Provisional Interconnection Study Report for PI-2024-18

11/22/2024

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1.0 Executive Summary

The PI-2024-18 project is a Provisional Interconnection Service (PIS)[1] request for 361.7 MW Solar Photovoltaic (PV) plus 180.2 MW Battery Energy Storage System (BESS) Generating Facility with a Point of Interconnection (POI) on the Pawnee – Missile Site 230 kV line. The combined solar PV and BESS project connect to the POI via a 0.2-mile generation tie-line. The maximum output will be controlled via power plant controller not to exceed 355 MW. This PIS request is associated with Generation Interconnection Request 5RSC-2024-07 in the 5RSC cluster.

The total cost of the transmission system improvements required for PI-2024-18 to qualify for Provisional Interconnection Service is **$28.591 million** (Table 11 and Table 12).

The initial maximum permissible output of PI-2024-18 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[2] will be reviewed quarterly and updated, if there are changes to the system conditions assumed in this analysis, to determine the maximum permissible output.

No Grid Charging will be permitted, as Network Upgrades (breaker replacements) are necessary to accommodate connection of the inverters to the grid.

Note during the 0.95 lagging power factor test the generator terminals, high side of the main power transformer bus, and the POI bus voltages exceed 1.05 p.u. voltage.

Security: PI-2024-18 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 is $5 million.

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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.

In addition, the Interconnection Customer would assume 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.

[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-2024-18 is the Provisional Interconnection Service[4] request for a 361.7 MW Solar Photovoltaic (PV) plus 180.2 MW Battery Energy Storage System (BESS) Generating Facility located in Adams 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 a tap on the Pawnee – Missile Site 230 kV line.
- The COD requested to be studied for PI-2024-18 was March 31, 2027 as noted on the Provisional Interconnection Service request form.
- The requested COD is not attainable by PSCo. The new estimated COD is November 30, 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.

[4] **Provisional Interconnection Service** 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.

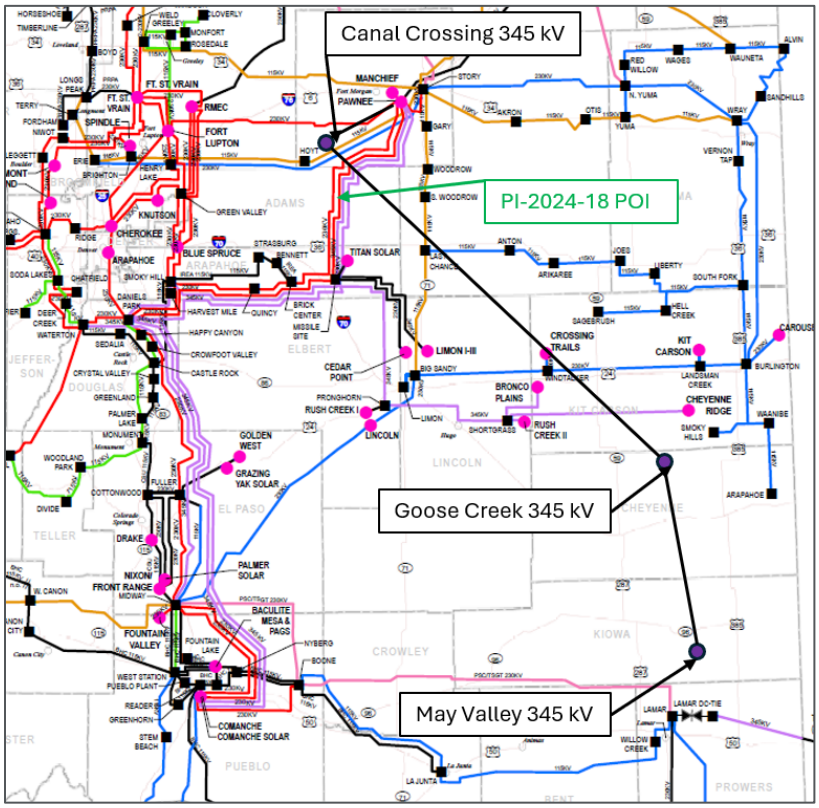

Figure 1: Point of Interconnection of PI-2024-18

3.0 Study Scope

The purpose of this study is to determine the impacts to the PSCo Transmission System and Affected Systems from interconnecting PI-2024-18 for Provisional Interconnection Service. Consistent with the assumption in the study agreement, PI-2024-18 selected Energy Resource Interconnection Service (ERIS)[5].

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 Transmission Provider's Interconnection Facilities and Station Network Upgrades.

[5] **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.

The study also identifies the estimated Security[6] 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

[6] **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 generating 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 Transmission System. Before the PI goes in-service an Affected System may choose to perform additional 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 part of area 73, as applicable.

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	Fault Category	Outage(s)	Clearing Time (Cycles)
1	No Fault	P0	Flat Run	-
2	PI-2024-18 POI 230 kV	P1	PI-2024-18 POI to Missile Site 230 kV CKT 1	5
3	PI-2024-18 POI 230 kV	P1	PI-2024-18 POI to Pawnee 230 kV CKT 1	5
4	PI-2024-18 POI 230 kV	P1	PI-2024-18 Generation	5
5	Pawnee 230 kV	P1	Pawnee 345/230 kV Transformer T2	5
6	Pawnee 230 kV	P1	Pawnee to Fort Lupton 230 kV CKT 1	5
7	Pawnee 230 kV	P1	Pawnee to Brick Center 230 kV CKT 1	5
8	Pawnee 230 kV	P1	Pawnee to Story 230 kV CKT 1	5
9	Missile Site 230 kV	P1	Missile Site to Daniels Park 230 kV CKT 1	5

Ref. No.	Fault Location	Fault Category	Outage(s)	Clearing Time (Cycles)
10	Missile Site 230 kV	P1	Missile Site 345/230 kV Transformer T1	5
11	Pawnee 230 kV	P1	Pawnee to Manchief 230 kV CKT 1 Manchief Generation	5
12	Pawnee 230 kV	P1	Pawnee to Peetz Logan 230 kV CKT 1 Peetz Logan Generation	5
13	Missile Site 230 kV	P1	Missile Site to Titan 230 kV CKT 1 Titan Generation	5
14	Missile Site 230 kV	P1	Missile Site to Cedar Point 230 kV CKT 1 Cedar Point Generation	5
15	Pronghorn 345 kV	P4	Rush Creek Generation	12

3.6 Study Area

The Eastern Colorado study area includes WECC designated zones 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 Pawnee, Beaver Creek and Missile Site substations.

4.0 Base Case Modeling Assumptions

The 2029HS2a WECC case released on May 3, 2023, was selected as the Starting Case. The 2027 Heavy Summer 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

The Base Case model includes higher-queued and existing PSCo's and Affected Systems' resources.

While the higher-queued Network Resource Interconnection Service (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 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, 4,050 MW of Native Load Priority (NLP) was dispatched on the Colorado's Power Pathway (CPP), as shown in Table 3.

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

Gen Bus Number	Name	ID	Status	Pgen (MW)	Pmax (MW)
70310	PAWNEE	C1	1	526.00	526.00
70314	MANCHEF1	G1	1	118.35	131.50
70315	MANCHEF2	G2	1	117.90	131.00
70767	RUSHCK1_W1	W1	1	161.60	202.00
70770	RUSHCK1_W2	W2	1	142.40	178.00
70771	RUSHCK2_W3	W3	1	176.00	220.00
70739	CHEYRGW_W1	W1	1	109.12	136.40
70742	CHEYRGW_W2	W2	1	105.60	132.00
70733	CHEYRGE_W1	W1	1	43.20	54.00
70736	CHEYRGE_W2	W2	1	88.00	110.00
70775	CHEYRGE_W3	W3	1	52.80	66.00
70818	MTNBRZ_W1	W1	1	126.32	157.90

Gen Bus Number	Name	ID	Status	Pgen (MW)	Pmax (MW)
70817	MTNBRZ_W2	W2	1	11.04	13.80
70670	CEDARPT_W1	W1	1	99.36	124.20
70671	CEDARPT_W2	W2	1	100.80	126.00
70635	LIMON1_W	W1	1	160.80	201.00
70636	LIMON2_W	W2	1	160.80	201.00
70637	LIMON3_W	W3	1	160.80	201.00
70753	BRONCO_W1	W1	1	117.28	146.60
70749	BRONCO_W2	W2	1	128.96	161.20
70710	PTZLOGN1	W1	1	160.80	201.00
70712	PTZLOGN2	W2	1	96.00	120.00
70713	PTZLOGN3	W3	1	63.60	79.50
70714	PTZLOGN4	W4	1	140.00	175.00
70721	SPRNGCAN1_W1	W1	1	51.84	64.80
70715	SPRNGCAN2_W2	W2	1	50.16	62.70
70723	RDGCREST	W1	1	23.76	29.70
70443	Arriba W1	W1	1	80.04	100.05
70442	Arriba W2	W2	1	80.04	100.05
Total (MW)				**3453.37**	**4152.40**

Table 3: NLP Generation Included in Benchmark Case

Generator Bus No.	Name	ID	Status	Pgen (MW)
700043	5RSC_24_10	B	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 Benchmark Case was created from the Base Case 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, the NLP dispatch described in Section 4.1, above, is also included in the Grid Charging Benchmark Case.

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

Gen Bus Number	Name	ID	Status	Pgen (MW)	Pmax (MW)
70310	PAWNEE	C1	1	526.00	526.00
70314	MANCHEF1	G1	1	118.35	131.50
70315	MANCHEF2	G2	1	117.90	131.00
70767	RUSHCK1_W1	W1	1	42.42	202.00
70770	RUSHCK1_W2	W2	1	37.38	178.00
70771	RUSHCK2_W3	W3	1	46.20	220.00
70739	CHEYRGW_W1	W1	1	28.64	136.40
70742	CHEYRGW_W2	W2	1	27.72	132.00
70733	CHEYRGE_W1	W1	1	11.34	54.00
70736	CHEYRGE_W2	W2	1	23.10	110.00
70775	CHEYRGE_W3	W3	1	13.86	66.00
70818	MTNBRZ_W1	W1	1	33.16	157.90
70817	MTNBRZ_W2	W2	1	2.90	13.80
70670	CEDARPT_W1	W1	1	26.08	124.20
70671	CEDARPT_W2	W2	1	26.46	126.00
70635	LIMON1_W	W1	1	42.21	201.00
70636	LIMON2_W	W2	1	42.21	201.00
70637	LIMON3_W	W3	1	42.21	201.00
70753	BRONCO_W1	W1	1	30.79	146.60
70749	BRONCO_W2	W2	1	33.85	161.20
70710	PTZLOGN1	W1	1	42.21	201.00
70712	PTZLOGN2	W2	1	25.20	120.00
70713	PTZLOGN3	W3	1	16.70	79.50
70714	PTZLOGN4	W4	1	36.75	175.00
70721	SPRNGCAN1_W1	W1	1	13.61	64.80
70715	SPRNGCAN2_W2	W2	1	13.17	62.70
70723	RDGCREST	W1	1	6.24	29.70
70443	Arriba W1	W1	1	21.01	100.05

Gen Bus Number	Name	ID	Status	Pgen (MW)	Pmax (MW)
70442	Arriba W2	W2	1	21.01	100.05
Total (MW)				**1468.67**	**4152.40**

4.3 Study Case Modeling

A Study Case was created from the Benchmark Case by turning on the PI-2024-18 generation. The additional 361.7 MW output any minus losses from PI-2024-18 was balanced against PSCo generation outside of the East study pocket.

A Grid Charging Study Case was created from the Grid Charging Benchmark Case by turning on the PI-2024-18 BESS as a load. The additional 180.2 MW of consumption from PI-2024-18 was balanced against PSCo generation outside of the East study pocket.

4.4 Short-Circuit Modeling

This request is for the interconnection of a 361.7 MW Solar Photovoltaic (PV) plus 180.2 MW Battery Energy Storage System (BESS) to the Pawnee – Missile Site 230 kV. The output will not exceed 355 MW at the POI.

This project assumes the use of ninety-three (93) Sungrow SG4400UD-MV 4.4 MW solar generators and fifty-two (52) Sungrow SC4000UD-MV BESS inverters. Each of the solar generators is connected to a collector transformer, 0.66/34.5 kV, rated at 4.4 MVA, and each of the BESS units is connected to a collector transformer, 0.8/34.5 kV, rated at 4 MVA. All three main power transformers for the solar generation and BESS have the same impedance and MVA rating. Two 230/34.5/13.8 kV main GSU transformers rated at 132/176/220 are used for the solar generation, and one transformer of the same rating is used for the BESS. These transformers step the voltage up from the collector transformer voltage to the POI voltage. The fault current from the interconnection is shared equally between the three GSUs. An approximately 0.2-mile-long generation tie line interconnects the project to a new switching station bisecting the Pawnee-Missile Site 230 kV.

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.

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

All the summary tables representing the GIR's 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 the range of 0.95 p.u. to 1.05 p.u. are highlighted in yellow to provide additional information.

The PI-2024-18 GIR is modeled as follows:

PV Generator 1: Pmax = 182.82 MW, Pmin = 0 MW, Qmax = 96.66 MVar, Qmin= -96.66 MVar
PV Generator 2: Pmax = 178.93 MW, Pmin = 0 MW, Qmax = 94.6 MVar, Qmin= -94.6 M MVar
BESS Generator 1: Pmax = 180.37 MW, Pmin = -180.37 MW, Qmax = 103.6 MVar, Qmin= -103.6 MVar
The summary for the Voltage and Reactive Power Capability Evaluation for PI-2024-18 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer. Note during the 0.95 lagging power factor test the generator terminals, high side of the main power transformer bus, and the POI bus voltages exceed 1.05 p.u. voltage.
- 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-2024-18 are summarized in Table 5.

Table 5 – Reactive Capability Evaluation for PI-2024-18

PV Generator Terminals					BESS Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (MVar)	Qmax (MVar)	Qmin (MVar)	V (p.u.)	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
240.0	105.3	191.3	-191.3	1.11	119.3	52.6	103.6	-103.6	1.11	354.9	117.0	1.06	0.950	354.9	116.7	1.05	0.950
240.0	-47.1	191.3	-191.3	0.98	119.3	-23.5	103.6	-103.6	1.01	354.5	-117.9	1.01	-0.949	354.4	-118.3	1.01	-0.949
361.8	181.3	191.3	-191.3	1.14	OFFLINE					355.0	117.0	1.06	0.950	355.0	116.7	1.05	0.950
OFFLINE					180.4	90.5	103.6	-103.6	1.13	177.3	60.2	1.05	0.947	177.3	60.2	1.04	0.947
361.8	-44.4	191.3	-191.3	0.97	OFFLINE					354.4	-117.9	1.00	-0.949	354.4	-118.3	1.00	-0.949
OFFLINE					180.4	-27.6	103.6	-103.6	0.98	177.1	-61.7	1.02	-0.944	177.0	-61.8	1.02	-0.944
0.0	-31.1	191.3	-191.3	1.01	0.0	-15.5	103.6	-103.6	1.00	-0.8	-41.5	1.02	-0.019	-0.8	-41.4	1.02	-0.019

5.2 Steady State Analysis – Grid Charging

Contingency analysis was performed on the East study pocket Grid Charging Study Case.

- Results of the system intact analysis showed no overloads or voltage violations attributable to the Study GIR.
- Results of the single contingency analysis showed no overloads or voltage violations attributable to the Study GIR.
- Results of the multiple contingency analysis showed no overloads or voltage violations attributable to the Study GIR.

5.3 Steady State Analysis – Discharging

Contingency analysis was performed on the East study pocket Study Case.

The power flow analysis showed that the category P1 contingencies: Smoky Hill – Missile Site 345 kV was divergent in the Study Case. As described in Section 7.4 of the BPM, single contingency issues should be mitigated using redispatch. Therefore, to resolve the divergence without requiring network upgrades or curtailment of the Study GIR's output, PSCo units located near the Study GIR were re-dispatched until the diverged contingency was resolved. The change in output of both units was balanced against PSCo generation outside of the Eastern Colorado study pocket. The following single and multiple contingency analyses are conducted with the dispatch presented in the last column of Table 6.

Table 6 – Generation Dispatch to Resolve the Diverged P1 Contingency

Bus No.	Bus Name	ID	Original Pgen (MW)	Modified Pgen (MW)
70635	LIMON1_W	W1	130.32	0.00
70636	LIMON2_W	W2	160.80	0.00
70637	LIMON3_W	W3	160.80	0.00

- Results of the system intact analysis showed no overloads or voltage violations attributable to the Study GIR.
- Results of the single contingency analysis are shown in Table 7. Single contingency analysis showed no voltage violations attributable to PI-2024-18.

- Results of the multiple contingency analysis are shown in Table 8. Multiple contingency analysis showed no voltage violations attributable to PI-2024-18.
    - Note four P7 contingencies were divergent as shown in Table 9. 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.

All the system intact and single contingency overloads identified in Table 7 are alleviated through generation redispatch as shown in the last column of Table 7.

Per TPL-001-5, multiple contingency overloads 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.

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Table 7 – East Pocket - Single Contingency Overloads

Ref. No.	Monitored Facility	Contingency Name	kV	Areas	Contingency Rating (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)	Redispatched Study Case Load (%)
1	Story (73192) - Pawnee (70311) 230 kV ckt 1	Smoky Hill - Missile Site #7081	230	73/70	772	99.86	101.67	1.81	100.00

Table 8 – East Pocket - Multiple Contingency Overloads

Ref. No.	Monitored Facility	Contingency Name	kV	Areas	Contingency Rating (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
1	Leetsdale (70260) - Sullivan (70365) 230 kV ckt 1	BF_004a: Arapahoe - Daniels Park 230 kV circuit 1 Arapahoe - Dakota 230 kV circuit 1 Arapahoe - Denver Terminal 230 kV circuit 1 Arapahoe - Greenwood_2 230 kV circuit 1 Dakota - Denver Terminal 230 kV circuit 1 Arapahoe 230/115 kV Transformer T5	230	70	425	93.71	101.13	7.42
2	Story (73192) - Pawnee (70311) 230 kV ckt 1	P7_135: Smoky Hill - Missile Site 345 kV circuit 1 Daniels Park - Missile Site 345 kV circuit 1	230	70	772	99.86	101.67	1.81

Table 9 – Diverged P7 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_161	Canal Crossing - FSV 345 kV circuit 1 Canal Crossing - FSV 345 kV circuit 2	Diverged	Diverged
P7_167	May Valley - Sandstone 345 kV circuit 1 May Valley - Sandstone 345 kV circuit 2	Diverged	Diverged

5.4 Transient Stability Results

The following results were obtained for the disturbances analysed:

- ✓ 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 10. Both the discharging and Grid Charging Scenarios are summarized in this table. The transient stability plots are shown in Appendix A and Appendix B in Section 10.0 of this report.

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Table 10 – Transient Stability Analysis Results

Ref. No.	Fault Location	Fault Category	Outage(s)	Clearing Time (Cycles)	Discharging		Grid Charging	
					Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
1	No Fault	P0	Flat Run	-	Stable	Stable	Stable	Stable
2	PI-2024-18 POI 230 kV	P1	PI-2024-18 POI to Missile Site 230 kV CKT 1	5	Stable	Stable	Stable	Stable
3	PI-2024-18 POI 230 kV	P1	PI-2024-18 POI to Pawnee 230 kV CKT 1	5	Stable	Stable	Stable	Stable
4	PI-2024-18 POI 230 kV	P1	PI-2024-18 Generation	5	Stable	Stable	Stable	Stable
5	Pawnee 230 kV	P1	Pawnee 345/230 kV Transformer T2	5	Stable	Stable	Stable	Stable
6	Pawnee 230 kV	P1	Pawnee to Fort Lupton 230 kV CKT 1	5	Stable	Stable	Stable	Stable
7	Pawnee 230 kV	P1	Pawnee to Brick Center 230 kV CKT 1	5	Stable	Stable	Stable	Stable
8	Pawnee 230 kV	P1	Pawnee to Story 230 kV CKT 1	5	Stable	Stable	Stable	Stable
9	Missile Site 230 kV	P1	Missile Site to Daniels Park 230 kV CKT 1	5	Stable	Stable	Stable	Stable
10	Missile Site 230 kV	P1	Missile Site 345/230 kV Transformer T1	5	Stable	Stable	Stable	Stable
11	Pawnee 230 kV	P1	Pawnee to Manchief 230 kV CKT 1 Manchief Generation	5	Stable	Stable	Stable	Stable
12	Pawnee 230 kV	P1	Pawnee to Peetz Logan 230 kV CKT 1 Peetz Logan Generation	5	Stable	Stable	Stable	Stable
13	Missile Site 230 kV	P1	Missile Site to Titan 230 kV CKT 1 Titan Generation	5	Stable	Stable	Stable	Stable
14	Missile Site 230 kV	P1	Missile Site to Cedar Point 230 kV CKT 1 Cedar Point Generation	5	Stable	Stable	Stable	Stable
15	Pronghorn 345 kV	P4	Rush Creek Generation	12	Stable	Stable	Stable	Stable

5.5 Short-Circuit and Breaker Duty Analysis Results

A study was completed to determine whether any overstressed 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 ten (10) circuit breakers that became over-dutied because of adding the PI-2024-18. The overduty breakers do not have projects initiated for their replacement and will require Network Upgrades. The fault currents at the POI for can be made available upon request by the Customer.

5.6 Affected Systems

No Affected Systems were identified.

5.7 Summary of Provisional Interconnection Analysis

All system intact and single contingency thermal violations were alleviated through generation redispatch, therefore, the maximum permission output of the Provisional Interconnection Service request without requiring any additional system Network Upgrades is 355 MW. Additionally, the requested Grid Charging capacity of 180.2 MW will be permitted as no Network Upgrades were found to be necessary to accommodate the consumption.

Note during the 0.95 lagging power factor test the generator terminals, high side of the main power transformer bus, and the POI bus voltages exceed 1.05 p.u. voltage.

6.0 Cost Estimates

The total estimated cost of the required upgrades for PI-2024-18 to interconnect for Provisional Interconnection Service by tapping the Pawnee – Missile Site 230 kV line is **$28.591 million**. Note the cost estimates for any Network Upgrades on Affected Systems is not provided by PSCo.

- **Cost of Transmission Provider's Interconnection Facilities (TPIF) is $2.472 million** (Table 11)
- **Cost of Station Network Upgrades is $26.119 million** (Table 12)
- **Cost of System Network Upgrades is $0**

The list of improvements required to accommodate the Provisional Interconnection Service of PI-2024-18 are given in Table 11, and Table 12.

Table 11 – Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (Million)
PSCo's New 230 kV switching station on the MSST - PAWN 230 kV Line	Interconnection of PI-2024-18 at the new 230 kV switching station on the MSST - PAWN 230 kV Line. 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 • (3) 230 kV 1-phase CT's for metering • (3) 230 kV CVTs • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying	$2.222
PSCo's New 230 kV switching station on the MSST - PAWN 230 kV Line	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.	$0.250
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$2.472**

Table 12 – Station Network Upgrades

Element	Description	Cost Est. (Million)
PSCo's New 230 kV switching station on the MSST - PAWN 230 kV Line	Install new 230 kV switching station tapping the MSST - PAWN 230 kV line. The new equipment includes: • (3) 230 kV deadend structures • (3) 230 kV 3000 A circuit breakers • (8) 230 kV 3000 A disconnect switches • (6) 230 kV CCVTs • (2) 230 kV SSVTs • (2) 230 kV 3-phase arresters • (1) Electrical Equipment Enclosure (EEE) • Site grading and fencing • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$20.551
PSCo's New 230 kV switching station on the MSST - PAWN 230 kV Line	Install required communication in the EEE at the new 230 kV switching station	$1.462
PSCo's MSST 230 kV substation	Remote end upgrade at the MSST 230 kV Substation, replace the line relaying associated with the 5457 line, which will now be going to the new 230 kV switching station	$0.749
PSCo's PAWN 230 kV substation	Remote end upgrade at the PAWN 230 kV substation, replace the line relaying associated with the 5457 line, which will now be going to the new 230 kV switching station, install surge arresters and single phase CCVT	$0.799
PSCO's CKT 5457 Deer Creek 2 - MSST	CKT 5457 - Adding (1) steel monopole corner deadend structure, (2) steel monopole in-line deadend structures, 1272 kcmil 45/7 strand "Bittern" ACSR, 48 count OPGW into new 230 kV switching station	$1.027
PSCO's CKT 5457 Deer Creek 2 - PAWN	CKT 5457 - Removal of hardware, insulators, and conductor and adding (1) steel monopole corner deadend structure, (2) steel monopole in-line deadend structures, 1272 kcmil 45/7 strand "Bittern" ACSR, 48 count OPGW into new 230 kV switching station	$1.031
PSCo's New 230 kV switching station on the MSST - PAWN 230 kV Line	Siting and Land Rights land acquisition and permitting, no land purchase costs included	$0.500
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$26.119**

PSCo has developed cost estimates for Transmission Provider's Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of PI-2024-18 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.
- Land for new switching station can be acquired at fair market value.
- 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 facilitate the fee simple ownership of the property required for the new switching station, approximately 15 acres, to interconnect the Deer Trail 2 solar and BESS development.
- Interconnection Customer will install two (2) redundant fiber optic circuits (one primary circuit with a redundant backup) into the Transmission Provider's switching station 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 coordinate with the Transmission Provider to include the PCO structure into the Interconnection Customer's permitting for the generation tie line.
- 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 most current version of the *Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW*, as amended from time to time, and available at: Interconnection | Transmission | Corporate | Xcel Energy

6.1 Schedule

This section provides proposed milestones for the interconnection of PI-2024-18 to the Transmission Provider's Transmission System. The customer requested a back-feed date (In-Service Date for Transmission Provider Interconnection Facilities and Station Network Upgrades required for interconnection) for the Provisional Interconnection of January 15, 2027. This is not 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-2024-18

Milestone	Responsible Party	Estimated Completion Date
LGIA Execution	Interconnection Customer and Transmission Provider	February 2025
In-Service Date for Transmission Provider Interconnection Facilities and Station Network Upgrades required for interconnection	Transmission Provider	September 21, 2028
In-Service Date & Energization of Interconnection Customer's Interconnection Facilities	Interconnection Customer	September 21, 2028
Initial Synchronization Date	Interconnection Customer	October 2, 2028
Begin trial operation & testing	Interconnection Customer and Transmission Provider	October 16, 2028
Commercial Operation Date	Interconnection Customer	November 30, 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 24 months of LGIA 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) will 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-2024-18 to qualify for Provisional Interconnection Service is **$28.591 million**.

The initial maximum permissible output of PI-2024-18 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[7] will be reviewed quarterly and updated, if there are changes to the system conditions assumed in this analysis, to determine the maximum permissible output.

No Grid Charging will be permitted, as Network Upgrades (breaker replacements) are necessary to accommodate connection of the inverters to the grid.

Note during the 0.95 lagging power factor test the generator terminals, high side of the main power transformer bus, and the POI bus voltages exceed 1.05 p.u. voltage.

Security: PI-2024-18 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

Contingent Facilities identified for PI-2024-18 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-2024-18

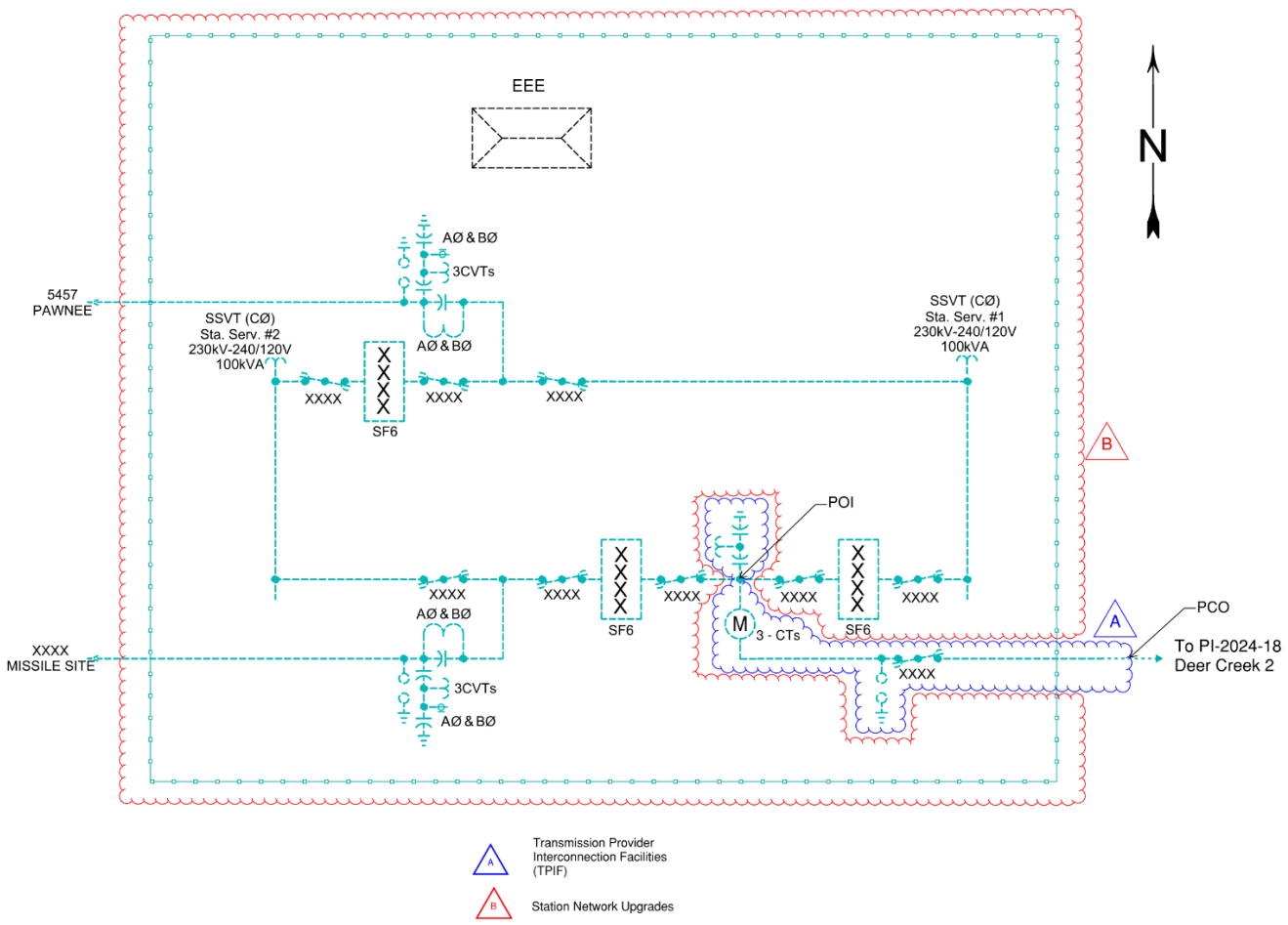


Figure 2: Preliminary One-Line of PI-2024-18 with a tap on Pawnee – Missile Site 230 kV line

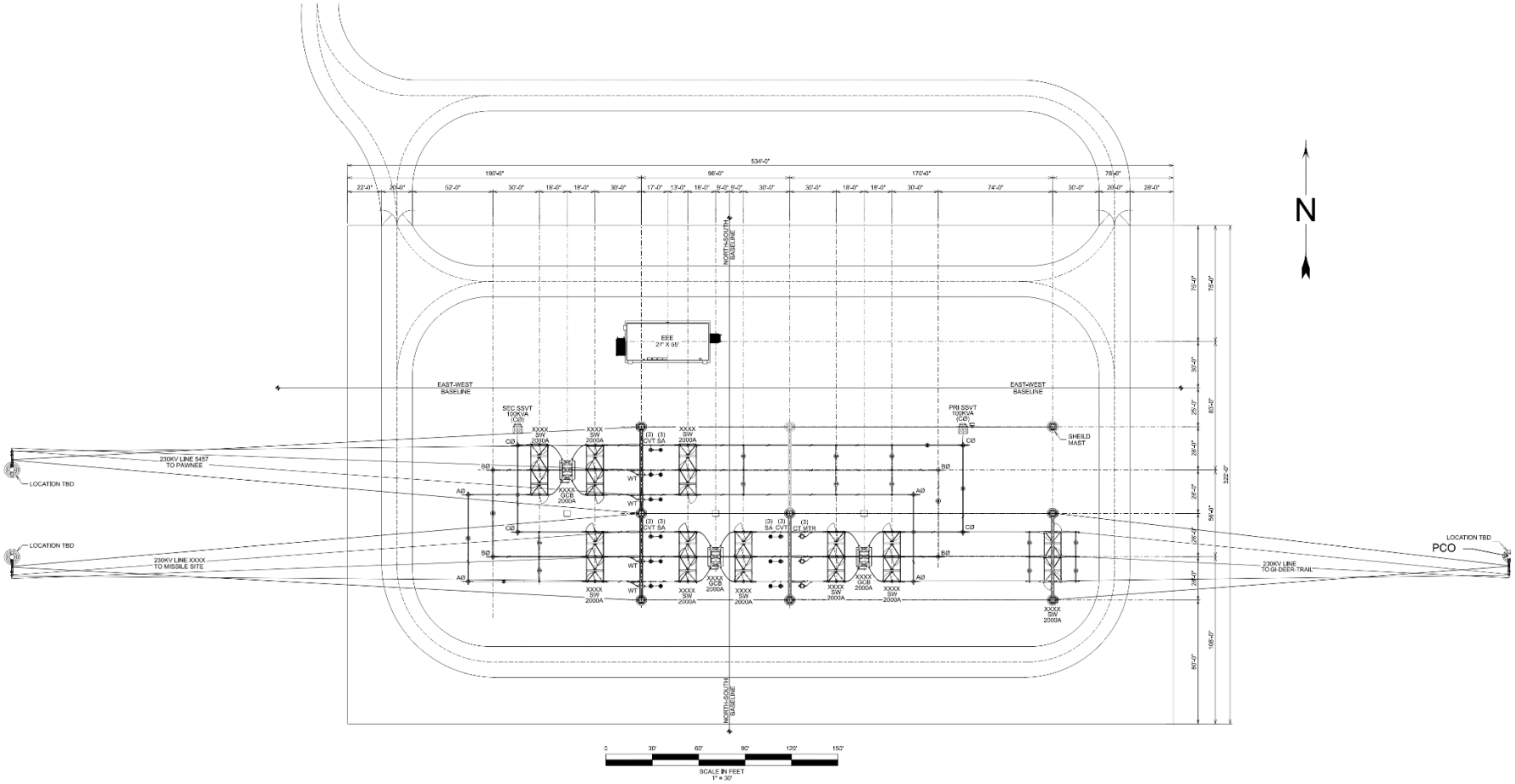
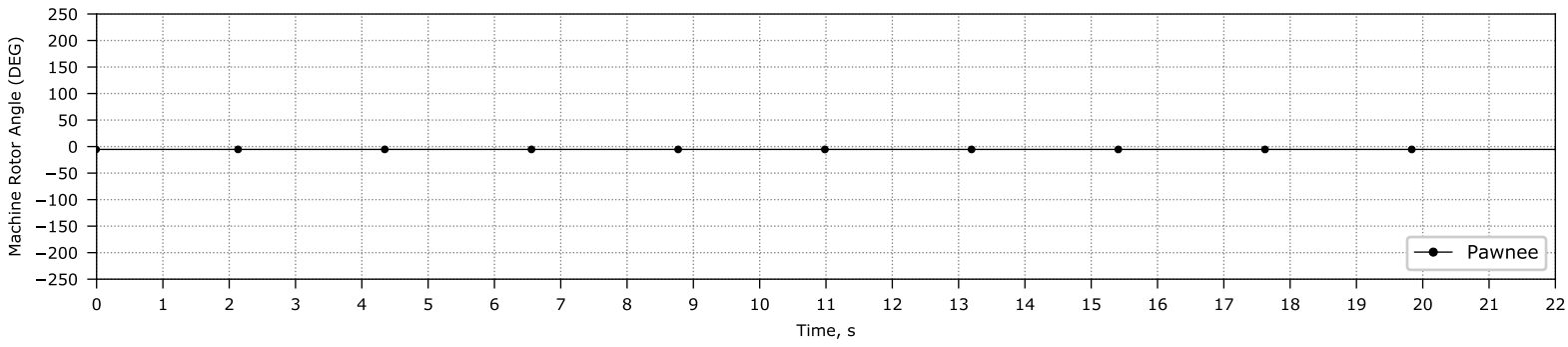


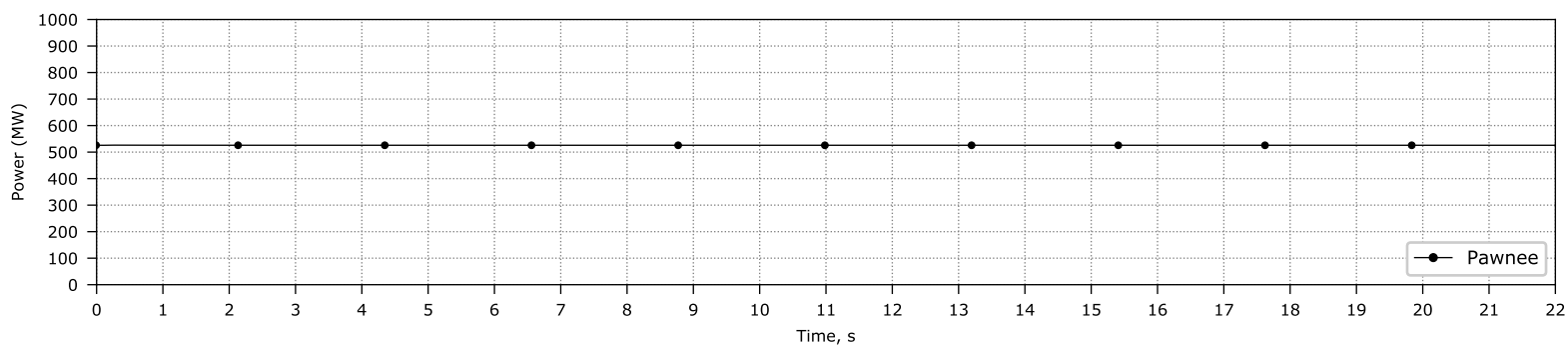
Figure 3: Preliminary General Arrangement for PI-2024-18 with a tap on Pawnee – Missile 230 kV line

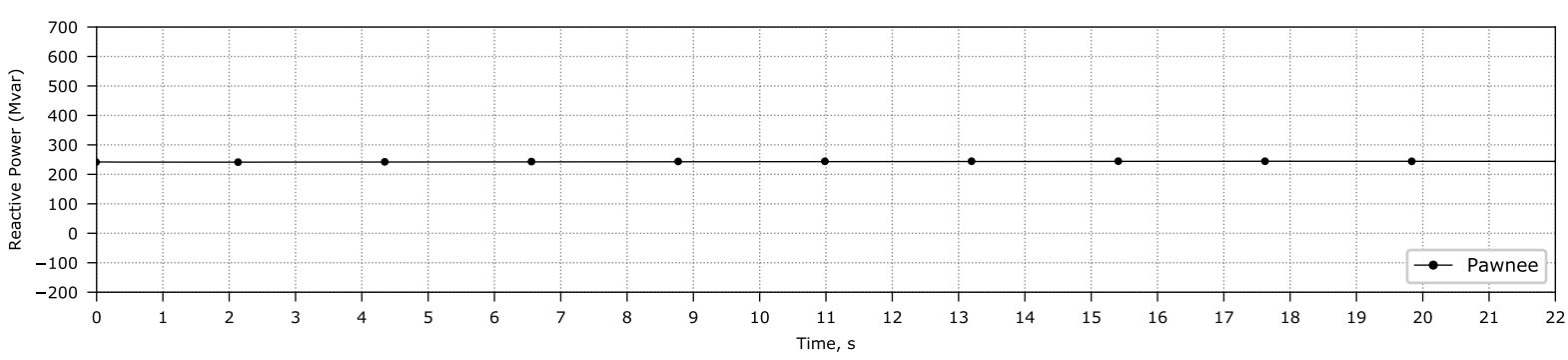
10.0 Appendices

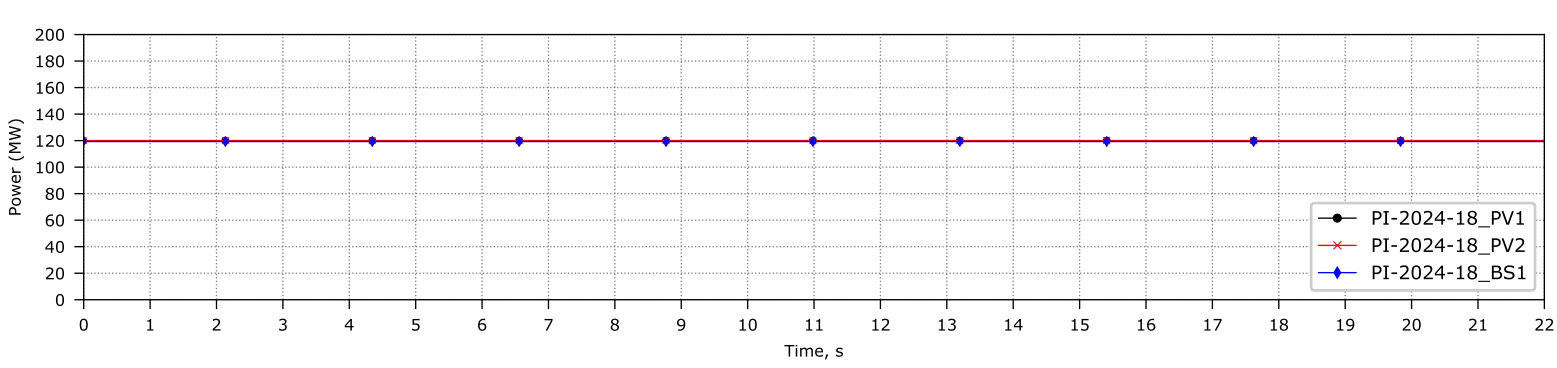
Appendix A: Transient Stability Plots (Discharging)	PI-2024-18_Transient Stability Analysis Plots
Appendix B: Transient Stability Plots (Grid Charging)	PI-2024-18_GC_Transient Stability Analysis

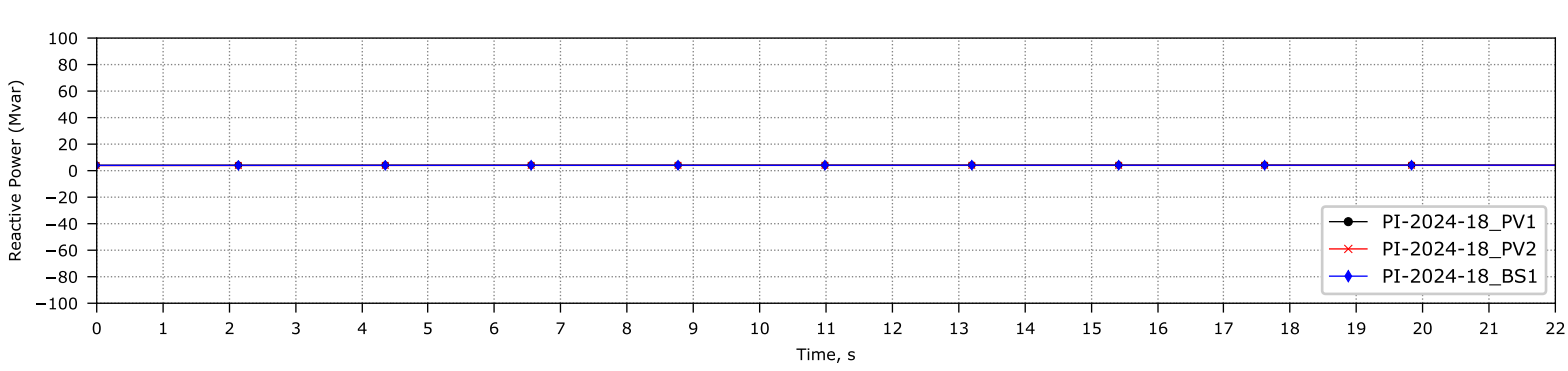
PI-2024-18_Study_East_flatrun

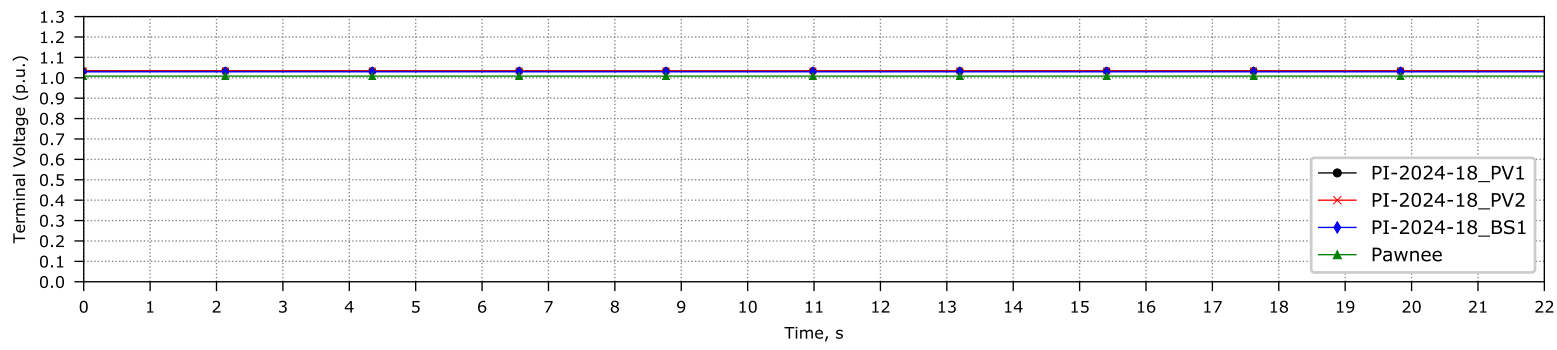


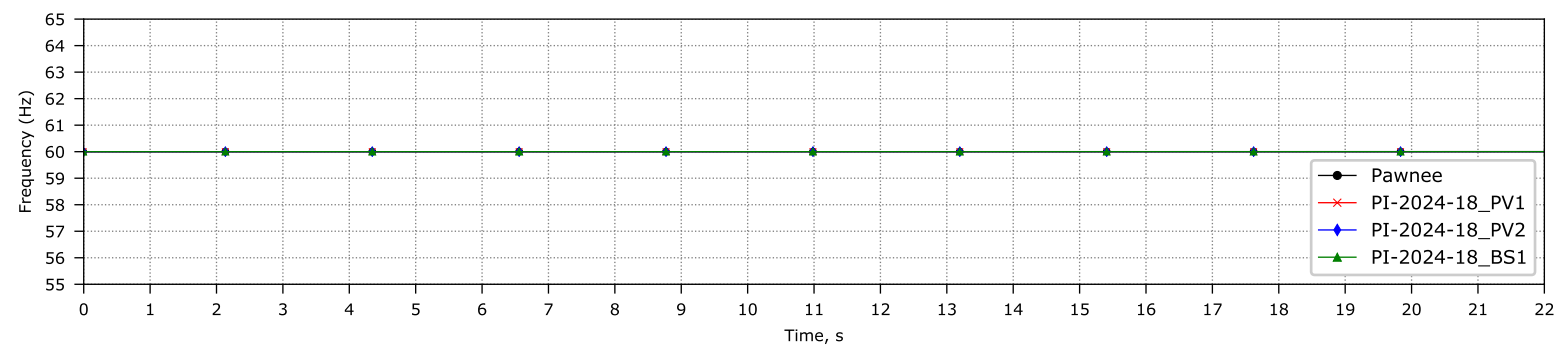


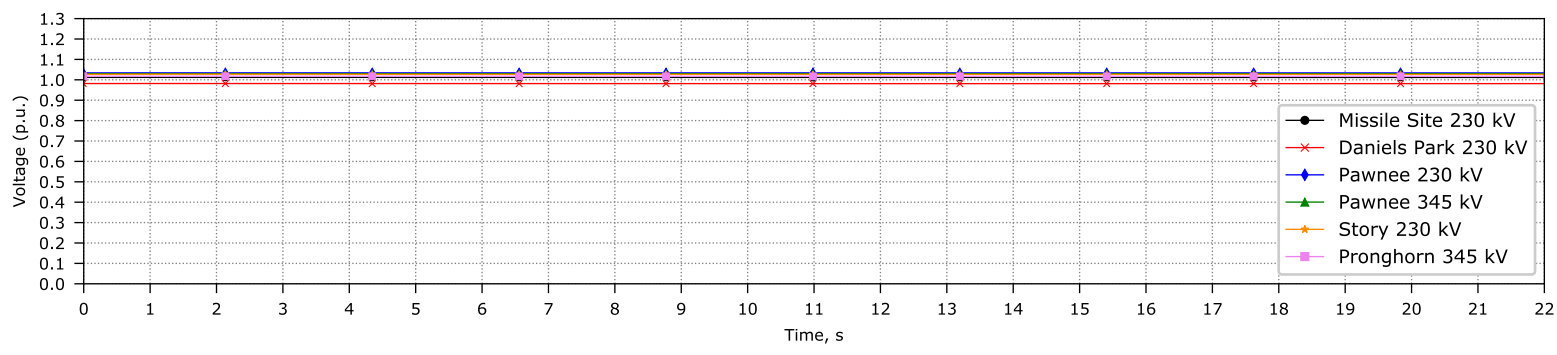












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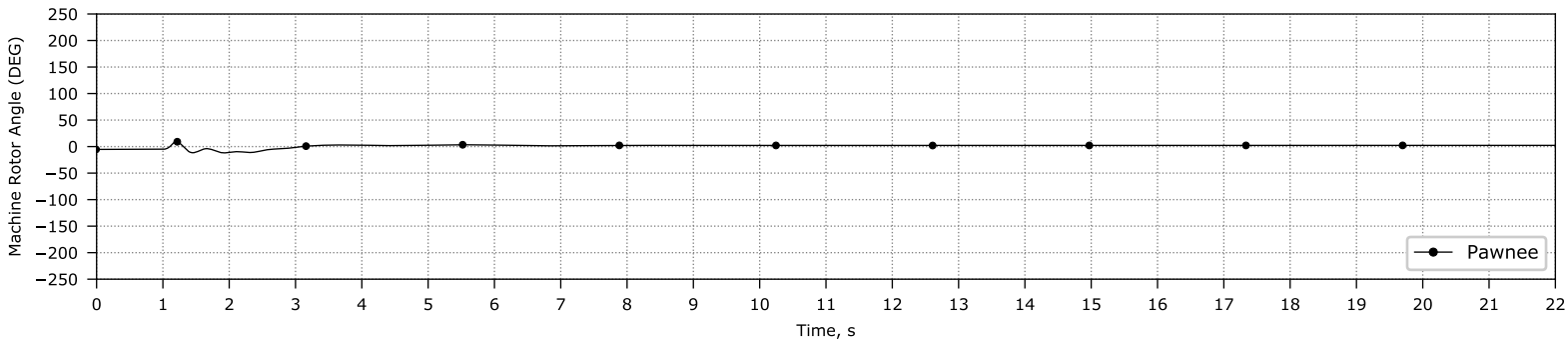

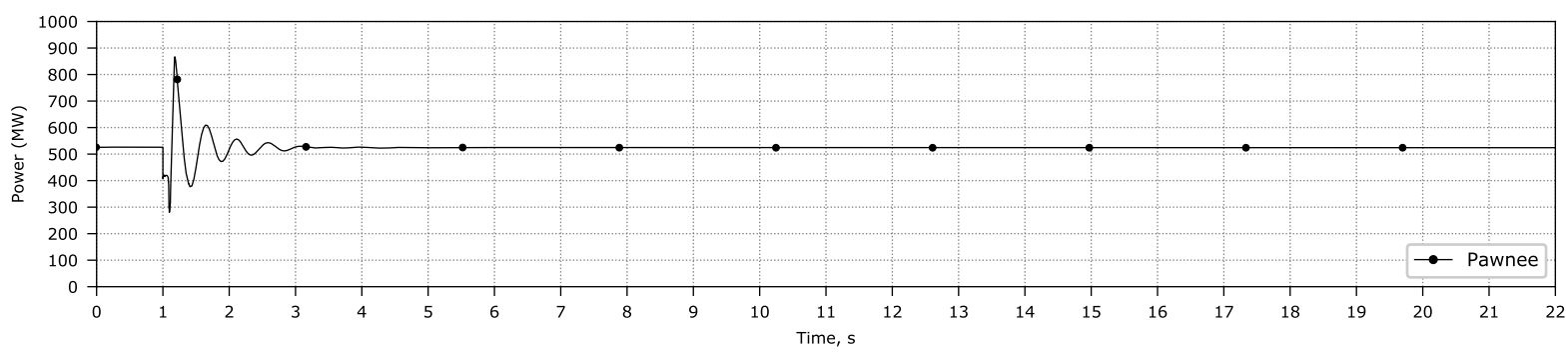

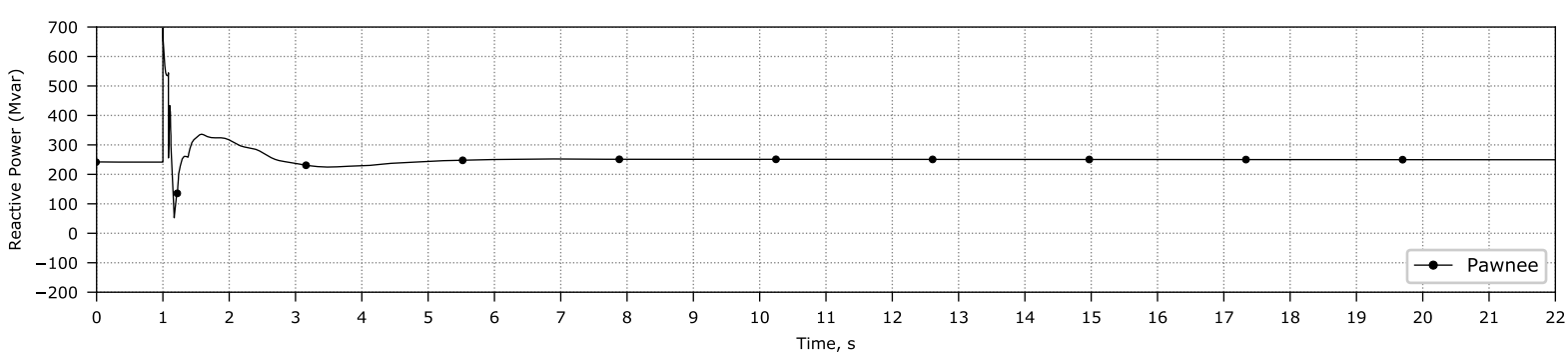

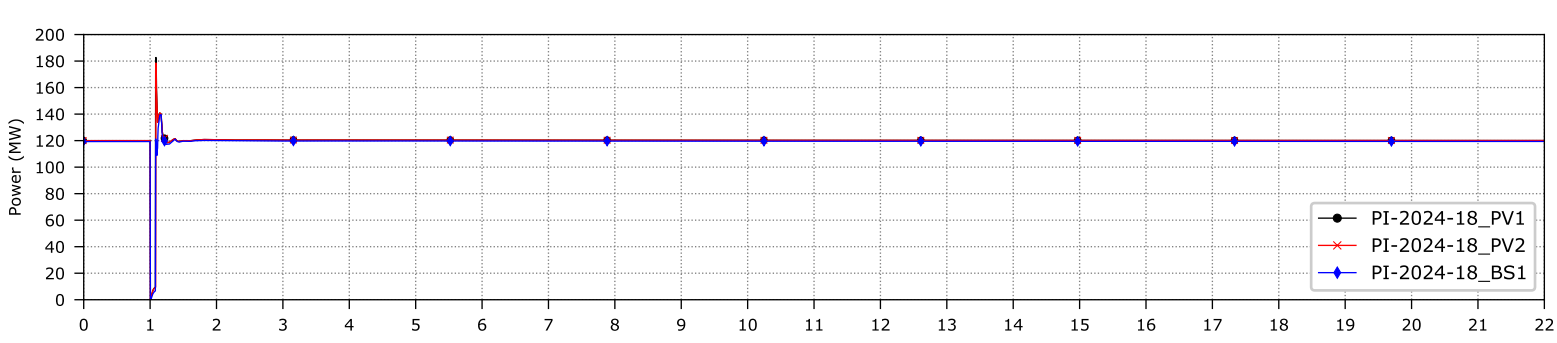

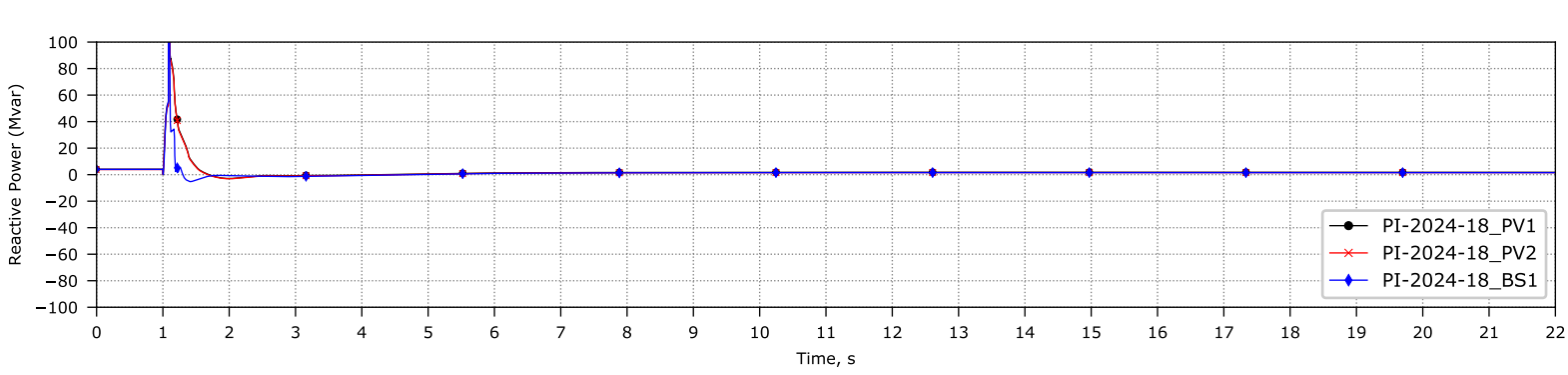

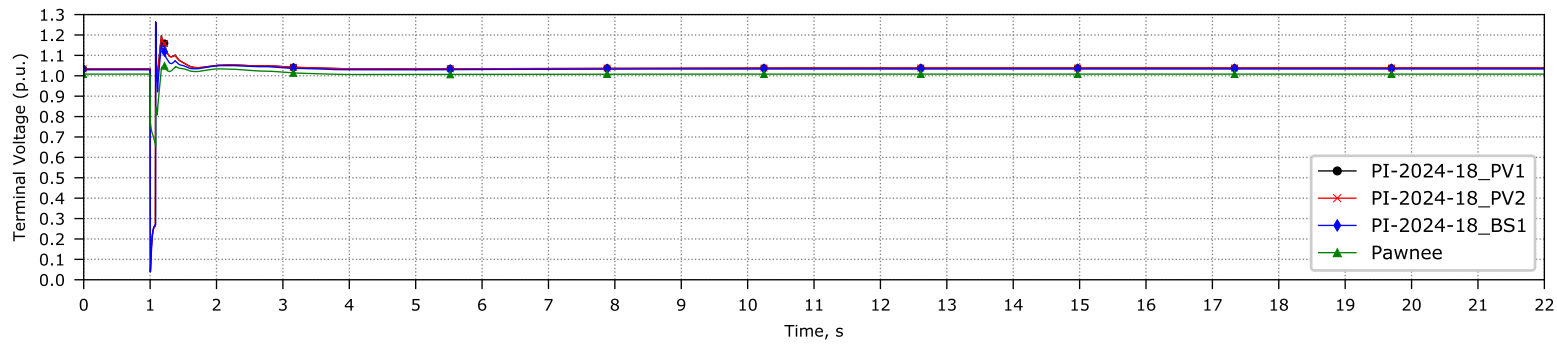

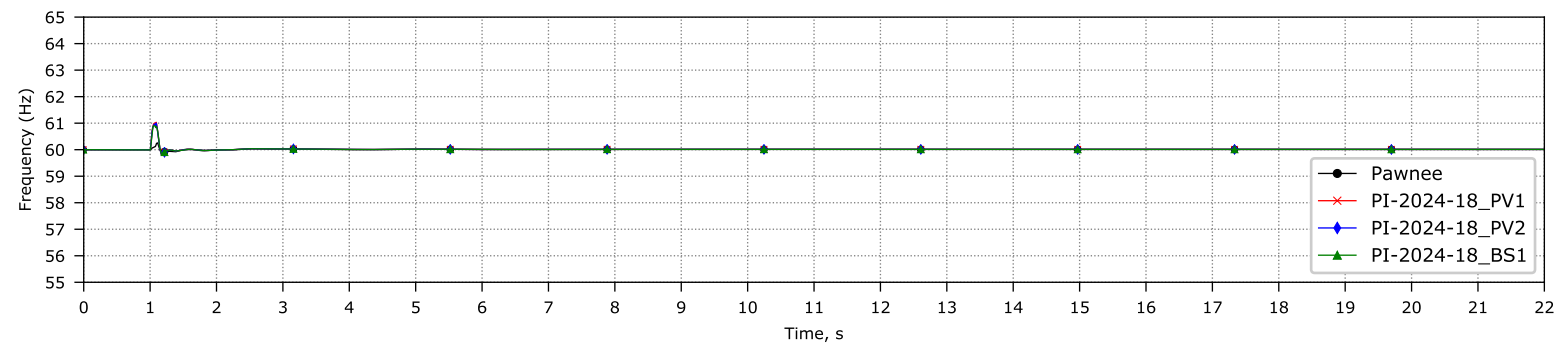

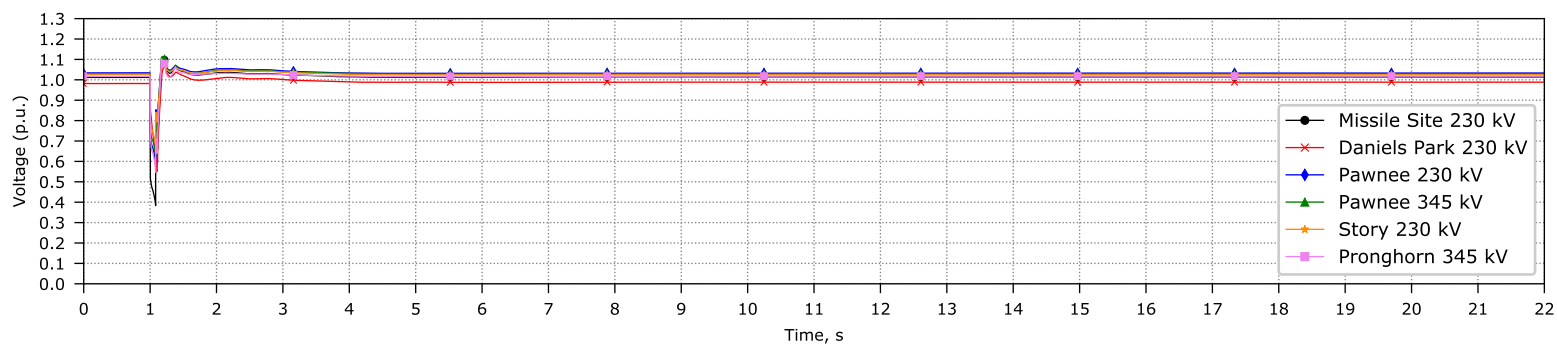

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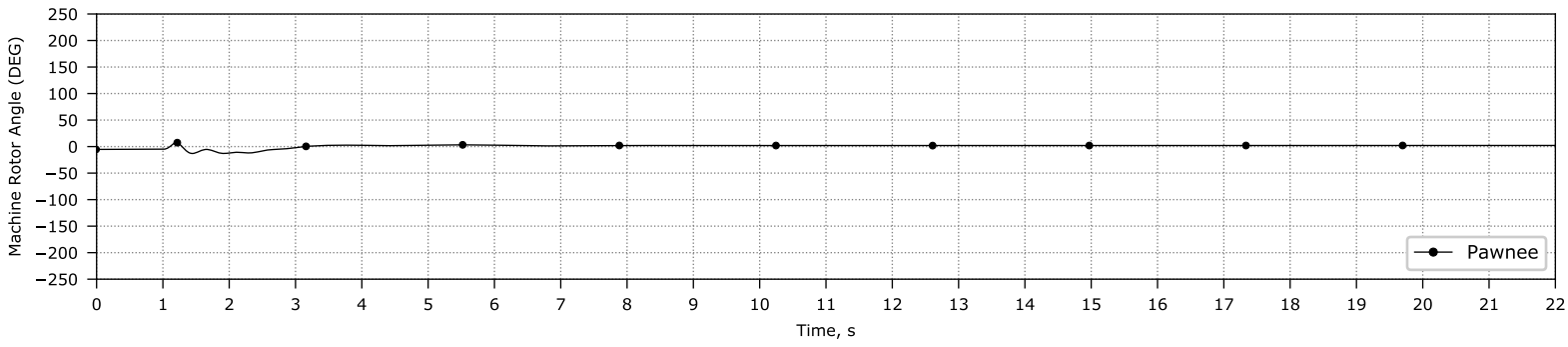

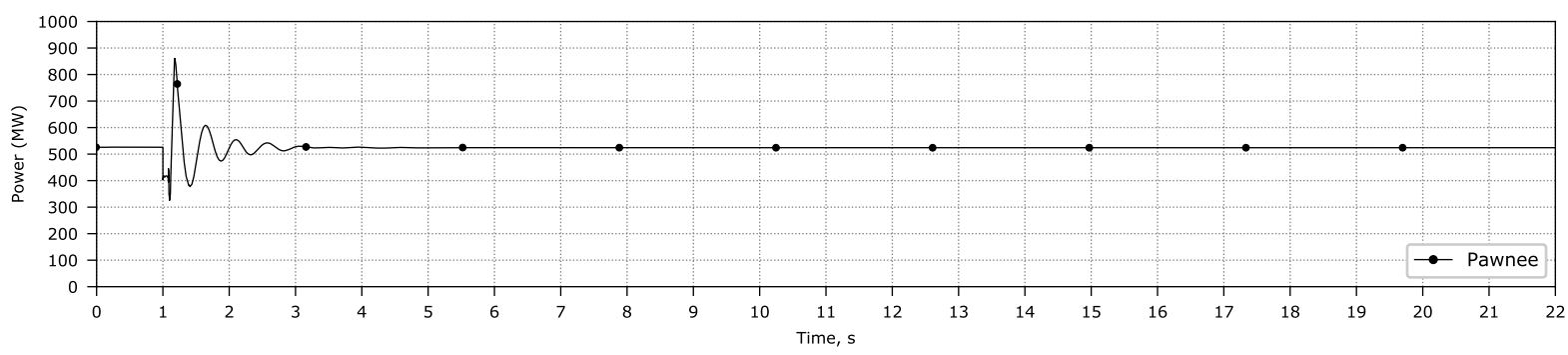

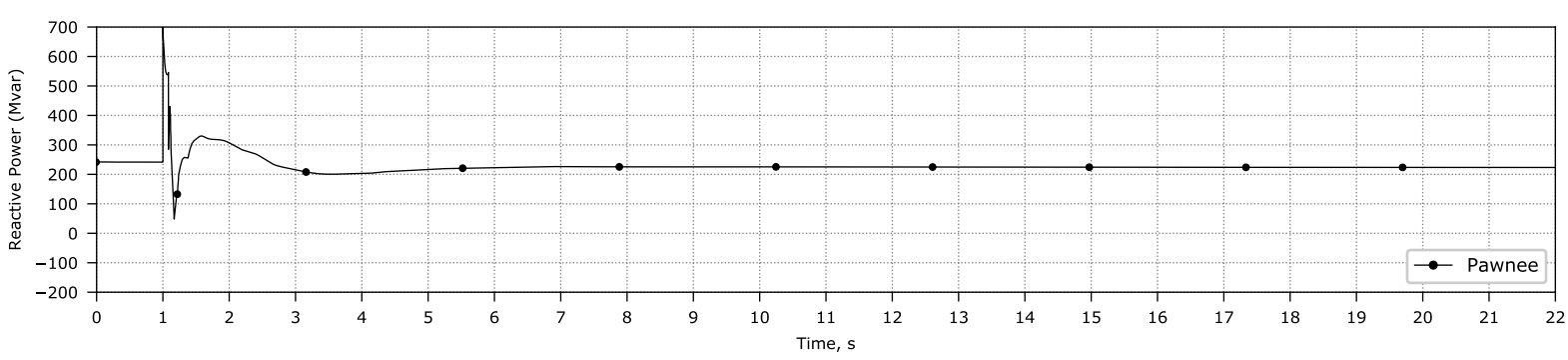

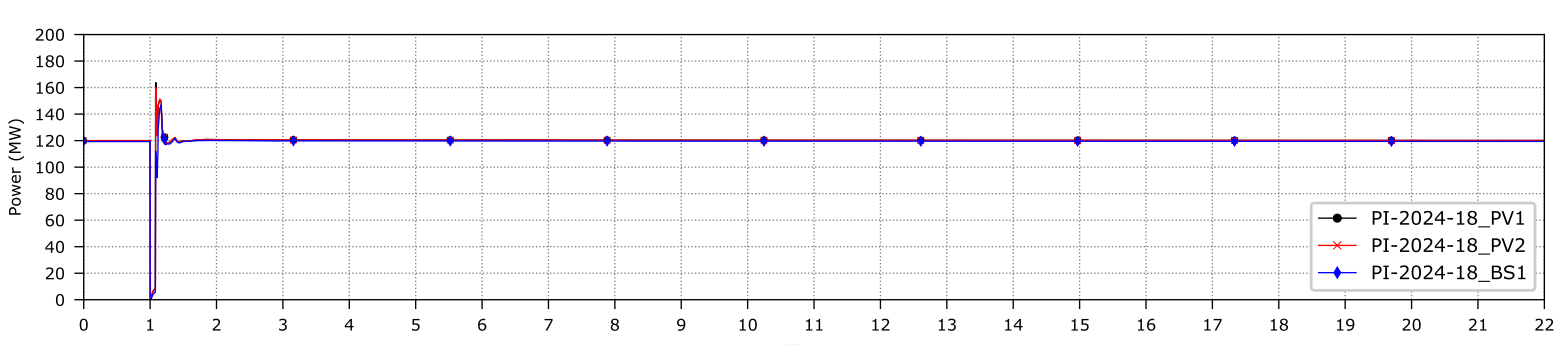

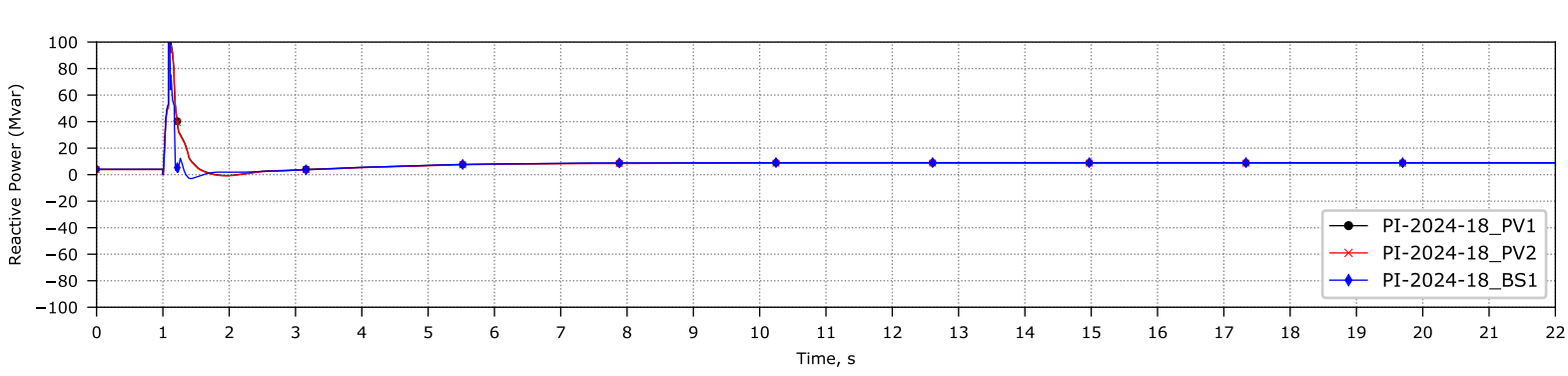

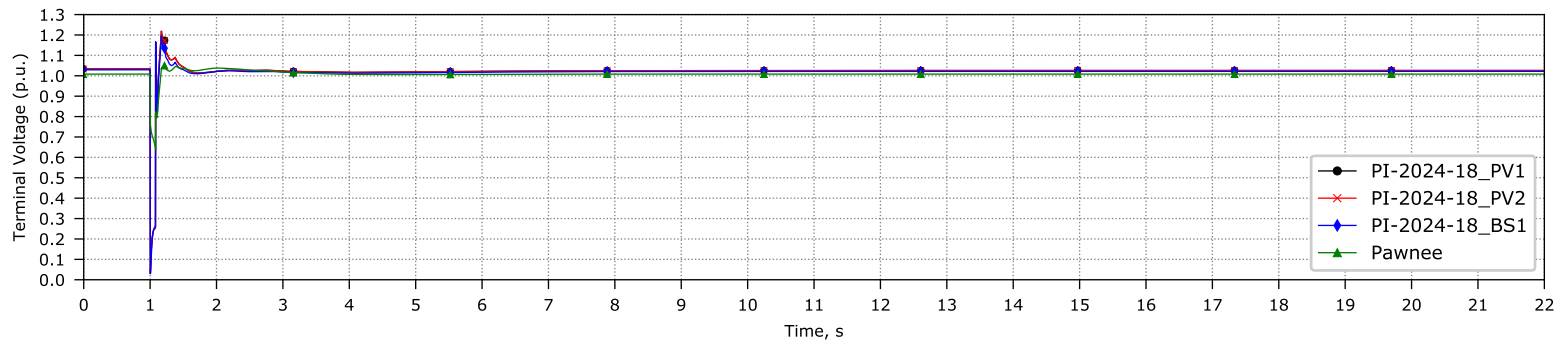

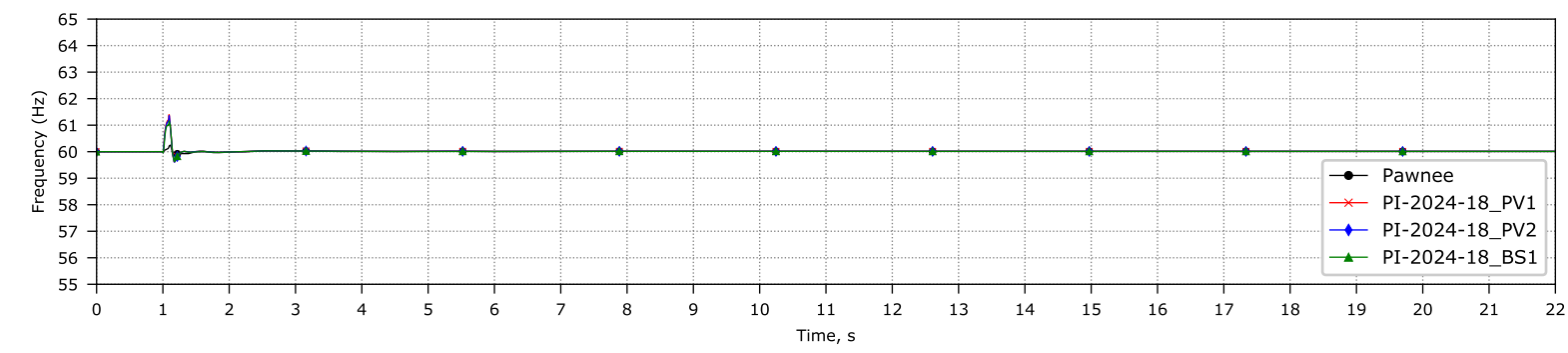

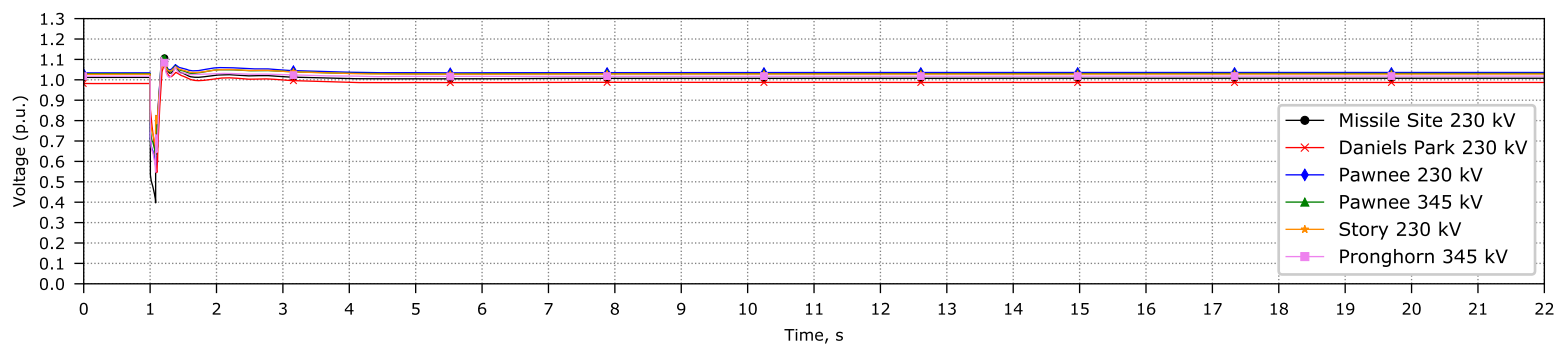

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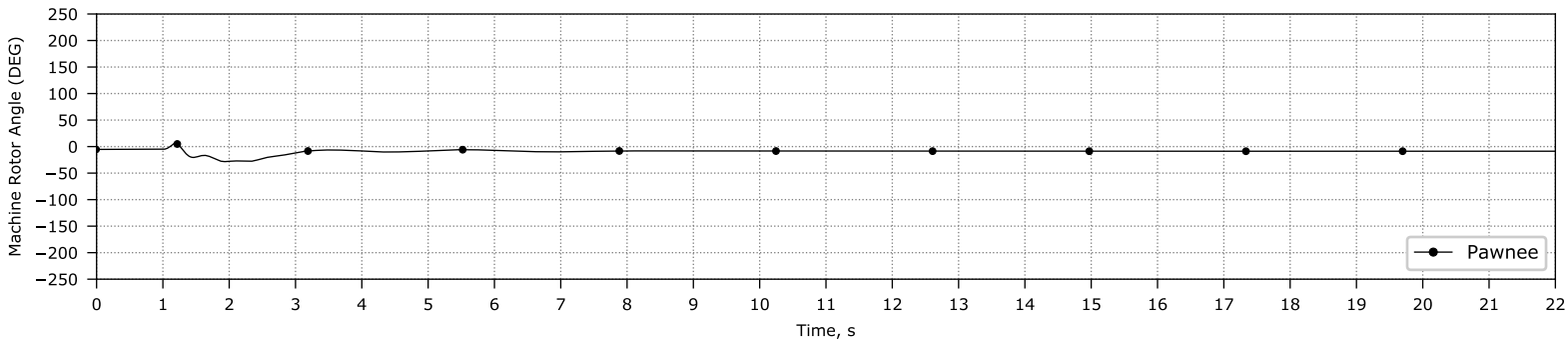
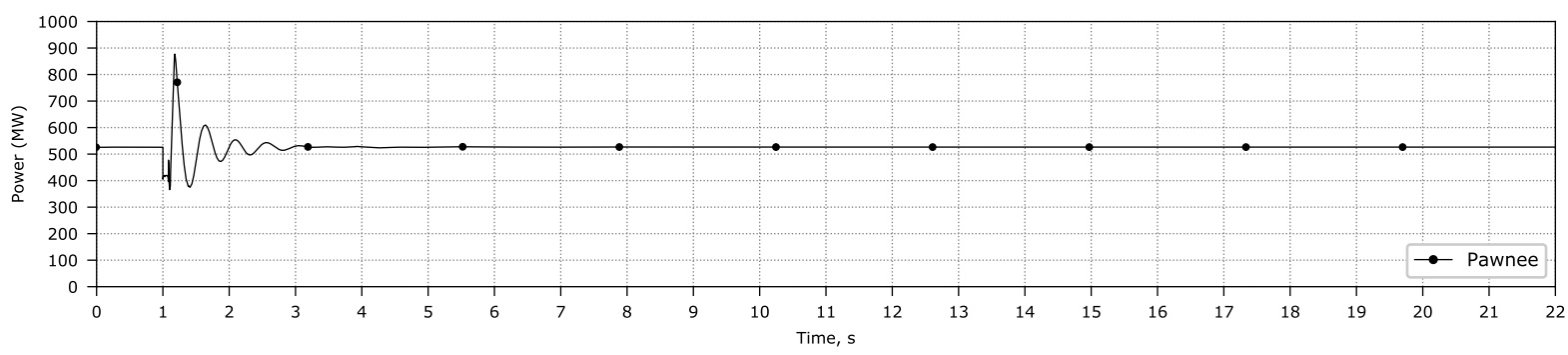
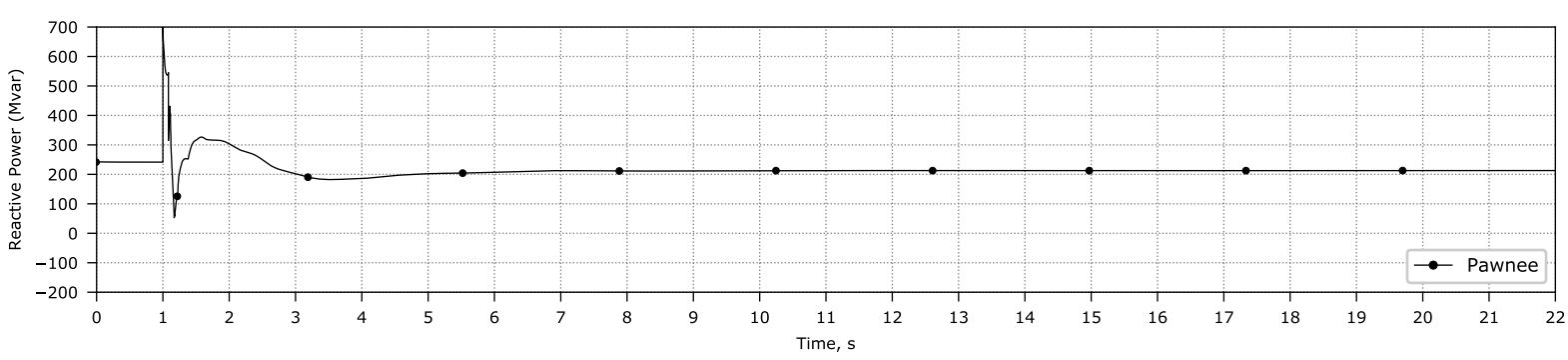
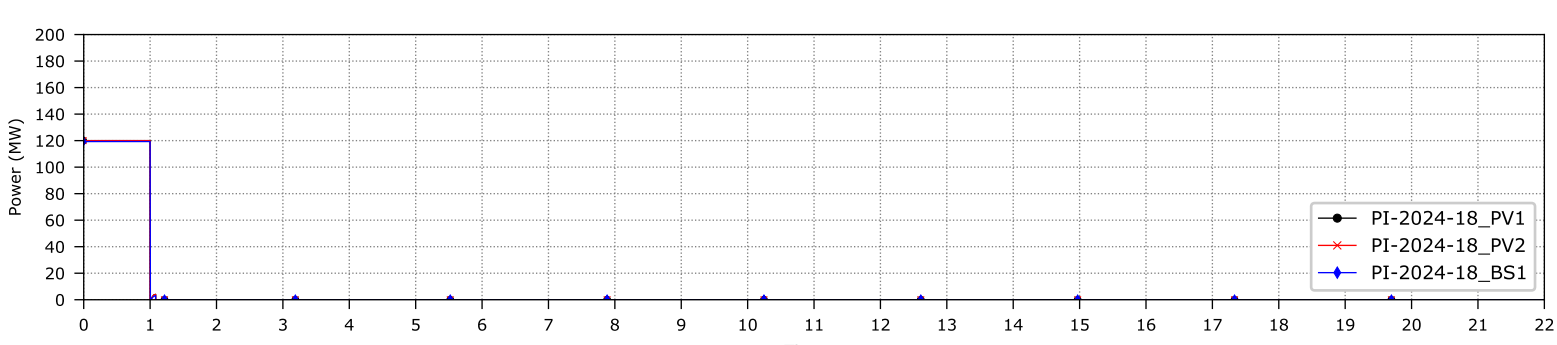
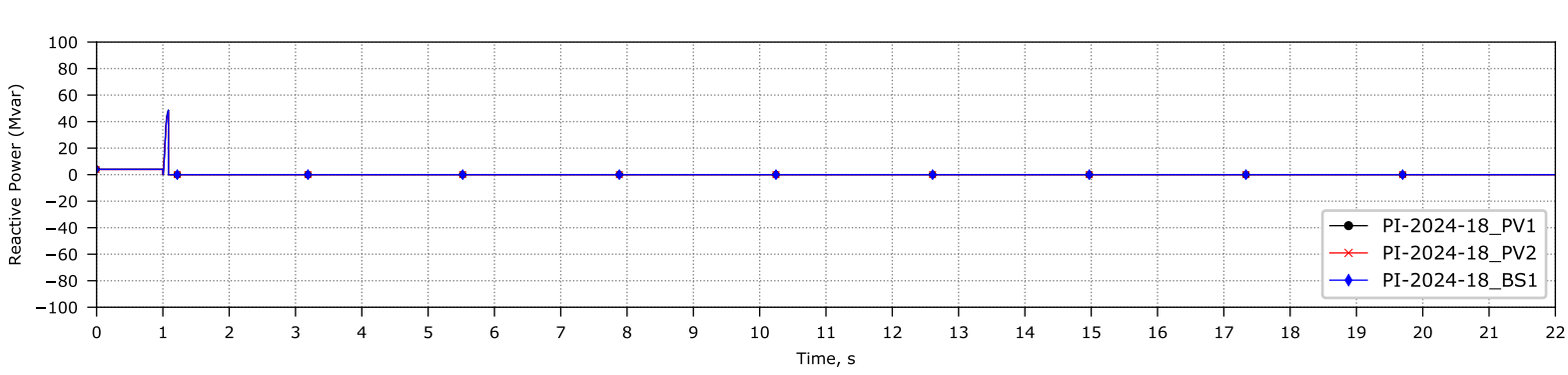
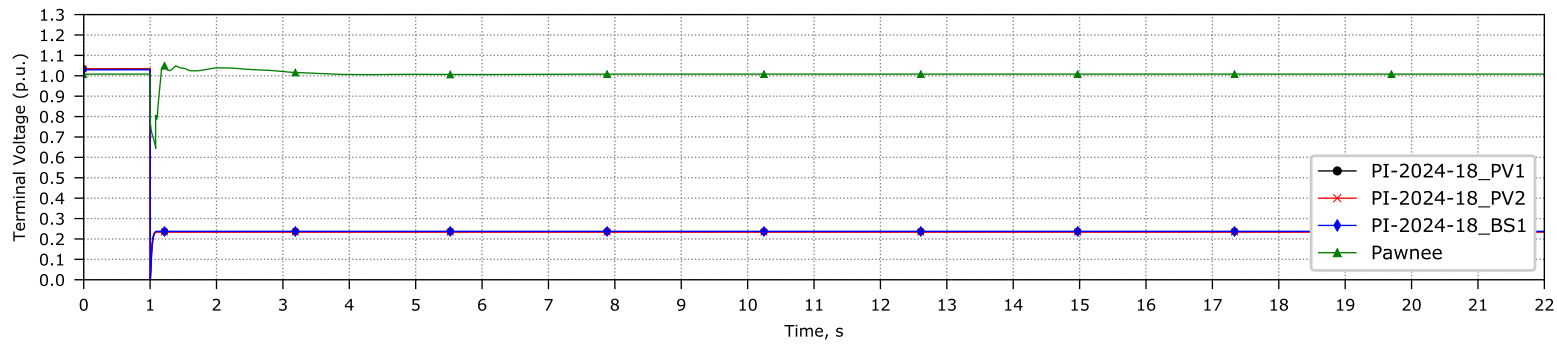


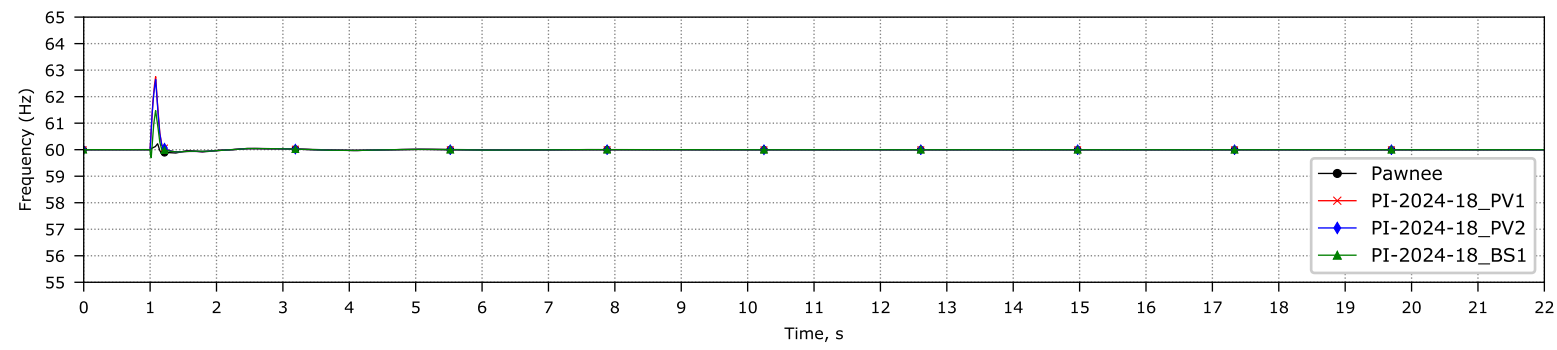


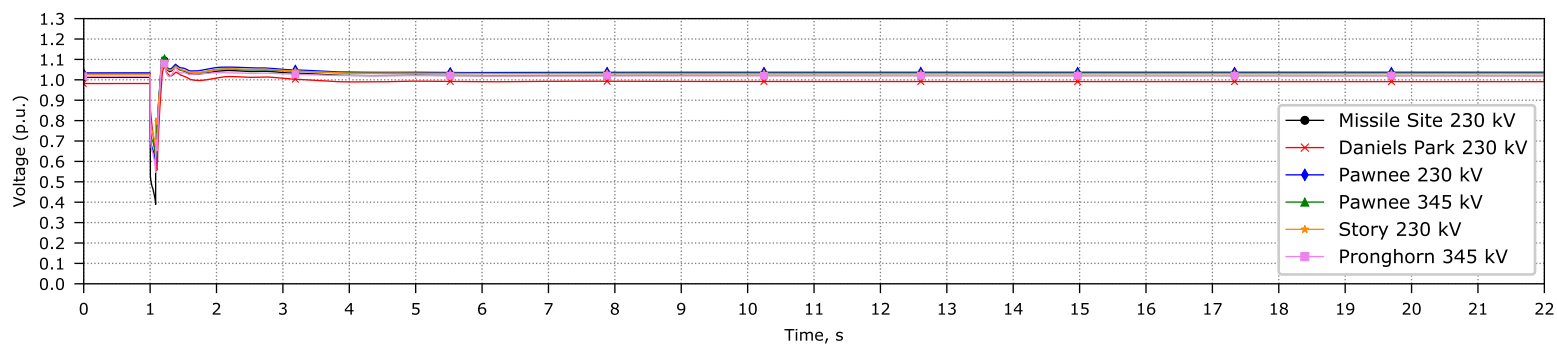




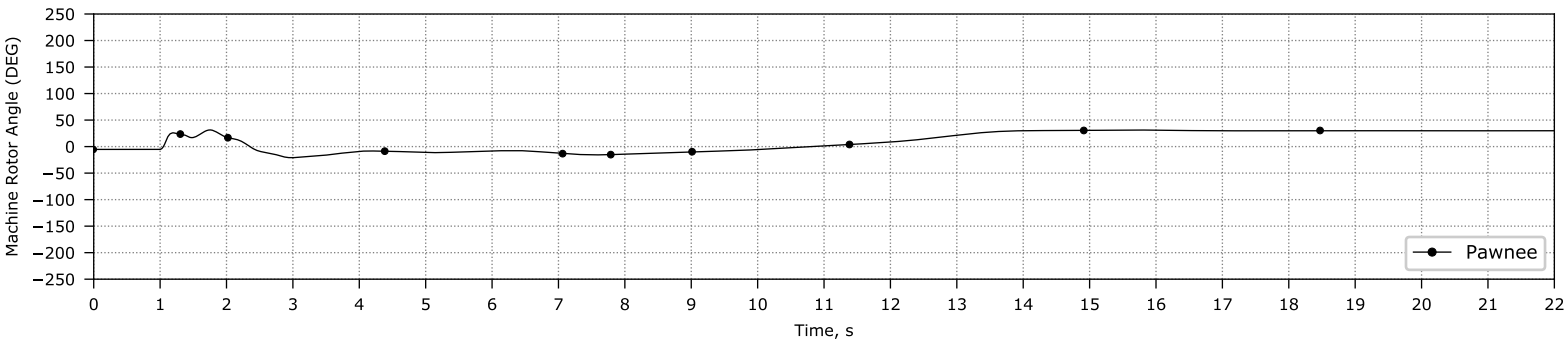


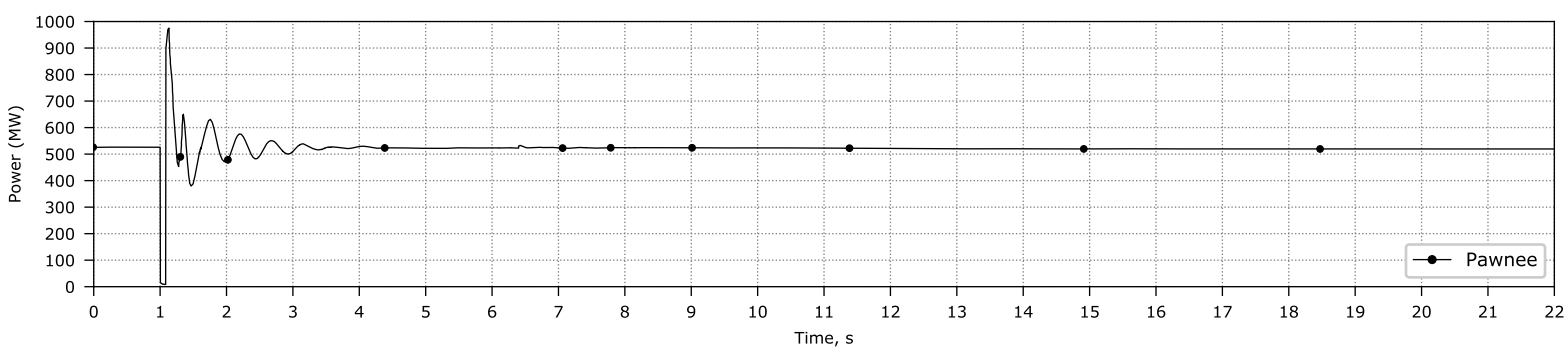


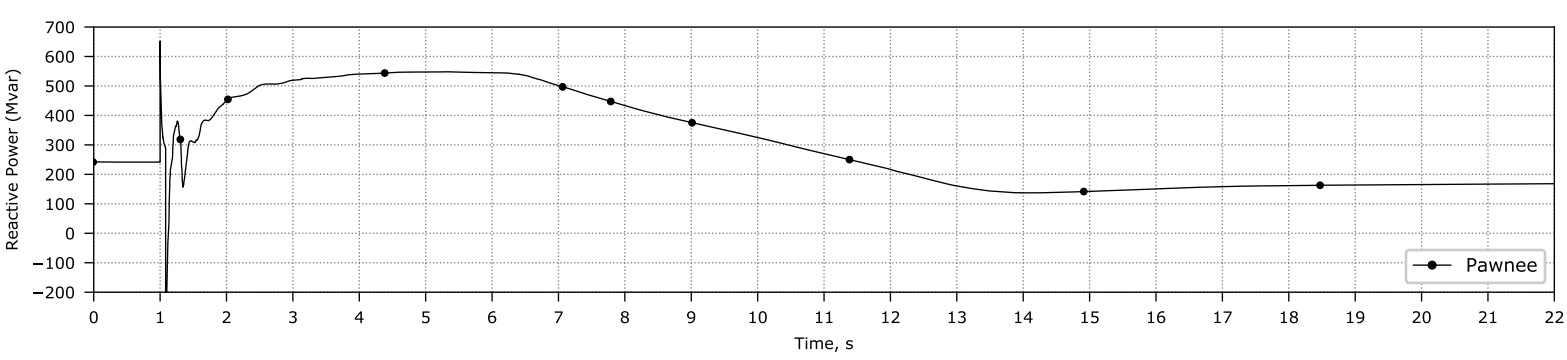


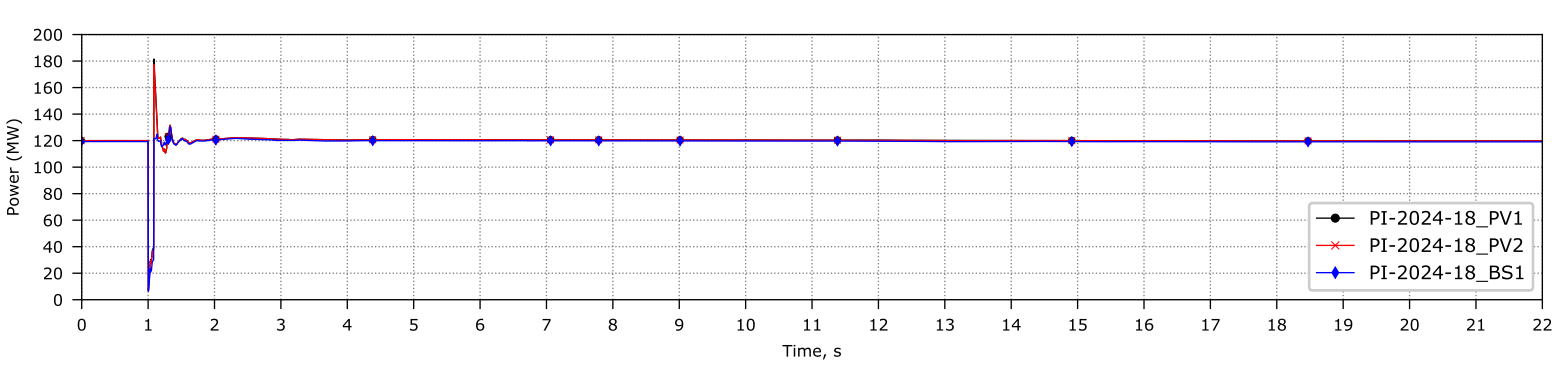


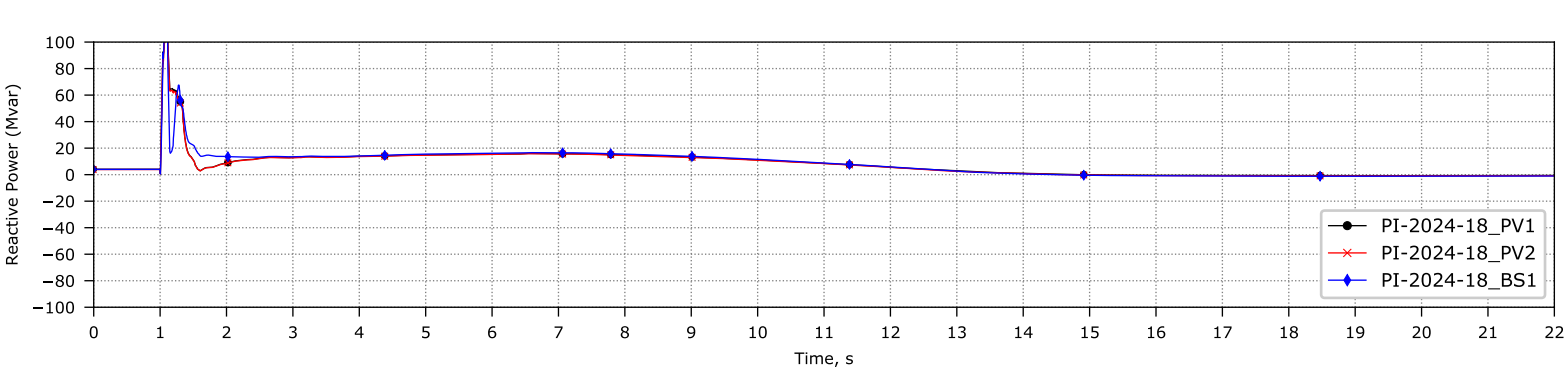
PI-2024-18_Study_East_Pawnee_Xfmr

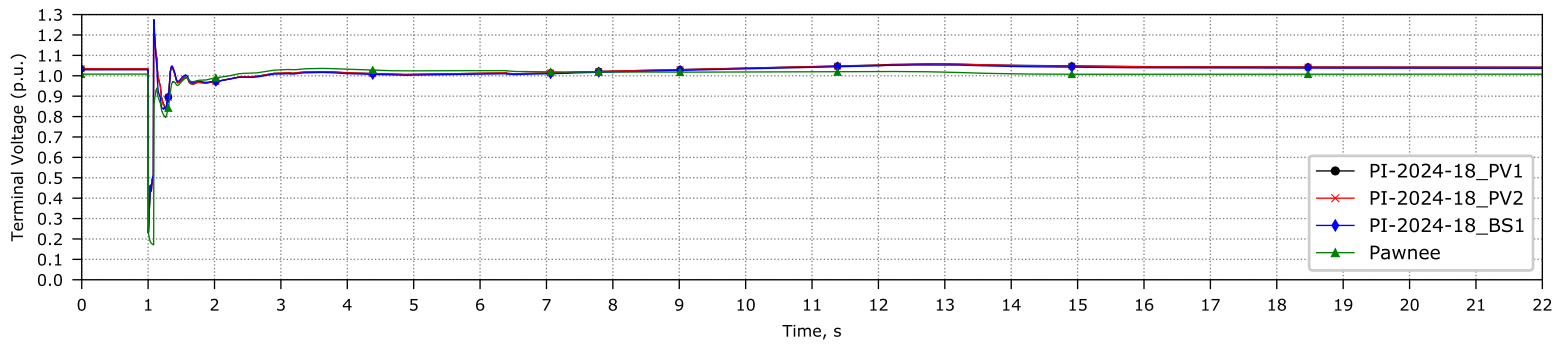


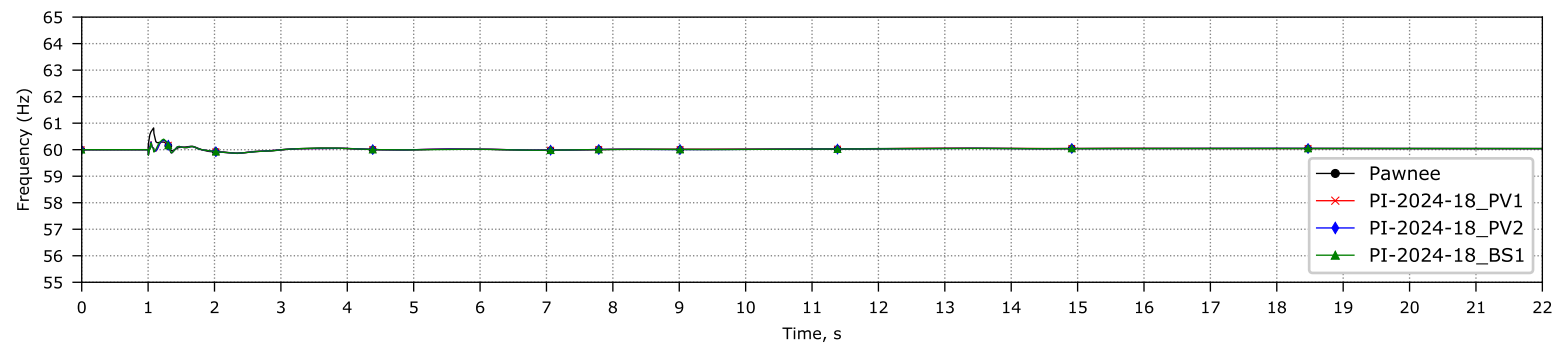


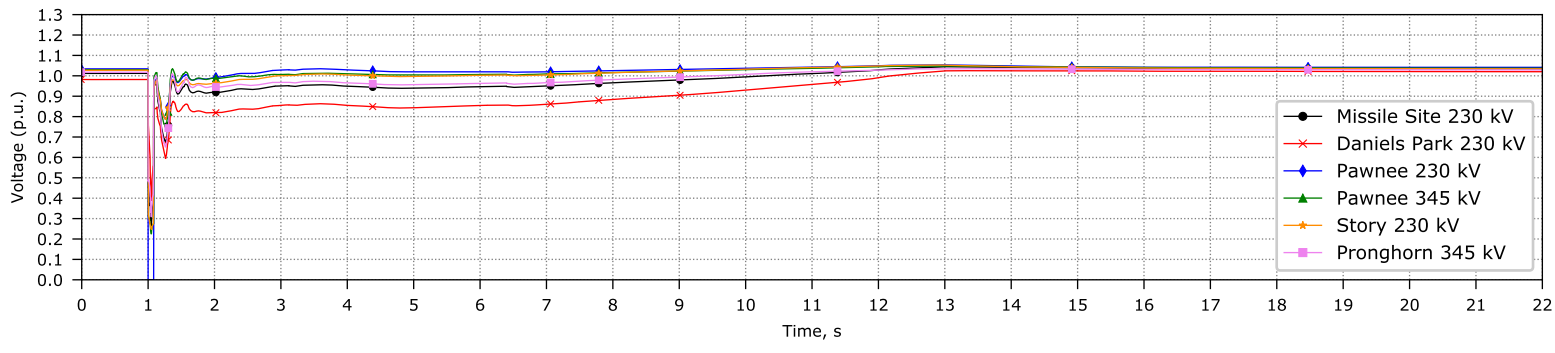




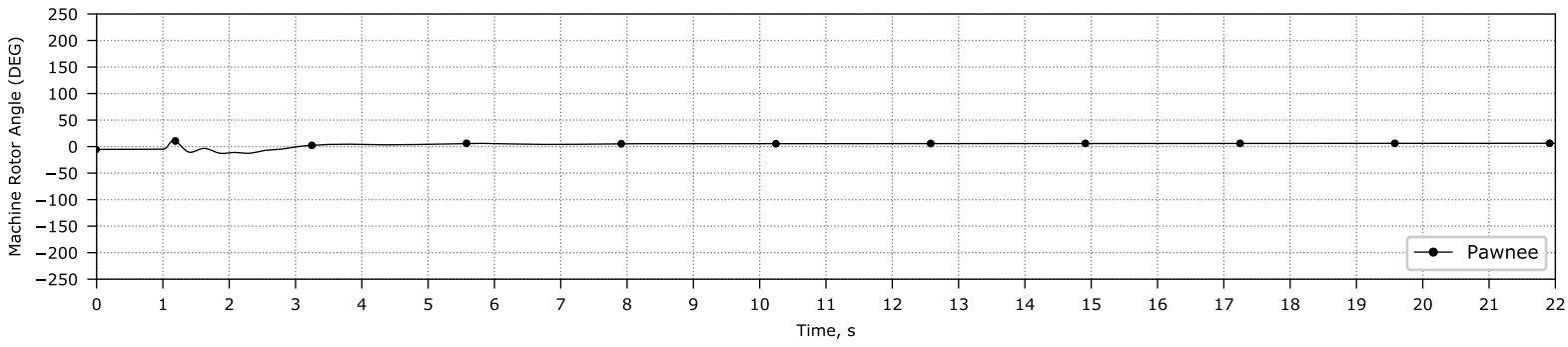


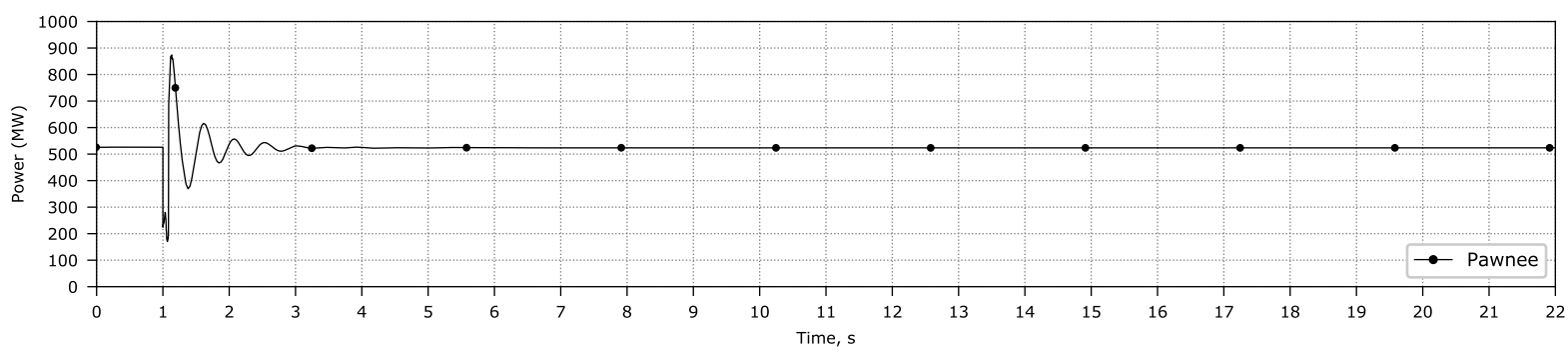


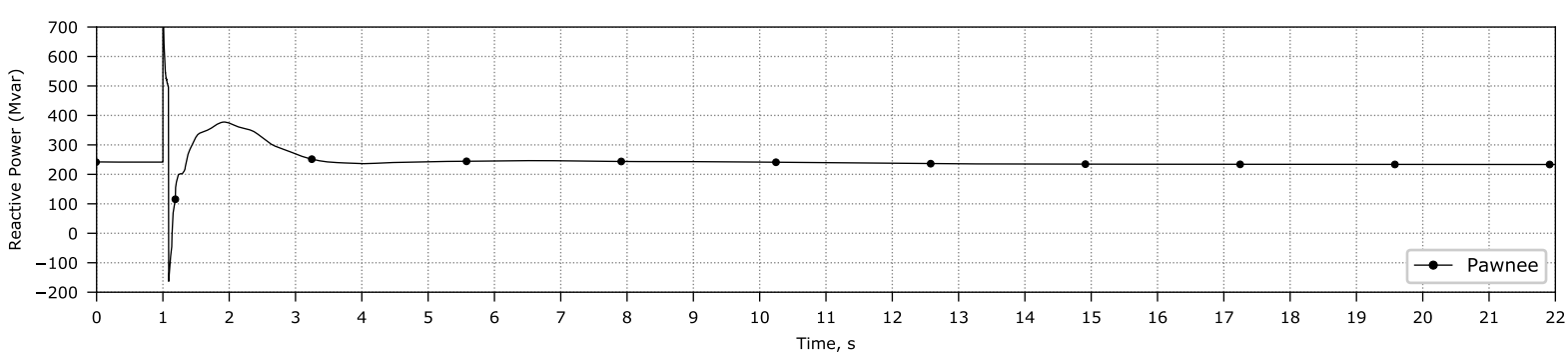


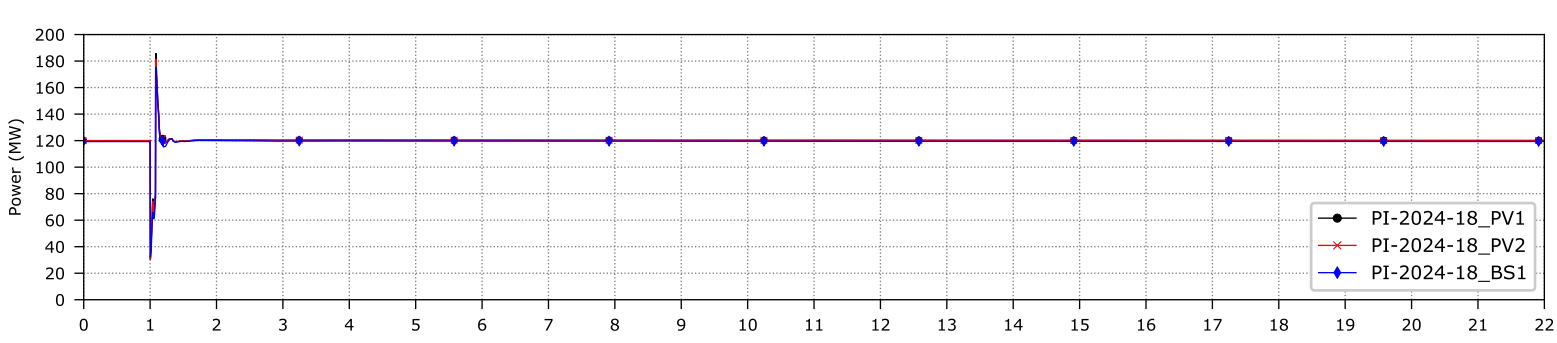


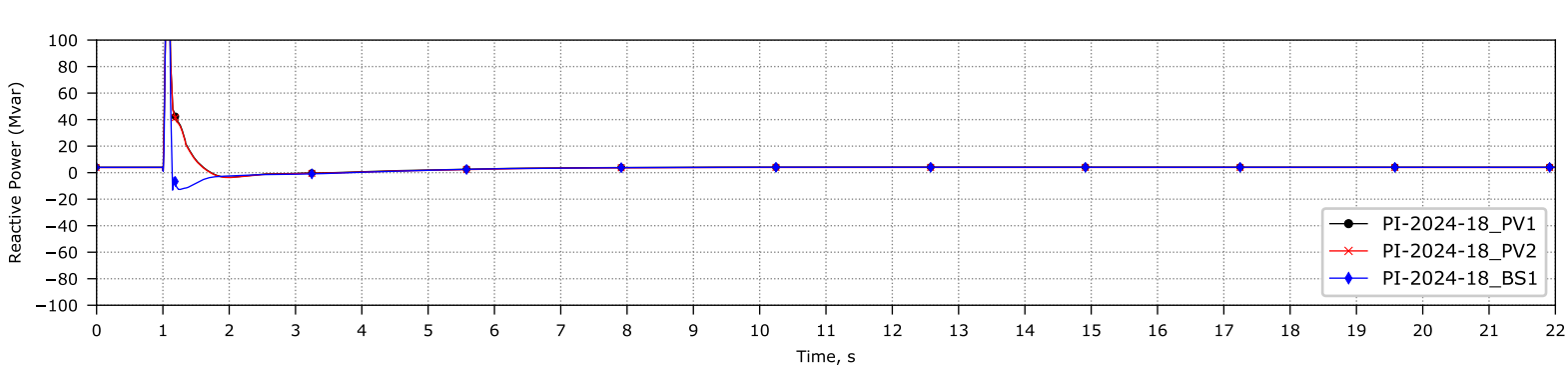
PI-2024-18_Study_East_Pawnee-FtLupton_230kV

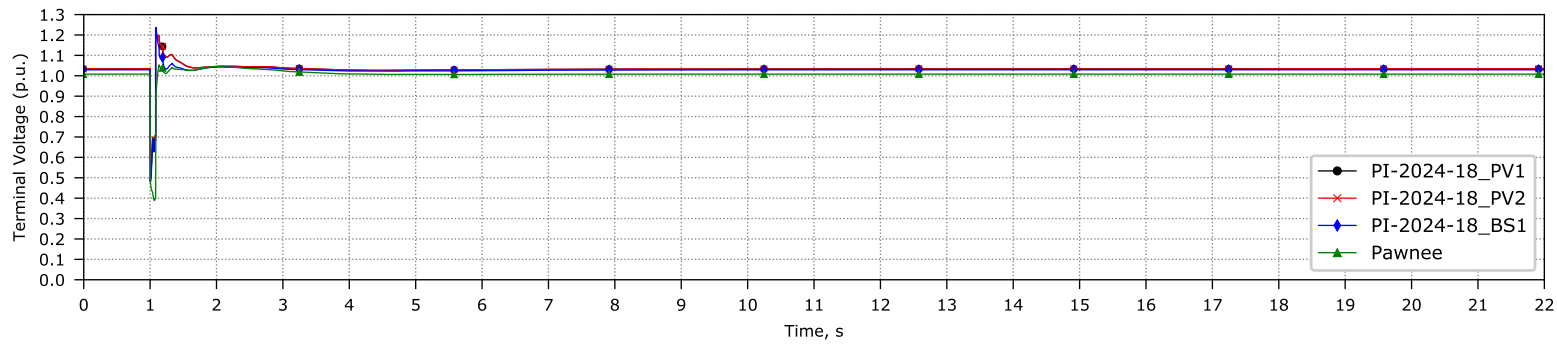


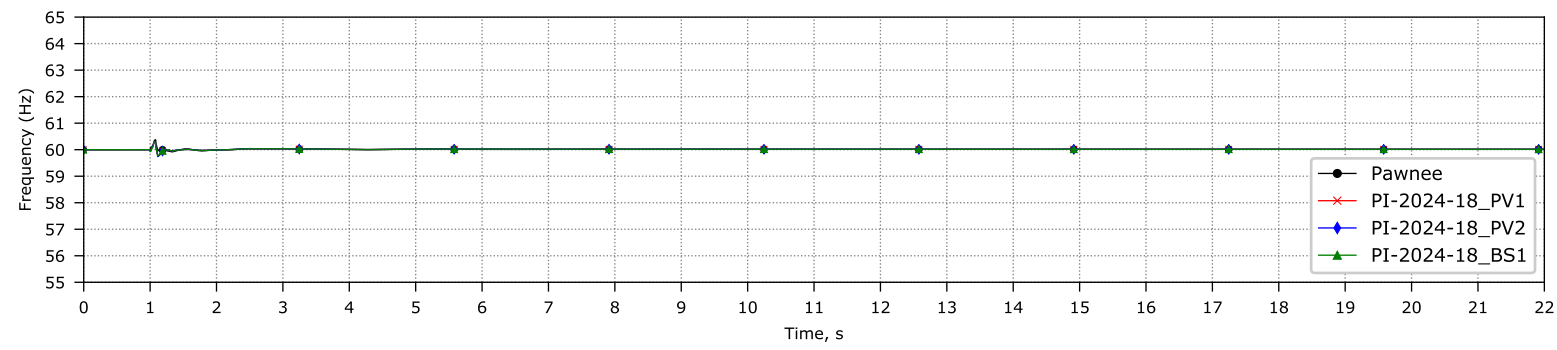


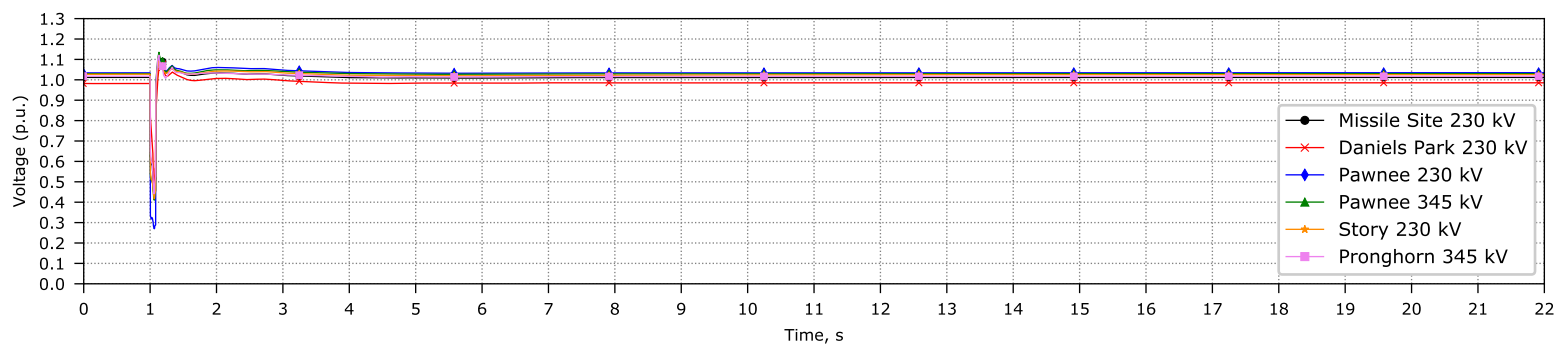




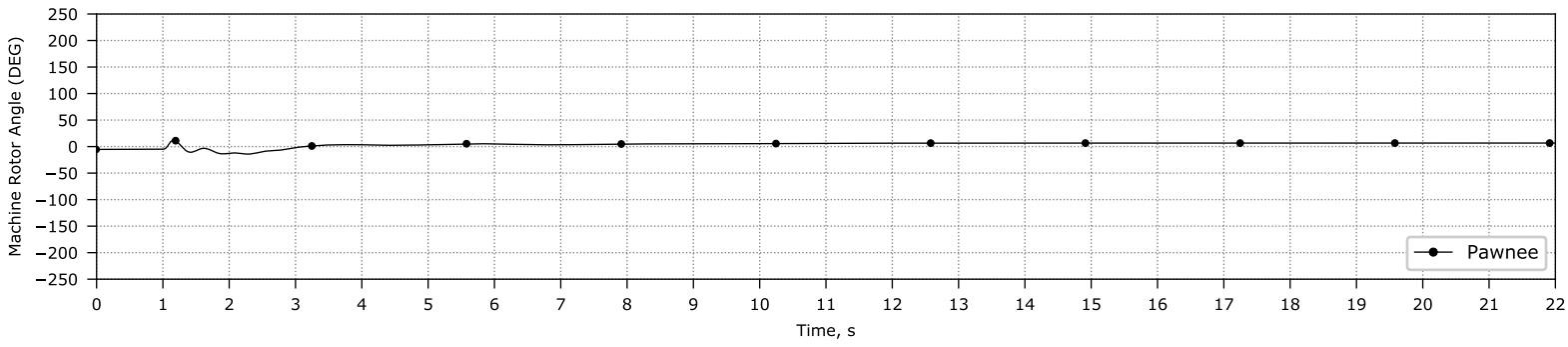


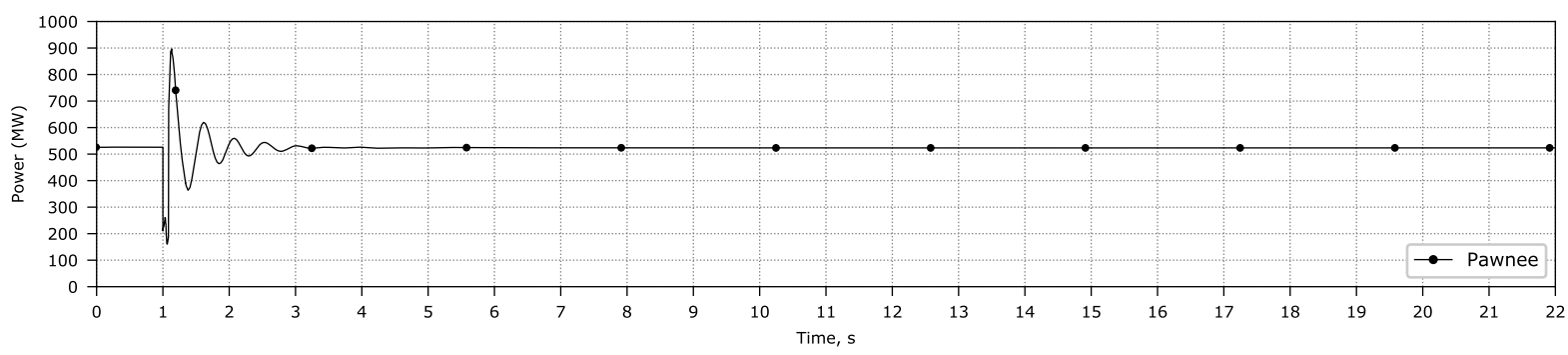


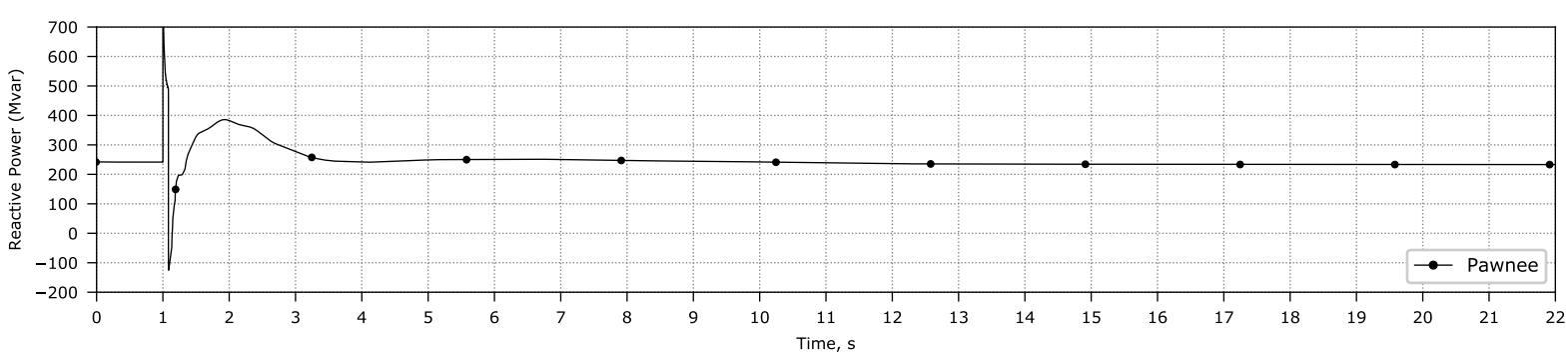


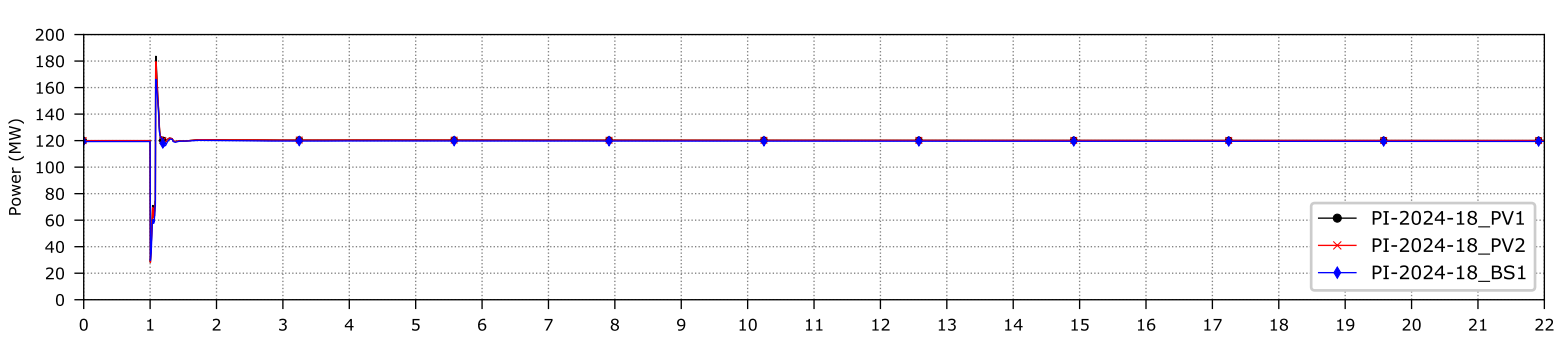


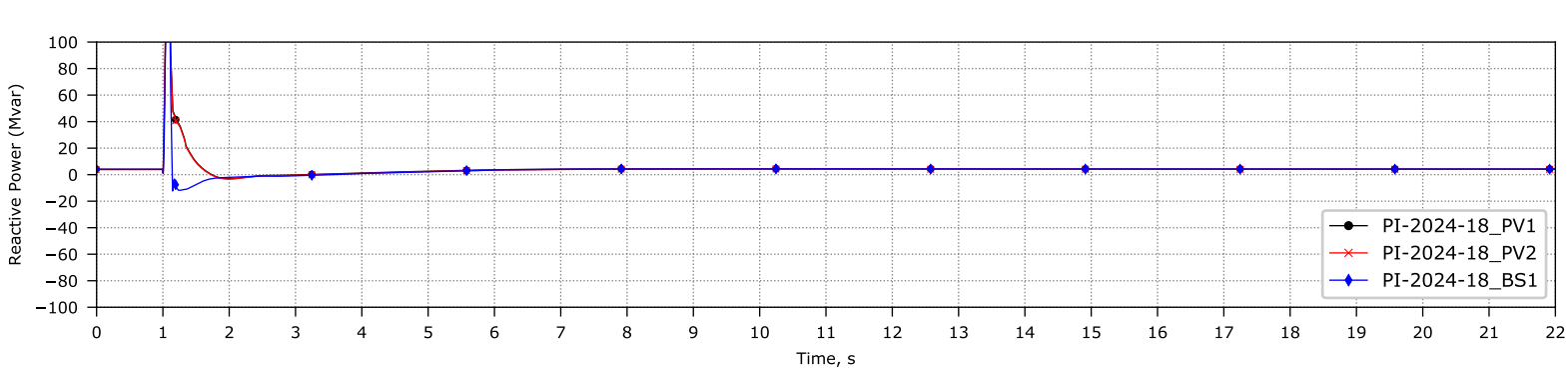
PI-2024-18_Study_East_Pawnee-BrickCtr_230kV

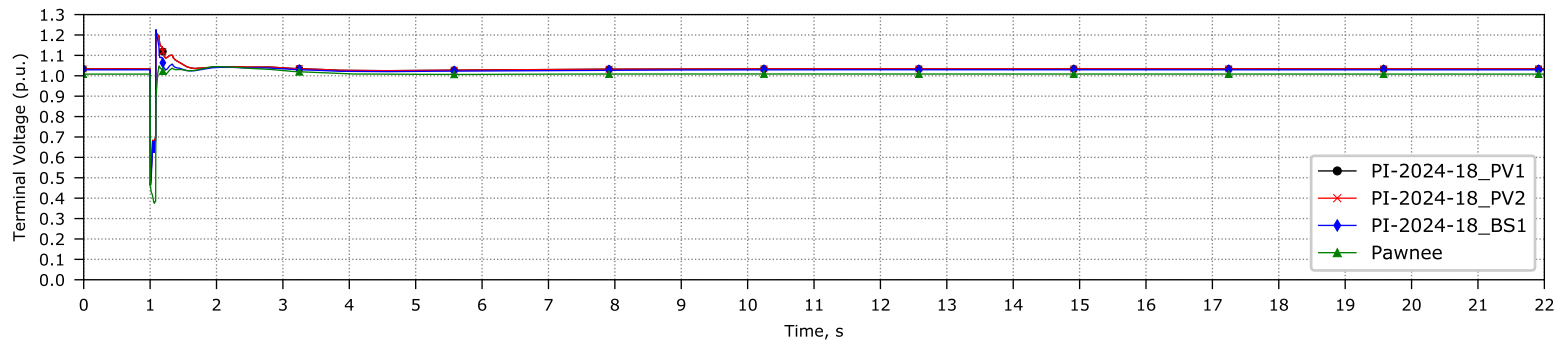


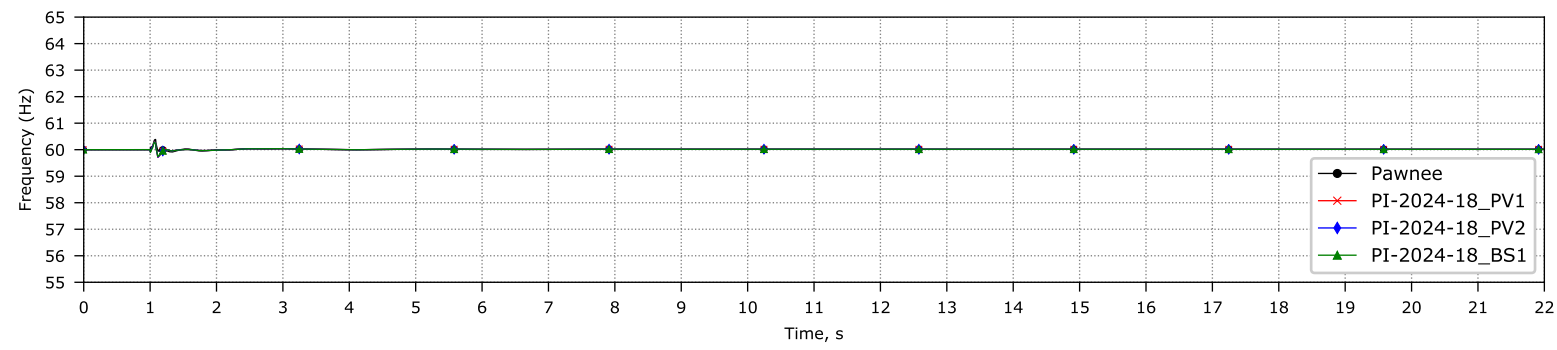


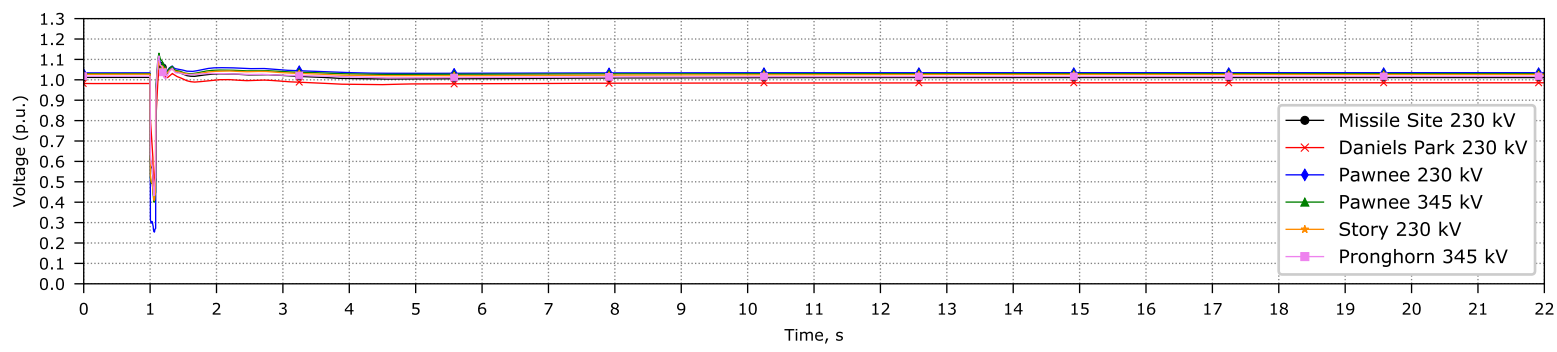




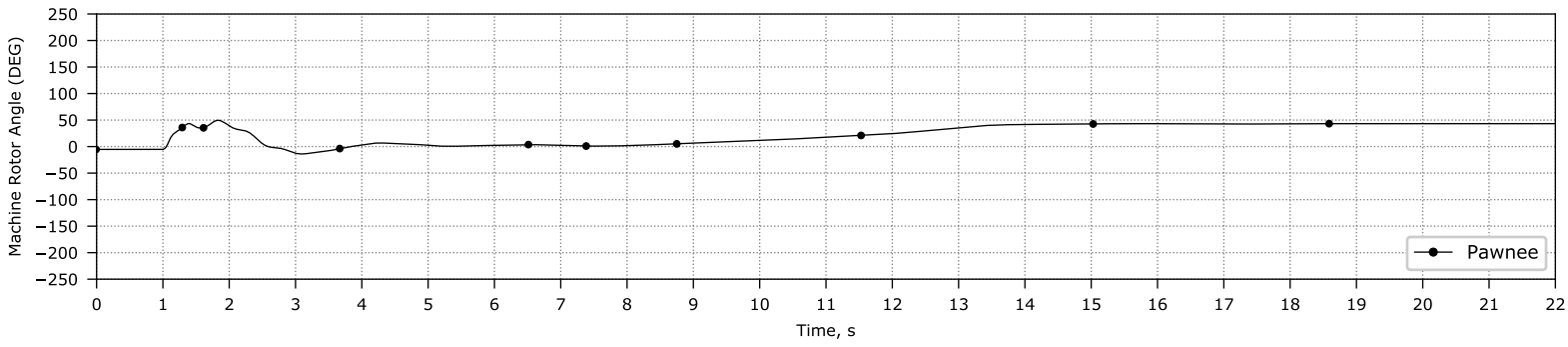


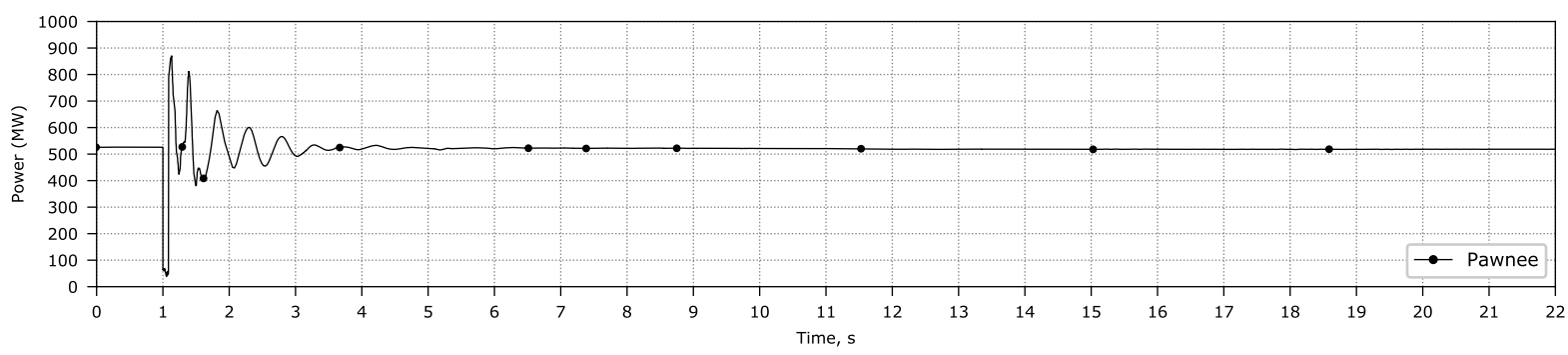


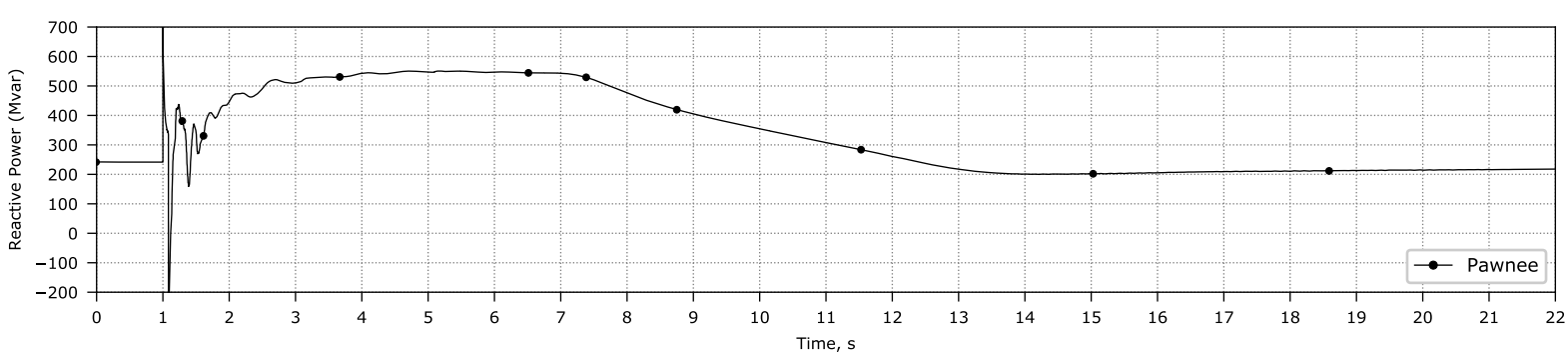


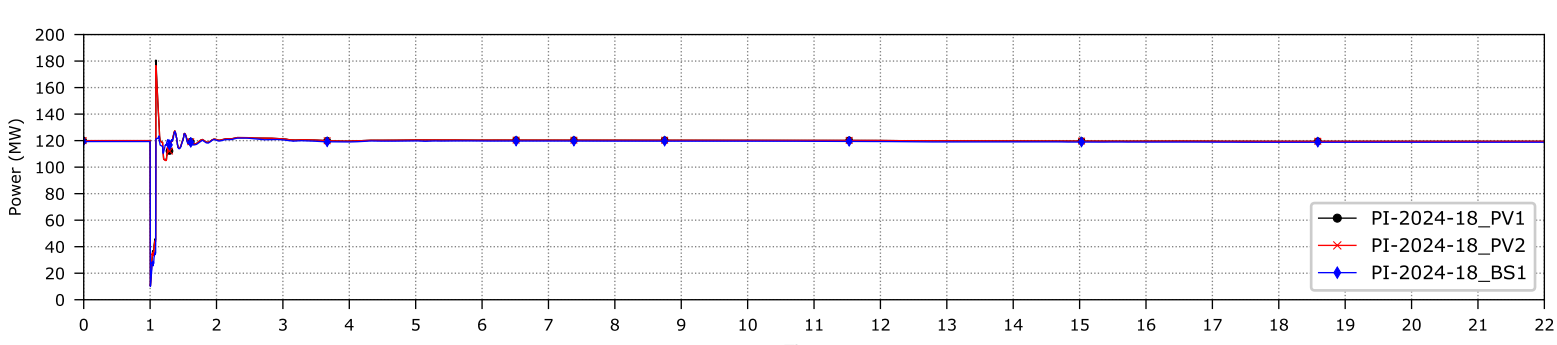


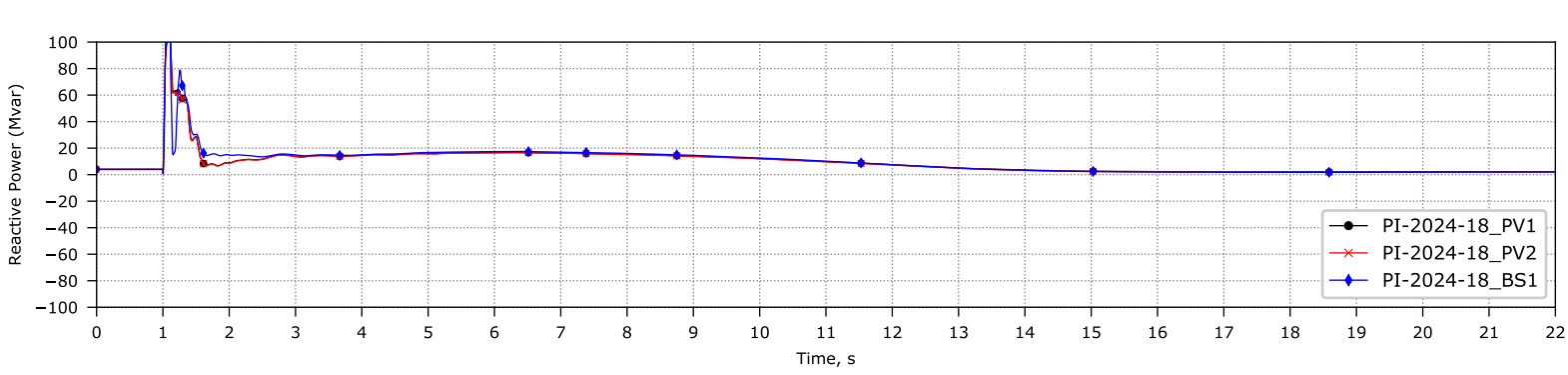
PI-2024-18_Study_East_Pawnee-Story_230kV

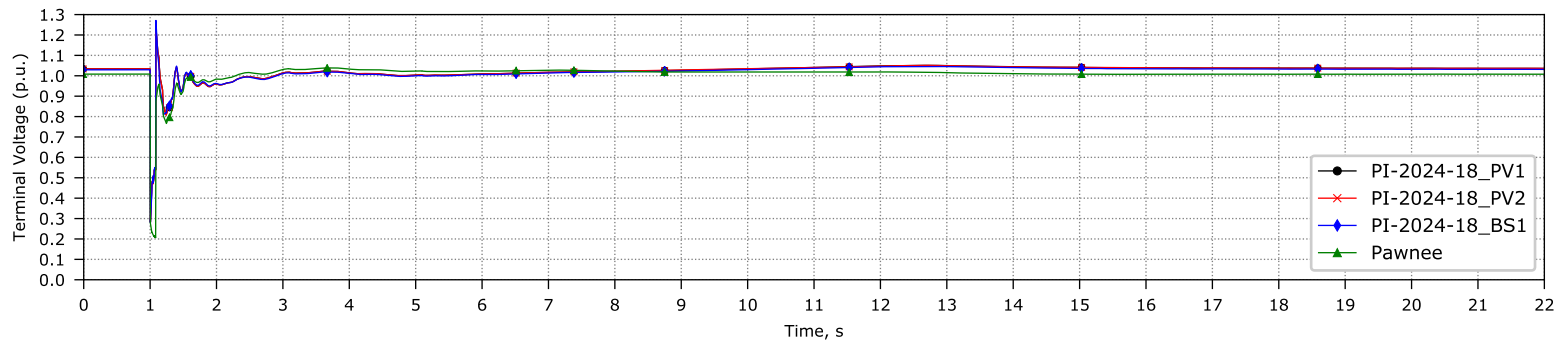


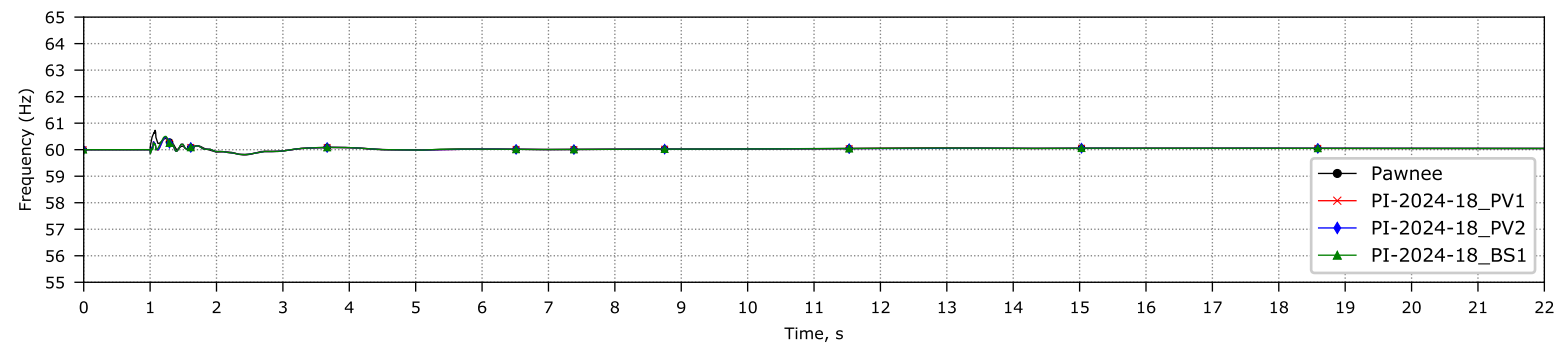


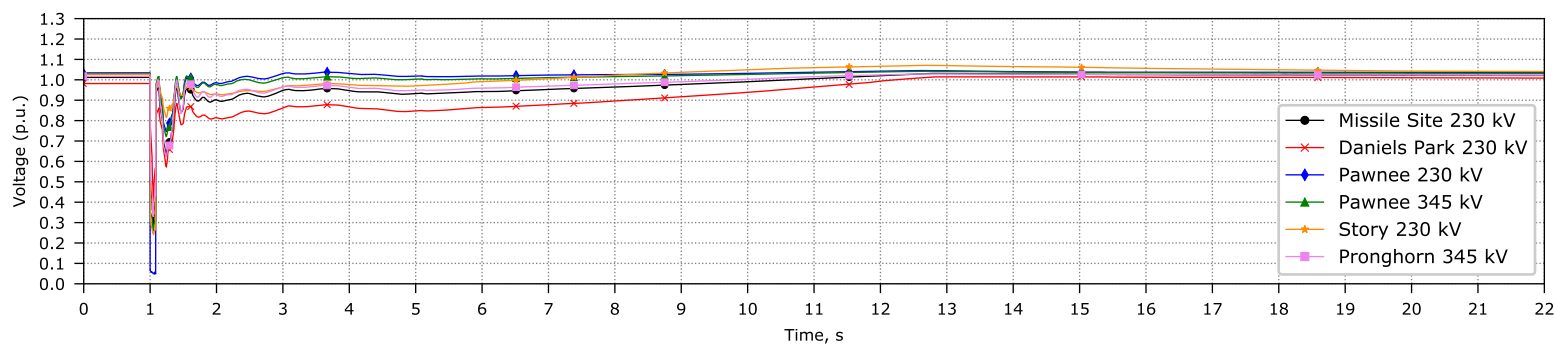




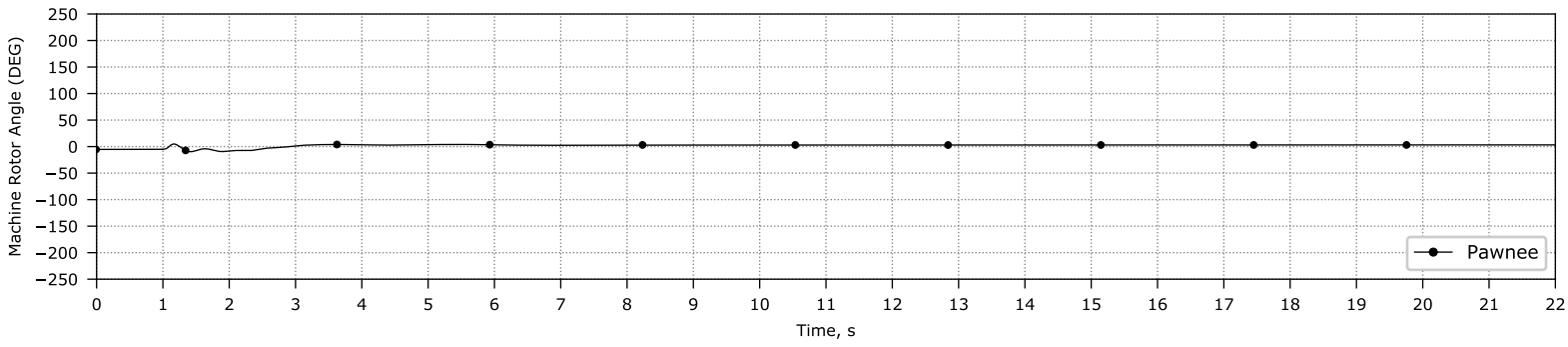


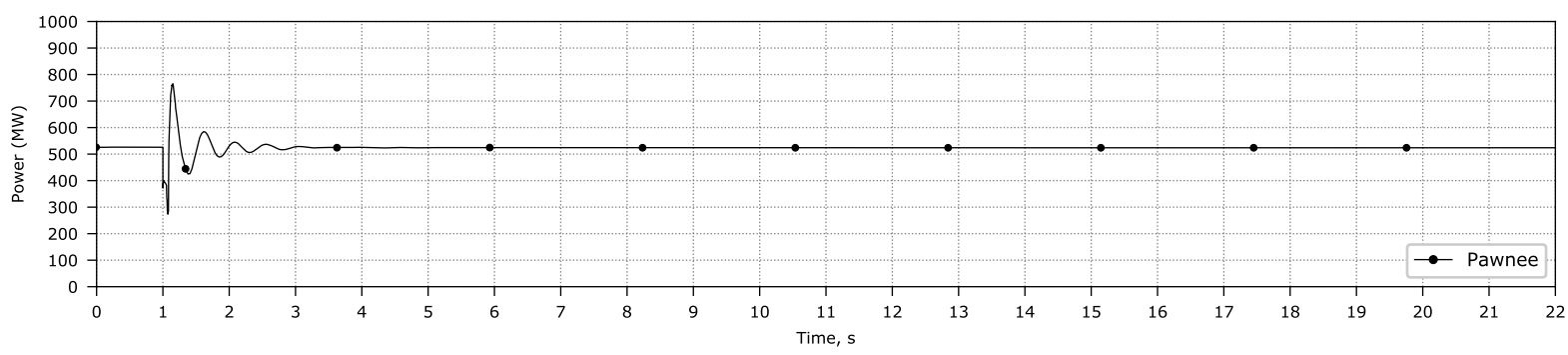


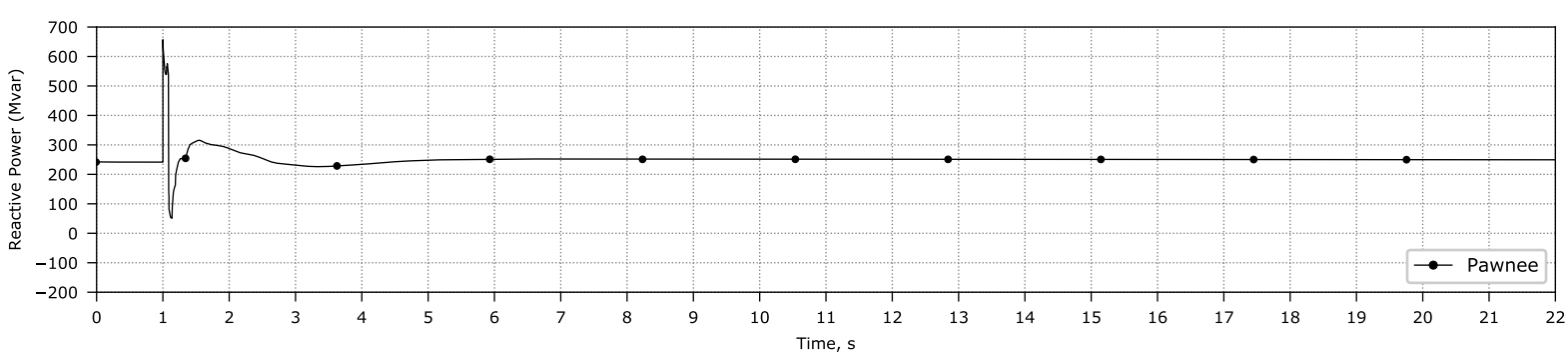


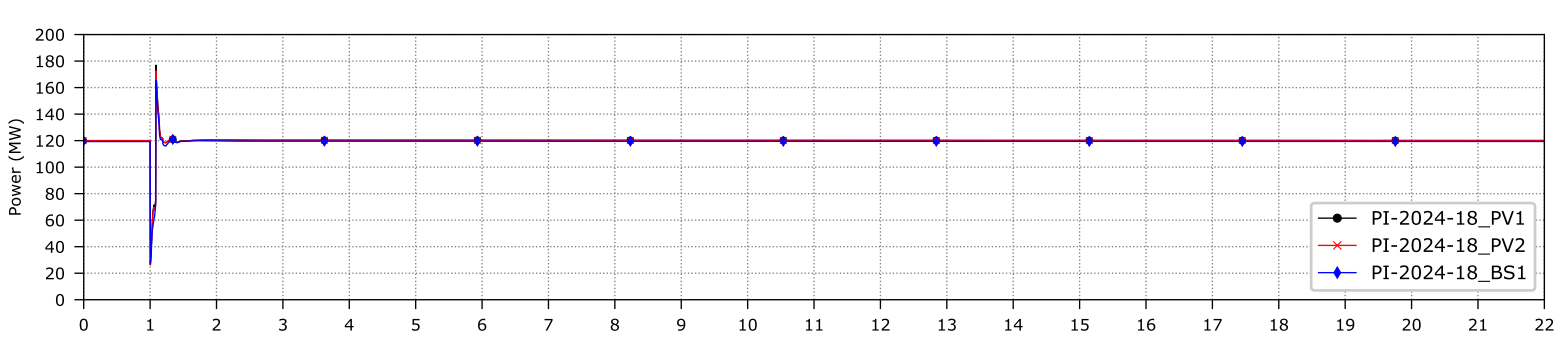


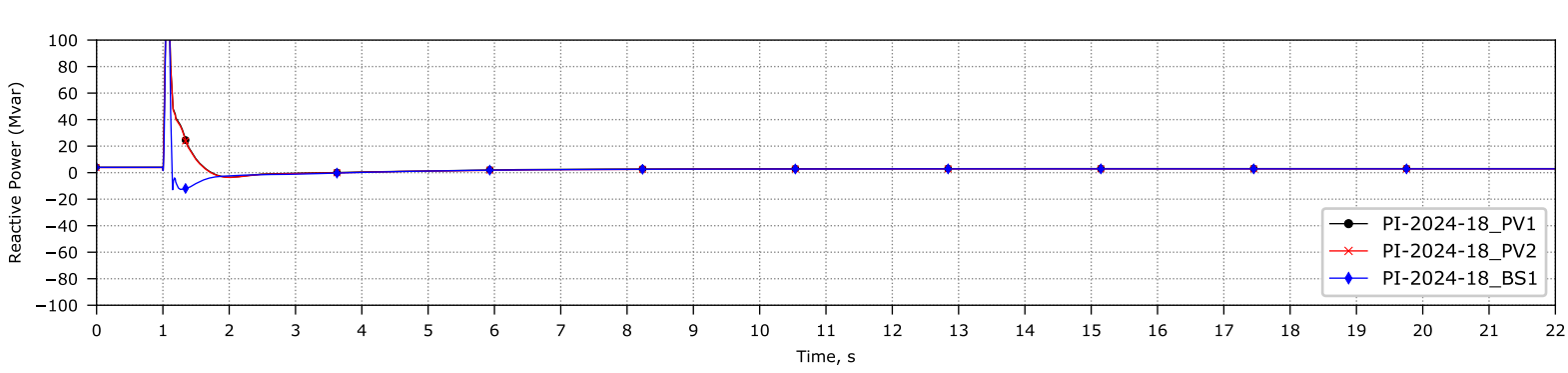
PI-2024-18_Study_East_MissSite-Daniels_230kV

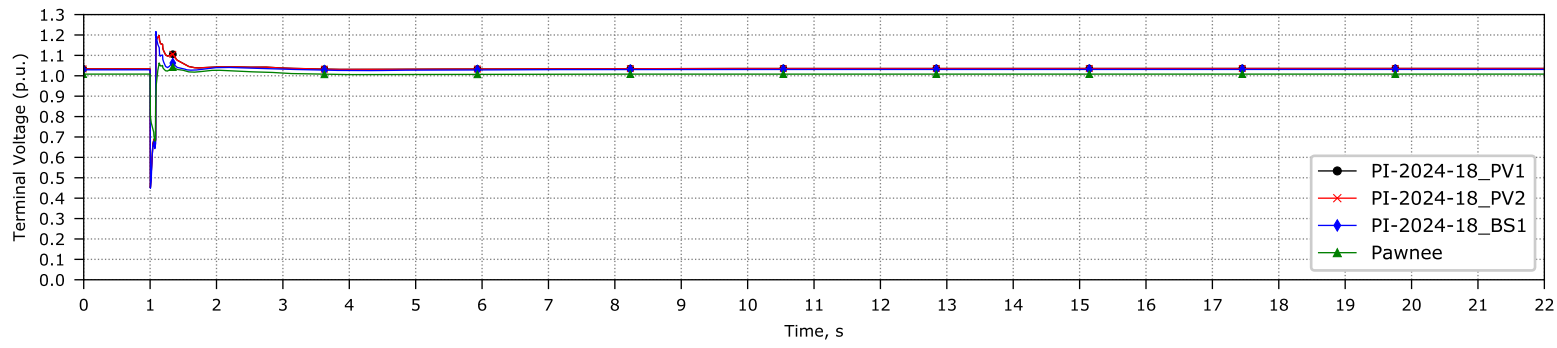


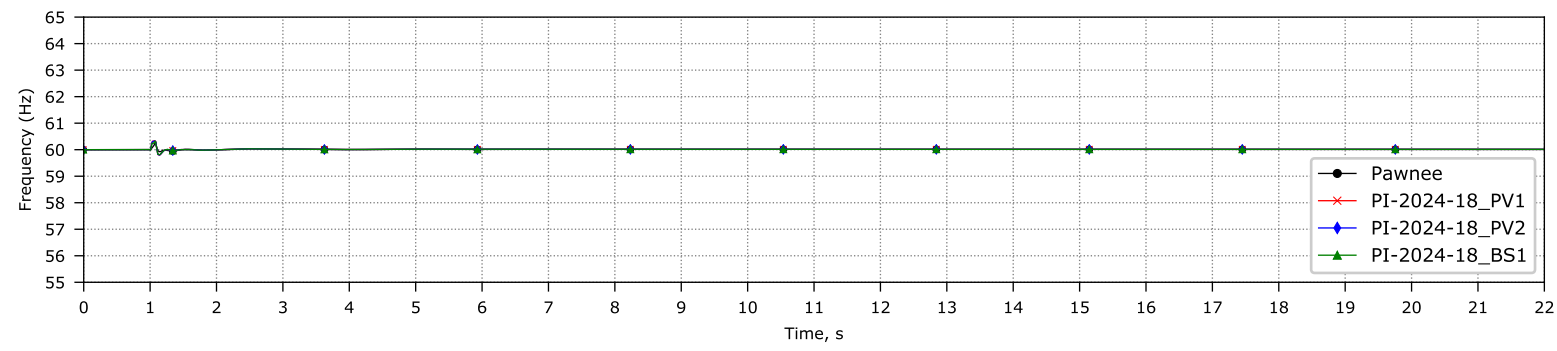


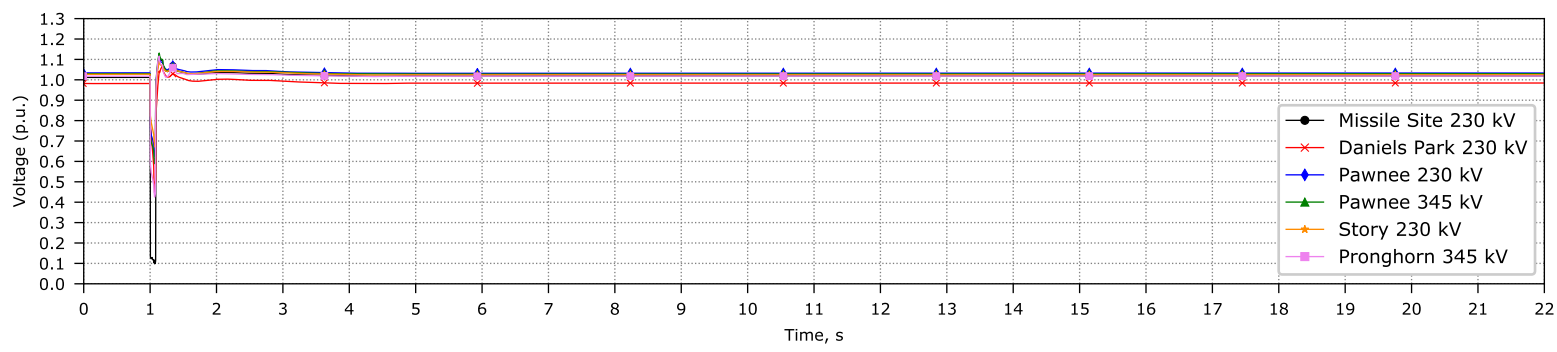




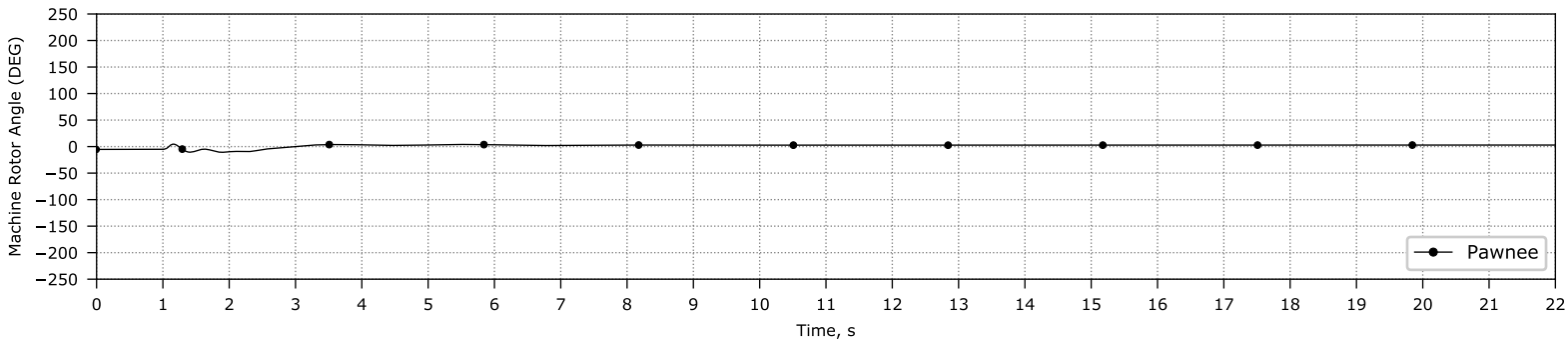


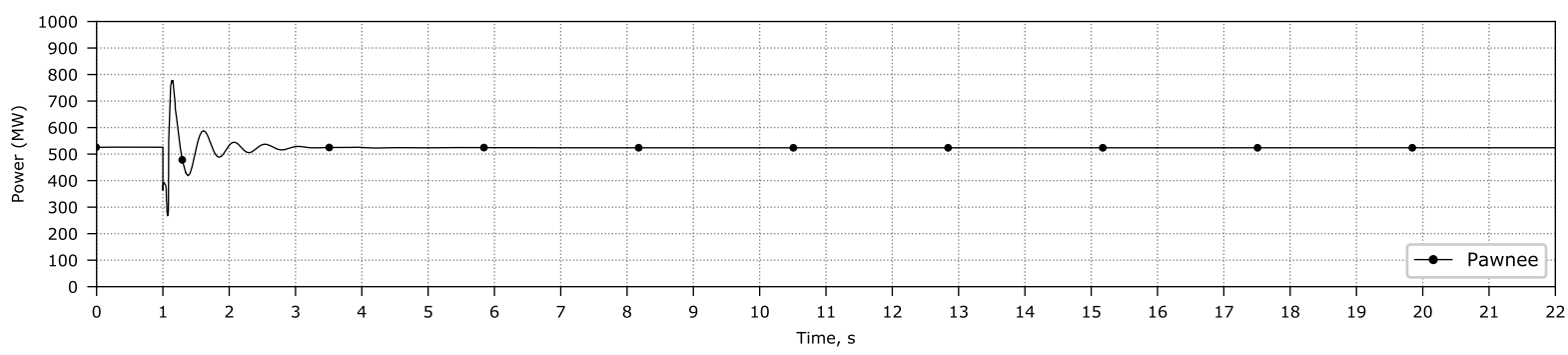


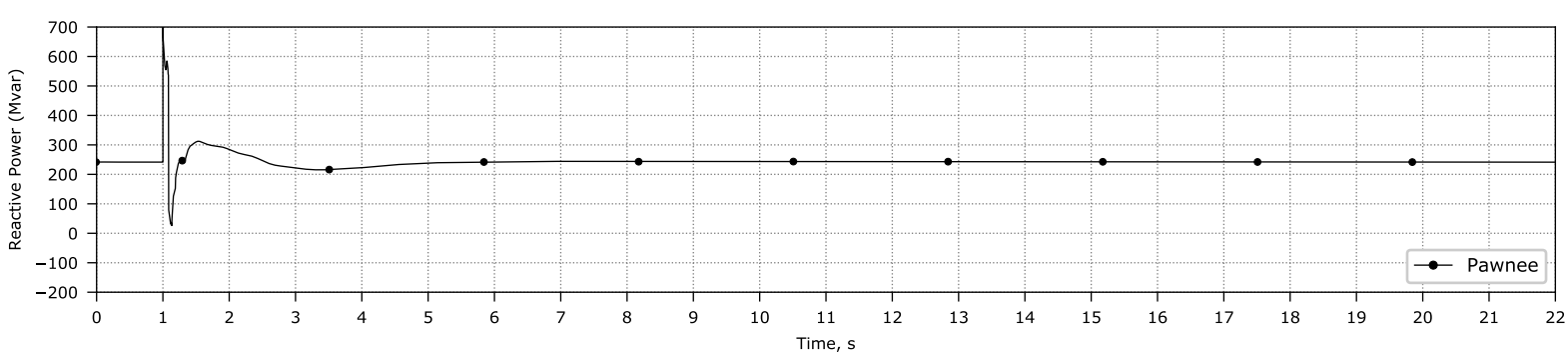


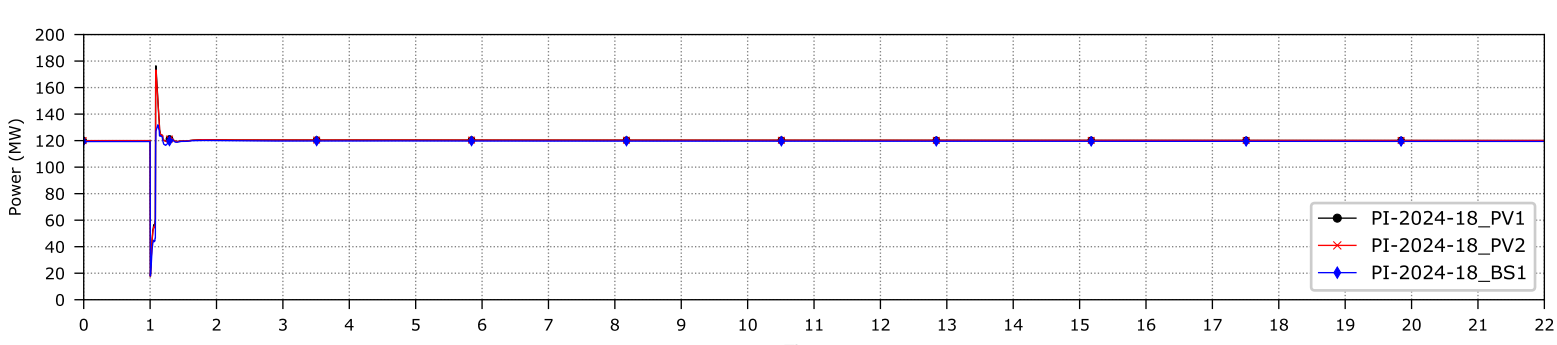


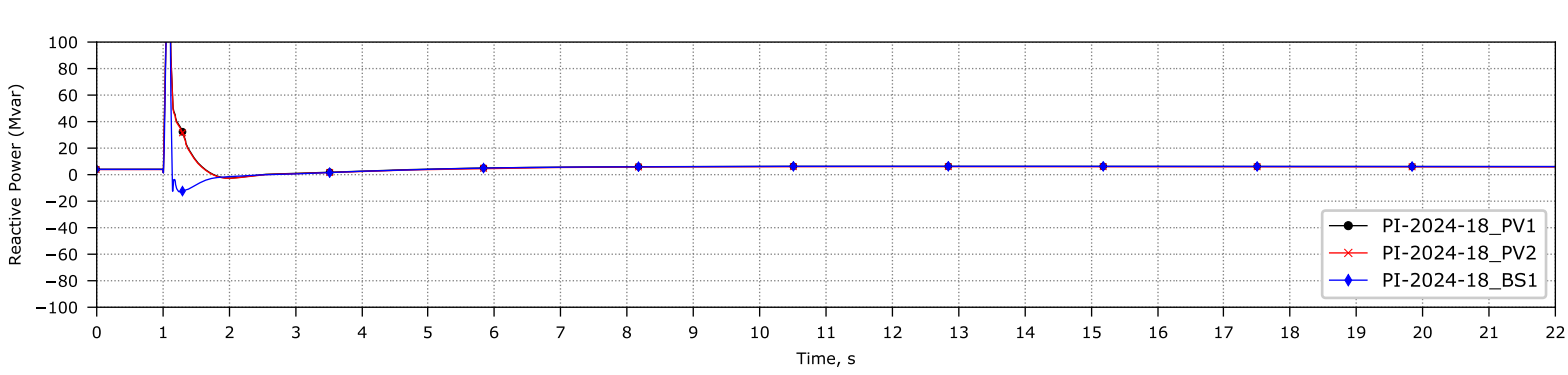
PI-2024-18_Study_East_MissSite_Xfmr

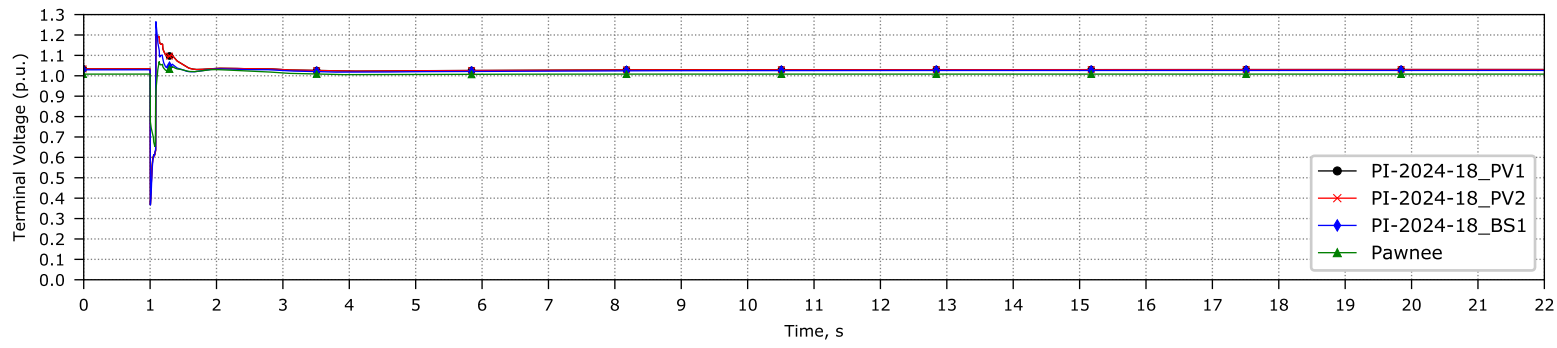


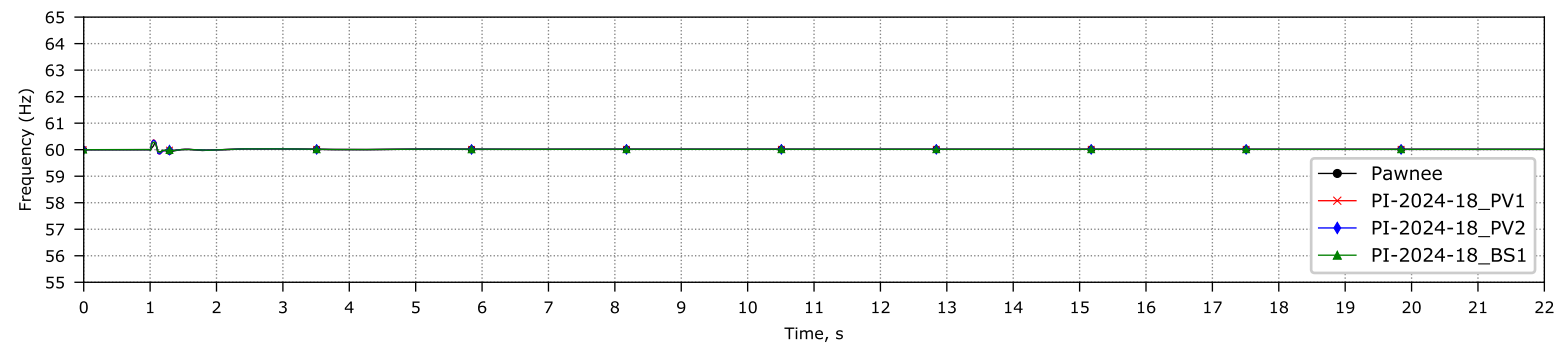


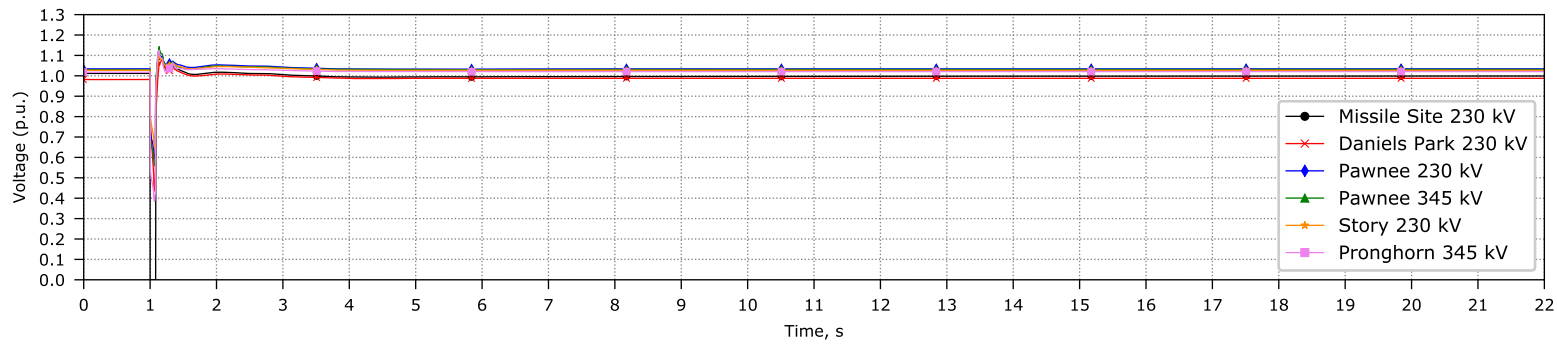




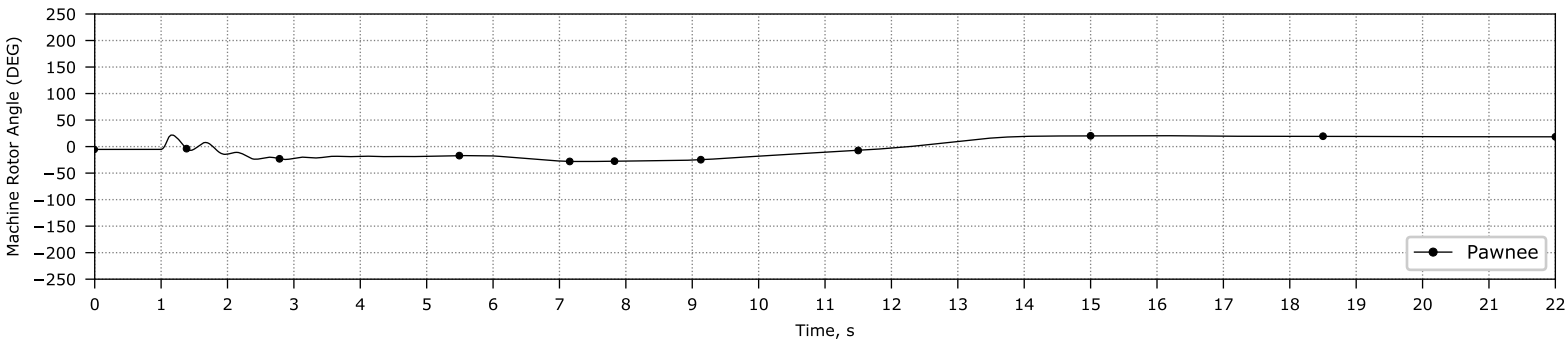


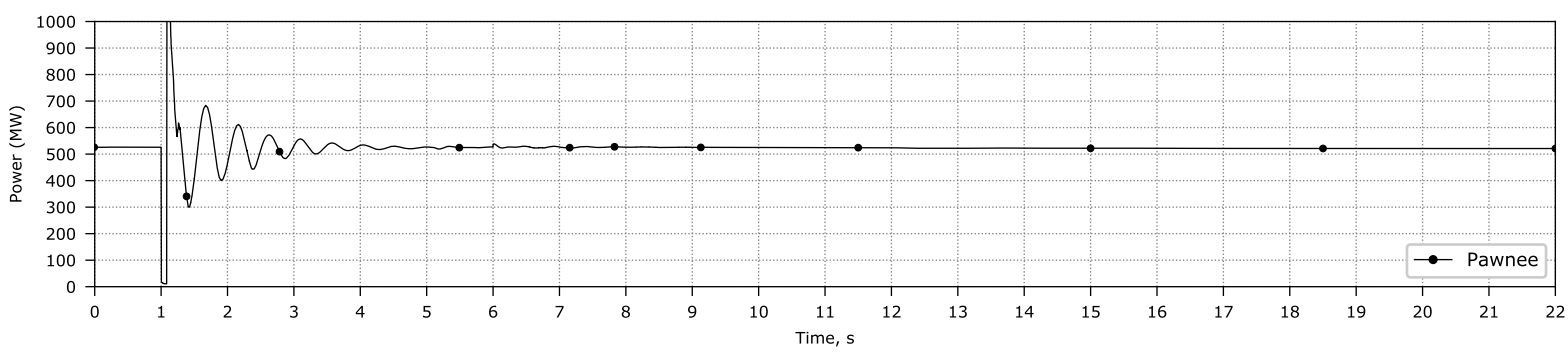


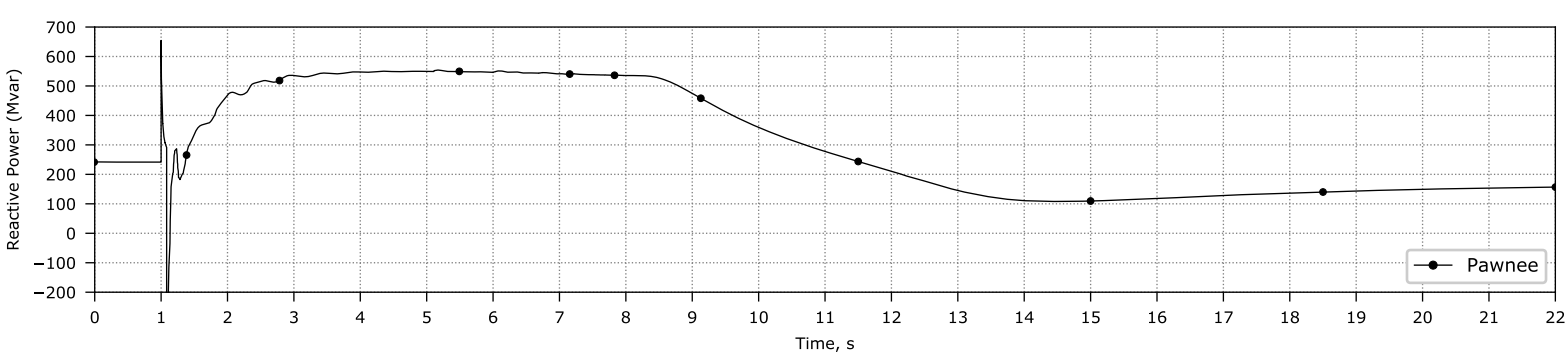


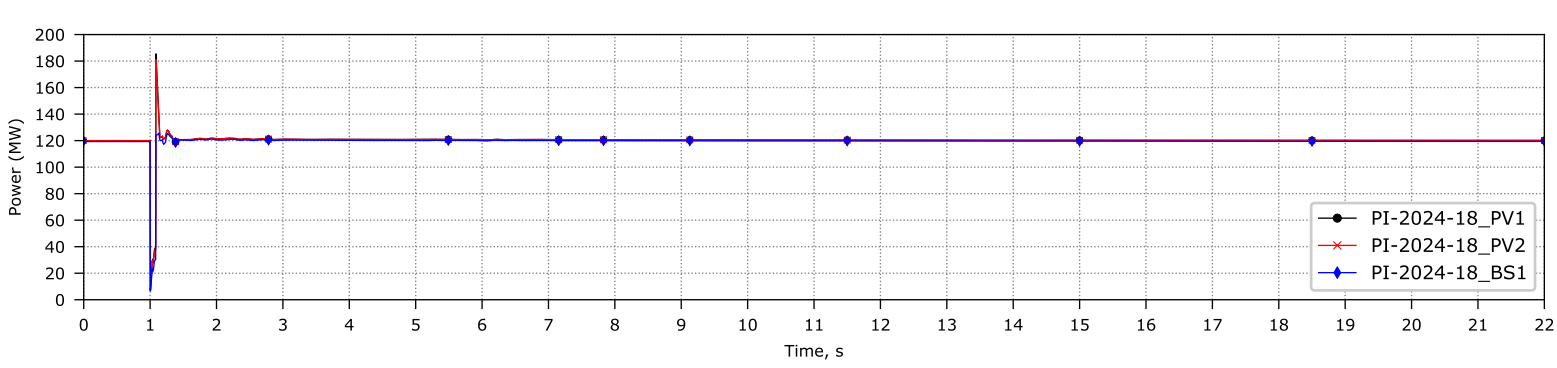


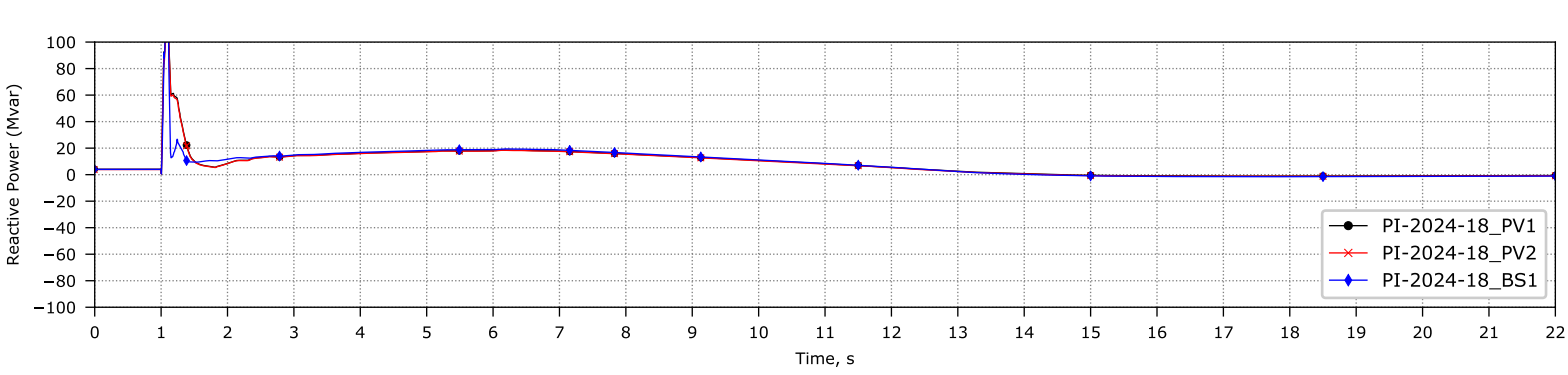
PI-2024-18_Study_East_Pawnee-Manchief_230kV

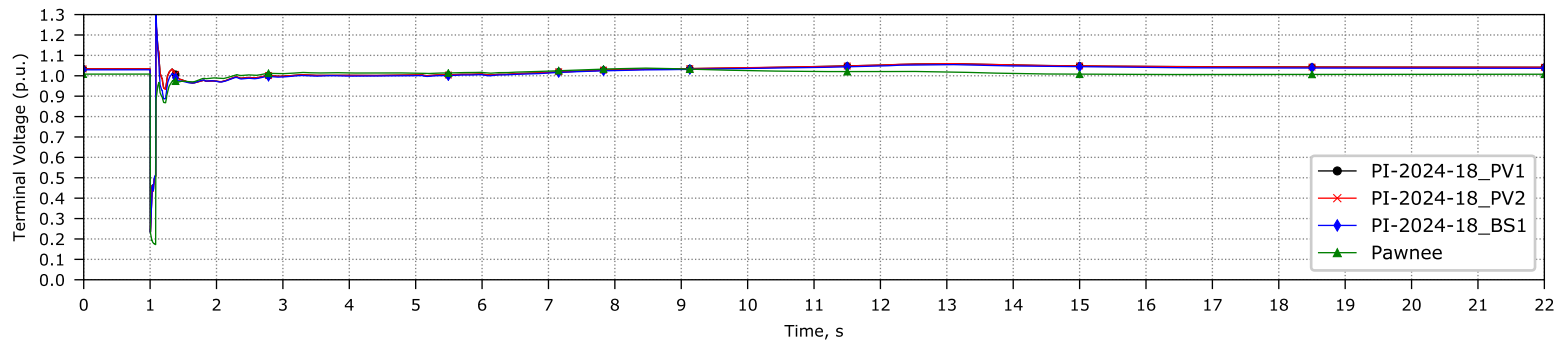


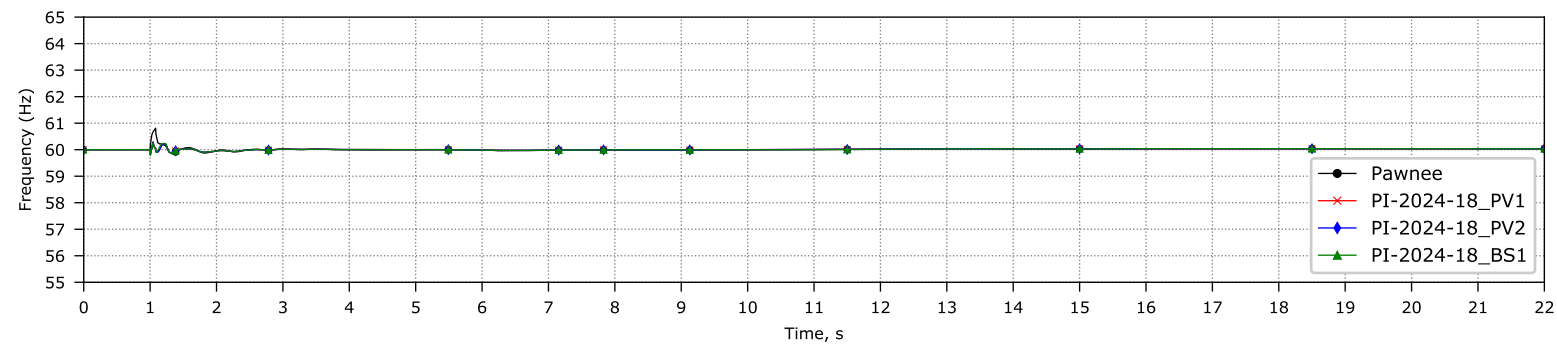


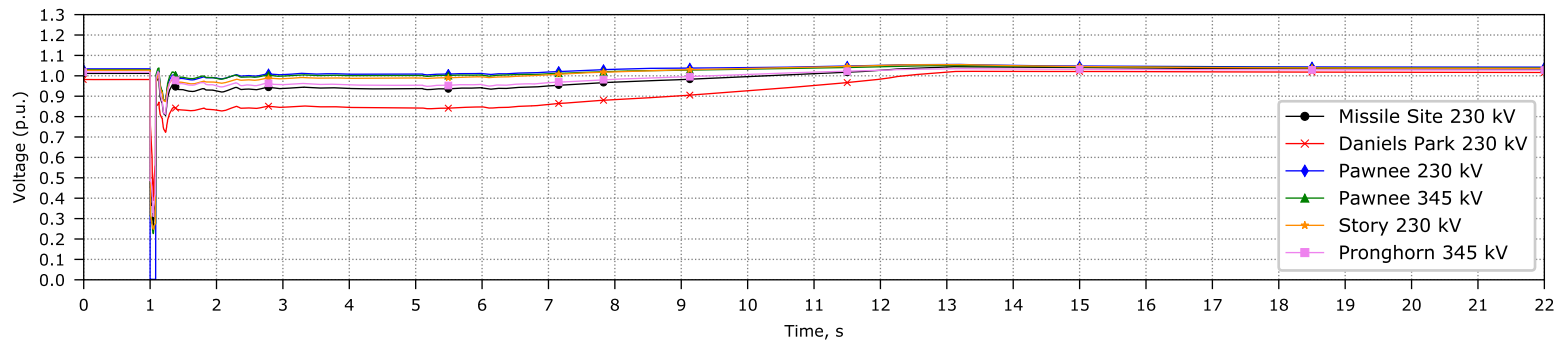




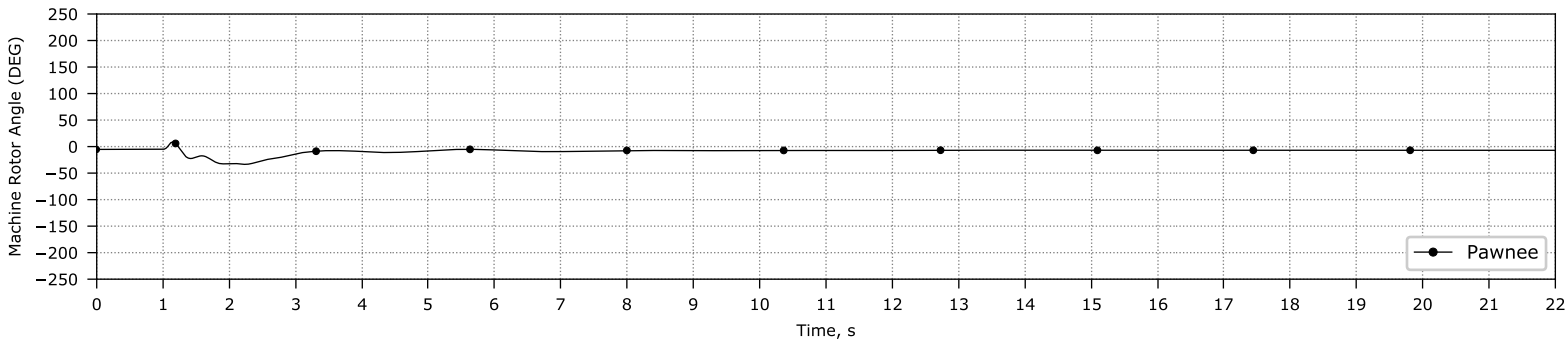


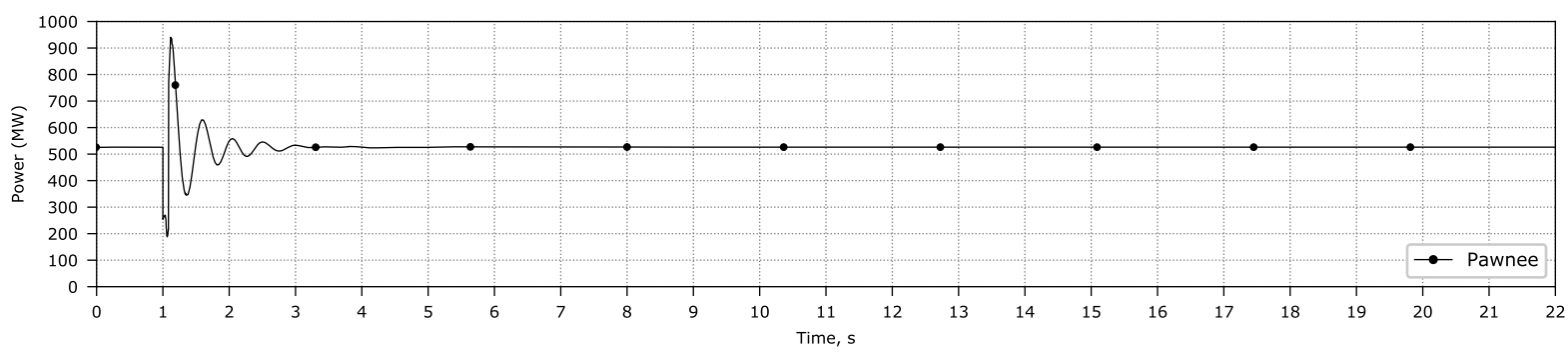


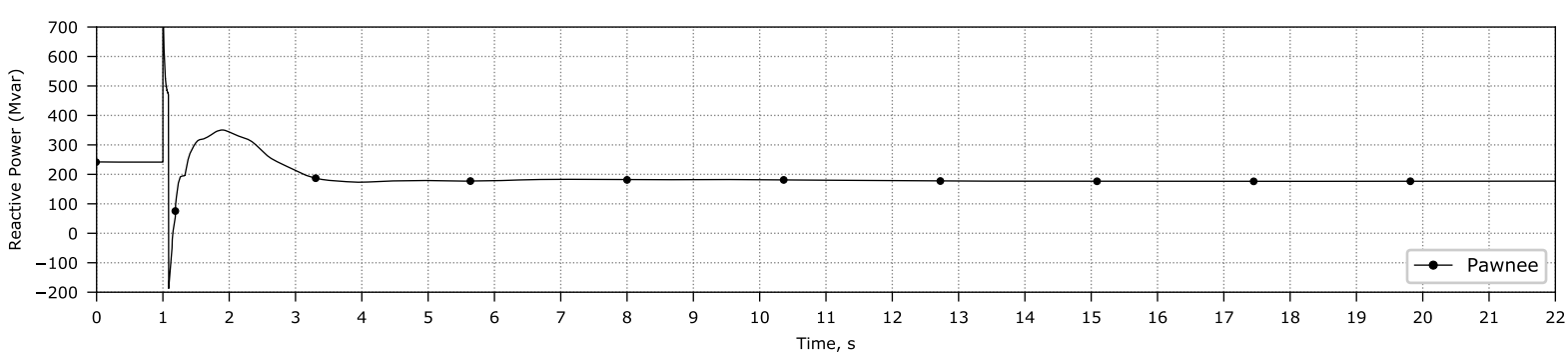


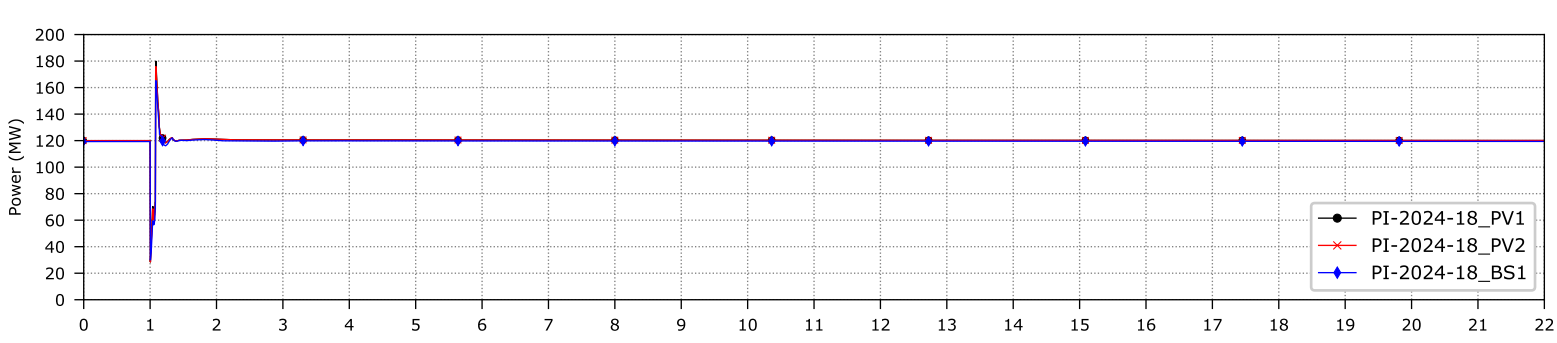


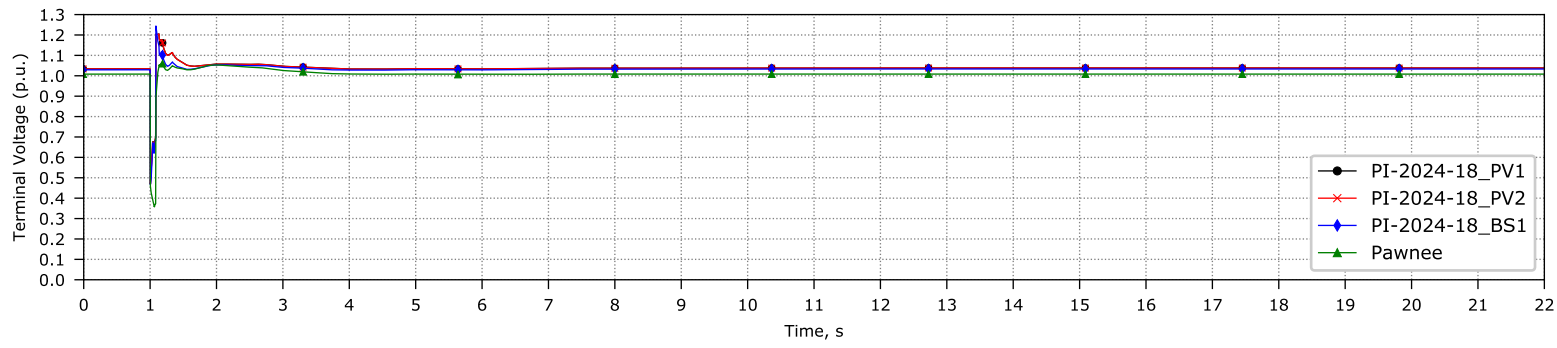
PI-2024-18_Study_East_Pawnee-Ptz_230kV

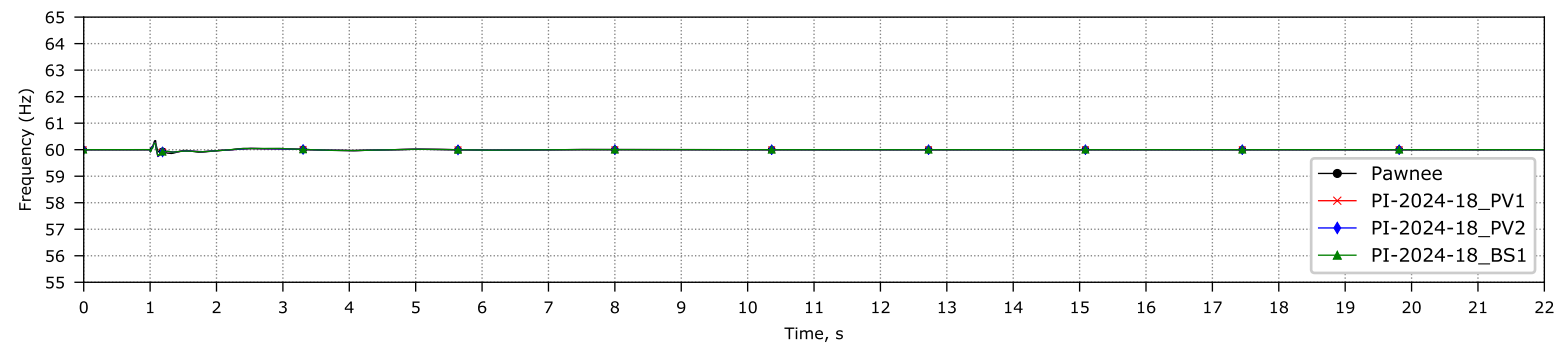


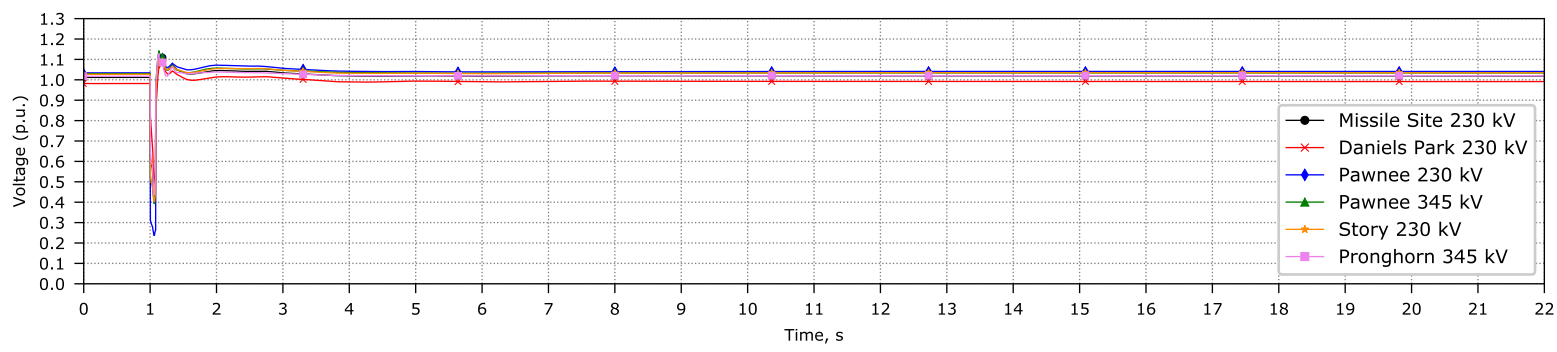




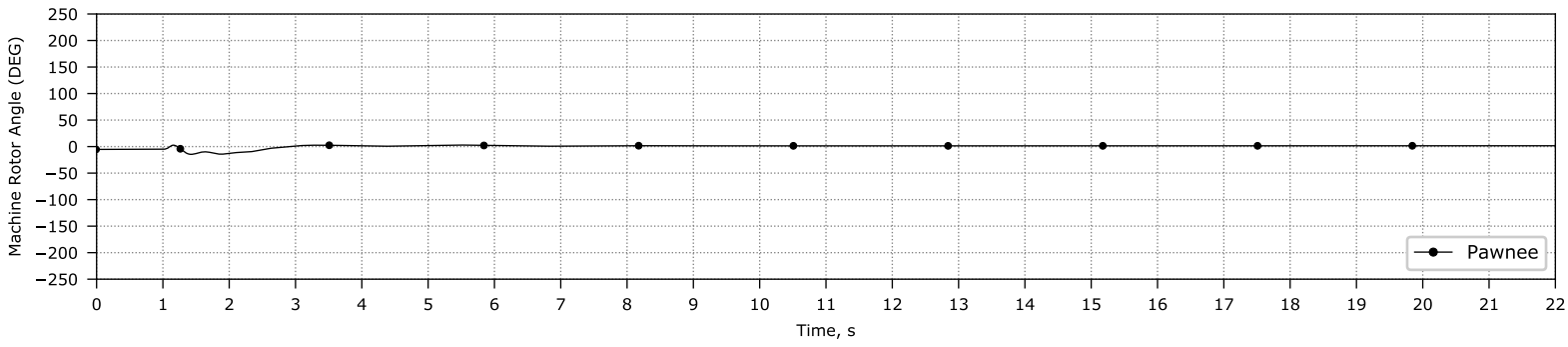


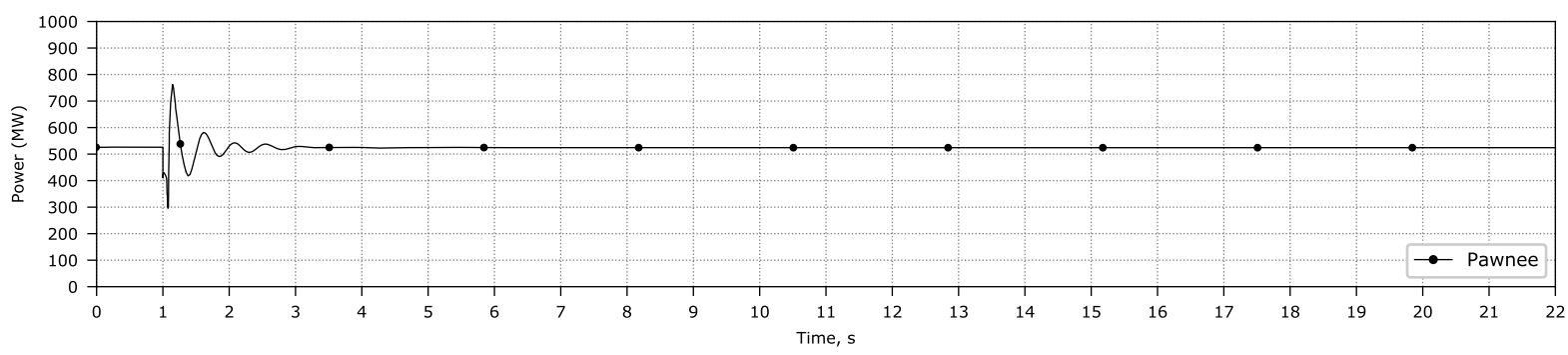


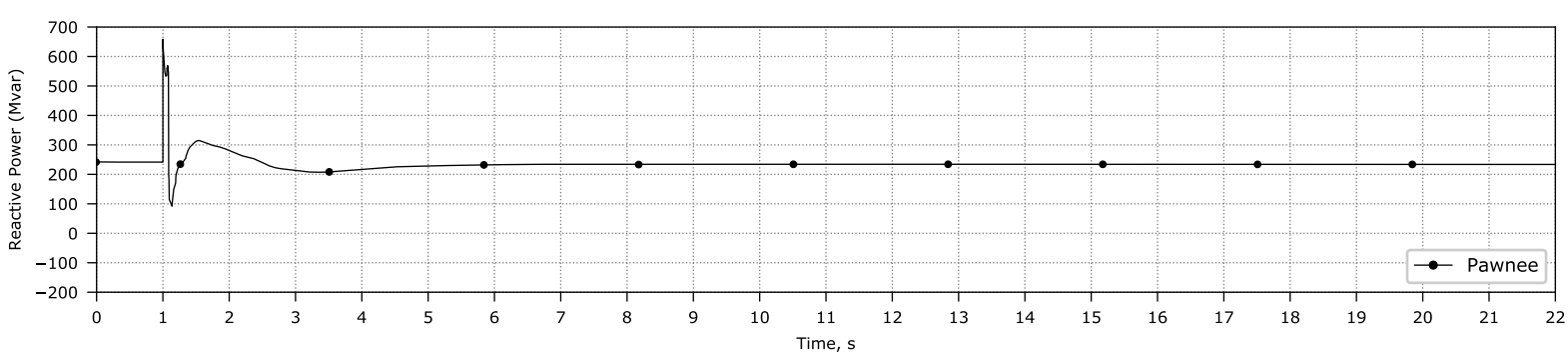


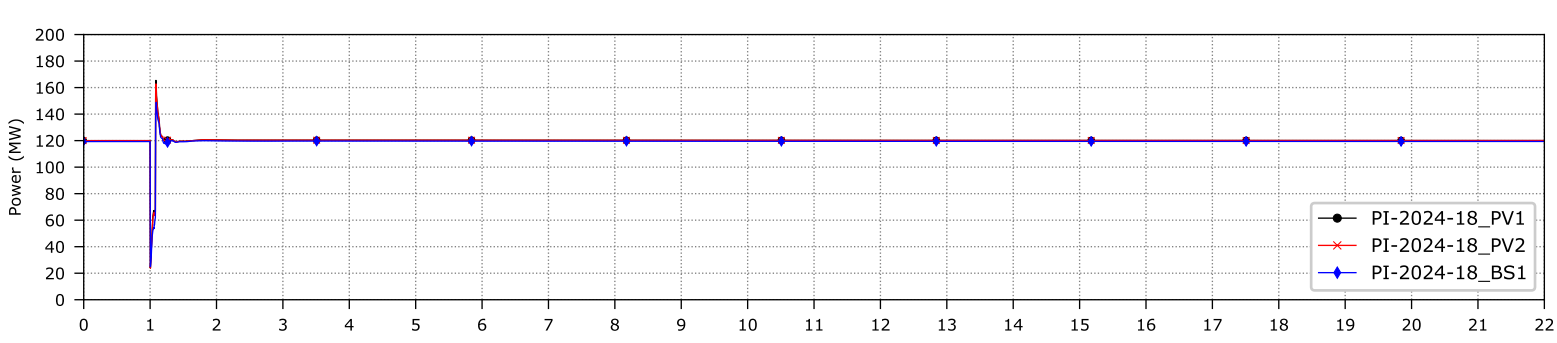


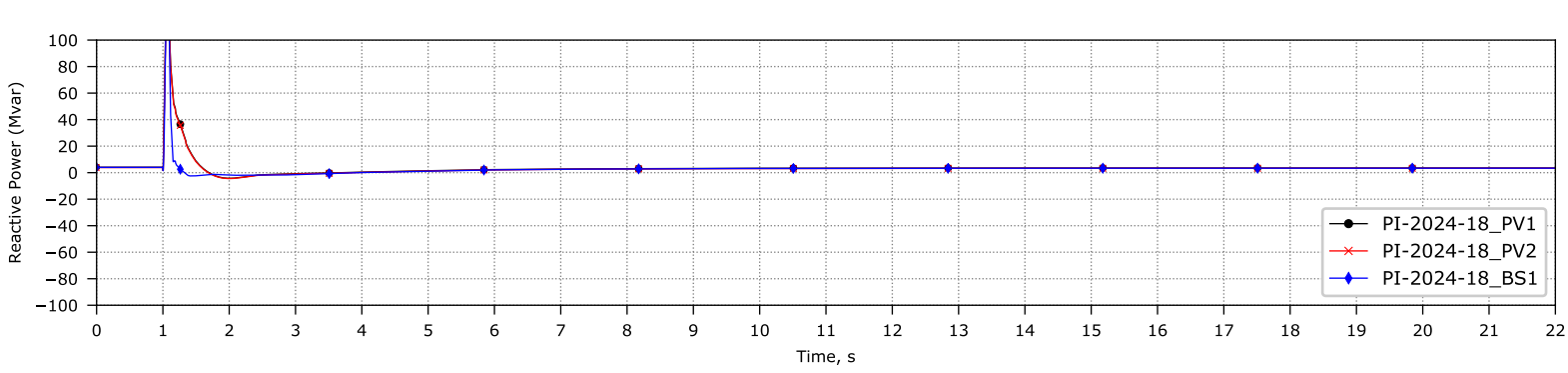
PI-2024-18_Study_East_MissSite-Titan_230kV

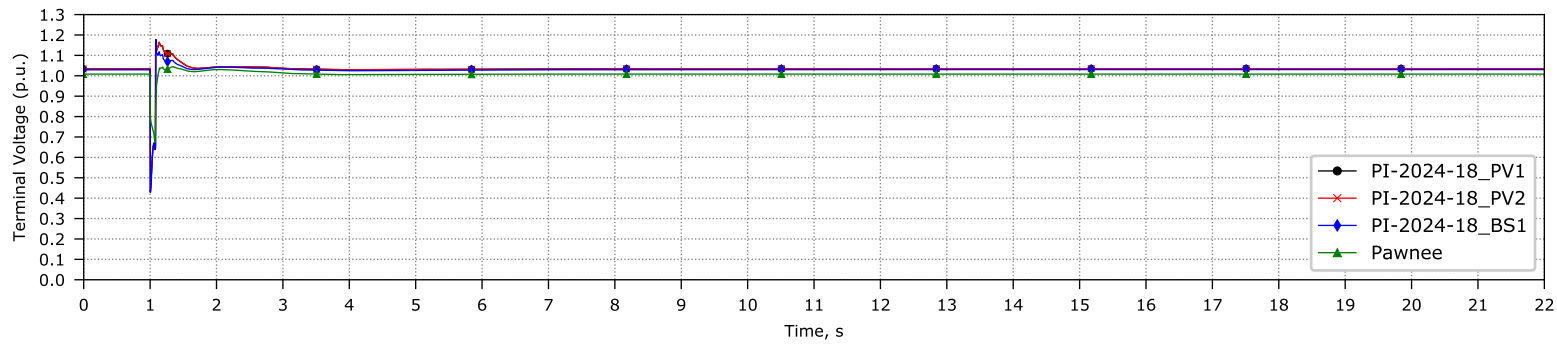


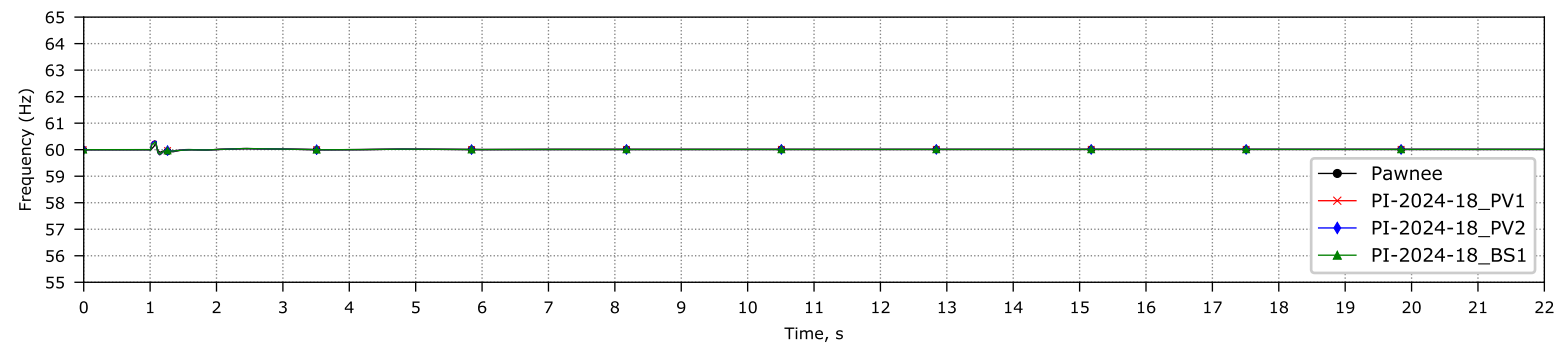


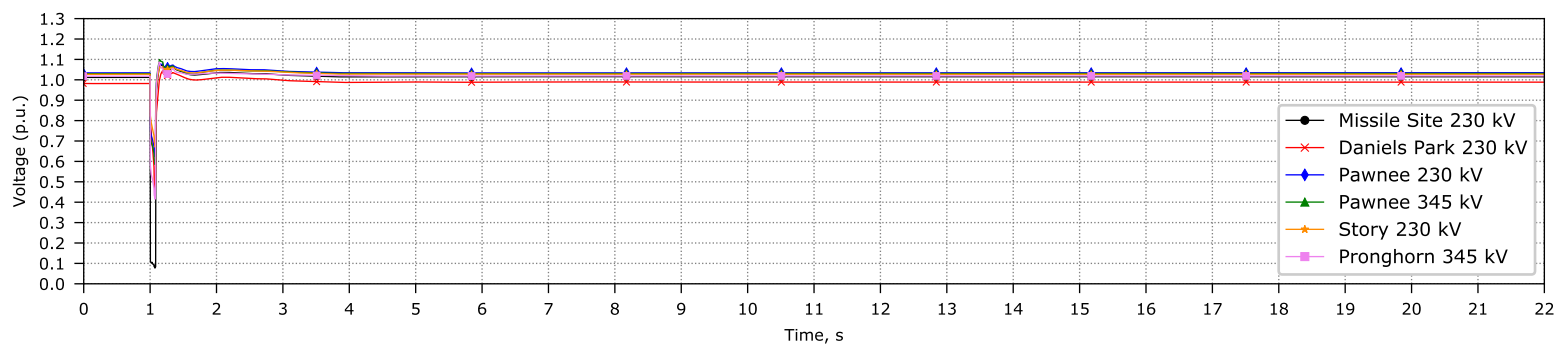




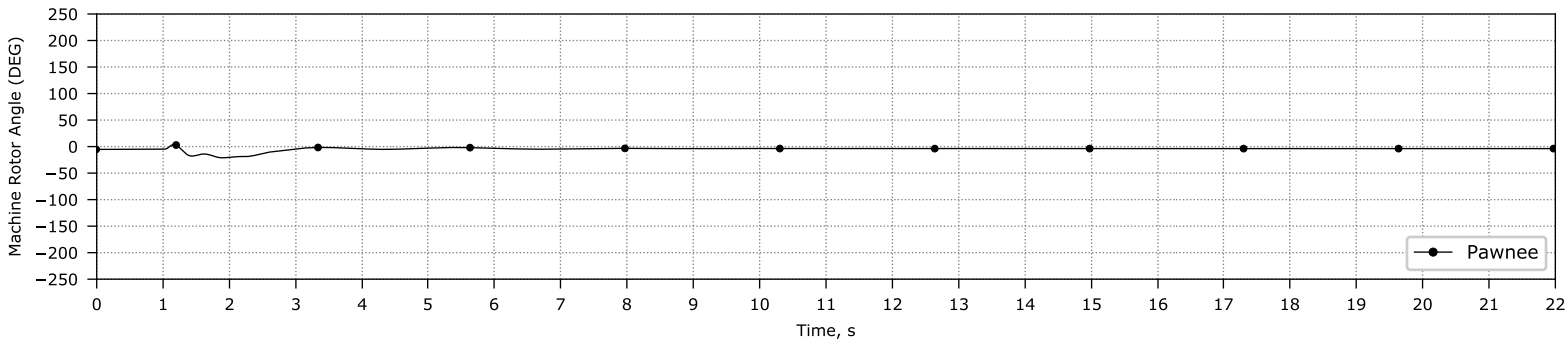


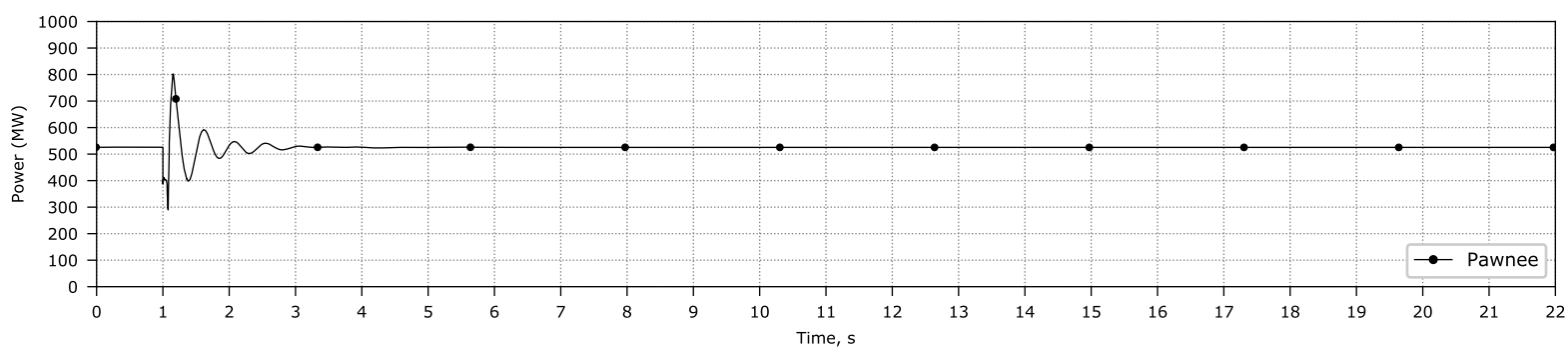


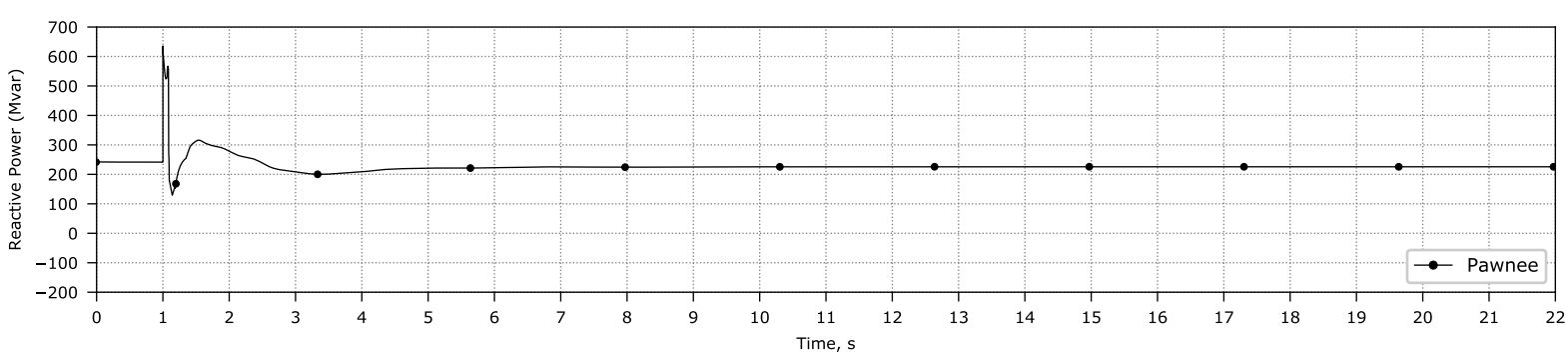


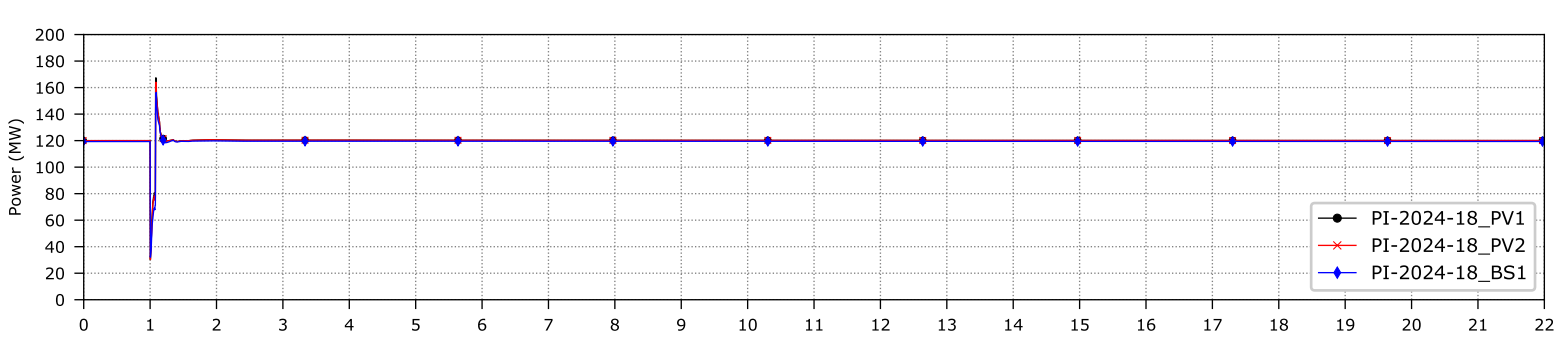


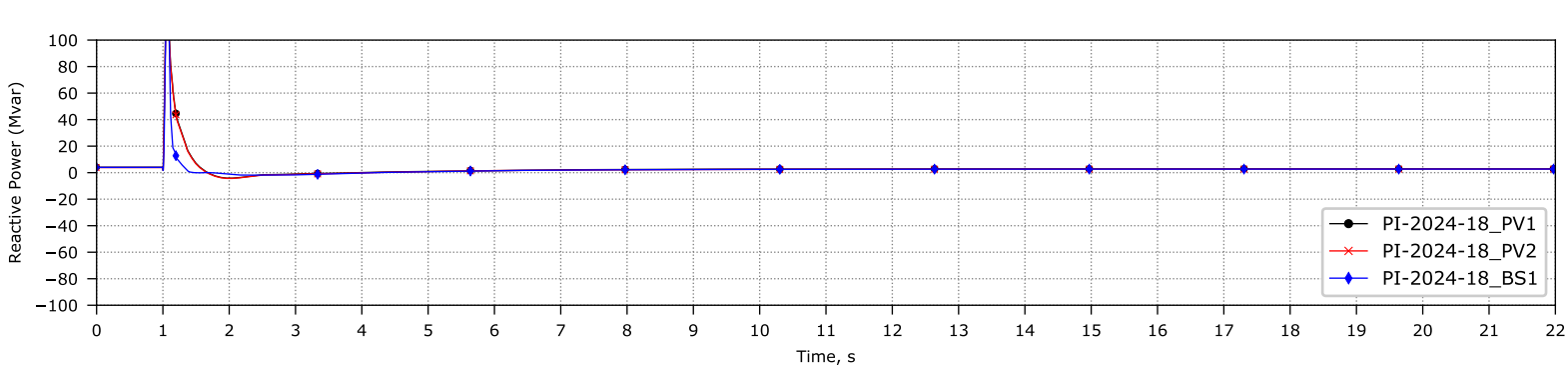
PI-2024-18_Study_East_MissSite-CedarPt_230kV

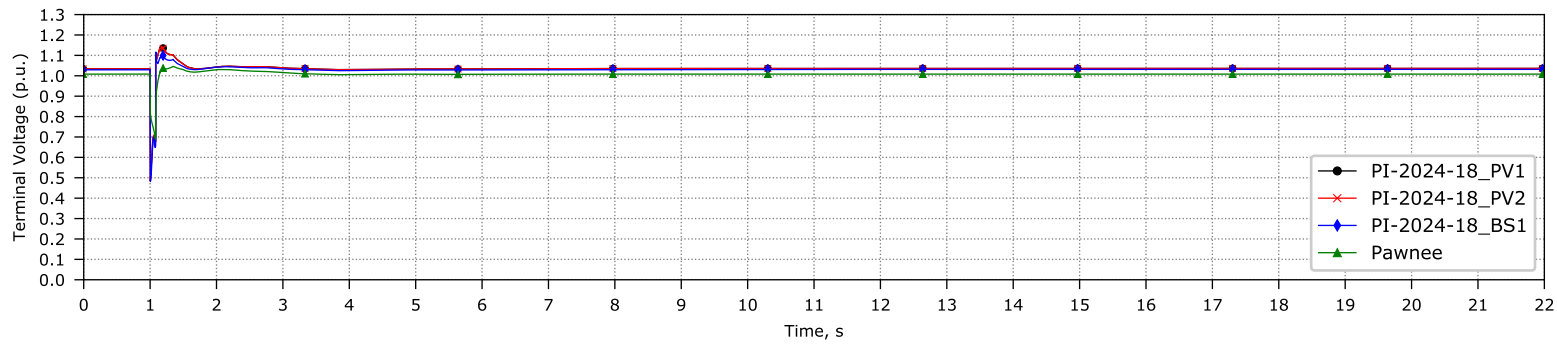


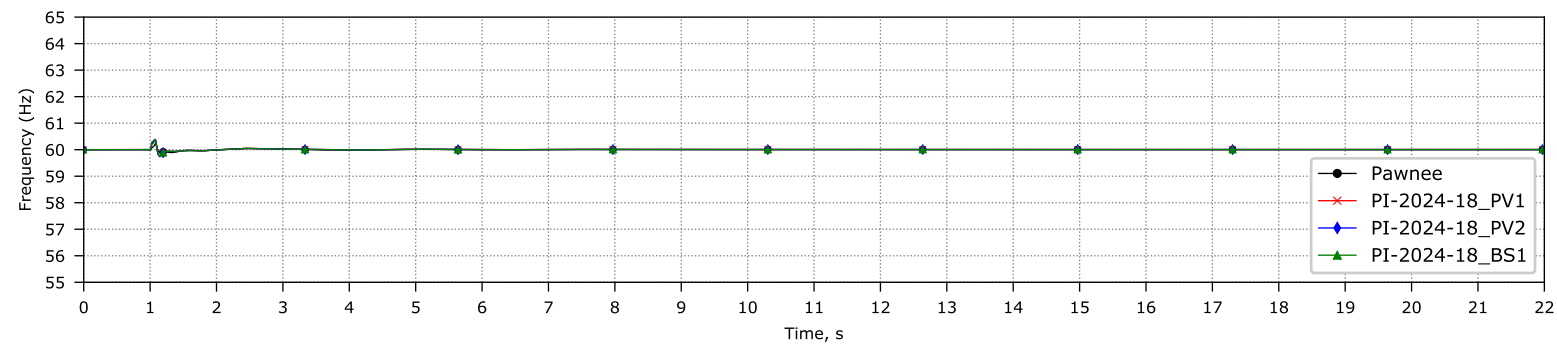


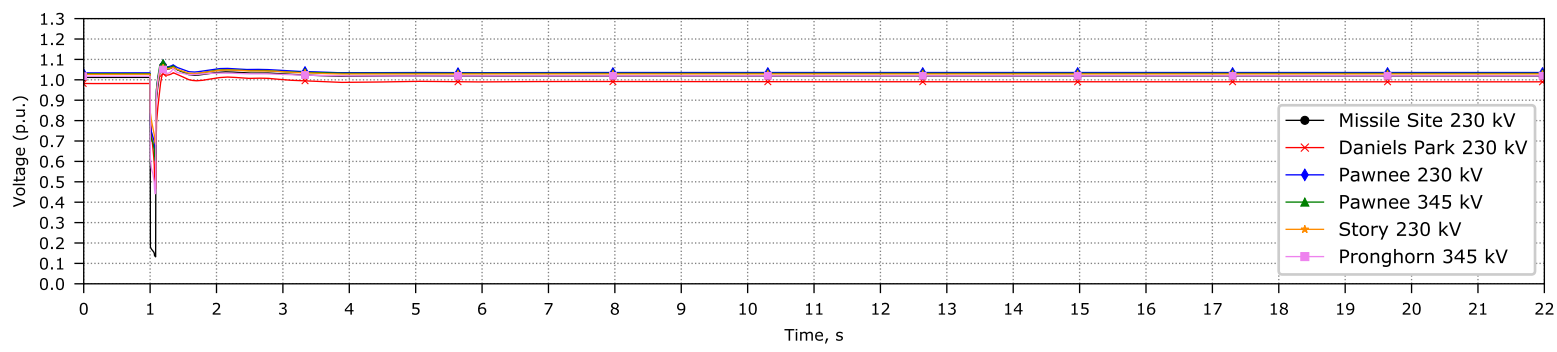




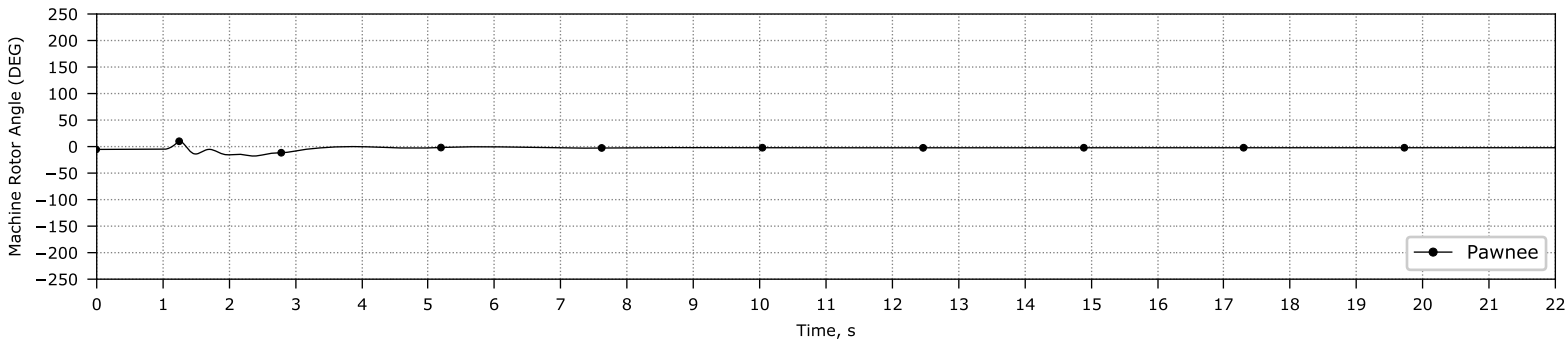


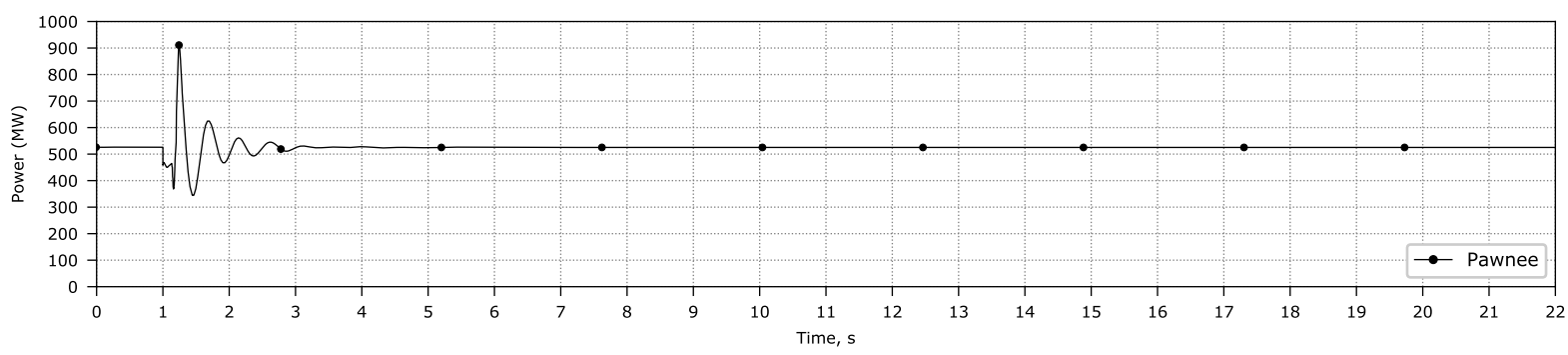


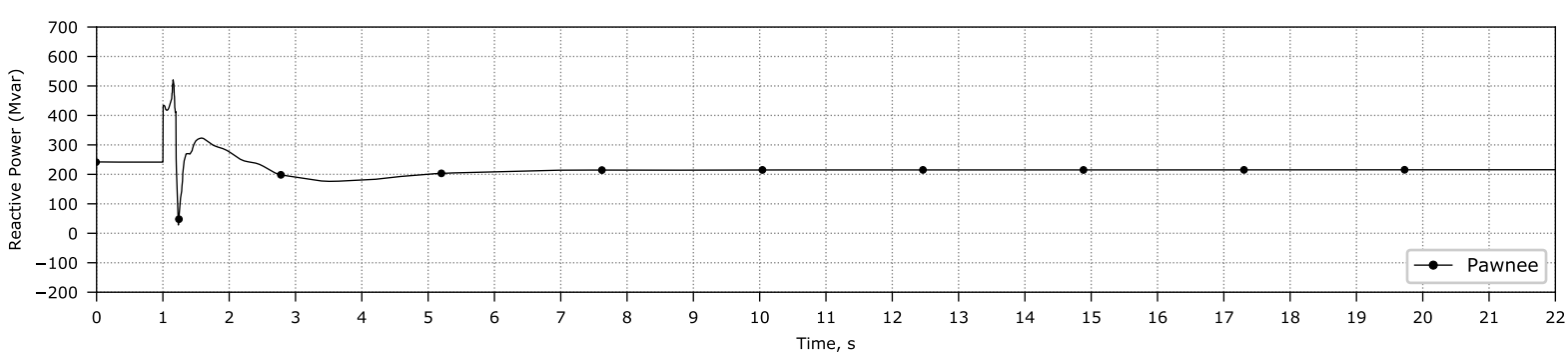


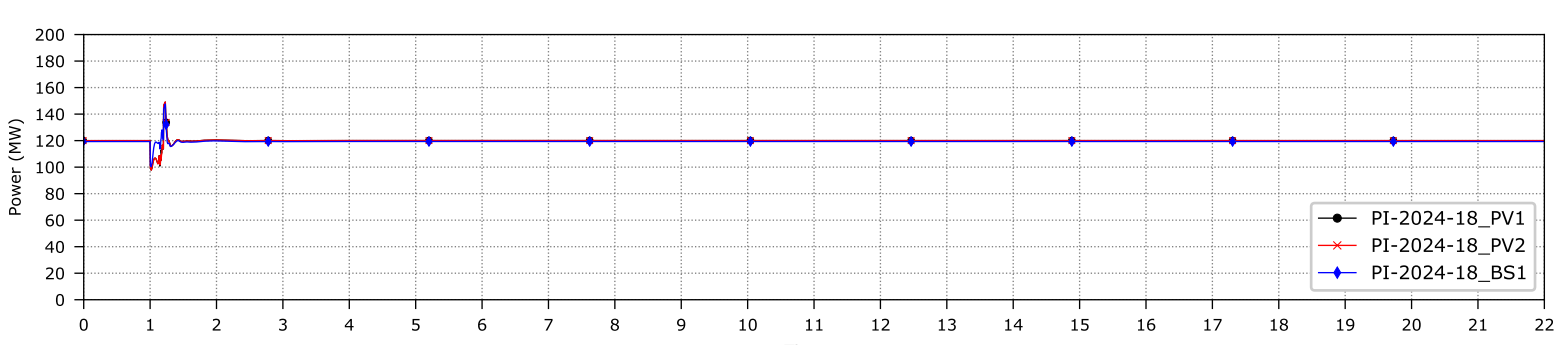


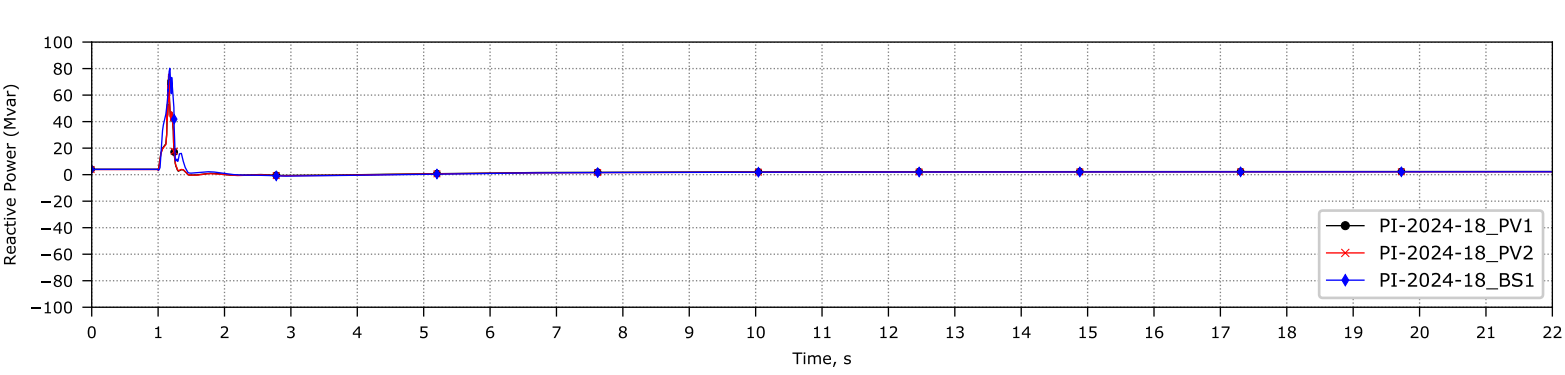
PI-2024-18_Study_East_line_324

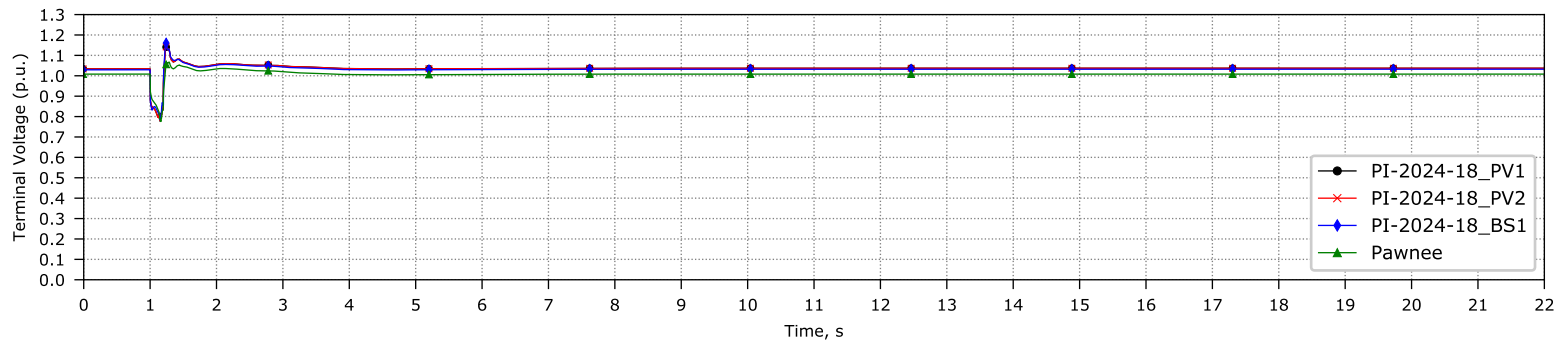


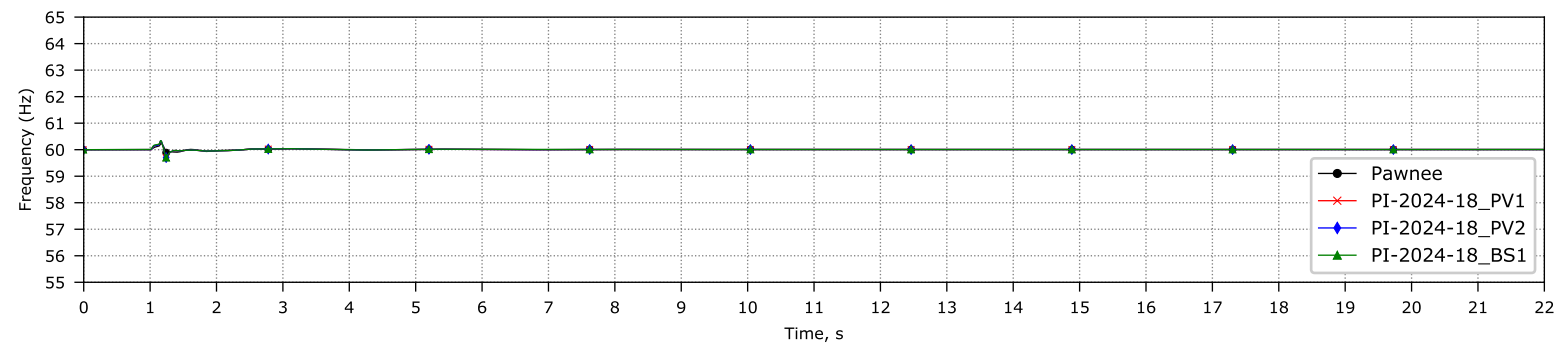


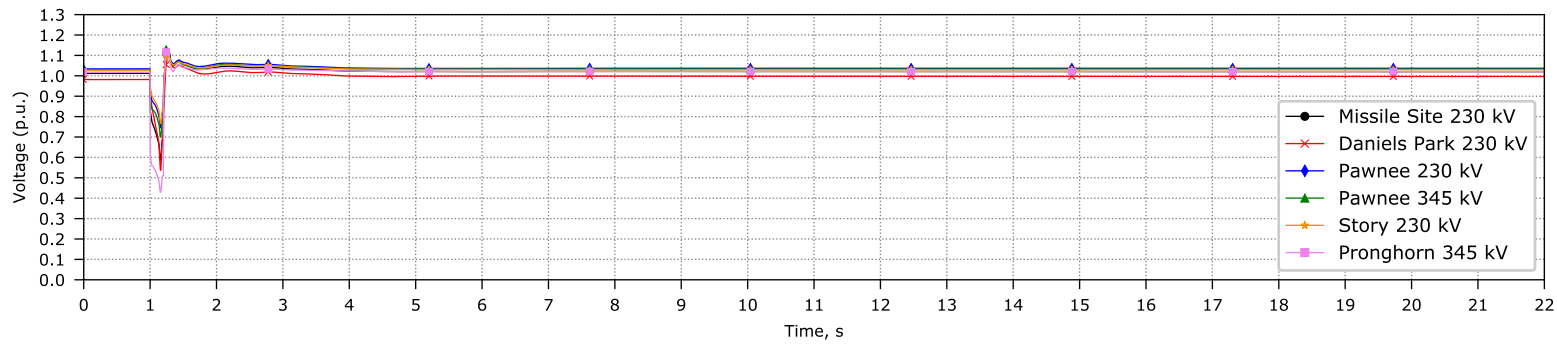




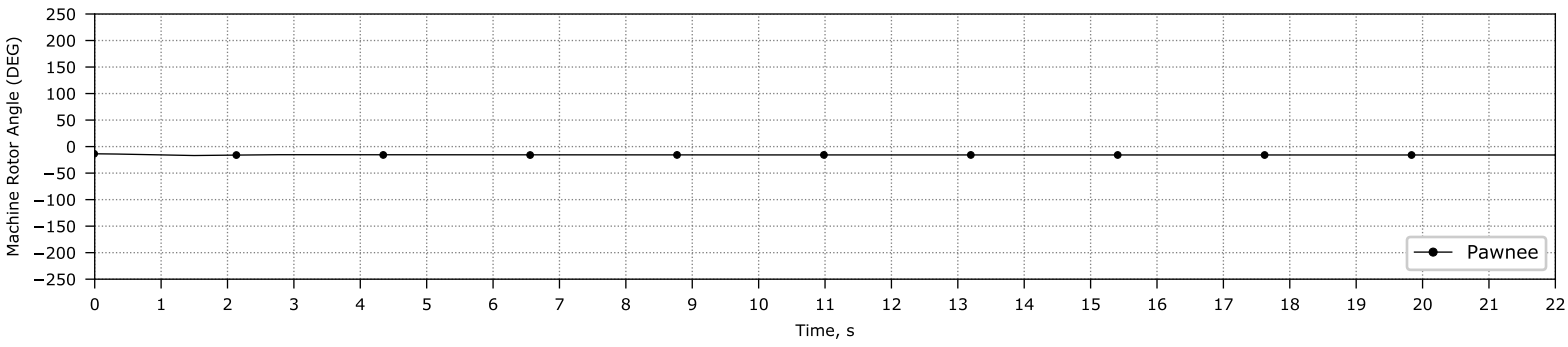


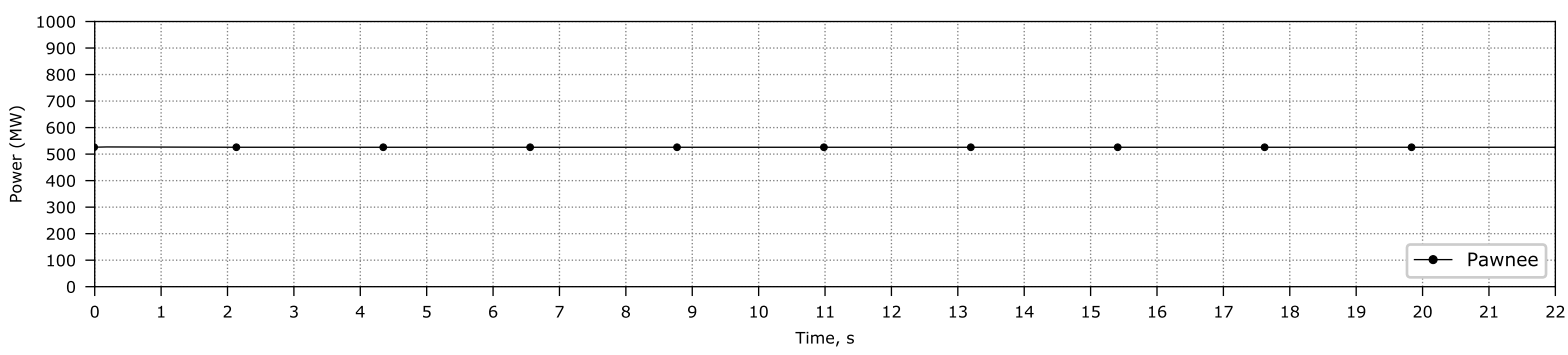


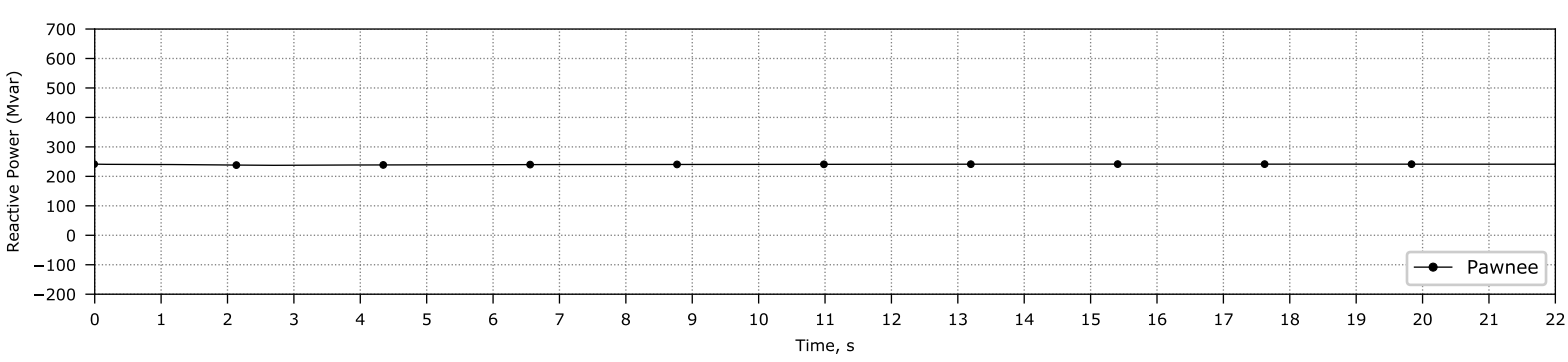


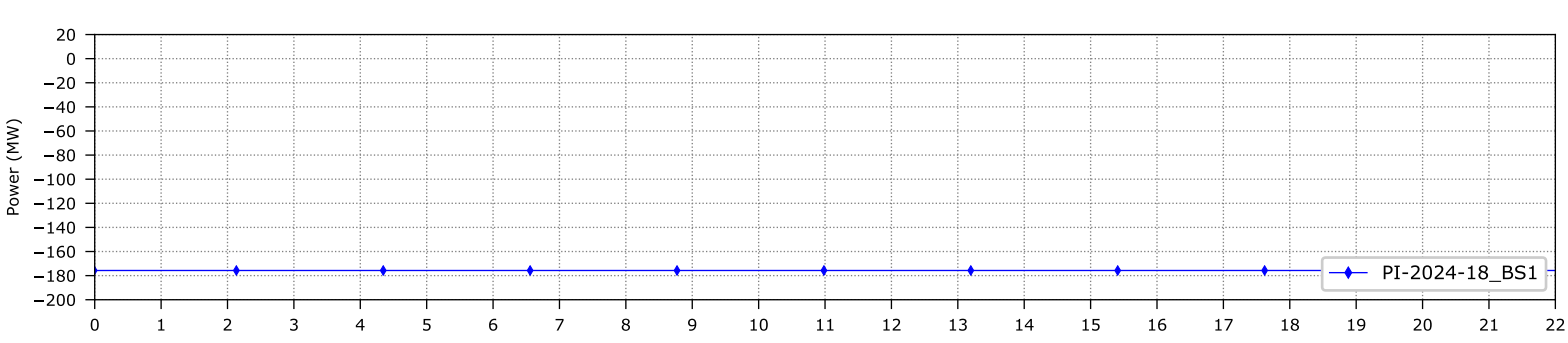


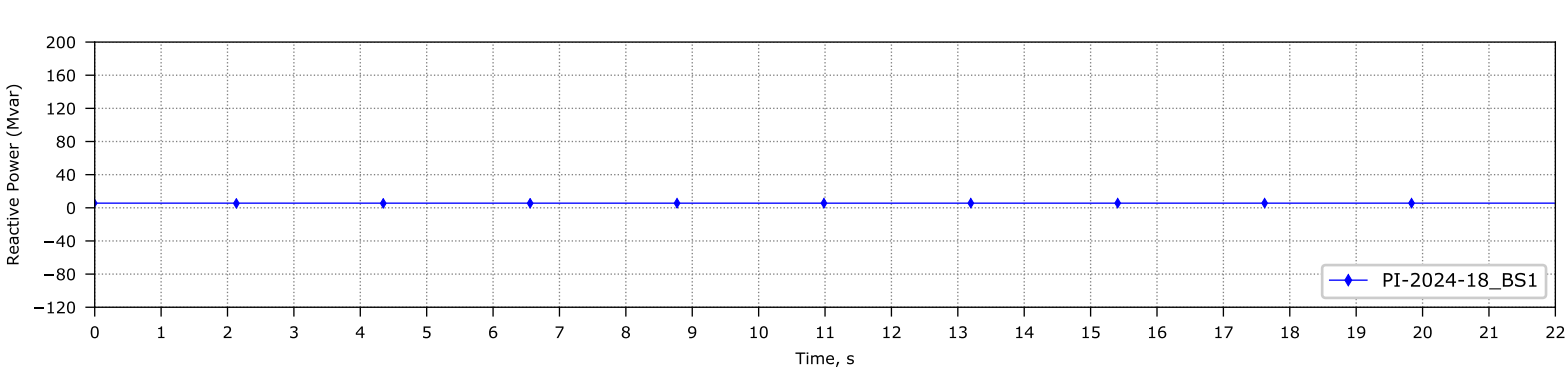
PI-2024-18_Study_East_flatrun

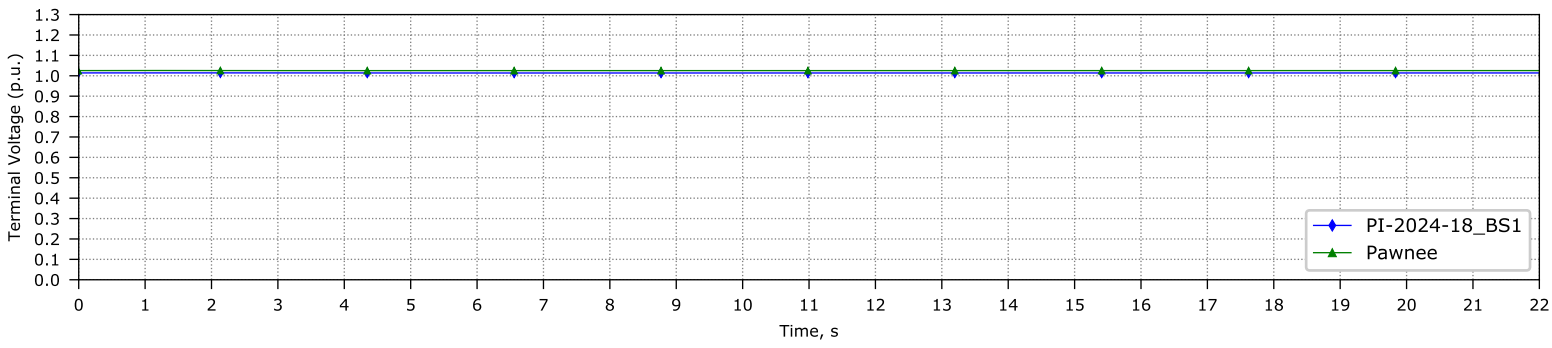


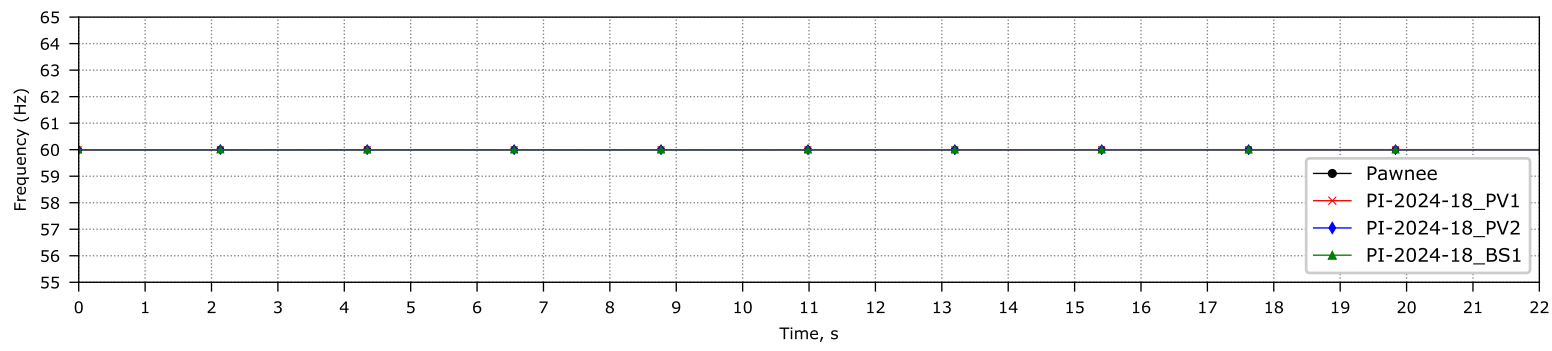


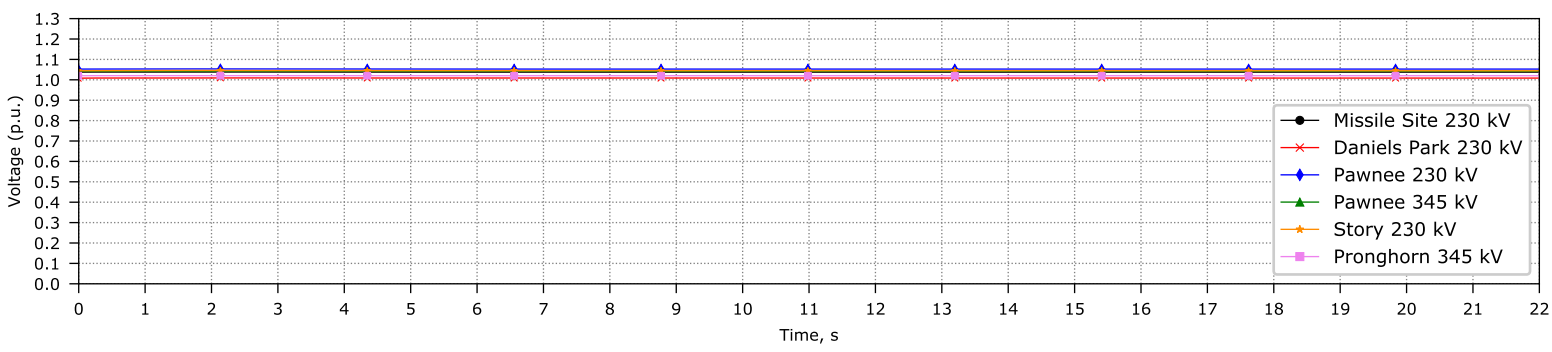




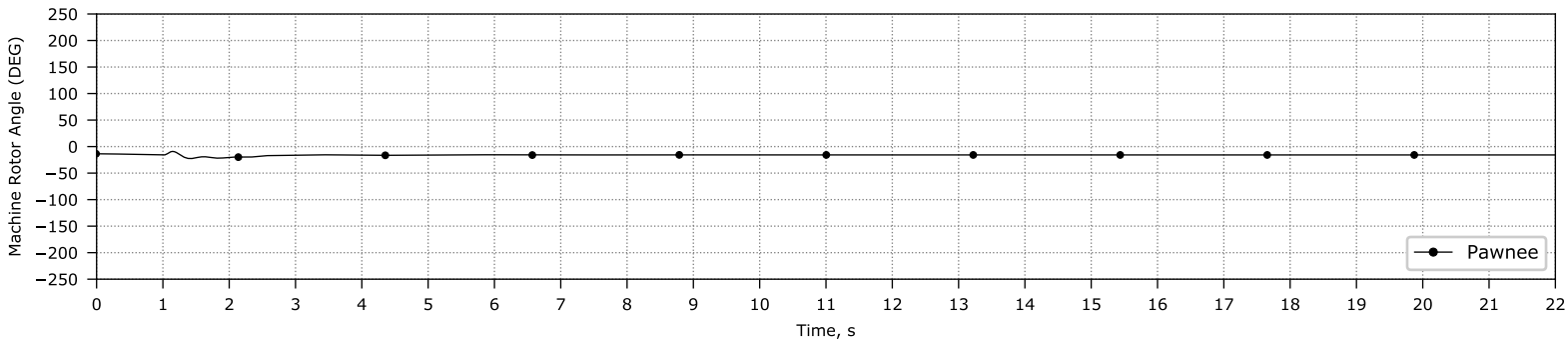


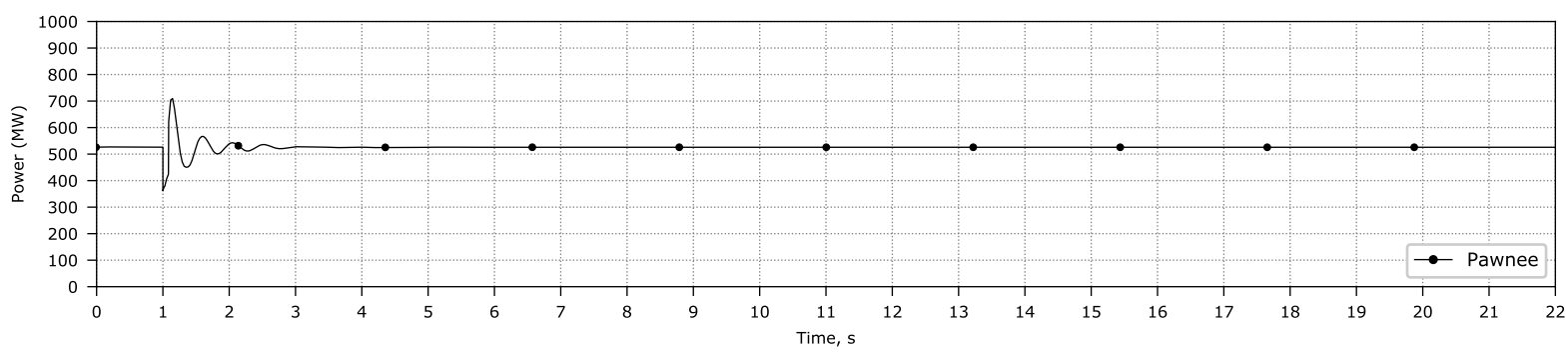


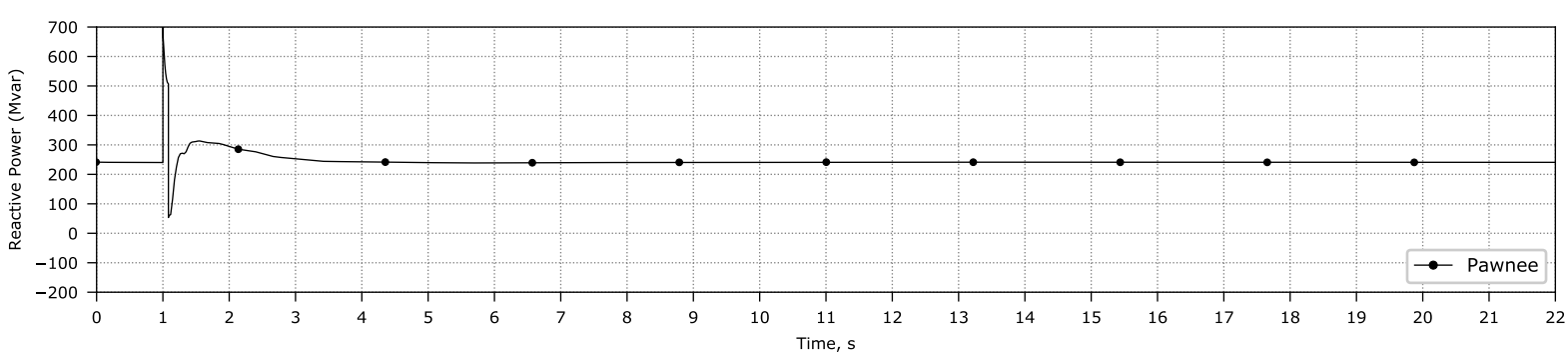


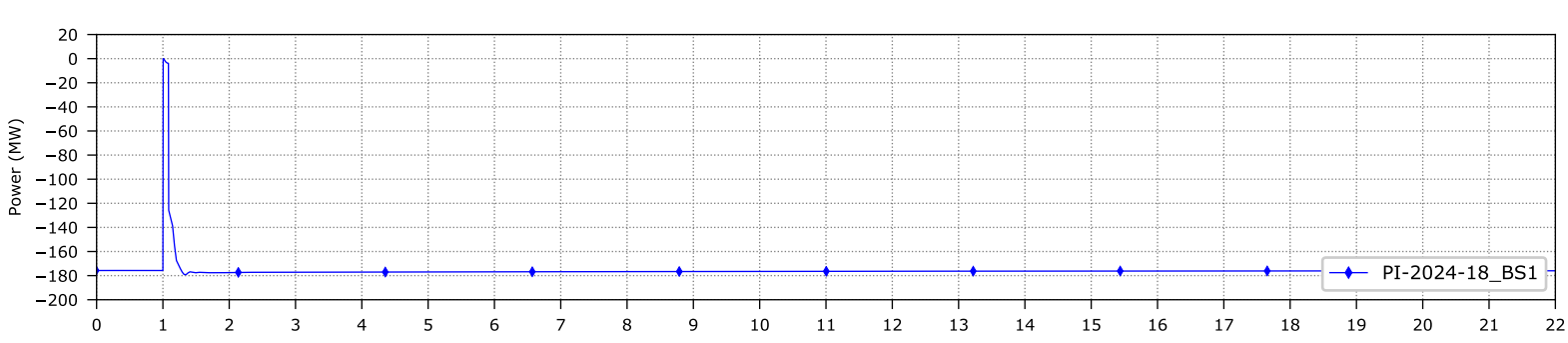


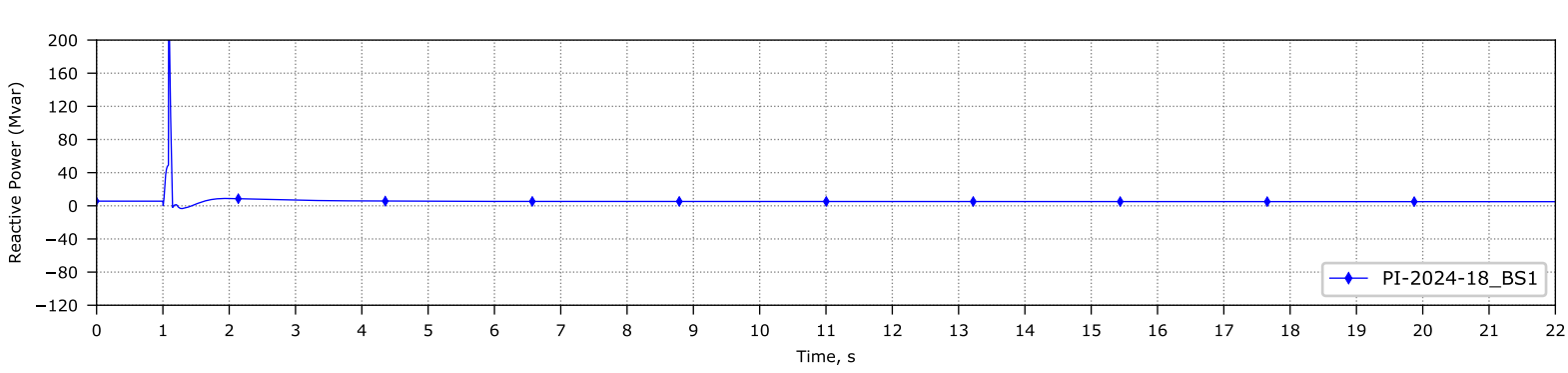
PI-2024-18_Study_East_PI-2024-18_POI-MissSite_230kV

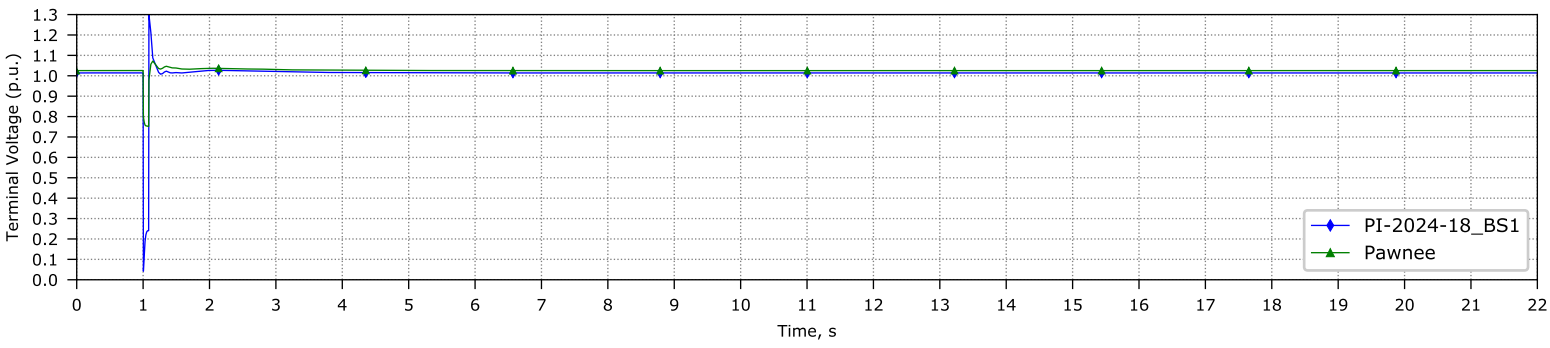


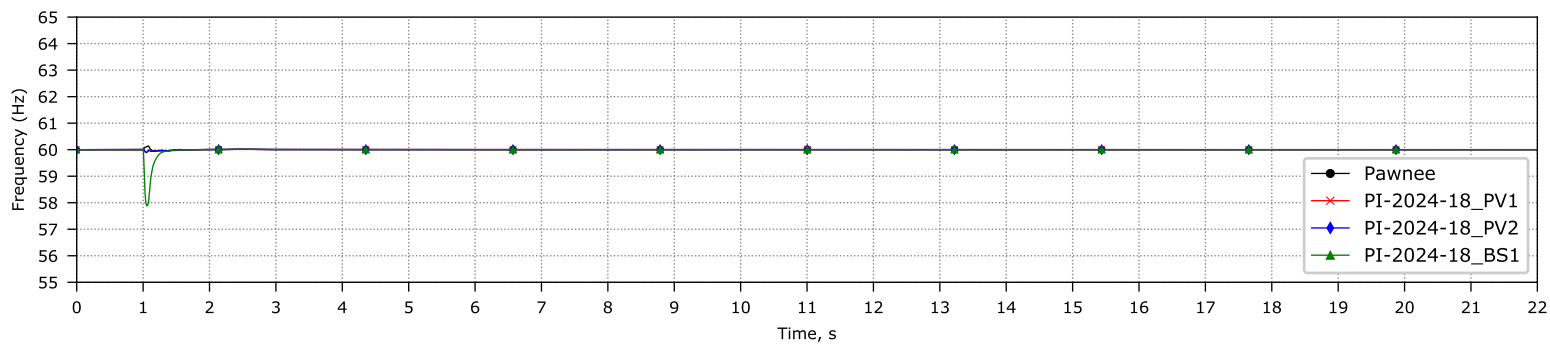


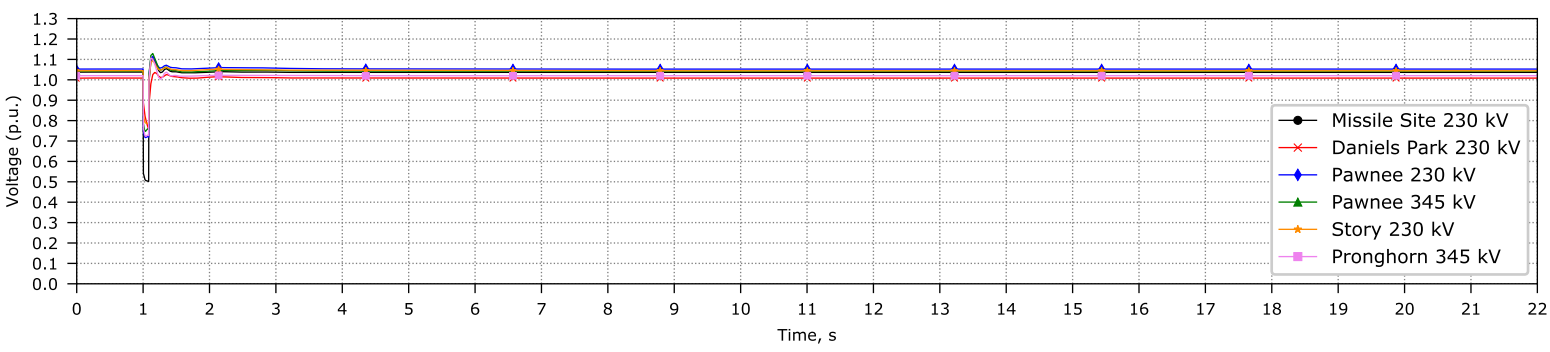




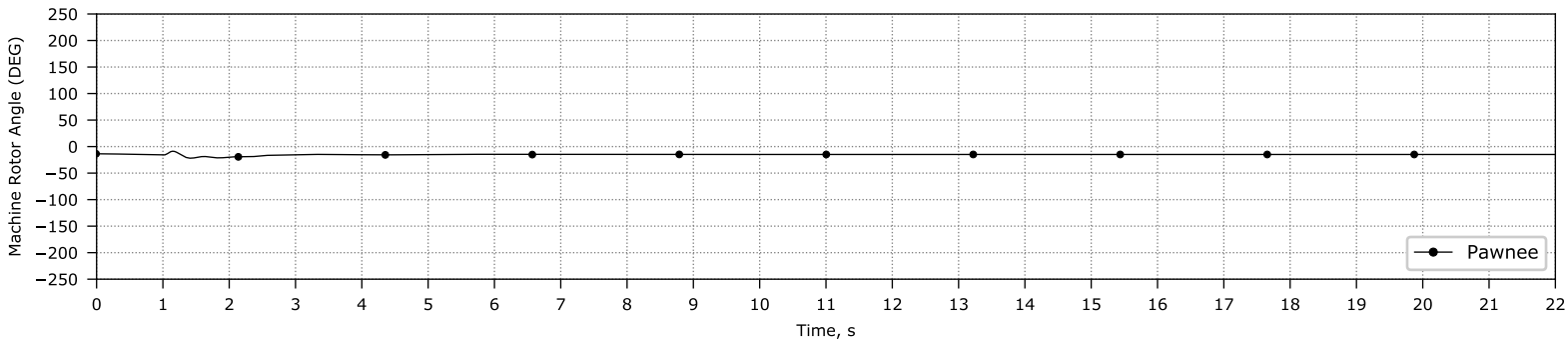


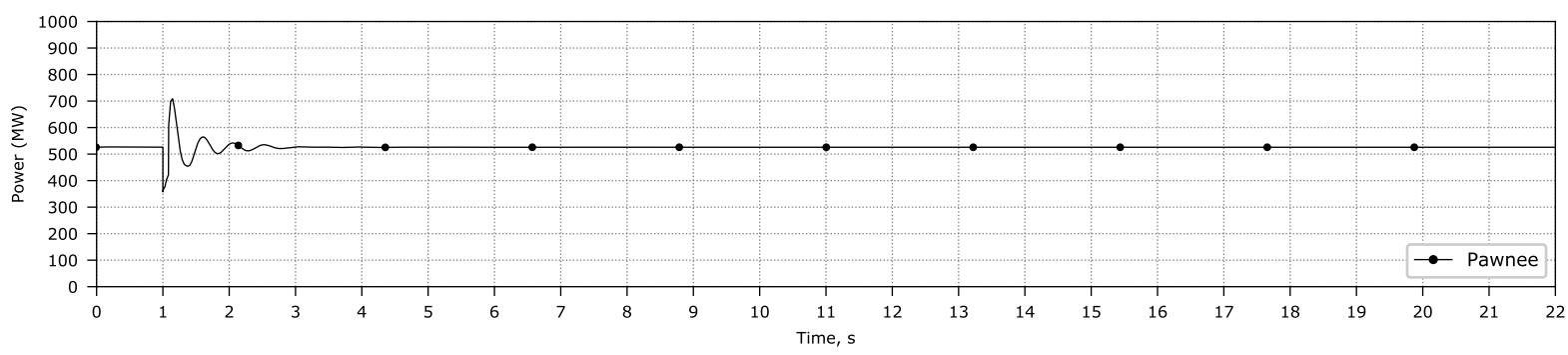


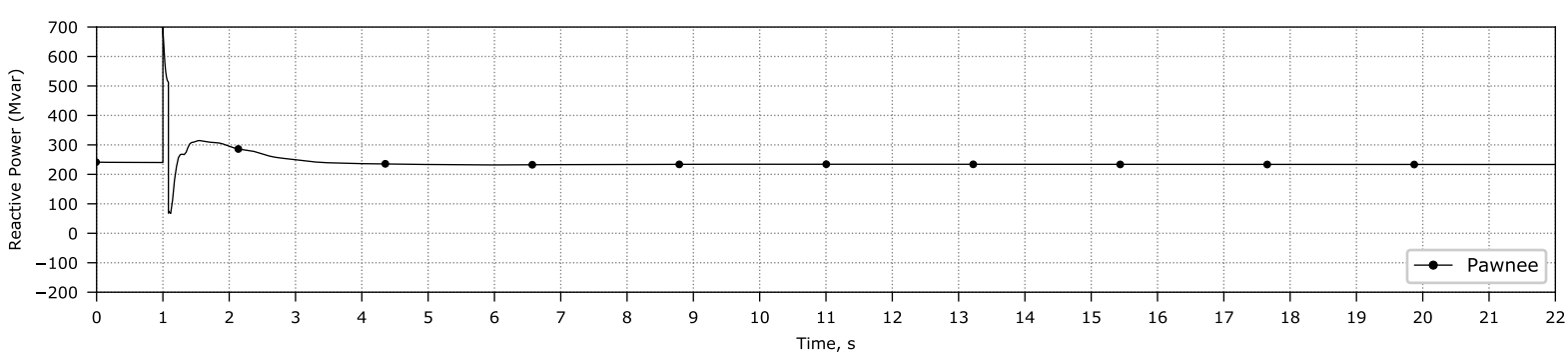


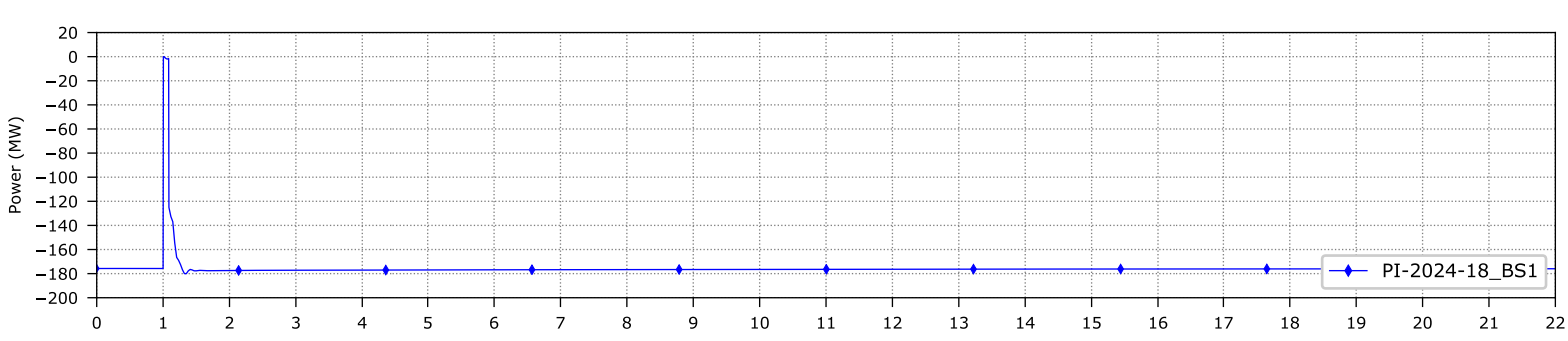


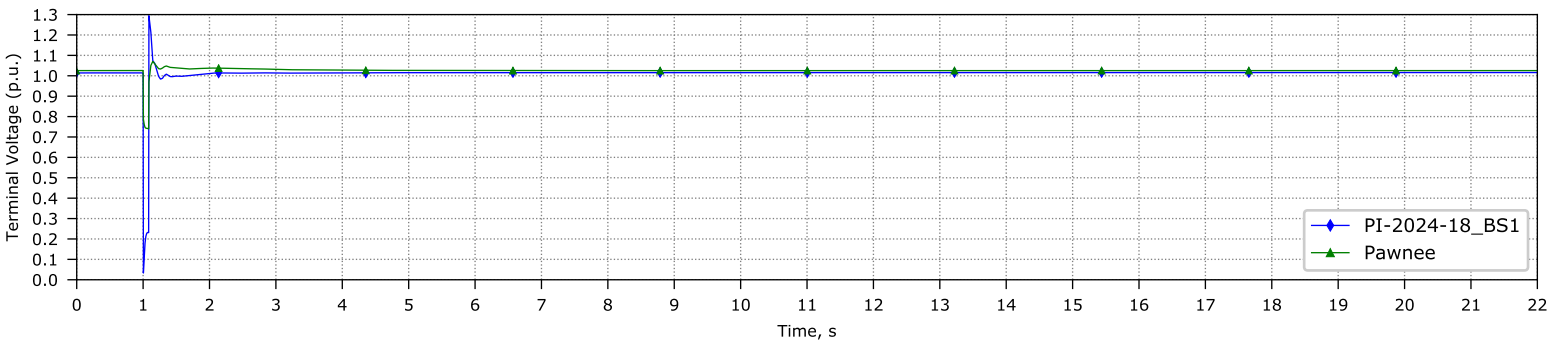
PI-2024-18_Study_East_PI-2024-18_POI-Pawnee_230kV

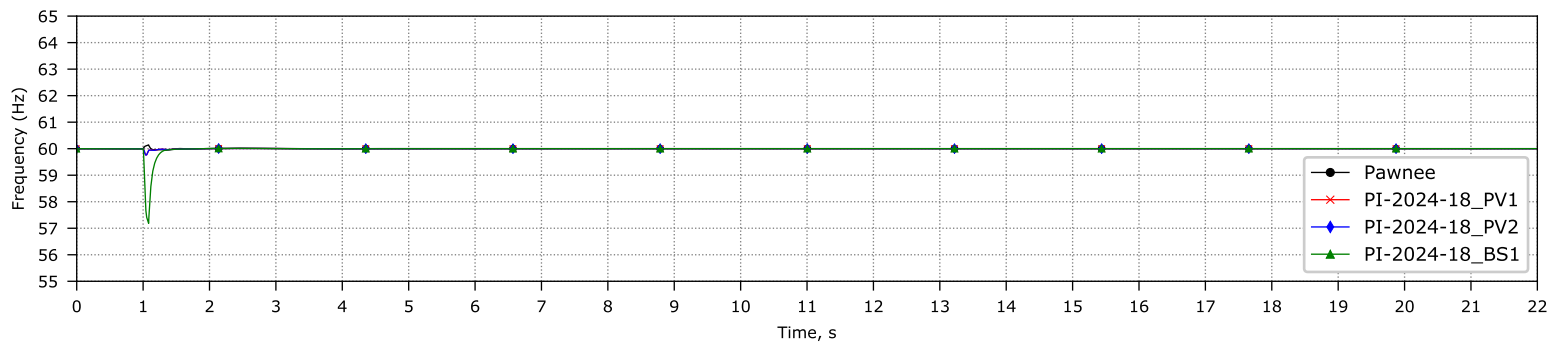


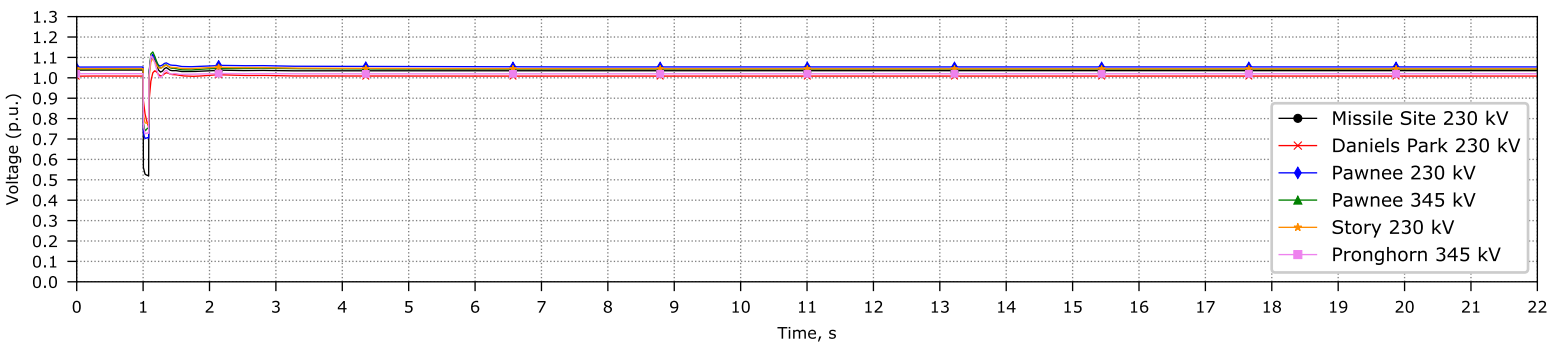




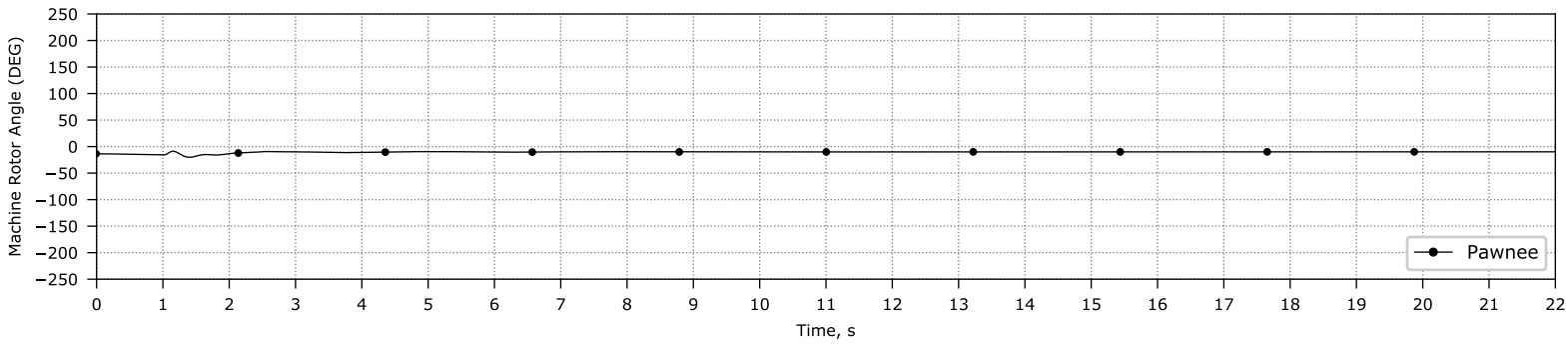


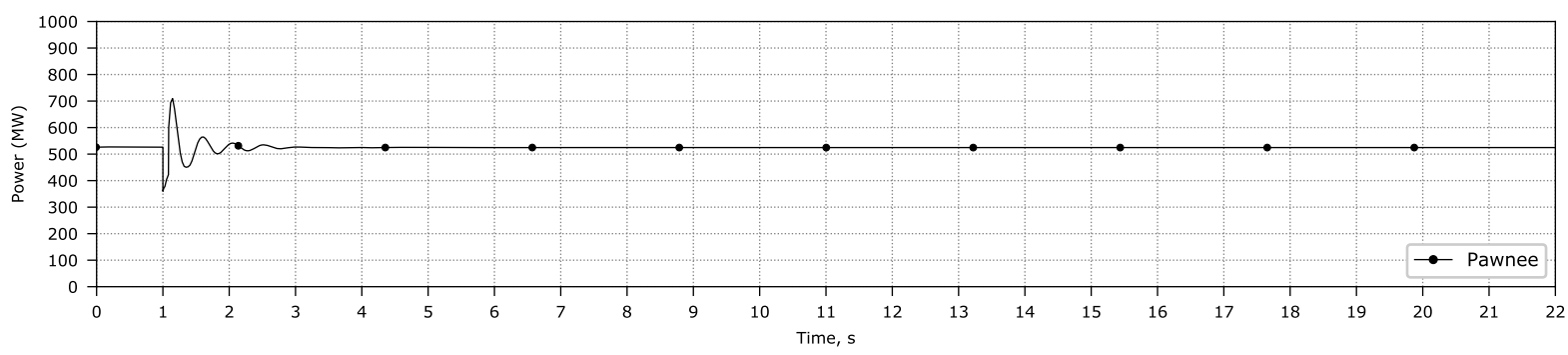


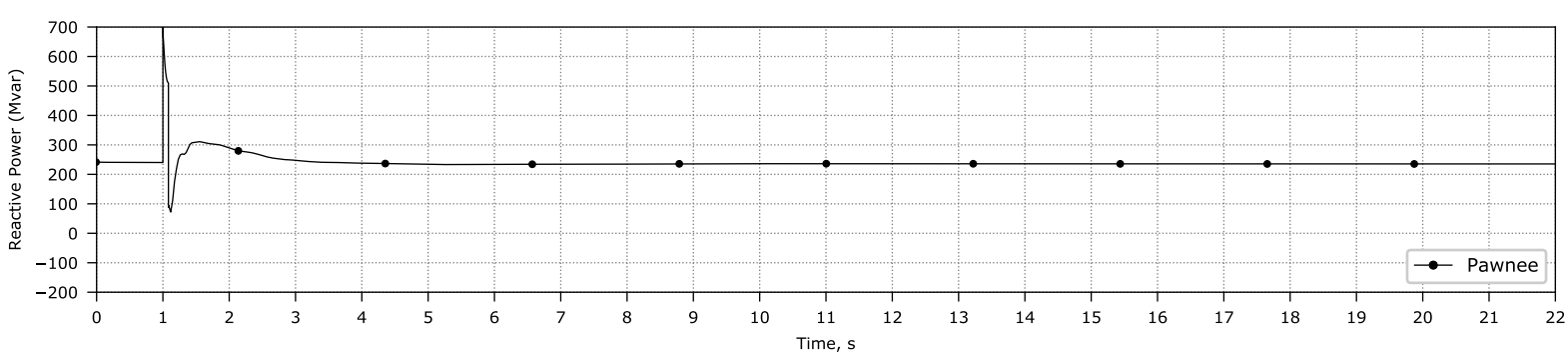


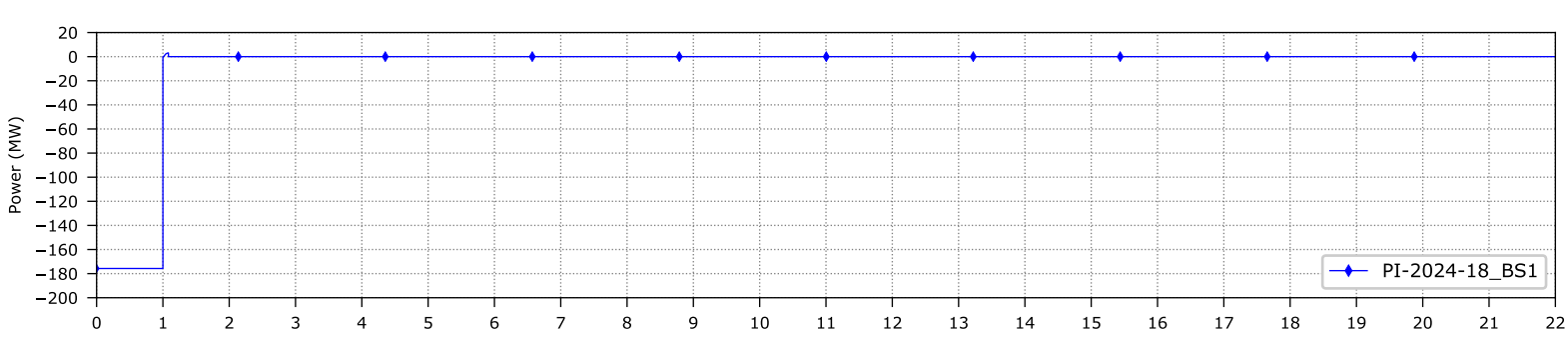


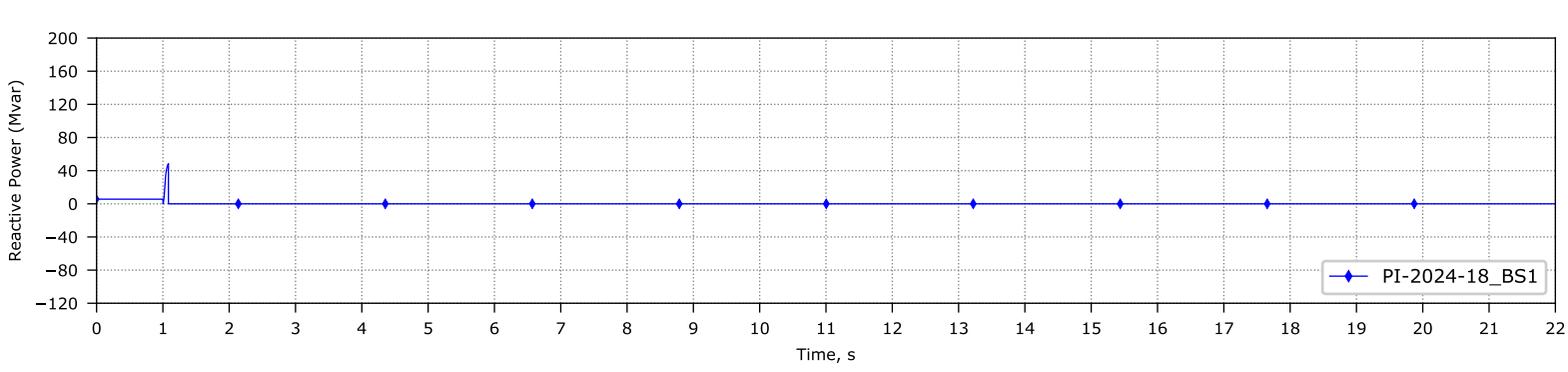
PI-2024-18_Study_East_PI-2024-18_Gen

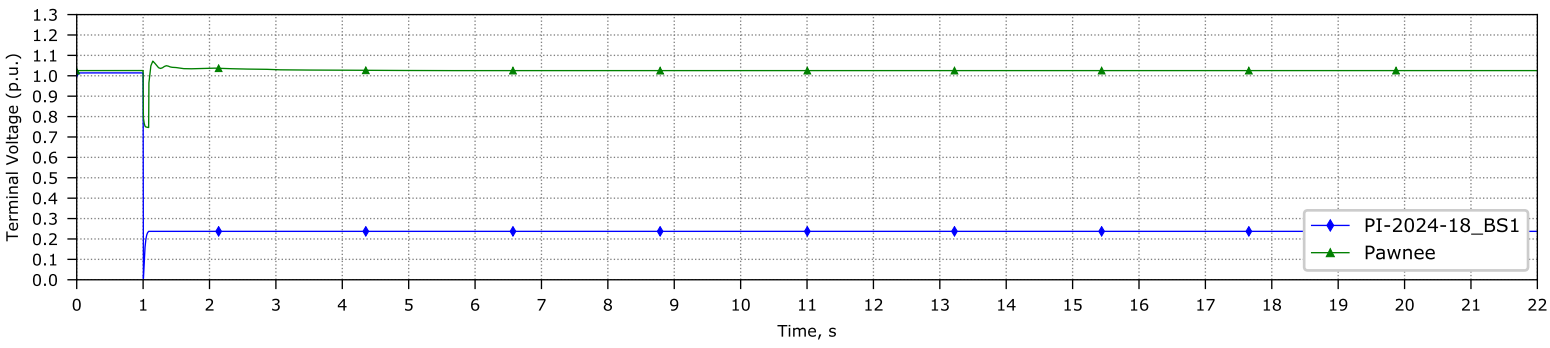


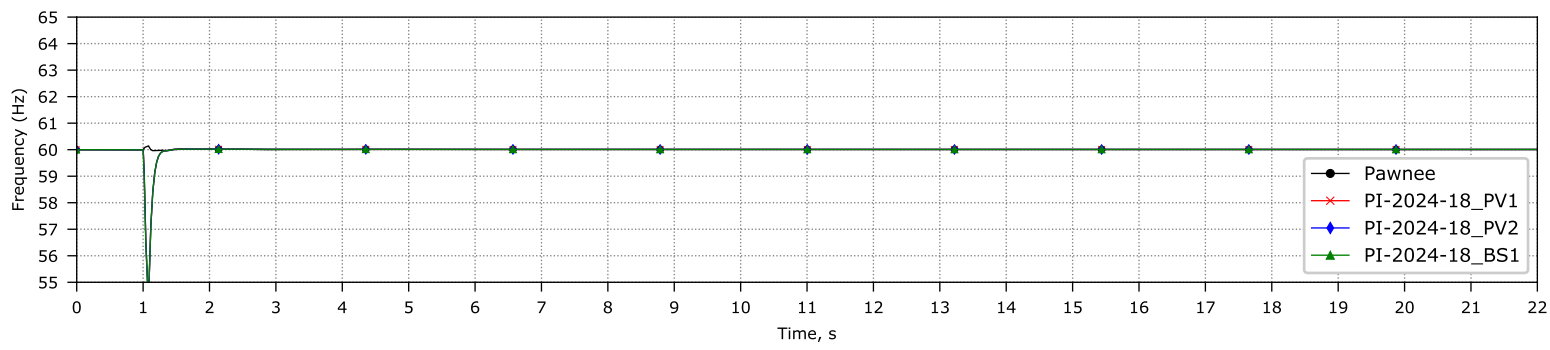


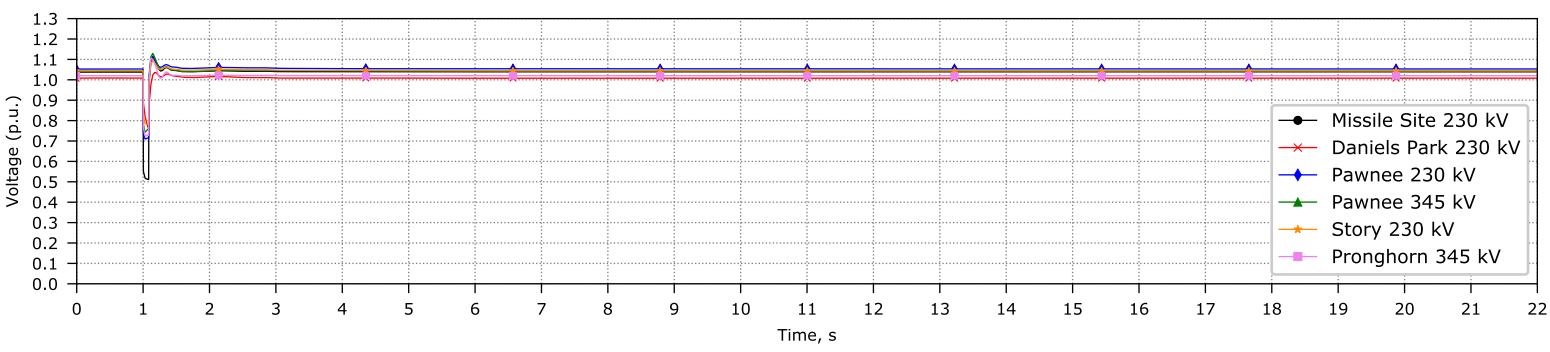




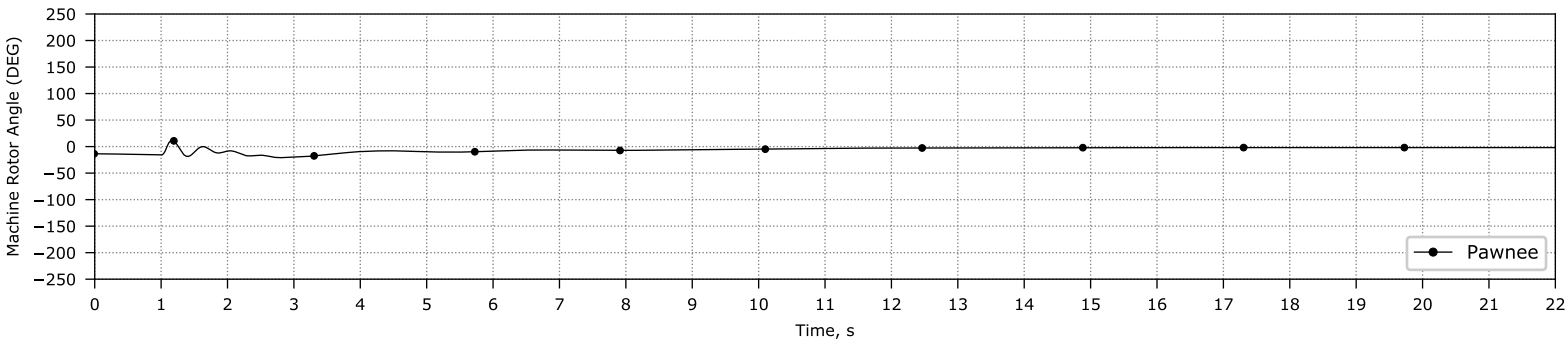


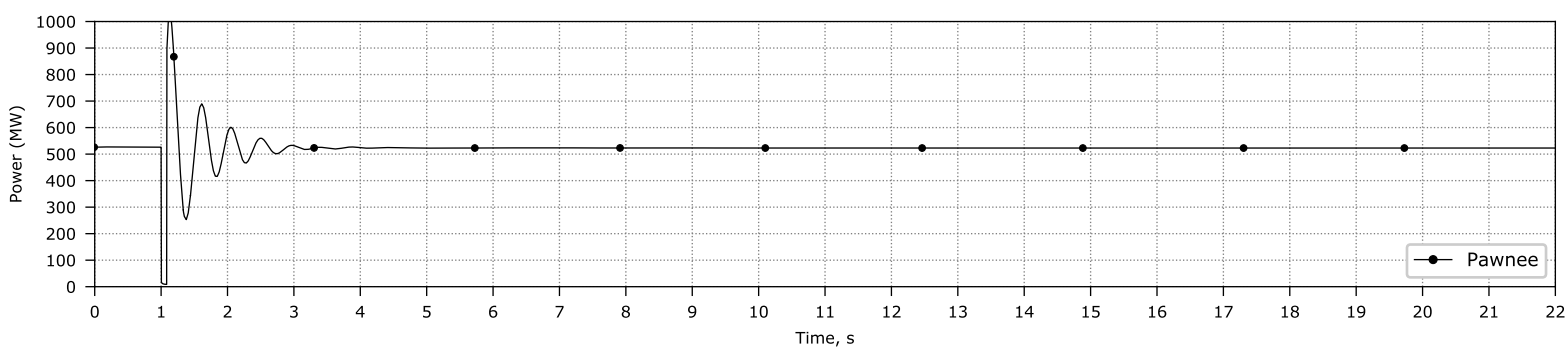


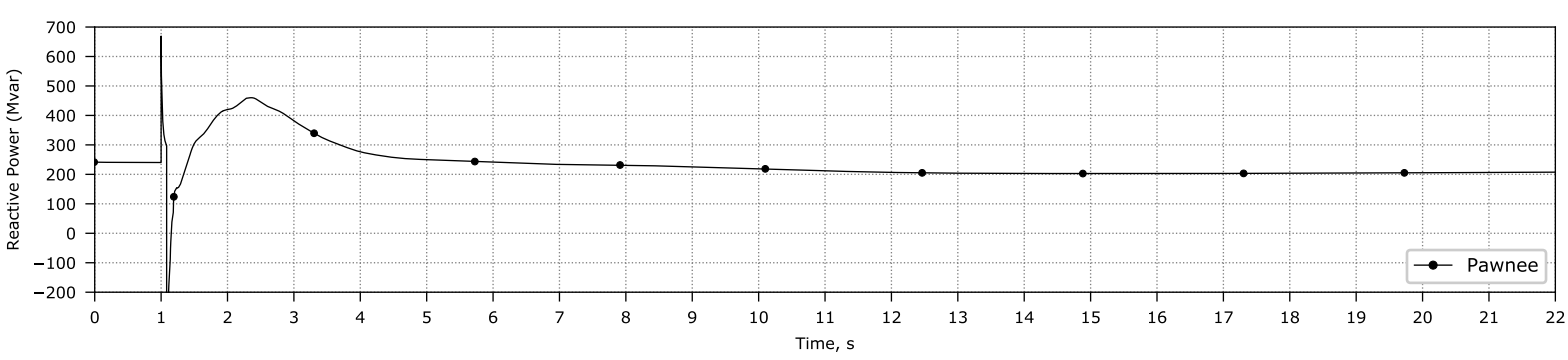


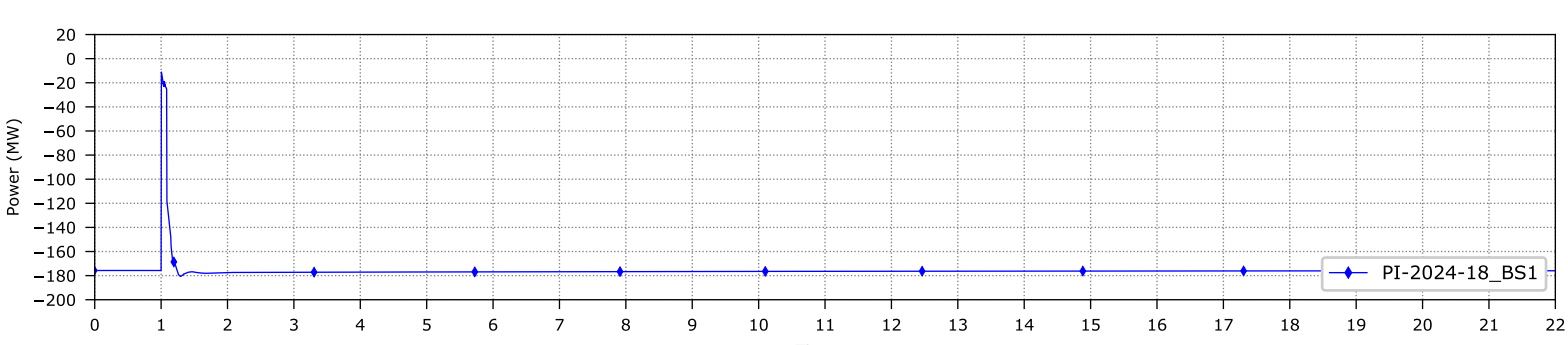


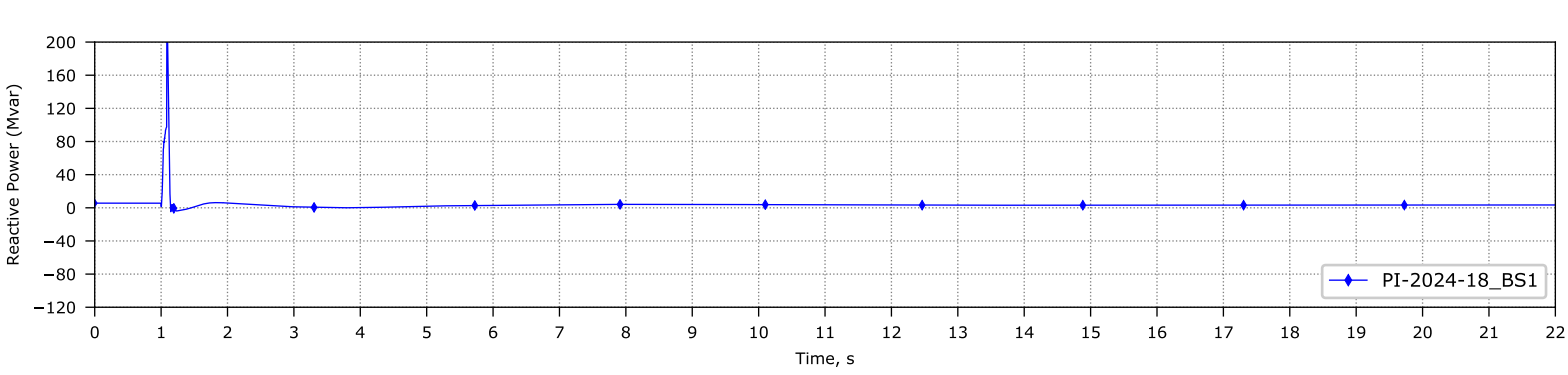
PI-2024-18_Study_East_Pawnee_Xfmr

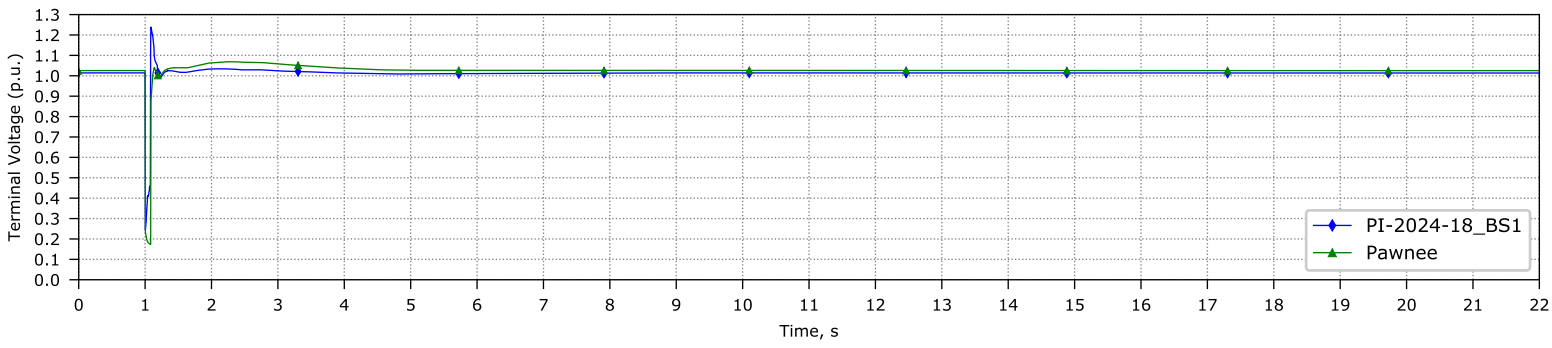


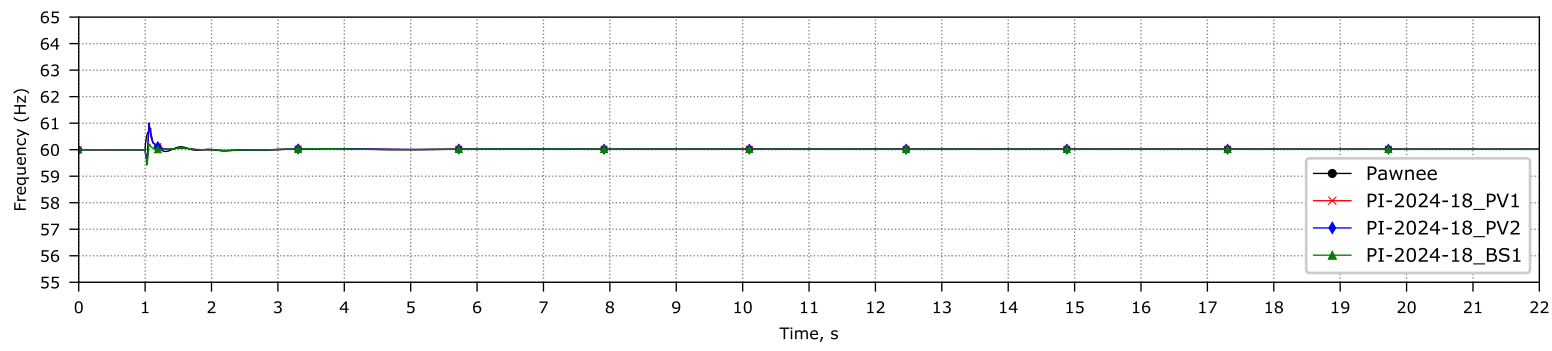


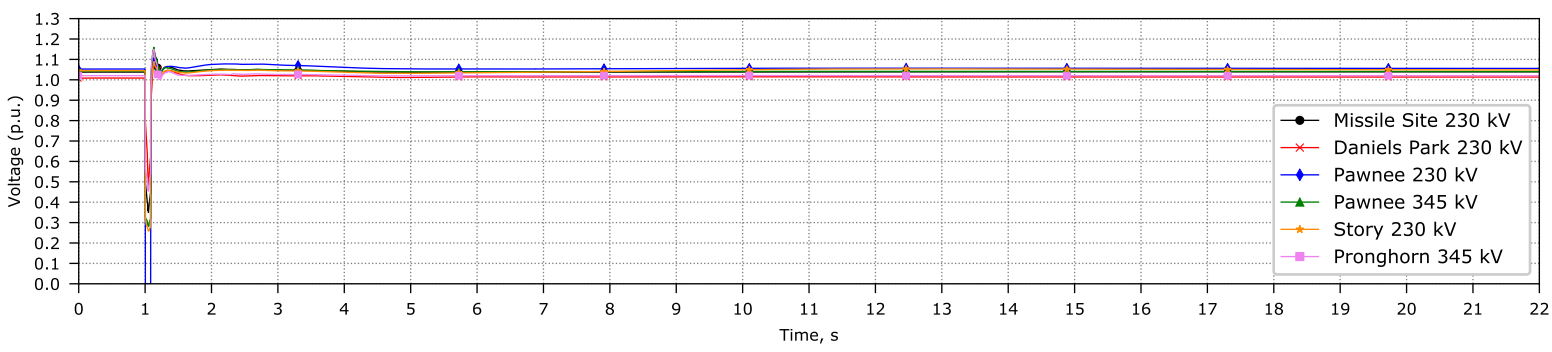




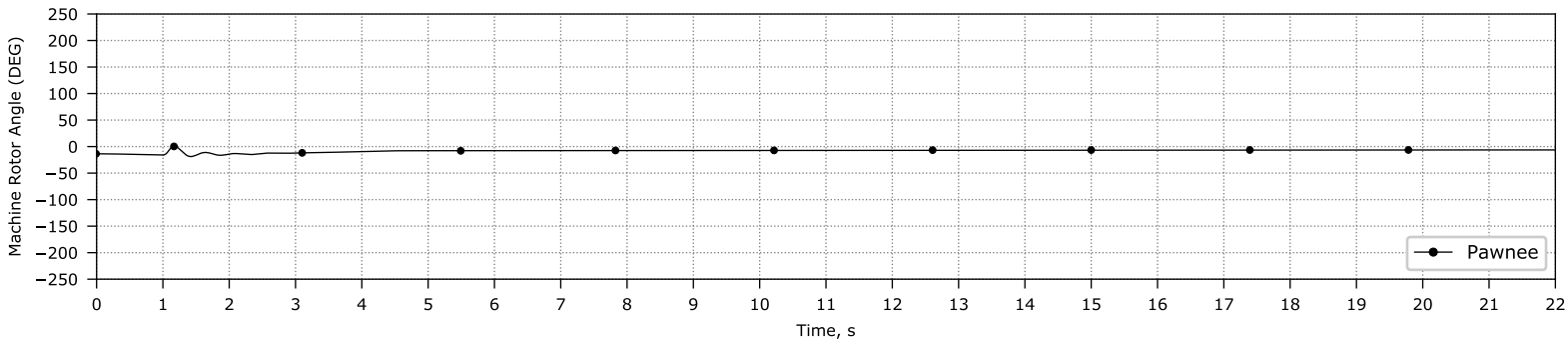


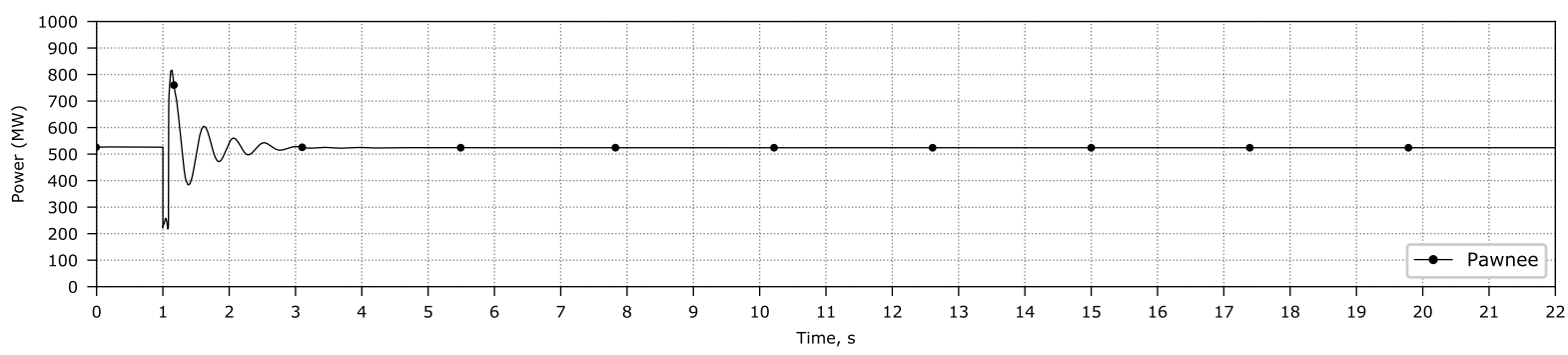


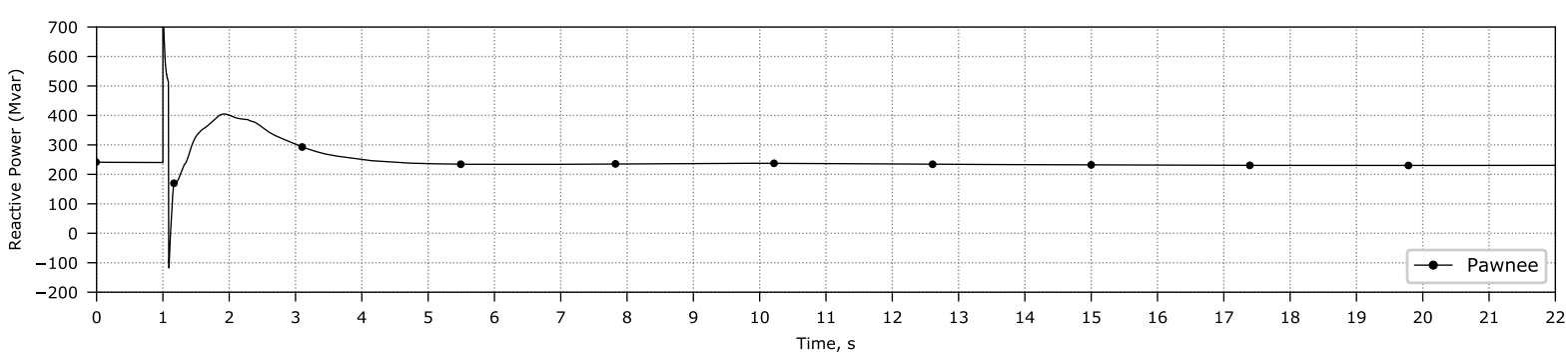


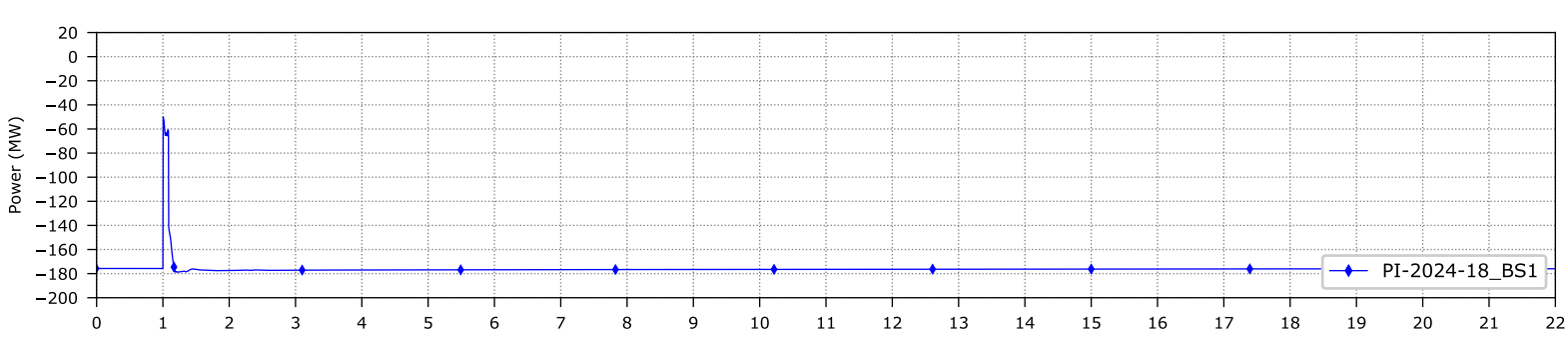


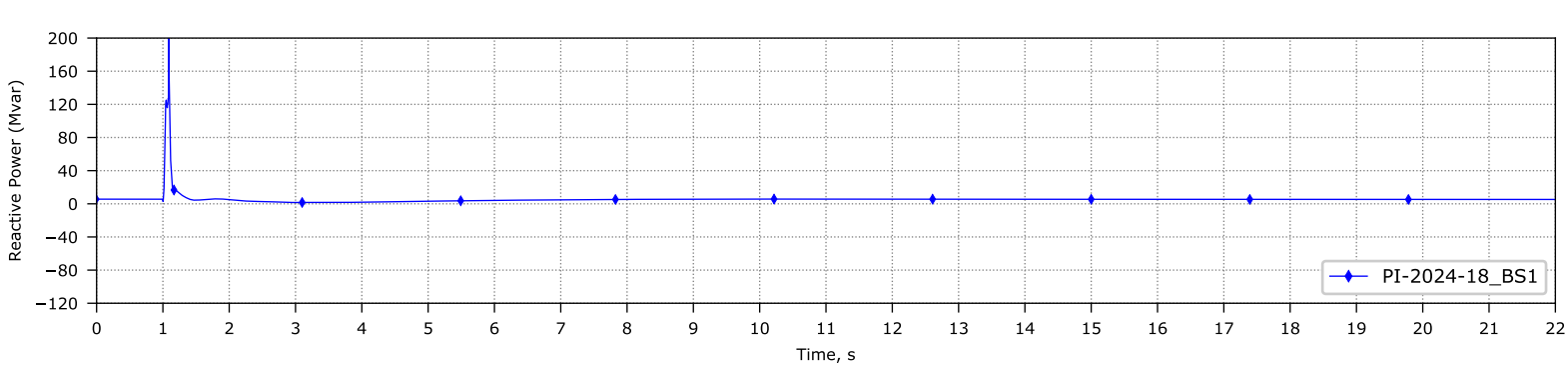
PI-2024-18_Study_East_Pawnee-FtLupton_230kV

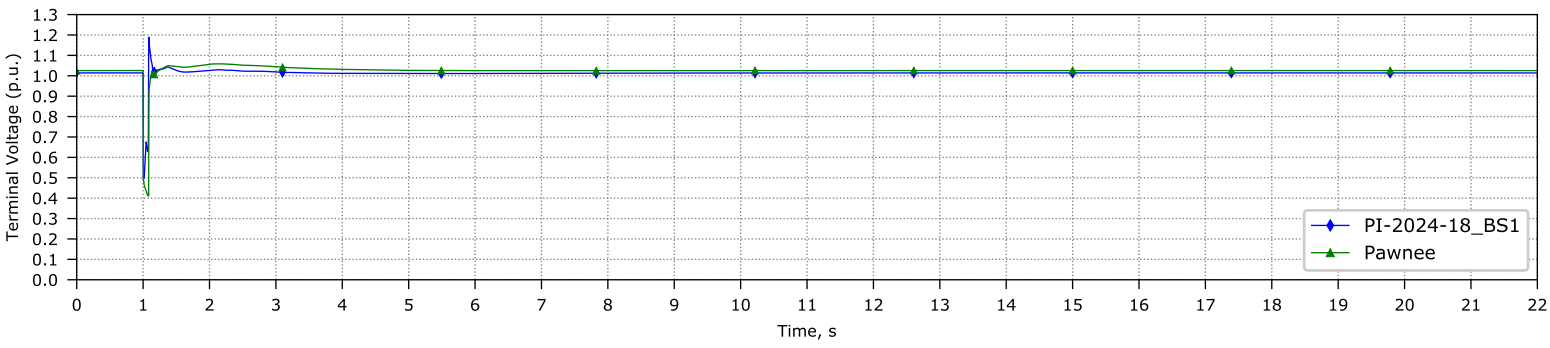


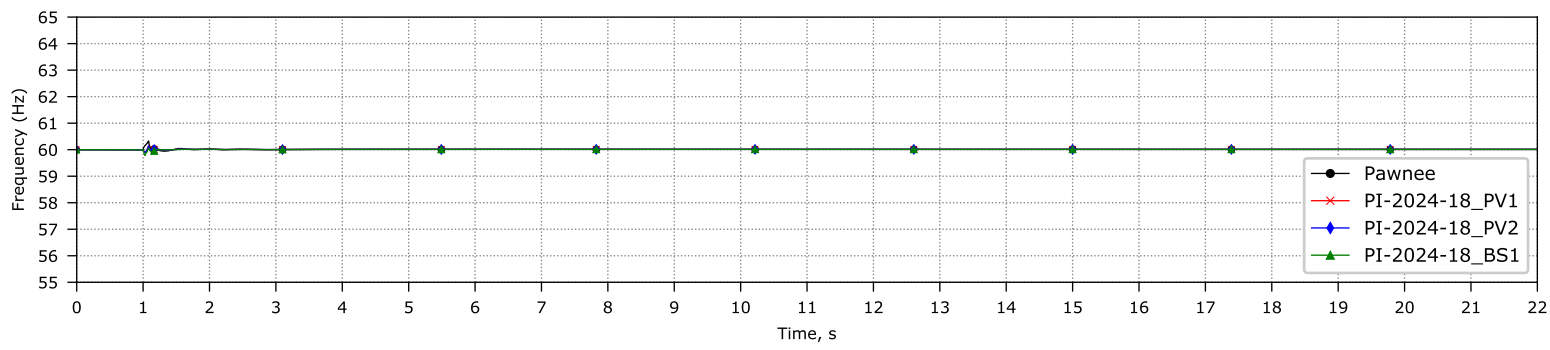


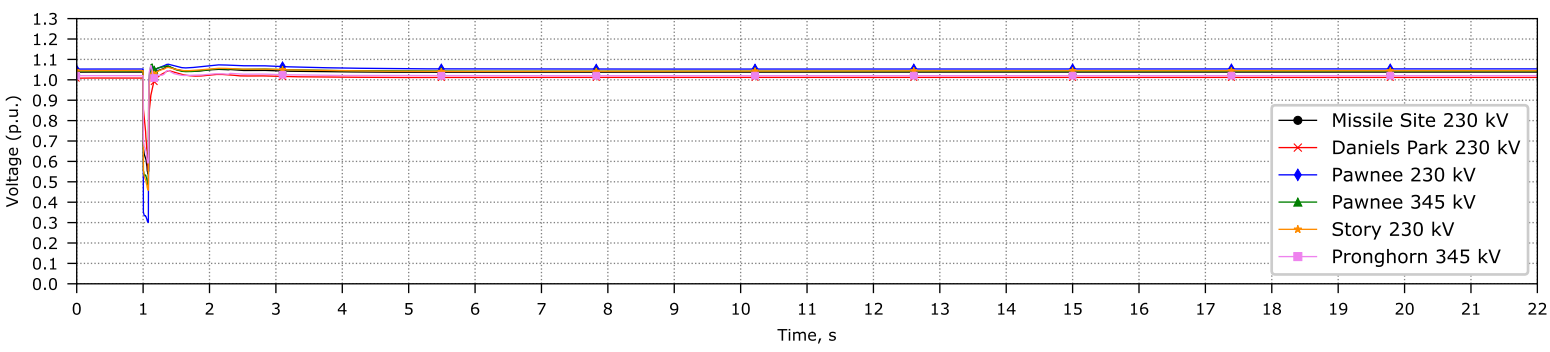




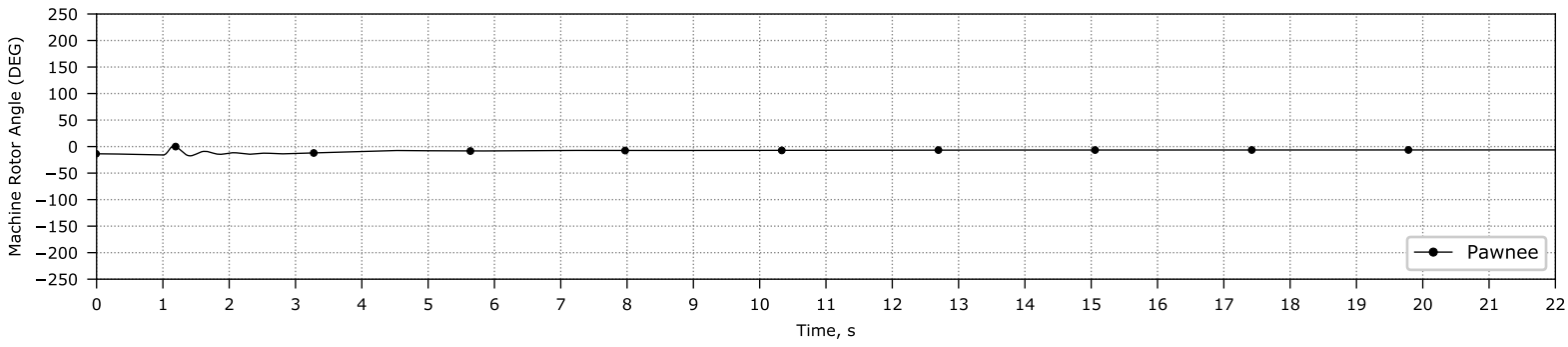


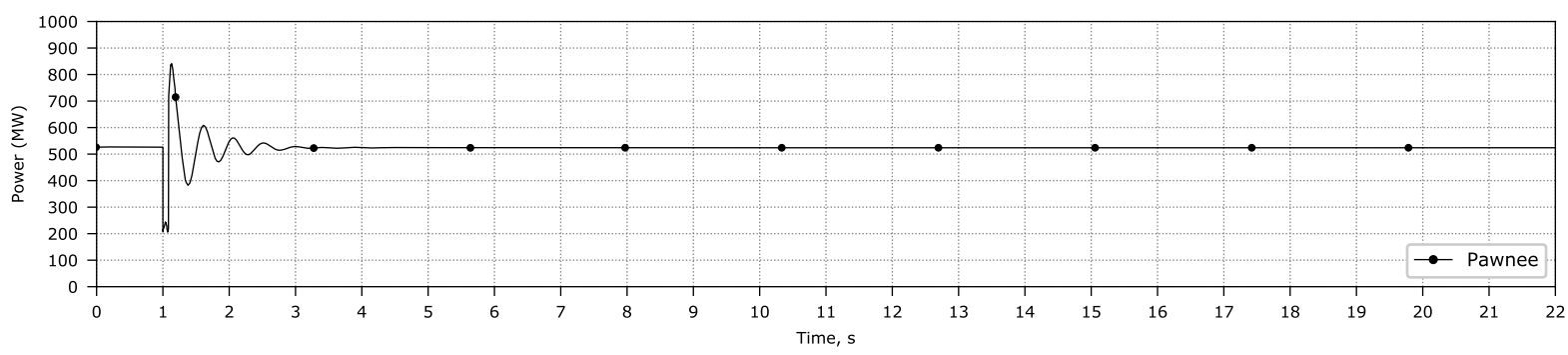


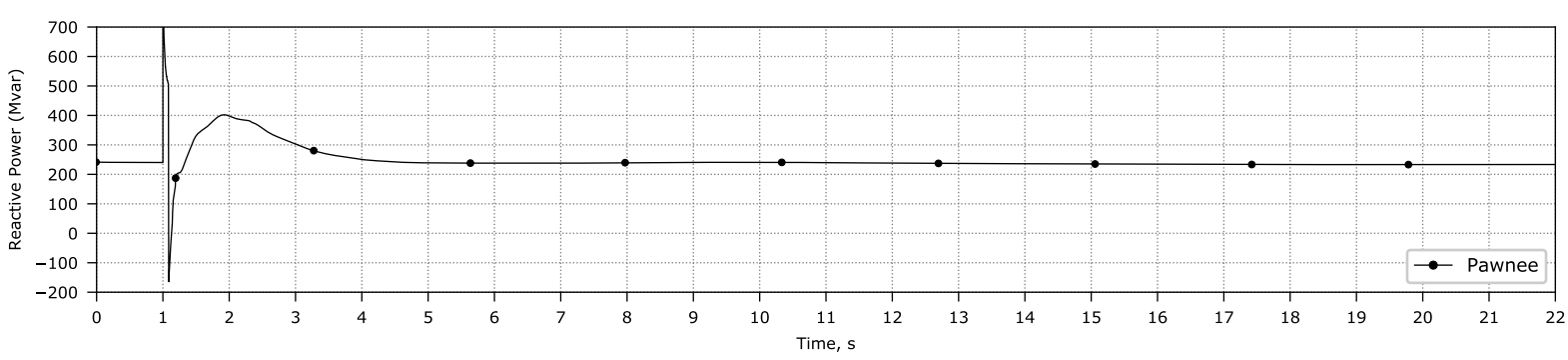


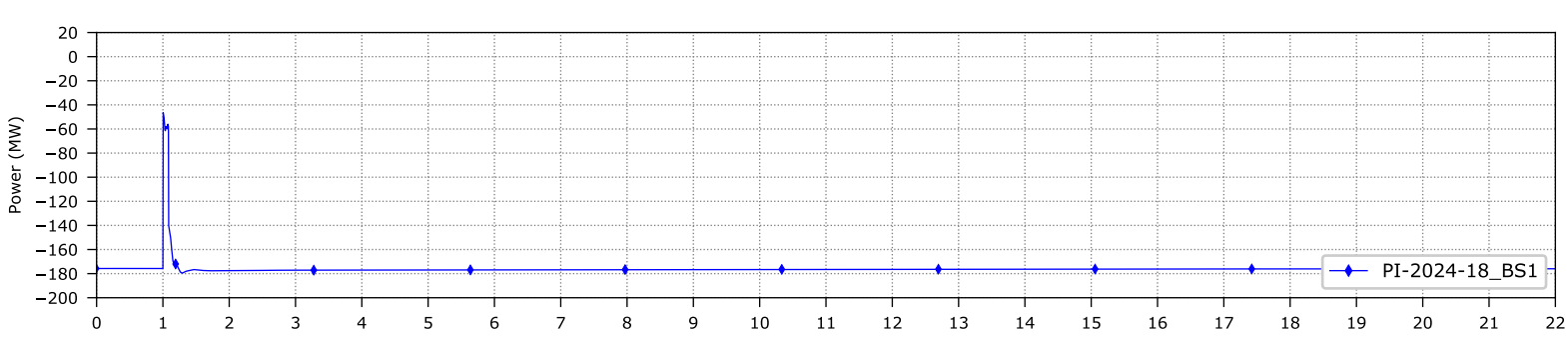


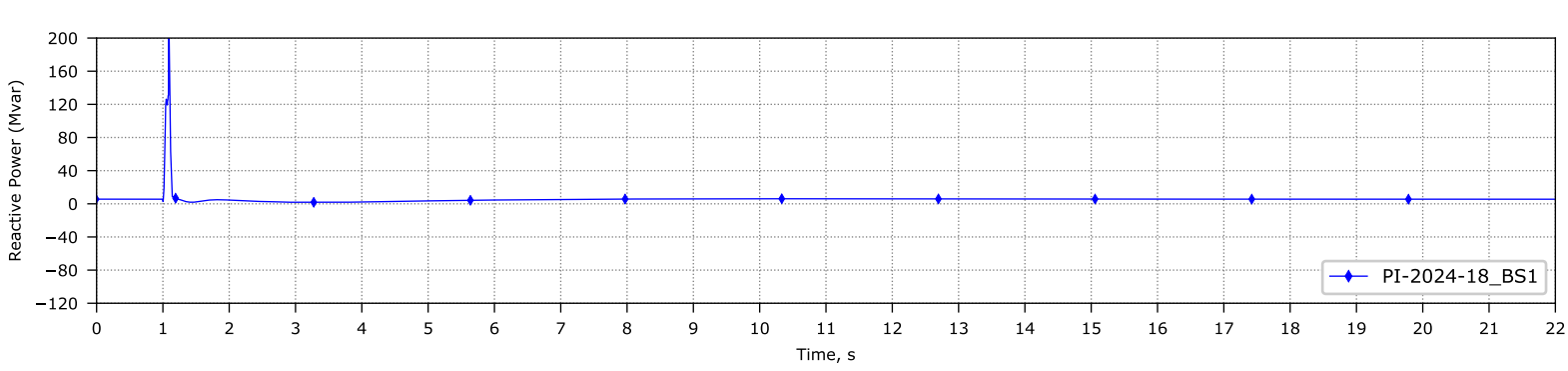
PI-2024-18_Study_East_Pawnee-BrickCtr_230kV

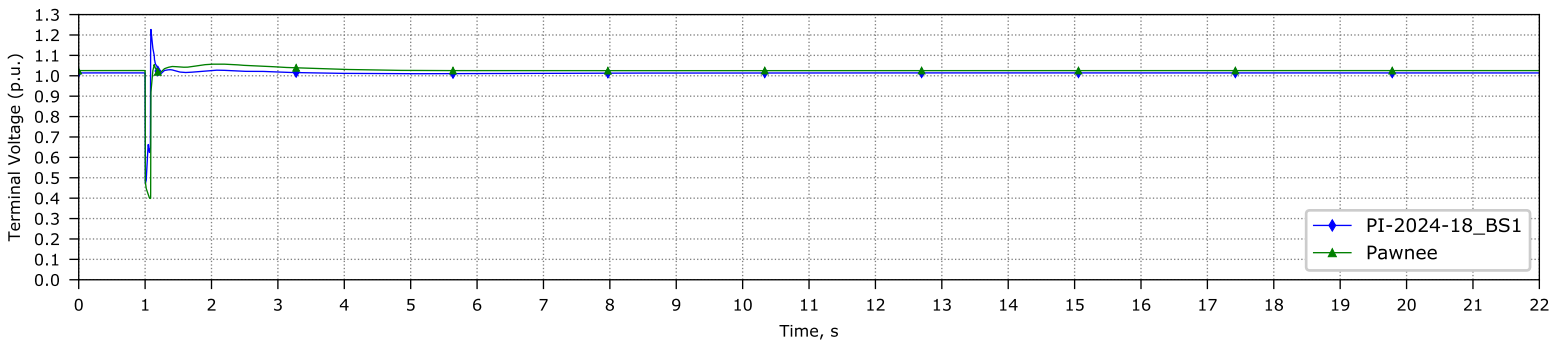


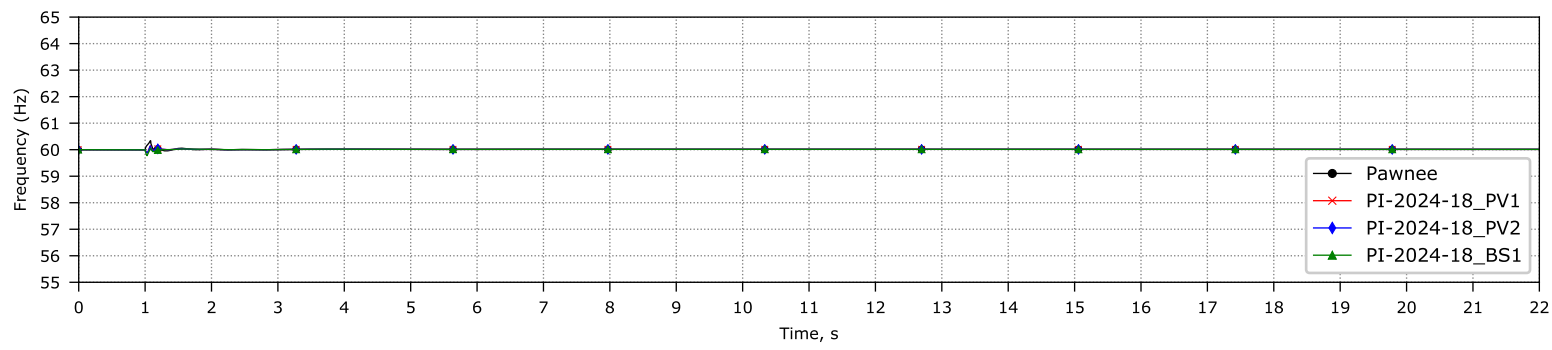


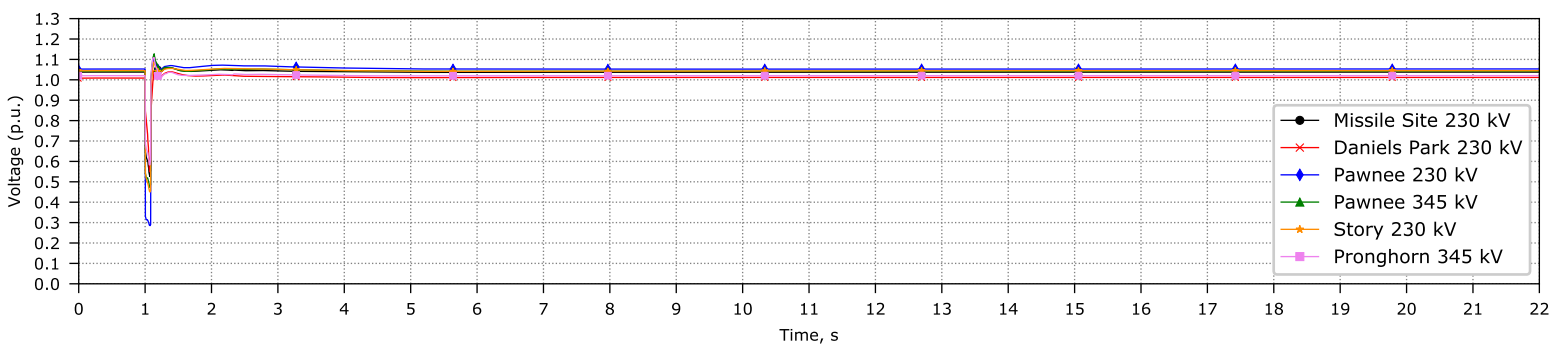




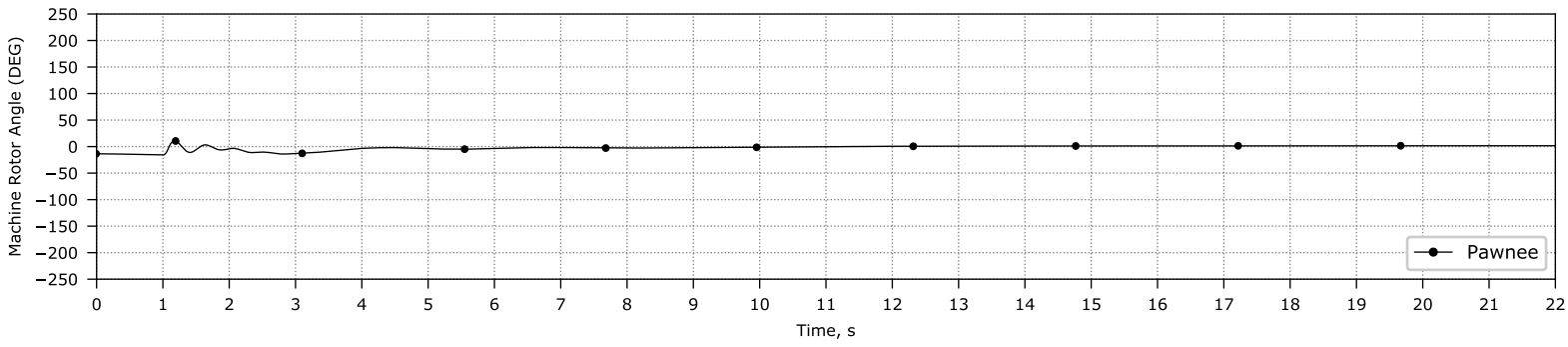


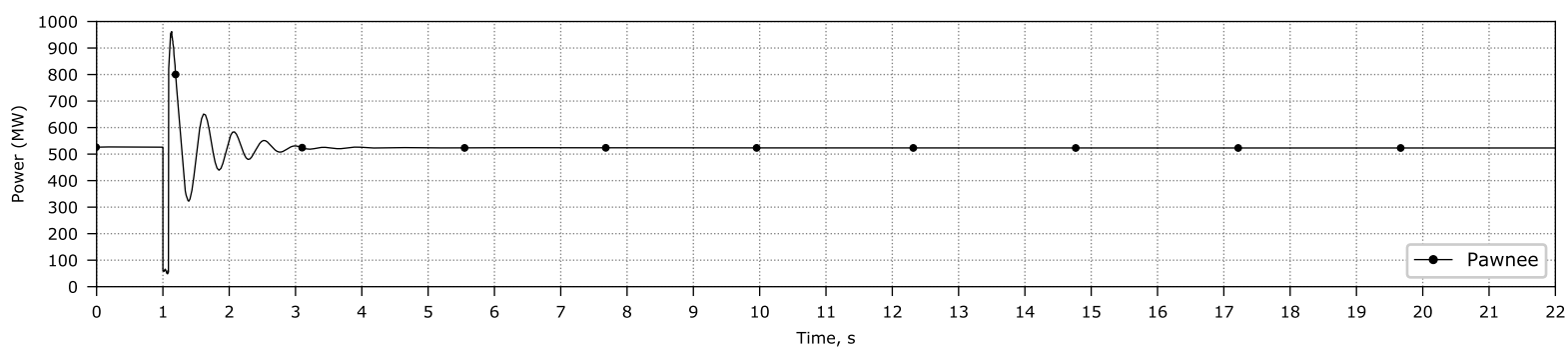


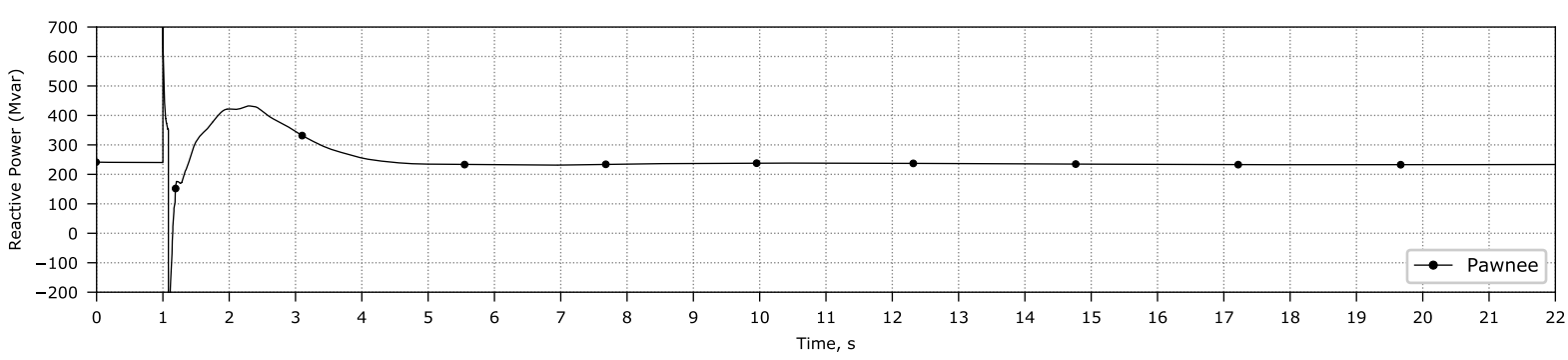


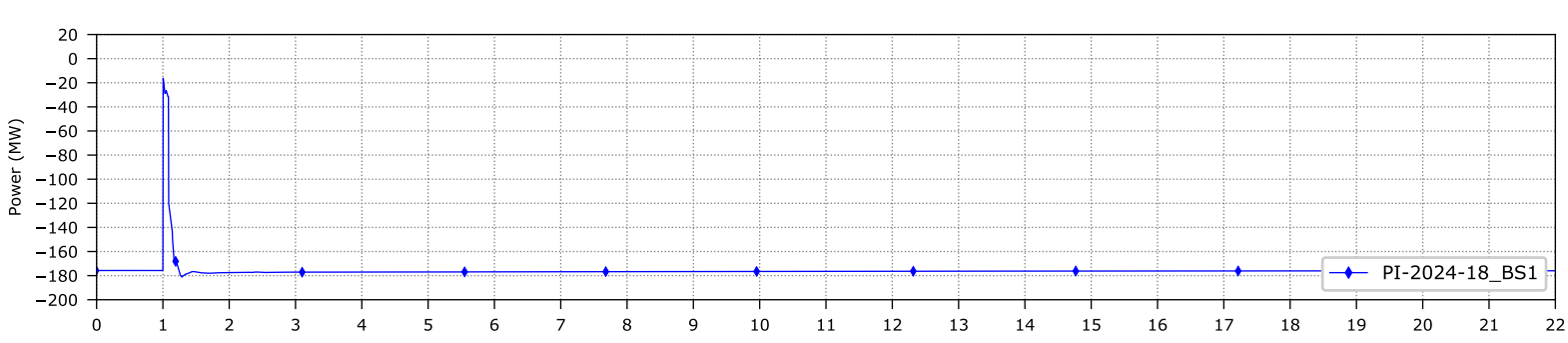


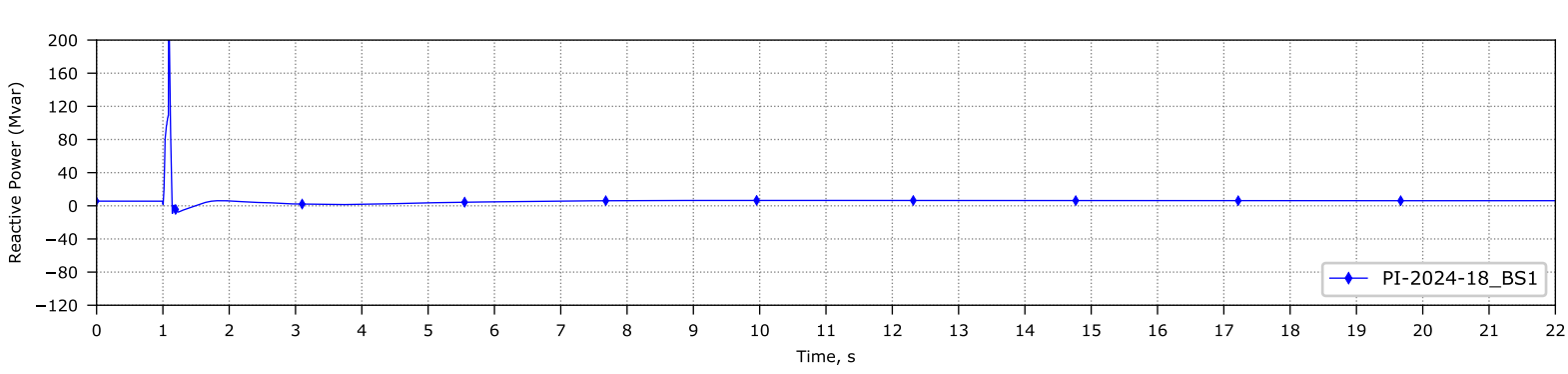
PI-2024-18_Study_East_Pawnee-Story_230kV

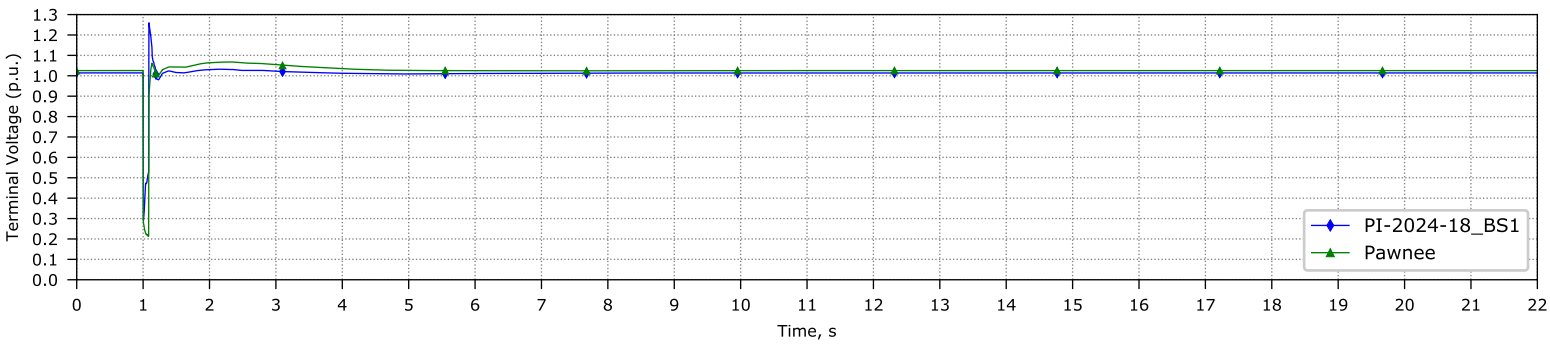


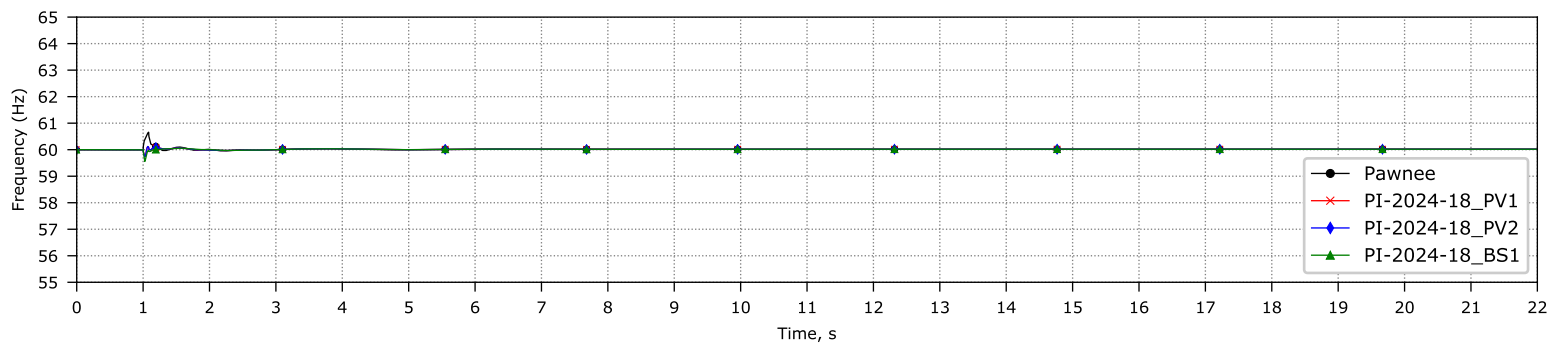


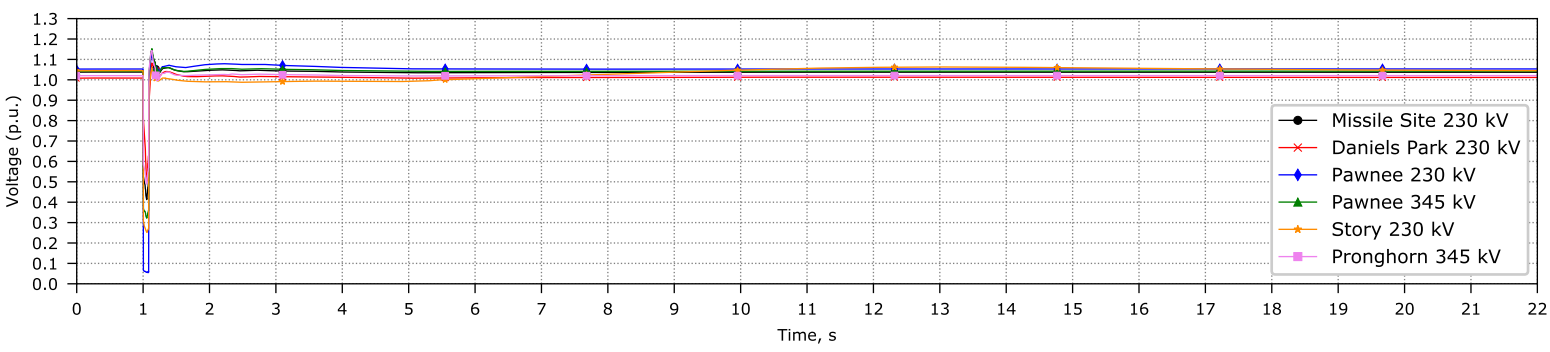




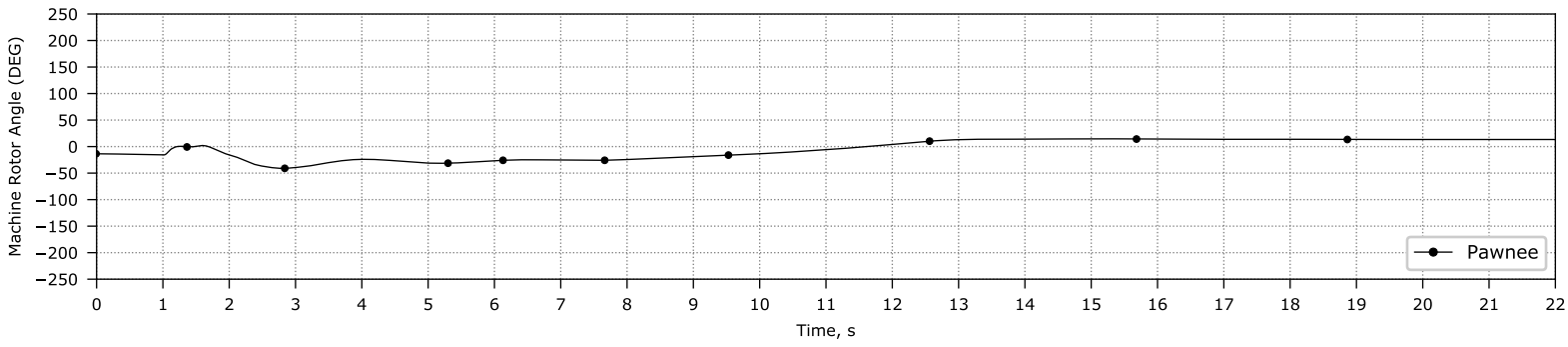


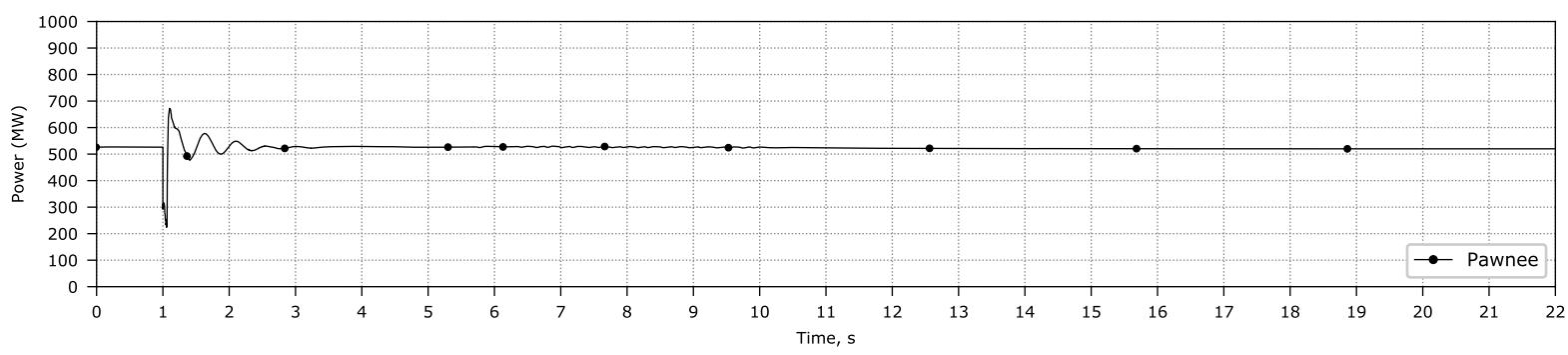


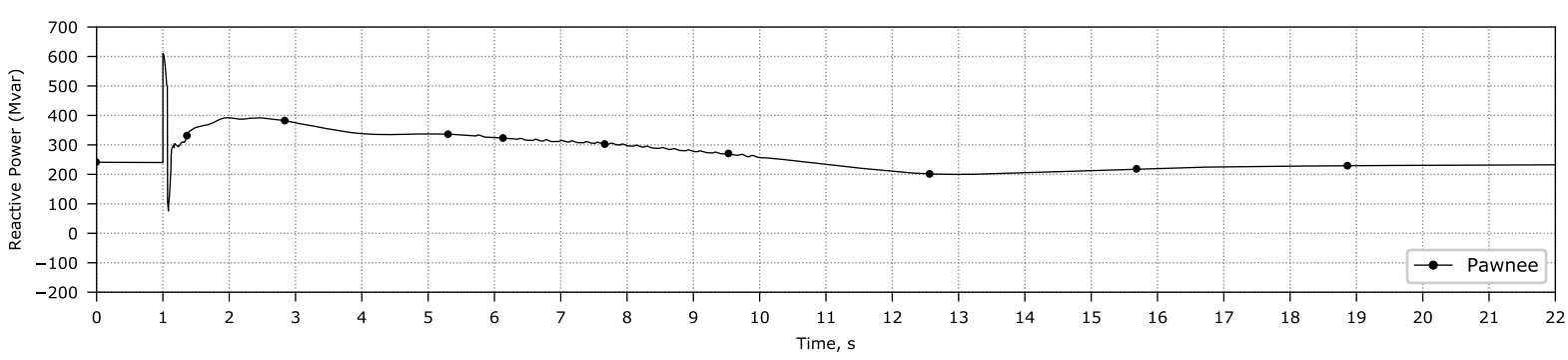


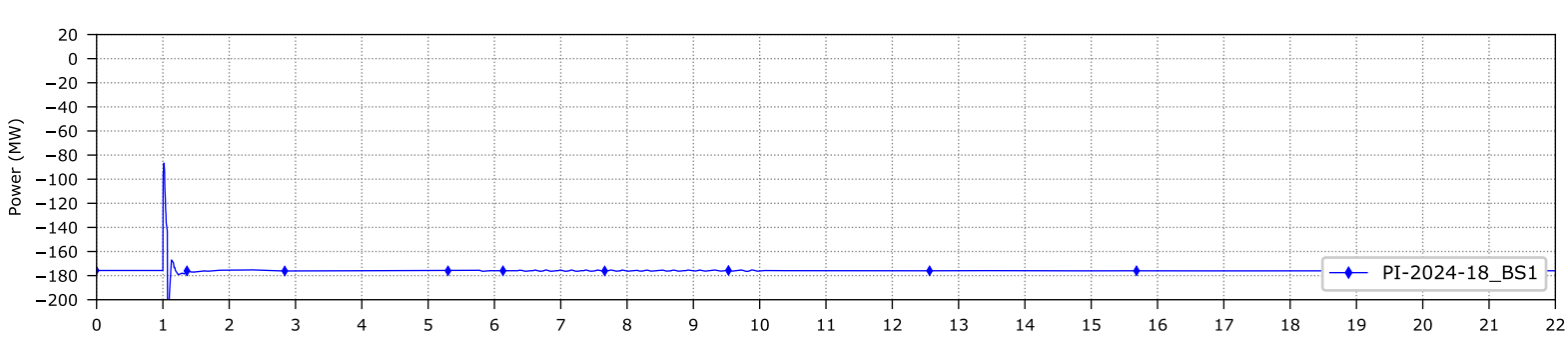


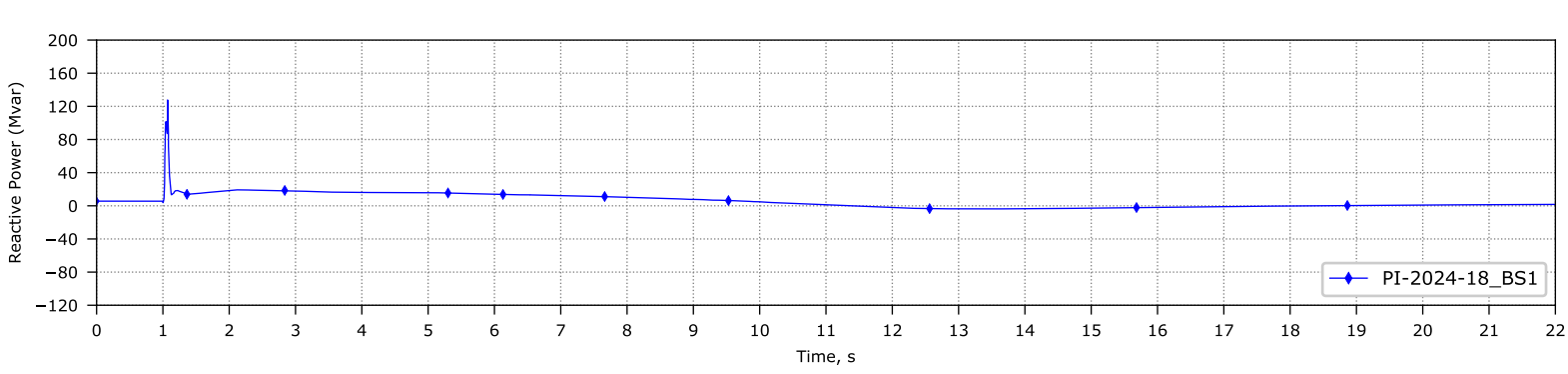
PI-2024-18_Study_East_MissSite-Daniels_230kV

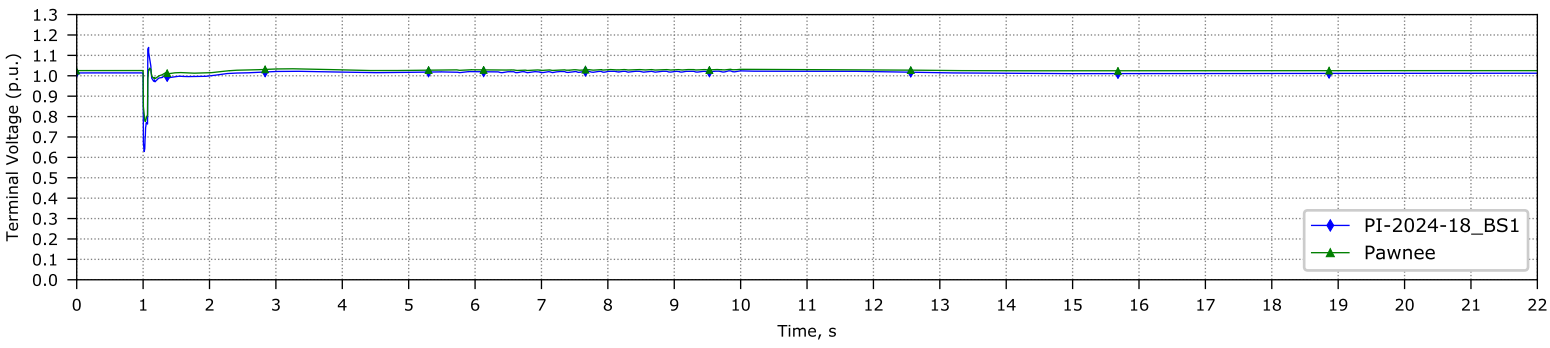


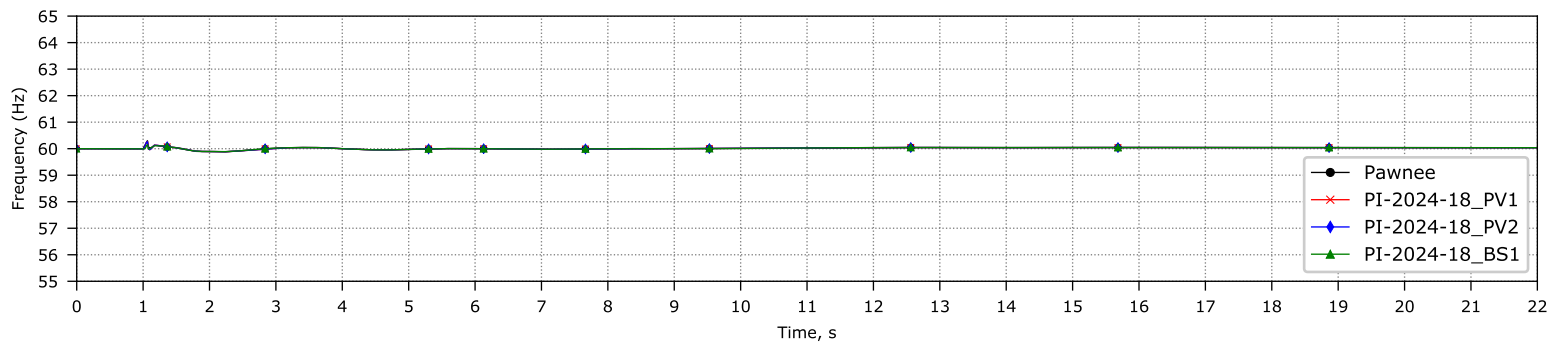


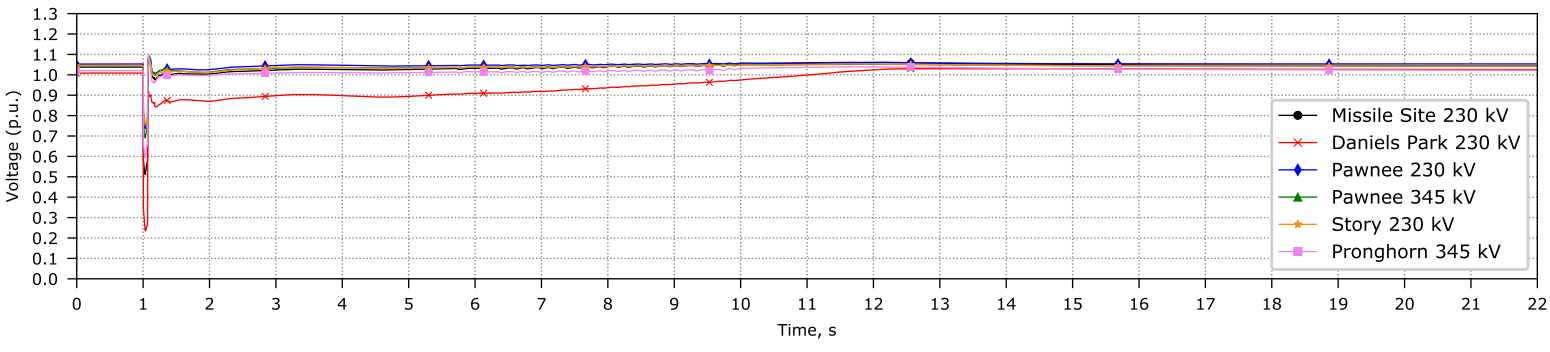




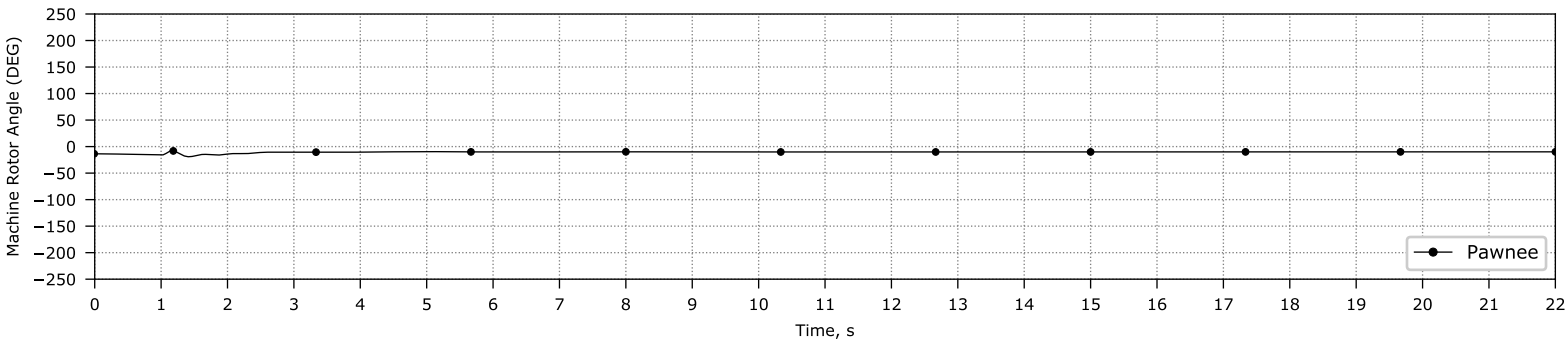


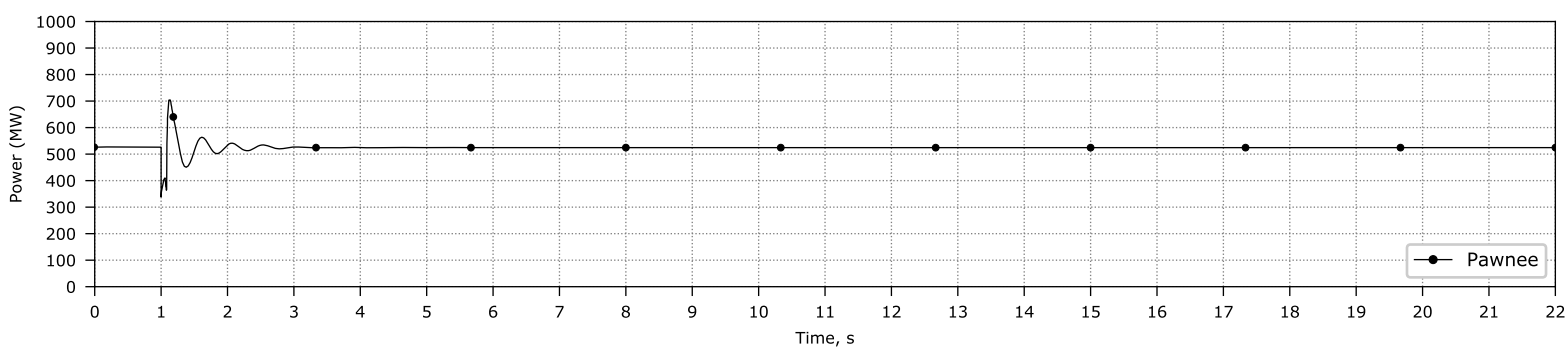


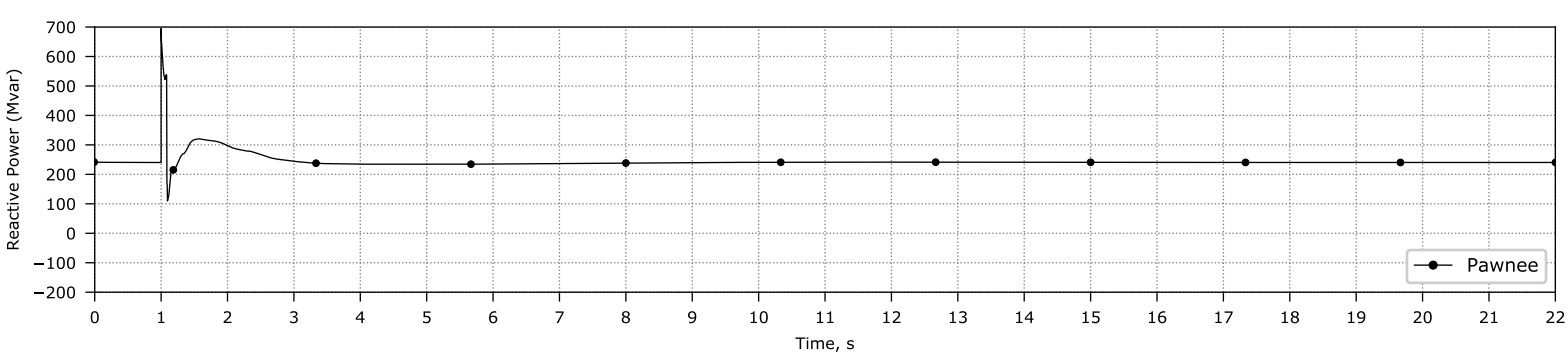


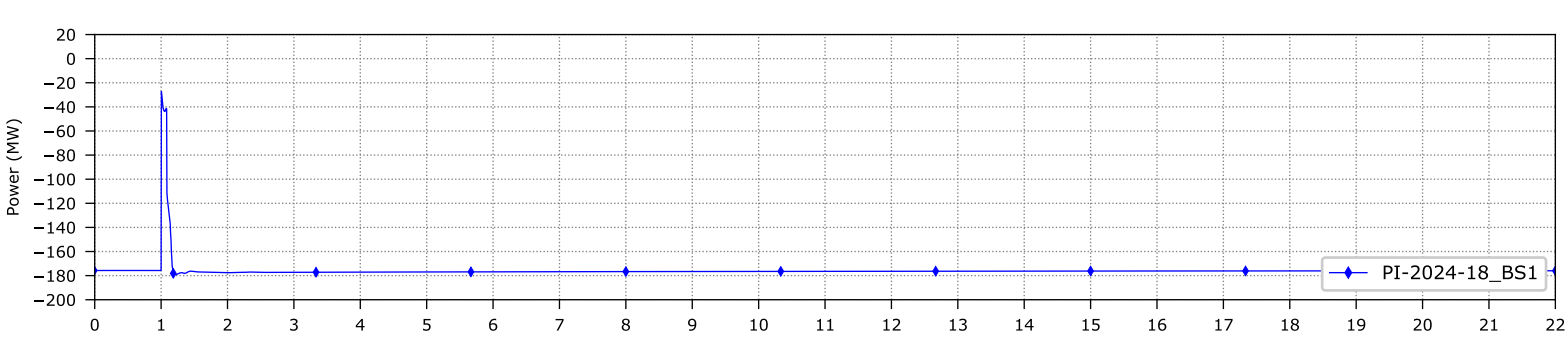


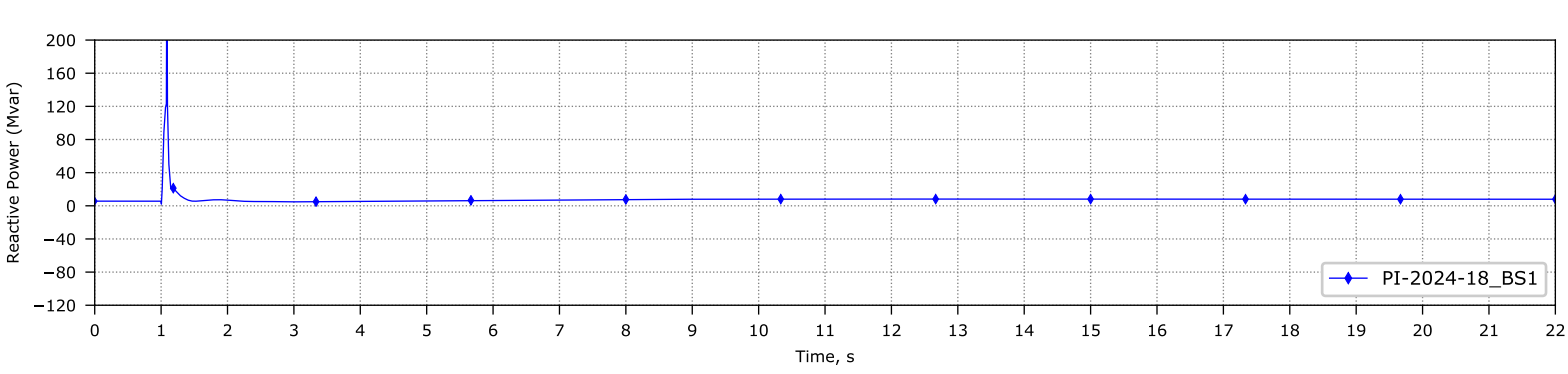
PI-2024-18_Study_East_MissSite_Xfmr

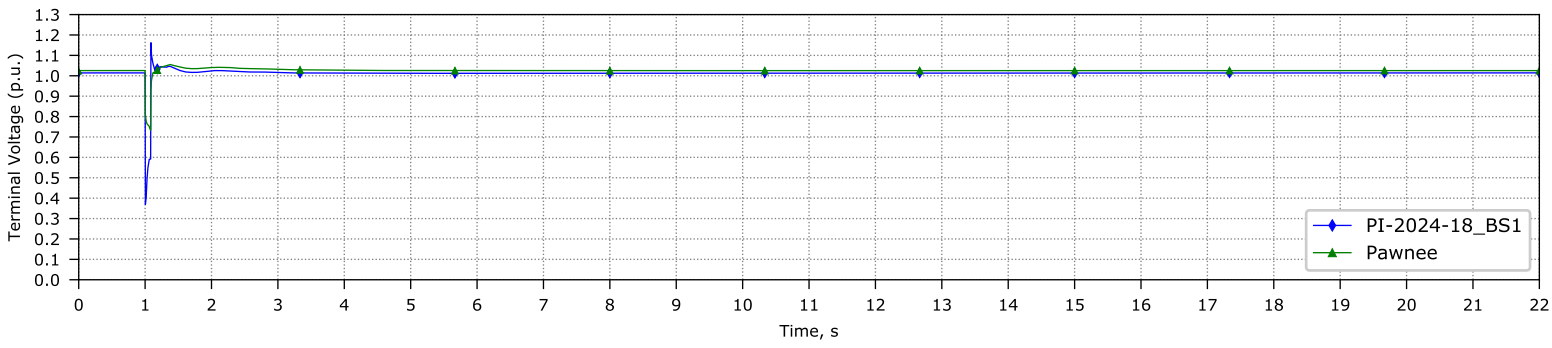


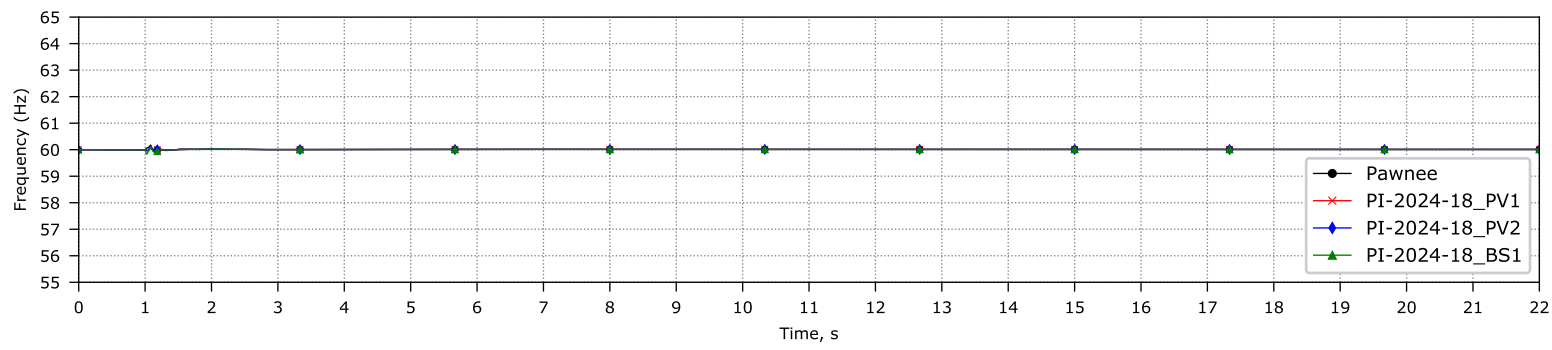


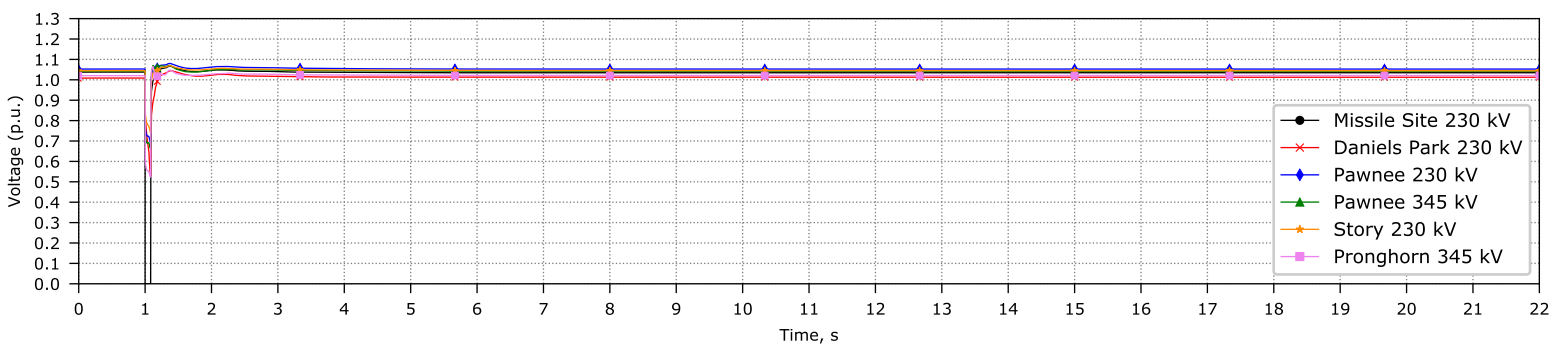




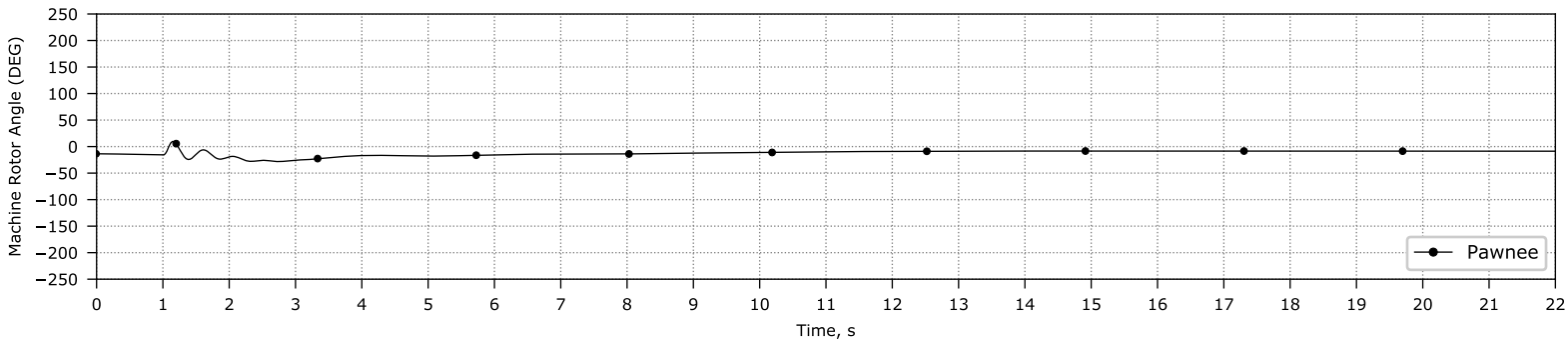


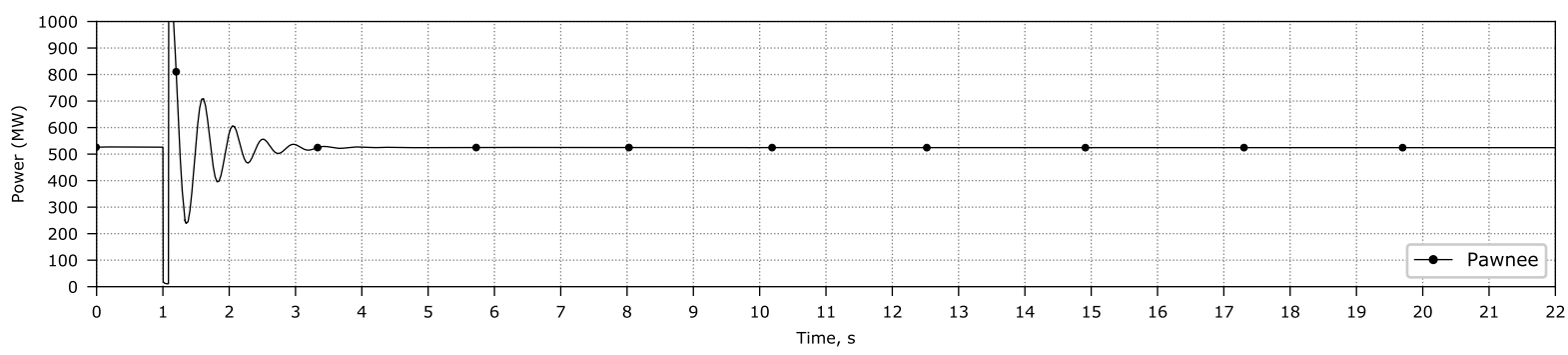


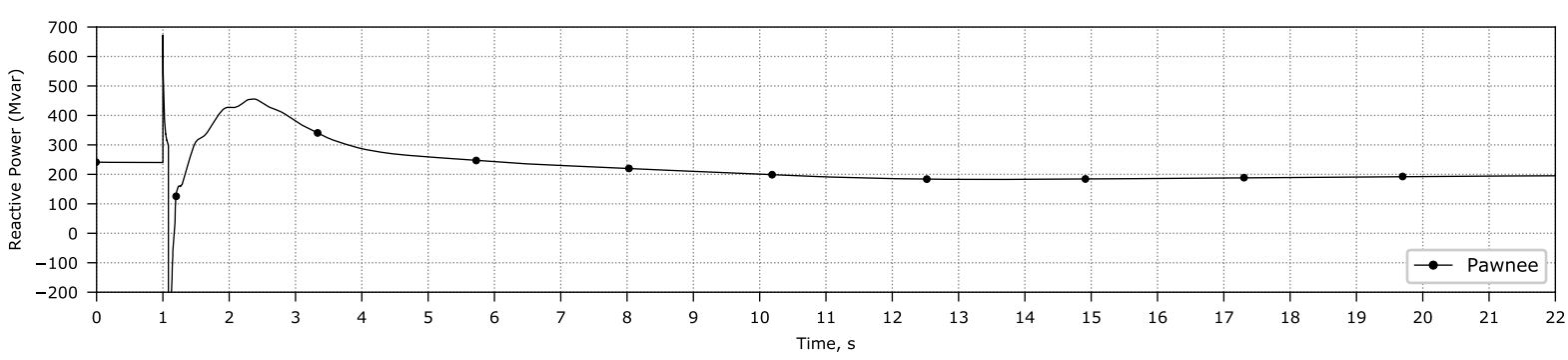


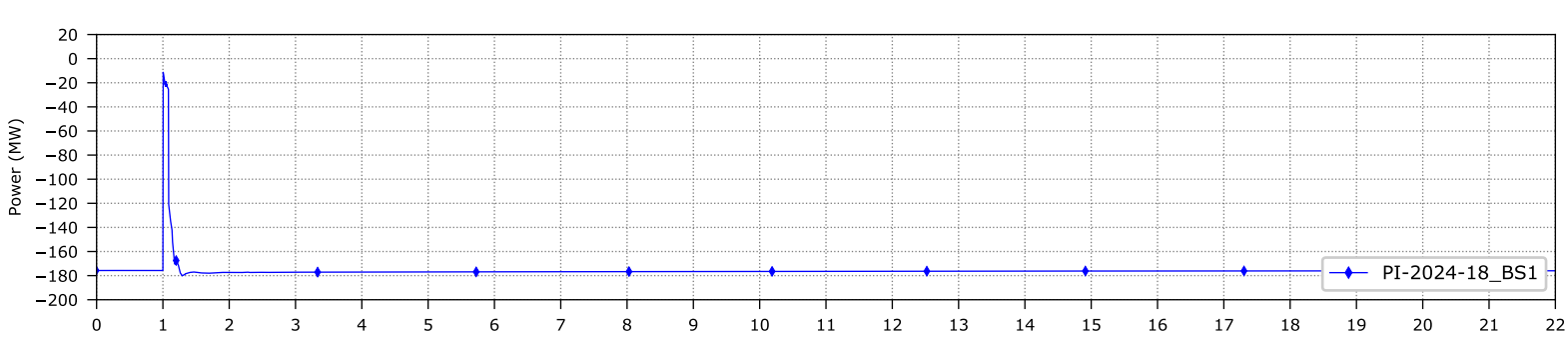


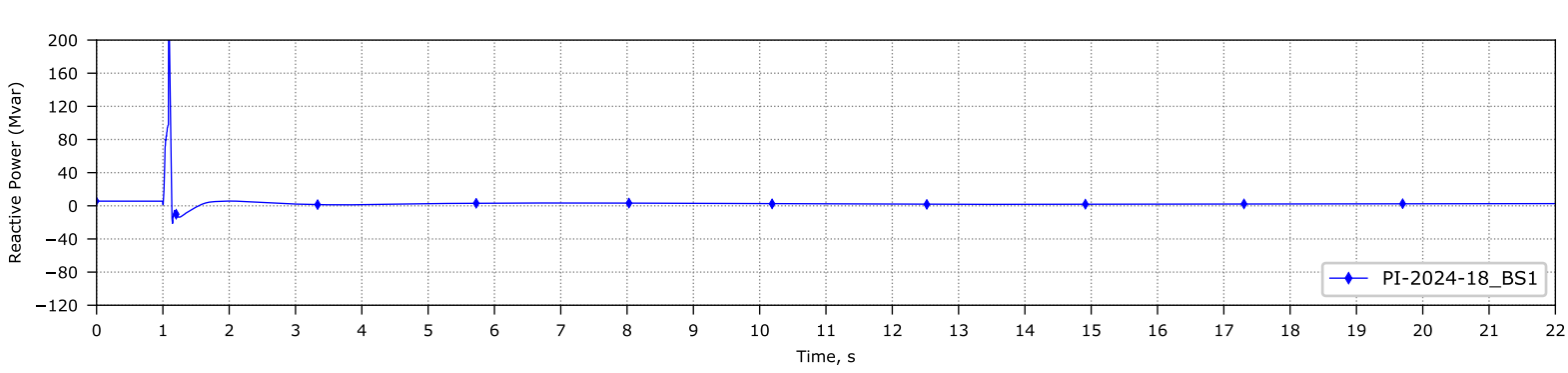
PI-2024-18_Study_East_Pawnee-Manchief_230kV

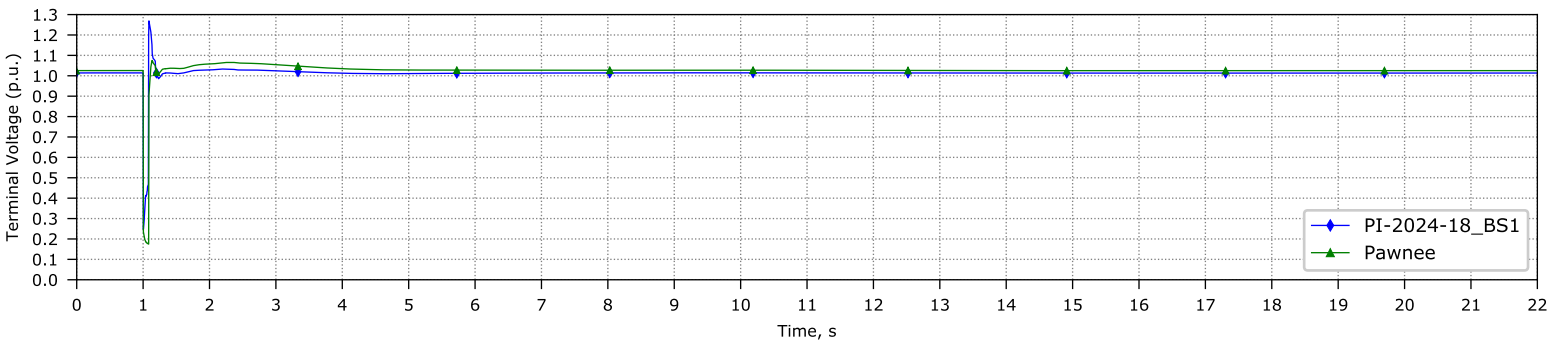


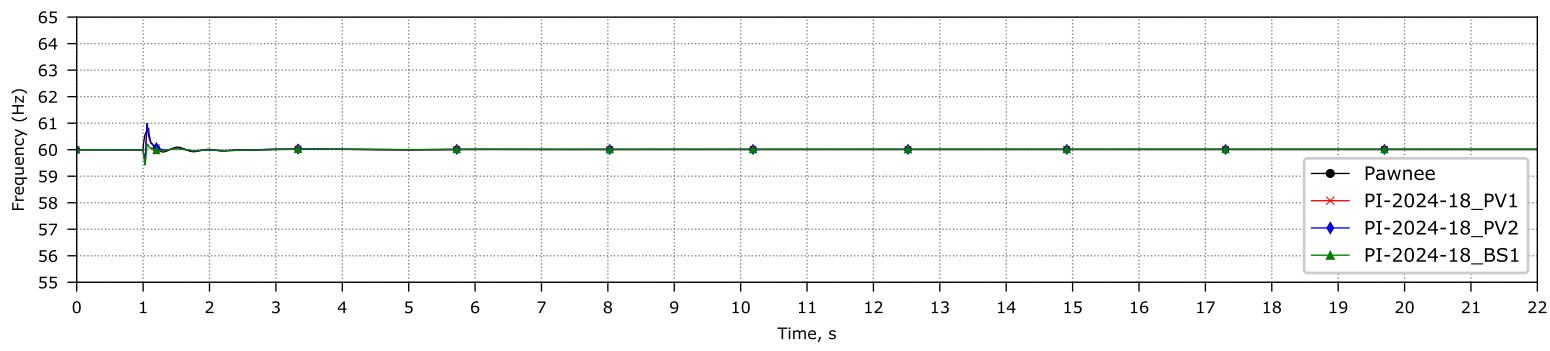


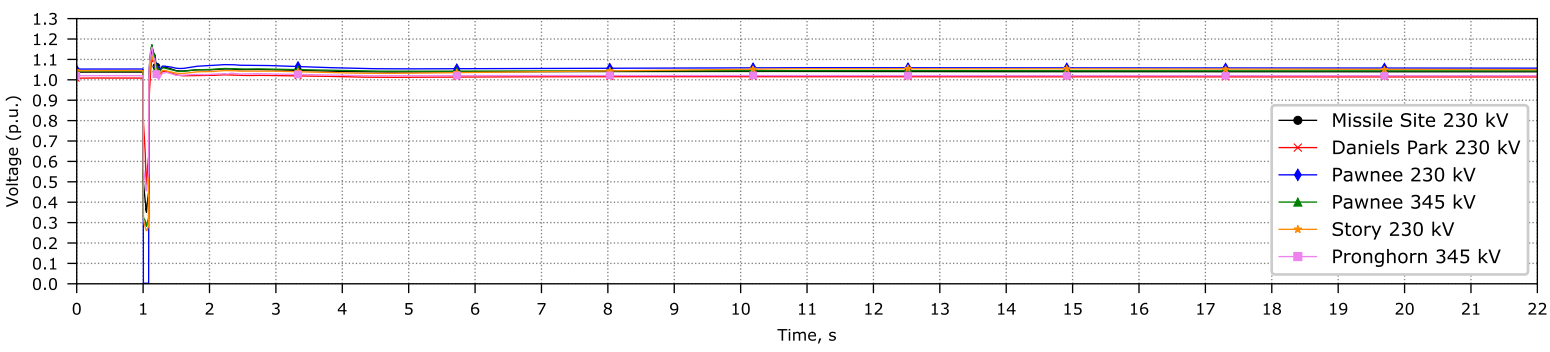












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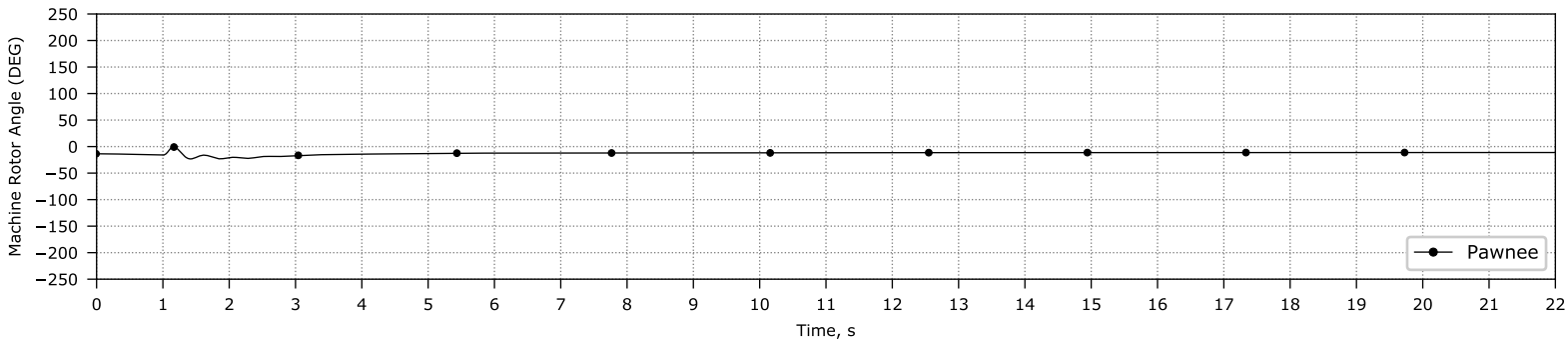

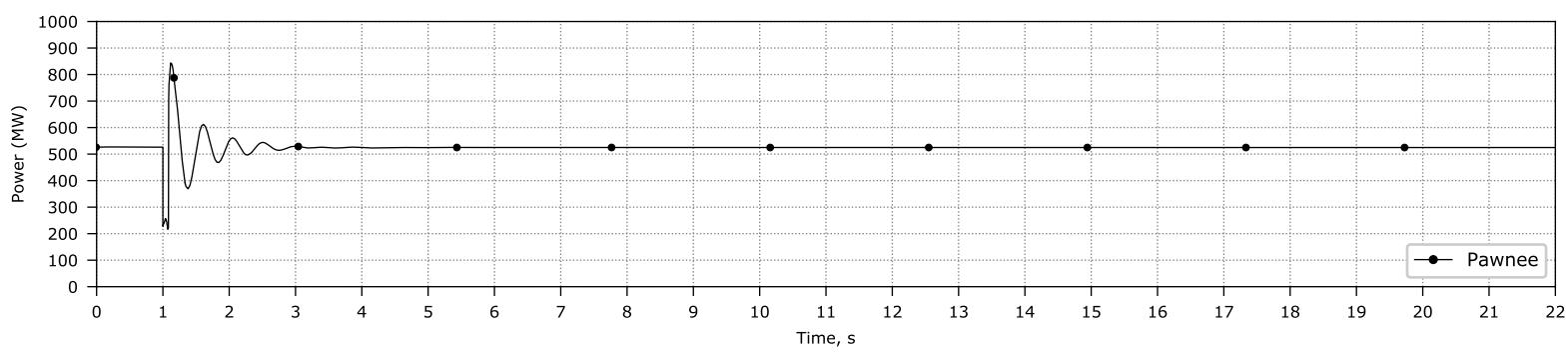

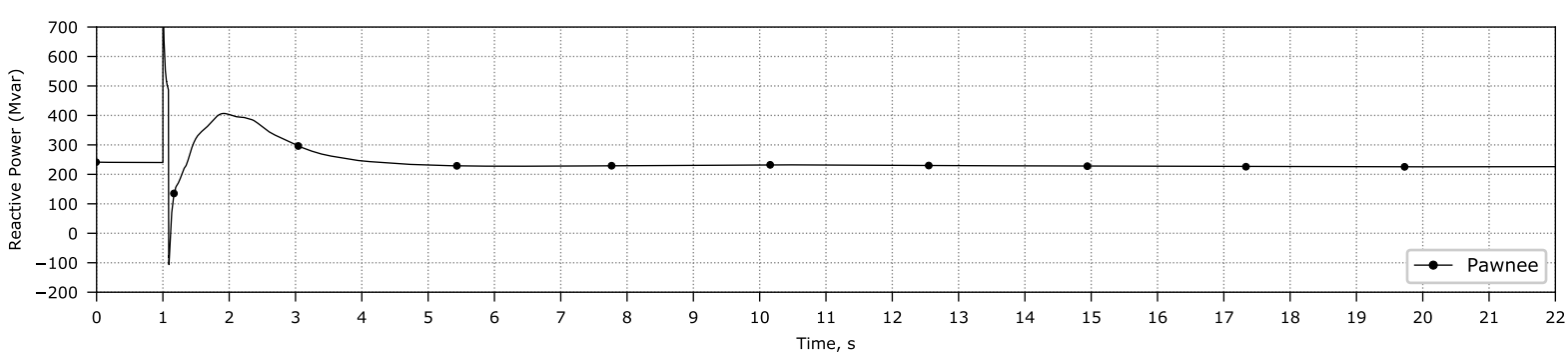

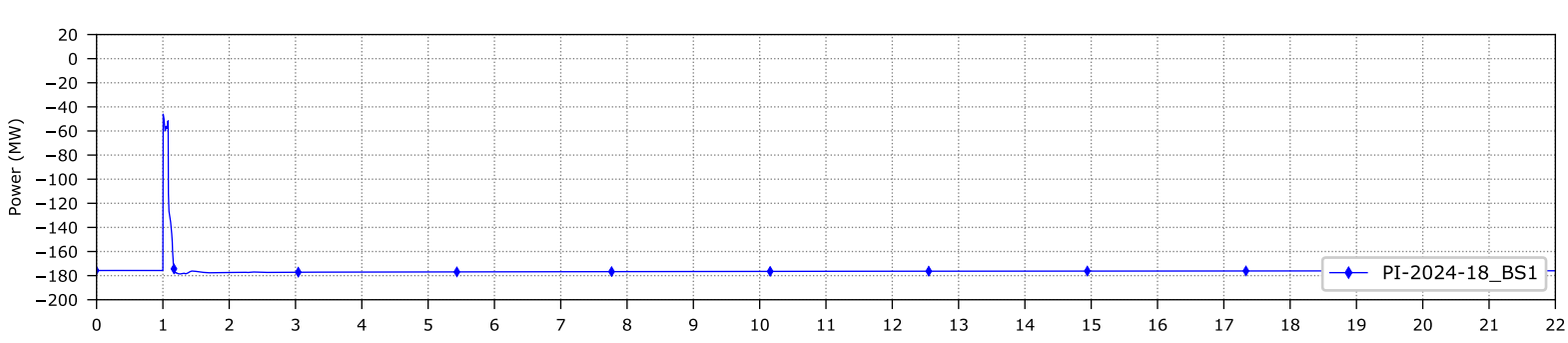

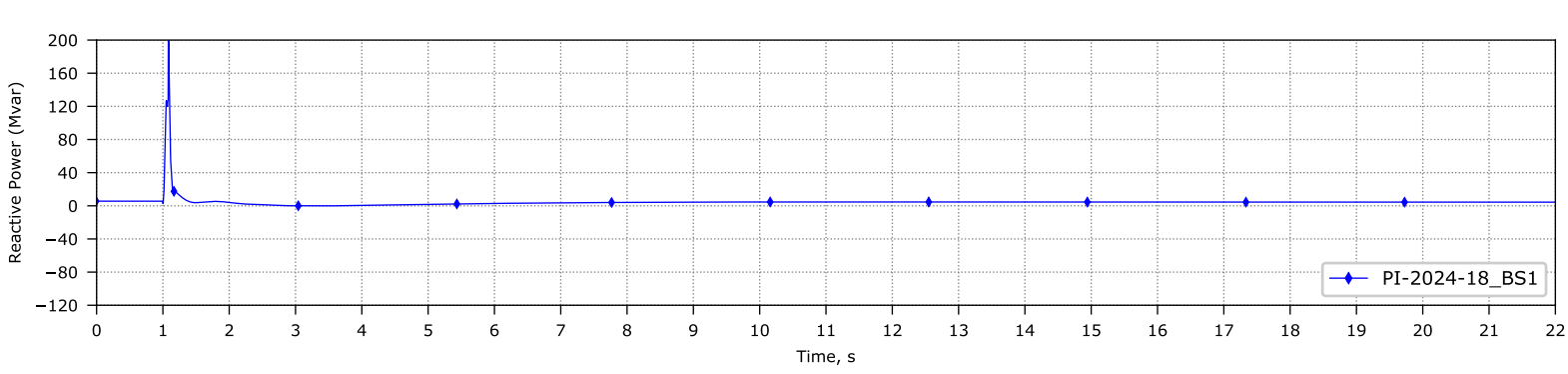

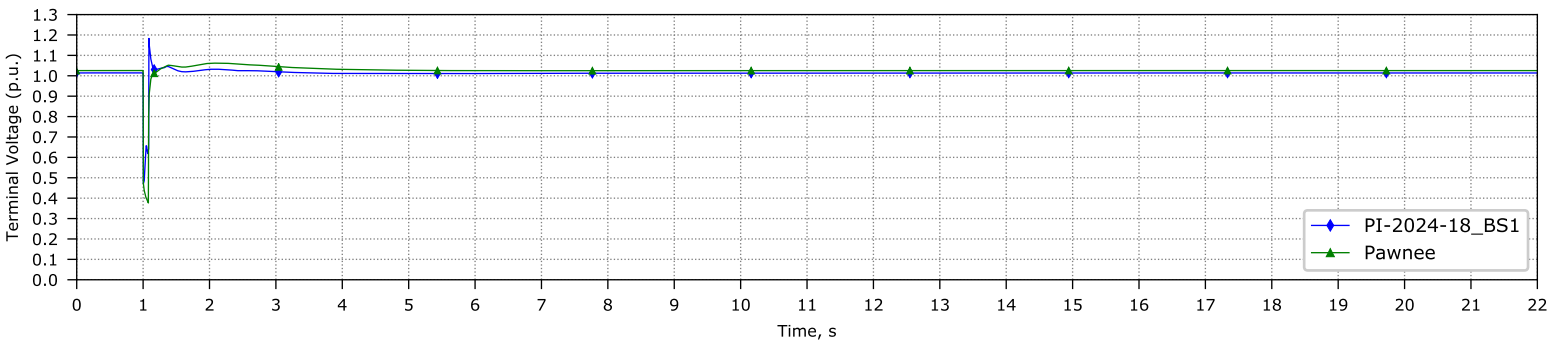

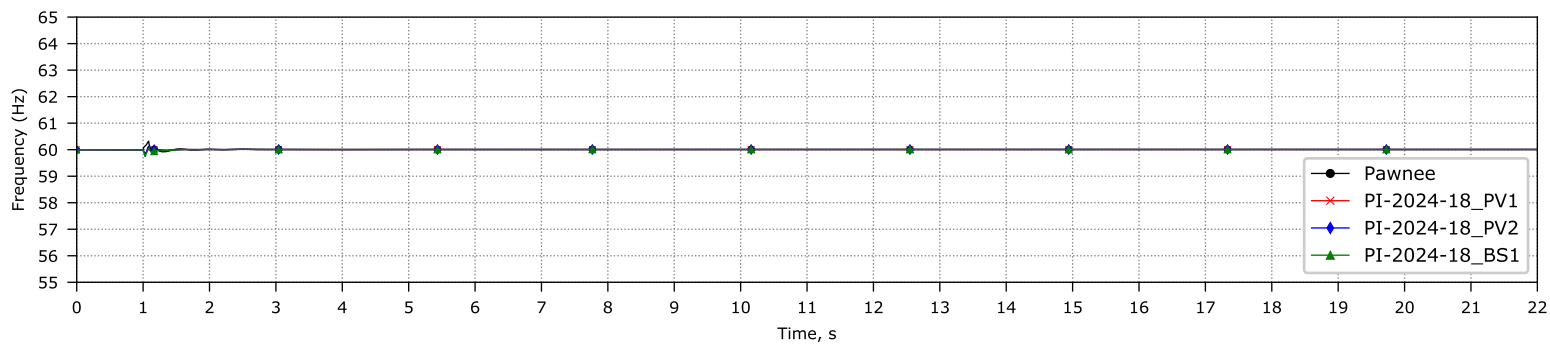

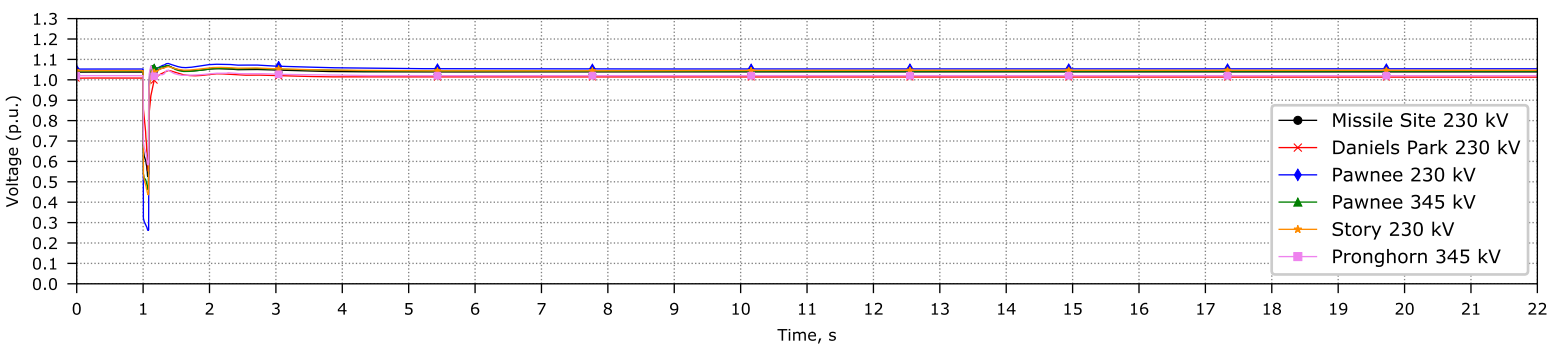

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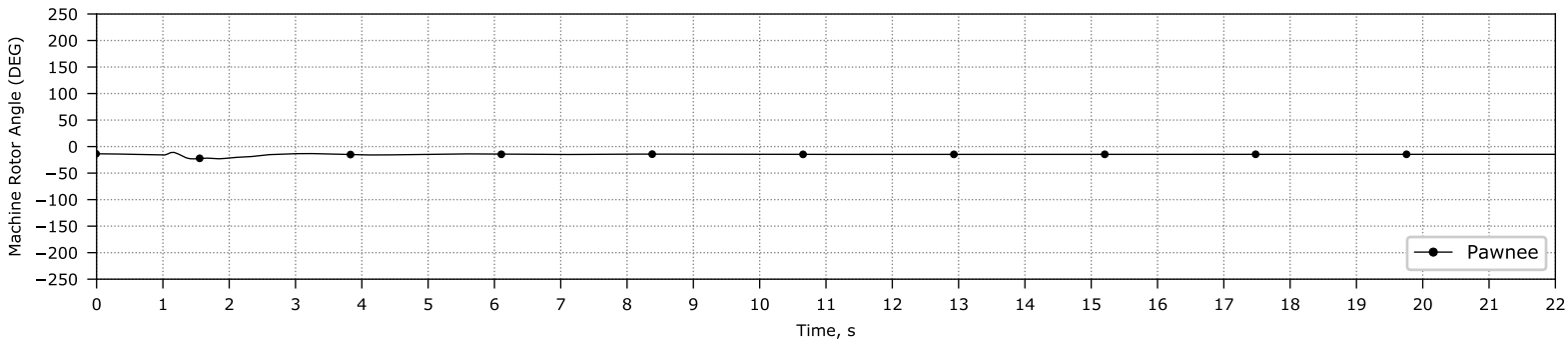

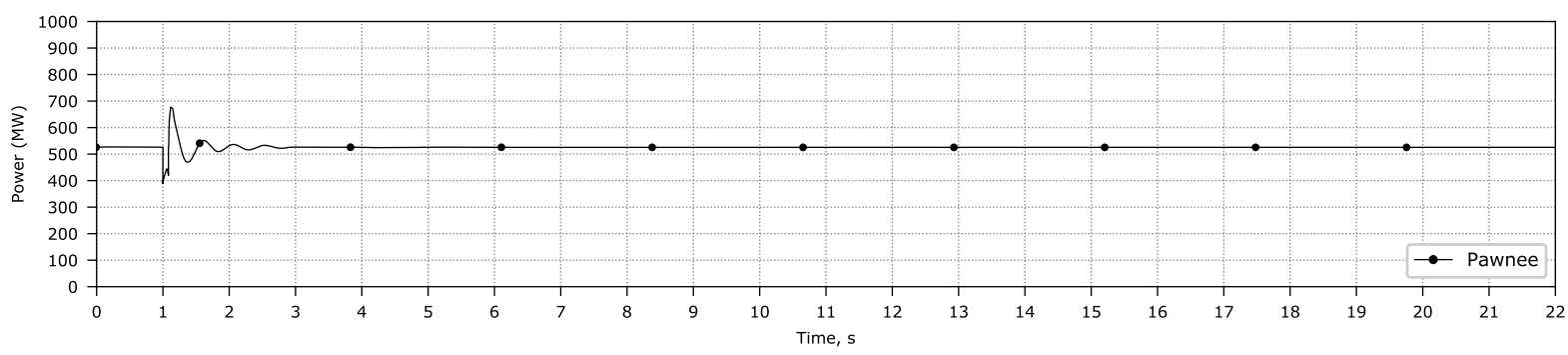

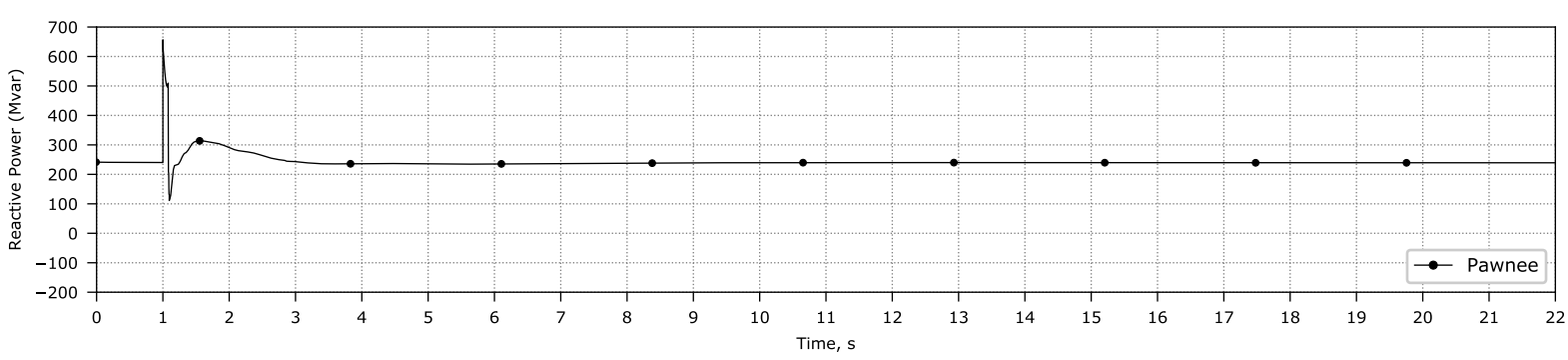

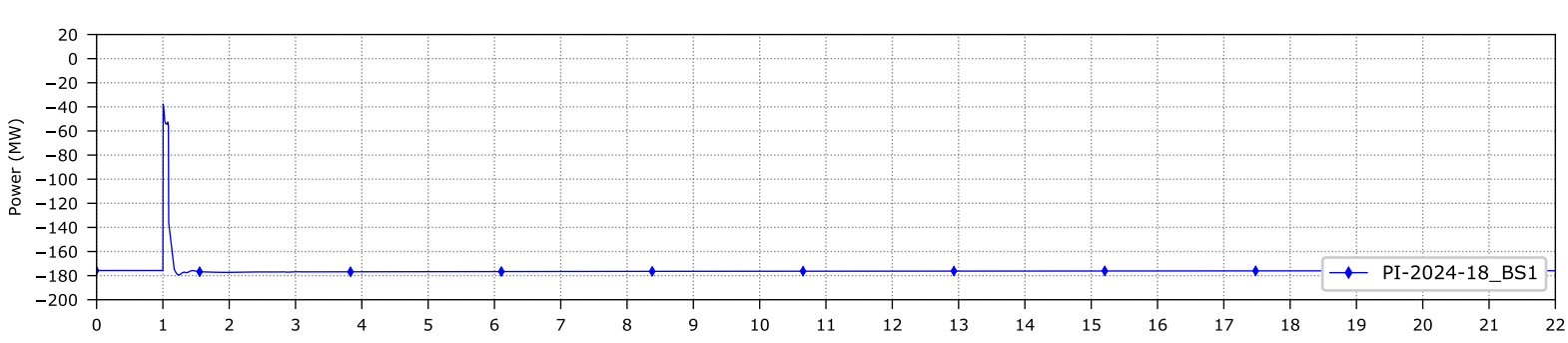

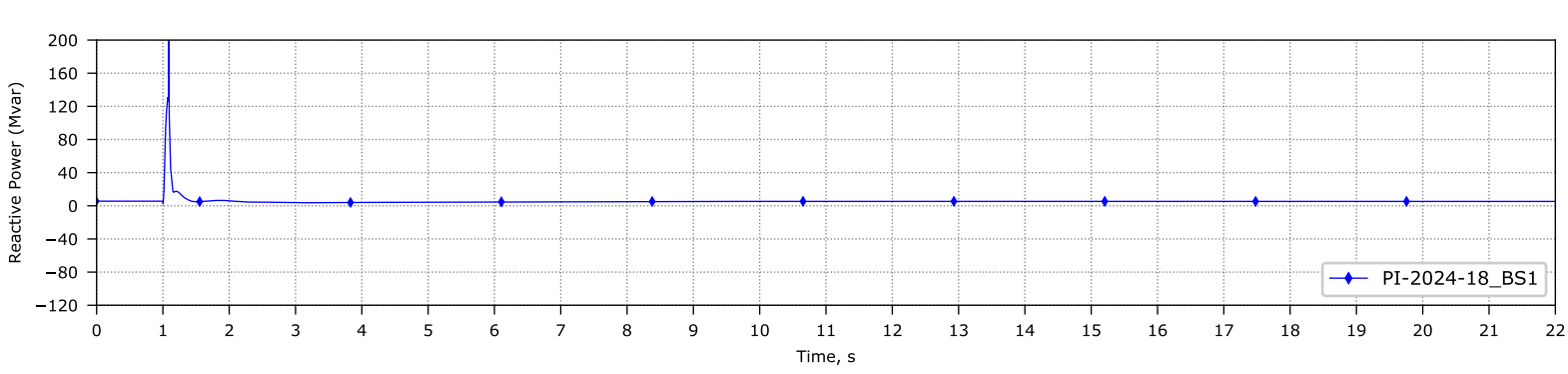

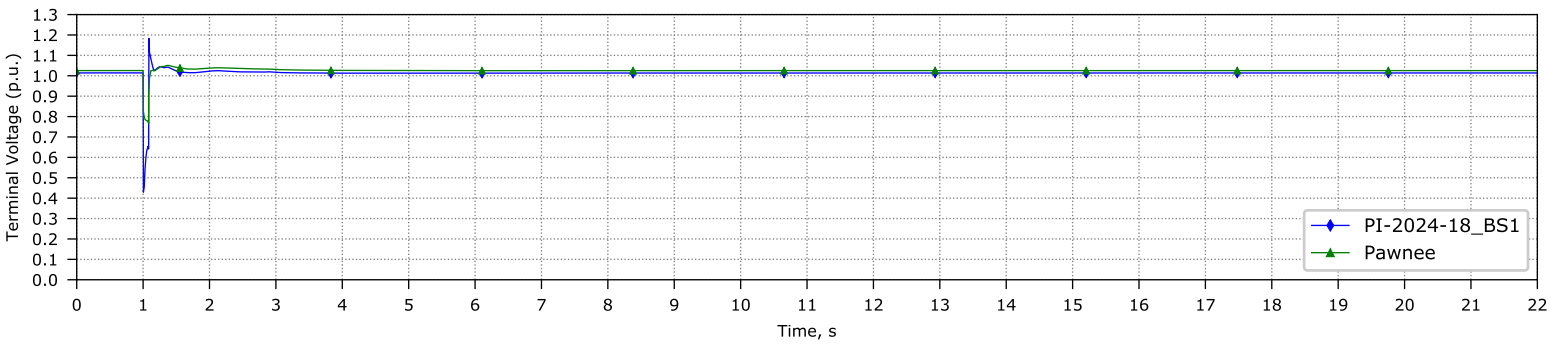

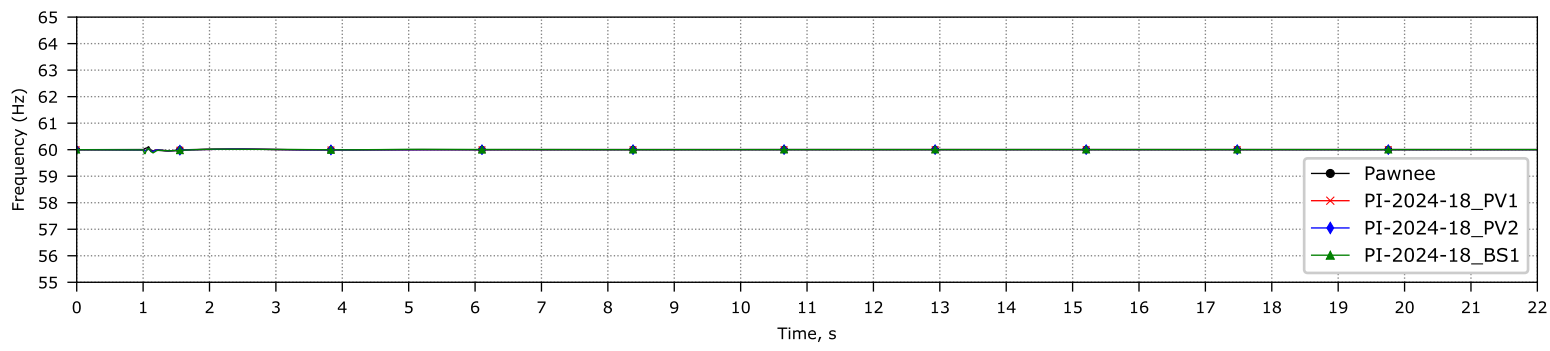

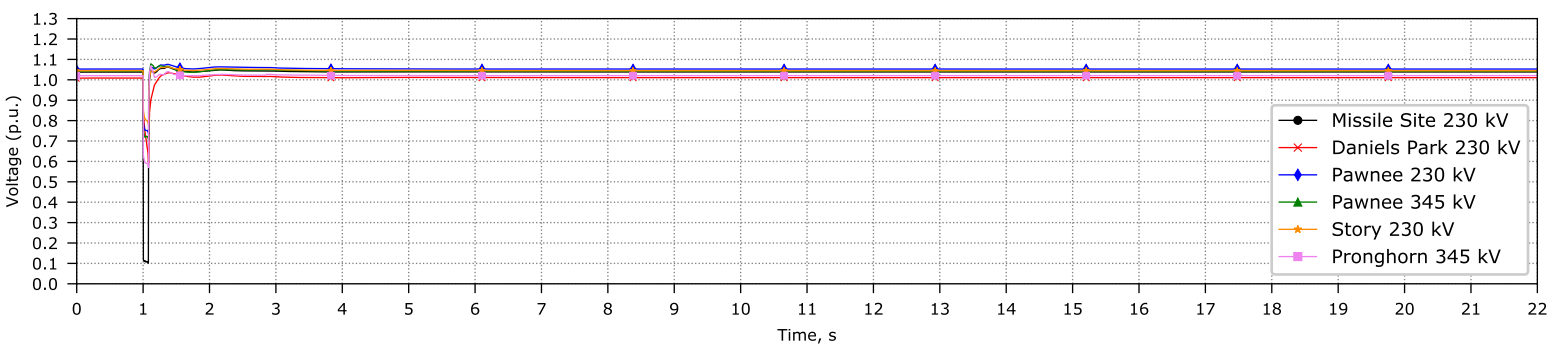

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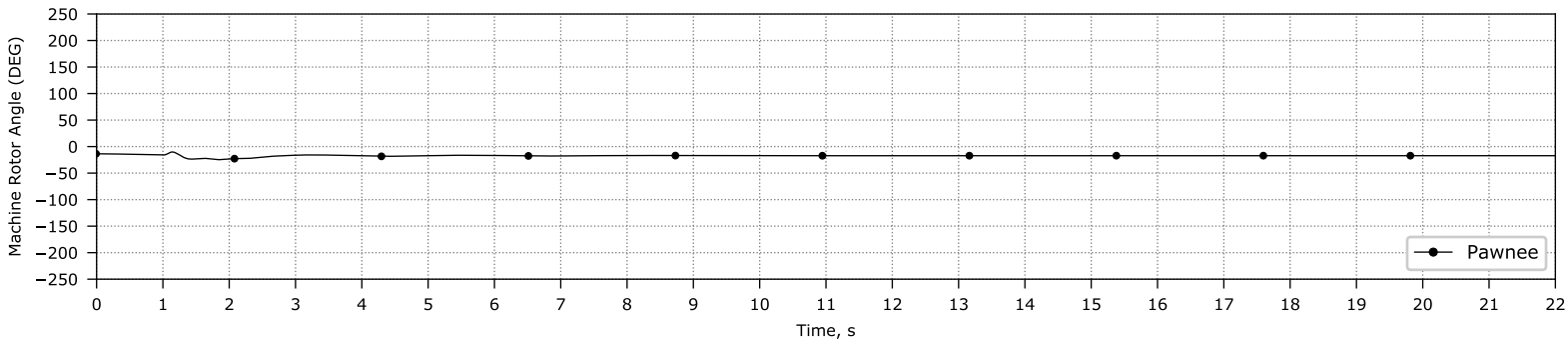

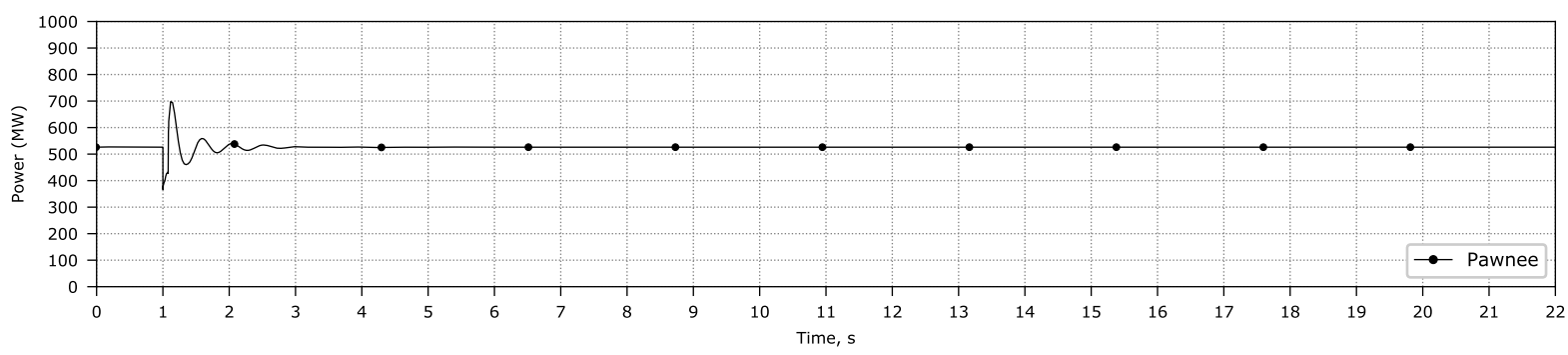

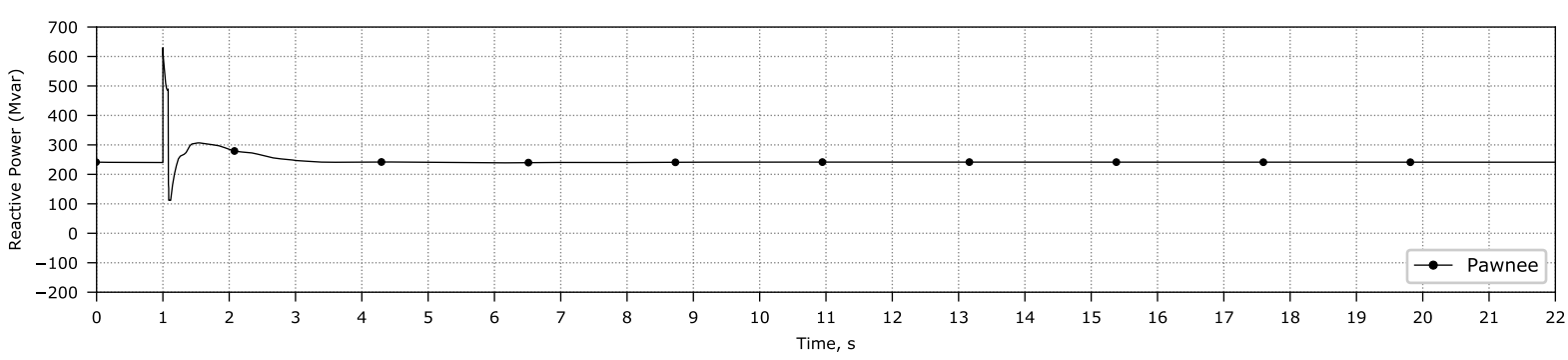

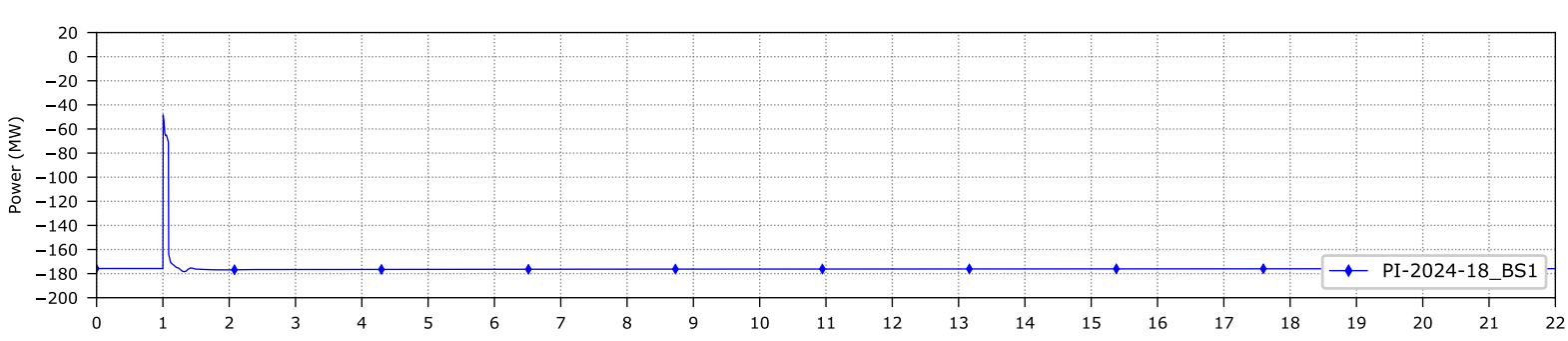

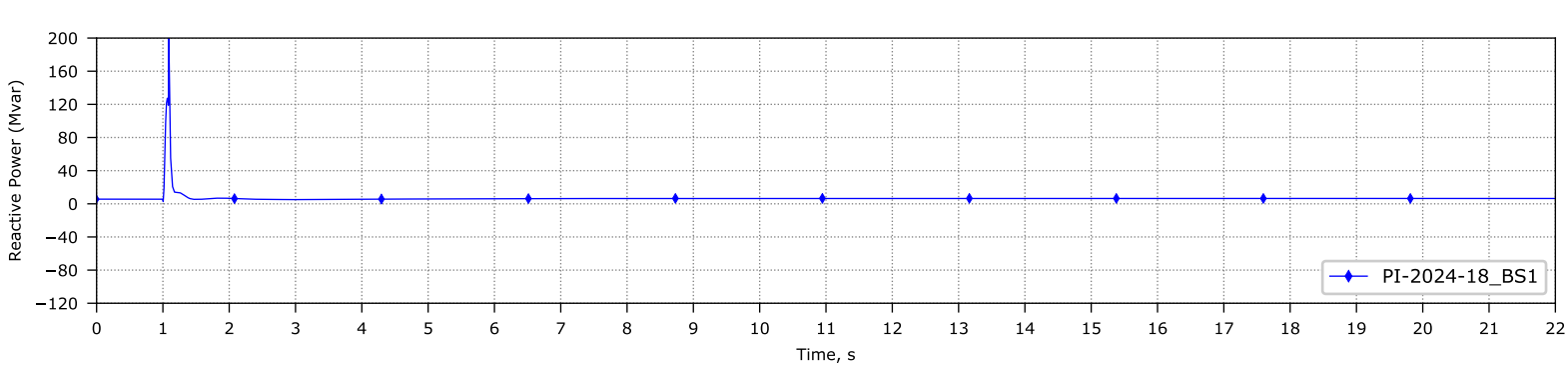

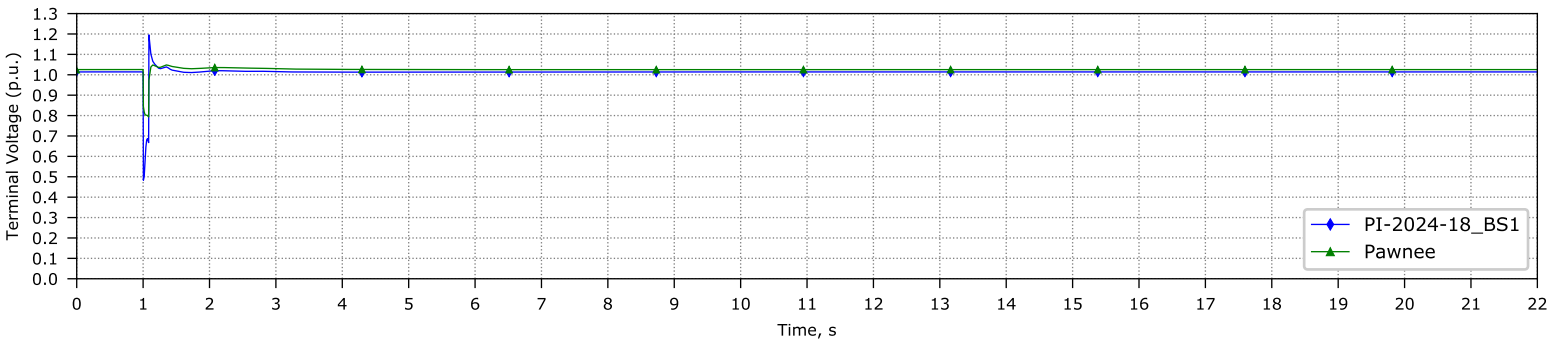

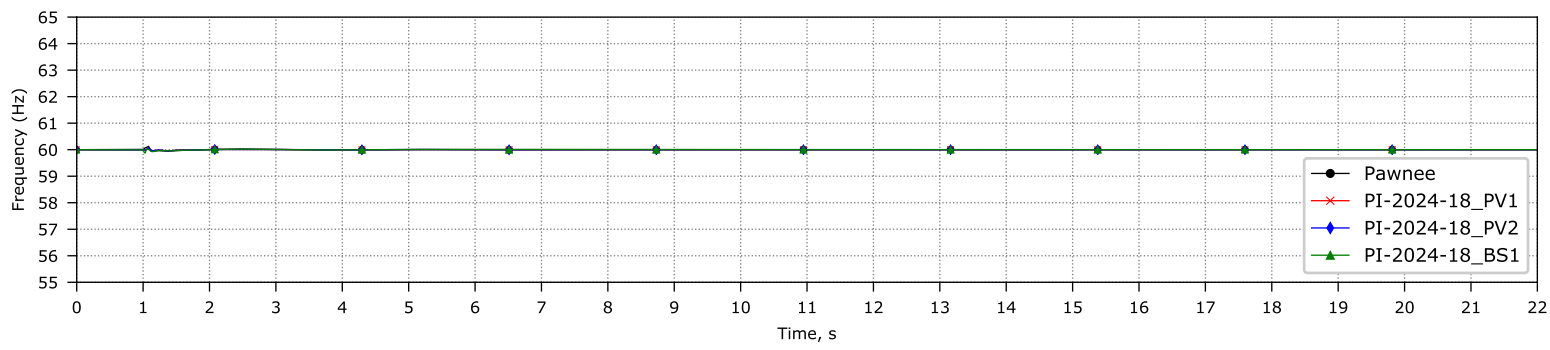

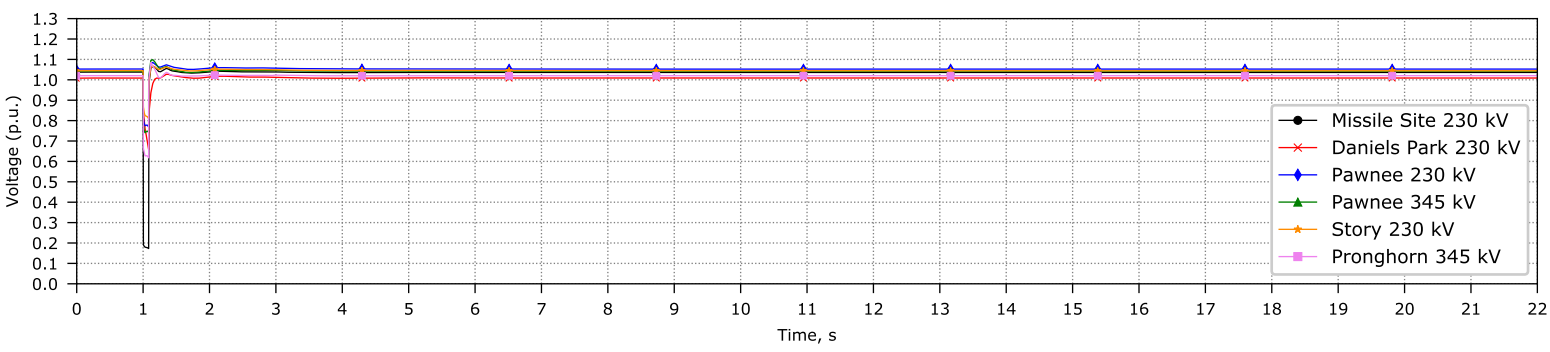

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