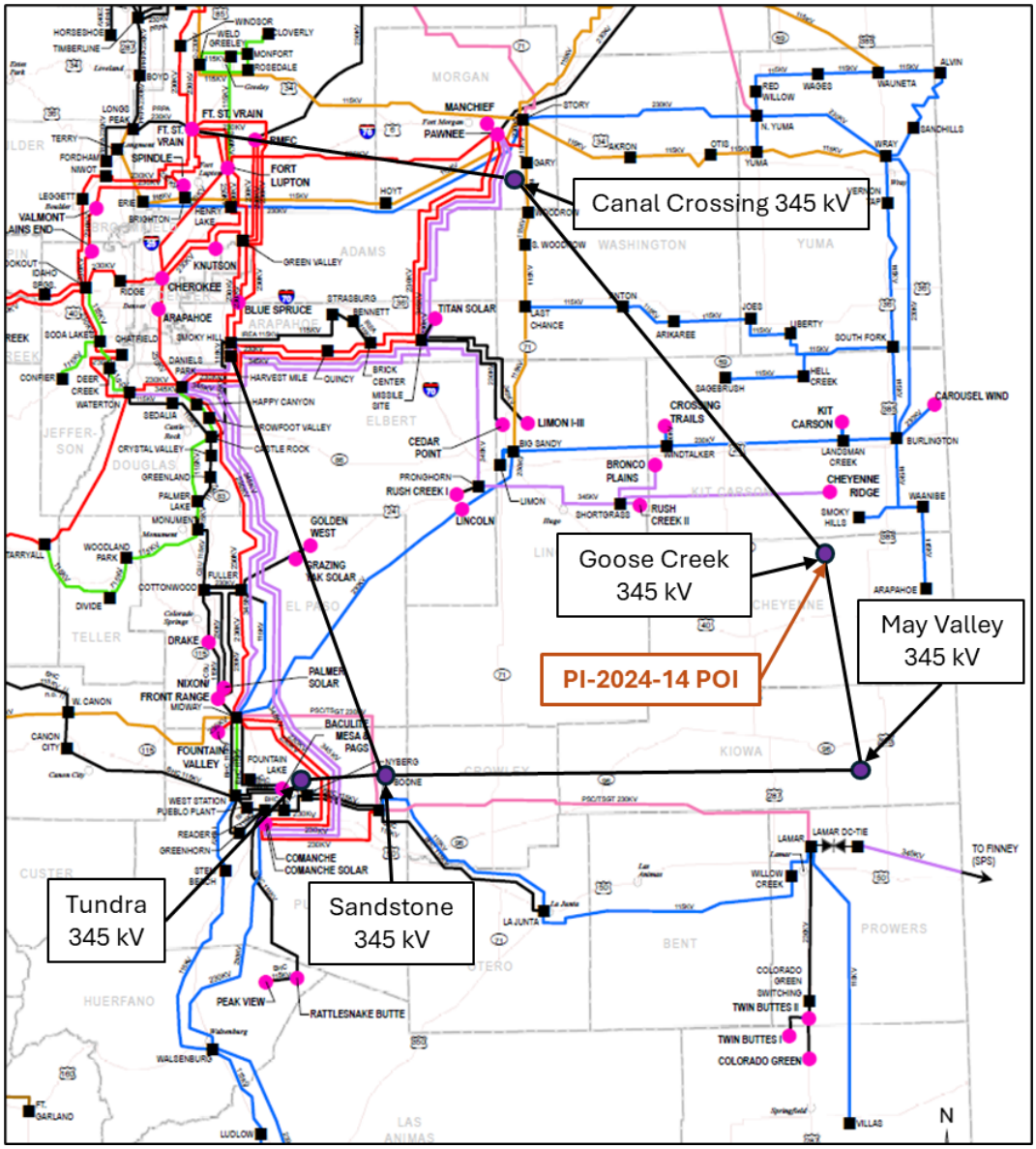

Figure 1: Approximate Point of Interconnection of PI-2024-14

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-2024-14 for Provisional Interconnection Service. Consistent with the assumption in the study agreement, PI-2024-14 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 transmission 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 applicable.

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

Table 1 – Transient Stability Contingencies

Ref. No.	Contingency Name	Fault Category	Outage(s)	Clearing Time (Cycles)
1	Flat Run	P0	-	-
2	PI-2024-14 Gen	P1	PI-2024-14 Generation	4
3	GseCrk - CanalXing-P1 (P1-2_1)	P1	Goose Creek - Canal Crossing 345 kV ckt 1	4
4	GseCrk - MayVal-P1 (P1-2_2)	P1	Goose Creek - May Valley 345 kV ckt 1	4
5	GseCrk - Shortgrass-P1 (P1-2_3)	P1	Goose Creek - Short Grass 345 kV ckt 1	4
6	Missile Site - Canal Crossing-P1 (P1-2_5)	P1	Missile Site - Canal Crossing 345 kV ckt 1	4
7	Canal Crossing - Pawnee-P1 (P1-2_7)	P1	Canal Crossing - Pawnee 345 kV ckt 1	4
8	Shortgrass - Pronghorn-P1 (P1-2_8)	P1	Shortgrass - Pronghorn 345 kV ckt 1	4
9	Shortgrass - Bronco_plns-P1 (P1-2_9)	P1	Shortgrass - Bronco Plains 345 kV ckt 1	4

Ref. No.	Contingency Name	Fault Category	Outage(s)	Clearing Time (Cycles)
10	May Valley - Sandstone-P1 (P1-2_10)	P1	May Valley - Sandstone 345 kV ckt 1	4
11	GseCrk - Cheyenne Ridge-P4 (BF_034)	P4	Goose Creek - Cheyenne Ridge 345 kV ckt 1	12
12	Canal Crossing - Goose Creek-P7 (P7_160)	P7	Canal Crossing - Goose Creek 345 kV ckt 1 Canal Crossing - Goose Creek 345 kV ckt 2	4
13	May Valley - Goose Creek-P7 (P7_163)	P7	May Valley - Goose Creek 345 kV ckt 1 May Valley - Goose Creek 345 kV ckt 2	4
14	Goose Creek to Shortgrass and Cheyenne Ridge-P7 (P7_164)	P7	Goose Creek - Short Grass 345 kV ckt 1 Goose Creek - Cheyenne Ridge 345 kV ckt 1	4

3.6 Study Area

The East Colorado study area includes WECC designated zone 706. As described in Section 3.11 of the BPM, the East study pocket is comprised of the eastern Colorado transmission system with major generation injecting into the following substations:

- Pawnee: Pawnee Coal, Manchief Gas, Peetz Logan Wind
- Beaver Creek: Brush Gas + Combined Cycle (CC)
- Missile Site: Cedar Point Wind, Limon Wind, Rush Creek Wind

4.0 Base Case Modeling Assumptions

The 2029HS2a WECC case released on May 8, 2023, was selected as the Starting Case. The 2027 Heavy Summer (2027HS) Base Case was created from the Starting Case by including the following modeling changes:

- Shortgrass to Goose Creek uprate to 1439 MVA – ISD TBD
- Poncha – San Luis Valley 115 kV L9811 uprate to 239 MVA – ISD 8/20/2025.
- Daniels Park-Prairie-Greenwood Uprate L5707 to 956 MVA – ISD 6/1/2026.
- Leetsdale-Monroe-Elati line 5283 uprate to 956 MVA – ISD 5/31/2026.
- Uprate Lines 6935/6936 69 kV from Alamosa - Mosca - San Luis Valley to 95 MVA – ISD 5/15/2026.
- Daniels Park-Prairie-Greenwood Uprate L5111 to 956 MVA – ISD 10/21/2026.
- NEW Harvest Mile to Smoky Hill 230 kV Line – ISD 5/14/2027.
- NEW Leetsdale to University Line 9338 – ISD 9/9/2026.
- Tollgate Load Shift – ISD 7/7/2026.
- NEW Arapahoe T6 230/115 kV, 272/319 MVA – ISD 2/10/2027.
- Cherokee-Federal Heights-Broomfield L9558 Line rebuild – ISD 11/18/2026.
- MidwayPS 230/115 T1 Transformer Replacement with 280 MVA – ISD 10/7/2026.

Additionally, the following segments of the Colorado's 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 (2027HS) described in Section 4.0 by changing the study pocket generation dispatch to reflect heavy generation in the East study

pocket. This was accomplished by adopting the stressed generation dispatch given in Table 2. Additionally, 4050 MW of Native Load Priority (NLP) was modeled, as shown in Table 3.

Table 2 – Generation Dispatch to Create the Eastern Colorado Benchmark Case for Discharging Scenario (MW is Gross Capacity)

Gen Bus Number	Name	ID	Status	Pgen (MW)
70310	PAWNEE	C1	1	526.00
70314	MANCHEF1	G1	1	118.35
70315	MANCHEF2	G2	1	117.90
70767	RUSHCK1_W1	W1	1	161.60
70770	RUSHCK1_W2	W2	1	142.40
70771	RUSHCK2_W3	W3	1	176.00
70739	CHEYRGW_W1	W1	1	109.12
70742	CHEYRGW_W2	W2	1	105.60
70733	CHEYRGE_W1	W1	1	43.20
70736	CHEYRGE_W2	W2	1	88.00
70775	CHEYRGE_W3	W3	1	52.80
70818	MTNBRZ_W1	W1	1	126.32
70817	MTNBRZ_W2	W2	1	11.04
70670	CEDARPT_W1	W1	1	99.36
70671	CEDARPT_W2	W2	1	100.80
70635	LIMON1_W	W1	1	160.80
70636	LIMON2_W	W2	1	160.80
70637	LIMON3_W	W3	1	160.80
70753	BRONCO_W1	W1	1	117.28
70749	BRONCO_W2	W2	1	128.96
70710	PTZLOGN1	W1	1	160.80
70712	PTZLOGN2	W2	1	96.00
70713	PTZLOGN3	W3	1	63.60
70714	PTZLOGN4	W4	1	140.00
70721	SPRNGCAN1_W1	W1	1	51.84
70715	SPRNGCAN2_W2	W2	1	50.16
70723	RDGCREST	W1	1	23.76
70443	Arriba W1	W1	1	80.04
70442	Arriba W2	W2	1	80.04

Table 3 - NLP Generation Included

Generator Bus No.	Name	ID	Status	Pgen (MW)
999003	NLP_SAND	1	1	253.60
700057	5RSC_24_15	W2	1	130.00
700060	5RSC_24_15	W3	1	130.00
700063	5RSC_24_15	W4	1	110.00
700067	5RSC_24_15	W1	1	130.00
700076	5RSC_24_16	W1	1	144.00
700077	5RSC_24_16	W2	1	162.00
700078	5RSC_24_16	W3	1	144.00
700079	5RSC_24_17	W1	1	153.00
700085	5RSC_24_17	W3	1	135.00
700088	5RSC_24_17	W4	1	153.00
700095	5RSC_24_18	W	1	310.90
999002	NLP_CACR	1	1	882.50
70920	NLP_MAYV	1	1	1212.00
Total (MW)				**4050.00**

4.2 Grid Charging Benchmark Case Modeling

The Grid Charging Benchmark Case was created from the Base Case (2027HS) described in Section 4.0 by changing the study pocket generation dispatch to reflect a Grid Charging scenario in the East study pocket. This was accomplished by adopting the stressed generation dispatch given in Table 4. Additionally, 4050 MW of Native Load Priority (NLP) was modeled, as shown in Table 3.

Table 4 - Generation Dispatch to Create the Eastern Colorado Benchmark Case for Grid Charging Scenario (MW is Gross Capacity)

Gen Bus Number	Name	ID	Status	Pgen (MW)
70310	PAWNEE	C1	1	526.00
70314	MANCHEF1	G1	1	118.35
70315	MANCHEF2	G2	1	117.90
70767	RUSHCK1_W1	W1	1	42.42
70770	RUSHCK1_W2	W2	1	37.38
70771	RUSHCK2_W3	W3	1	46.20

Gen Bus Number	Name	ID	Status	Pgen (MW)
70739	CHEYRGW_W1	W1	1	28.64
70742	CHEYRGW_W2	W2	1	27.72
70733	CHEYRGE_W1	W1	1	11.34
70736	CHEYRGE_W2	W2	1	23.10
70775	CHEYRGE_W3	W3	1	13.86
70818	MTNBRZ_W1	W1	1	33.16
70817	MTNBRZ_W2	W2	1	2.90
70670	CEDARPT_W1	W1	1	26.08
70671	CEDARPT_W2	W2	1	26.46
70635	LIMON1_W	W1	1	42.21
70636	LIMON2_W	W2	1	42.21
70637	LIMON3_W	W3	1	42.21
70753	BRONCO_W1	W1	1	30.79
70749	BRONCO_W2	W2	1	33.85
70710	PTZLOGN1	W1	1	42.21
70712	PTZLOGN2	W2	1	25.20
70713	PTZLOGN3	W3	1	16.70
70714	PTZLOGN4	W4	1	36.75
70721	SPRNGCAN1_W1	W1	1	13.61
70715	SPRNGCAN2_W2	W2	1	13.17
70723	RDGCREST	W1	1	6.24
70443	Arriba W1	W1	1	21.01
70442	Arriba W2	W2	1	21.01

4.3 Study Case Modeling

The PI-2024-14 project includes 250 MW of Battery Storage using 75 PE 4200M inverters connected through 75 two-winding transformers to the 34.5kV bus. The voltage is stepped up to the POI voltage level via two (2) 34.5/345 kV 102/135/170 MVA transformers. The high side of the transformers are connected to the POI via a 0.1-mile generation tie-line. The output at the POI will be limited to 250 MW.

A Study Case was created from the Benchmark Case by turning on the PI-2024-14 generation. The additional 250 MW of net output from PI-2024-14 at the POI was balanced against PSCo generation outside of the East Colorado study pocket.

A Grid Charging Study Case was created from the Benchmark Case by adding the PI-2024-14 BESS modeled as a load (250 MW). The additional 250 MW of consumption from PI-2024-14 was balanced against PSCo generation outside the East Colorado study pocket.

4.4 Short-Circuit Modeling

This request is for the Interconnection of a 250 MW Battery Energy Storage Systems (BESS) (PI-2024-14) to the Goose Creek 345 kV switching station. The net output shall not exceed 250 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-2024-14 GIR is modeled as follows:

Generator gross capacity: Pmax = 250 MW, Pmin = -250 MW, Qmax = 129 Mvar, Qmin= -129 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for PI-2024-14 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-2024-14 are summarized in Table 5.

Table 5 – Reactive Power Capability Evaluation for PI-2024-14

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
252.2	110.3	129.0	-129.0	1.05	250.0	83.9	1.01	0.9480	250.0	83.9	1.01	0.9480
252.2	-60.7	129.0	-129.0	0.97	250.0	-83.7	1.00	-0.9483	249.8	-83.7	1.00	-0.9482
0.0	-13.3	129.0	-129.0	1.00	0.0	-13.4	1.01	0.0000	0.0	-13.3	1.01	0.0000

5.2 Steady-State Analysis

Contingency analysis was performed on the East Colorado Study pocket using the Study Case and the Grid Charging Study Case models. The results obtained with the Study Case model for Discharging scenario are summarized below:

- System Intact analysis showed no thermal or voltage violations attributed to PI-2024-14.
- Single Contingency analysis showed no thermal or voltage violations attributed to PI-2024-14.
- Multiple Contingency analysis showed the following thermal overloads and voltage violations, presented in Table 6 and Table 7, respectively.
    - 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 GIRs.
    - Table 8 summarizes the diverged P7 contingencies. As it was discussed previously, diverged multiple contingencies will be mitigated using system adjustments, including generation redispatch and/or operator actions.

The results obtained with the Grid Charging Study Case model for Grid Charging scenario are summarized below:

- System Intact analysis showed no thermal or voltage violations attributed to PI-2024-14.
- Single Contingency analysis showed no thermal or voltage violations attributed to PI-2024-14.
- Multiple Contingency analysis showed no thermal or voltage violations attributed to PI-2024-14.

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Table 6 - Multiple Contingency Thermal Overloads

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
1	CLARK(70112) - JORDAN(70241) 230 kV ckt 1	P7_150	230	70	364	108.86	114.03	5.17
2	BUCKLEY2 (70046) – SMOKY_HL (70396) 230 kV ckt 1	P7_101	230	70	478	99.02	101.80	2.78
3	BUCKLEY2 (70046) – JEWELL2 (70239) 230 kV ckt 1	P7_101	230	70	484	97.90	100.65	2.75

Table 7 – Multiple Contingency Voltage Violations

Bus Number	Bus Name	Contingency Name	Base kV	Area	Benchmark Case Voltage (p.u.)	Study Case Bus Voltage (p.u.)	Voltage Difference (p.u.)
70018	SODA_LAKES	P7_154	230	70	0.8860	0.873	-0.0130
70544	ISABELLE	P7_88	230	70	0.9144	0.8727	-0.0417
70211	GUNBARREL_2	P7_88	230	70	0.9152	0.8735	-0.0417
70213	GUNBARREL_1	P7_88	230	70	0.9152	0.8736	-0.0416
70972	GUNBARREL_3	P7_88	230	70	0.9152	0.8736	-0.0416
70297	NIWOT	P7_88	230	70	0.9152	0.8736	-0.0416
70261	LEGGETT	P7_88	230	70	0.9159	0.8745	-0.0414
70260	LEETSDALE	P7_88	230	70	0.9222	0.8857	-0.0365
70291	MONROEPS	P7_88	230	70	0.9229	0.8862	-0.0367
70543	SIMMS	P7_88	230	70	0.9234	0.8827	-0.0407
70574	MOONGLCH	P7_88	230	70	0.9236	0.8832	-0.0404
70431	PLAINS_NG1	P7_88	230	70	0.9240	0.8837	-0.0403
70570	PLAINS_END	P7_88	230	70	0.9240	0.8837	-0.0403
70163	ELATI1	P7_88	230	70	0.9241	0.8872	-0.0369
70433	PLAINS_NG2	P7_88	230	70	0.9242	0.8838	-0.0404
70149	DENVER_TM	P7_88	230	70	0.9252	0.8882	-0.0370
70141	DAKOTA	P7_88	230	70	0.9257	0.8887	-0.0370

Bus Number	Bus Name	Contingency Name	Base kV	Area	Benchmark Case Voltage (p.u.)	Study Case Bus Voltage (p.u.)	Voltage Difference (p.u.)
70239	JEWELL2	P7_88	230	70	0.9269	0.8907	-0.0362
70447	VALMONT	P7_88	230	70	0.9274	0.8863	-0.0411
70038	ARAPAHOE	P7_88	230	70	0.9274	0.8904	-0.037
70480	WEST_PS	P7_88	230	70	0.9275	0.8887	-0.0388
70152	BARKER	P7_88	230	70	0.9277	0.8911	-0.0366
70324	LACOMBE	P7_88	230	70	0.9277	0.8911	-0.0366
70266	LOOKOUT	P7_88	230	70	0.9291	0.8896	-0.0395
70041	ARVADA_PS	P7_88	230	70	0.9299	0.8925	-0.0374
70100	CHATFLD	P7_88	230	70	0.9299	0.8920	-0.0379
70355	RIDGE	P7_88	230	70	0.9304	0.8925	-0.0379
70365	SULLIVAN_2	P7_88	230	70	0.9311	0.8950	-0.0361
70466	WATERTON	P7_88	345	70	0.9313	0.9000	-0.0313
70417	SULLIVAN_1	P7_88	230	70	0.9314	0.8954	-0.036
70369	RUSSELL	P7_88	230	70	0.9314	0.8946	-0.0368
70527	SANTA_FE	P7_88	230	70	0.9326	0.8965	-0.0361
70622	ALLI	P7_88	230	70	0.9326	0.8944	-0.0382
70601	DANIEL_PK	P7_88	345	70	0.9327	0.8989	-0.0338
70512	JEWELL1	P7_88	230	70	0.9331	0.8973	-0.0358
70481	MONACO_12	P7_88	230	70	0.9334	0.8975	-0.0359
70428	TECH_CENTER	P7_88	230	70	0.9334	0.8975	-0.0359
70524	SULPHUR	P7_88	230	70	0.9346	0.8999	-0.0347
70244	LAFAYETTE	P7_88	115	70	0.9347	0.8942	-0.0405
70604	PARKWAY	P7_88	115	70	0.9347	0.8970	-0.0377
70107	CHEROKEE	P7_88	230	70	0.9348	0.8991	-0.0357
70491	TOLLGATE	P7_88	230	70	0.9350	0.8993	-0.0357

Table 8 – Multiple Diverged Contingencies

Diverged Contingency	Contingency Description	BM Case	Study Case
P7_136	Pawnee - Brick Center 230 kV circuit 1 Smoky Hill - Missile Site 345 kV circuit 1	Diverged	Diverged
P7_160	Canal Crossing - Goose Creek 345 kV circuit 1 Canal Crossing - Goose Creek 345 kV circuit 2	Diverged	Diverged
P7_166	Tundra - Sandstone 345 kV circuit 1 Tundra - Sandstone 345 kV circuit 2	Diverged	Diverged
P7_167	May Valley - Sandstone 345 kV circuit 1 May Valley - Sandstone 345 kV circuit 2	Diverged	Diverged
P7_90	Lines 5307 5385 5953	Converged	Diverged
P7_135	Smoky Hill - Missile Site 345 kV circuit 1 Daniels Park - Missile Site 345 kV circuit 1	Converged	Diverged
P7_137	Lines: 7081 7087	Converged	Diverged
P7_161	Canal Crossing - FSV 345 kV circuit 1 Canal Crossing - FSV 345 kV circuit 2	Converged	Diverged

5.3 Transient Stability Results

Discharging Scenario

Table 9 presents a summary of the contingencies evaluated and their respective results. The study assessed a total of ten P1s, one P4, and three P7s contingencies. The results show that 8 (out of 14) simulations presented post-fault delayed voltage recovery and/or significative oscillatory behavior. To determine whether the study unit was responsible for these outcomes, the same contingencies were simulated using the Benchmark case. The results were consistent, confirming that the study unit did not contribute to the observed issues.

Below are the key takeaways from the sensitivity analysis conducted for the Transient Stability Study for Discharging scenario:

- During the study, it was noted that placeholder NLP sites in the base cases were represented using generic dynamic models. Specifically, the generic model used for the NLP at May Valley introduced undesired oscillations in the simulation results. As result, the model was removed (netted out).
- Abnormal voltage responses were observed in both the Study and Benchmark Cases, furthering supporting the conclusion that the Study Unit does not contribute to post-fault delayed voltage recovery.

In addition to the delayed voltage recovery observations, the study unit was tripped on low voltage protection during contingency reference #6. All the other contingencies exhibited the following:

- ✓ No rotor angle instability.
- ✓ No transient voltage violations were observed.
- ✓ Machine rotor angles displayed positive damping.

Grid Charging Scenario

Table 10 below summarizes the contingencies studied and their results for Grid Charging Scenario. A total of ten P1s, one P4 and three P7s were studied as in discharging scenario. Contingencies in Ref. No. 12 and 13 presented post-fault delayed voltage recovery. Similar behavior was observed for these contingencies in the Discharging Scenario too. All the other contingencies exhibited the following:

- ✓ No rotor angle instability.
- ✓ No transient voltage violations were observed.
- ✓ Machine rotor angles displayed positive damping.

The transient stability plots are shown in Appendix A and B in Section 10.0 of this report.

Table 9 – Transient Stability Analysis Results for Study Case Model in Discharging Scenario

Ref. No.	Contingency Name	Fault Category	Outage(s)	Clearing Time (Cycles)	Post-Fault Voltage Recovery	Angular Stability
1	Flat Run	P0	-	-	Stable	Stable
2	PI-2024-14 Gen	P1	PI-2024-14 Generation	4	Stable	Stable
3	GseCrk-CanalXing-P1 (P1-2_1)	P1	Goose Creek - Canal Crossing 345 kV ckt 1	4	Delayed Voltage Recovery	Stable
4	GseCrk-MayVal-P1 (P1-2_2)	P1	Goose Creek - May Valley 345 kV ckt 1	4	Stable	Stable
5	GseCrk-Shortgrass-P1(P1-2_3)	P1	Goose Creek - Short Grass 345 kV ckt 1	4	Delayed Voltage Recovery	Stable
6	Missile Site-Canal Crossing-P1 (P1-2_5)[6]	P1	Missile Site - Canal Crossing 345 kV ckt 1	4	Delayed Voltage Recovery	Stable
7	Canal Crossing - Pawnee-P1 (P1-2_7)	P1	Canal Crossing - Pawnee 345 kV ckt 1	4	Delayed Voltage Recovery	Stable
8	Shortgrass - Pronghorn-P1 (P1-2_8)	P1	Shortgrass - Pronghorn 345 kV ckt 1	4	Delayed Voltage Recovery	Stable
9	Shortgrass - Bronco_plns-P1 (P1-2_9)	P1	Shortgrass - Bronco Plains 345 kV ckt 1	4	Stable	Stable
10	May Valley - Sandstone-P1 (P1-2_10)	P1	May Valley - Sandstone 345 kV ckt 1	4	Delayed Voltage Recovery	Stable
11	GseCrk - Cheyenne Ridge-P4 (BF_034)	P4	Goose Creek - Cheyenne Ridge 345 kV ckt 1	12	Stable	Stable
12	Canal Crossing - Goose Creek-P7 (P7_160)	P7	Canal Crossing - Goose Creek 345 kV ckt 1 Canal Crossing - Goose Creek 345 kV ckt 2	4	Delayed Voltage Recovery	Stable

[6] This contingency resulted unstable for the Study unit.

Ref. No.	Contingency Name	Fault Category	Outage(s)	Clearing Time (Cycles)	Post-Fault Voltage Recovery	Angular Stability
13	May Valley - Goose Creek-P7 (P7_163)	P7	May Valley - Goose Creek 345 kV ckt 1 May Valley - Goose Creek 345 kV ckt 2	4	Delayed Voltage Recovery	Stable
14	Goose Creek to Shortgrass and Cheyenne Ridge-P7 (P7_164)	P7	Goose Creek - Short Grass 345 kV ckt 1 Goose Creek - Cheyenne Ridge 345 kV ckt 1	4	Stable	Stable

Table 10 – Transient Stability Analysis Results for Study Case Model in Grid Charging Scenario

Ref. No.	Contingency Name	Fault Category	Outage(s)	Clearing Time (Cycles)	Post-Fault Voltage Recovery	Angular Stability
1	Flat Run	P0	-	-	Stable	Stable
2	PI-2024-14 Gen	P1	PI-2024-14 Generation	4	Stable	Stable
3	GseCrk-CanalXing-P1 (P1-2_1)	P1	Goose Creek - Canal Crossing 345 kV ckt 1	4	Stable	Stable
4	GseCrk-MayVal-P1 (P1-2_2)	P1	Goose Creek - May Valley 345 kV ckt 1	4	Stable	Stable
5	GseCrk-Shortgrass-P1(P1-2_3)	P1	Goose Creek - Short Grass 345 kV ckt 1	4	Stable	Stable
6	Missile Site-Canal Crossing-P1 (P1-2_5)	P1	Missile Site - Canal Crossing 345 kV ckt 1	4	Stable	Stable
7	Canal Crossing - Pawnee-P1 (P1-2_7)	P1	Canal Crossing - Pawnee 345 kV ckt 1	4	Stable	Stable
8	Shortgrass - Pronghorn-P1 (P1-2_8)	P1	Shortgrass - Pronghorn 345 kV ckt 1	4	Stable	Stable

Ref. No.	Contingency Name	Fault Category	Outage(s)	Clearing Time (Cycles)	Post-Fault Voltage Recovery	Angular Stability
9	Shortgrass - Bronco_plns-P1 (P1-2_9)	P1	Shortgrass - Bronco Plains 345 kV ckt 1	4	Stable	Stable
10	May Valley - Sandstone-P1 (P1-2_10)	P1	May Valley - Sandstone 345 kV ckt 1	4	Stable	Stable
11	GseCrk - Cheyenne Ridge-P4 (BF_034)	P4	Goose Creek - Cheyenne Ridge 345 kV ckt 1	12	Stable	Stable
12	Canal Crossing - Goose Creek-P7 (P7_160)	P7	Canal Crossing - Goose Creek 345 kV ckt 1 Canal Crossing - Goose Creek 345 kV ckt 2	4	Delayed Voltage Recovery	Stable
13	May Valley - Goose Creek-P7 (P7_163)	P7	May Valley - Goose Creek 345 kV ckt 1 May Valley - Goose Creek 345 kV ckt 2	4	Delayed Voltage Recovery	Stable
14	Goose Creek to Shortgrass and Cheyenne Ridge-P7 (P7_164)	P7	Goose Creek - Short Grass 345 kV ckt 1 Goose Creek - Cheyenne Ridge 345 kV ckt 1	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 no circuit breaker that became over-dutied because of adding the PI-2024-14. 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

There were no thermal or voltage violations for System Intact and Single Contingency analyses conducted for the Study Case model in the Discharging scenario. Multiple Contingency analysis showed some thermal and voltage violations. Per TPL-001-5, Multiple Contingency overloads and voltage violations are mitigated using system adjustments, including generation redispatch and/or operator actions. There were some diverged P7 contingencies, listed in Table 8 above, during multiple contingency analysis which will be mitigated using system adjustments including generation redispatch and/or operator actions too.

There were no thermal or voltage violations for System Intact, Single Contingency, and Multiple Contingency analyses conducted for the Study Case model in the Grid Charging scenario.

In the Transient Stability analysis, a total of ten P1s, one P4, and three P7s were studied. The results show that 8 (out of 14) simulations presented post-fault delayed voltage recovery in the Discharging scenario and the study unit tripped on low voltage protection during P1 Contingency Missile Site - Canal Crossing. In the Grid Charging scenario 2 (out of 14)

simulations presented post-fault delayed voltage recovery. The evaluation, discussed in detail in section 5.3, proved that the study unit is not contributing to the post-fault delayed voltage recovery. Apart from delayed voltage recovery issues, there were no voltage violations observed in the remaining contingencies, or angular instability for all the contingencies studied.

The initial maximum permissible output of the Provisional Interconnection Service request is 250 MW at the POI and 250 MW in Grid Charging mode at the generator terminal. 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-2024-14 to interconnect for Provisional Interconnection Service at Goose Creek 345 kV switching station is **$8.118 million**.

- **Cost of Transmission Provider's Interconnection Facilities (TPIF) is $3.248 million** (Table 11)
- **Cost of Station Network Upgrades is $4.870 million** (Table 12)
- **Cost of System Network Upgrades is $0**

The list of improvements required to accommodate the Provisional Interconnection Service of PI-2024-14 are given in Table 11, and Table 12.

Table 11 – Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (Million)
PSCo's Goose Creek 345 kV switching station	Interconnection of 5RSC-2024-10 (PI-2024-14) at the Goose Creek 345 kV switching station. The new equipment includes: • (1) 345 kV single bay dead end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV 1-phase CCVTs • Dual fiber communication equipment • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing	$2.620
PSCo's Goose Creek 345 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.	$0.628
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$3.248**

Table 12 – Station Network Upgrades

Element	Description	Cost Est. (Million)
PSCo's Goose Creek 345 kV switching station	Interconnection of 5RSC-2024-10 (PI-2024-14) at Goose Creek 345 kV Switching Station. The new equipment includes: • (1) 345 kV dead end structure • (1) 345 kV 3000 A SF6 circuit breakers • (1) 345 kV 3000 A disconnect switch • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures	$4.529
PSCo's Goose Creek 345 kV switching station	Install required communication in the EEE at the Goose Creek 345 kV switching station	$0.341
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$4.870**

PSCo has developed cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of PI-2024-14 for Provisional Interconnection Service. The estimated costs provided in this report are based upon the following assumptions:

- The estimated costs are in 2025 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 Remote Terminal Unit (RTU) at their Customer substation. PSCo will be provided with indications, readings, and data from the 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-2024-14 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, 2026. 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 13.

Table 13 – Proposed Milestones for PI-2024-14

Milestone	Responsible Party	Estimated Completion Date
PLGIA Execution	Interconnection Customer and Transmission Provider	November 2025
In-Service Date for Transmission Provider Interconnection Facilities and Station Network Upgrades required for interconnection	Transmission Provider	October 1, 2026
In-Service Date & Energization of Interconnection Customer's Interconnection Facilities	Interconnection Customer	October 1, 2026
Initial Synchronization Date	Interconnection Customer	January 15, 2027
Begin trial operation & testing	Interconnection Customer and Transmission Provider	February 1, 2027
Commercial Operation Date	Interconnection Customer	May 1, 2027

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-2024-14 to qualify for Provisional Interconnection Service would be **$8.118 million**.

The initial maximum permissible output of PI-2024-14 Generating Facility is 250 MW in the Discharging mode at the Point of Interconnection and 250 MW in Grid Charging mode at the generator terminal. The maximum permissible output of the Generating Facility in the PLGIA[7] will be reviewed quarterly and updated, if there are changes to the system conditions assumed in this analysis.

Security: PI-2024-14 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.

[7] **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-2024-14 include the TPIF and Station Network Upgrades identified in Table 11 and Table 12, respectively.

9.0 Preliminary One-Line Diagram and General Arrangement for PI-2024-14

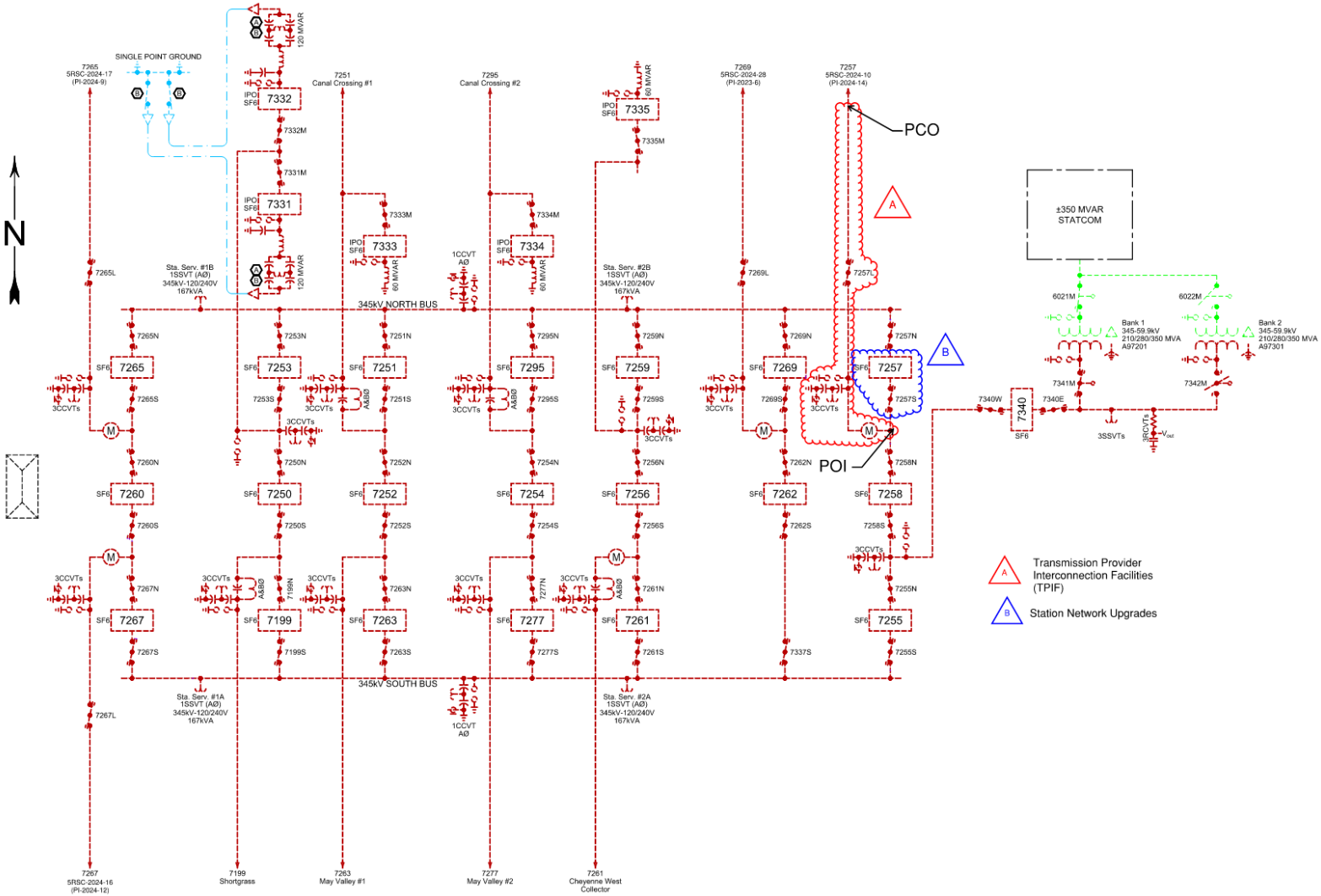


Figure 2: Preliminary One-Line for PI-2024-14 at the Goose Creek 345 kV Switching Station

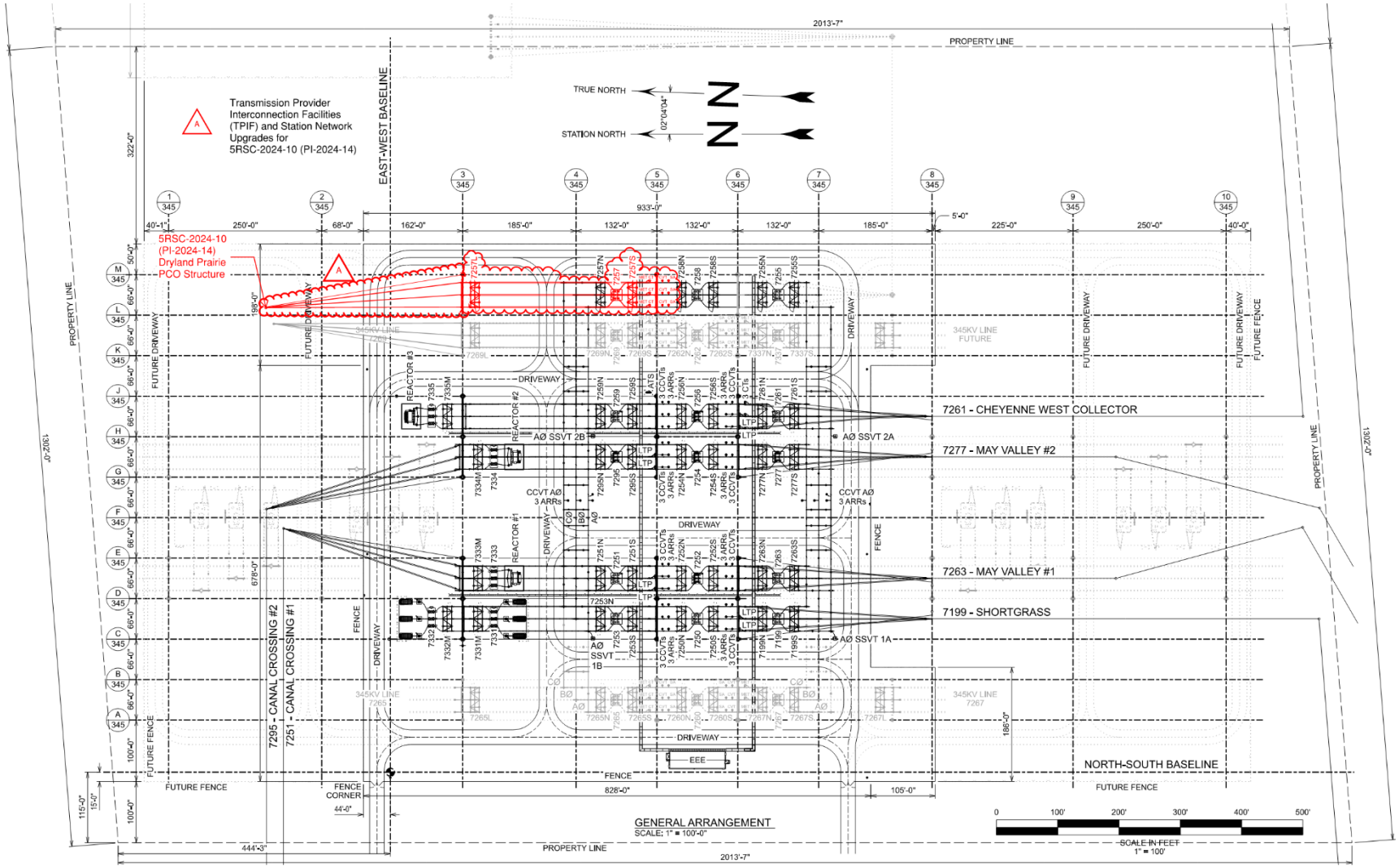
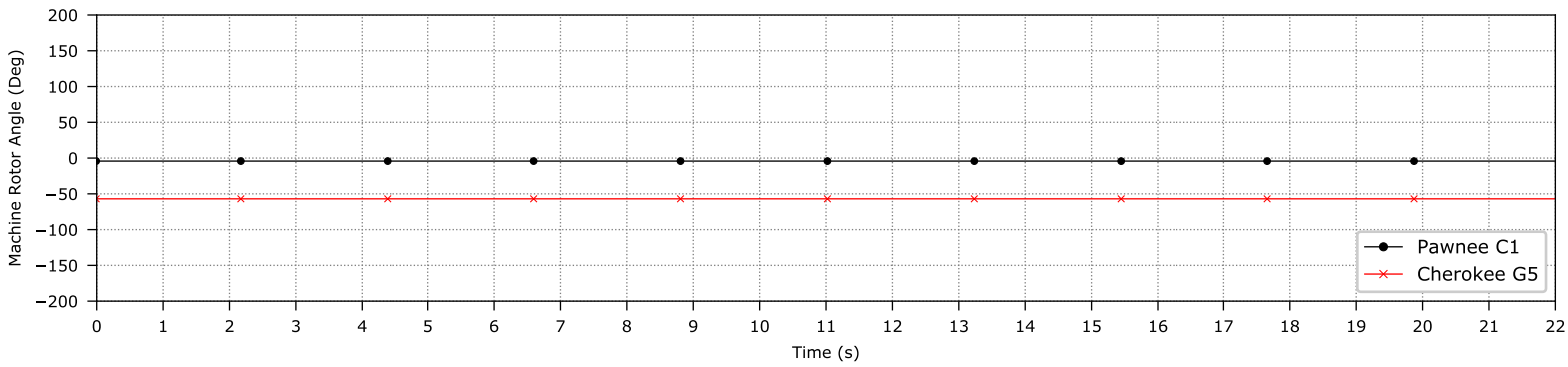


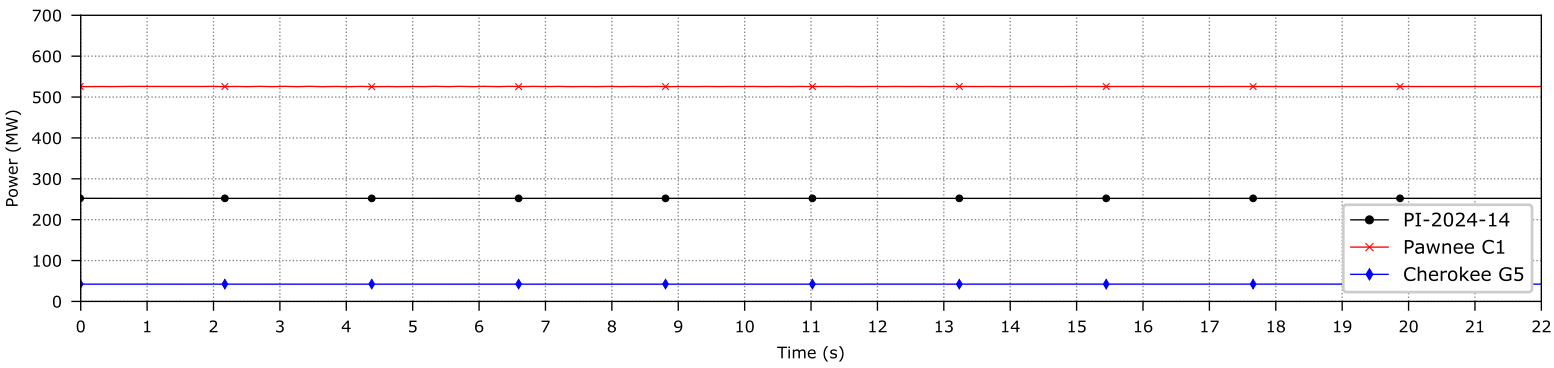
Figure 3: Preliminary General Arrangement for PI-2024-14 at the Goose Creek 345 kV Switching Station

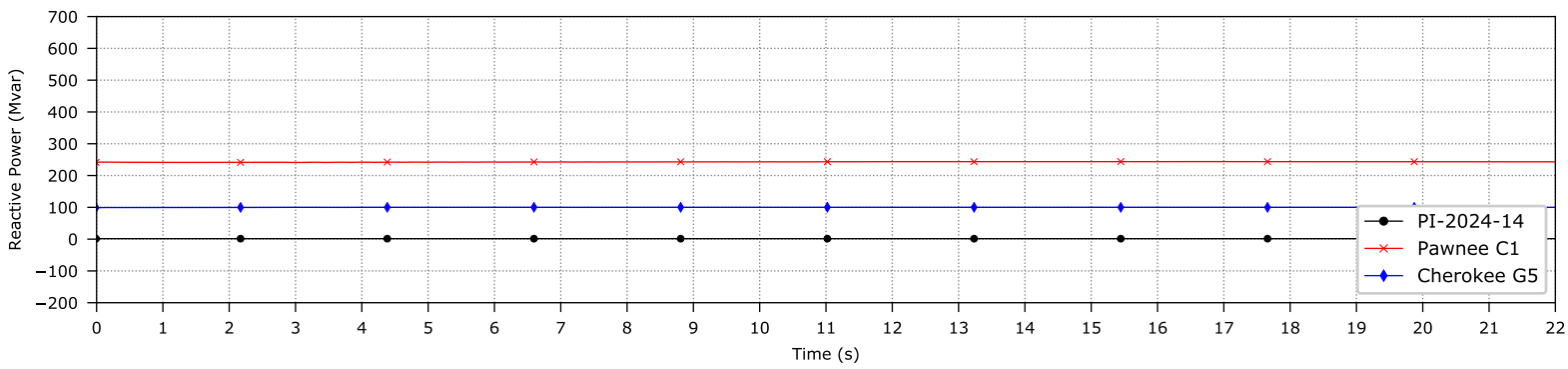
10.0 Appendices

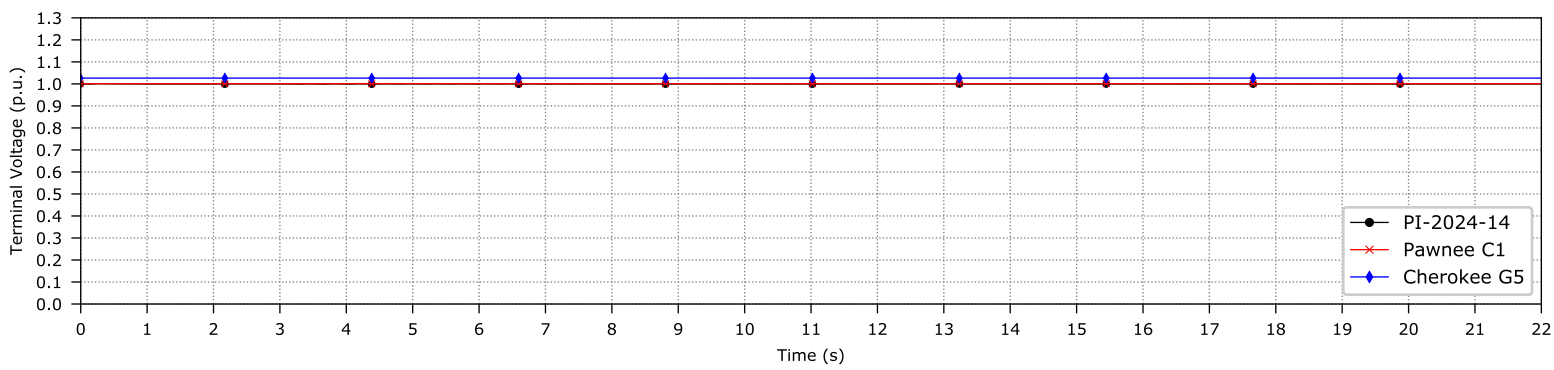
Appendix A: Transient Stability Plots for Discharging Scenario	 PI-2024-14_Discharging
Appendix B: Transient Stability Plots for Grid Charging Scenario	 PI-2024-14_Grid_Charging

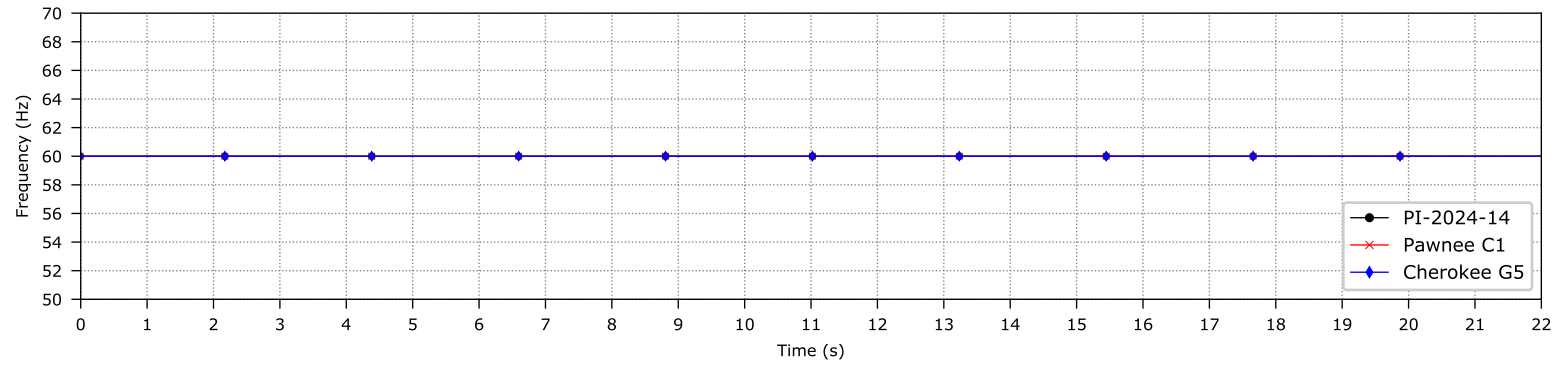
flatrun

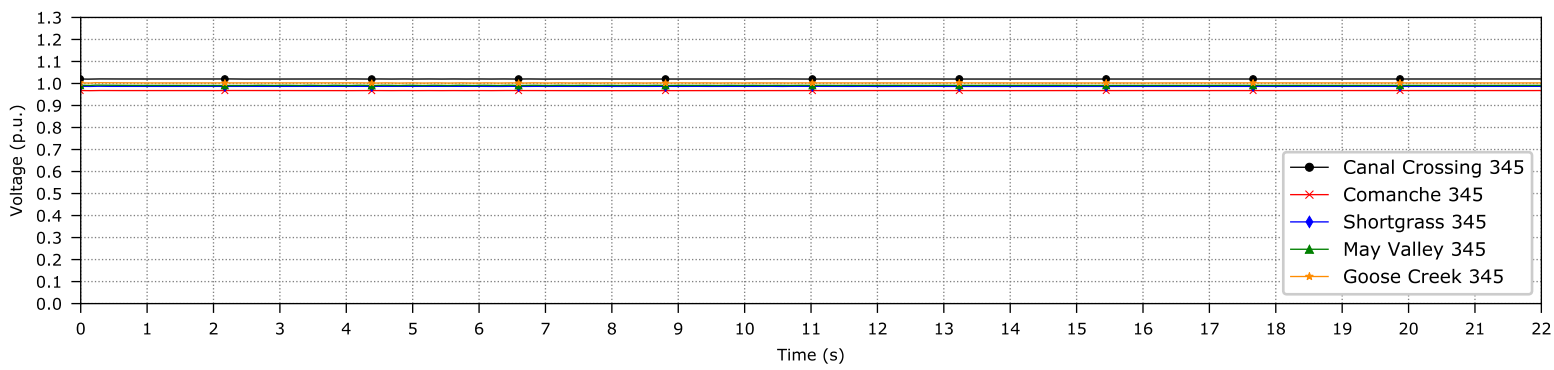

Machine Rotor Angle (Deg)
Time (s)
Pawnee C1
Cherokee G5


Power (MW)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

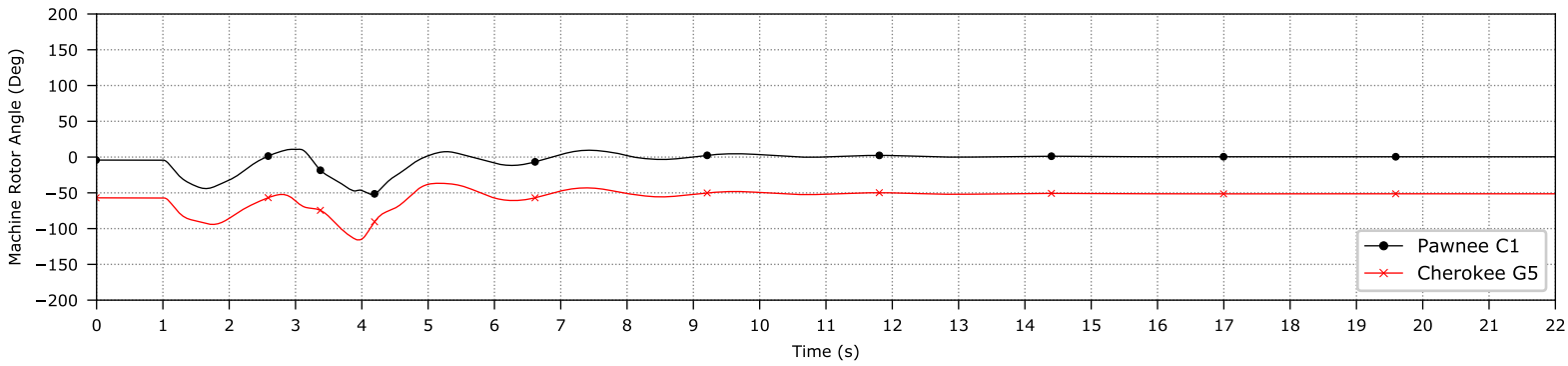

Reactive Power (Mvar)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

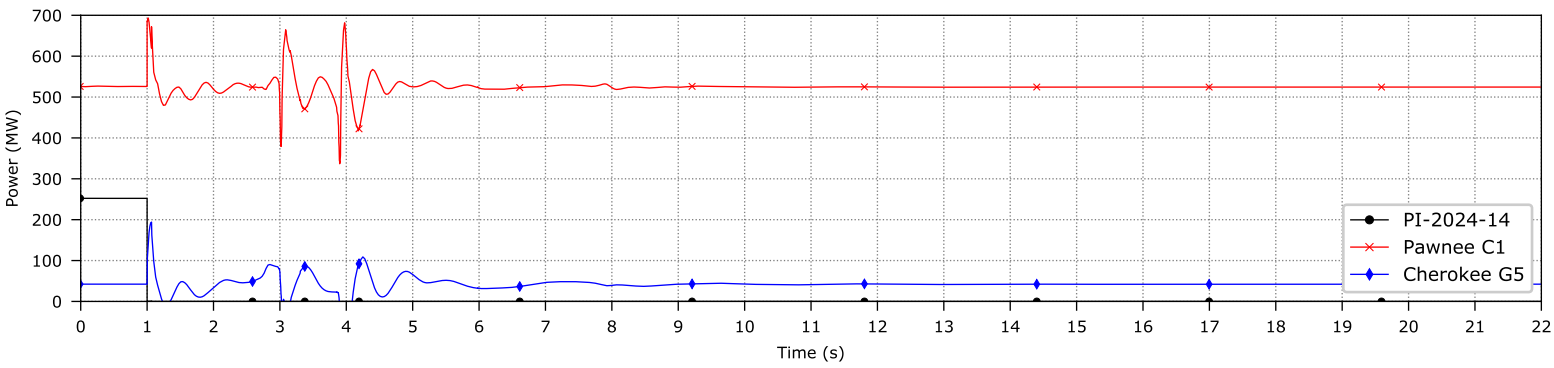

Terminal Voltage (p.u.)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

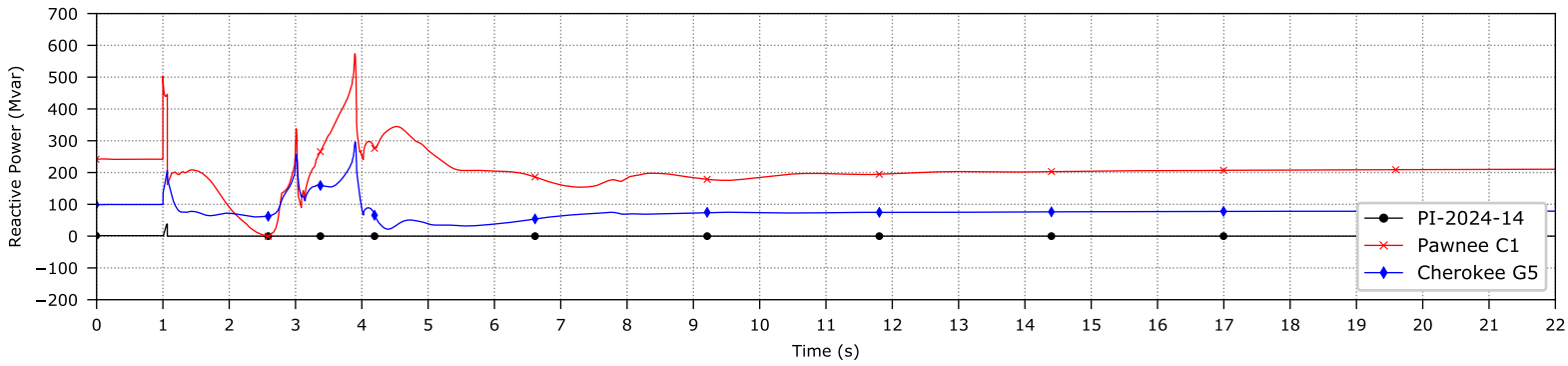

Frequency (Hz)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

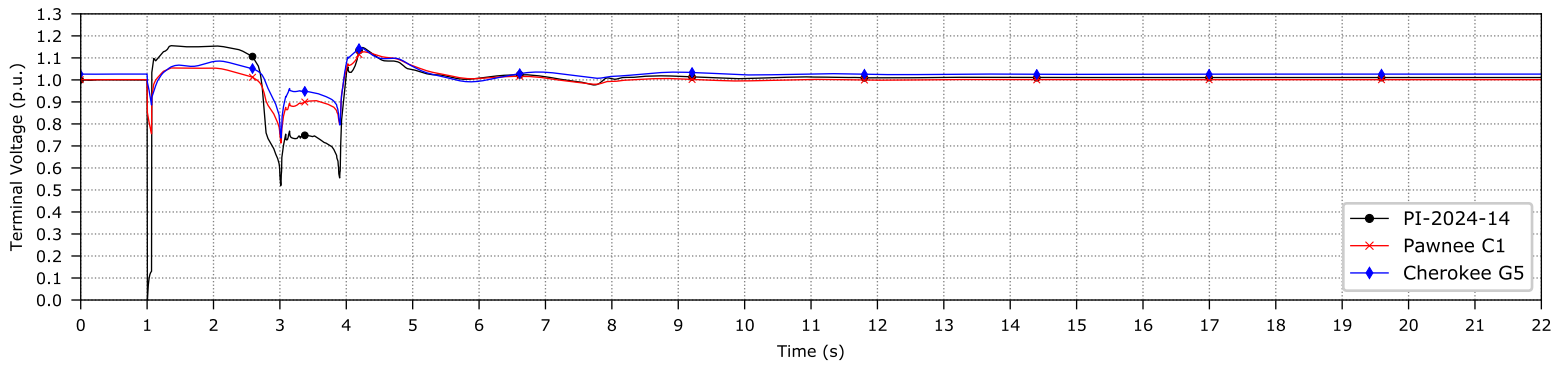

Voltage (p.u.)
Time (s)
Canal Crossing 345
Comanche 345
Shortgrass 345
May Valley 345
Goose Creek 345

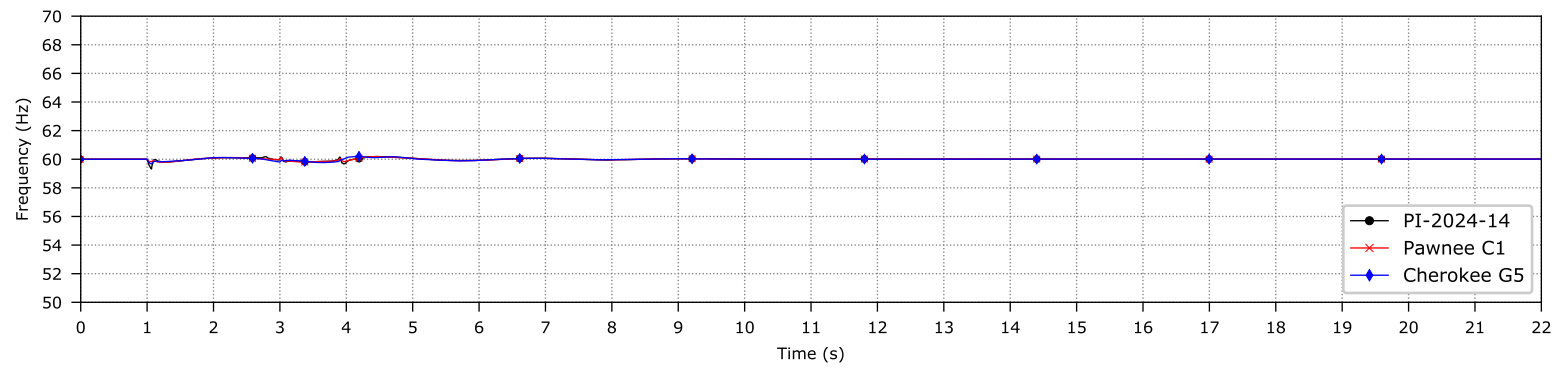
PI-2024-14

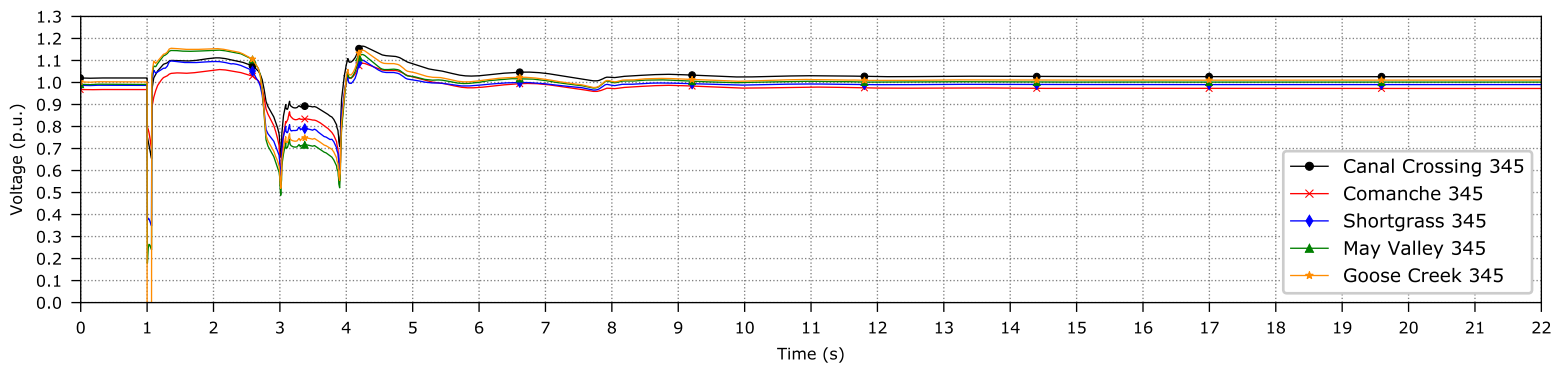

Machine Rotor Angle (Deg)
Time (s)
Pawnee C1
Cherokee G5


Power (MW)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

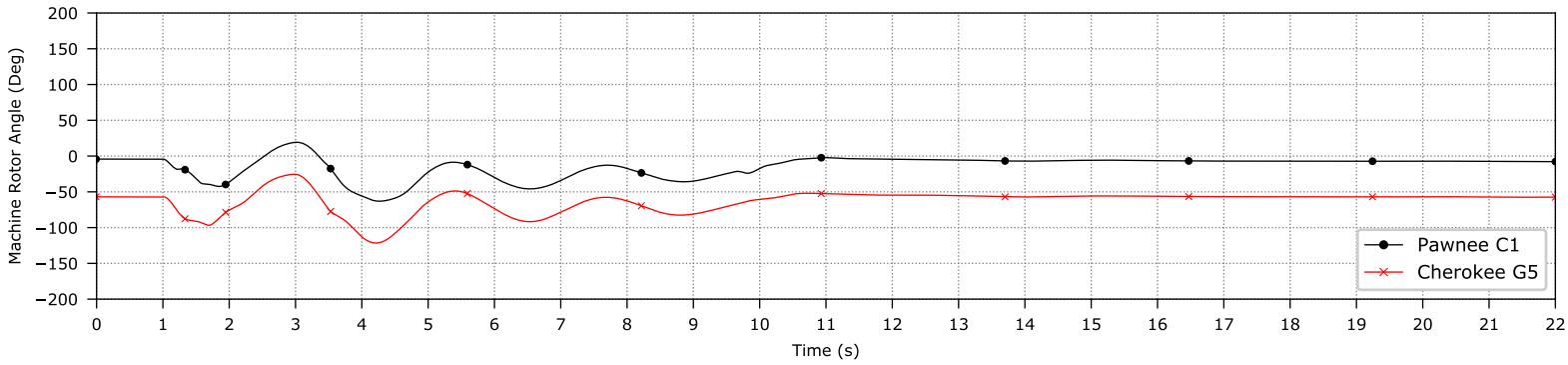

Reactive Power (Mvar)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

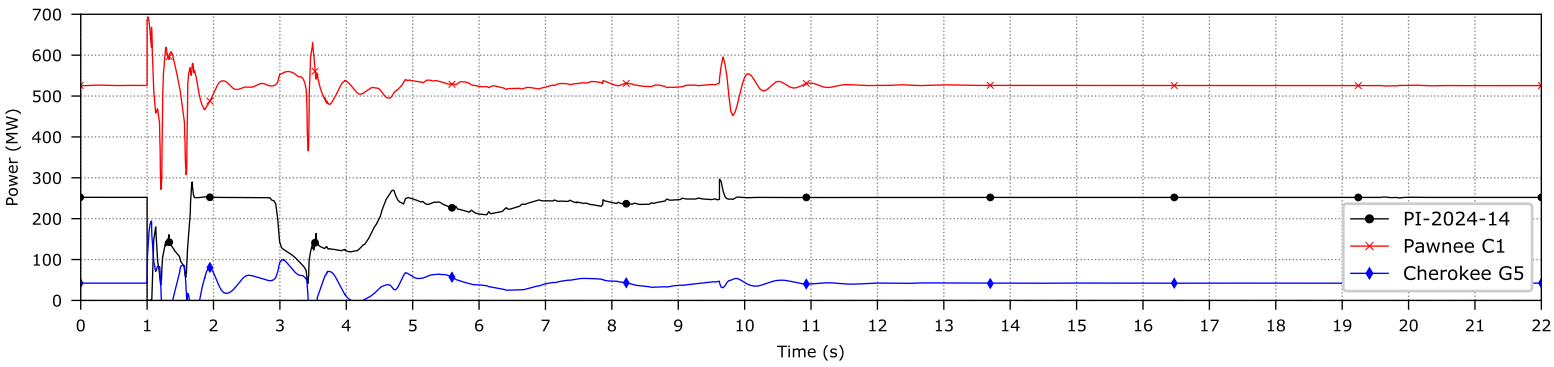

Terminal Voltage (p.u.)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

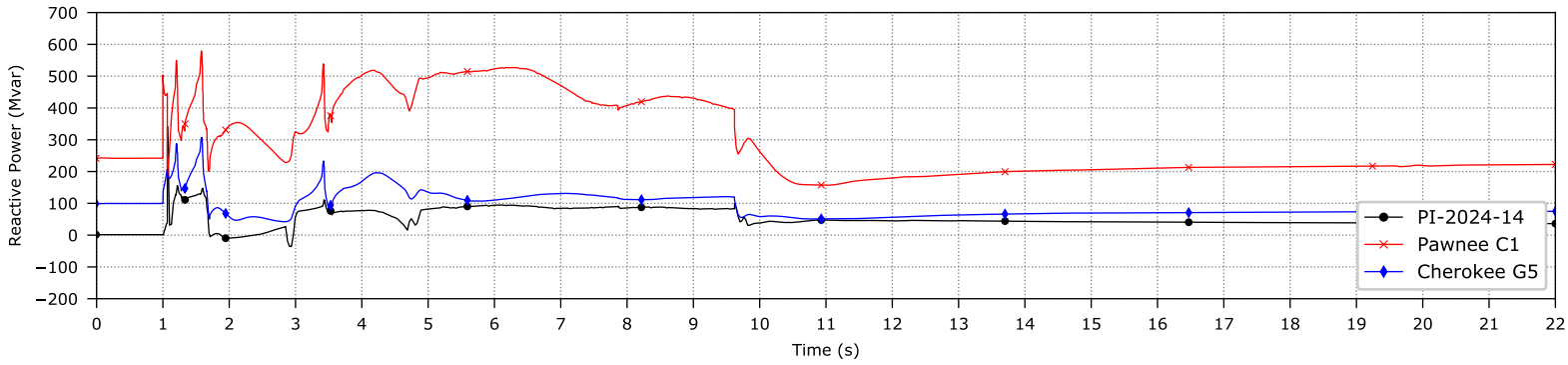

Frequency (Hz)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

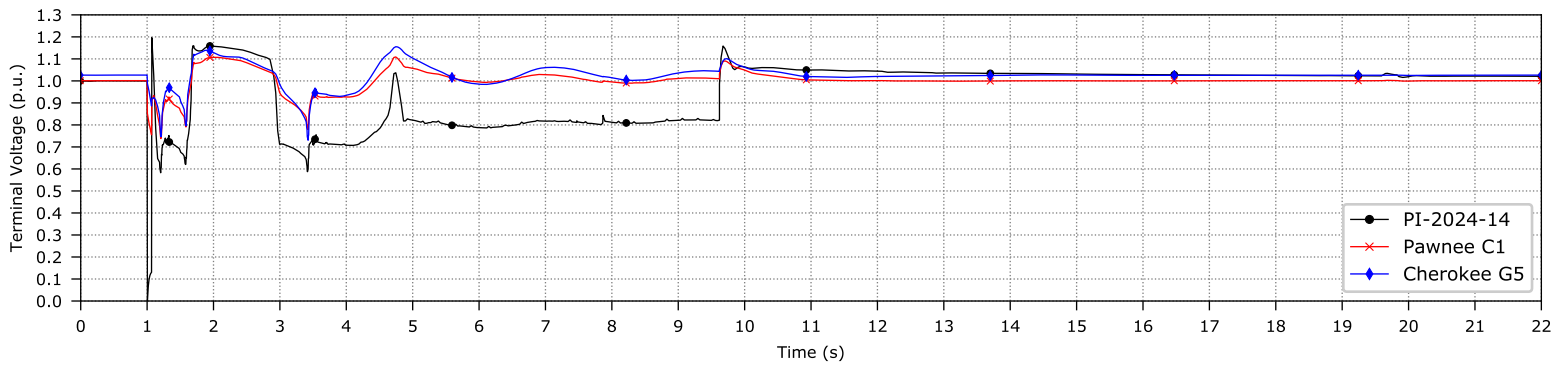

Voltage (p.u.)
Time (s)
Canal Crossing 345
Comanche 345
Shortgrass 345
May Valley 345
Goose Creek 345

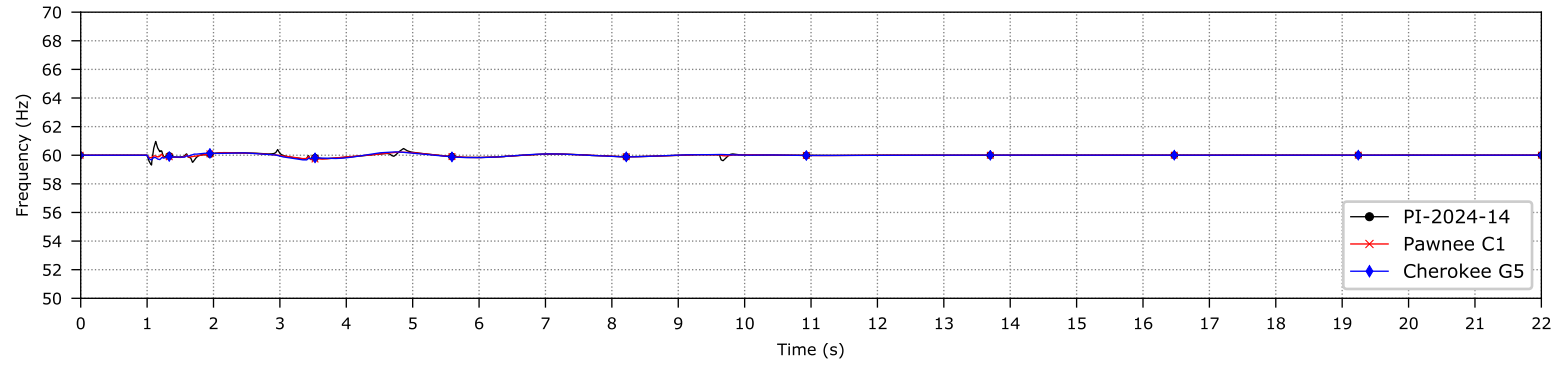
GseCrk-CanalXing-P1

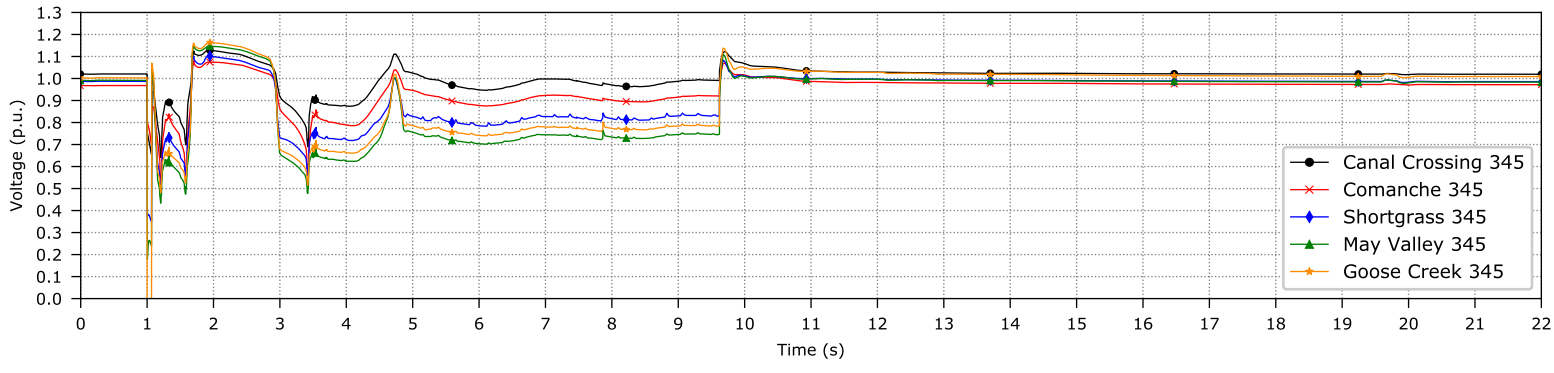




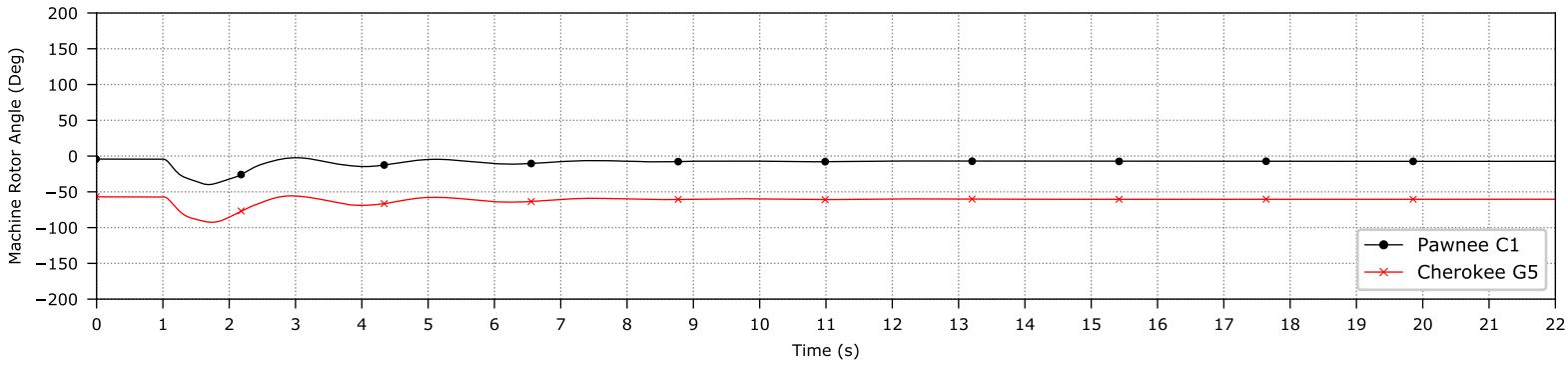


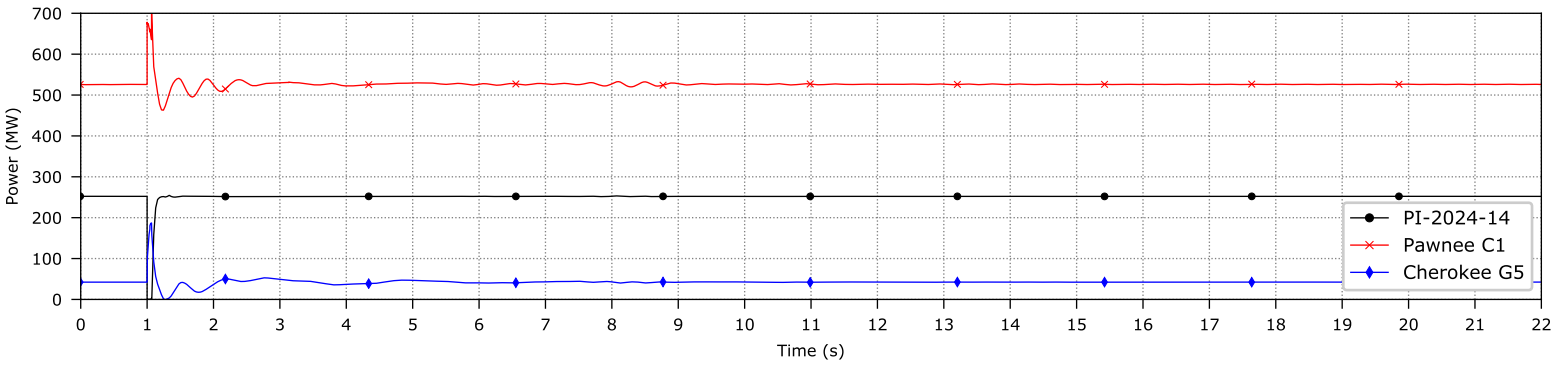


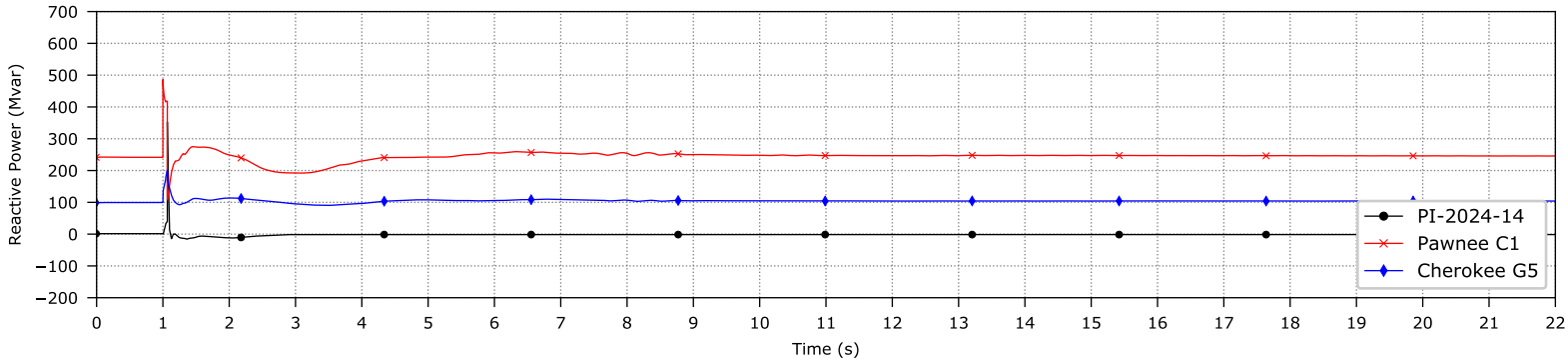


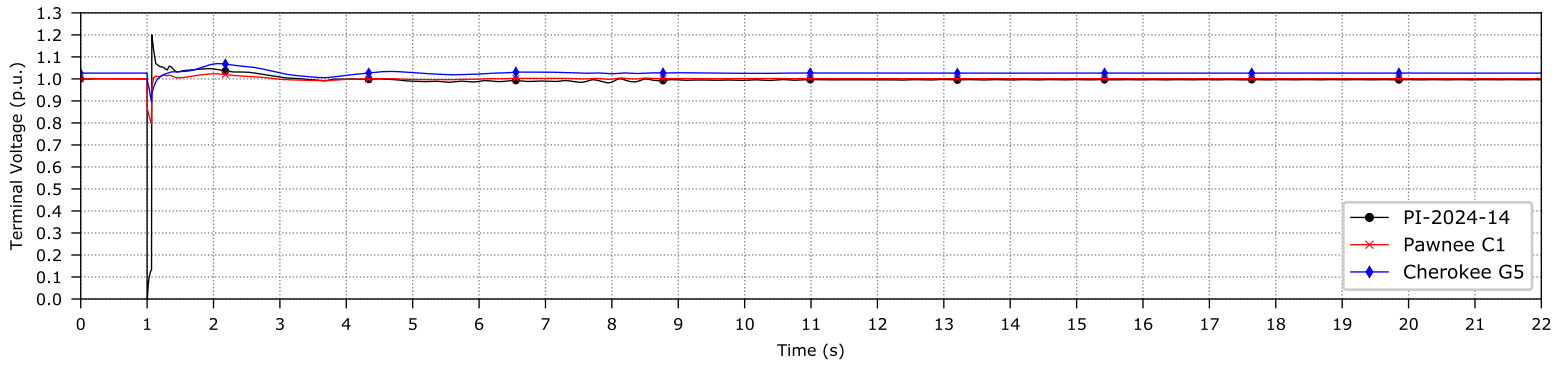


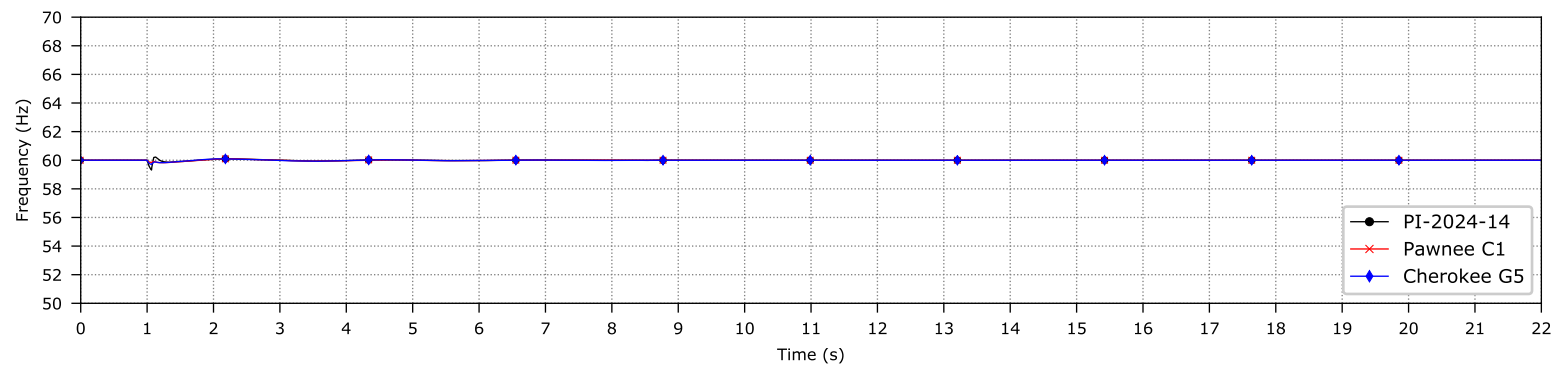
GseCrk-MayVal-P1

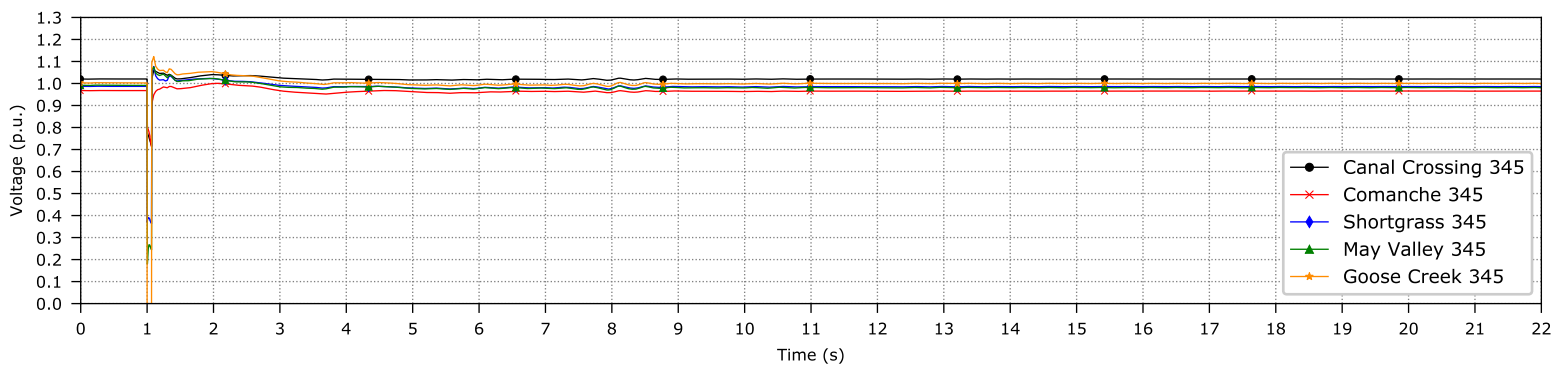




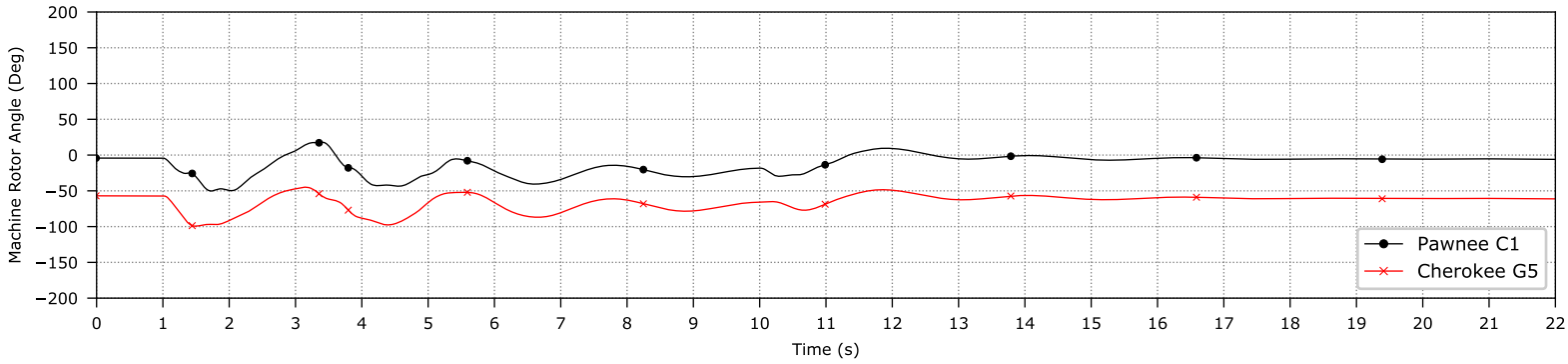


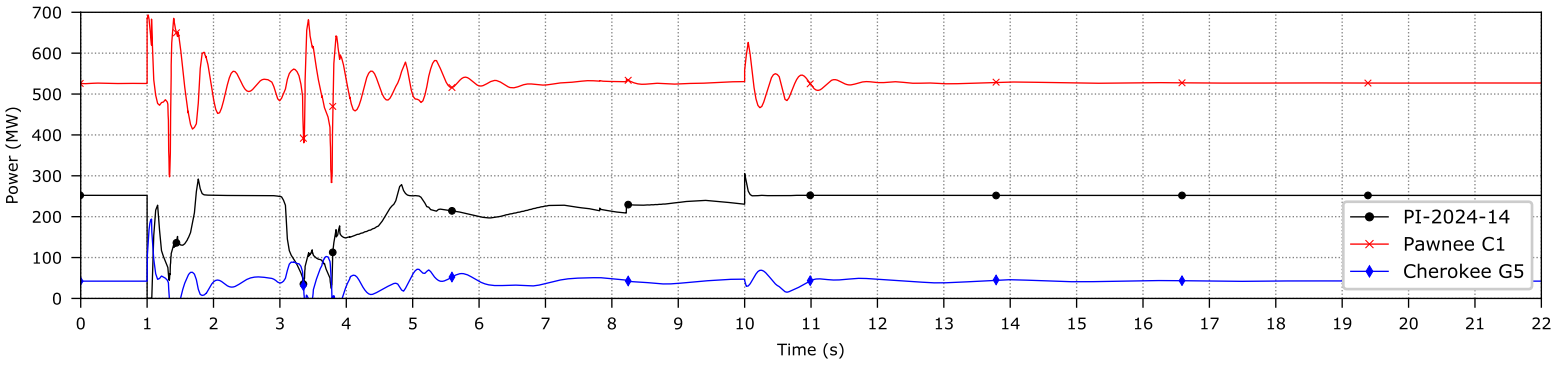


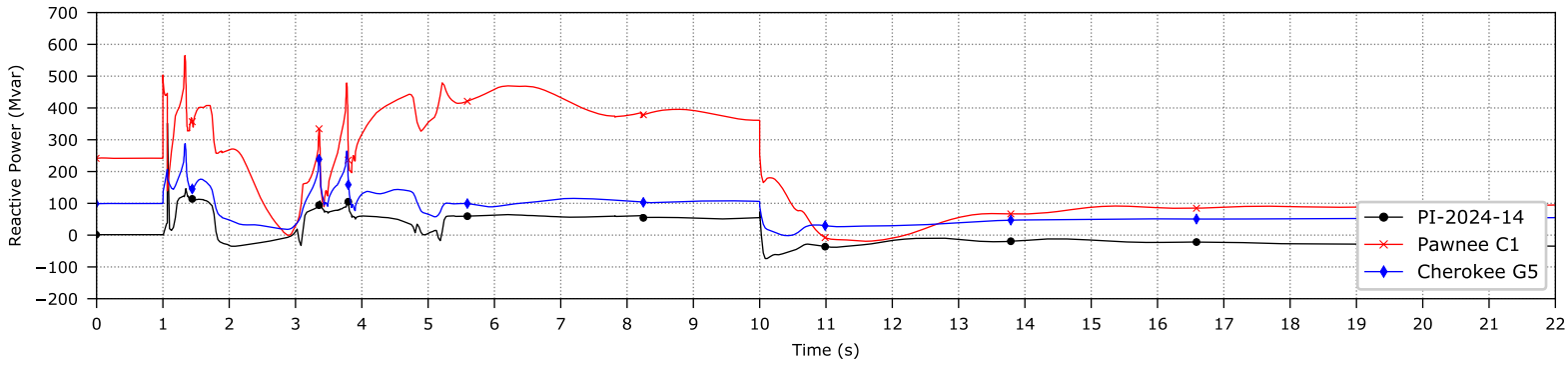


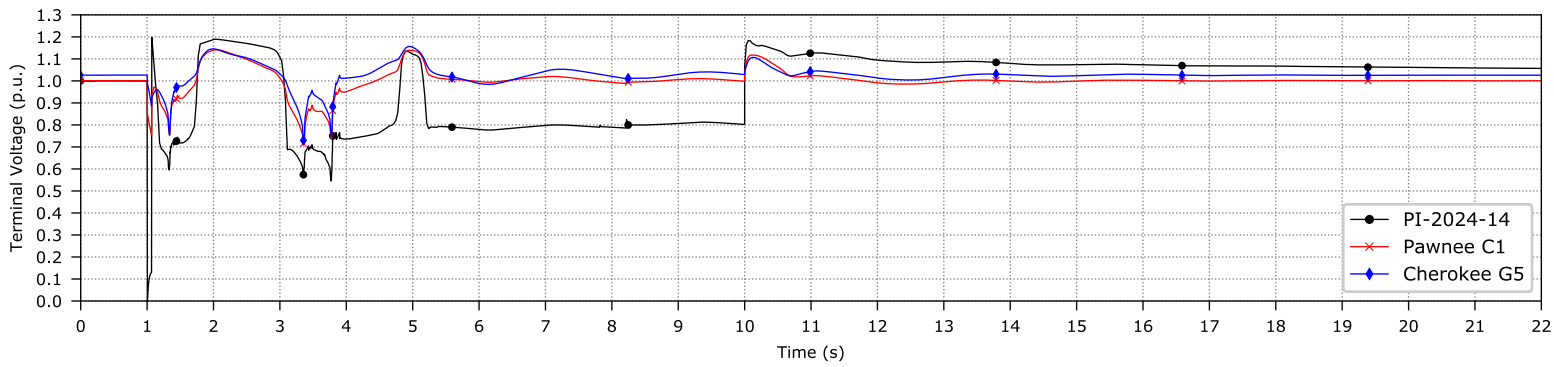


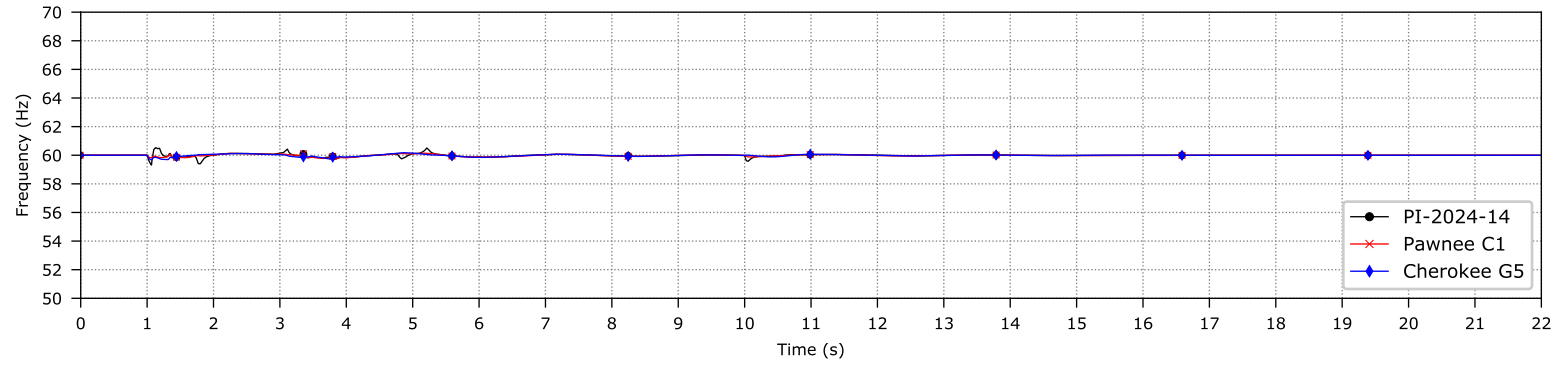
GseCrk-Shortgrass-P1

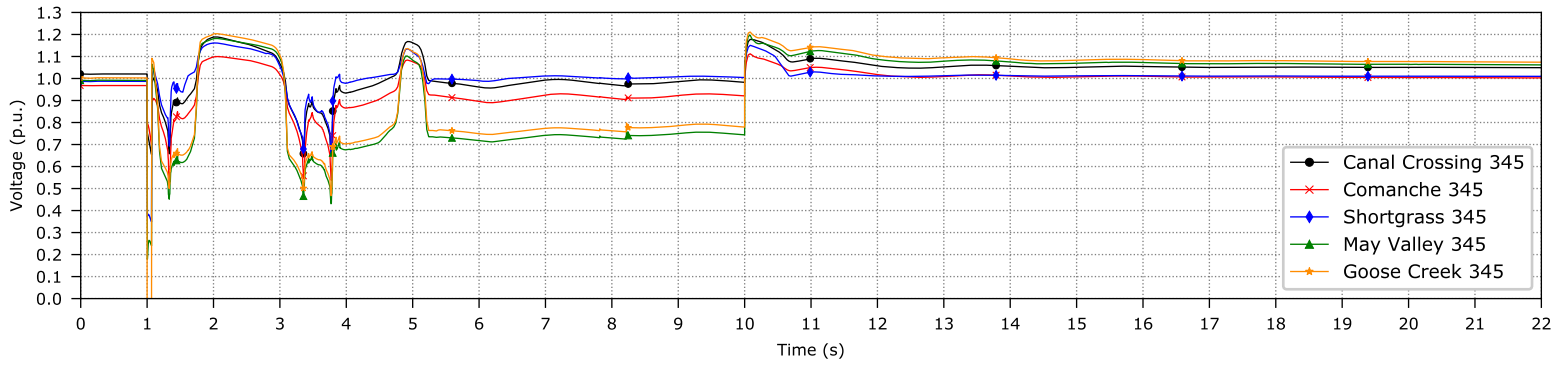




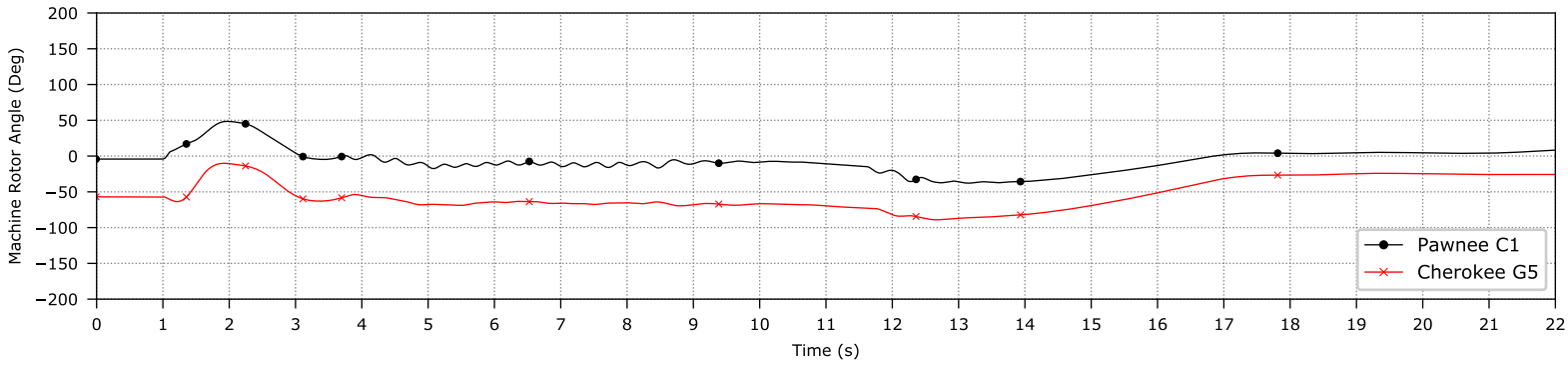


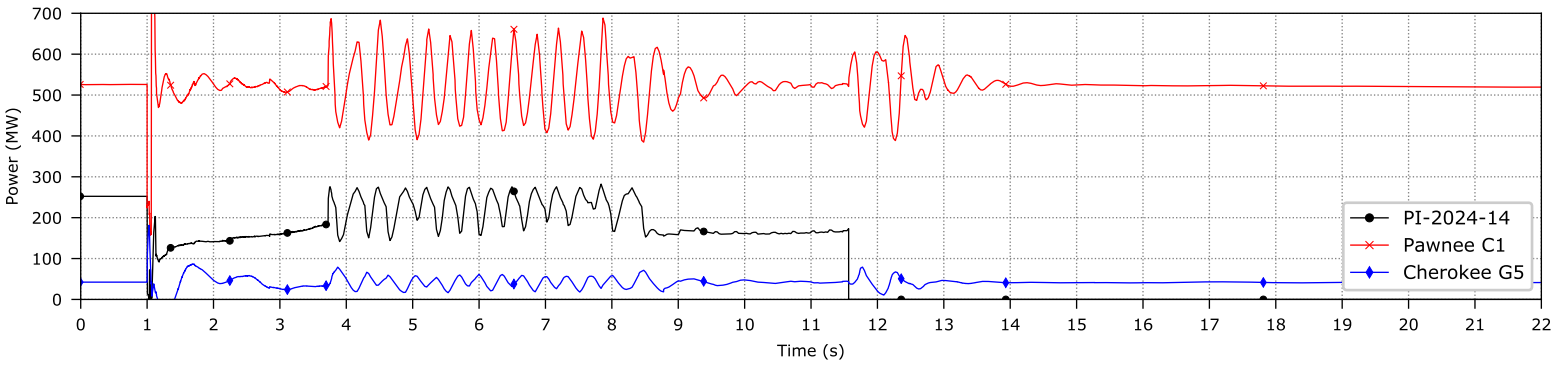


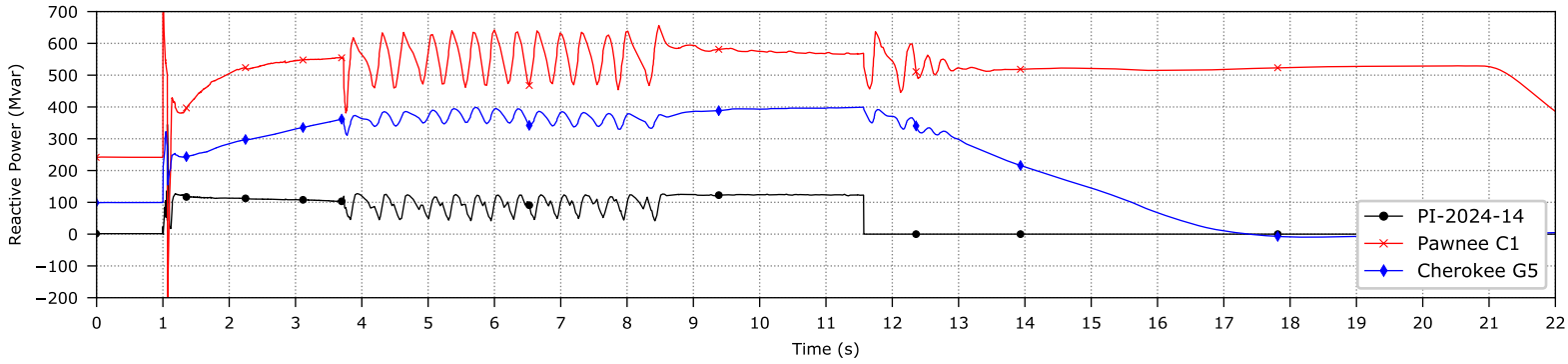


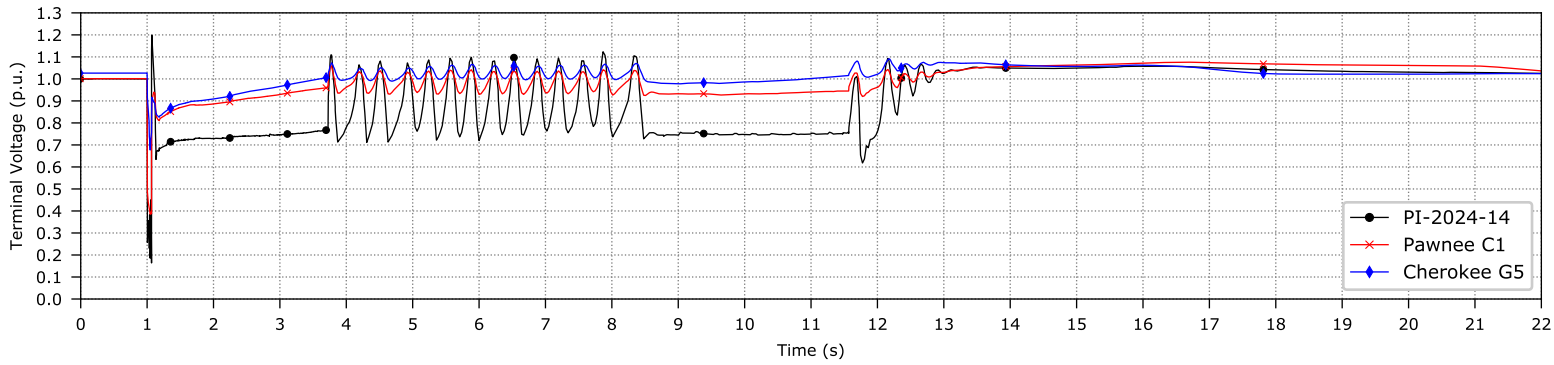


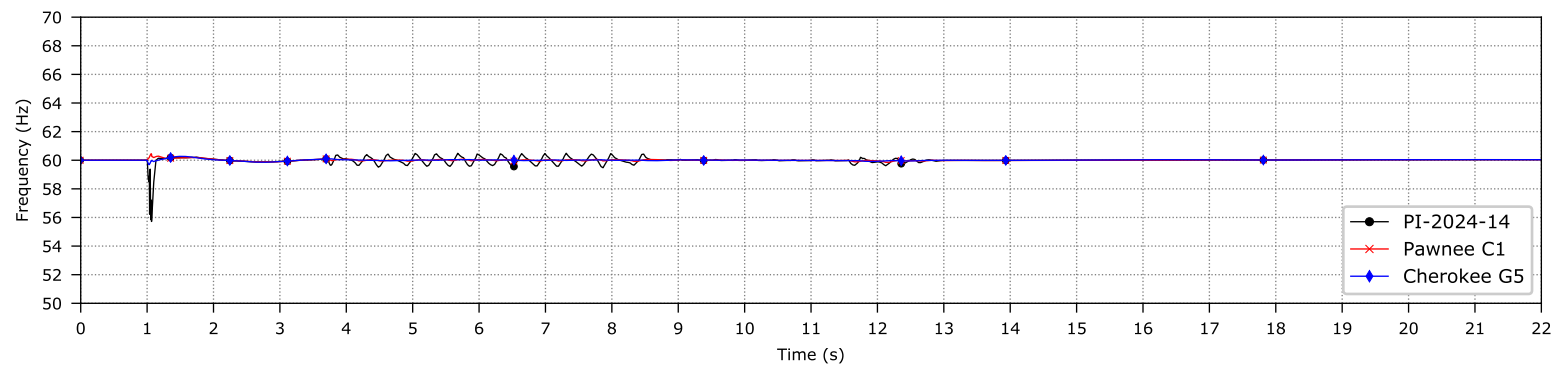
Missile Site - Canal Crossing-P1

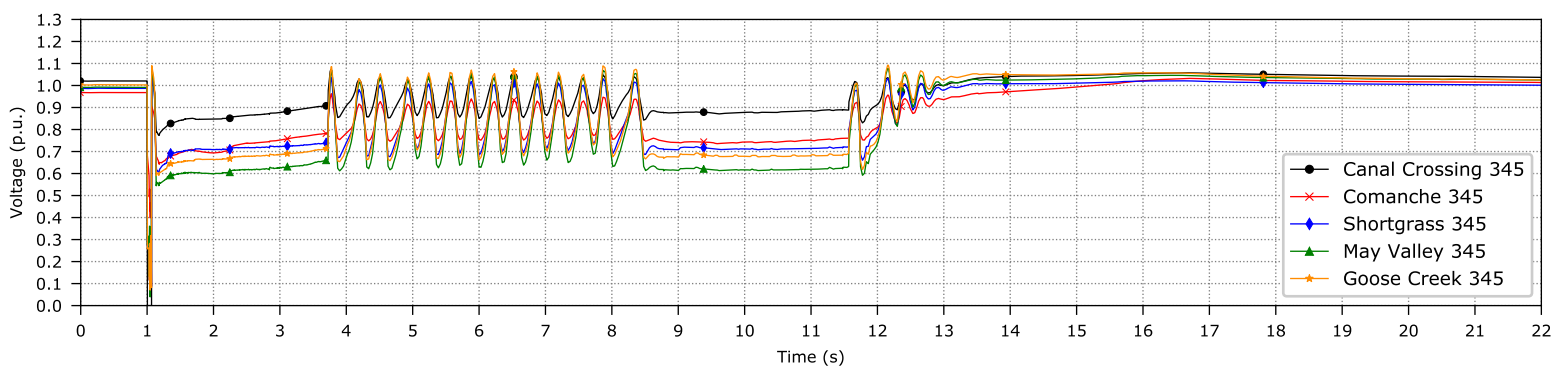




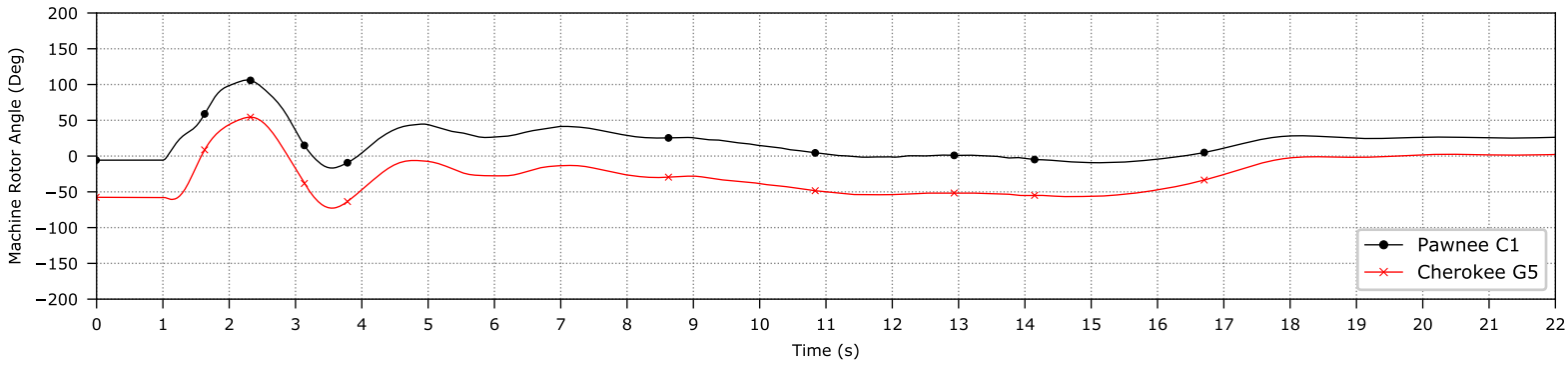


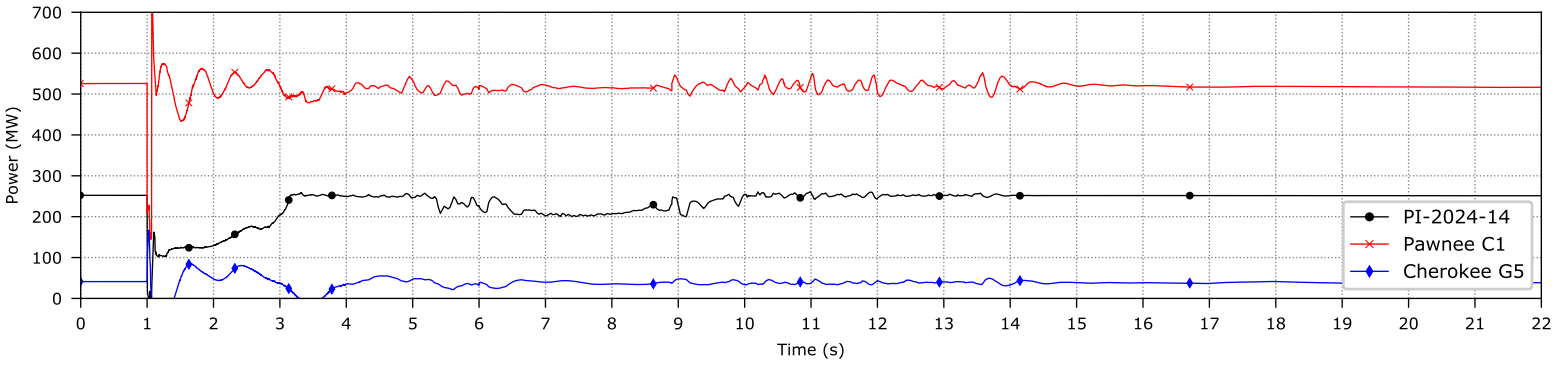


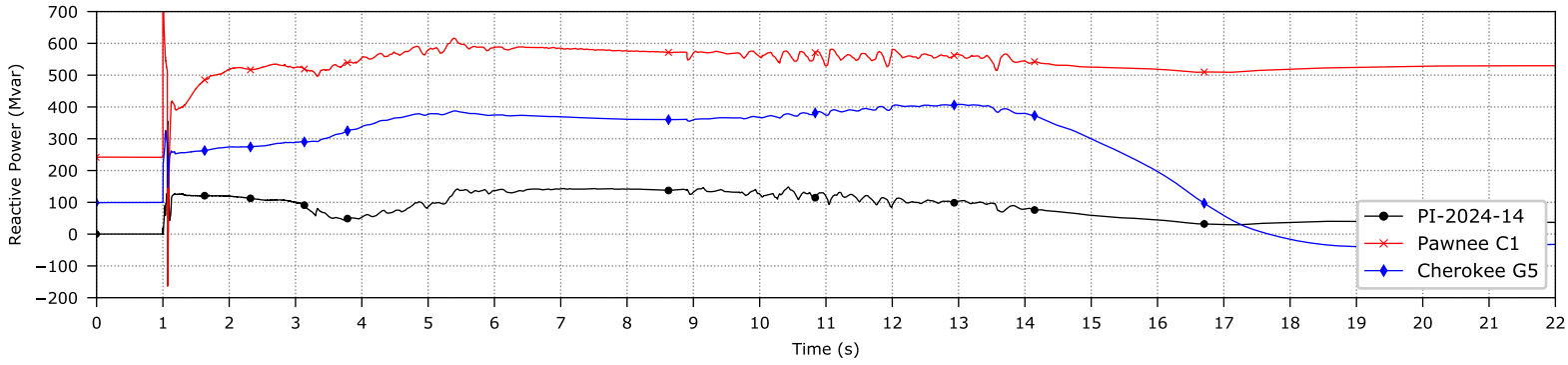


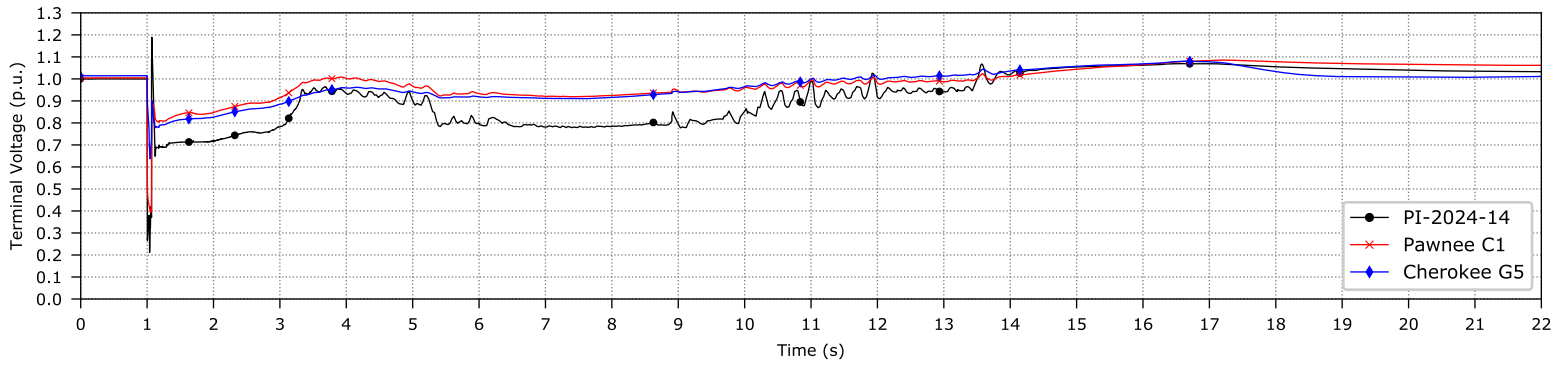


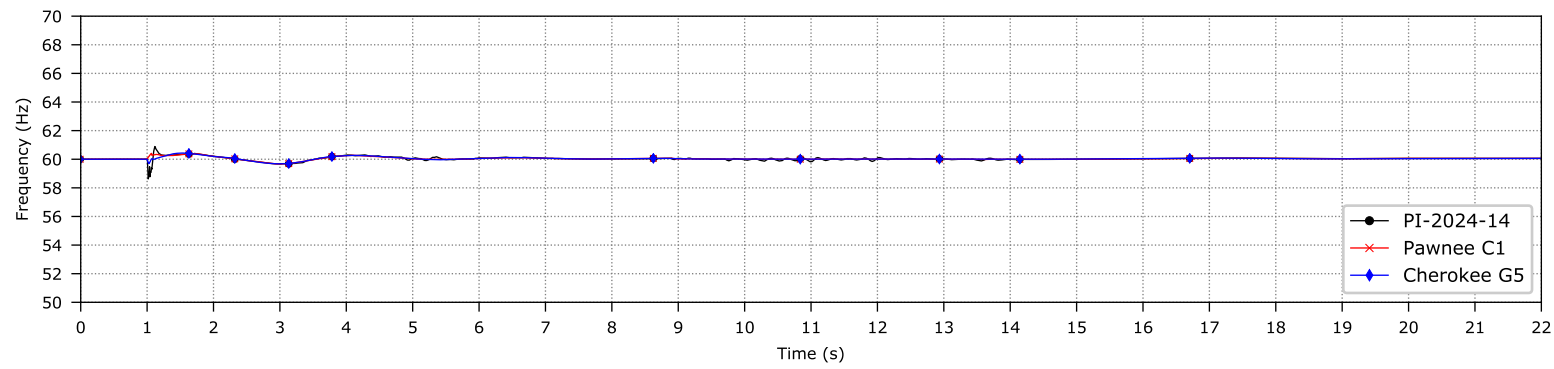
Canal Crossing - Pawnee-P1

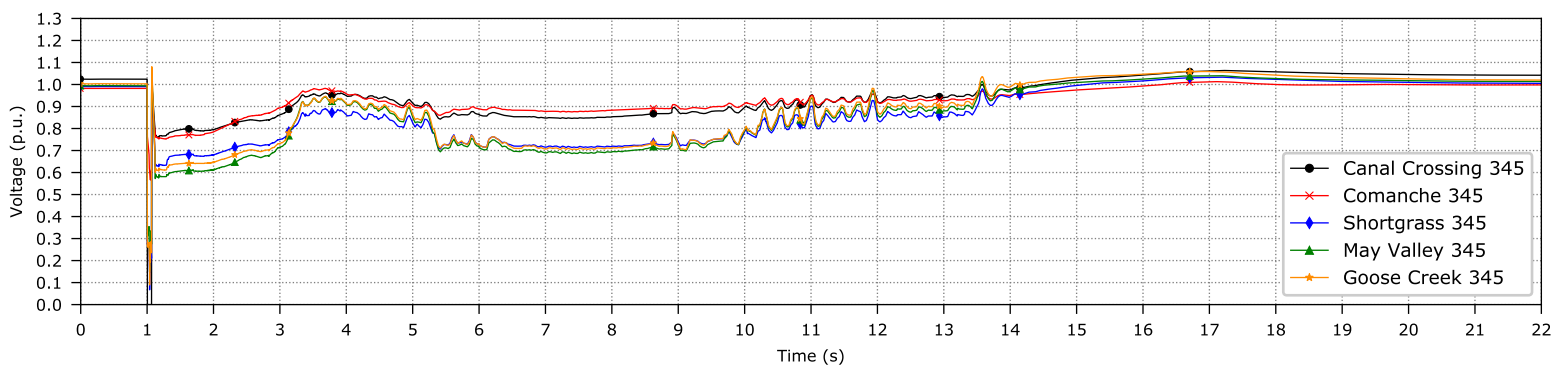




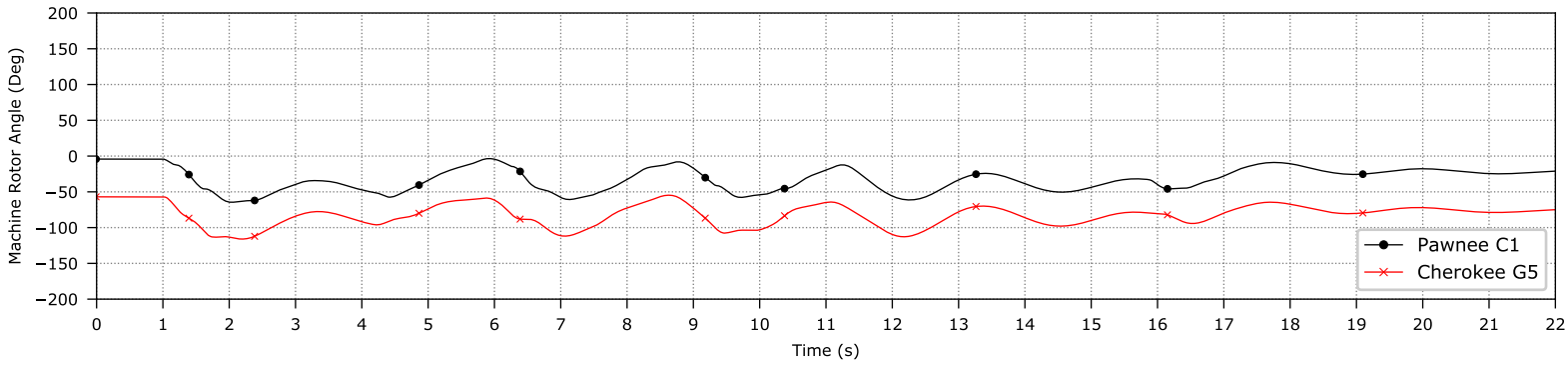


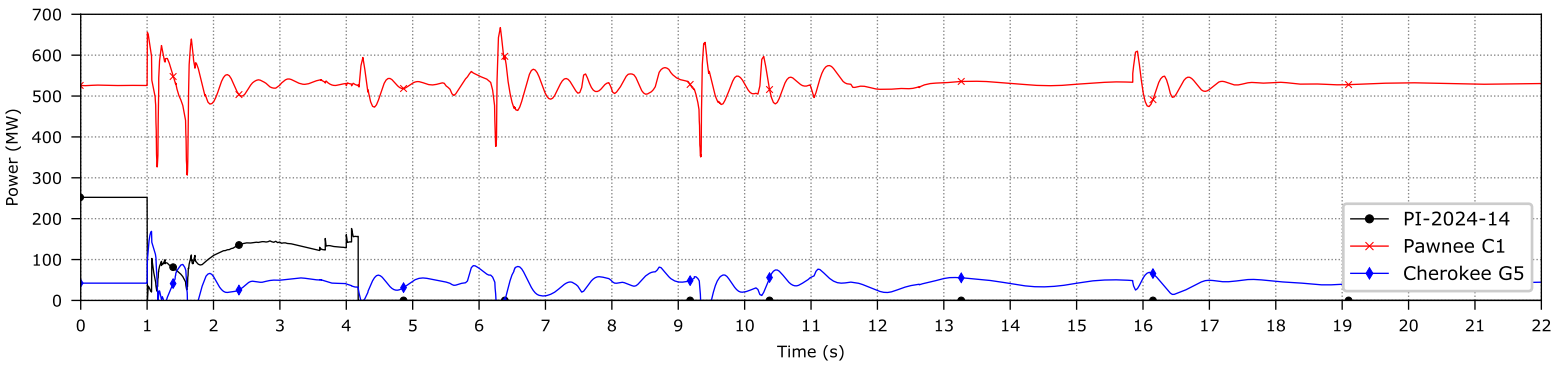


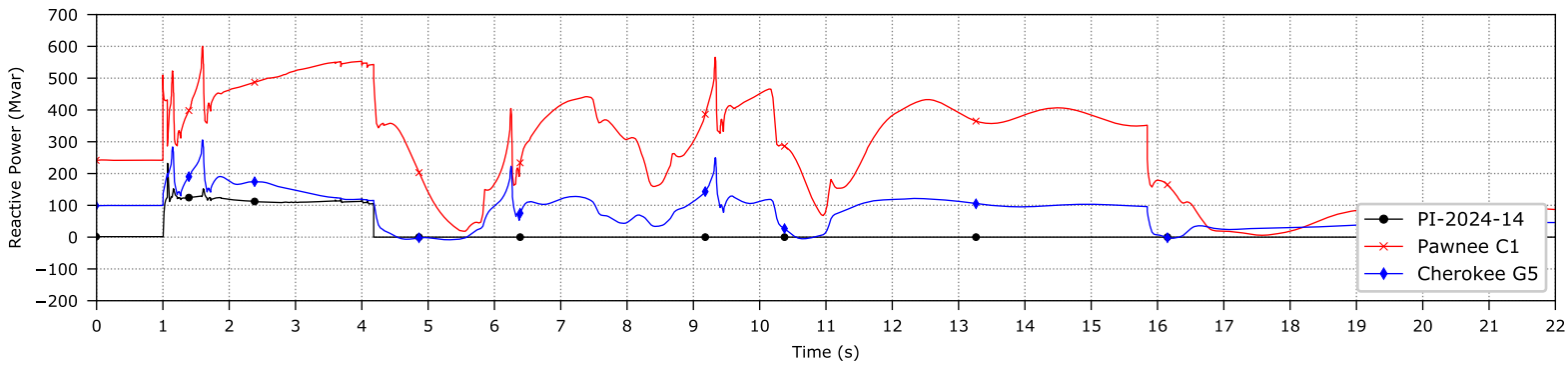


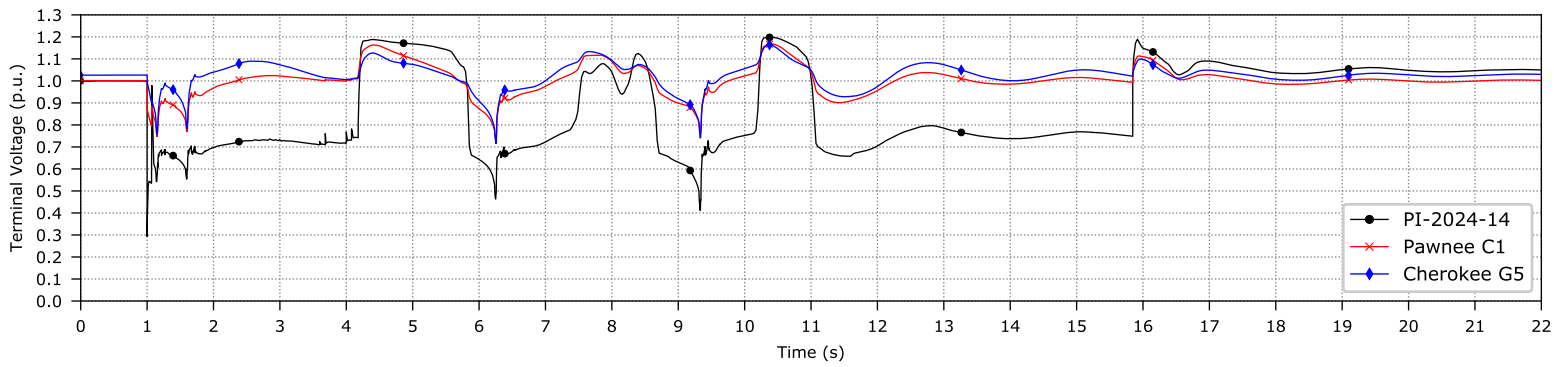


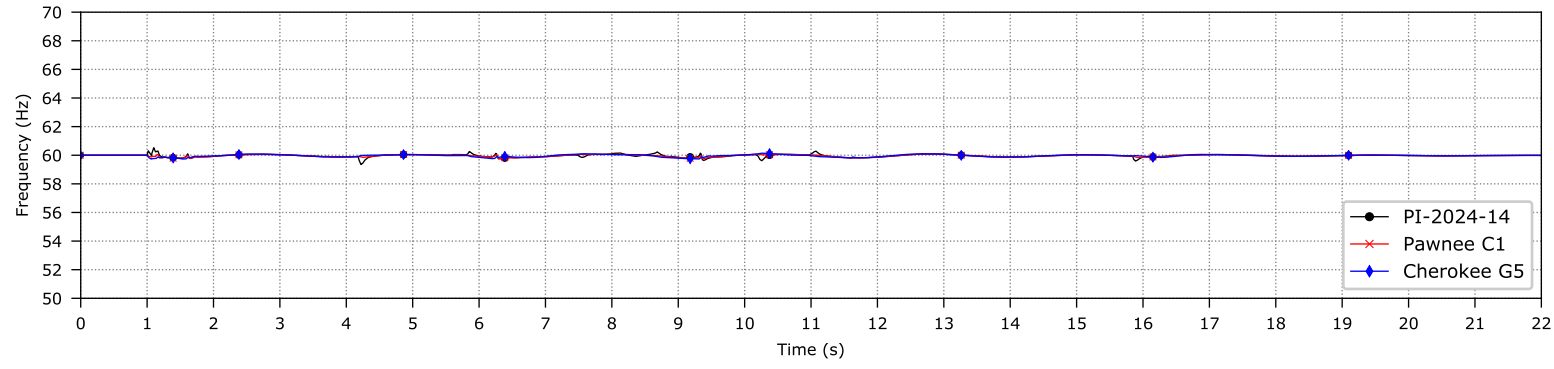
Shortgrass - Pronghorn-P1

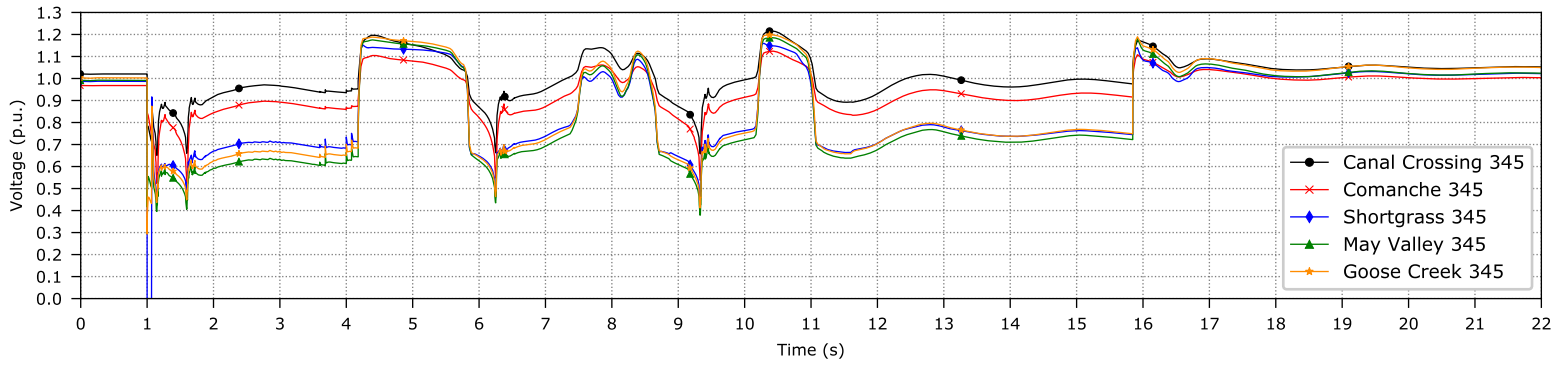




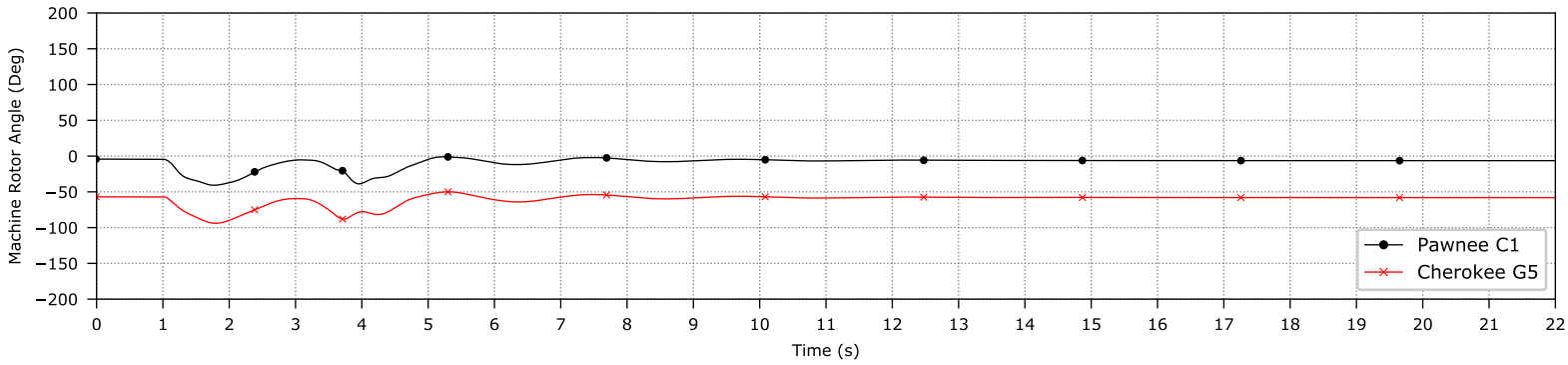


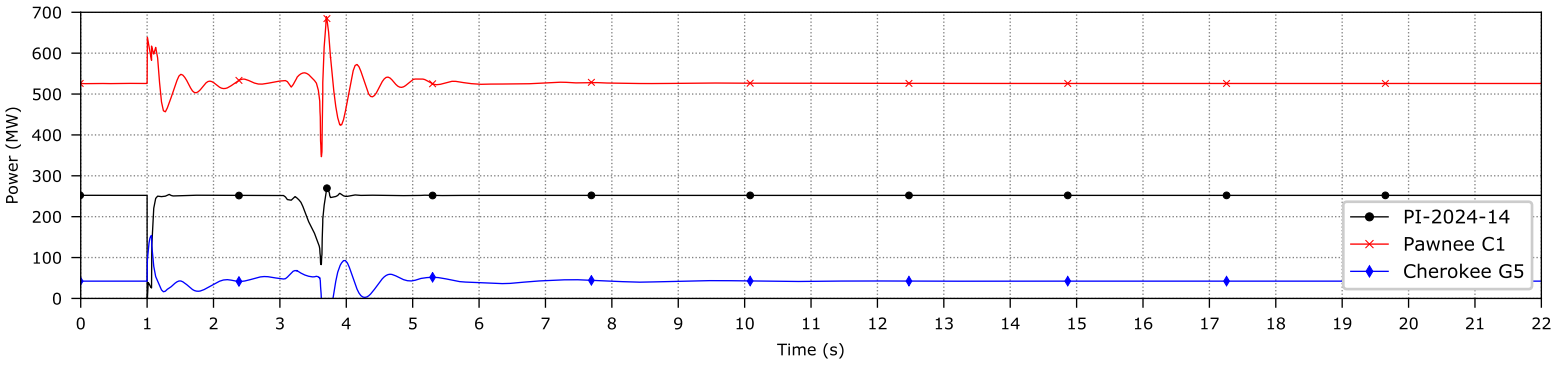


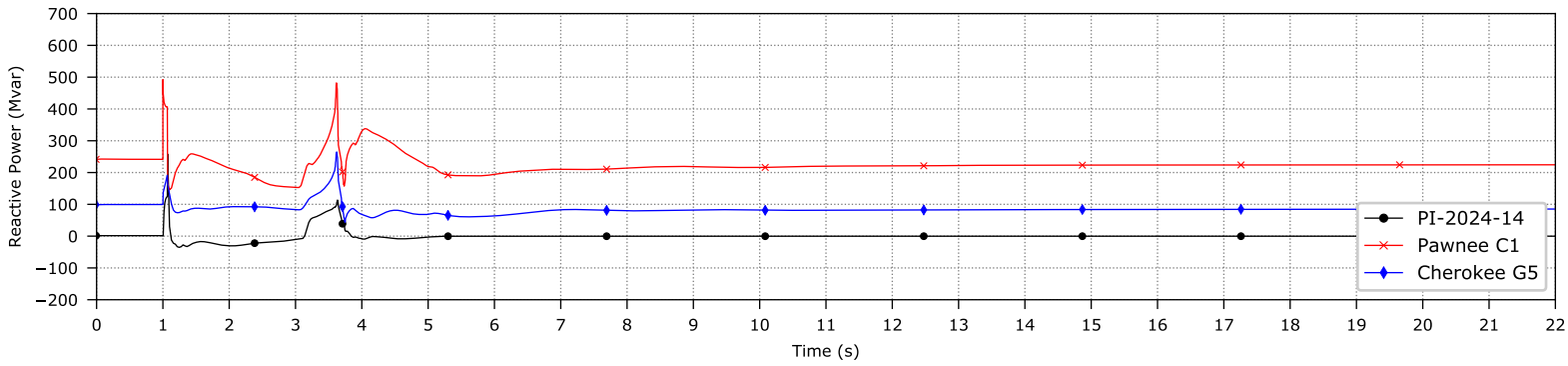


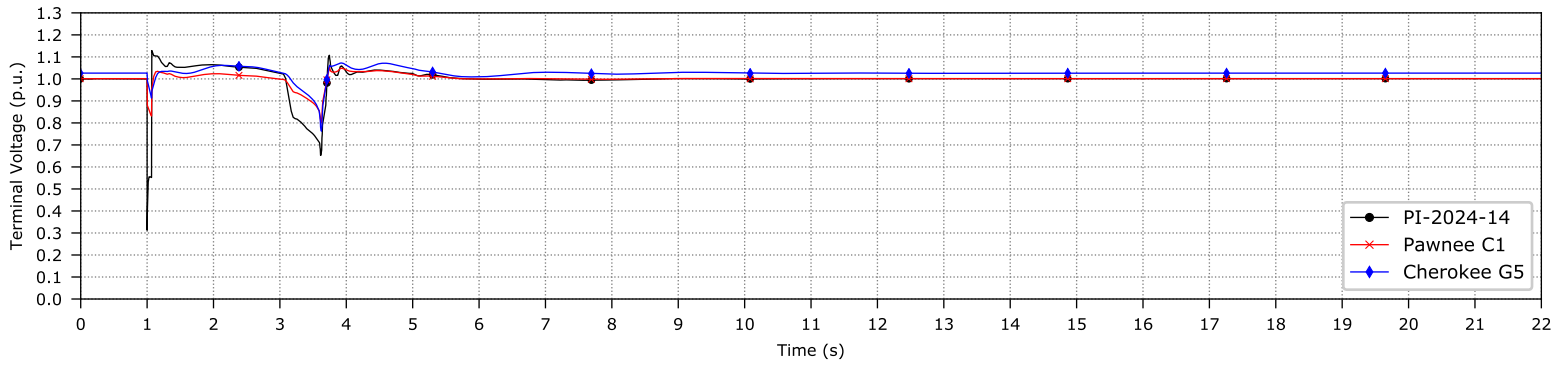


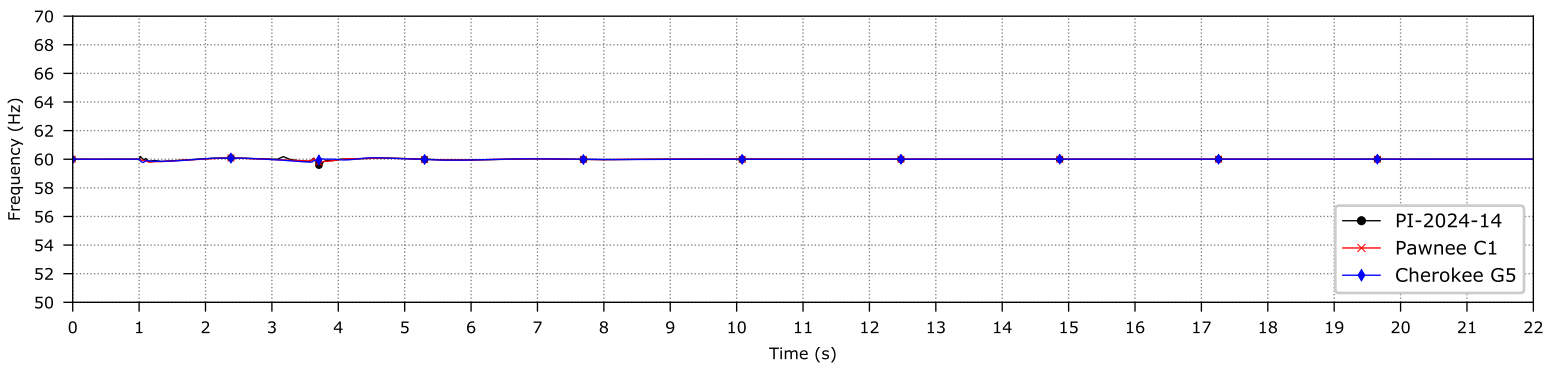
Shortgrass - Bronco_plns-P1

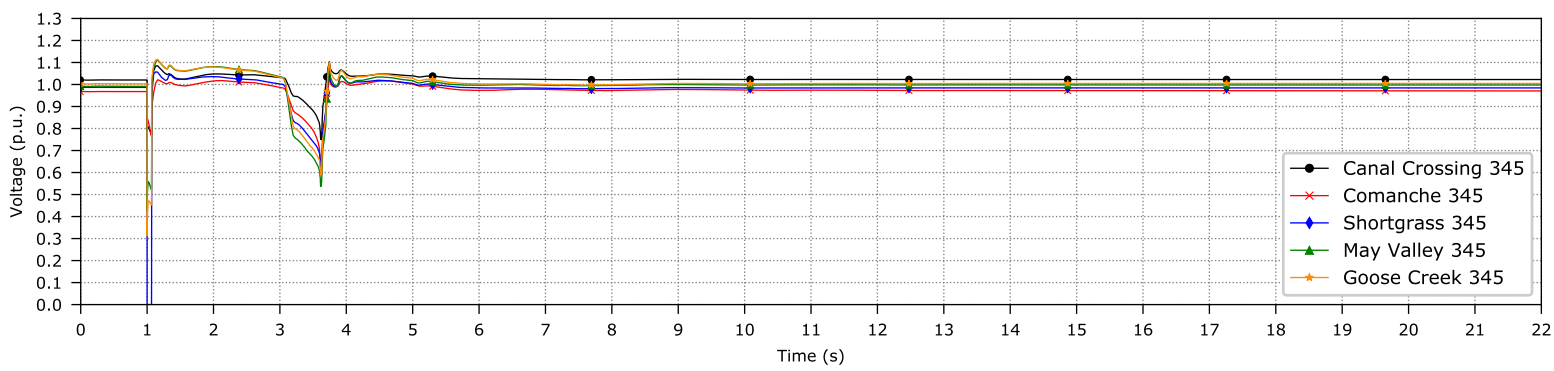




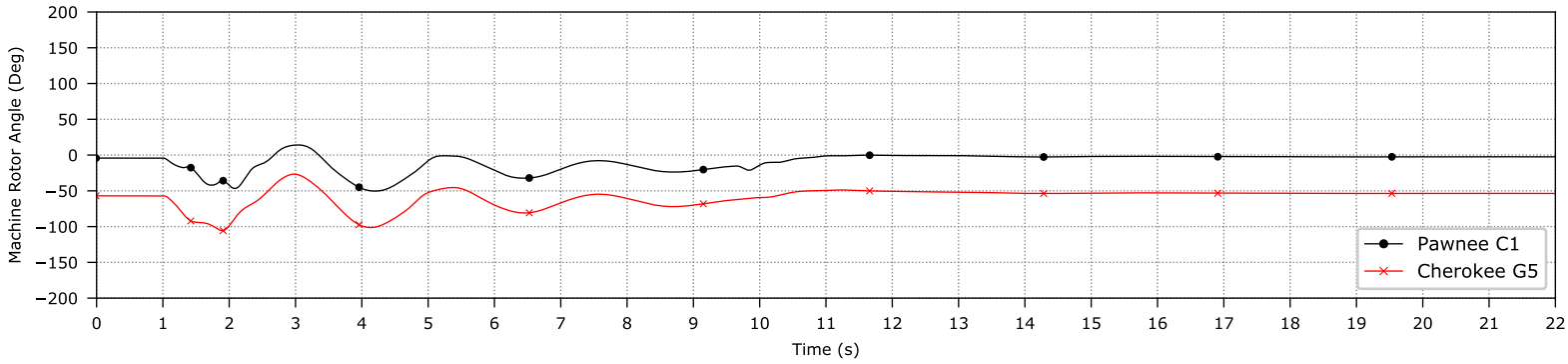


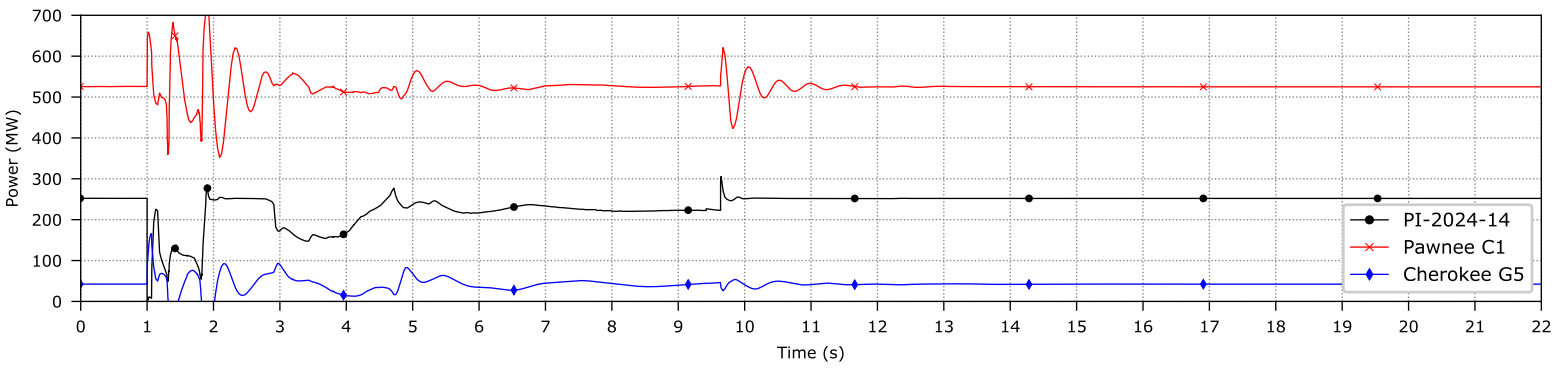


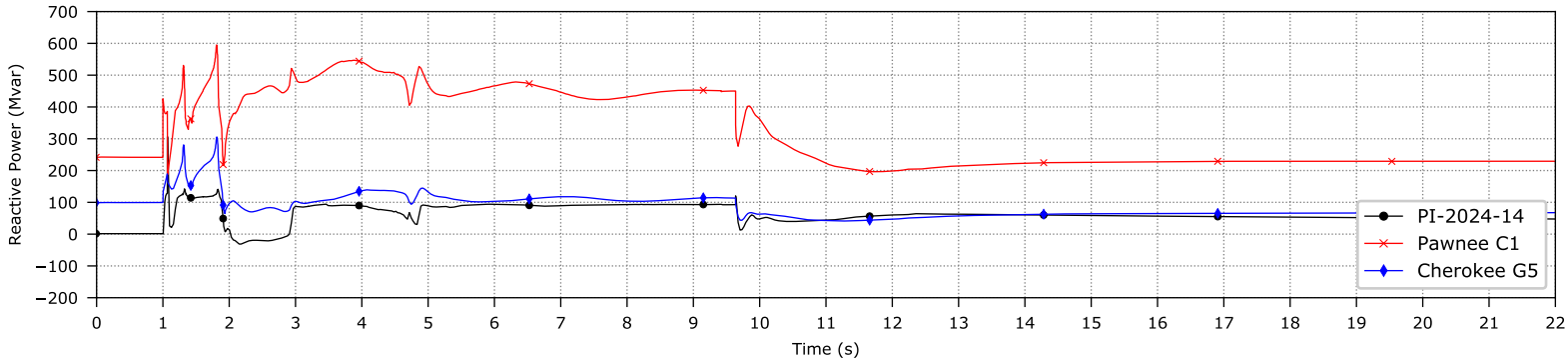


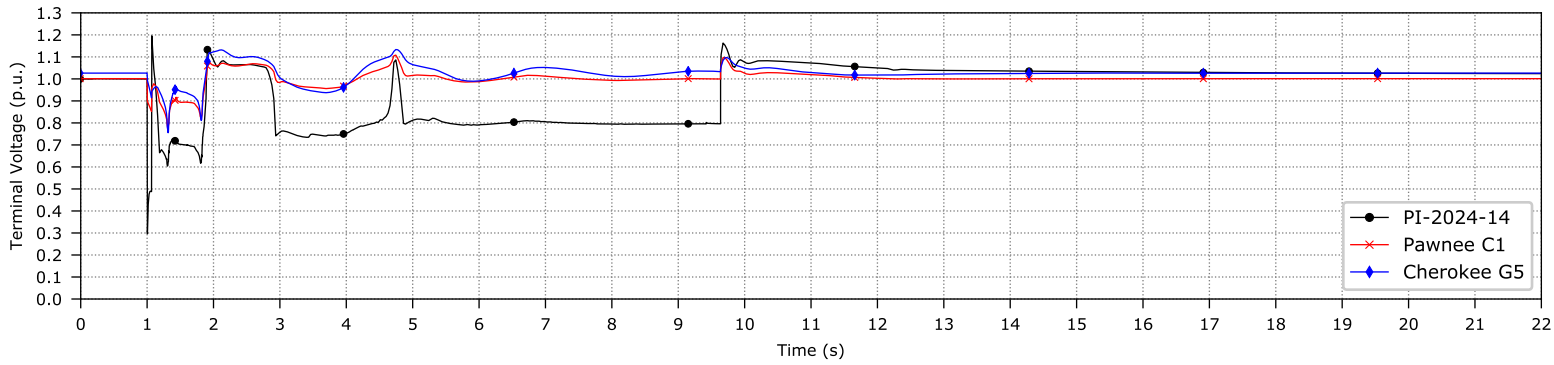


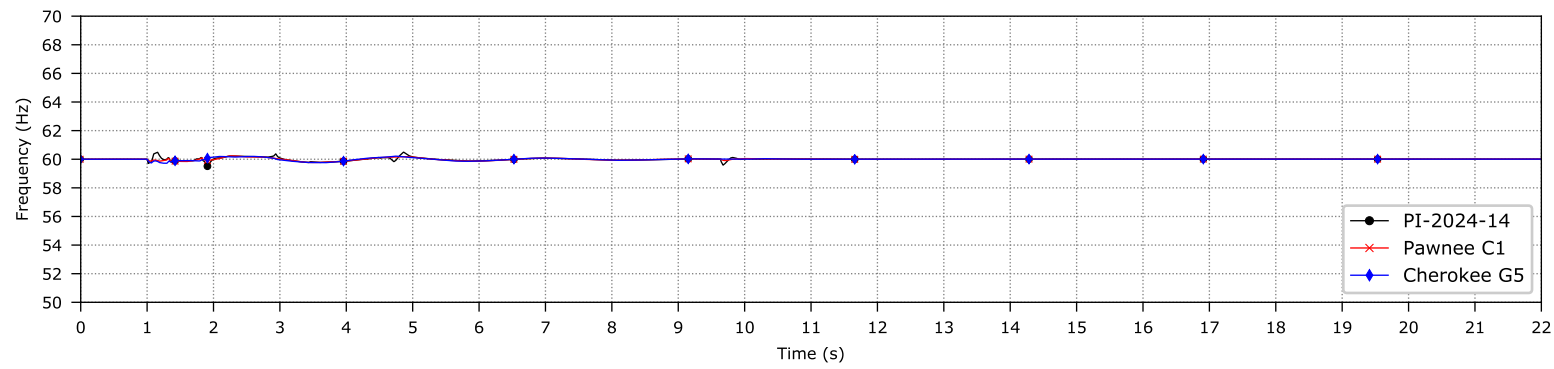
May Valley - Sandstone-P1

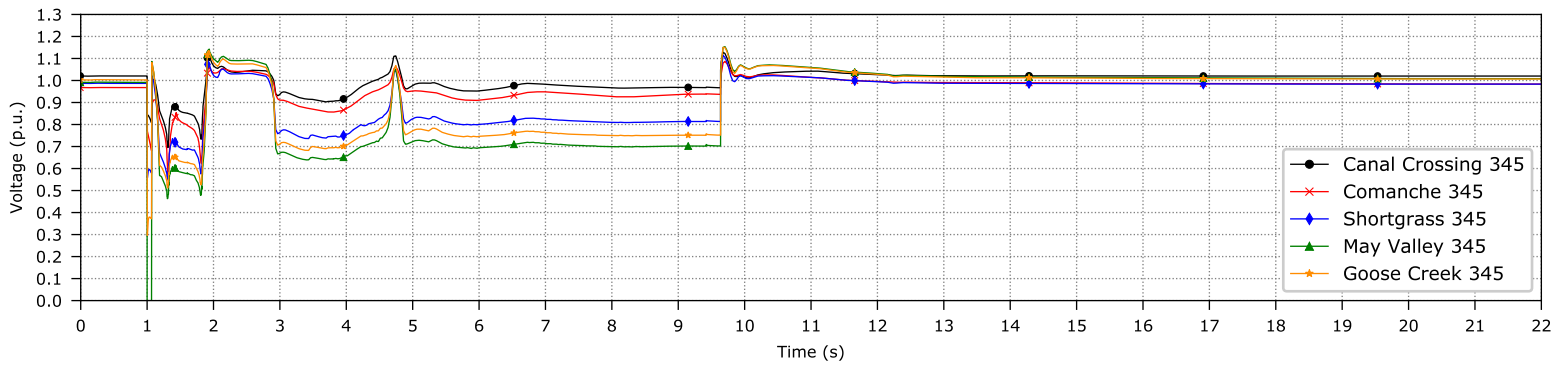




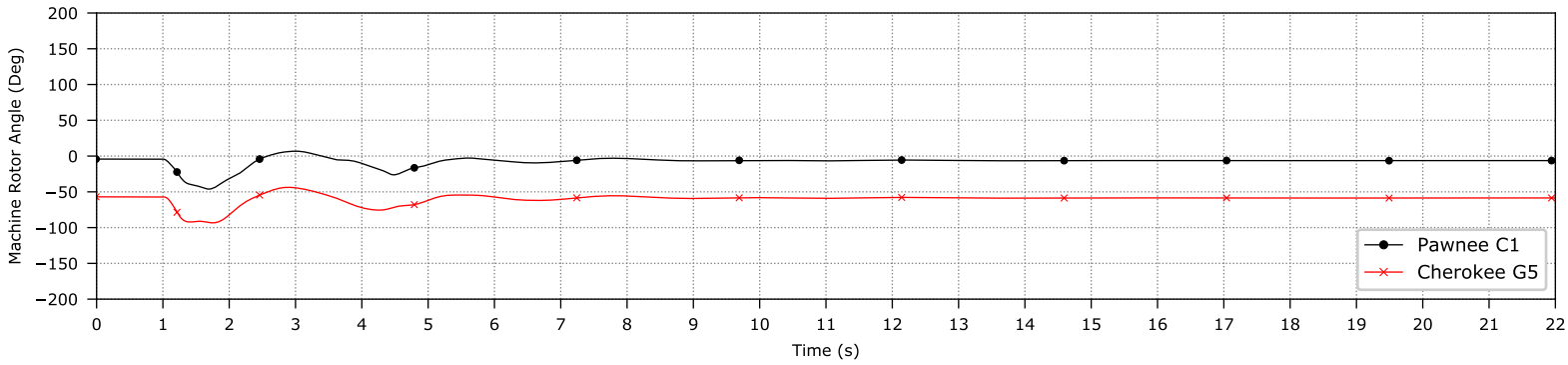


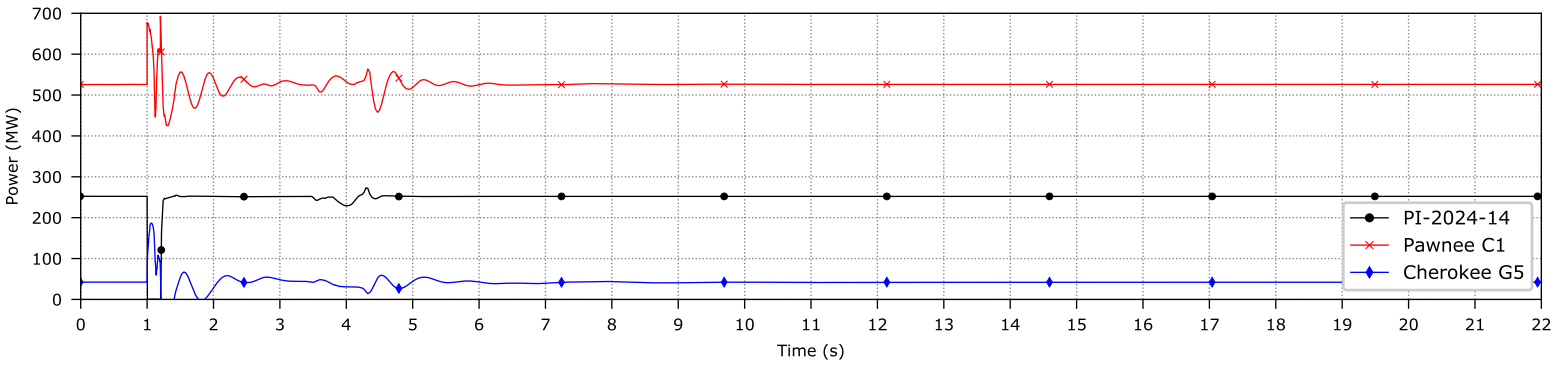


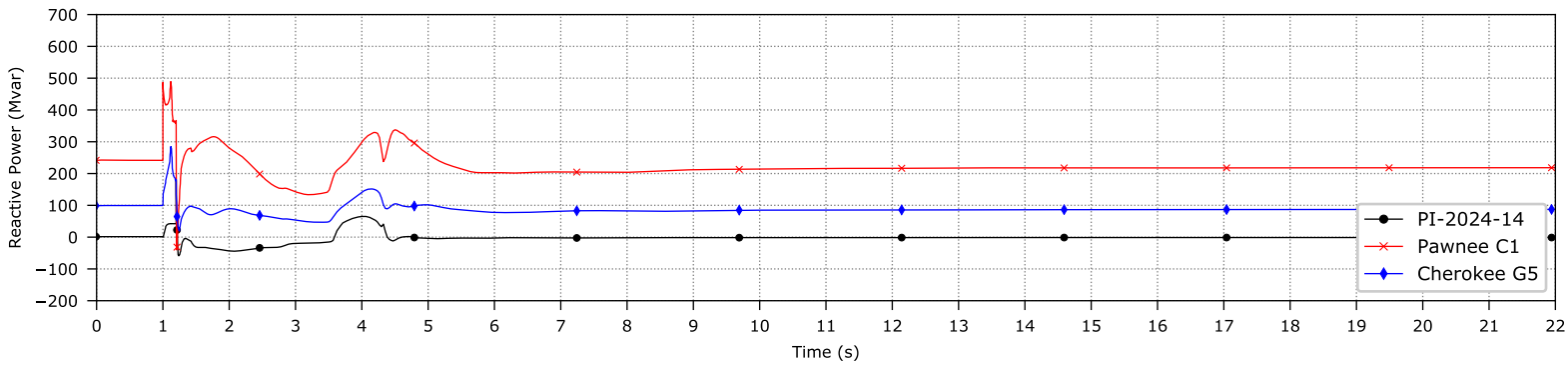


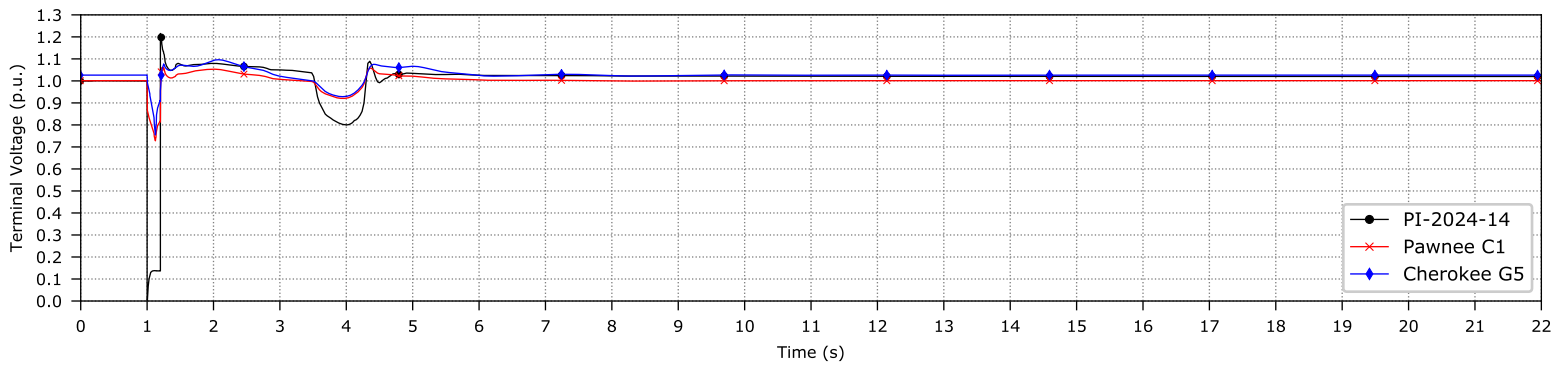


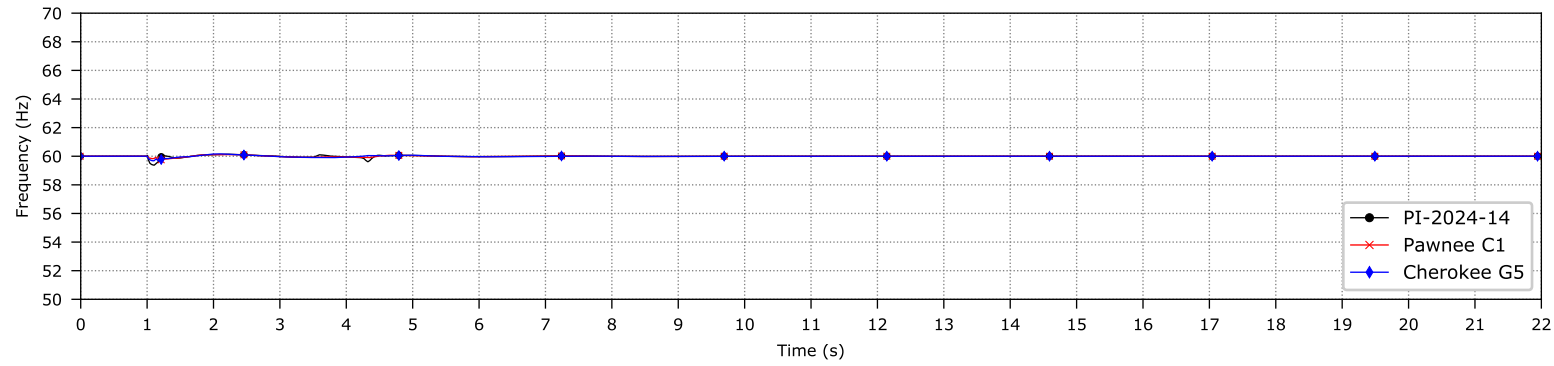
GseCrk-Cheyenne Ridge-P4

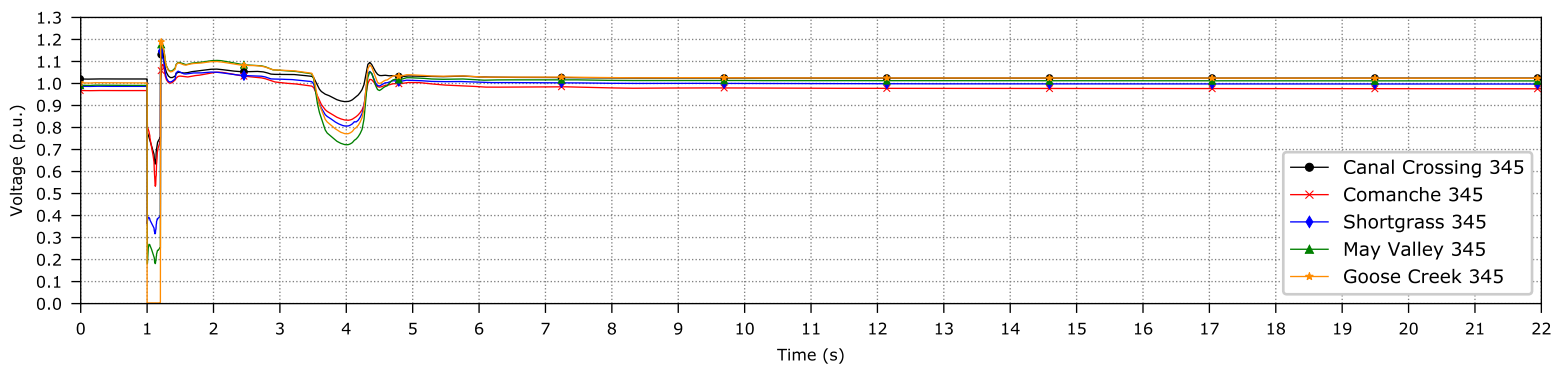




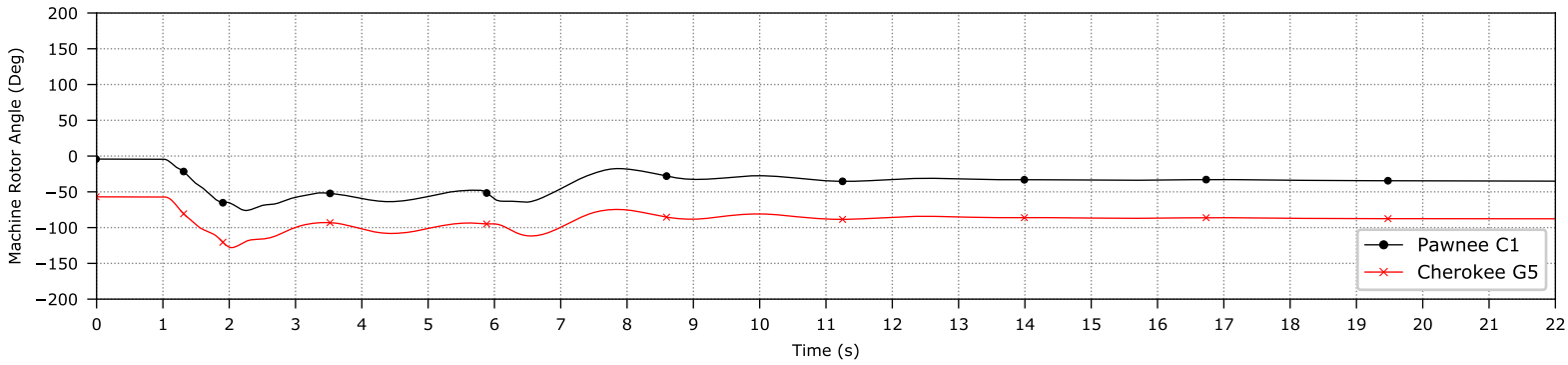


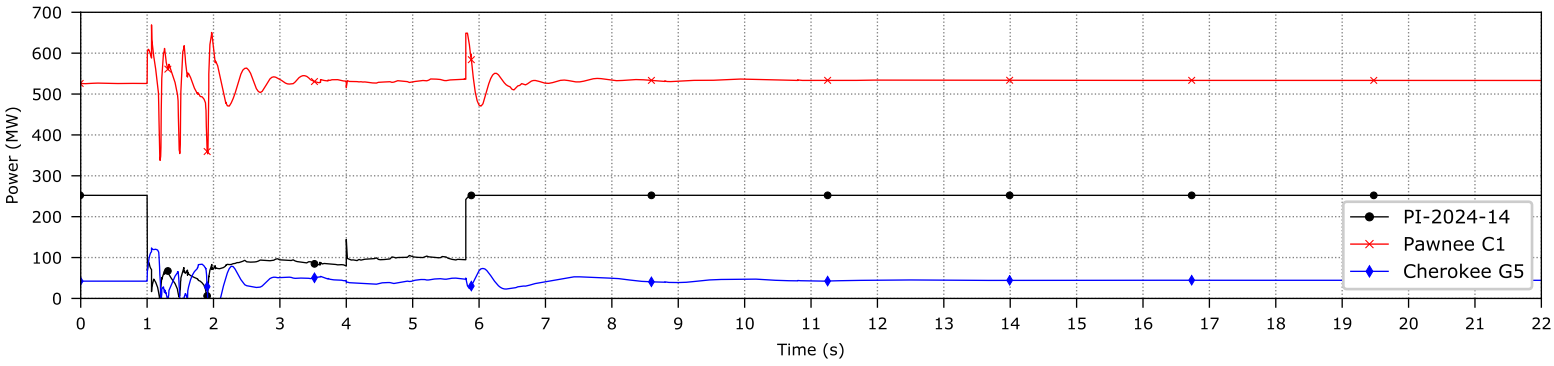


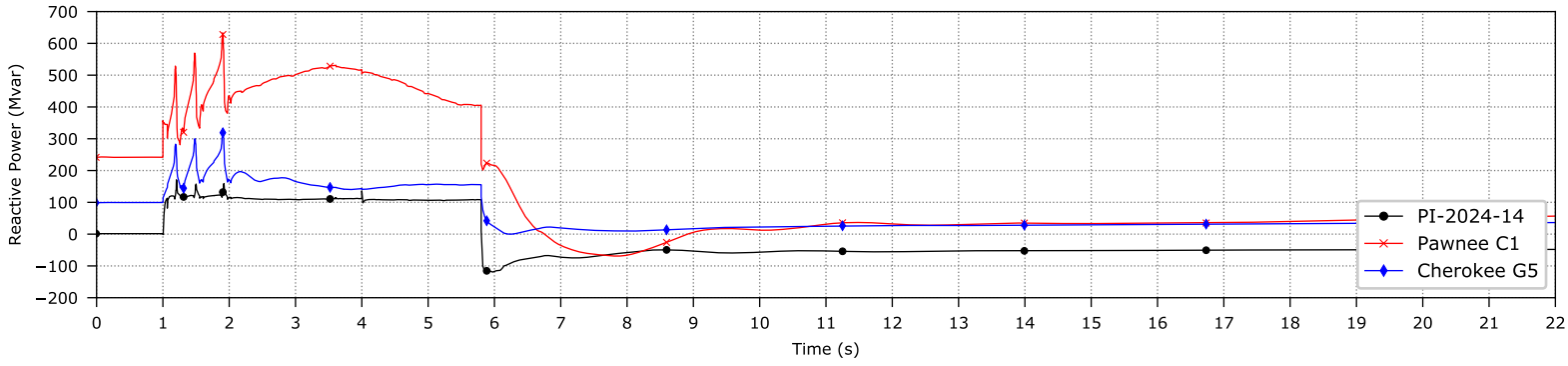


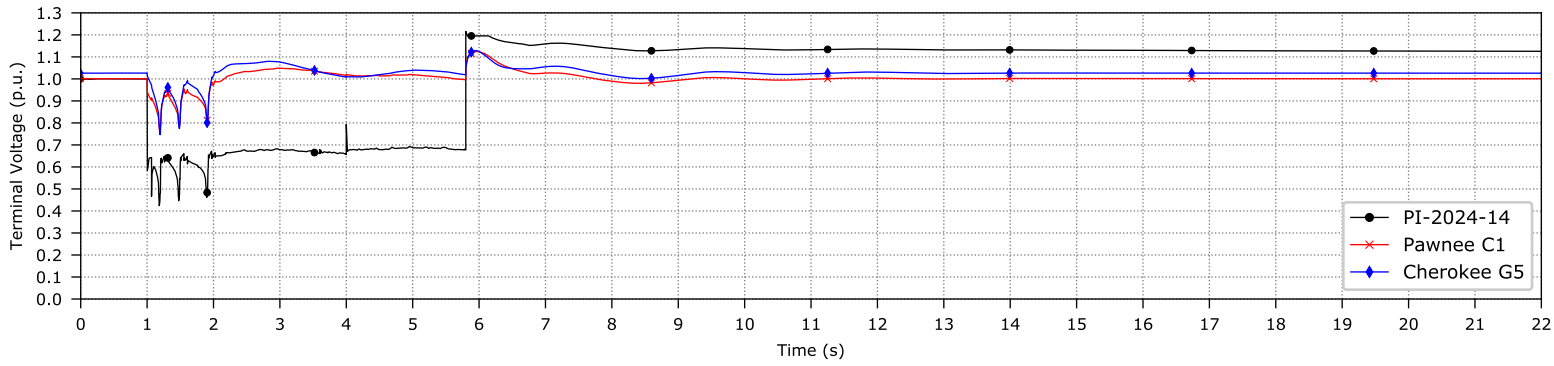


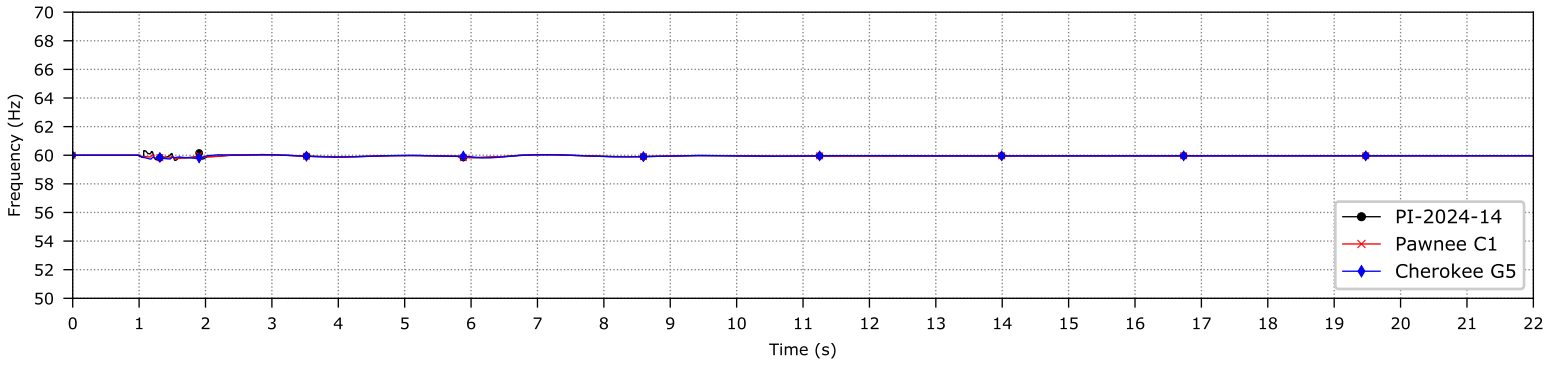
Canal Crossing - Goose Creek-P7

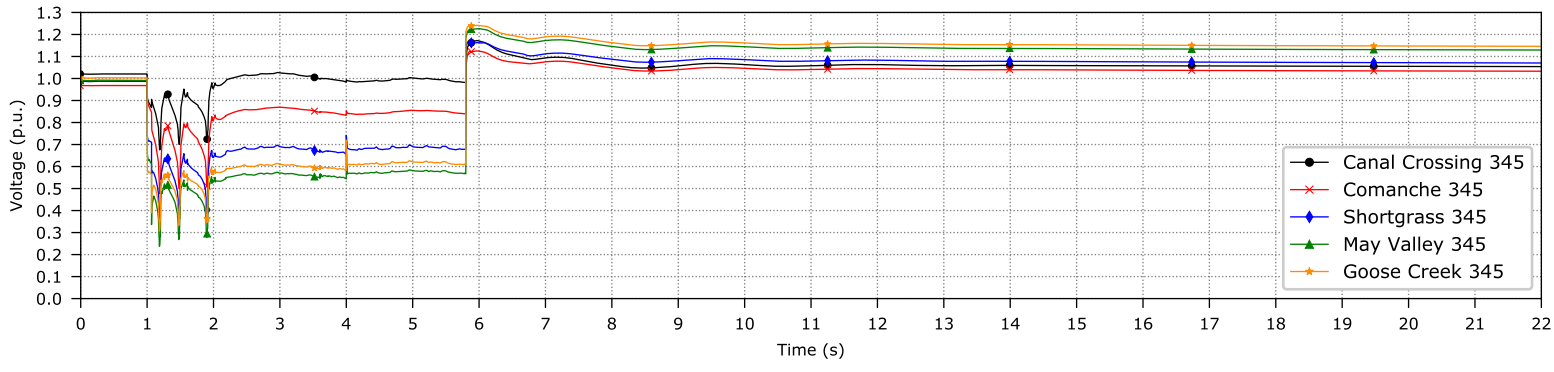




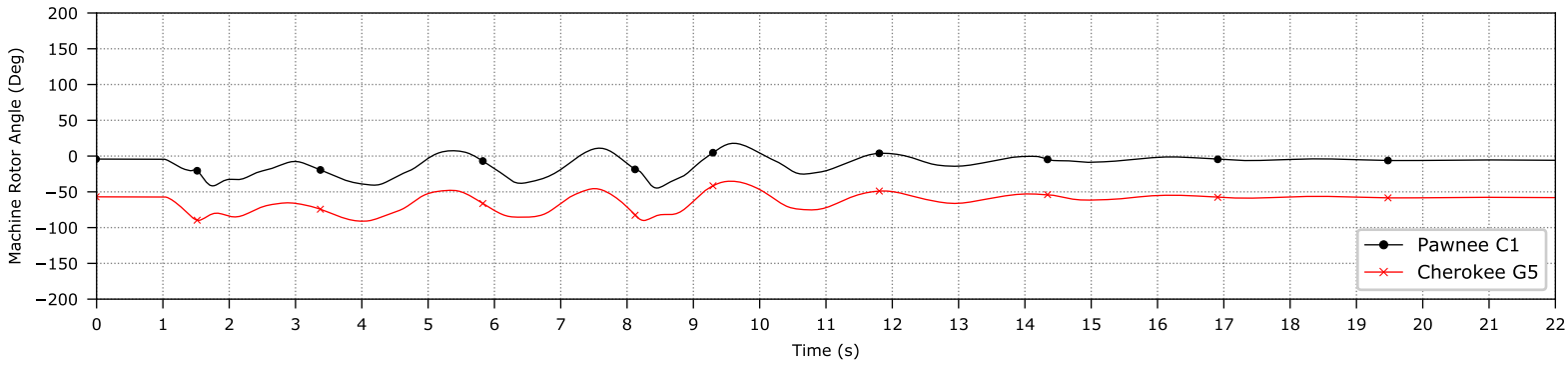


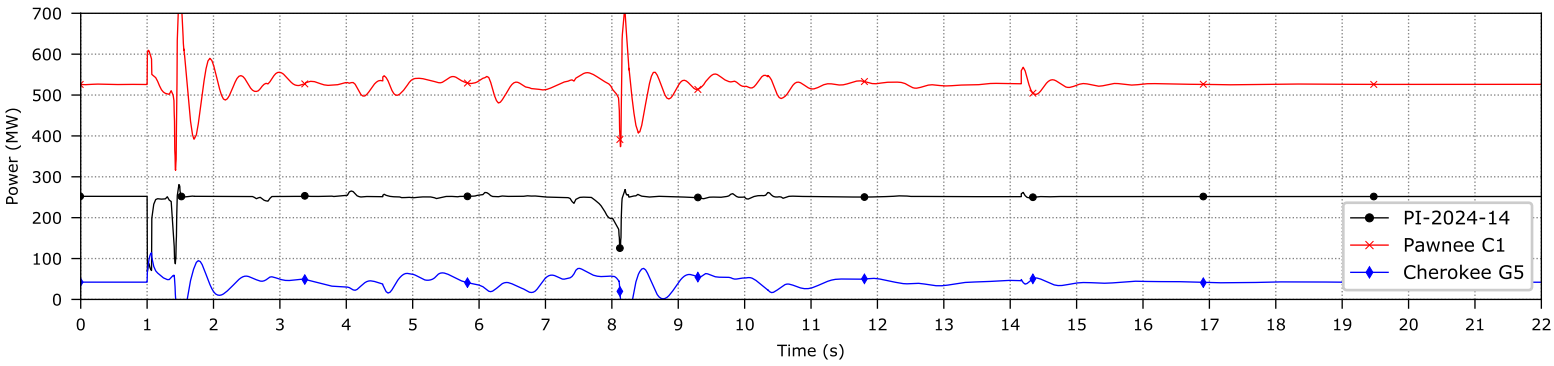


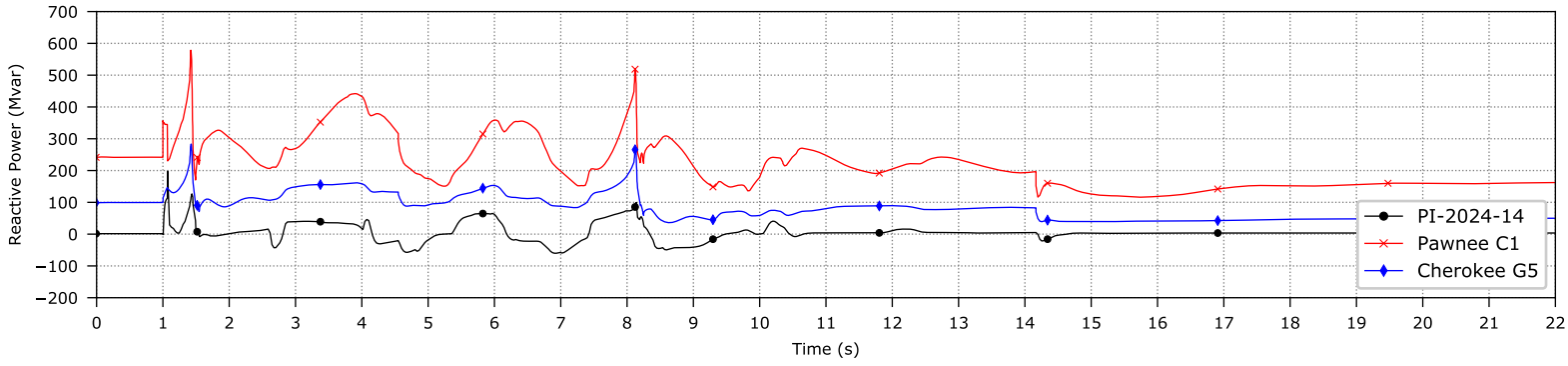


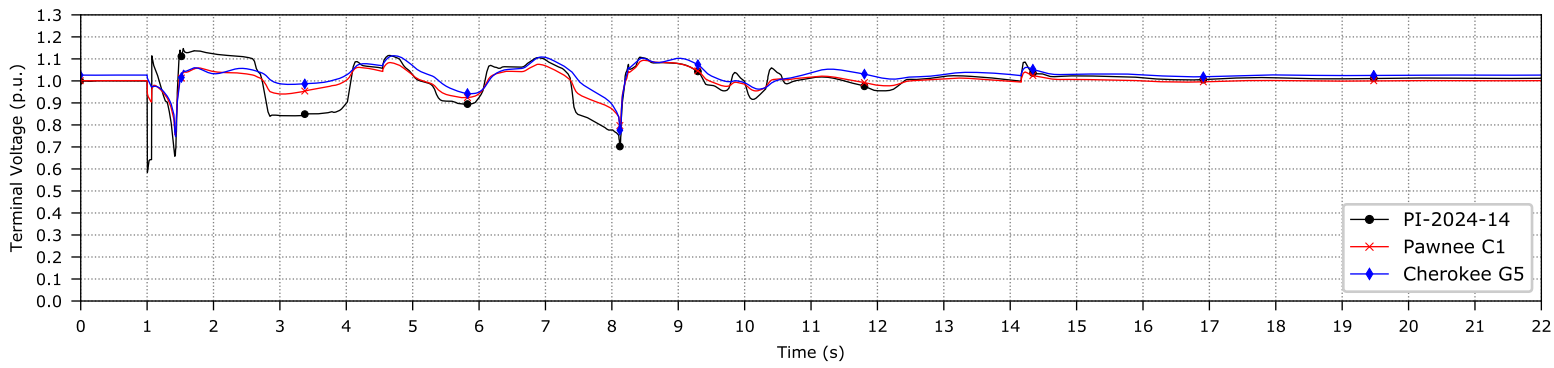


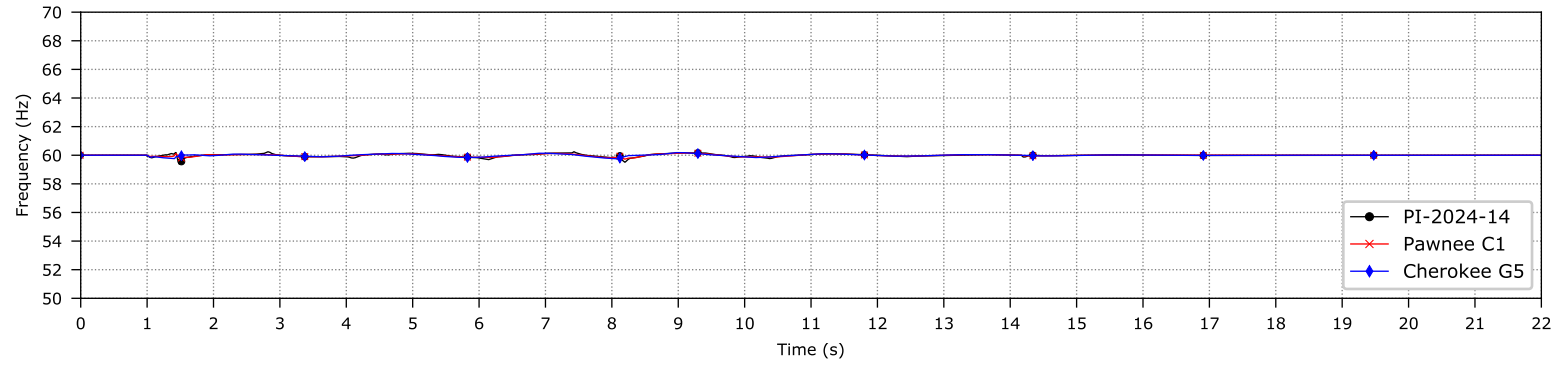
May Valley - Goose Creek-P7

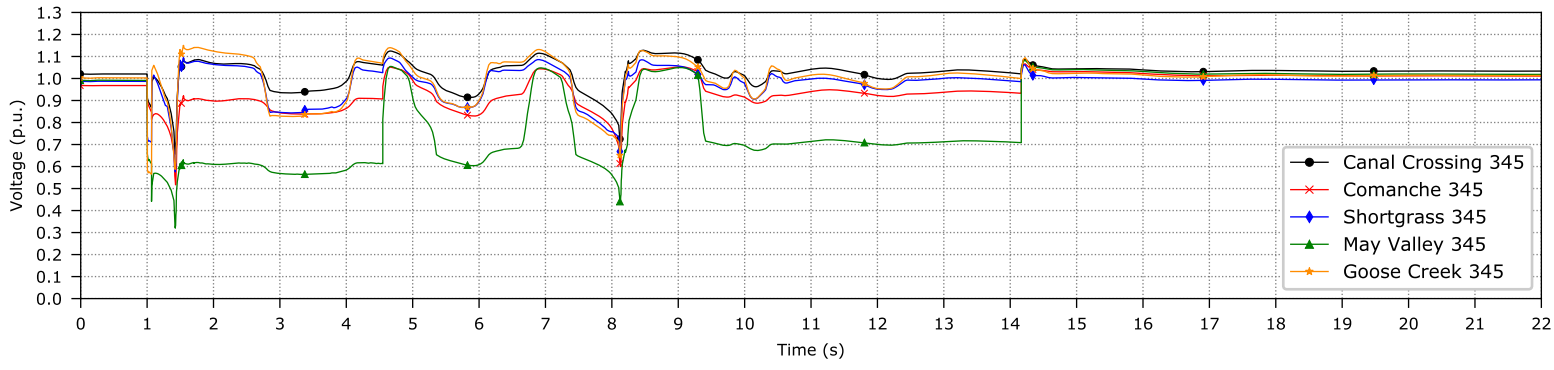




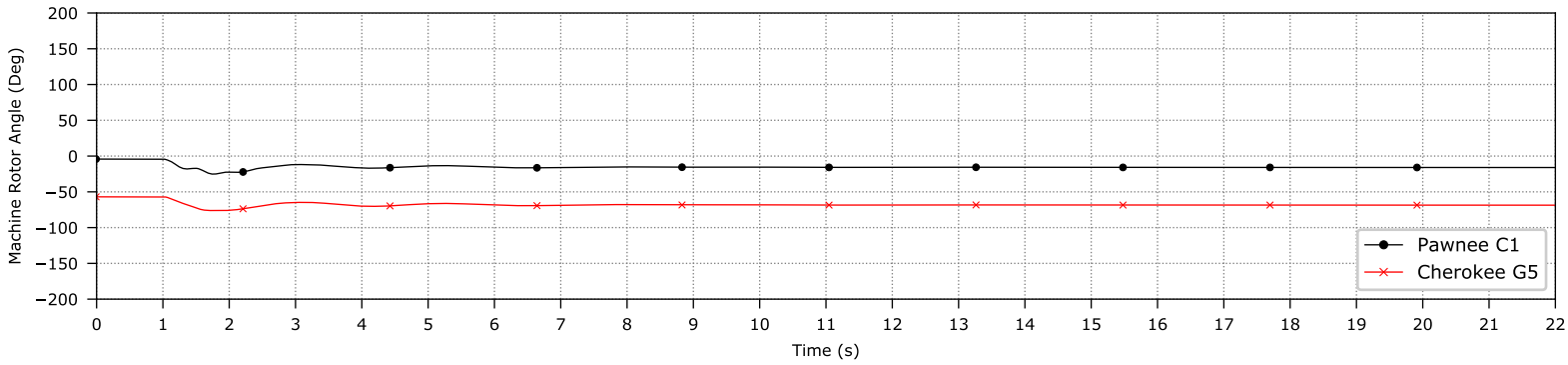


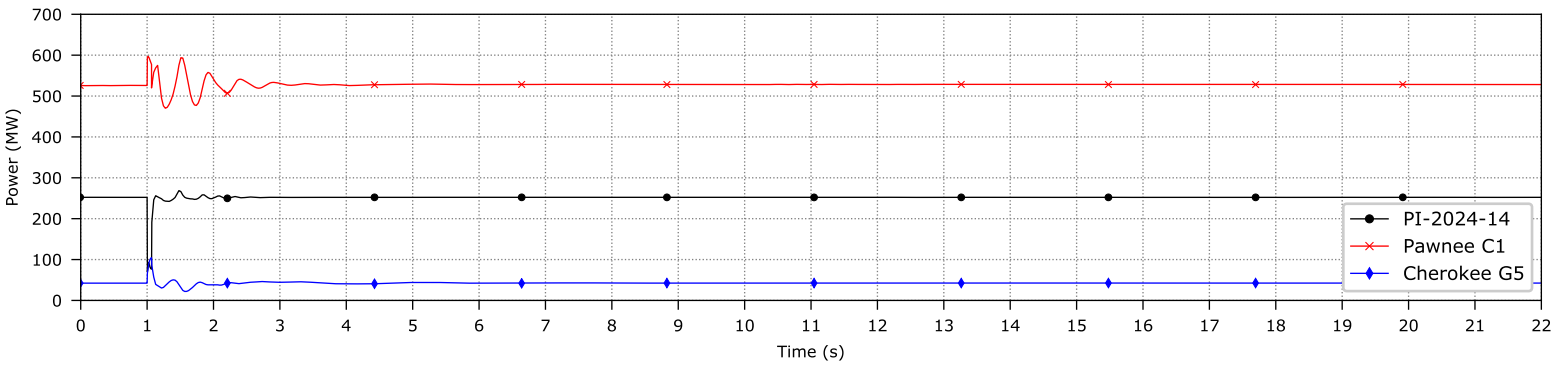


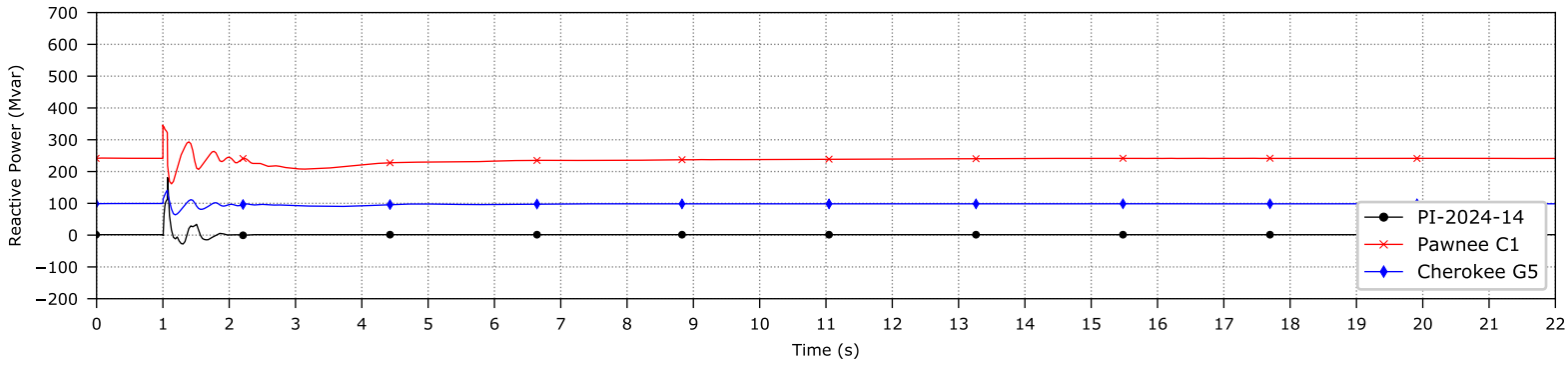


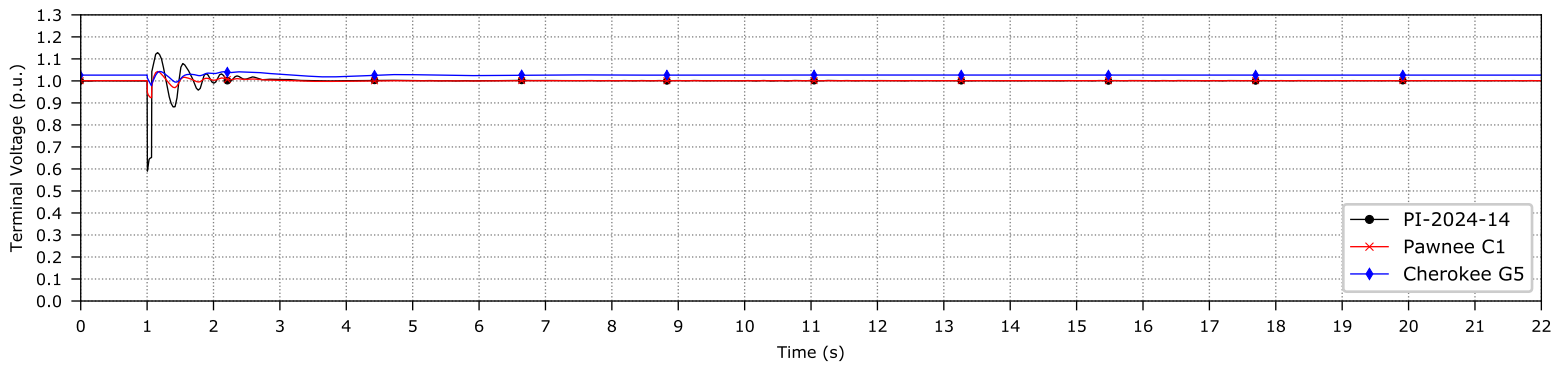


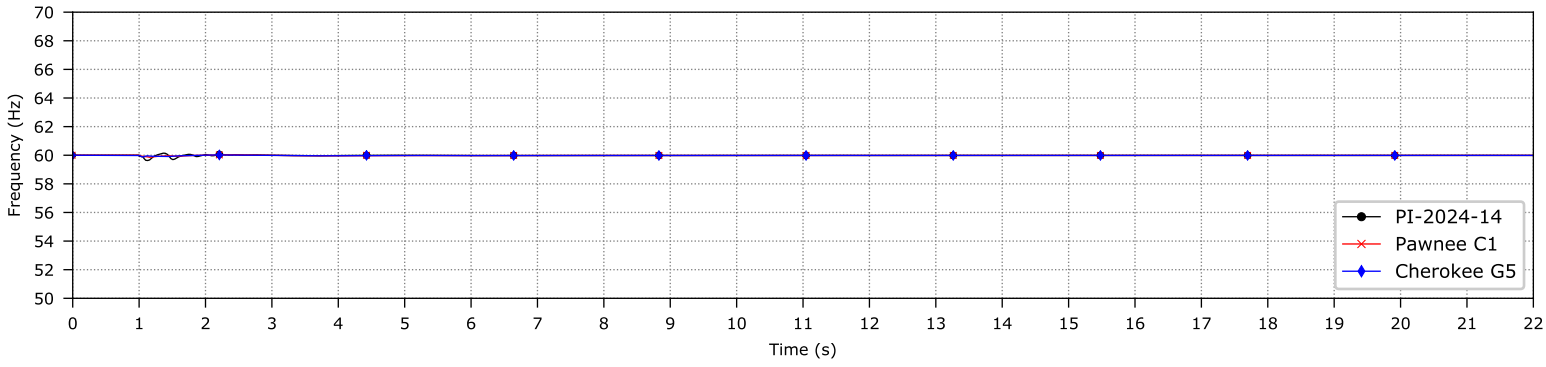
Goose Creek to Shortgras and Cheyenne Ridge-P7

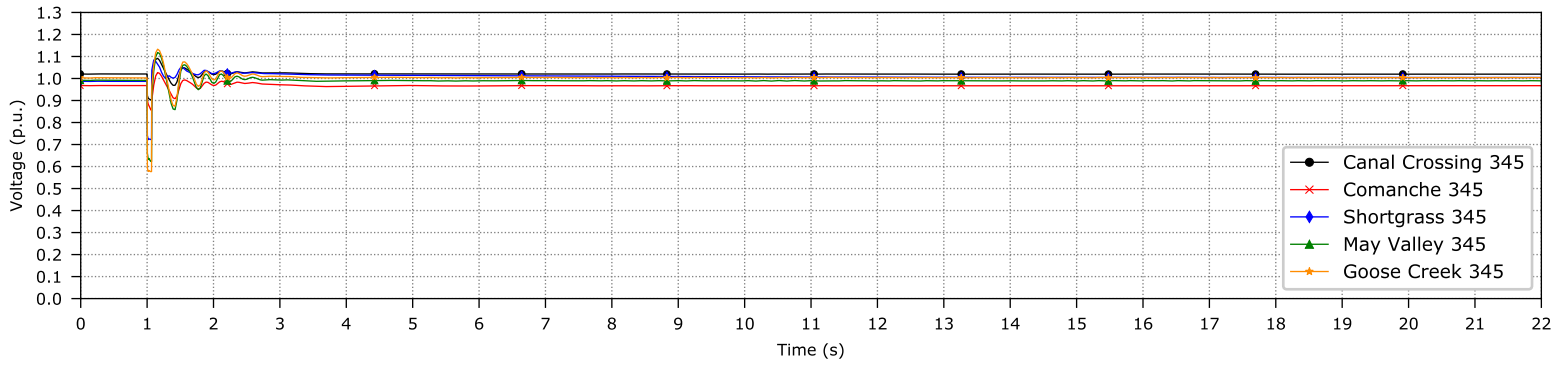












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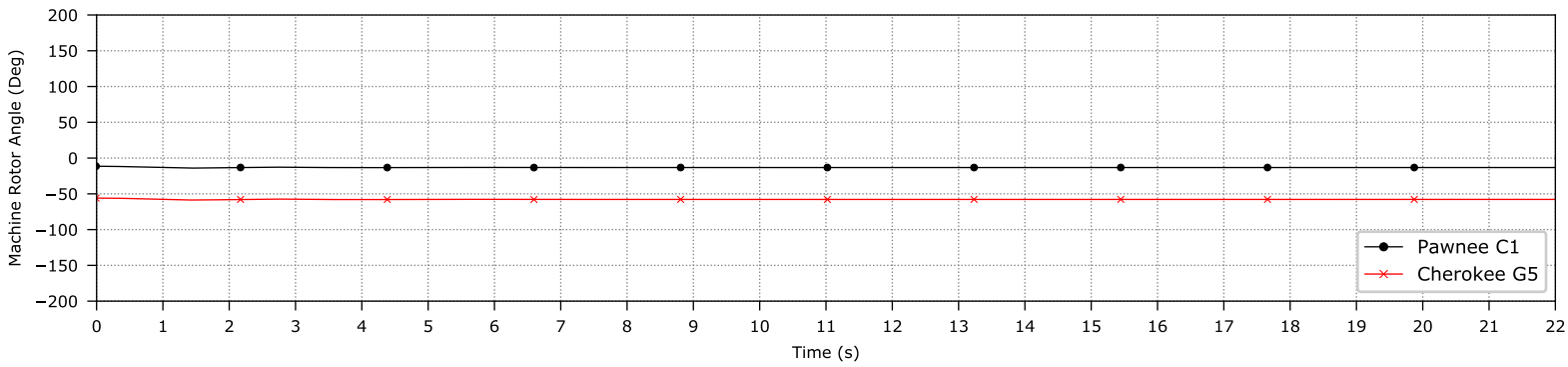
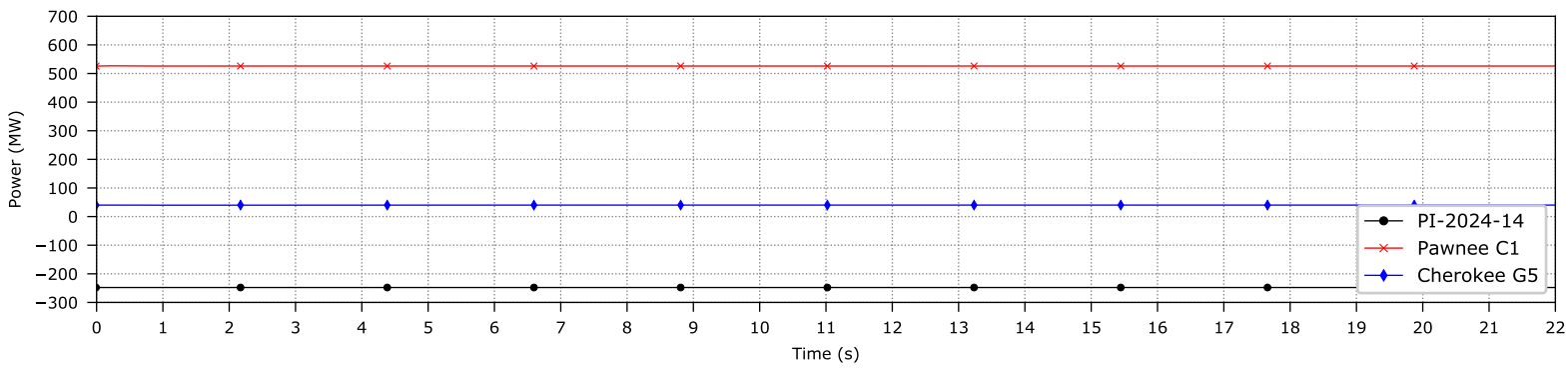
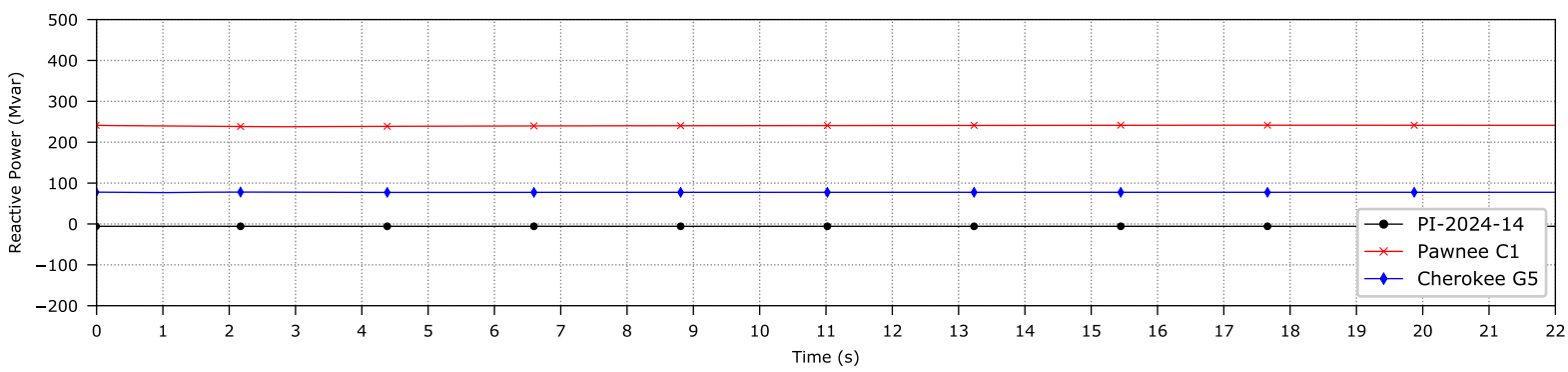
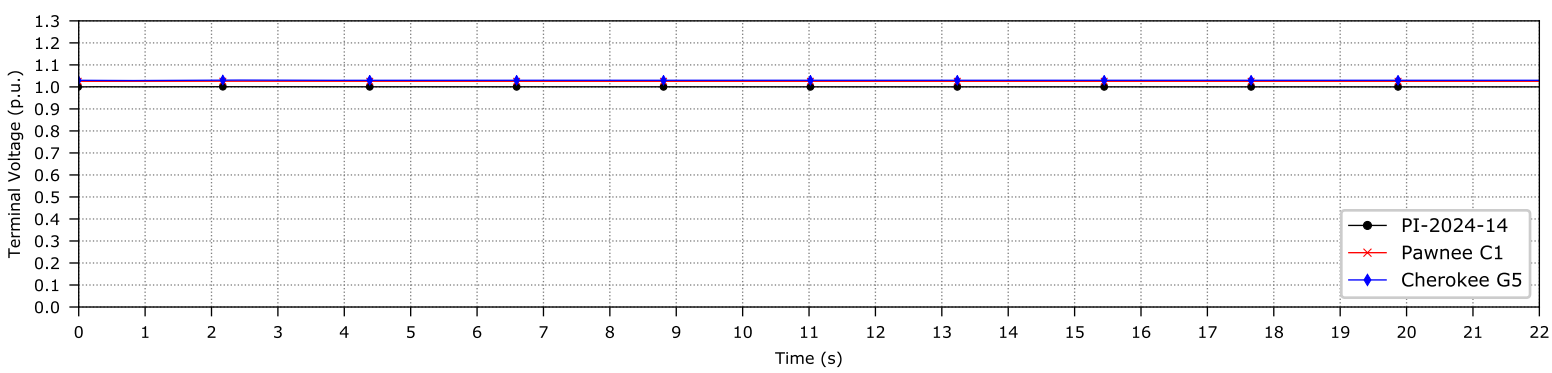
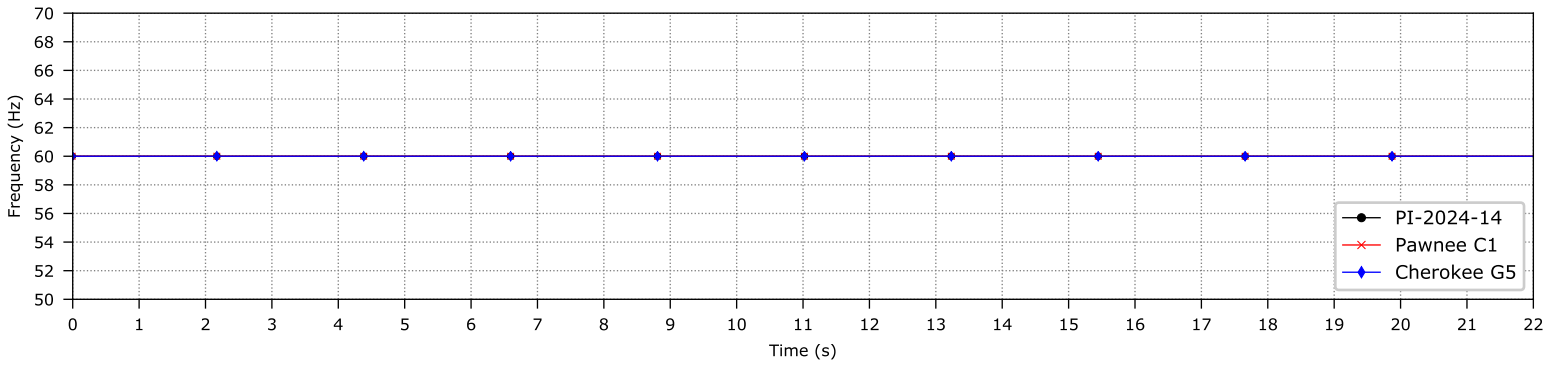
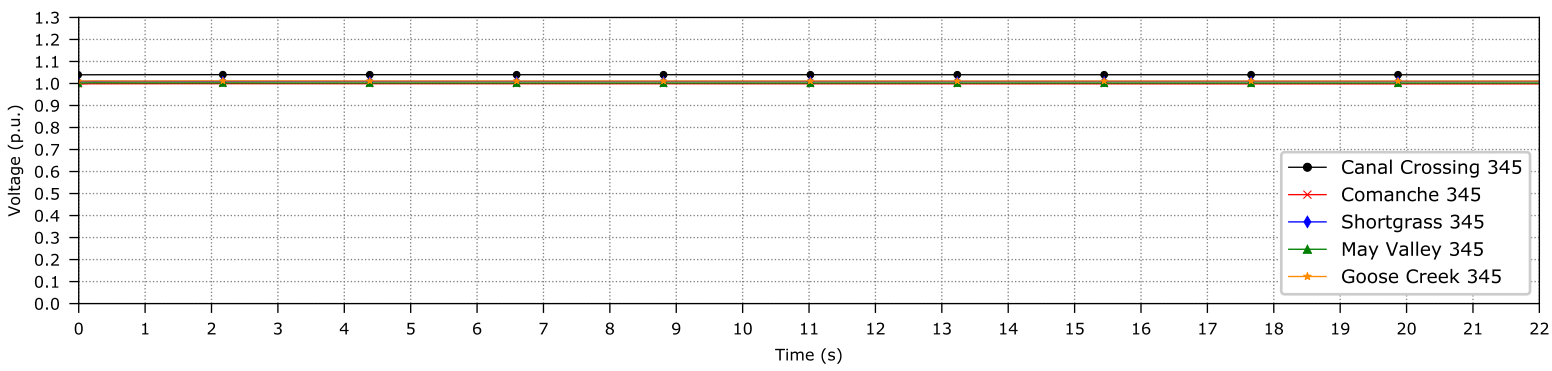

Machine Rotor Angle (Deg)
Time (s)
Pawnee C1
Cherokee G5


Power (MW)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

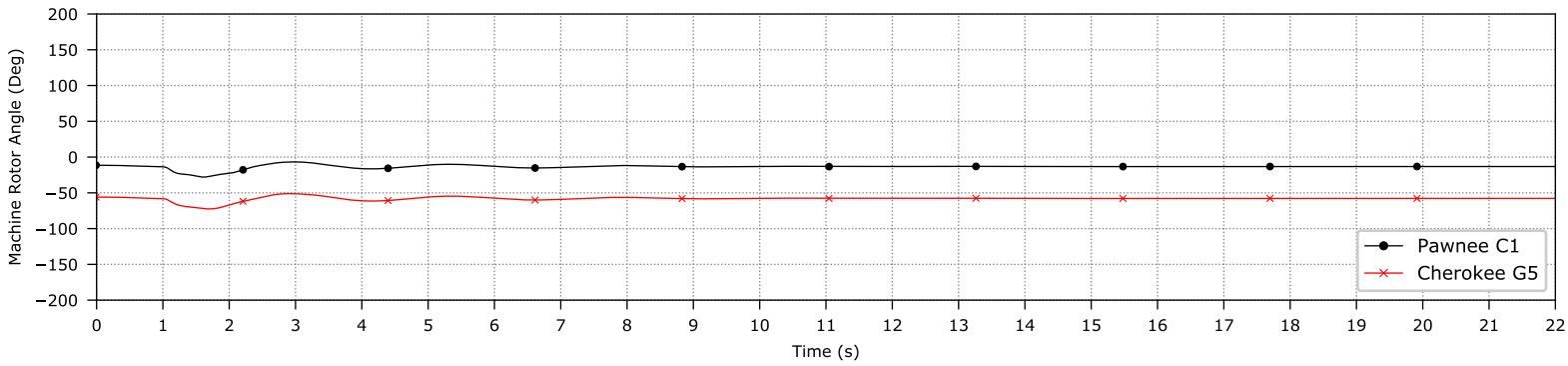

Reactive Power (Mvar)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

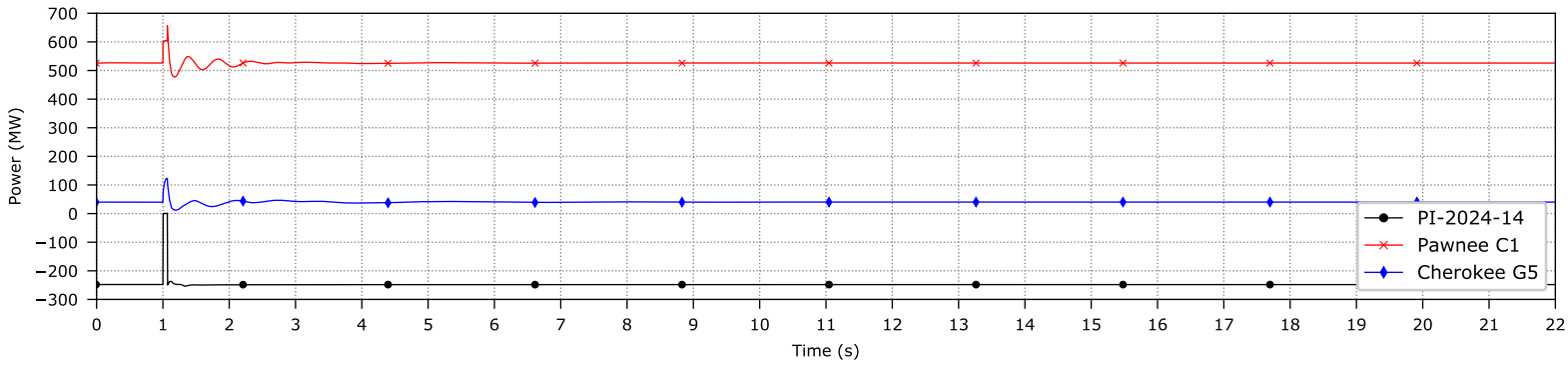

Terminal Voltage (p.u.)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

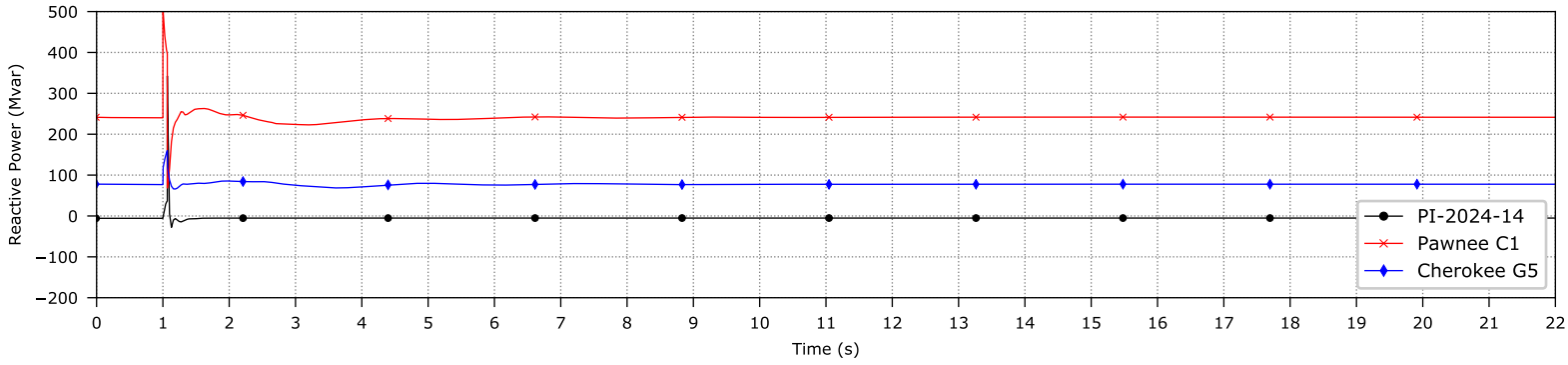

Frequency (Hz)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

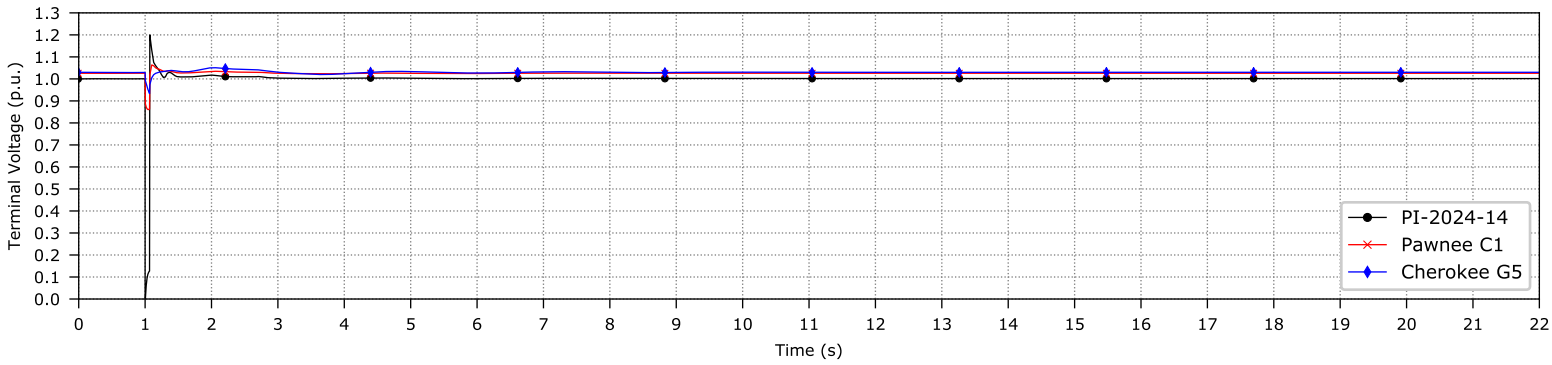

Voltage (p.u.)
Time (s)
Canal Crossing 345
Comanche 345
Shortgrass 345
May Valley 345
Goose Creek 345

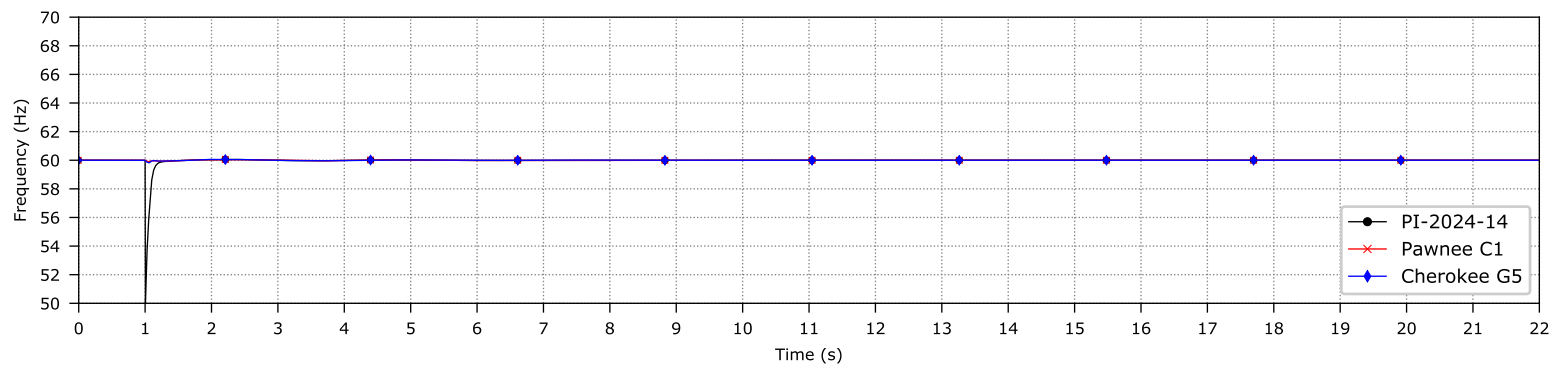
PI-2024-14

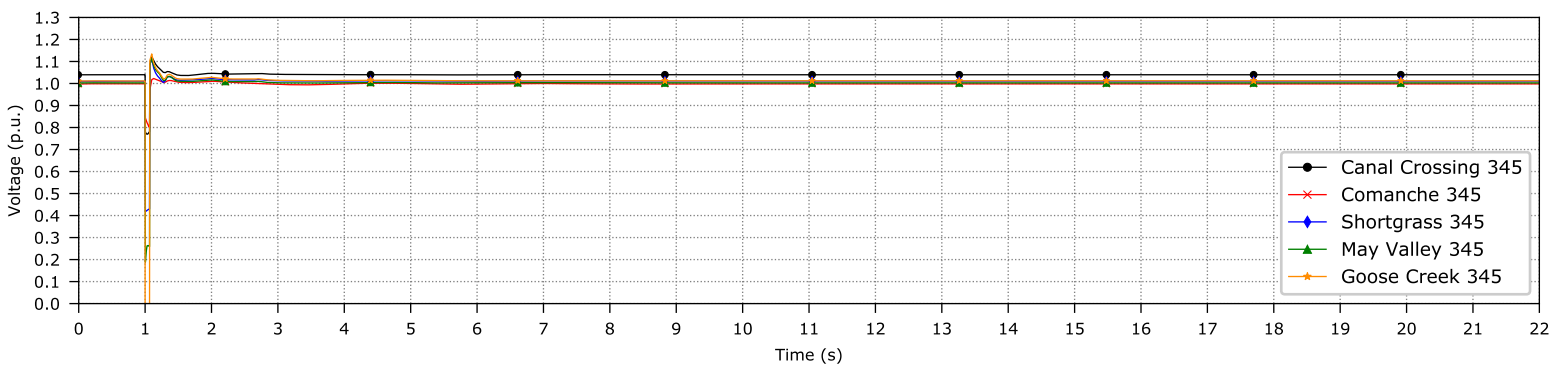

Machine Rotor Angle (Deg)
Time (s)
Pawnee C1
Cherokee G5


Power (MW)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

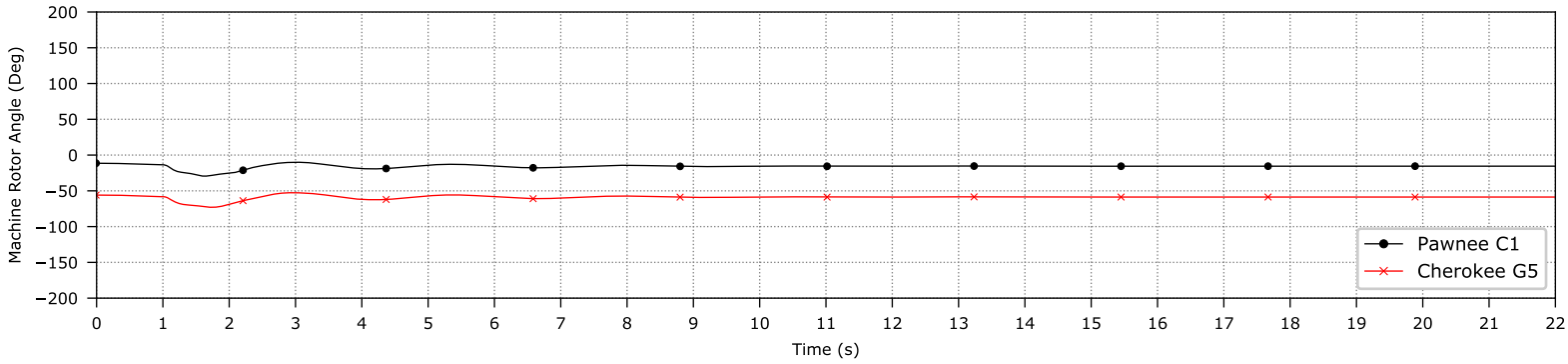

Reactive Power (Mvar)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

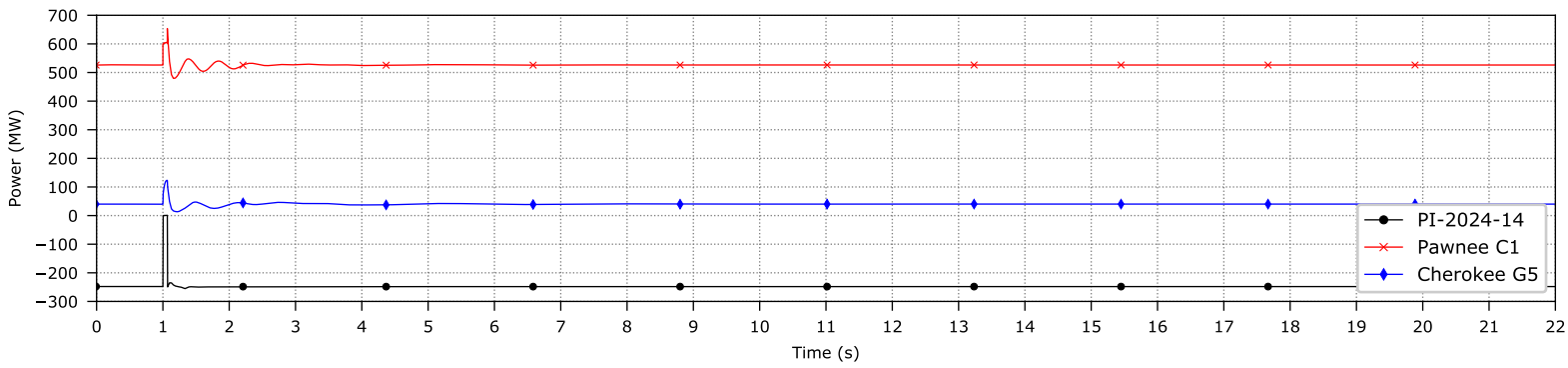

Terminal Voltage (p.u.)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

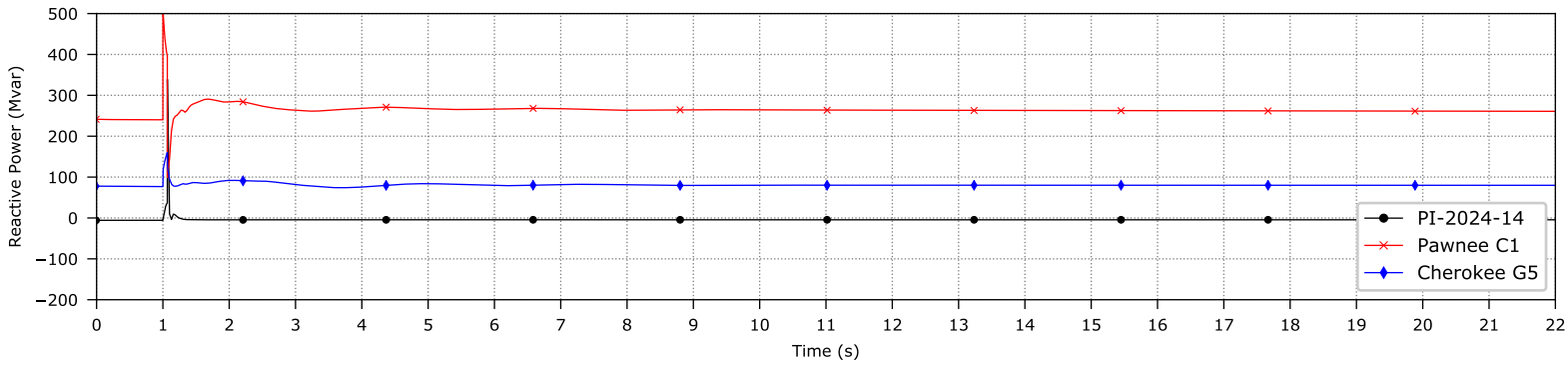

Frequency (Hz)
Time (s)
PI-2024-14
Pawnee C1
Cherokee G5

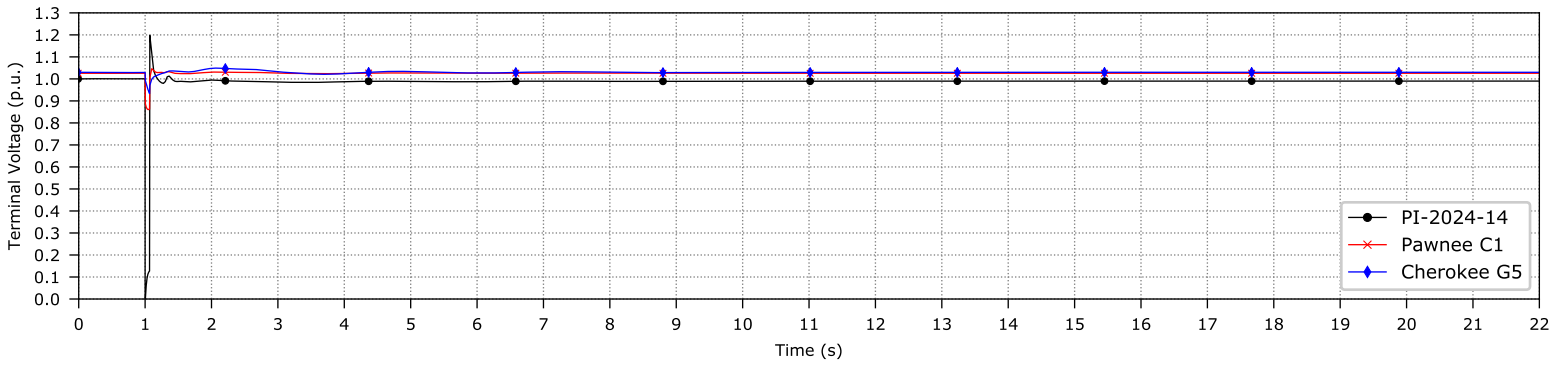

Voltage (p.u.)
Time (s)
Canal Crossing 345
Comanche 345
Shortgrass 345
May Valley 345
Goose Creek 345

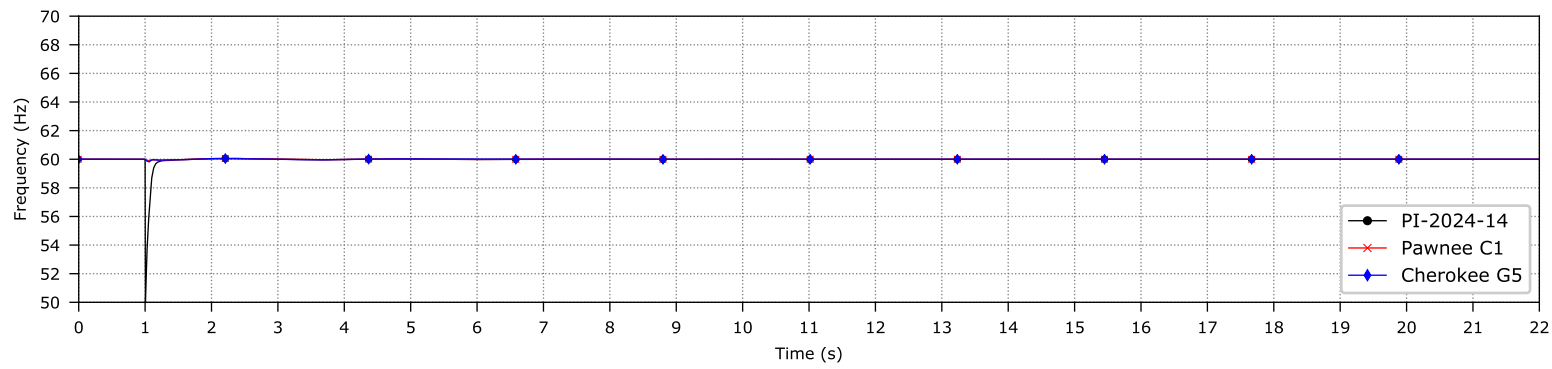
GseCrk-CanalXing-P1

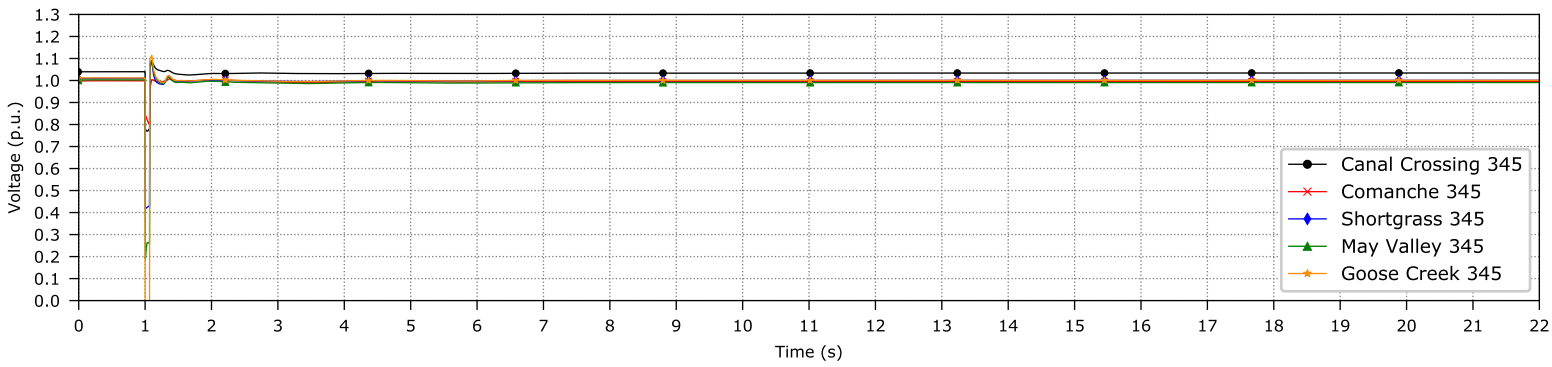




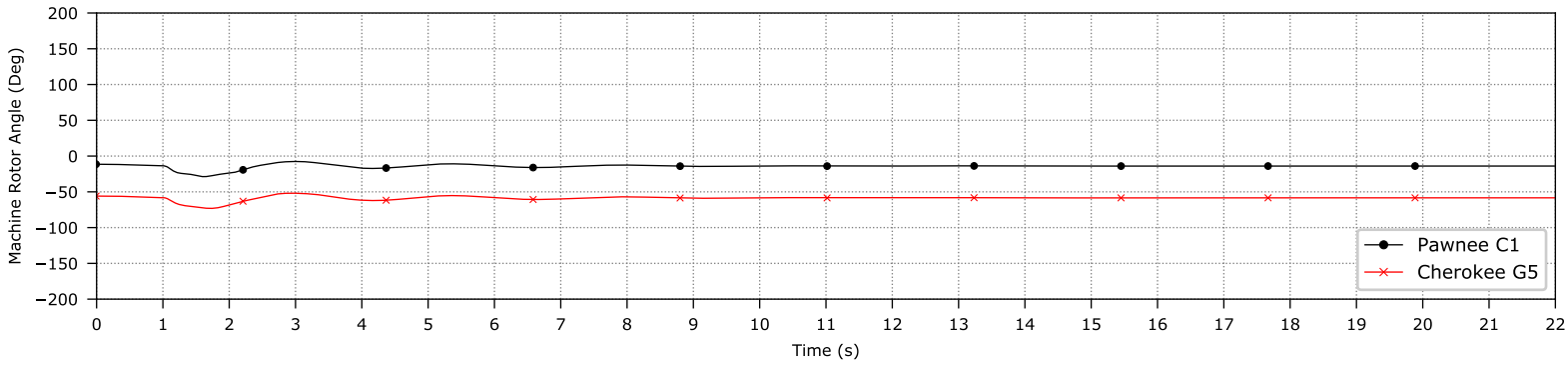


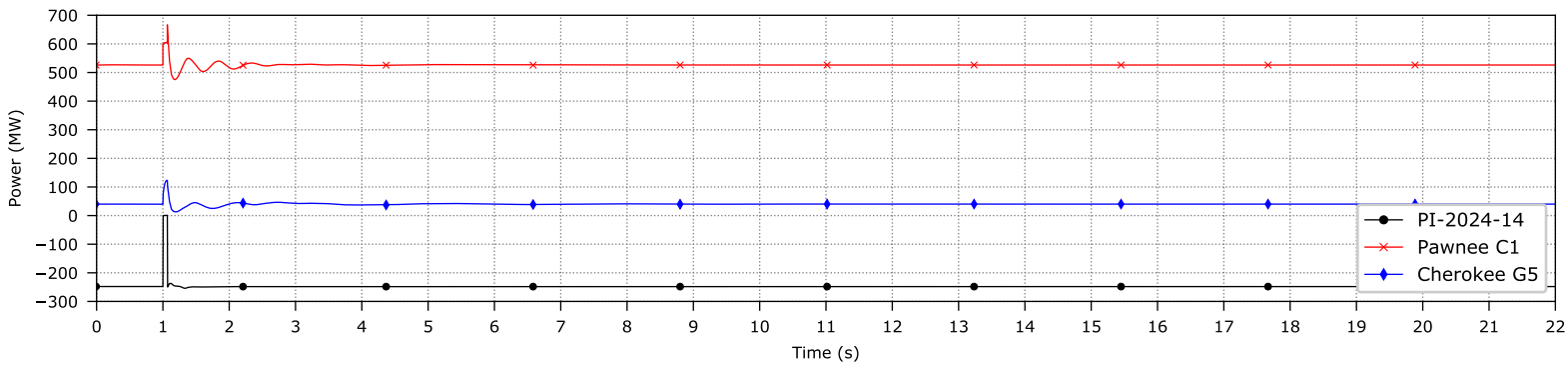


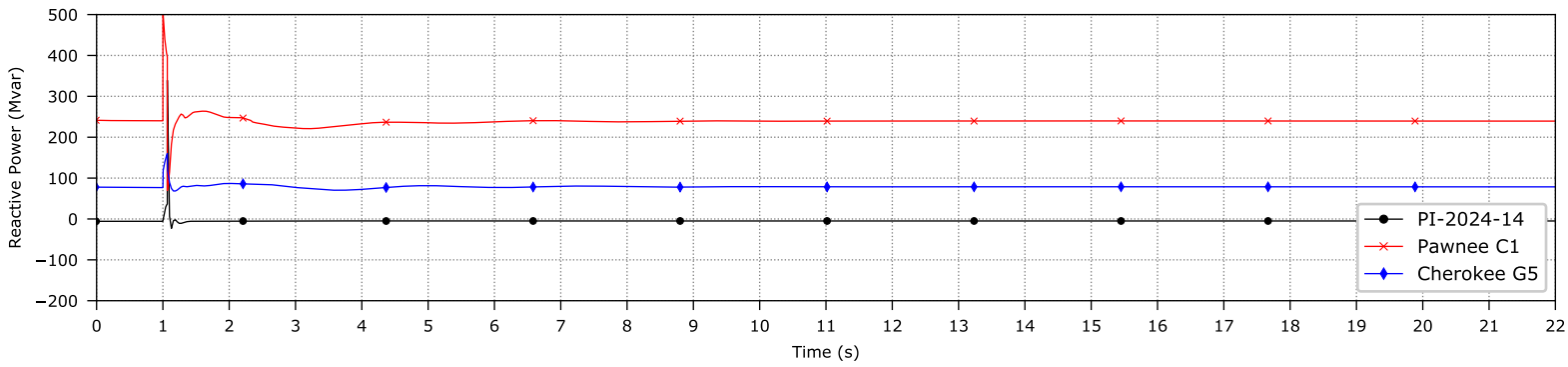


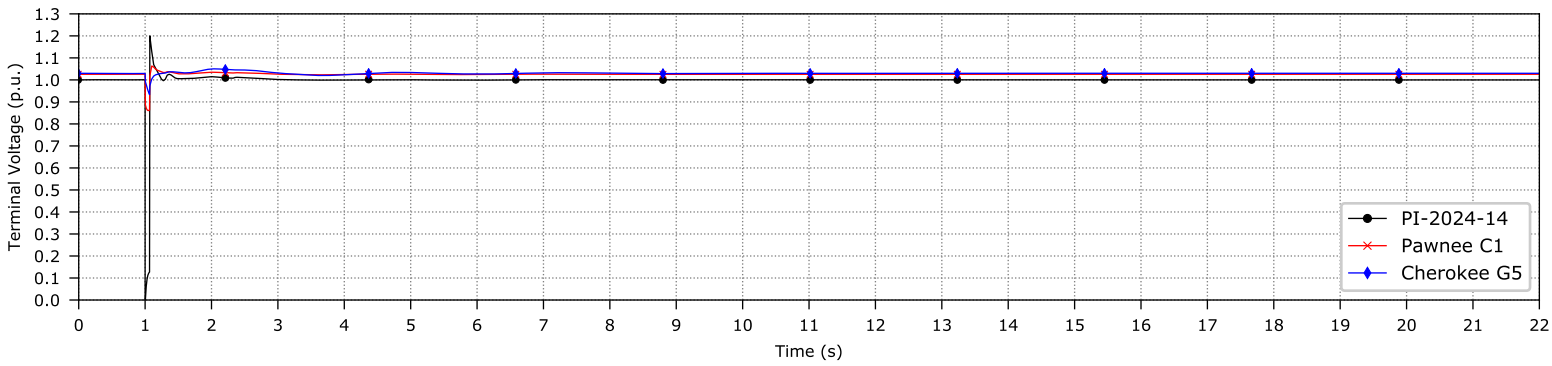


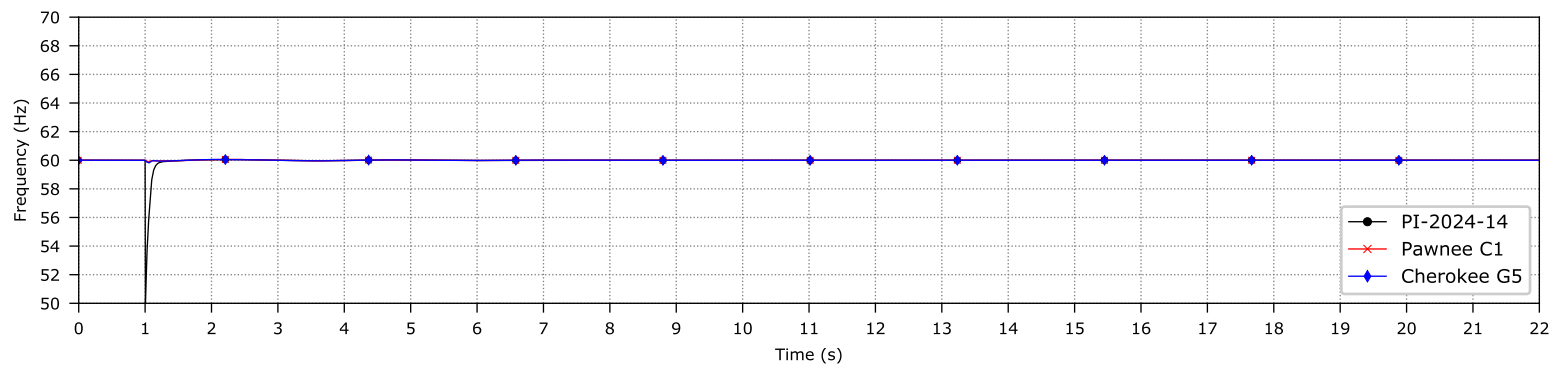
GseCrk-MayVal-P1

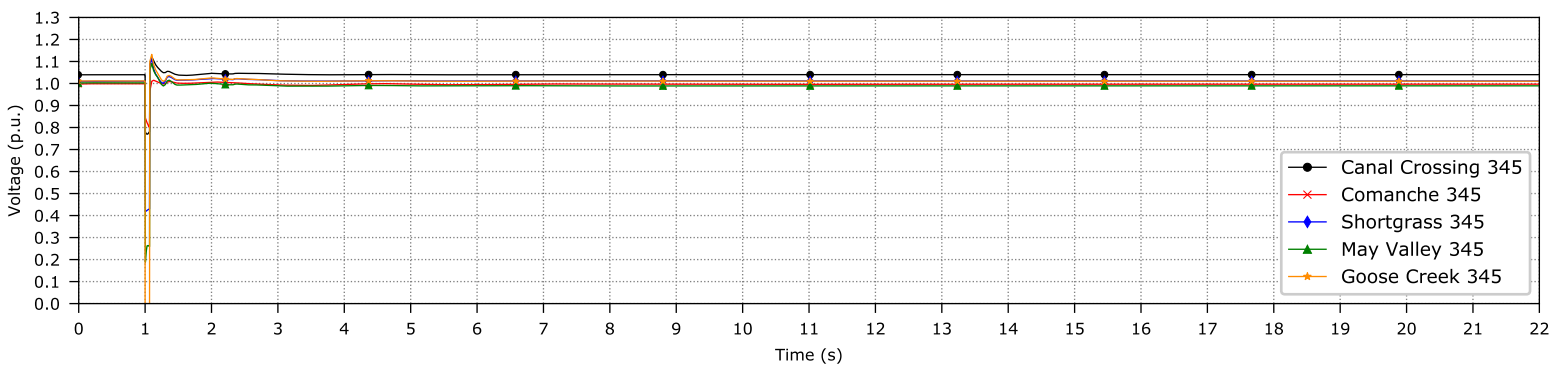




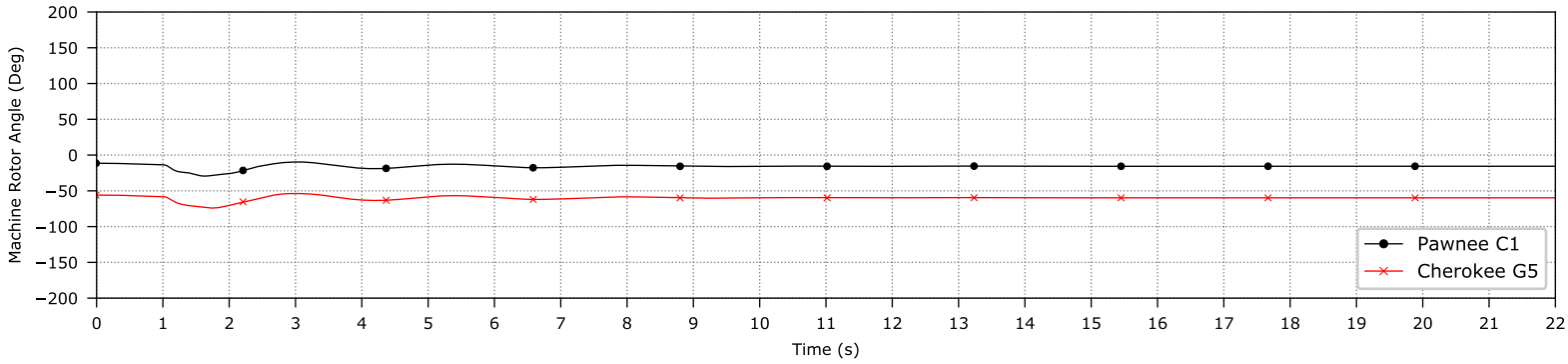


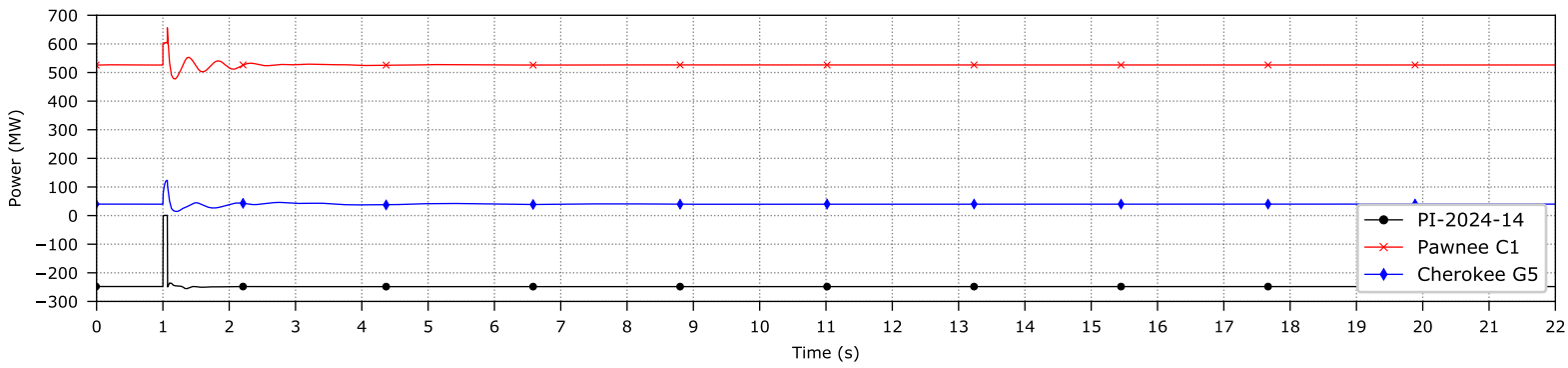


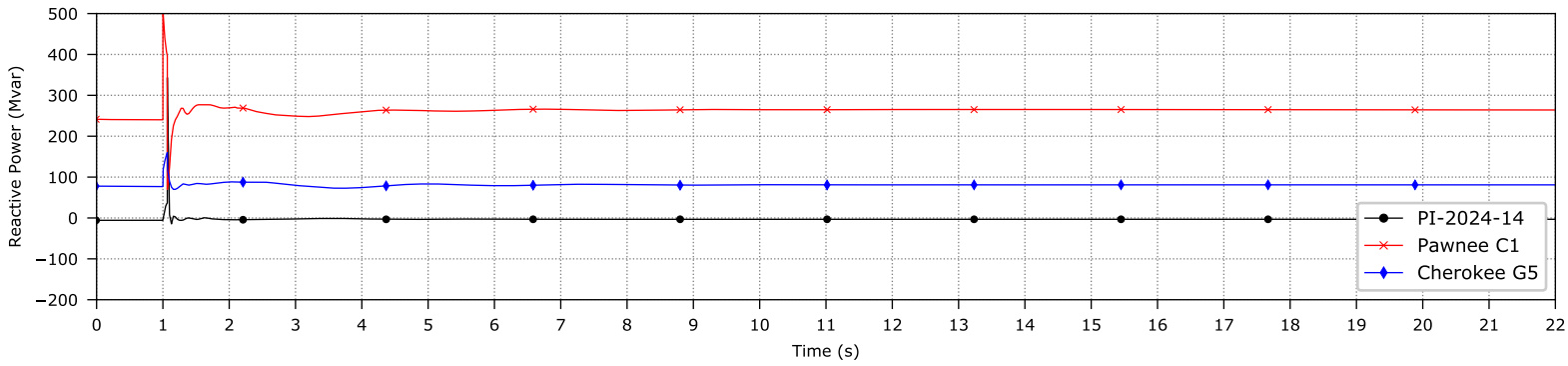


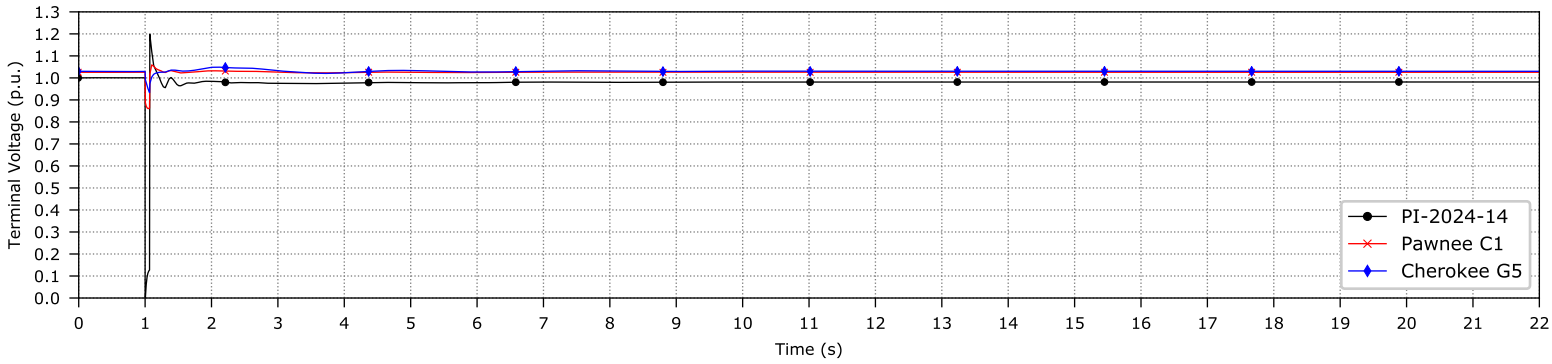


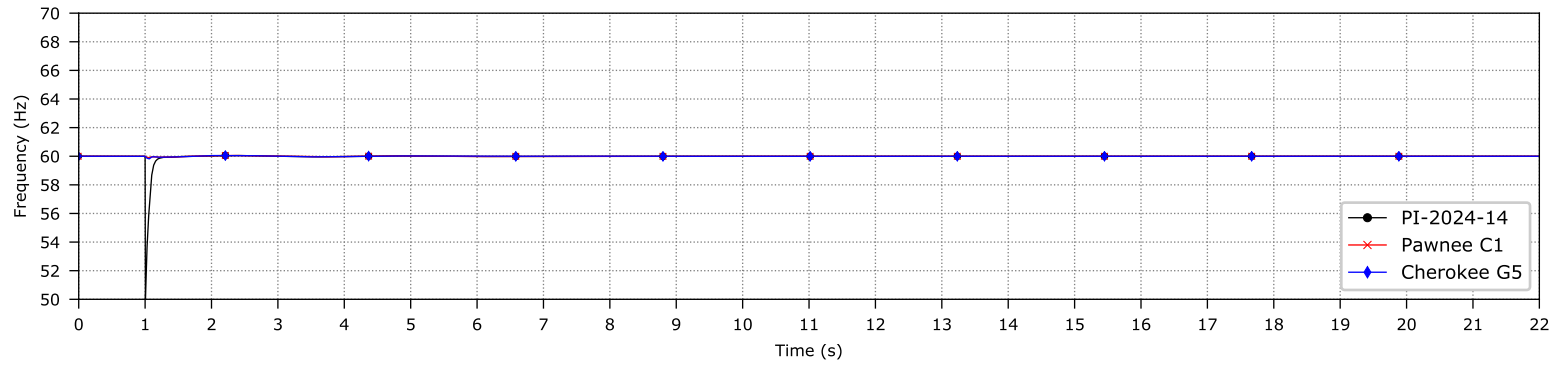
GseCrk-Shortgrass-P1

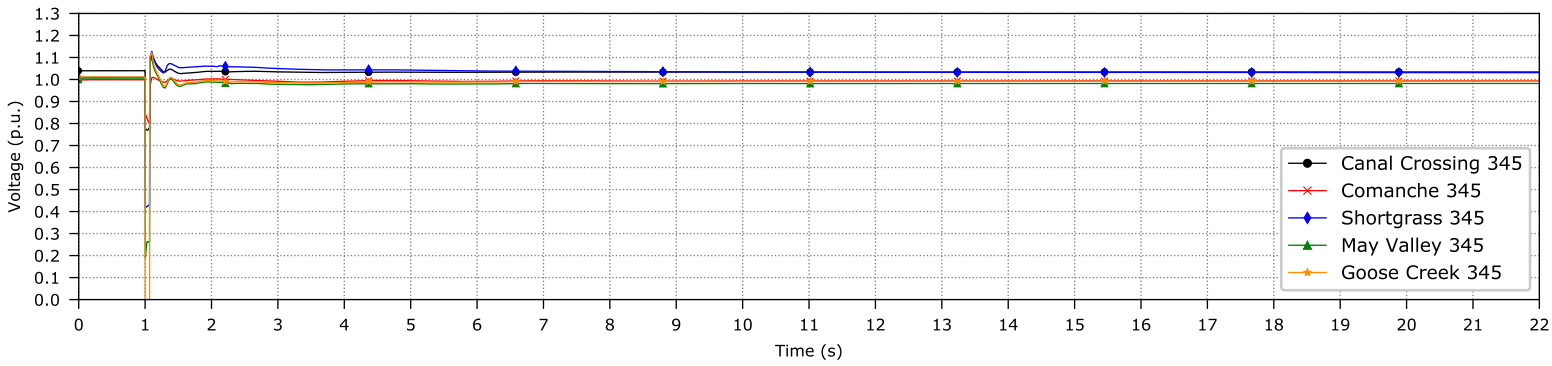




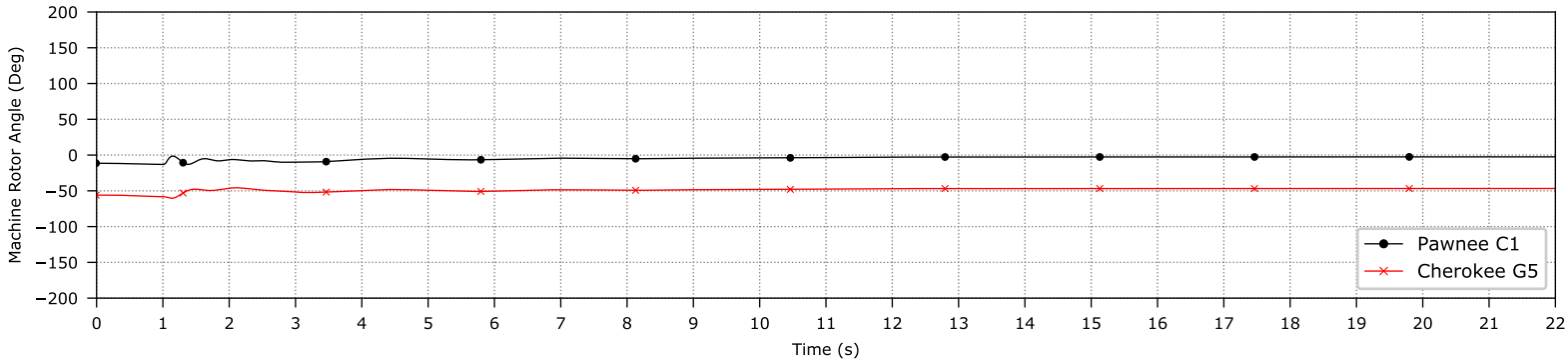


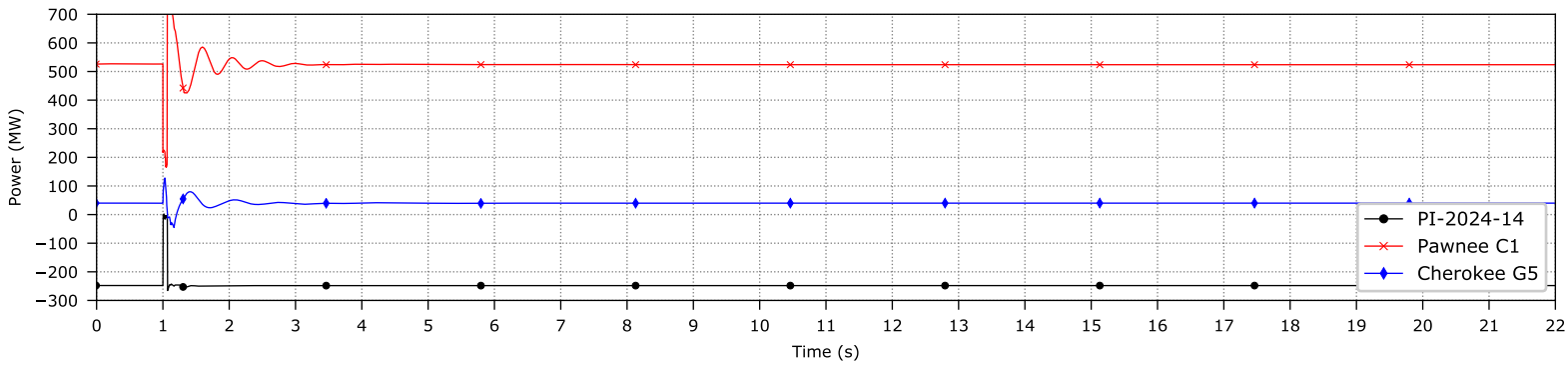


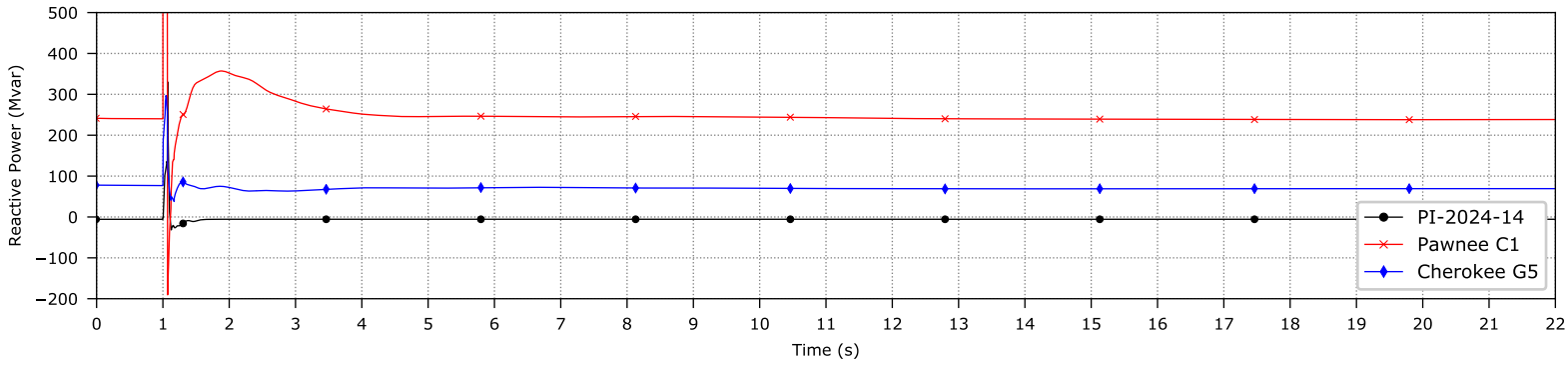


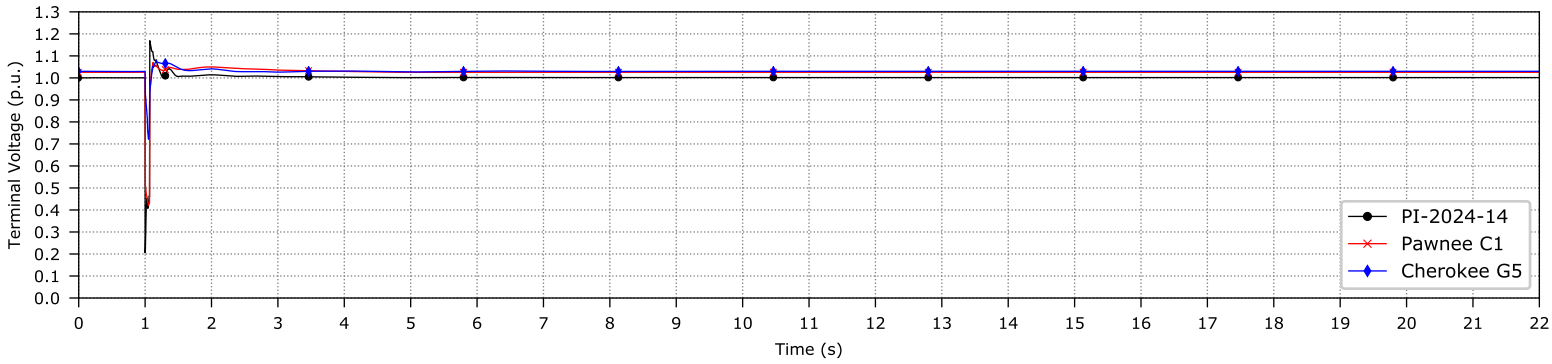


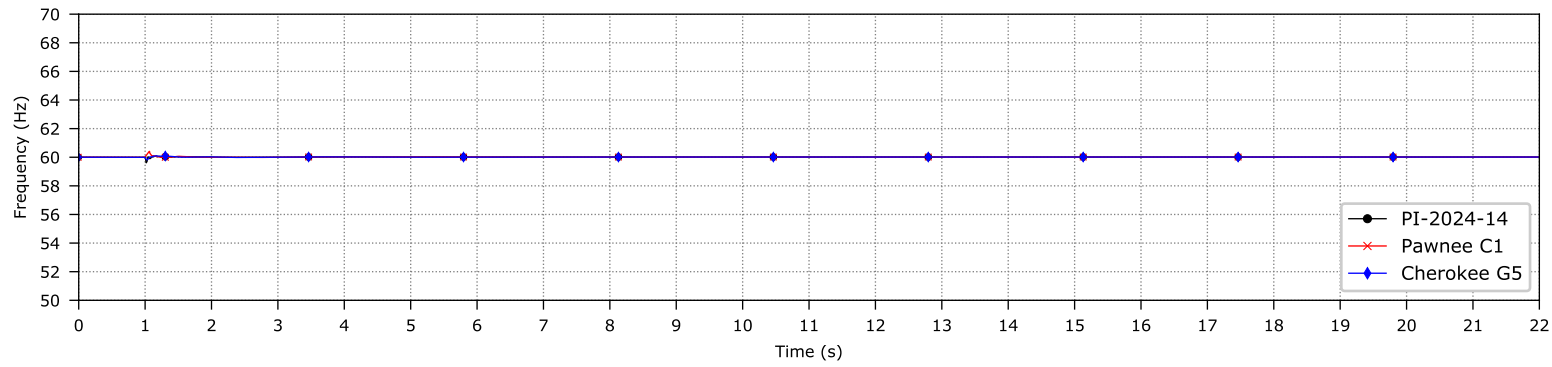
Missile Site - Canal Crossing-P1

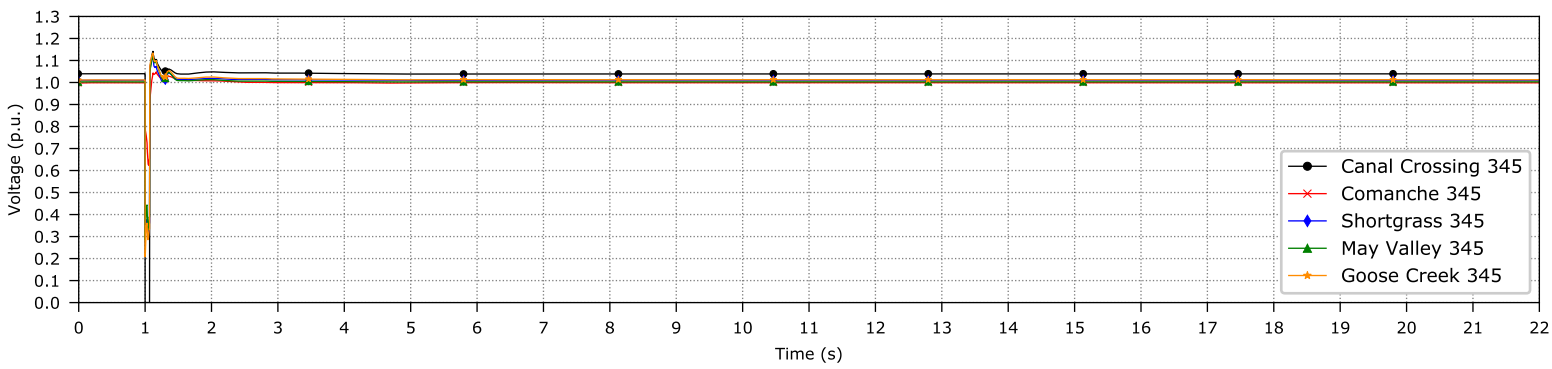




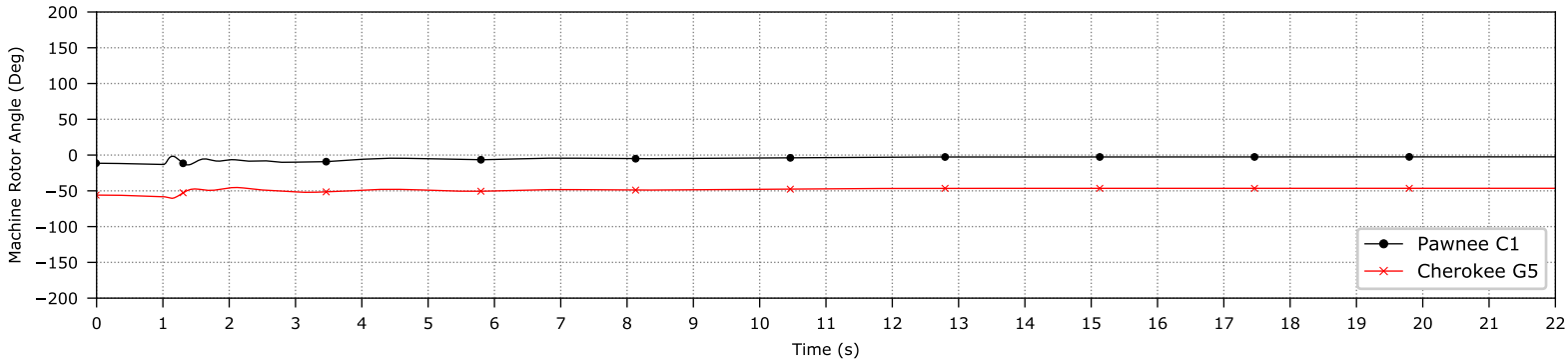


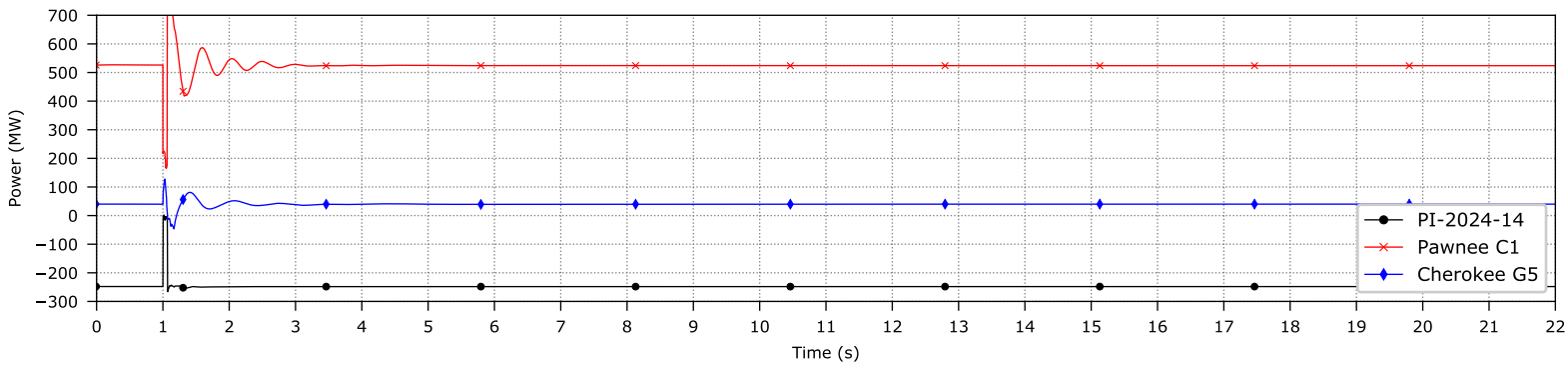


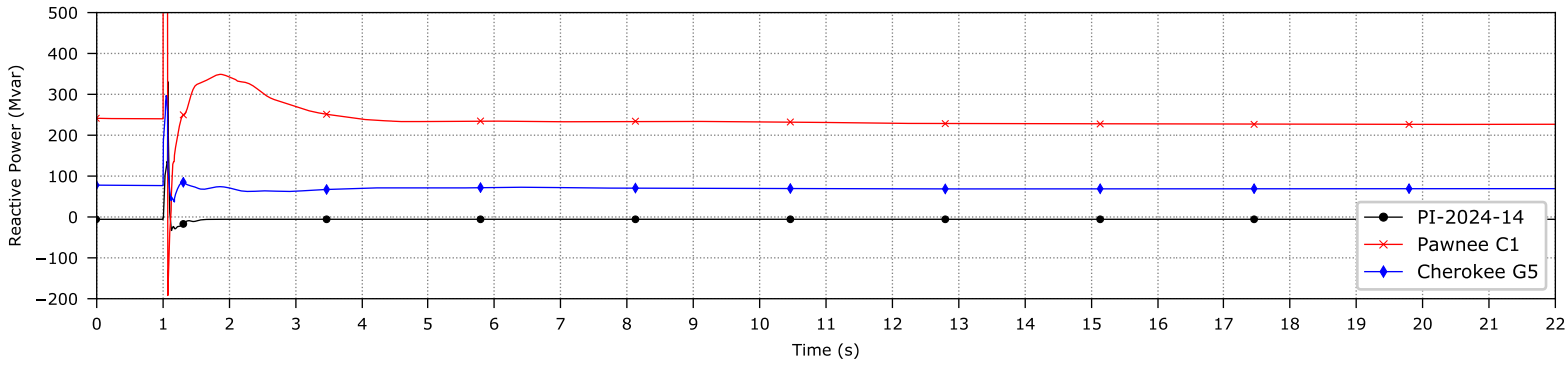


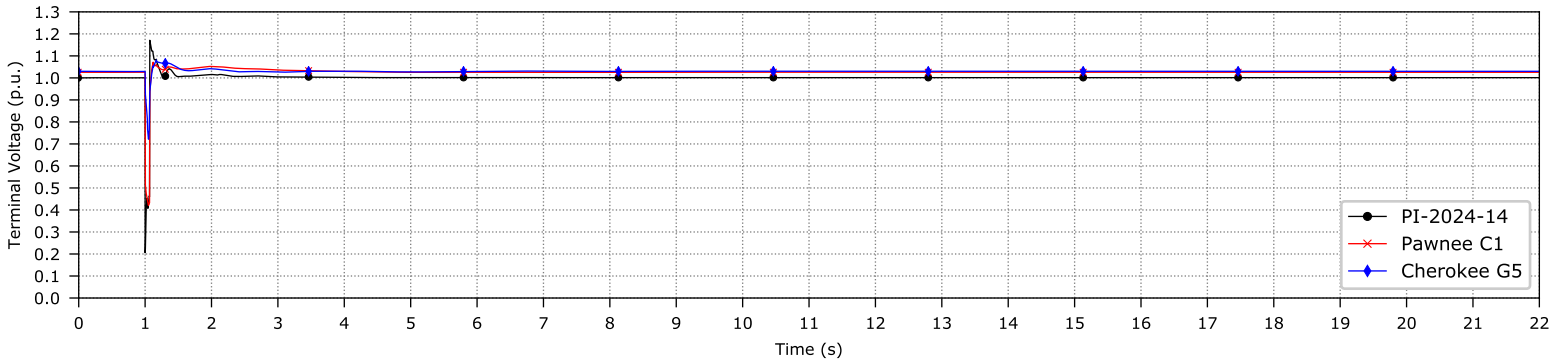


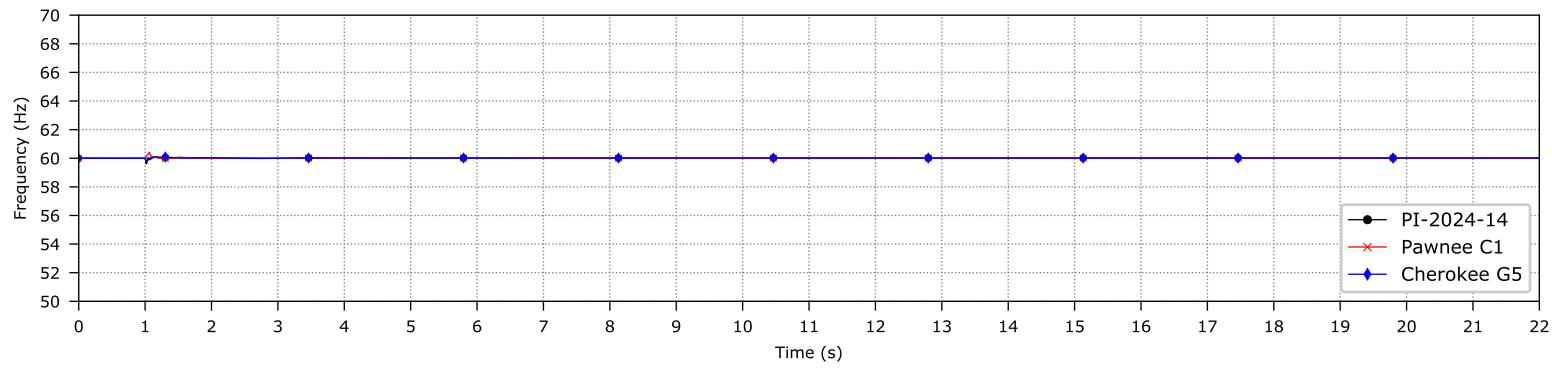
Canal Crossing - Pawnee-P1

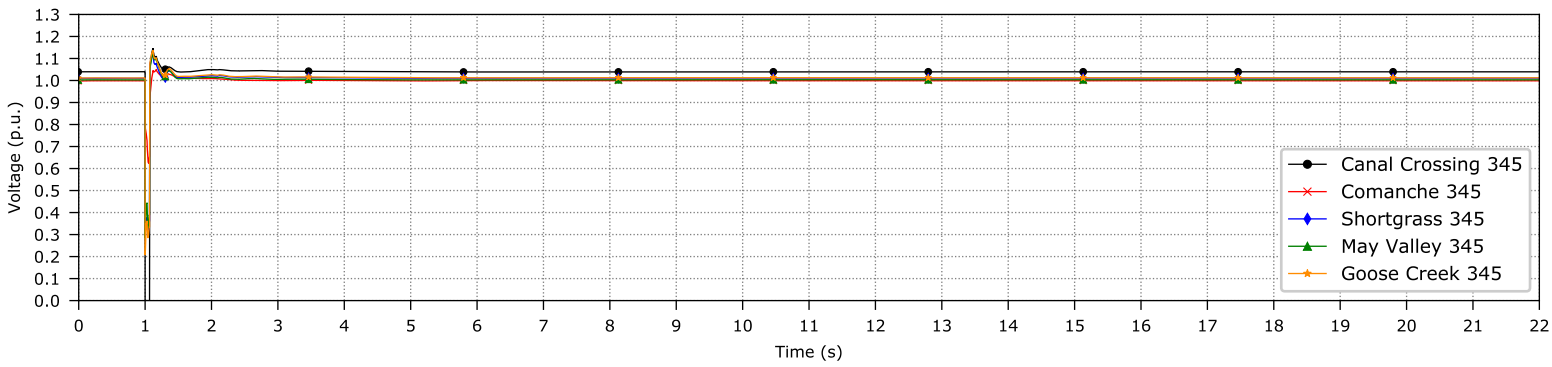




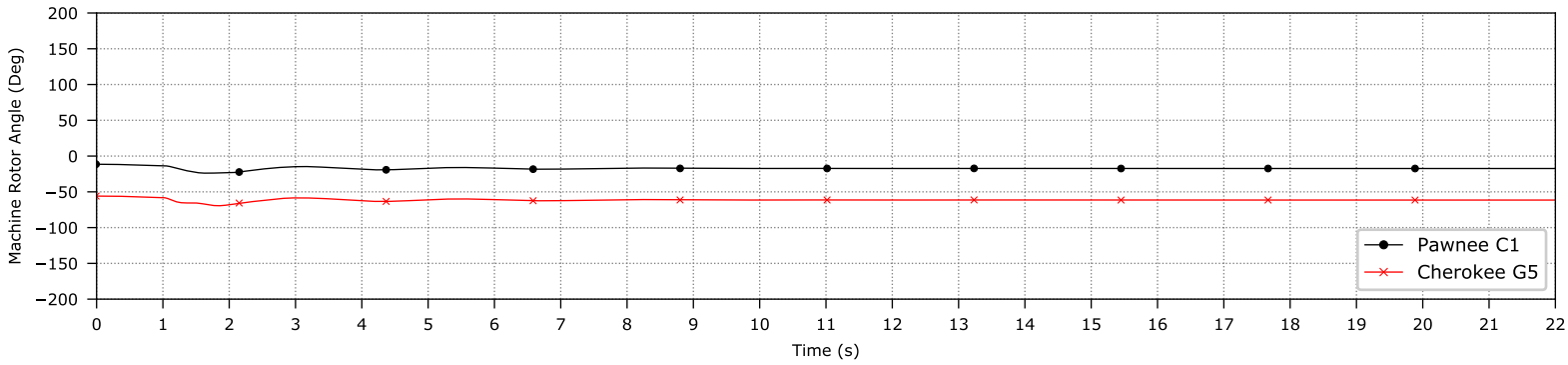


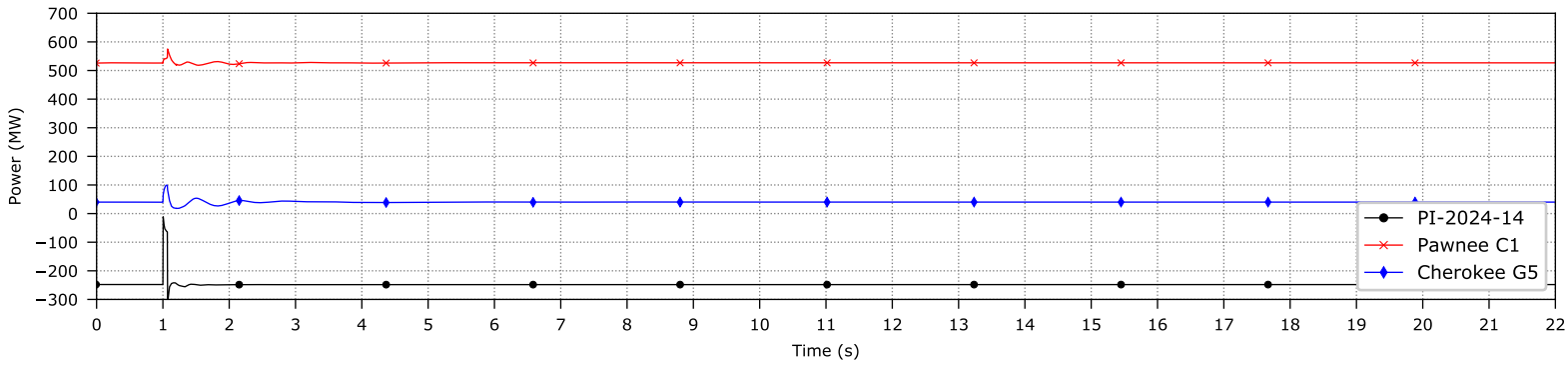


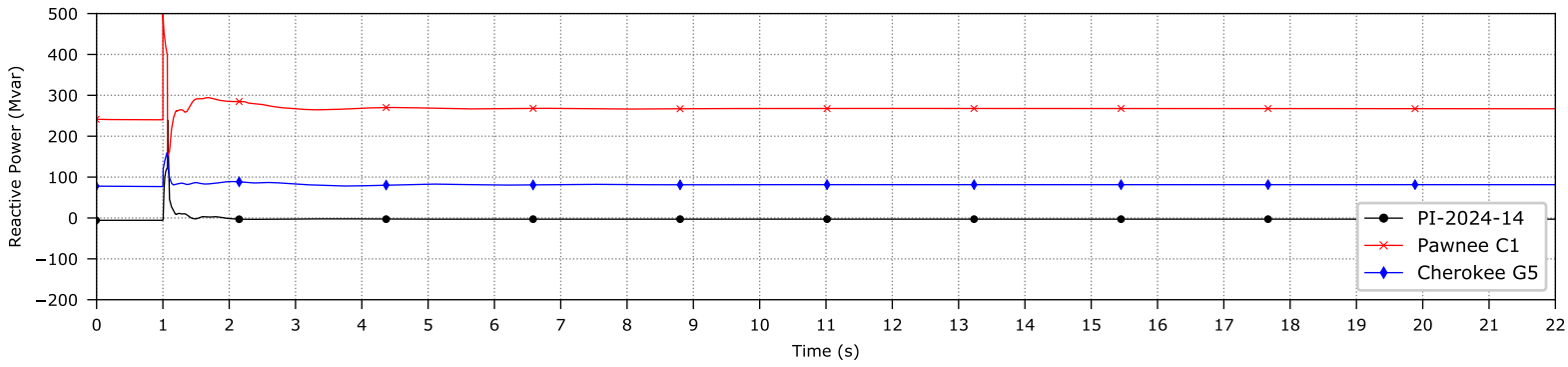


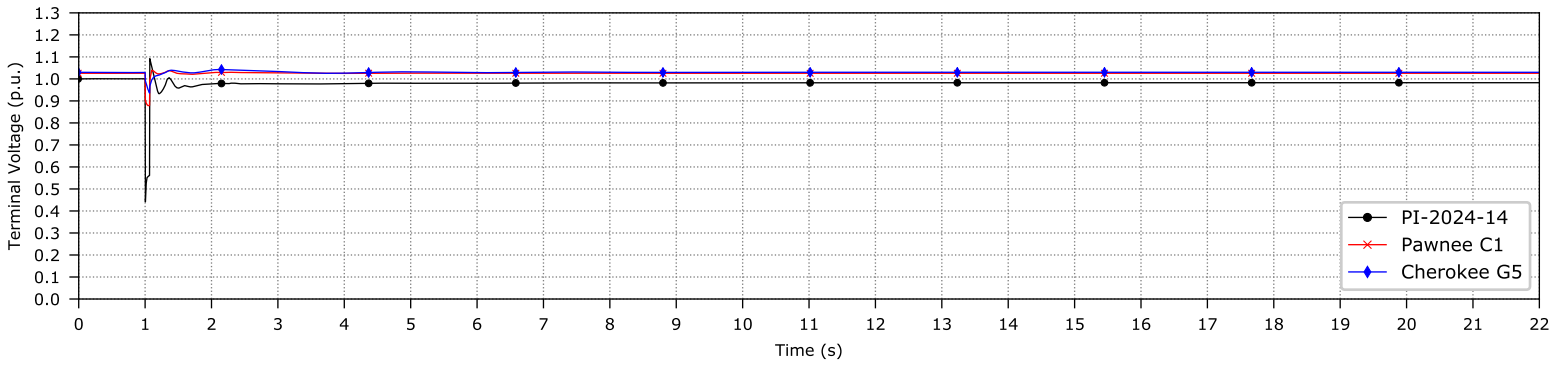


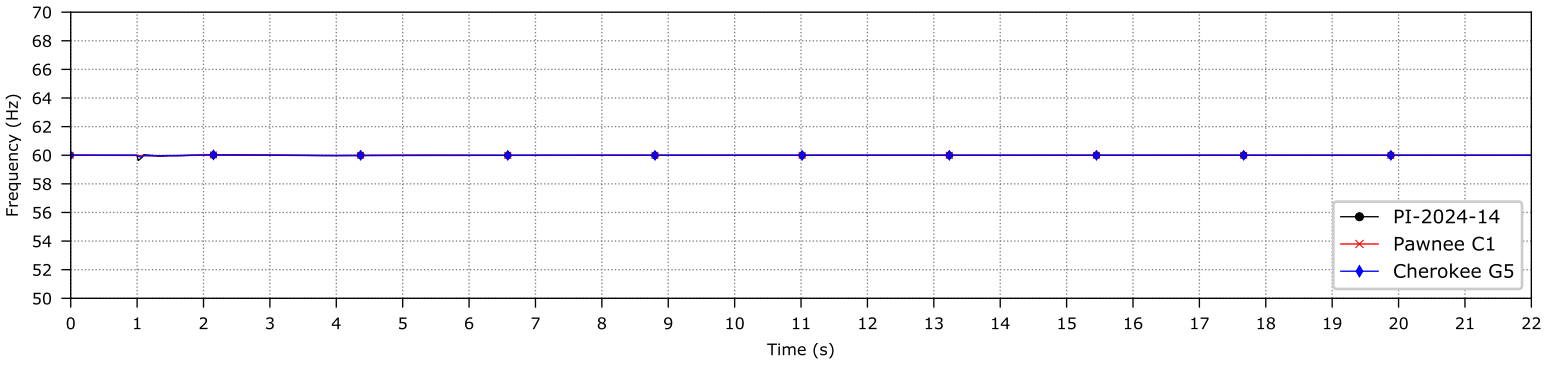
Shortgrass - Pronghorn-P1

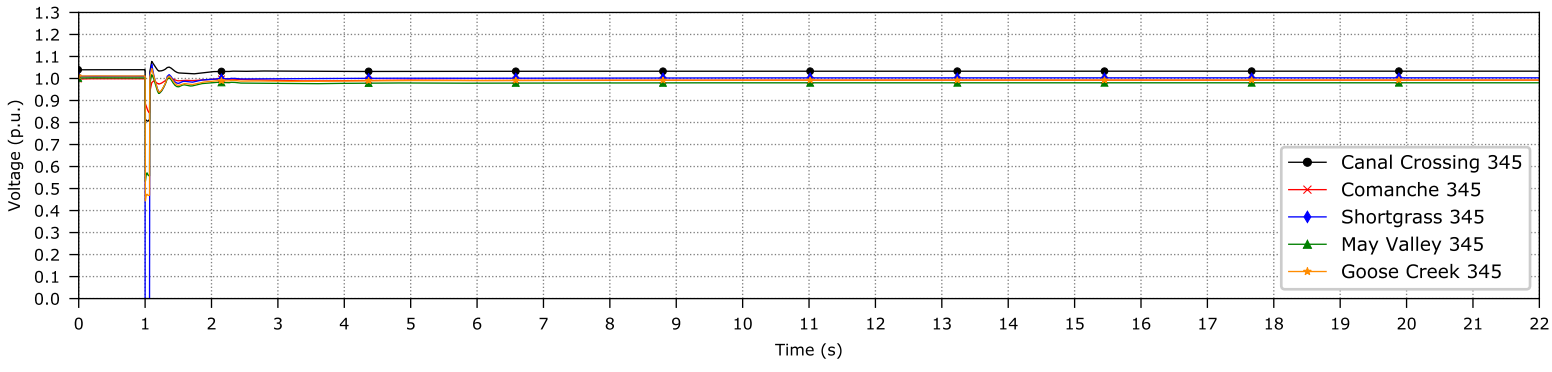




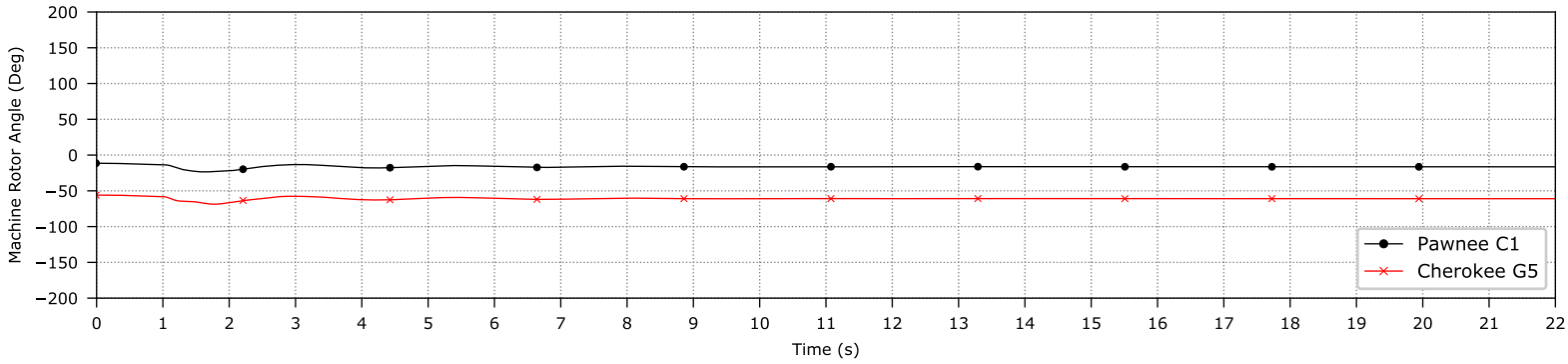


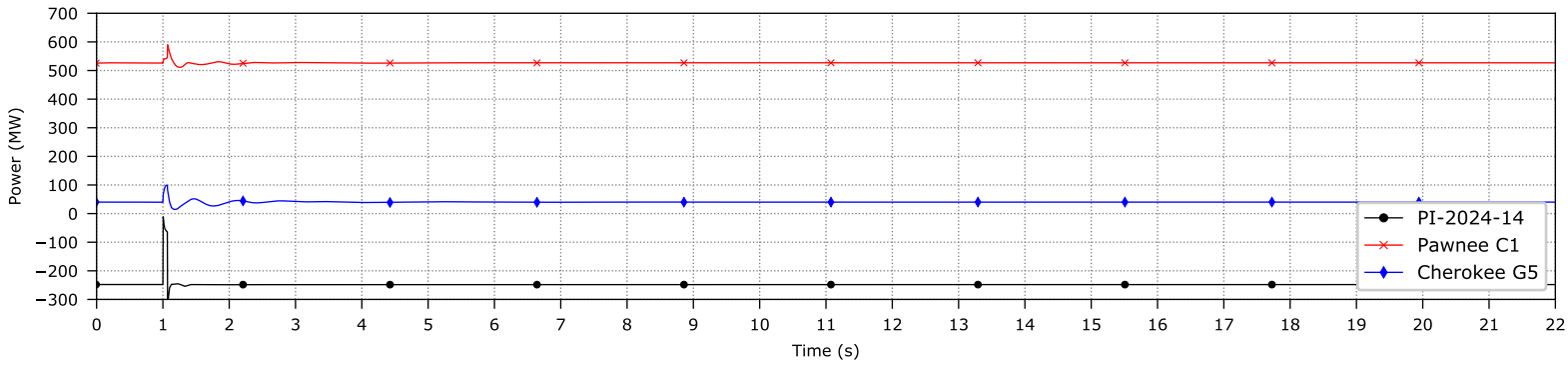


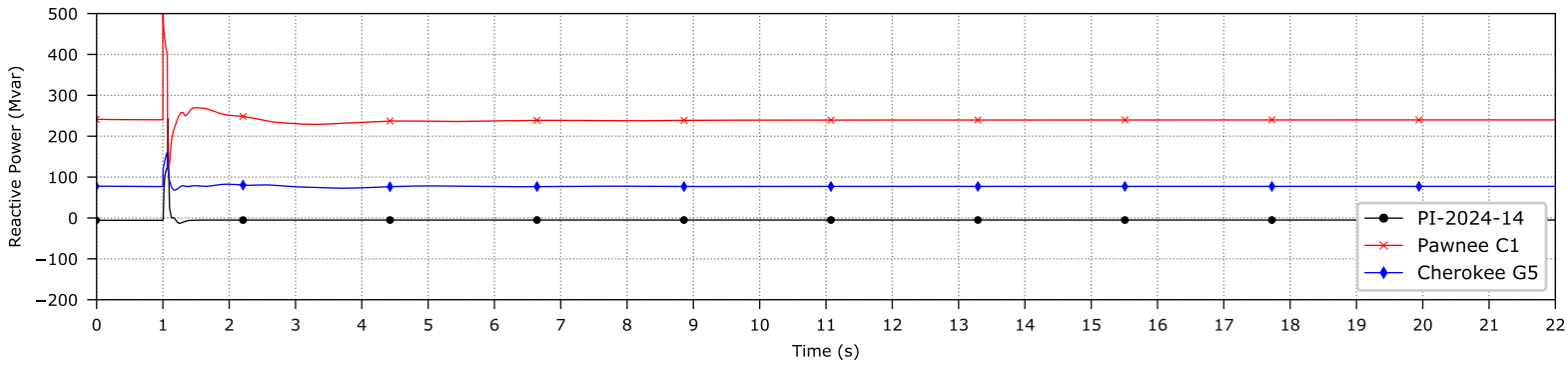


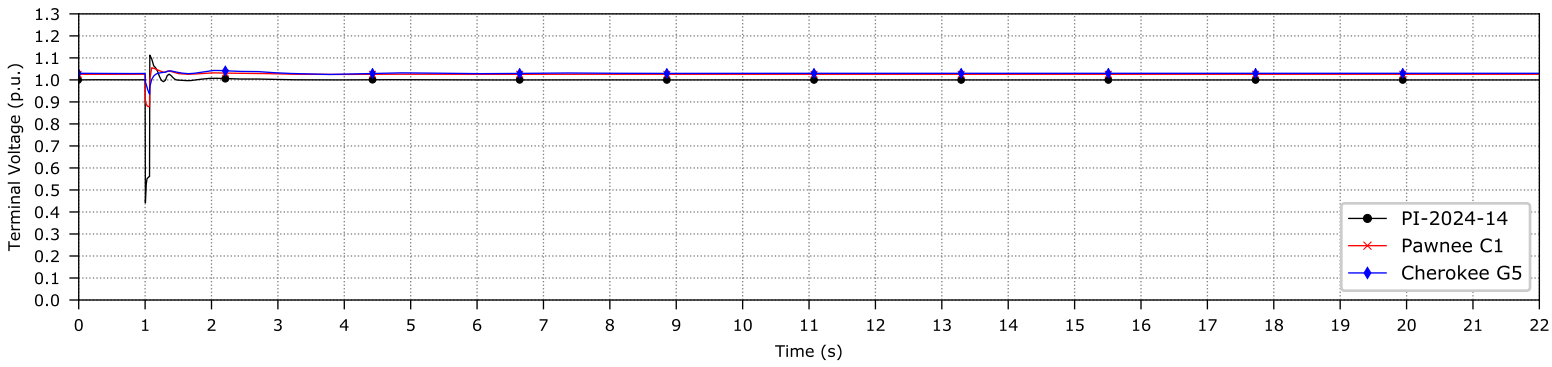


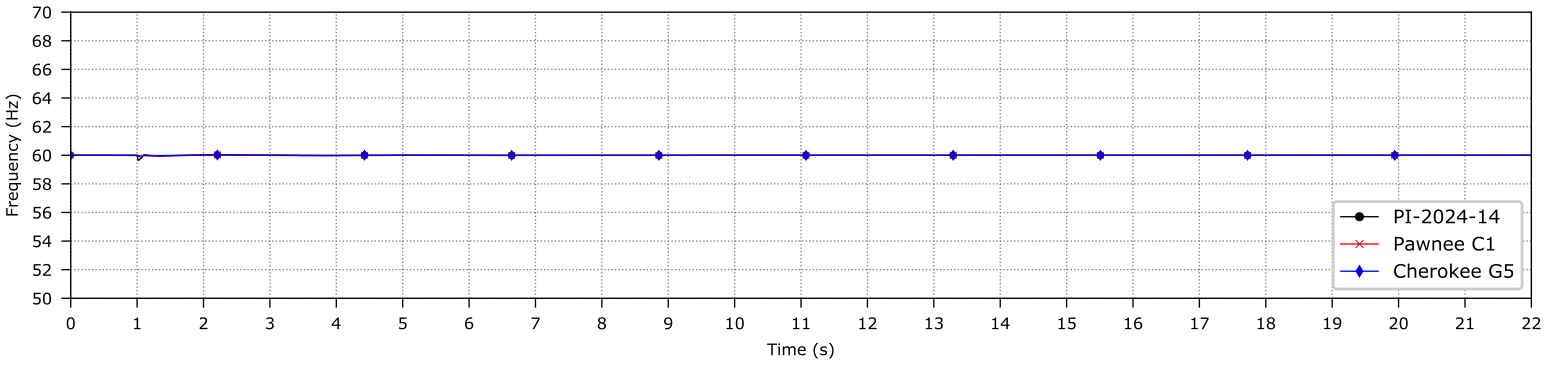
Shortgrass - Bronco_plns-P1

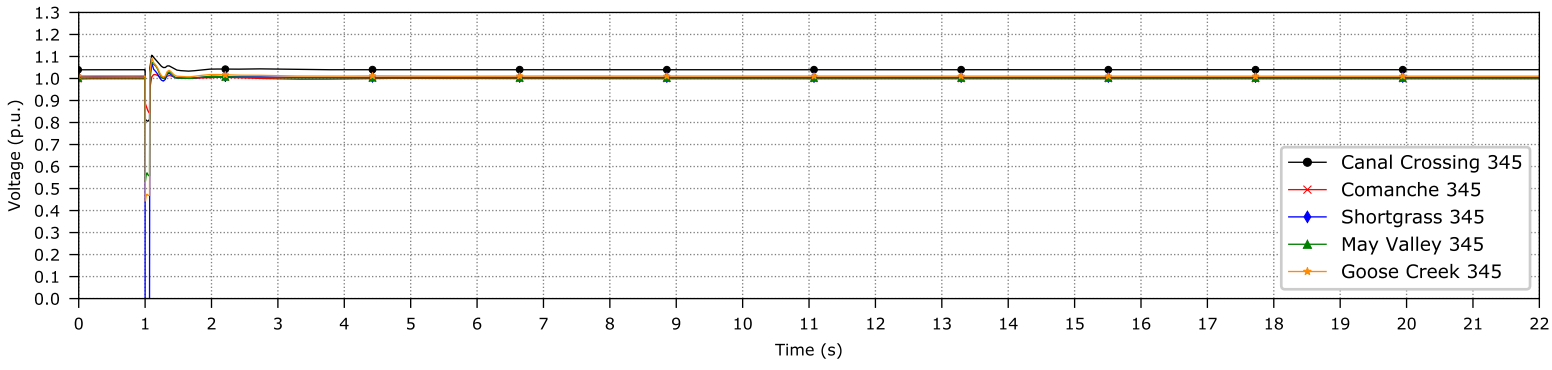




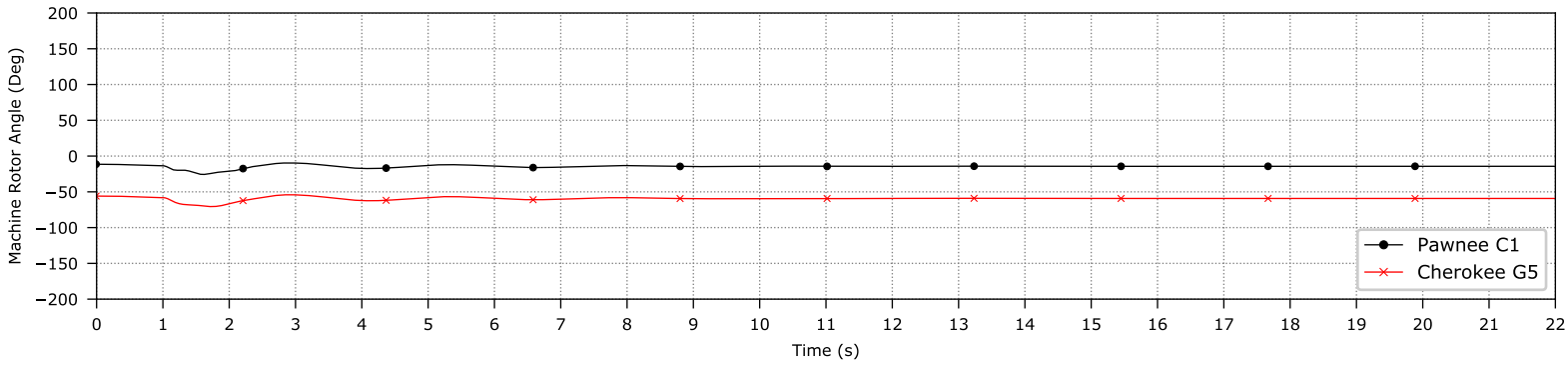


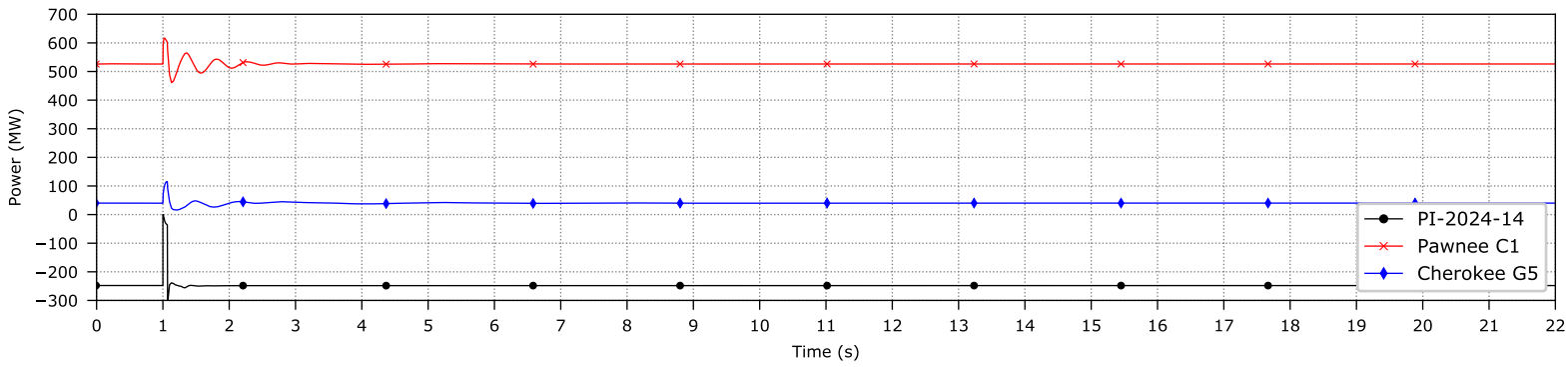


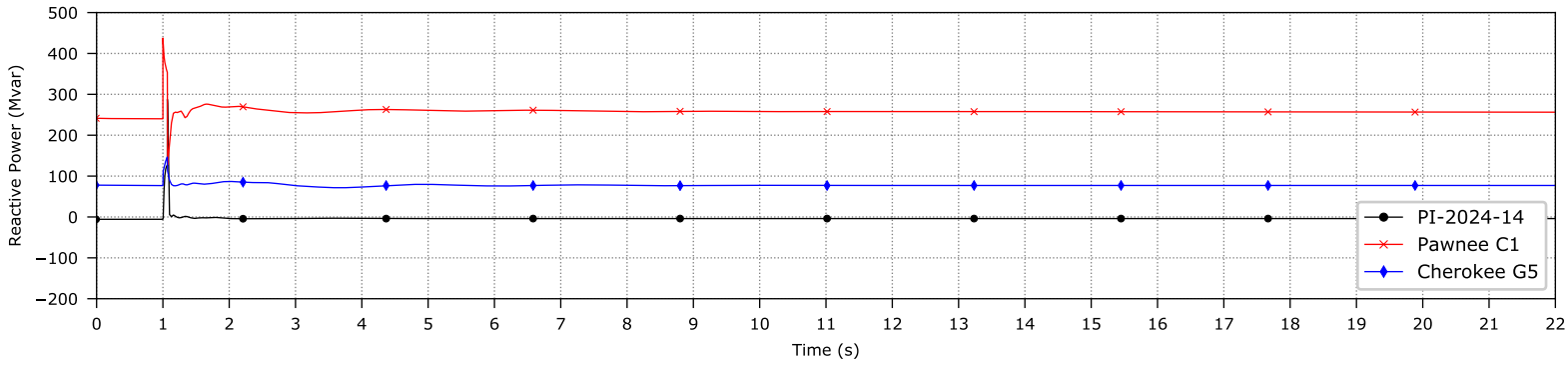


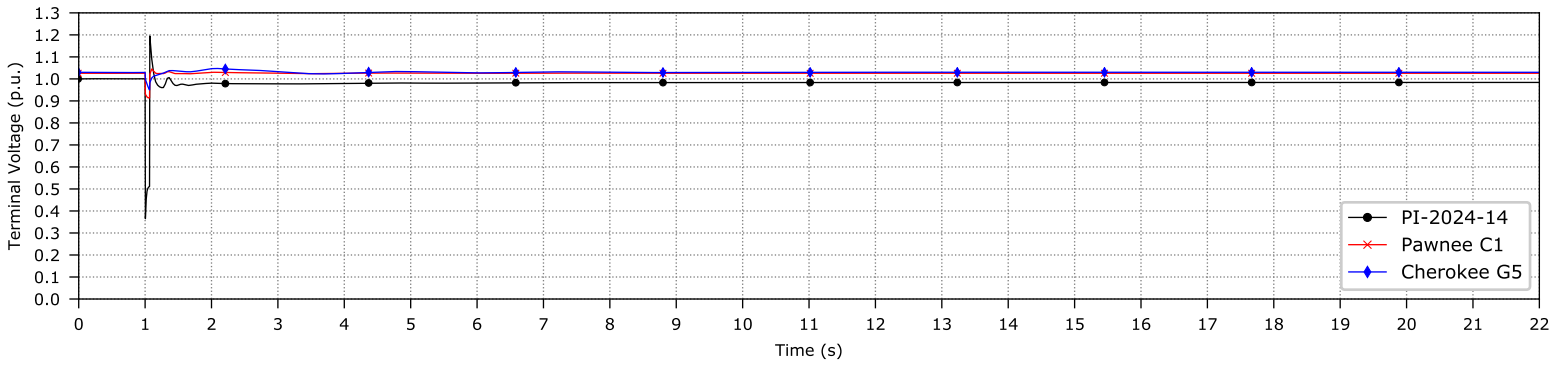


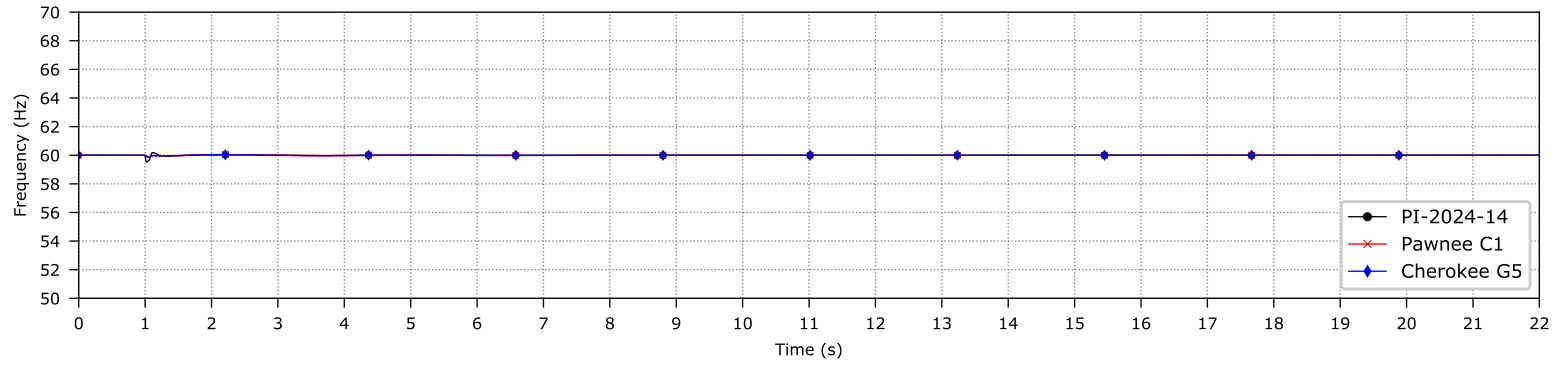
May Valley - Sandstone-P1

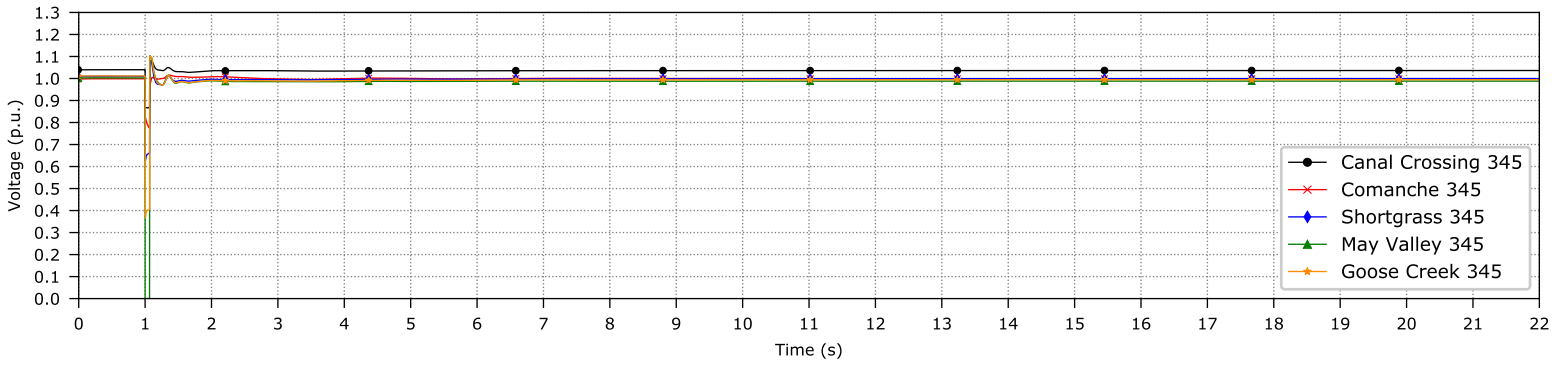




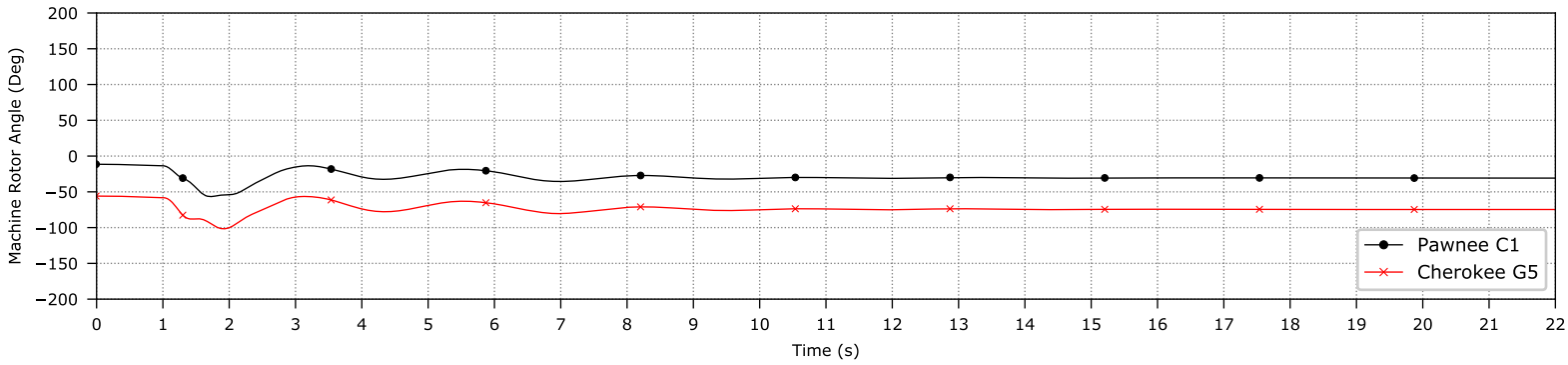


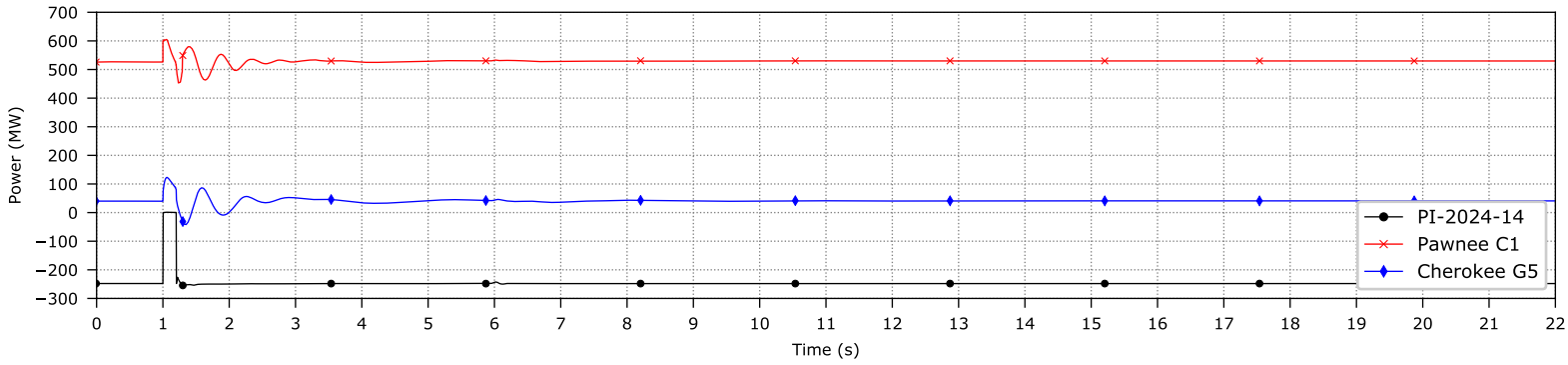


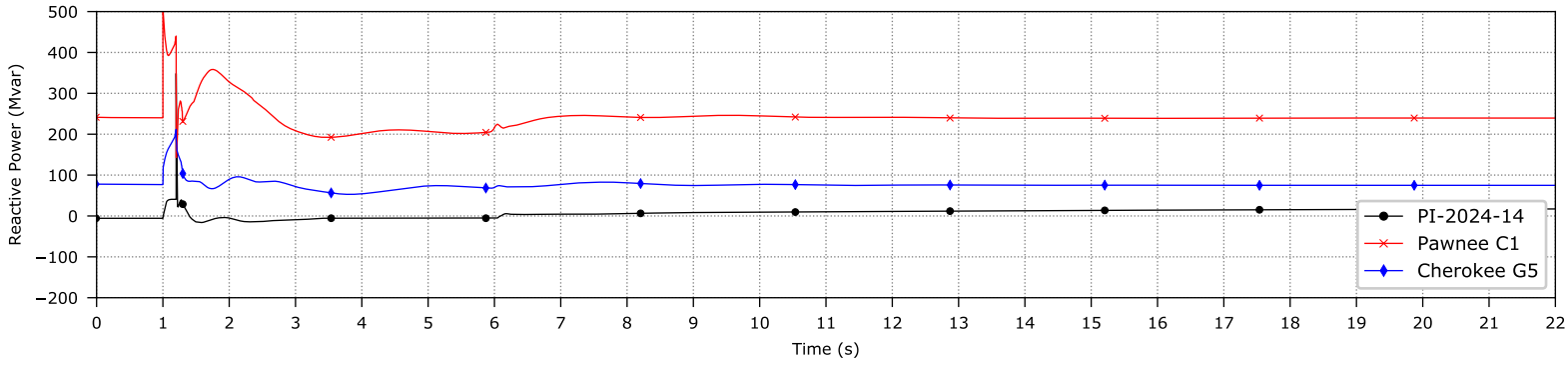


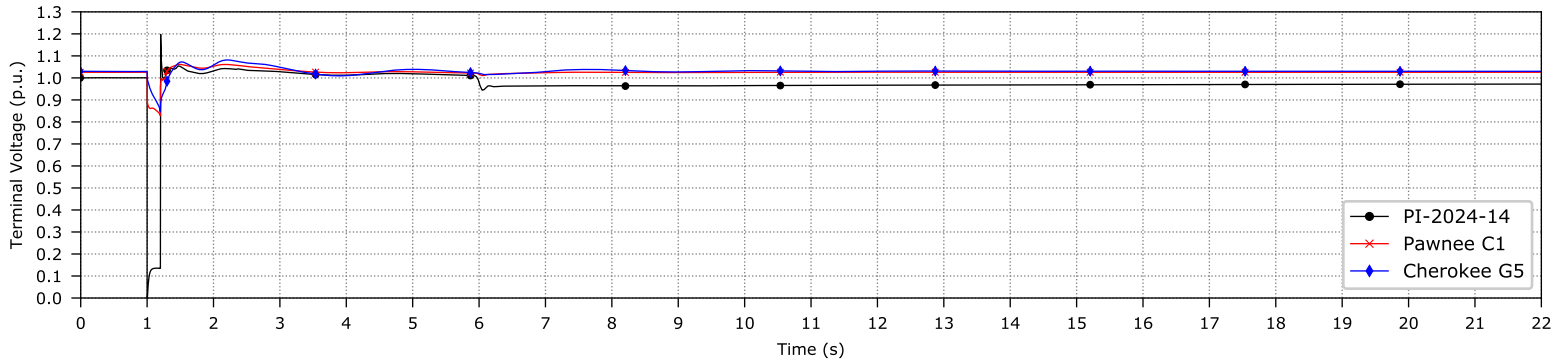


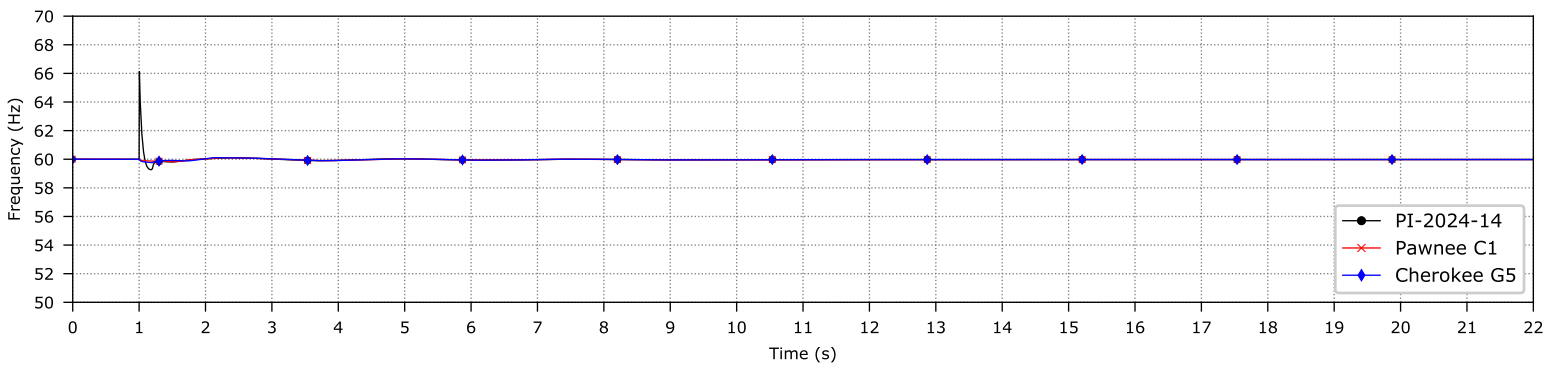
GseCrk-Cheyenne Ridge-P4

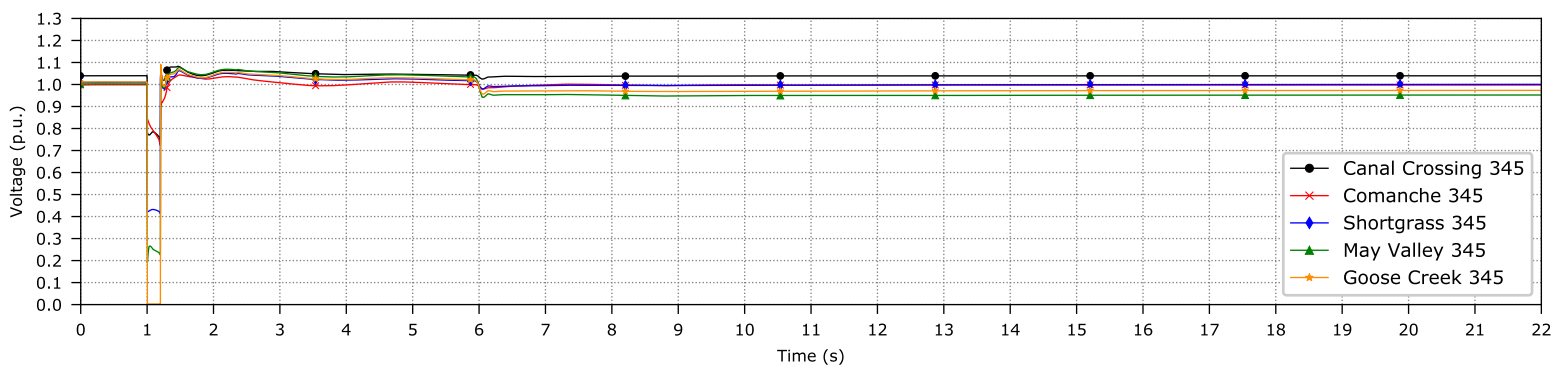




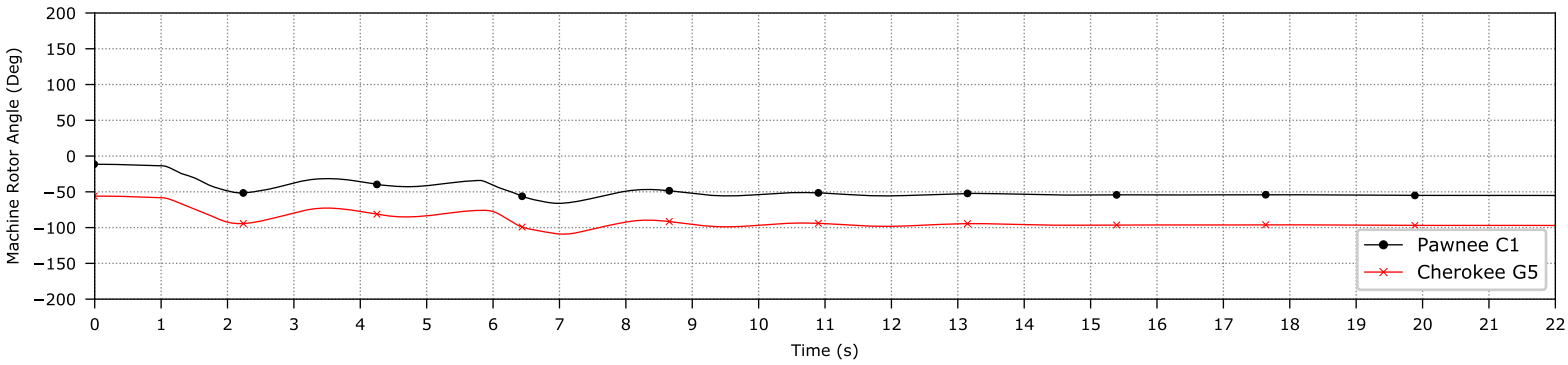


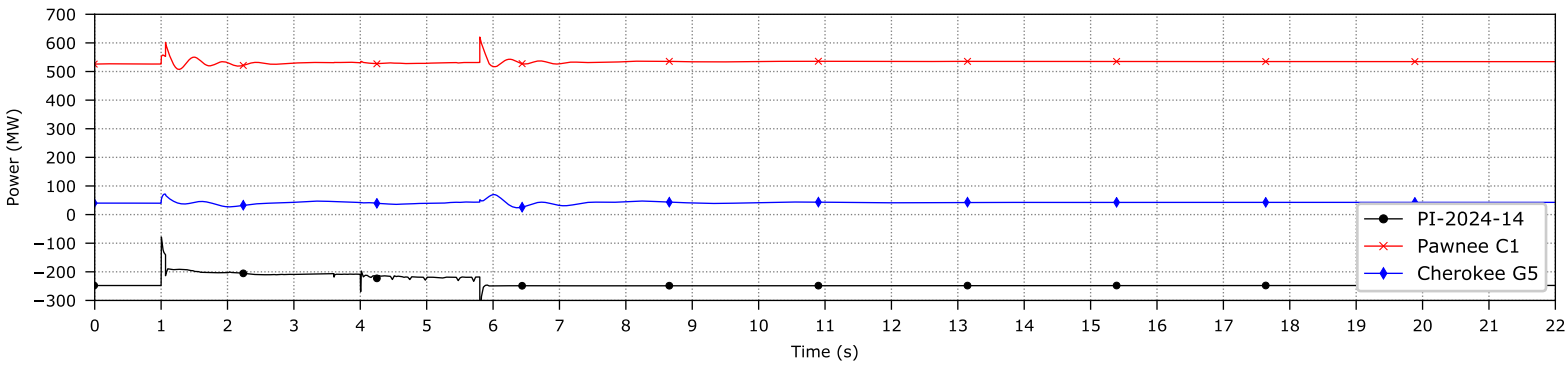


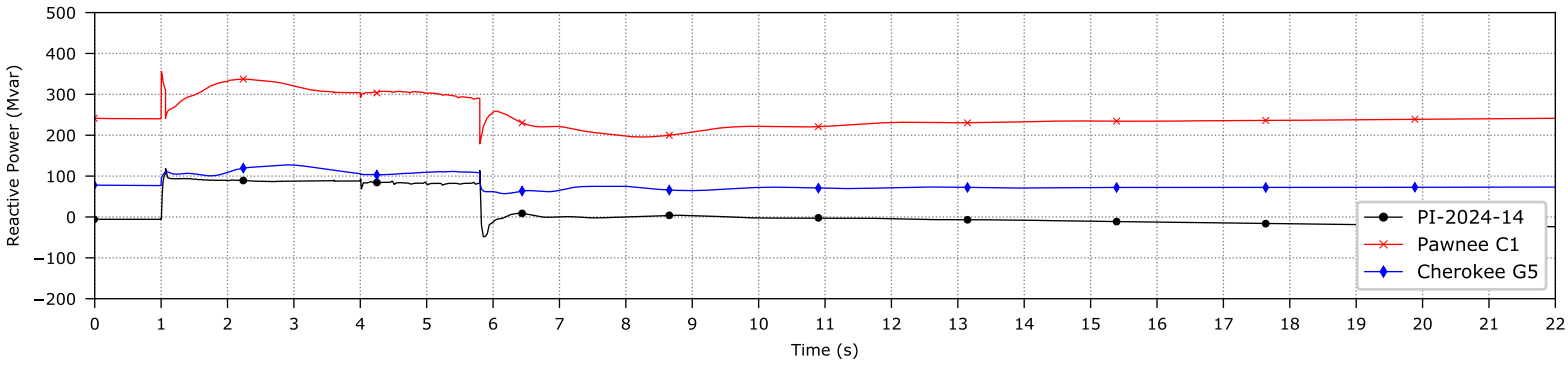


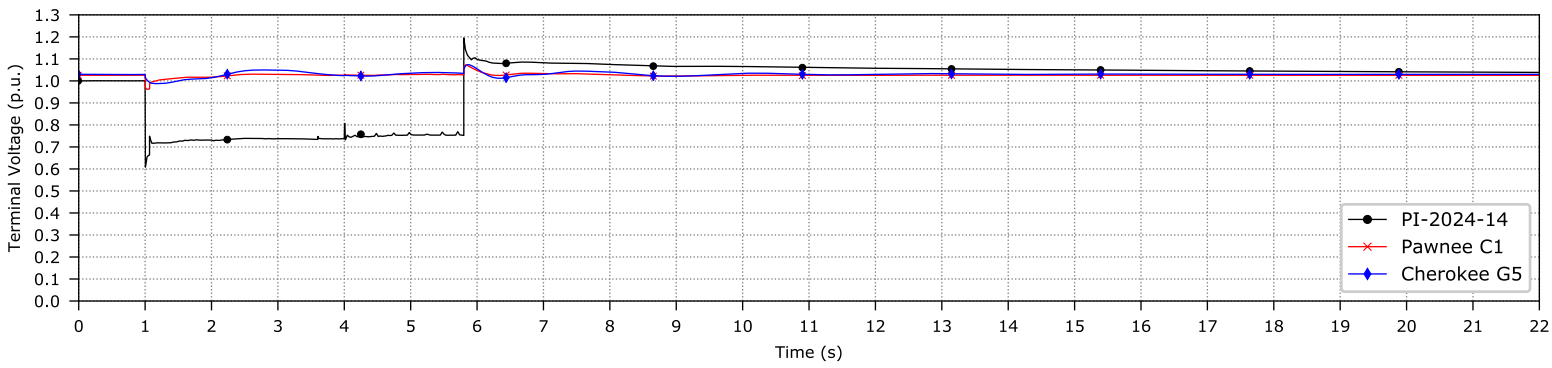


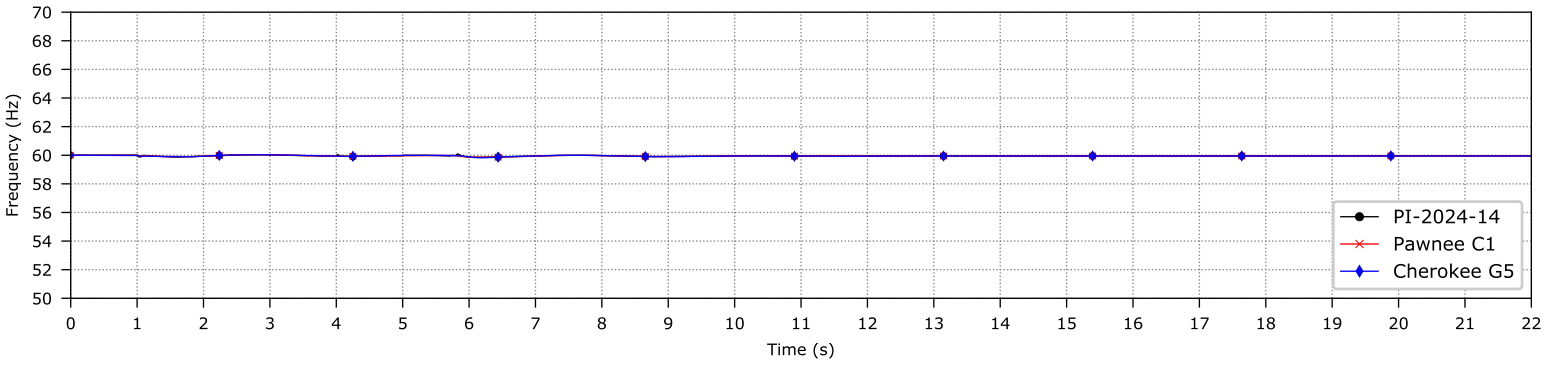
Canal Crossing - Goose Creek-P7

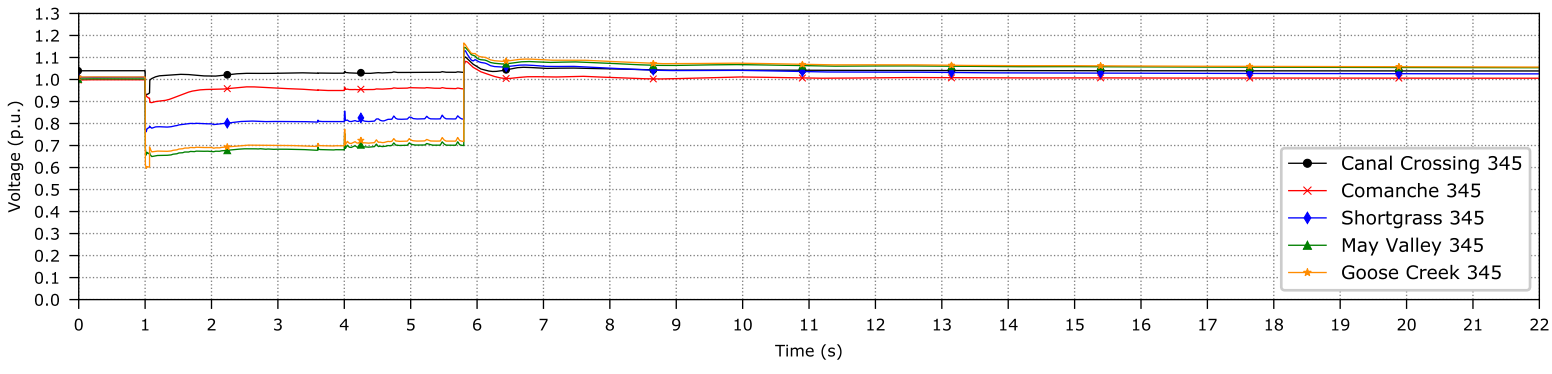




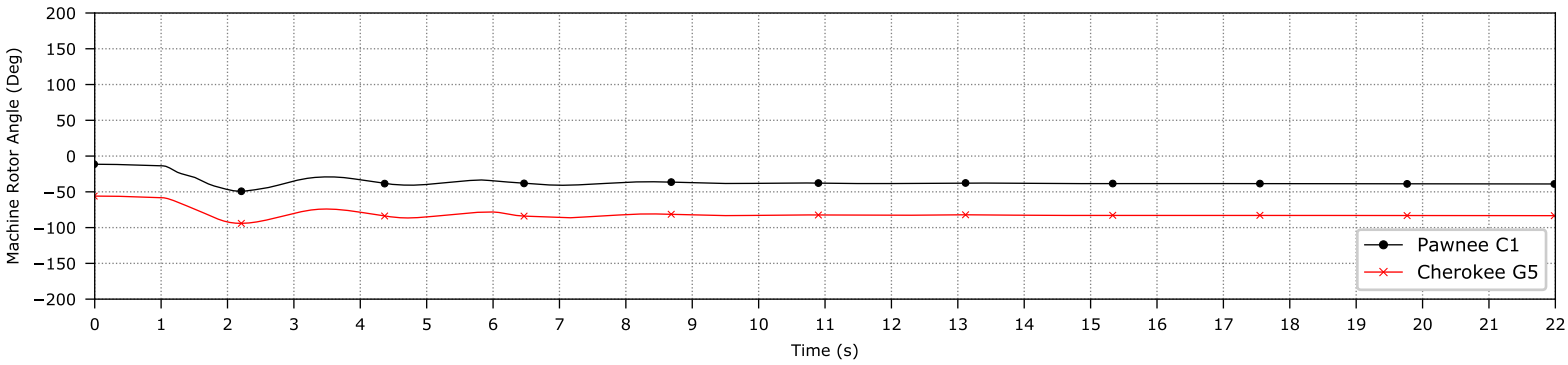


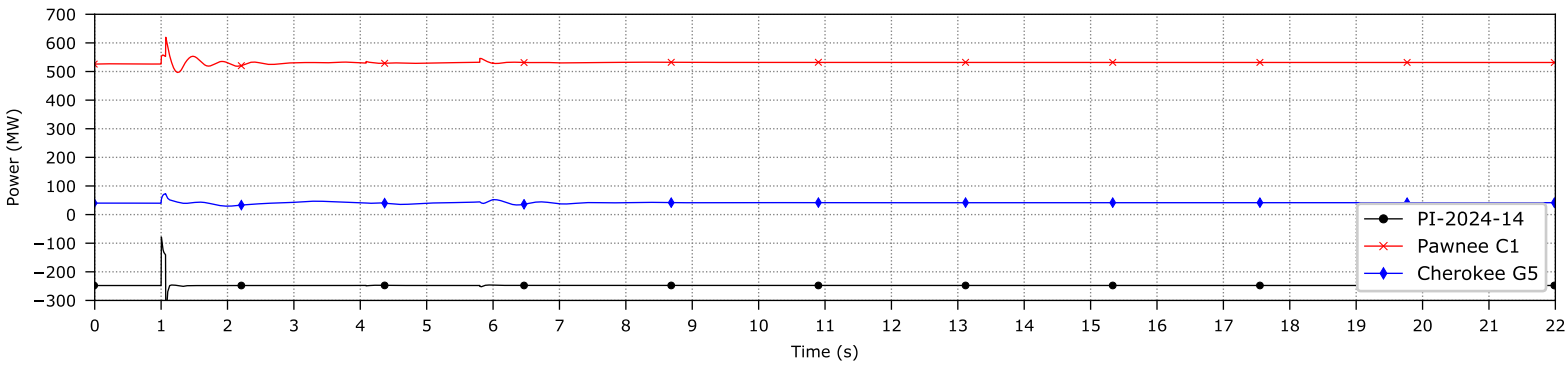


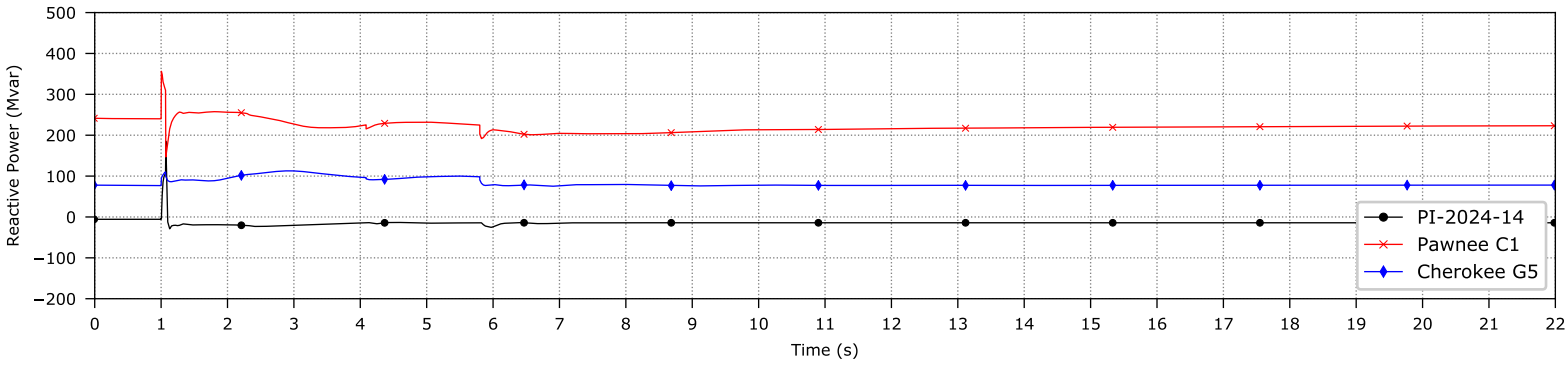


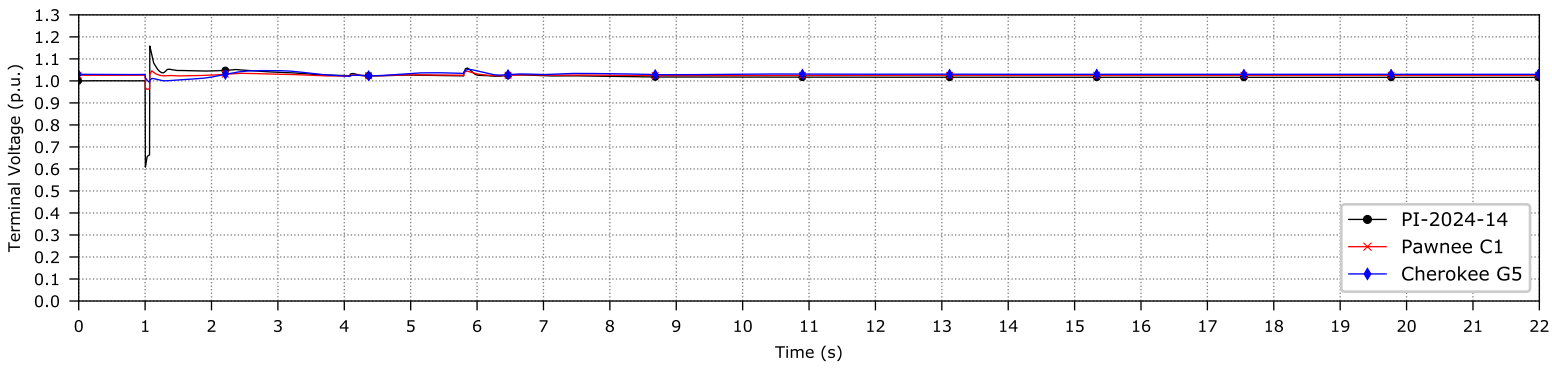


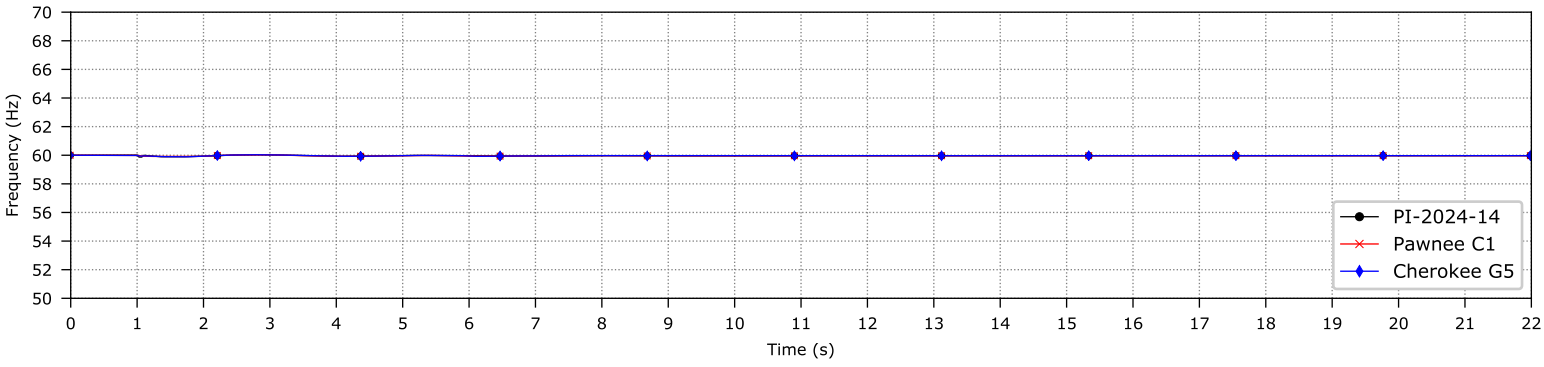
May Valley - Goose Creek-P7

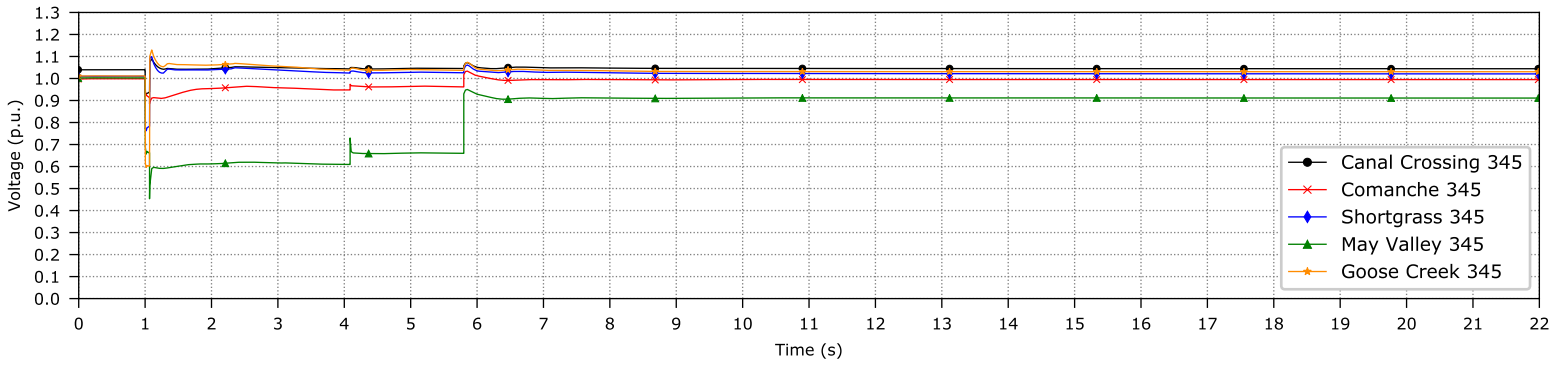












Goose Creek to Shortgras and Cheyenne Ridge-P7