Provisional Interconnection Study Report for PI-2024-13

4/14/2025

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1.0 Executive Summary

The PI-2024-13 project is a Provisional Interconnection Service (PIS)[1] request for a 489.7 MW Wind Generating Facility with a Point of Interconnection (POI) at the May Valley 345 kV switching station. The Wind Generating Facility connects to the POI via a 23.5-mile generation tie-line. This PIS request is associated with Generation Interconnection Request 5RSC-2024-15 in the 5RSC cluster.

The total cost of the transmission system improvements required for PI-2024-13 to qualify for Provisional Interconnection Service is estimated to be $10.659 million (Table 15 and Table 16).

The initial maximum permissible output of PI-2024-13 Generating Facility is 489.7 MW. The maximum permissible output of the Generating Facility in the PLGIA[2] would be reviewed quarterly and updated, if there are changes to the system conditions assumed in this analysis, to determine the maximum permissible output.

Note during the 0.95 lagging power factor test the Wind Generator 4 terminal bus exceeded 1.05 p.u. voltage.

Security: PI-2024-13 is a request for Energy Resource Interconnection Service. For ERIS requests, security shall estimate the risks associated with the Network Upgrades and the Interconnection Facilities and is assumed to be a minimum of $5 million.

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

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

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

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

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

2.0 Introduction

PI-2024-13 is the Provisional Interconnection Service[4] request for a 489.7 MW Wind Generating Facility located in Kiowa County, Colorado.

- The POI of this project is the new May Valley 345 kV switching station. The May Valley 345 kV switching station is part of the Colorado Power Pathway project.
- The Commercial Operation Date (COD) to be studied for PI-2024-13 as noted on the Provisional Interconnection request is May 17, 2027.

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 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.

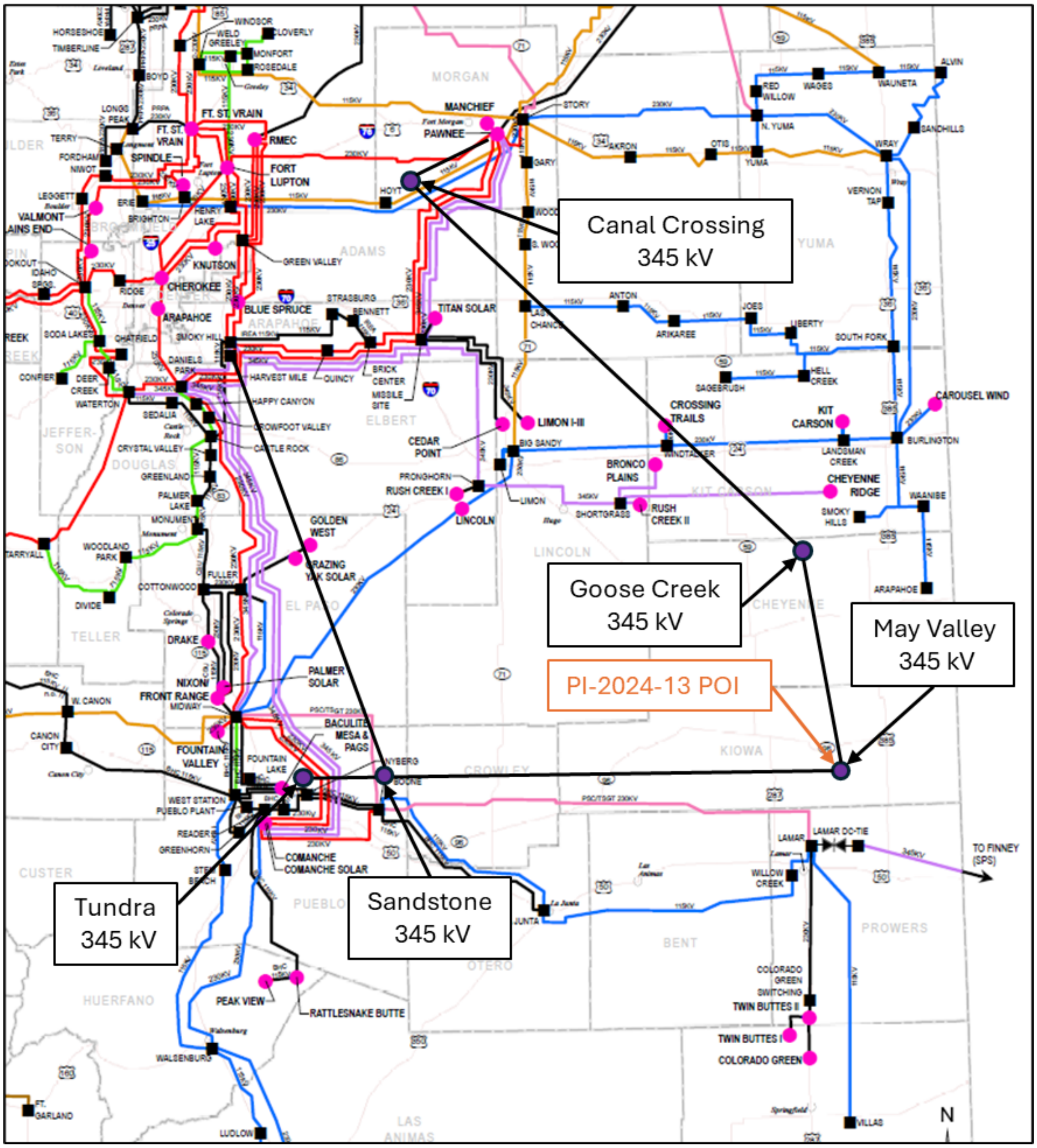

Figure 1: Approximate Point of Interconnection of PI-2024-13

3.0 Study Scope

The purpose of this study is to determine the impacts to the PSCo system and the Affected Systems from interconnecting PI-2024-13 for Provisional Interconnection Service. Consistent with the assumption in the study agreement, PI-2024-13 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 Interconnection Facilities and Station Network Upgrades. The study also identifies the estimated Security[6] and Contingent Facilities associated with the Provisional 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

[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.

[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 generation facilities.
c. P1–P7—The relative rotor angle (power) oscillations are characterized by positive damping (i.e., amplitude reduction of successive peaks) > 5% within 30 seconds.

3.3 Breaker Duty Analysis Criteria

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

3.4 Study Methodology

For PSCo and non-PSCo 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 Service, if thermal or voltage violations are seen, the maximum permissible Provisional Interconnection before violations is identified. For voltage violations caused by reactive power deficiency at the POI, voltage upgrades are identified.

The Provisional Interconnection 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 areas 70 and 73.

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

Table 1 – Transient Stability Contingencies

Ref. No.	Fault Location	Outage(s)	Clearing Time (Cycles)
1	-	Flat Run	-
2	May Valley 345 kV	May Valley - Goose Creek 345 kV ckt 1	4
3	May Valley 345 kV	May Valley - Sandstone 345 kV ckt 1	4
4	May Valley 345 kV	PI-2024-13 Generation	4
5	May Valley 345 kV	PI-2024-18 Generation	4
6	Goose Creek 345 kV	Goose Creek - Canal Crossing 345 kV ckt 1	4
7	Goose Creek 345 kV	Goose Creek - Shortgrass 345 kV ckt 1	4
8	Goose Creek 345 kV	Goose Creek - Cheyenne Ridge 345 kV ckt 1 Cheyenne Ridge Wind Generation	4
9	Sandstone 345 kV	Sandstone - Tundra 345 kV ckt 1	4
10	Sandstone 345 kV	Sandstone - Harvest Mile 345 kV ckt 1	4
11	Pronghorn 345 kV	Pronghorn - Rush Creek 345 kV ckt Rush Creek Wind Generation	12

Ref. No.	Fault Location	Outage(s)	Clearing Time (Cycles)
12	Canal Crossing 345 kV	Goose Creek - Canal Crossing 345 kV ckt 1 Goose Creek - Canal Crossing 345 kV ckt 2 Canal Crossing 345 kV Cap Bank	12
13	May Valley 345 kV	May Valley - Goose Creek 345 kV ckt 1 May Valley - Goose Creek 345 kV ckt 2	4
14	Tundra 345 kV	Tundra - Sandstone 345 kV ckt 1 Tundra - Sandstone 345 kV ckt 2	4
15	May Valley 345 kV	May Valley - Sandstone 345 kV ckt 1 May Valley - Sandstone 345 kV ckt 2	4
16	Sandstone 345 kV	Sandstone - Harvest Mile 345 kV ckt 1 Sandstone - Harvest Mile 345 kV ckt 2	4
17	Canal Crossing 345 kV	Goose Creek - Canal Crossing 345 kV ckt 1 Goose Creek - Canal Crossing 345 kV ckt 2	4
18	Goose Creek 345 kV	Goose Creek - Shortgrass 345 kV ckt 1 Goose Creek - Cheyenne Ridge 345 kV ckt 1 Cheyenne Ridge Wind Generation	4

3.6 Study Area

The Eastern Colorado study area includes WECC designated zone 706. As described in Section 3.11 of the BPM, the East study pocket is comprised of the eastern Colorado transmission system with major generation injecting into 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
- Segment #4: May Valley – Sandstone – Tundra 345 kV Double Circuit
- Segment #5: Sandstone – Harvest Mile 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
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

Gen Bus Number	Name	ID	Status	Pgen (MW)	Pmax (MW)
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
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
999003	NLP_SAND	1	1	500.00
Total (MW)				**4050.00**

4.2 Study Case Modeling

A Study Case was created from the Benchmark Case by turning on the PI-2024-13 generation. The additional 489.7 MW output from PI-2024-13 was balanced against PSCo generation outside of the East study pocket.

This project assumes the use of one hundred eleven (111) Vestas V163-4.5 MW wind turbine generators (WTGs) rated at 5.3 MVA operating at +/-0.90 pf for PI-2024-13. Each of the WTGs is connected to the 34.5 kV collector system through a pad-mount transformer rated at 0.72 / 34.5 kV, rated at 5.3 MVA. Two 345/34.5/13.8 kV Main Power Transformers (MPT) rated at 113/150/188 MVA step the voltage up from the collector system voltage to the POI voltage. A 23.5-mile-long generation tie line interconnects the project to the May Valley 345 kV switching station.

4.3 Short-Circuit Modeling

The Integrated System Planning - OATT Department has requested Fault Studies for a Provisional Interconnection request. This request is for the Interconnection of a 489.7 MW Wind Generating Facility (PI-2024-13) to the May Valley 345 kV switching station. The output will not exceed 489.7 MW at the POI.

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

5.0 Provisional Interconnection Service Analysis

5.1 Voltage and Reactive Power Capability Evaluation

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

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

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

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

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

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

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

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

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

The PI-2024-13 GIR is modeled as follows:

Wind Generator 1: Pmax = 189.0 MW, Pmin = 0 MW, Qmax = 87.19 MVar, Qmin= -67.20 MVar
Wind Generator 2: Pmax = 189.0 MW, Pmin = 0 MW, Qmax = 87.19 MVar, Qmin= -67.20 MVar
Wind Generator 3: Pmax = 189.0 MW, Pmin = 0 MW, Qmax = 87.19 MVar, Qmin= -67.20 MVar
Wind Generator 4: Pmax = 162.0 MW, Pmin = 0 MW, Qmax = 74.74 MVar, Qmin= -57.60 MVar
The summary for the Voltage and Reactive Power Capability Evaluation for PI-2024-13 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request. Note during the lagging test, Wind Generator 4 terminal bus slightly exceeded 1.05 p.u. voltage.
- 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-2024-13 are summarized in Table 4.

Table 4 – Reactive Power Capability Evaluation for PI-2024-13

Generator 1 Terminals					Generator 2 Terminals					High Side of Main Transformer			
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
130.10	63.74	87.19	-67.20	1.04	130.10	63.74	87.19	-67.20	1.04	491.00	175.20	1.03	0.94
130.10	-25.36	87.19	-67.20	0.99	130.10	-25.36	87.19	-67.20	0.99	492.00	-169.20	0.98	-0.95
0.00	-8.43	87.19	-67.20	0.98	0.00	-8.43	87.19	-67.20	0.98	-0.90	-11.00	1.00	-0.08
Generator 3 Terminals					**Generator 4 Terminals**					**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**
130.10	63.74	87.19	-67.20	1.04	110.10	63.74	87.19	-67.20	1.05	488.50	165.50	1.00	0.95
130.10	-25.36	87.19	-67.20	0.99	110.10	-25.36	87.19	-67.20	1.00	489.30	-182.50	0.99	-0.94
0.00	-8.43	87.19	-67.20	0.98	0.00	-8.43	87.19	-67.20	0.98	-0.90	9.40	1.00	-0.10

5.2 Steady-State Analysis

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

The power flow analysis showed that the following contingencies shown in Table 5, were 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 redispatch to resolve these contingencies is described in Table 6, below. The System Intact and Single Contingency analyses were then performed with this redispatch applied to the Study Case.

Table 5 –Diverged P1 Contingency

Diverged Contingency	Contingency Description	Case
Line_077_SGL_115_085	P1: Cherokee Gen drop	Study
Line_144_SGL_345_001	P1: Smoky Hill - Missile Site #7081	Study
GseCrk-CanalXing-1_P1-2_1	P1-2: Goose Creek - Canal Crossing 345 kV ckt 1	Study
FSV-CanalXing-1_P1-2_7	P1-2: FSV - Canal Crossing 345 kV ckt 1	Study

Table 6 – Generation Dispatch to Resolve the Diverged P1 Contingency

Generator Bus Number	Generator Name	ID	Initial Pgen (MW)	Modified Pgen (MW)
70758	NEPTUNE_S1	S1	0.00	120.00
70950	ST.VR_5	G5	0.00	64.80
70771	RUSHCREEK_W3	W3	176.00	0.00
70767	RUSHCREEK_W1	W1	161.60	125.00
70495	JMSHAFR1	G2	27.00	0.00
70487	JMSHAFR4	G4	12.80	0.00
70487	JMSHAFR4	G5	14.10	0.00
70490	JMSHAFR3	ST	7.60	0.00
70409	ST.VRAIN	ST	0.00	44.20
70120	COMAN_2	C2	0.00	195.00
70635	LIMON1_W	W1	160.80	0.00

The following results were obtained from the power flow contingency analysis:

- System Intact analysis showed no thermal violations attributable to PI-2024-13. System Intact voltage violations are shown in Table 7.
    - Note all System Intact violations are alleviated via the redispatch shown in Table 9. None of the System Intact overloads are attributed to the Study GIR.
- Single Contingency analysis showed the following thermal violations in Table 8. No Single Contingency voltage violations attributable to PI-2024-13 were observed.
    - Note all Single Contingency violations are alleviated via the redispatch shown in Table 9. The loading obtained with the re-dispatched units is shown in the last column of Table 8. None of the Single Contingency overloads are attributed to the Study GIR.
- Multiple Contingency analysis showed the following thermal violations in Table 10. Multiple Contingency analysis showed the following voltage violations in Table 11. Per TPL-001-5, Multiple Contingency violations are mitigated using system adjustments, including generation redispatch (including GIRs under study) and/or operator actions. None of the Multiple Contingency overloads are attributed to the Study GIR.
    - Note four P4 and seventeen P7 contingencies were divergent, as shown in Table 12. Multiple Contingency issues are resolved using system adjustments, including generation redispatch (including GIRs under study) and/or operator actions. Therefore, they are not attributable to the Study GIR.

Table 7 – System Intact Voltage Violations

Bus #	Bus Name	Base kV	Area	Zone	Zone Name	Contingency Name	Benchmark Case Contingency Voltage (p.u.)	Study Case Contingency Voltage (p.u.)	Voltage Difference (p.u.)
70260	LEETSDALE	230	70	700	ZoneRD	System Intact	0.9661	0.9379	-0.0282
70291	MONROEPS	230	70	700	ZoneRD	System Intact	0.9671	0.9389	-0.0282
70163	ELATI1	230	70	700	ZoneRD	System Intact	0.9688	0.9405	-0.0283
72208	DELCAMIN	69	73	754	ZoneFH	System Intact	0.9670	0.9412	-0.0258
70149	DENVER_TM	230	70	700	ZoneRD	System Intact	0.9701	0.9418	-0.0283
70239	JEWELL2	230	70	700	ZoneRD	System Intact	0.9701	0.9420	-0.0281
70141	DAKOTA	230	70	700	ZoneRD	System Intact	0.9705	0.9421	-0.0284
70601	DANIEL_PK	345	70	704	ZoneRS	System Intact	0.9719	0.9423	-0.0296
70466	WATERTON	345	70	700	ZoneRD	System Intact	0.9666	0.9425	-0.0241
72019	BROMLEY	115	73	754	ZoneFH	System Intact	0.9704	0.9427	-0.0277
72025	PRARI_TS	115	73	754	ZoneFH	System Intact	0.9705	0.9427	-0.0278
70038	ARAPAHOE	230	70	700	ZoneRD	System Intact	0.9720	0.9434	-0.0286
70152	BARKER	230	70	700	ZoneRD	System Intact	0.9722	0.9437	-0.0285
70324	LACOMBE	230	70	700	ZoneRD	System Intact	0.9722	0.9437	-0.0285
70018	SODA_LAKES	230	70	700	ZoneRD	System Intact	0.9711	0.9444	-0.0267
70365	SULLIVAN_2	230	70	700	ZoneRD	System Intact	0.9737	0.9453	-0.0284
70417	SULLIVAN_1	230	70	700	ZoneRD	System Intact	0.9740	0.9456	-0.0284
72028	REUNION	115	73	754	ZoneFH	System Intact	0.9737	0.9458	-0.0279
70200	GLENNPS	230	70	700	ZoneRD	System Intact	0.9750	0.9465	-0.0285
70524	SULPHUR	230	70	700	ZoneRD	System Intact	0.9754	0.9469	-0.0285
70461	WASHINGTON	230	70	700	ZoneRD	System Intact	0.9752	0.9470	-0.0282
70512	JEWELL1	230	70	700	ZoneRD	System Intact	0.9753	0.9470	-0.0283

Bus #	Bus Name	Base kV	Area	Zone	Zone Name	Contingency Name	Benchmark Case Contingency Voltage (p.u.)	Study Case Contingency Voltage (p.u.)	Voltage Difference (p.u.)
70527	SANTA_FE	230	70	700	ZoneRD	System Intact	0.9755	0.9470	-0.0285
70428	TECH_CENTER	230	70	700	ZoneRD	System Intact	0.9758	0.9475	-0.0283
70481	MONACO_12	230	70	700	ZoneRD	System Intact	0.9758	0.9475	-0.0283
72024	HENRYLAK	115	73	754	ZoneFH	System Intact	0.9750	0.9475	-0.0275
70041	ARVADA_PS	230	70	700	ZoneRD	System Intact	0.9764	0.9479	-0.0285
70529	JLGREEN	230	70	706	ZoneRN	System Intact	0.9762	0.9481	-0.0281
70369	RUSSELL	230	70	700	ZoneRD	System Intact	0.9769	0.9484	-0.0285
70100	CHATFLD	230	70	700	ZoneRD	System Intact	0.9757	0.9487	-0.0270
70491	TOLLGATE	230	70	700	ZoneRD	System Intact	0.9769	0.9487	-0.0282
70533	LEMON_GLCH	230	70	700	ZoneRD	System Intact	0.9776	0.9492	-0.0284
70107	CHEROKEE	230	70	700	ZoneRD	System Intact	0.9783	0.9495	-0.0288
70480	WEST_PS	230	70	700	ZoneRD	System Intact	0.9768	0.9498	-0.0270
70355	RIDGE	230	70	700	ZoneRD	System Intact	0.9780	0.9498	-0.0282

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Table 8 – Single Contingency Overloads

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)	Re-dispatched Study Case Loading (%)
1	DANIEL_PK 230/345 kV (70139/70601) TRANSFORMER T4	DanielsPark T3_P1-3_15	230/345	70	560	97.66	103.58	5.92	99.96
2	DANIEL_PK 230/345 kV (70139/70601) TRANSFORMER T5	DanielsPark T3_P1-3_15	230/345	70	560	97.66	103.58	5.92	99.96
3	LEETSDALE (70260) – SULLIVAN_2 (70365) 230 kV CKT 1	Line_104_SGL_230_026	115	70	425	96.98	102.60	5.62	98.61

Table 9 – Generation Dispatch to Resolve Single Contingency Overloads

Bus No.	Bus Name	Base kV	ID	Original Pgen (MW)	Modified status	Modified Pgen (MW)
70554	ARAP7	13.8	ST	0.0	1	45.0
70553	ARAP5&6	13.8	G6	0.0	1	39.5
70553	ARAP5&6	13.8	G5	0.0	1	34.9
71003	BAC_MSA_GEN4	13.8	S1	24.8	1	23.0
70756	NEPTUNE_B1	0.48	B1	75.6	1	69.1
70758	NEPTUNE_S1	0.66	S1	120.0	0	0.0

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Table 10 – Multiple Contingency Overloads

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
1	LEETSDALE (70260) – SULLIVAN_2 (70365) 230 kV CKT 1	Line_003_BF_004A	230	70	425	99.51	107.12	7.61
2	HARRISON_P1 (70215) – HARRISON_P2 (70182) 115 kV CKT 1	Line_186_BF_048J	115	70	239	99.50	103.41	3.91
3	GREENWOOD_1 (70212) – TECH_CENTER (70428) 230 kV CKT 1	Line_229_BF_064A	230	70	405	97.73	103.08	5.35
4	CLARK (70112) – JORDAN (70241) 230 kV CKT 1	P7_150 (Lines: 5167 5285)	230	70	331	113.67	117.19	3.52
5	CLARK (70112) – JORDAN (70241) 230 kV CKT 1	P7_58 (Lines: 5707 5111)	230	70	331	109.79	115.12	5.33
6	BUCKLEY2 (70046) – SMOKY_HL (70396) 230 kV CKT 1	P7_101 (Lines: 5705 5167 5717)	230	70	478	98.45	102.62	4.17
7	STORY (73192) – PAWNEE (70311) 230 kV CKT 1	P7_133 (Lines: 5457 5467)	230	73/70	772	93.91	101.48	7.57
8	BUCKLEY2 (70046) – JEWELL2 (70239) 230 kV CKT 1	P7_101 (Lines: 5705 5167 5717)	230	70	484	97.35	101.46	4.11
9	MEADOW_HLS (70283) – SMOKY_HL (70396) 230 kV CKT 1	P7_150 (Lines: 5167 5285)	230	70	564	97.95	100.86	2.91
10	MEADOW_HLS (70283) – SMOKY_HL (70396) 230 kV CKT 1	P7_58 (Lines: 5707 5111)	230	70	564	96.23	100.46	4.23

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Table 11 – Multiple Contingency Voltage Violations

Bus #	Bus Name	Base kV	Area	Zone	Zone Name	Contingency Name	Benchmark Case Contingency Voltage (p.u.)	Study Case Contingency Voltage (p.u.)	Voltage Difference (p.u.)
70303	ORDWAY	69	70	712	ZoneWP	line_042_BF_019a	0.8523	0.8346	-0.0177
70275	MANZANOL	69	70	712	ZoneWP	line_042_BF_019a	0.8558	0.8383	-0.0175
70178	FOWLER	69	70	712	ZoneWP	line_042_BF_019a	0.8560	0.8384	-0.0176
70372	S_FWL_TP	69	70	712	ZoneWP	line_042_BF_019a	0.8584	0.8408	-0.0176
71027	S.FOWLR	115	70	712	ZoneWP	line_042_BF_019a	0.8584	0.8408	-0.0176
70366	ROCKYFRD	69	70	712	ZoneWP	line_042_BF_019a	0.8649	0.8476	-0.0173
73377	EXCEL	115	73	752	ZoneEC	line_030_BF_014d	0.8801	0.8432	-0.0369
73310	FME	115	73	752	ZoneEC	line_030_BF_014d	0.8809	0.8440	-0.0369
73309	HENDERSON	115	73	752	ZoneEC	line_030_BF_014d	0.8821	0.8453	-0.0368
73031	BRUSHTAP	115	73	752	ZoneEC	line_030_BF_014d	0.8823	0.8455	-0.0368
73378	FMN	115	73	752	ZoneEC	line_030_BF_014d	0.8825	0.8457	-0.0368
73305	EFMORGTP	115	73	752	ZoneEC	line_030_BF_014d	0.8825	0.8457	-0.0368
73311	FMS	115	73	752	ZoneEC	line_030_BF_014d	0.8846	0.8479	-0.0367
73379	FMWEST	115	73	752	ZoneEC	line_030_BF_014d	0.8846	0.8479	-0.0367
73023	BIJOUTAP	115	73	752	ZoneEC	line_030_BF_014d	0.8954	0.8598	-0.0356
70249	LAJUNTAW	115	70	712	ZoneWP	line_042_BF_019a	0.8987	0.8823	-0.0164
70250	LAJUNTAW	69	70	712	ZoneWP	line_042_BF_019a	0.8987	0.8823	-0.0164
70319	PHILLIPS	69	70	712	ZoneWP	line_042_BF_019a	0.9061	0.8898	-0.0163
70320	PHLPS_TP	69	70	712	ZoneWP	line_042_BF_019a	0.9064	0.8902	-0.0162
73147	ORCHARD	115	73	752	ZoneEC	line_030_BF_014d	0.9122	0.8779	-0.0343
73097	KIOWA CK	115	73	752	ZoneEC	line_030_BF_014d	0.9122	0.8779	-0.0343
73213	WIGGINS TAP	115	73	752	ZoneEC	line_030_BF_014d	0.9181	0.8839	-0.0342

Bus #	Bus Name	Base kV	Area	Zone	Zone Name	Contingency Name	Benchmark Case Contingency Voltage (p.u.)	Study Case Contingency Voltage (p.u.)	Voltage Difference (p.u.)
70018	SODA_LAKES	230	70	700	ZoneRD	P7_154 (Lines: 5851 5023)	0.8903	0.8597	-0.0306
72026	REUNION	230	73	754	ZoneFH	P7_34 (Lines: 5309 5875 5877)	0.9174	0.8873	-0.0301
72028	REUNION	115	73	754	ZoneFH	P7_34 (Lines: 5309 5875 5877)	0.9257	0.8959	-0.0298

Table 12 – Diverged Multiple Contingency

Diverged Contingency	Contingency Description	Benchmark Case	Study Case
Line_057_BF_025a	Cabin Creek – Dillon 230 kV circuit 1 Cabin Creek – Idaho Spgs 230 kV circuit 1 Cabin Creek – Lookout 230 kV circuit 1 Cabin Creek 230/115 kV Transformer T1 Cabin Creek 230/115 kV Transformer T2 Cabin Creek Generation	Converged	Diverged
Line_152_BF_045c	Daniel Park – Hmil_N 345 kV circuit 1 Daniel Park – Tundra 345 kV circuit 1	Converged	Diverged
Line_154_BF_045g	Daniel Park – Tundra 345 kV circuit 2 Daniel Park Capacitor Bank	Converged	Diverged
Line_155_BF_045h	Daniel Park – Tundra 345 kV circuit 1 Daniel Park Capacitor Bank	Converged	Diverged
P7_22	Cabin Creek – Lookout 230 kV circuit 1 Cabin Creek – Georgetn 115 kV circuit 1 Georgetn – Hendrsn 115 kV circuit 1 Cabin Creek – Idaho Spgs 230 kV circuit 1 Idaho Spgs – Lookout 230 kV circuit 1 Cabin Creek – Dillon 230 kV circuit 1	Converged	Diverged

Diverged Contingency	Contingency Description	Benchmark Case	Study Case
P7_23	Cabin Creek – Lookout 230 kV circuit 1 Cabin Creek – Idaho Spgs 230 kV circuit 1 Idaho Spgs – Lookout 230 kV circuit 1	Converged	Diverged
P7_24	Cabin Creek – Lookout 230 kV circuit 1 Cabin Creek – Georgetn 115 kV circuit 1 Georgetn – Hendrsn 115 kV circuit 1 Cabin Creek – Idaho Spgs 230 kV circuit 1 Idaho Spgs – Lookout 230 kV circuit 1	Converged	Diverged
P7_51	Daniels Park – Comanche 345 kV circuit 2 Daniels Park – Tundra 345 kV circuit 1 Daniels Park – Tundra 345 kV circuit 2	Converged	Diverged
P7_88	Ft St Vrain – Isabelle 230 kV circuit 1 Valmont – Spindle 230 kV circuit 1	Converged	Diverged
P7_90	Ft St Vrain – Isabelle 230 kV circuit 1 Valmont – Spindle 230 kV circuit 1 Ft St Vrain – Spindle 230 kV circuit 1	Converged	Diverged
P7_93	Valmont – Spindle 230 kV circuit 1 Ft St Vrain – Spindle 230 kV circuit 1	Converged	Diverged
P7_119	Valmont – Spindle 230 kV circuit 1 Niwot – Isabelle 230 kV circuit 1	Converged	Diverged
P7_129	Daniels Park – Fuller 230 kV circuit 1 Midway_PS – Waterton 345 kV circuit 1	Converged	Diverged
P7_135	Daniels Park – Missile Site 345 kV circuit 1 Smoky Hill – Missile Site 345 kV circuit 1	Converged	Diverged
P7_136	Pawnee – BrickCTR 230 kV circuit 1 Smoky Hill – Missile Site 345 kV circuit 1	Converged	Diverged
P7_137	Smoky Hill – Missile Site 345 kV circuit 1 Harvest Mile – Smoky Hill 345 kV circuit 2	Converged	Diverged
P7_160	Canal Crossing – Goose Creek 345 kV circuit 1 Canal Crossing – Goose Creek 345 kV circuit 2	Converged	Diverged
P7_161	Canal Crossing – Ft St Vrain 345 kV circuit 1 Canal Crossing – Ft St Vrain 345 kV circuit 2	Converged	Diverged

Diverged Contingency	Contingency Description	Benchmark Case	Study Case
P7_162	Harvest Mile – Sandstone 345 kV circuit 1 Harvest Mile – Sandstone 345 kV circuit 2	Converged	Diverged
P7_166	Tundra – Sandstone 345 kV circuit 1 Tundra – Sandstone 345 kV circuit 2	Diverged	Diverged
P7_167	May Valley – Sandstone 345 kV circuit 1 May Valley – Sandstone 345 kV circuit 2	Diverged	Diverged

5.3 Transient Stability Results

One P4 contingency and three P7 contingencies did not meet BPM's performance criteria after fault clearing in the Study Case. System voltages in the study area were unable to recover to its pre fault voltage level and oscillations persisted throughout the simulation. The responses observed are summarized in Table 1 (Ref. Nos. 12, 14, 15 and 17) below and are shown in the plots presented in Appendix A. Oscillations were also observed when these contingencies were simulated in the Benchmark Case.

- Ref. Nos. 12 and 15: The Study Case showed a voltage recovery time (voltage remained below 80% of pre contingency voltage) greater than 2.0 seconds and sustained oscillations. However, the Benchmark Case also exhibited sustained oscillations, but with a reduced amplitude. Additionally, the contingency was simulated under steady-state conditions with both Benchmark and Study Cases resulting in non-convergence, which indicates a highly stressed system.
- Ref. No. 14: The Study Case showed a voltage recovery time (voltage remained below 80% of pre contingency voltage) greater than 2.0 seconds. However, the Benchmark Case presented a stable response. Additionally, the contingency was simulated under steady-state conditions with both Benchmark and Study Cases resulting in non-convergence, which indicates a highly stressed system.
- Ref. No. 17: The Study Case showed a voltage recovery time (voltage remained below 80% of pre contingency voltage) greater than 2.0 seconds and sustained oscillations. However, the Benchmark Case also exhibited sustained oscillations, but with a reduced amplitude. Additionally, the contingency was simulated under steady-state conditions with only Study Case resulting in non-convergence.

The four unstable contingencies (Ref. Nos. 12, 14, 15, and 17) were also evaluated in the Benchmark Case, exhibiting sustained oscillations and non-convergence in the steady-state analysis, confirming that the system is already in a highly stressed condition prior to the inclusion of the PI-2024-13 project. The addition of this project, which injects more generation into the area, will further exacerbate these conditions during the occurrence of these critical contingencies, ultimately leading to voltage collapse. Note Multiple Contingency issues are resolved using system adjustments, including generation redispatch (including GIRs under study) and/or operator actions.

Apart from contingencies mentioned above the following results were obtained for the disturbances analyzed:

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

The results of the contingency analysis are shown in Table 13. The transient stability plots are shown in Appendix A in Section 10.0 of this report.

Table 13 – Transient Stability Analysis Results

Ref. No.	Fault Location	Fault Category	Outage(s)	Clearing Time (Cycles)	Post-Fault Voltage Recovery	Angular Stability
1	-	P0	Flatrun	-	Stable	Stable
2	May Valley 345 kV	P1	May Valley - Goose Creek 345 kV ckt 1	4	Stable	Stable
3	May Valley 345 kV	P1	May Valley - Sandstone 345 kV ckt 1	4	Stable	Stable
4	May Valley 345 kV	P1	PI-2024-13 Generation	4	Stable	Stable
5	May Valley 345 kV	P1	PI-2024-18 Generation	4	Stable	Stable
6	Goose Creek 345 kV	P1	Goose Creek - Canal Crossing 345 kV ckt 1	4	Stable	Stable
7	Goose Creek 345 kV	P1	Goose Creek - Shortgrass 345 kV ckt 1	4	Stable	Stable
8	Goose Creek 345 kV	P1	Goose Creek - Cheyenne Ridge 345 kV ckt 1 Cheyenne Ridge Wind Generation	4	Stable	Stable
9	Sandstone 345 kV	P1	Sandstone – Tundra 345 kV ckt 1	4	Stable	Stable
10	Sandstone 345 kV	P1	Sandstone – Harvest Mile 345 kV ckt 1	4	Stable	Stable
11	Pronghorn 345 kV	P4	Pronghorn - Rush Creek 345 kV ckt 1 Rush Creek Wind Generation	12	Stable	Stable
12	Canal Crossing 345 kV	P4	Goose Creek - Canal Crossing 345 kV ckt 1 Goose Creek - Canal Crossing 345 kV ckt 2 Canal Crossing 345 kV Cap Bank	12	Unstable	Stable
13	May Valley 345 kV	P7	May Valley - Goose Creek 345 kV ckt 1 May Valley - Goose Creek 345 kV ckt 2	4	Stable	Stable
14	Tundra 345 kV	P7	Tundra – Sandstone 345 kV ckt 1 Tundra – Sandstone 345 kV ckt 2	4	Unstable	Stable
15	May Valley 345 kV	P7	May Valley – Sandstone 345 kV ckt 1 May Valley – Sandstone 345 kV ckt 2	4	Unstable	Stable
16	Sandstone 345 kV	P7	Sandstone – Harvest Mile 345 kV ckt 1 Sandstone – Harvest Mile 345 kV ckt 2	4	Stable	Stable

Ref. No.	Fault Location	Fault Category	Outage(s)	Clearing Time (Cycles)	Post-Fault Voltage Recovery	Angular Stability
17	Canal Crossing 345 kV	P7	Goose Creek - Canal Crossing 345 kV ckt 1 Goose Creek - Canal Crossing 345 kV ckt 2	4	Unstable	Stable
18	Goose Creek 345 kV	P7	Goose Creek - Shortgrass 345 kV ckt 1 Goose Creek - Cheyenne Ridge 345 kV ckt 1 Cheyenne Ridge Wind Generation	4	Stable	Stable

5.4 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 breaker duty study on the PSCo transmission system did not identify any circuit breakers that became over-dutied because of adding the PI-2024-13. Should any circuit breakers become overdue, the fault currents at the POI for three-phase and phase-to-ground will be provided in this report. Conversely, the fault currents can be made available upon request by the customer.

5.5 Affected Systems

The study did not identify any impacts to Affected Systems.

5.6 Summary of Provisional Interconnection Analysis

All System Intact and Single Contingency thermal violations were alleviated through generation redispatch, therefore, the maximum allowable output of the GIR without requiring any additional System Network Upgrades is 489.7 MW.

During the 0.95 lagging power factor test, as shown in Section 5.1, Wind Generator 4 terminal bus exceeded 1.05 p.u. voltage.

During Transient Stability Analysis, four contingencies (one P4 and three P7s) presented unsatisfactory voltage behavior. However, Multiple Contingency issues are resolved using system adjustments, including generation redispatch (including GIRs under study) and/or operator actions. Therefore, these issues are not attributable to the Study GIR.

6.0 Cost Estimates

The total cost of the required Upgrades for PI-2024-13 to interconnect for Provisional Interconnection Service at May Valley 345 kV switching station is estimated to be **$10.659 million**.

- **Cost of Transmission Provider's Interconnection Facilities (TPIF) is $4.393 million** (Table 15)
- **Cost of Station Network Upgrades is $6.266 million** (Table 16)
- **Cost of System Network Upgrades is $0**

The list of improvements required to accommodate the Provisional Interconnection of PI-2024-13 are given in Table 14, and Table 15.

Table 14 – Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (Million)
PSCo's May Valley 345 kV Switching Station	Interconnection of 5RSC-2024-15 (PI-2024-13) at the May Valley 345 kV Switching Station. The new equipment includes: • (1) 345 kV single bay dead end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000A line disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV 1-phase CCVTs • Dual fiber communication equipment • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing	$3.424
PSCo's May Valley 345 kV Switching Station	Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Dead end structure, single span, 3 conductors, insulators, hardware, jumpers and labor.	$0.969
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$4.393**

Table 15 – Station Network Upgrades

Element	Description	Cost Est. (Million)
PSCo's May Valley 345 kV switching station	Interconnection of 5RSC-2024-15 (PI-2024-13) at May Valley 345 kV Switching Station. The new equipment includes: • (1) 345 kV dead end structure • (2) 345 kV 3000 A SF6 circuit breakers • (4) 345 kV 3000 A disconnect switches • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures	$5.858
PSCo's May Valley 345 kV switching station	Install required communication in the EEE at the May Valley 345 kV switching station	$0.358
PSCo's May Valley 345 kV switching station	Siting and Land Rights permitting	$0.050
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$6.266**

PSCo has developed cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of PI-2024-13 for Provisional Interconnection Service. The estimated costs provided in this report are based upon the following assumptions:

- The estimated costs are in 2025 dollars with escalation and contingencies applied.
- Allowances for Funds Used During Construction (AFUDC) is not included.
- The estimated costs include all applicable labor and overheads associated with the siting, engineering, design, and construction of these new PSCo facilities.
- The estimated costs do not include the cost for any Customer owned equipment and associated design and engineering.
- Labor is estimated for straight time only—no overtime included.
- PSCo (or its Contractor) will perform all construction, wiring, testing, and commissioning for PSCo owned and maintained facilities.

The customer requirements include:

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

- Power Quality Metering (PQM) will be required on the Customer's generation tie-line terminating into the POI.
- The Customer will be required to design, procure, install, own, operate and maintain a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer substation. PSCo will be provided with indications, readings, and data from the LF/AGC RTU.
- At the Point of Change of Ownership (PCO), the Transmission Provider will be responsible for the structure at the PCO and transmission line into new switching station from the PCO. The Interconnection Customer will connect its gen-tie line to the PCO structure including insulators and associated hardware. The Transmission Provider will be responsible for the jumpers at the PCO structure. At the PCO, the Interconnection Customer will install and own the cable, insulators, shield wires, and connection hardware on the Collector Station side of the PCO structure.
- The Interconnection Customer will comply with the Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW, as amended from time to time, and available at: XEL-POL-Transmission Interconnection Guideline Greater 20MW

6.1 Schedule

This section provides proposed milestones for the interconnection of PI-2024-13 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 10/28/2026. This is attainable by the Transmission Provider based upon the current schedule developed for this interconnection request. The Transmission Provider proposes the milestones provided below in Table 16.

Table 16 – Proposed Milestones for PI-2024-13

Milestone	Responsible Party	Estimated Completion Date
PLGIA Execution	Interconnection Customer and Transmission Provider	June 2025
In-Service Date for Transmission Provider Interconnection Facilities and Station Network Upgrades required for interconnection	Transmission Provider	October 28, 2026
In-Service Date & Energization of Interconnection Customer's Interconnection Facilities	Interconnection Customer	October 28, 2026
Initial Synchronization Date	Interconnection Customer	November 4, 2026
Begin trial operation & testing (90% of IC facilities available for testing)	Interconnection Customer and Transmission Provider	November 12, 2026
Commercial Operation Date	Interconnection Customer	May 17, 2027

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

- Construction permitting (if required) for new facilities will be completed within 12 months of PLGIA execution.
- The Transmission Provider is currently experiencing continued increases to material lead times which could impact the schedule milestones. The schedule milestones are based upon material lead times known at this time.
- Availability of line outages to interconnect new facilities to the transmission system.

7.0 Summary of Provisional Interconnection Service Analysis

The total estimated cost of the PSCo transmission system improvements required for PI-2024-13 to qualify for Provisional Interconnection Service would be $10.659 million.

The initial maximum permissible output of PI-2024-13 Generating Facility is 489.7 MW. The maximum permissible output of the Generating Facility in the PLGIA would be reviewed quarterly and updated if there are changes to system conditions compared to the system conditions previously used to determine the maximum permissible output.

Note during the 0.95 lagging power factor test the Wind Generator 4 terminal bus exceeded 1.05 p.u. voltage.

Security: PI-2024-13 is a request for Energy Resource Interconnection Service. For ERIS requests, security shall estimate the risks associated with the Network Upgrades and the Interconnection Facilities and is assumed to be a minimum of $5 million.

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

8.0 Contingent Facilities

The Contingent Facilities identified for PI-2024-13 include the TPIF and Station Network Upgrades identified in Table 14, and Table 15, respectively.

9.0 Preliminary One-Line Diagram and General Arrangement for PI-2024-13

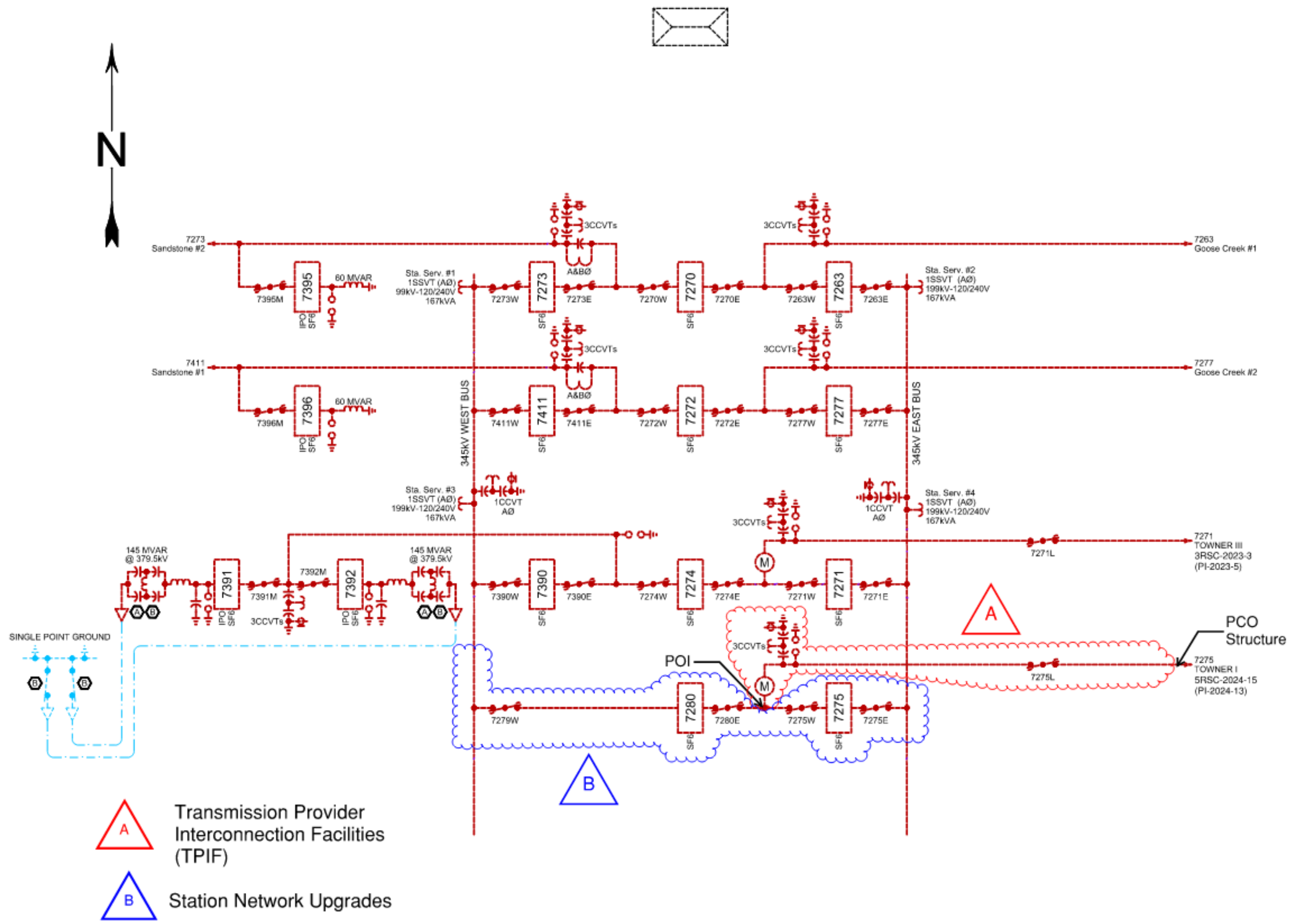


Figure 2: Preliminary One-Line for PI-2024-13 at the May Valley 345 kV Switching Station

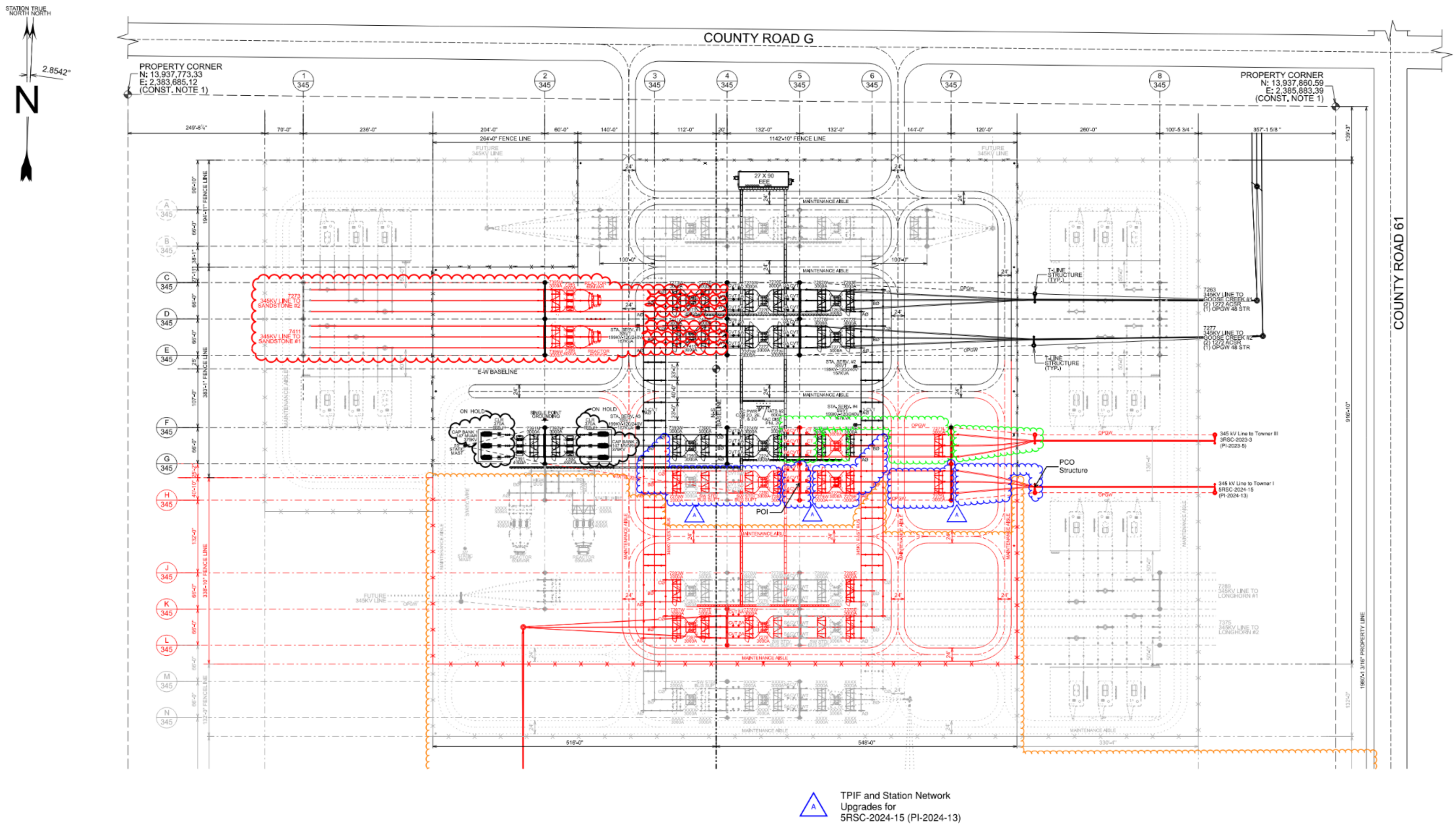
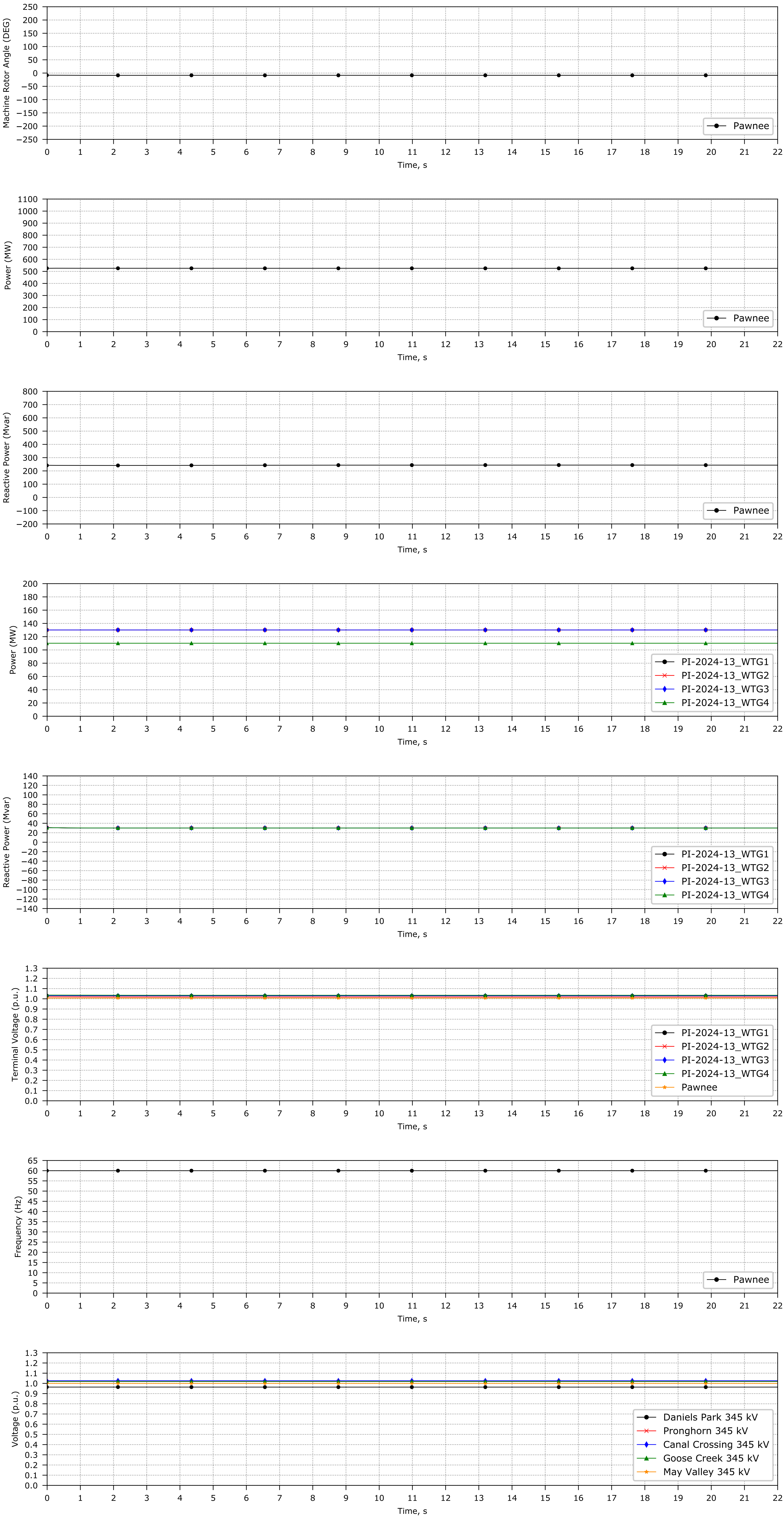


Figure 3: Preliminary General Arrangement for PI-2024-13 at the May Valley 345 kV Switching Station

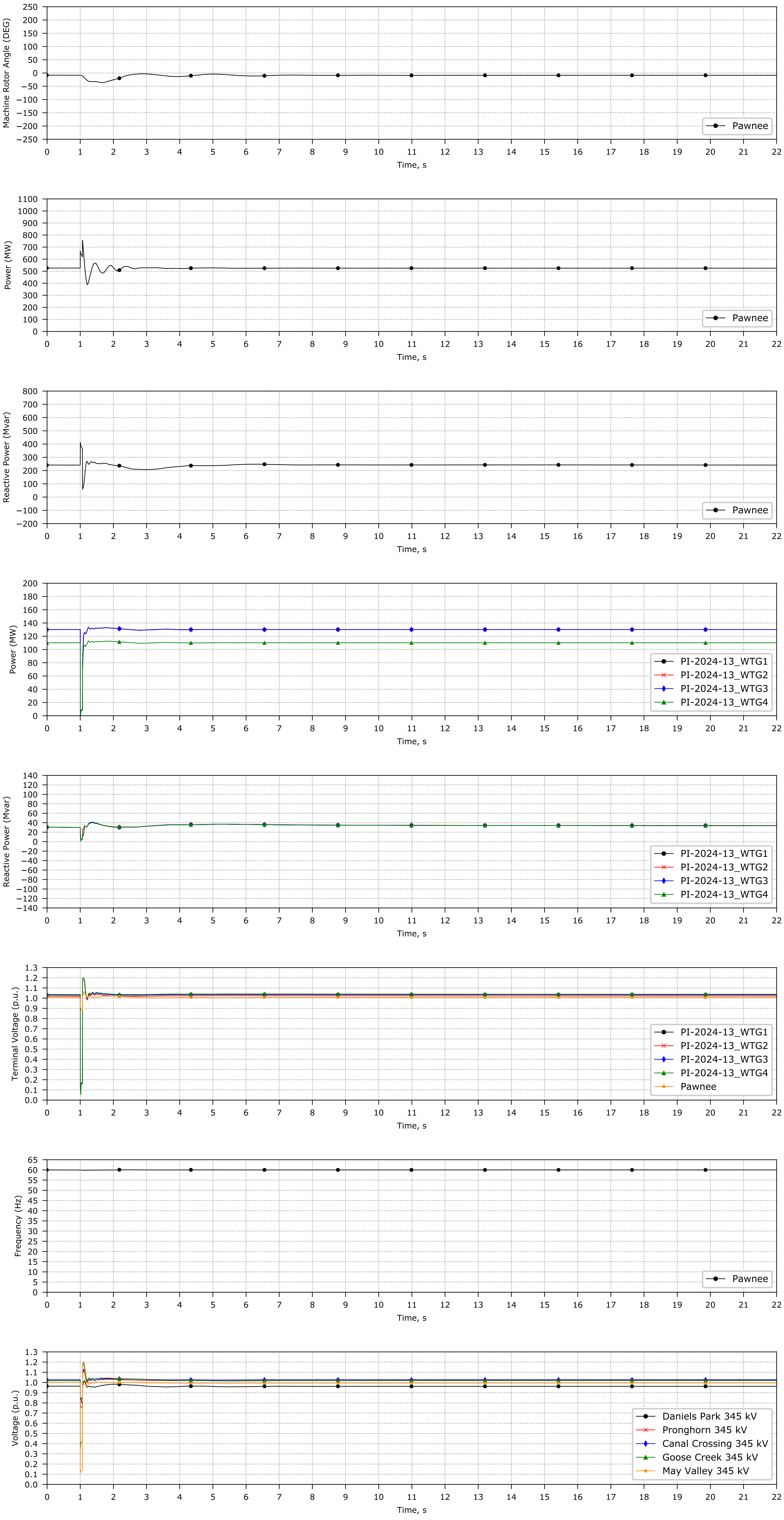
10.0 Appendices

Appendix A: Transient Stability Plots	PI-2024-13_Restudy_Transient_Stability_Plots

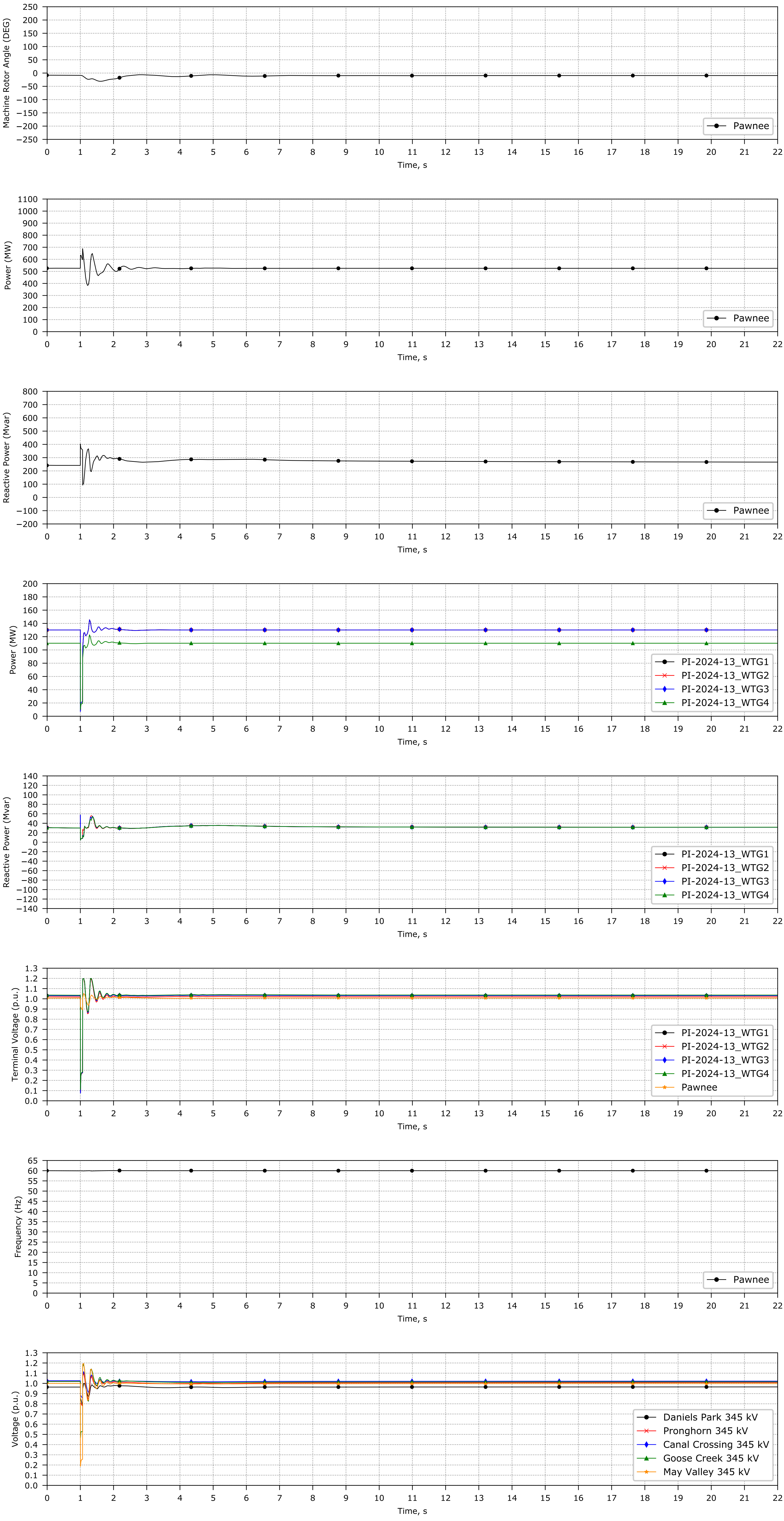
PI-2024-13_Study_East_flatrun



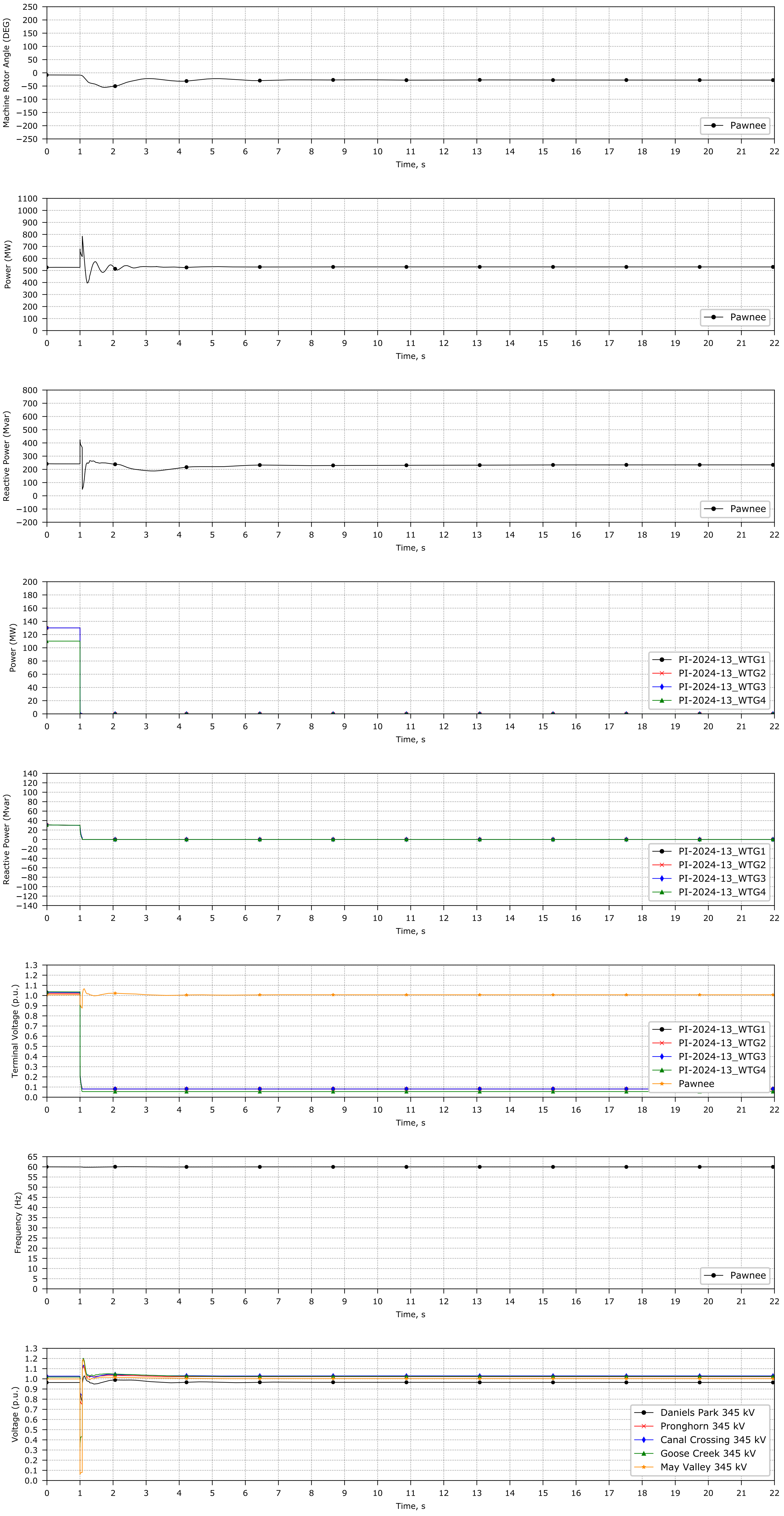
PI-2024-13_Study_East_MayValley-GooseCrk-1_345kV



PI-2024-13_Study_East_MayValley-Sandstone-1_345kV



PI-2024-13_Study_East_MayValley_PI-2024-13_Gen



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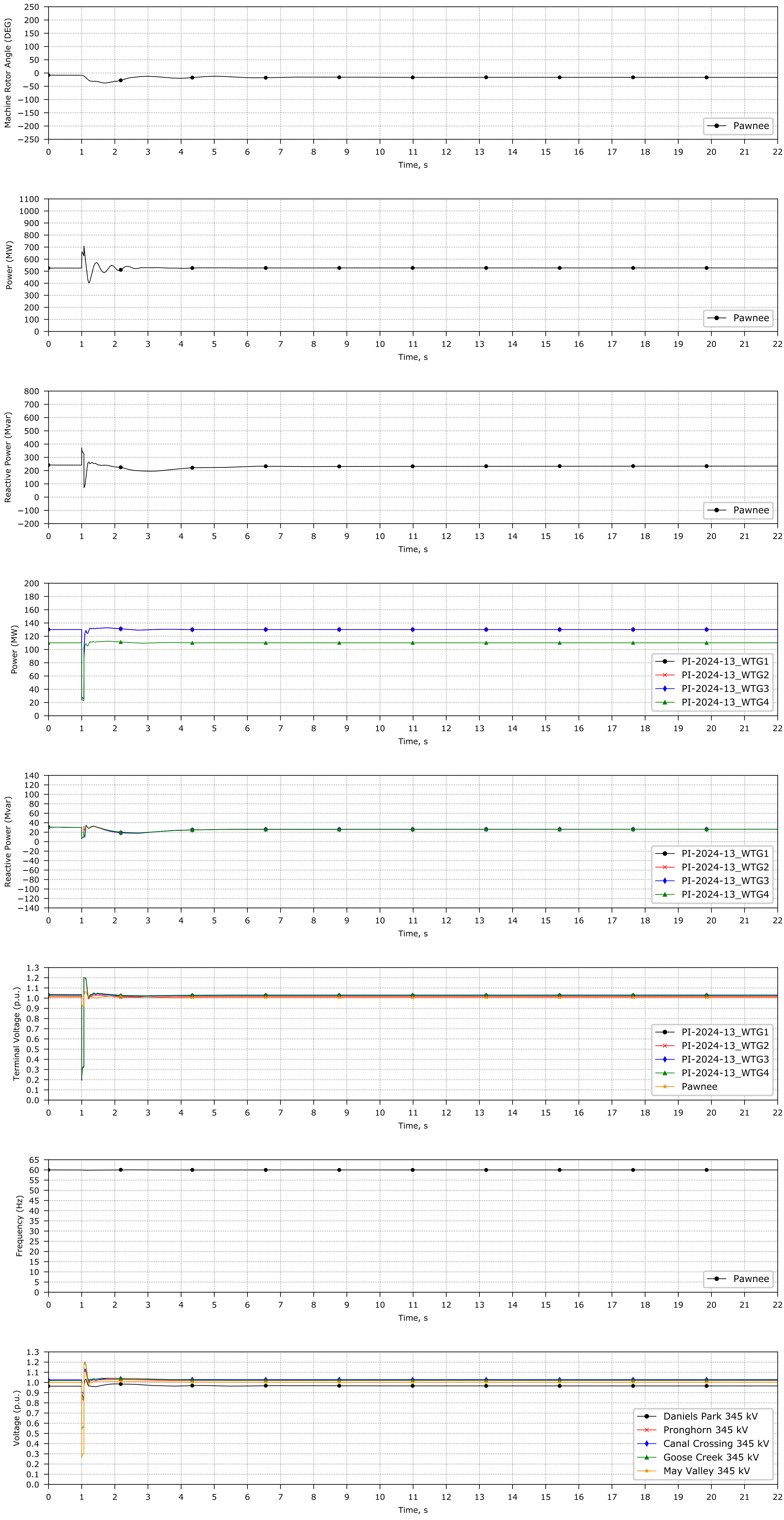
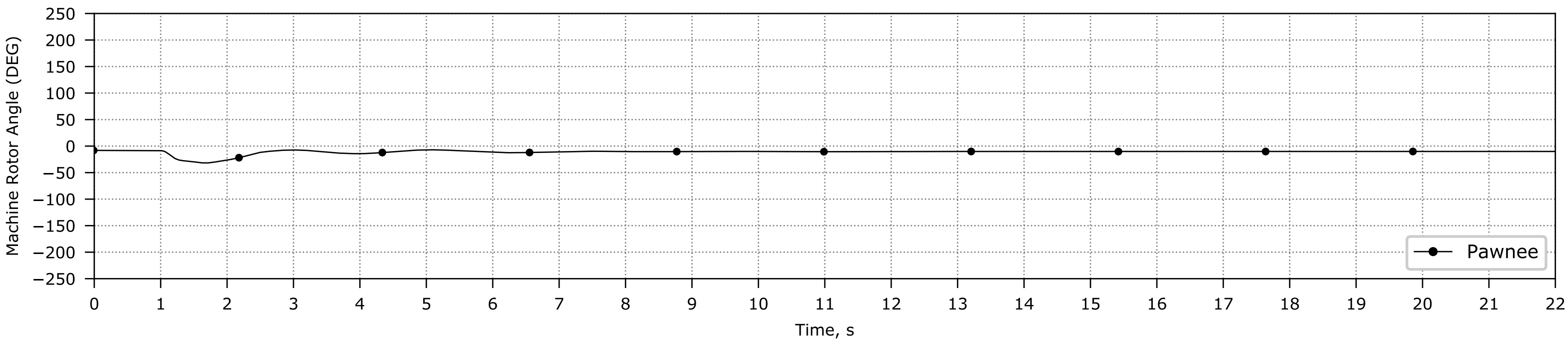
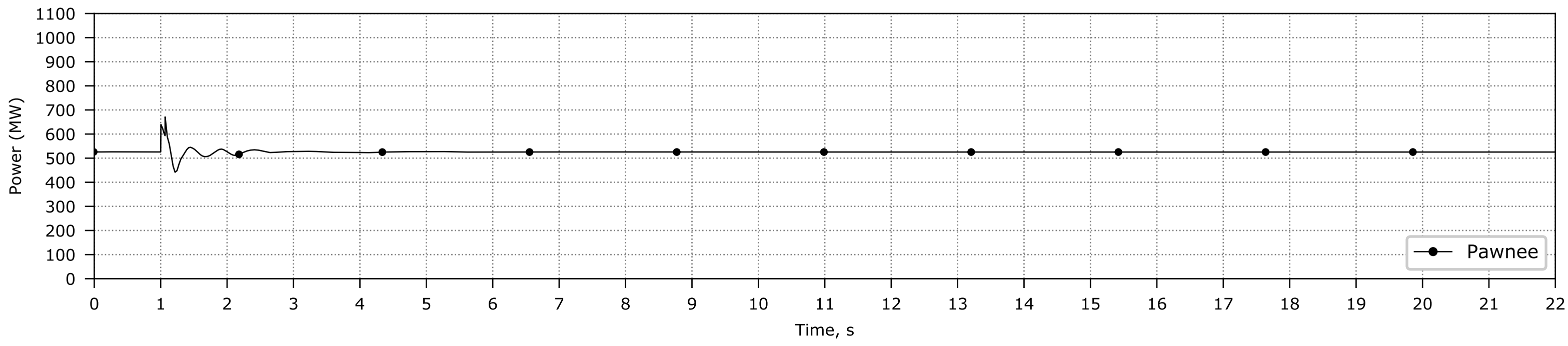
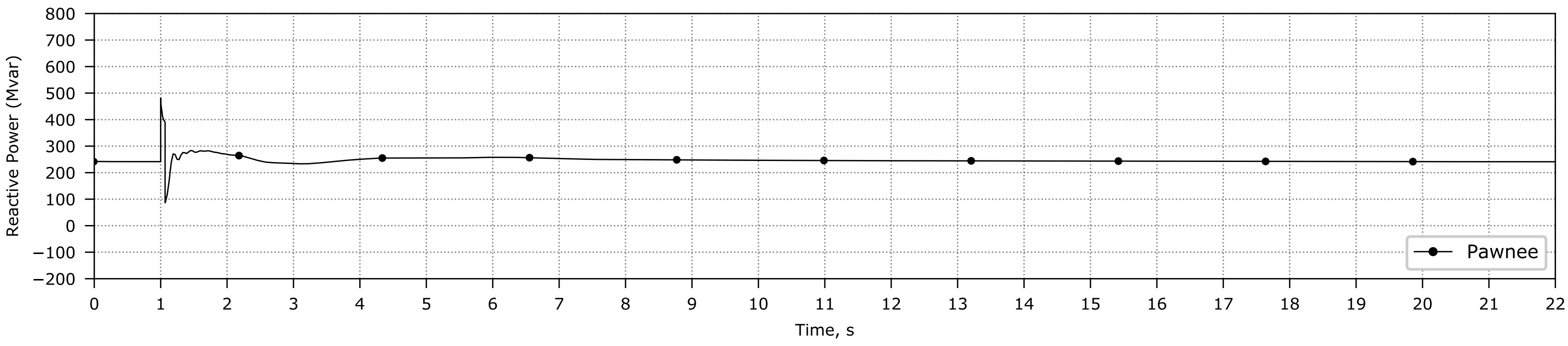
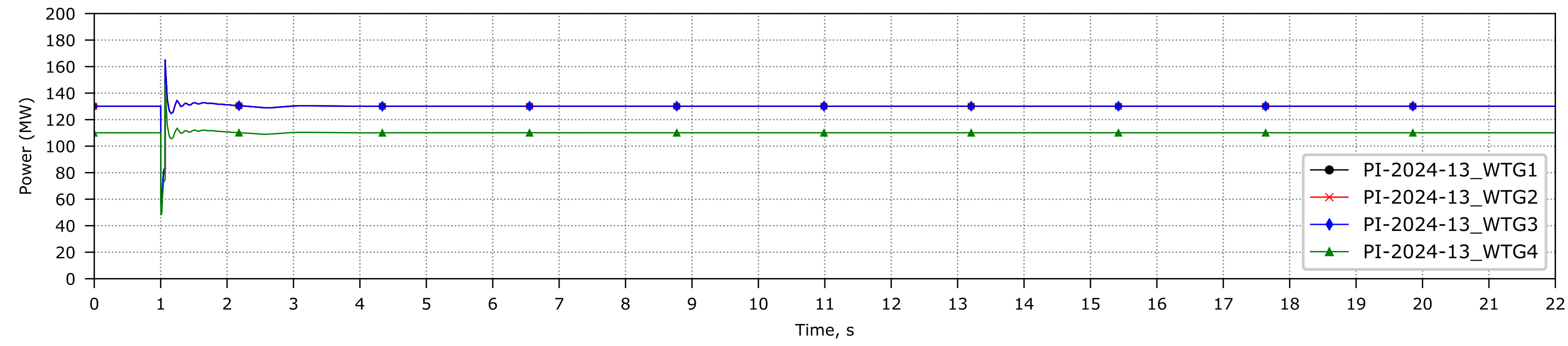


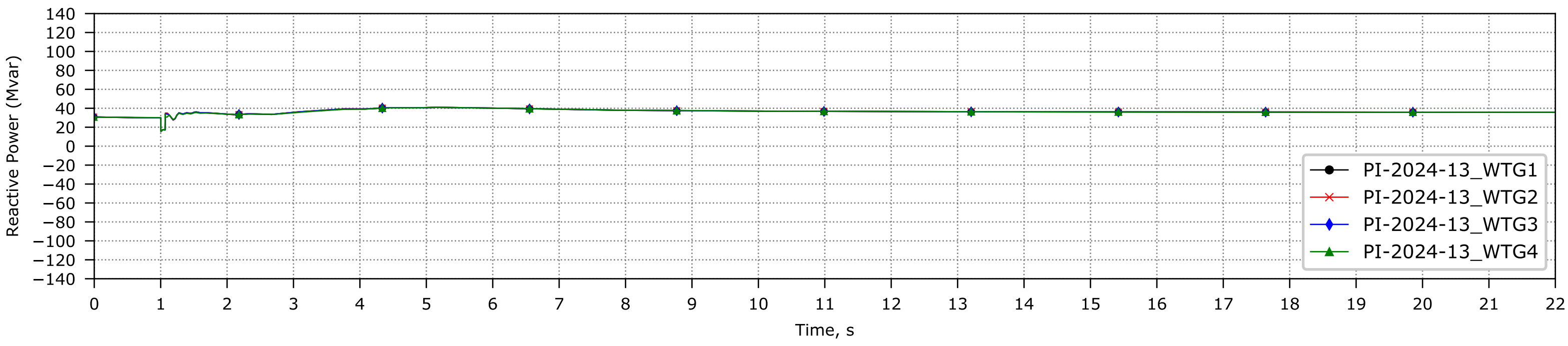
PI-2024-13_Study_East_GooseCrk-CanalXing-1_345kV

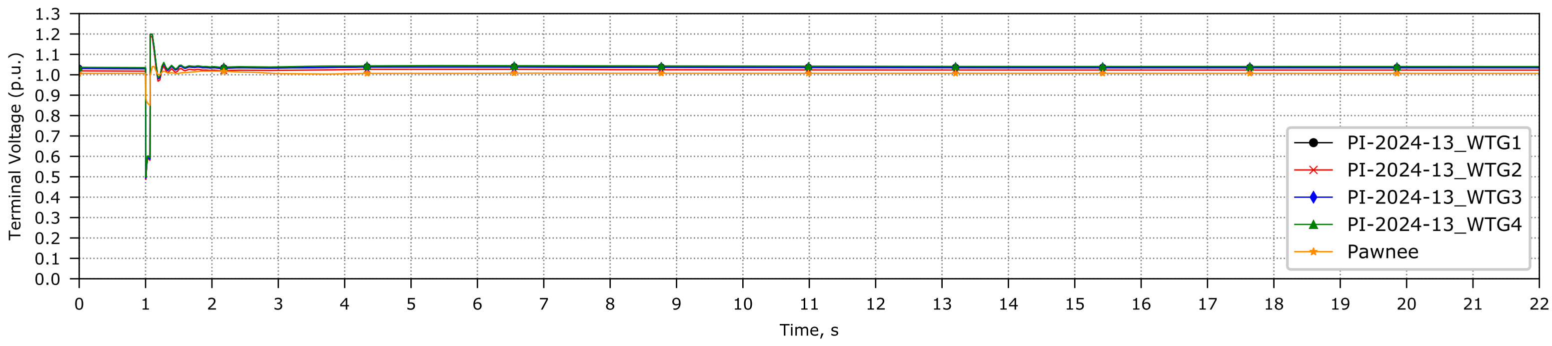


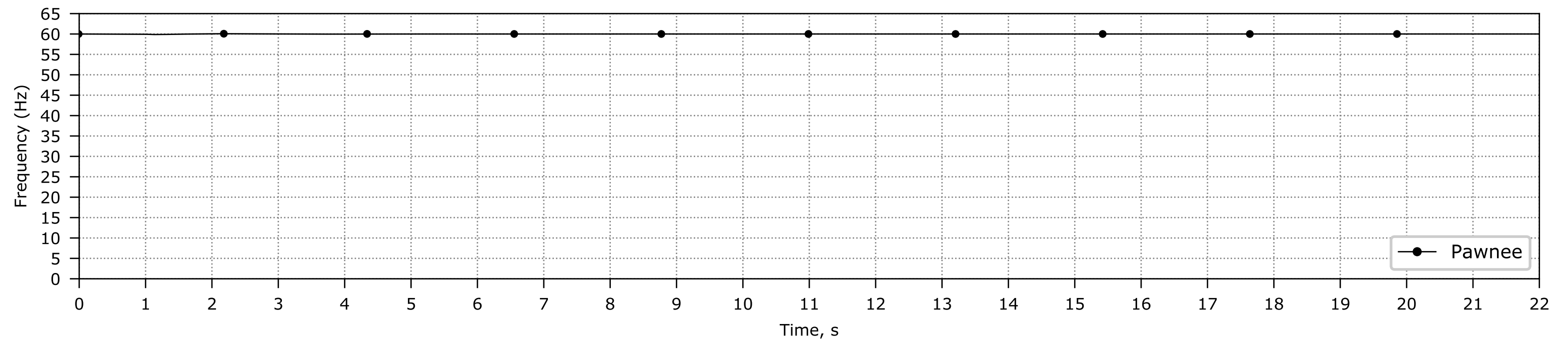


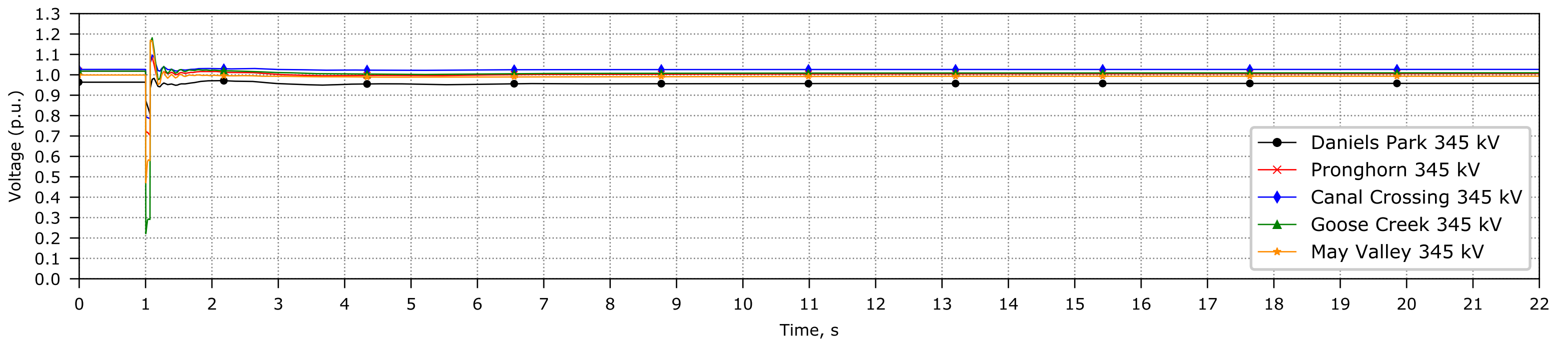












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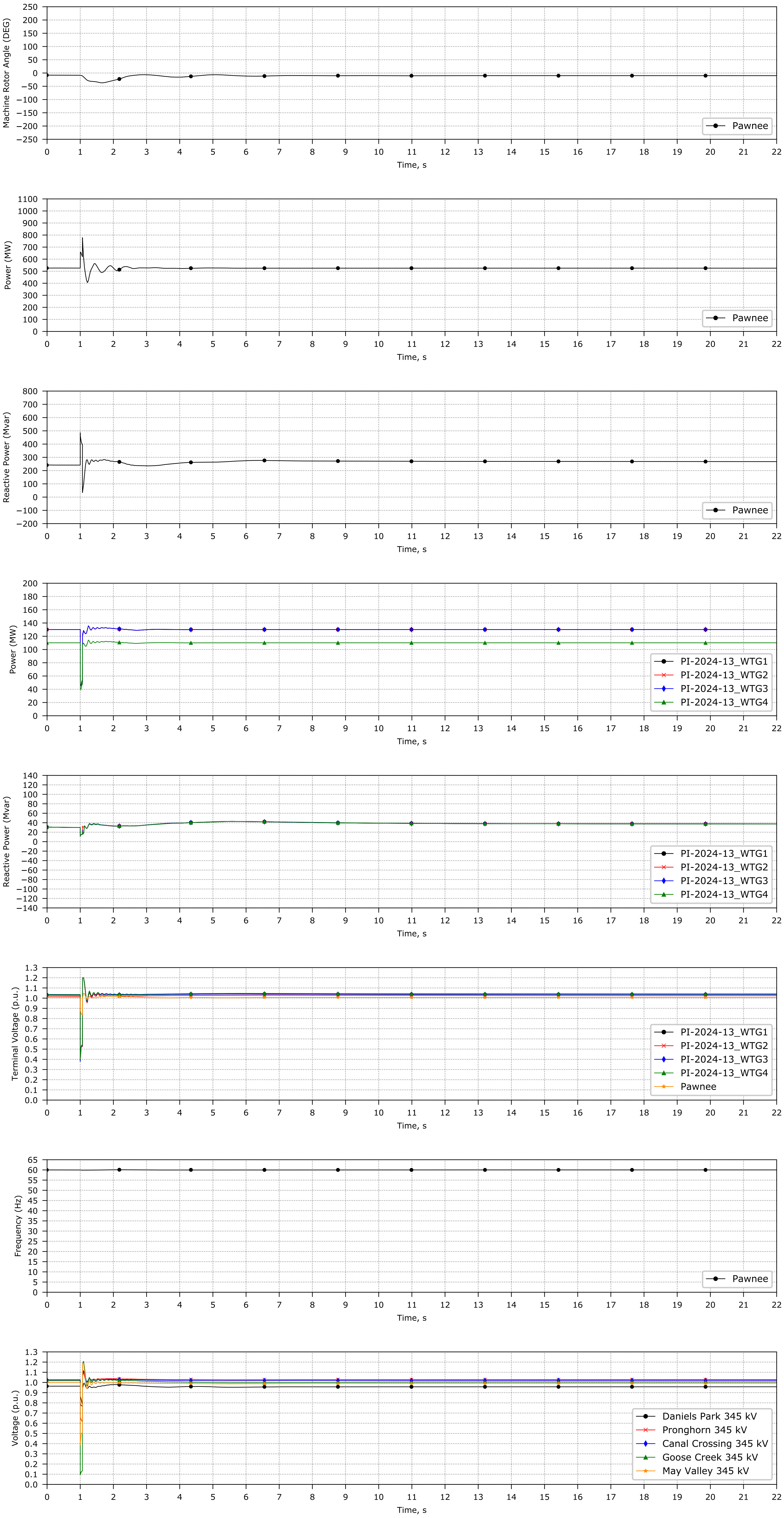
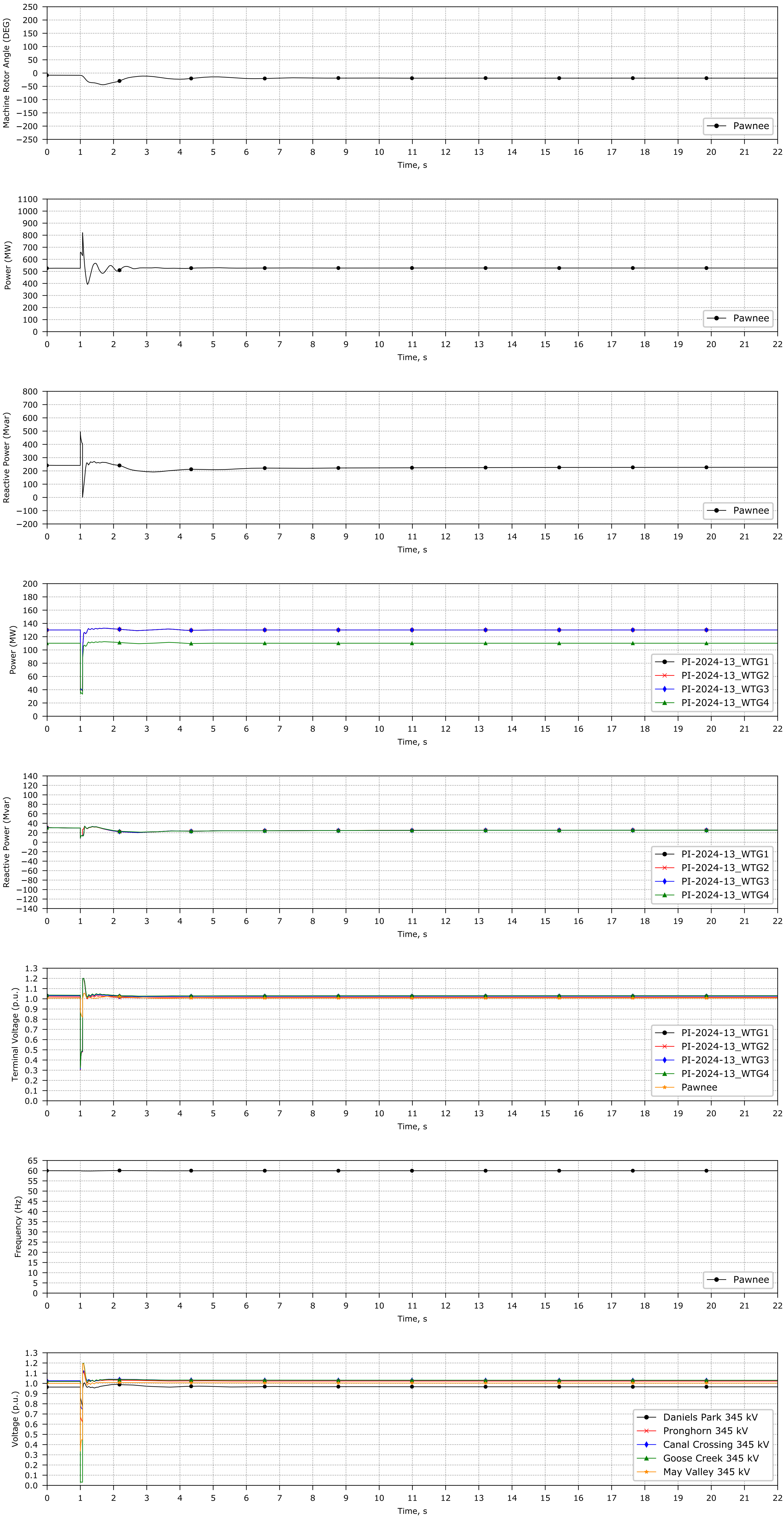


PI-2024-13_Study_East_GooseCrk-CheyRdg_345kV



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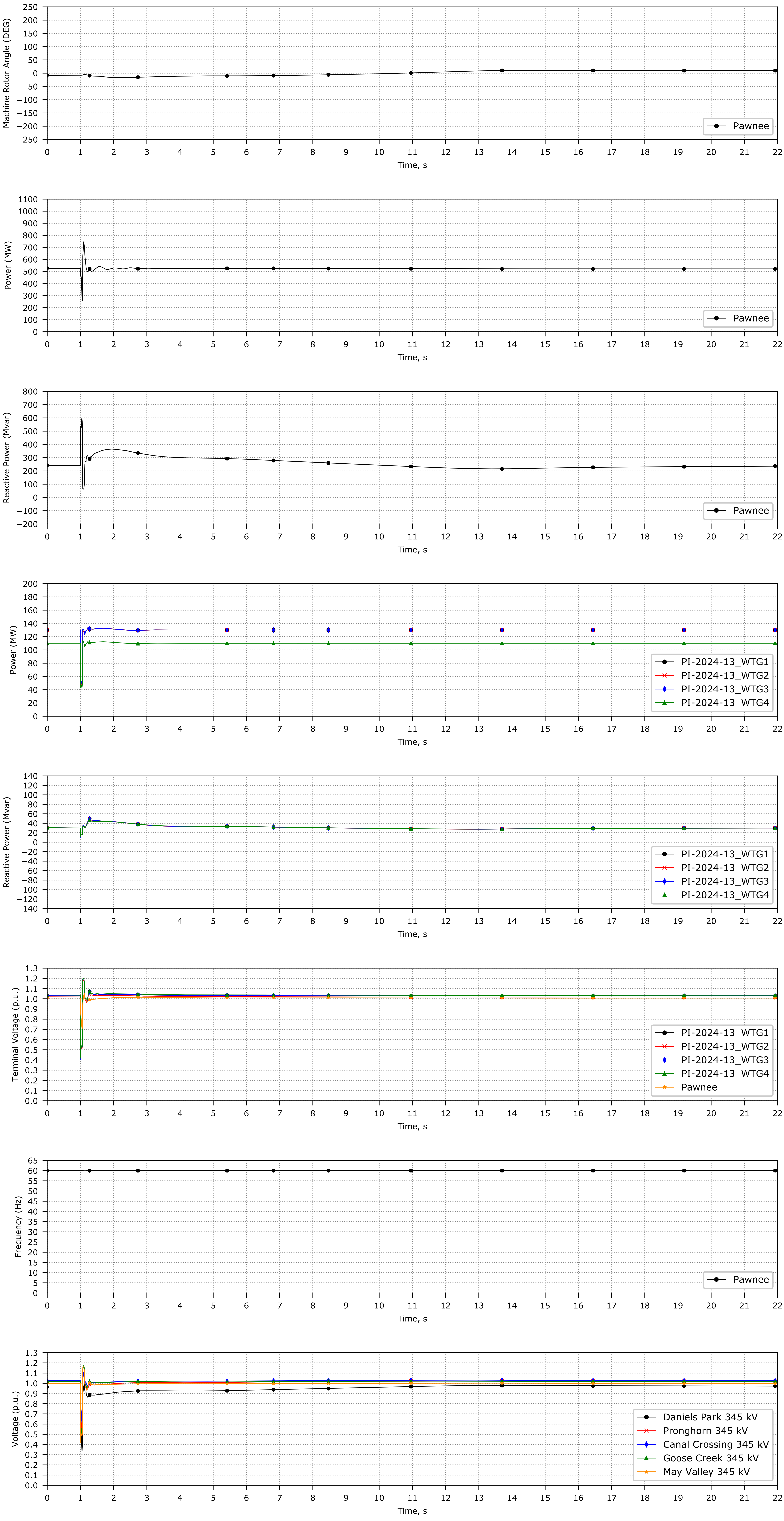

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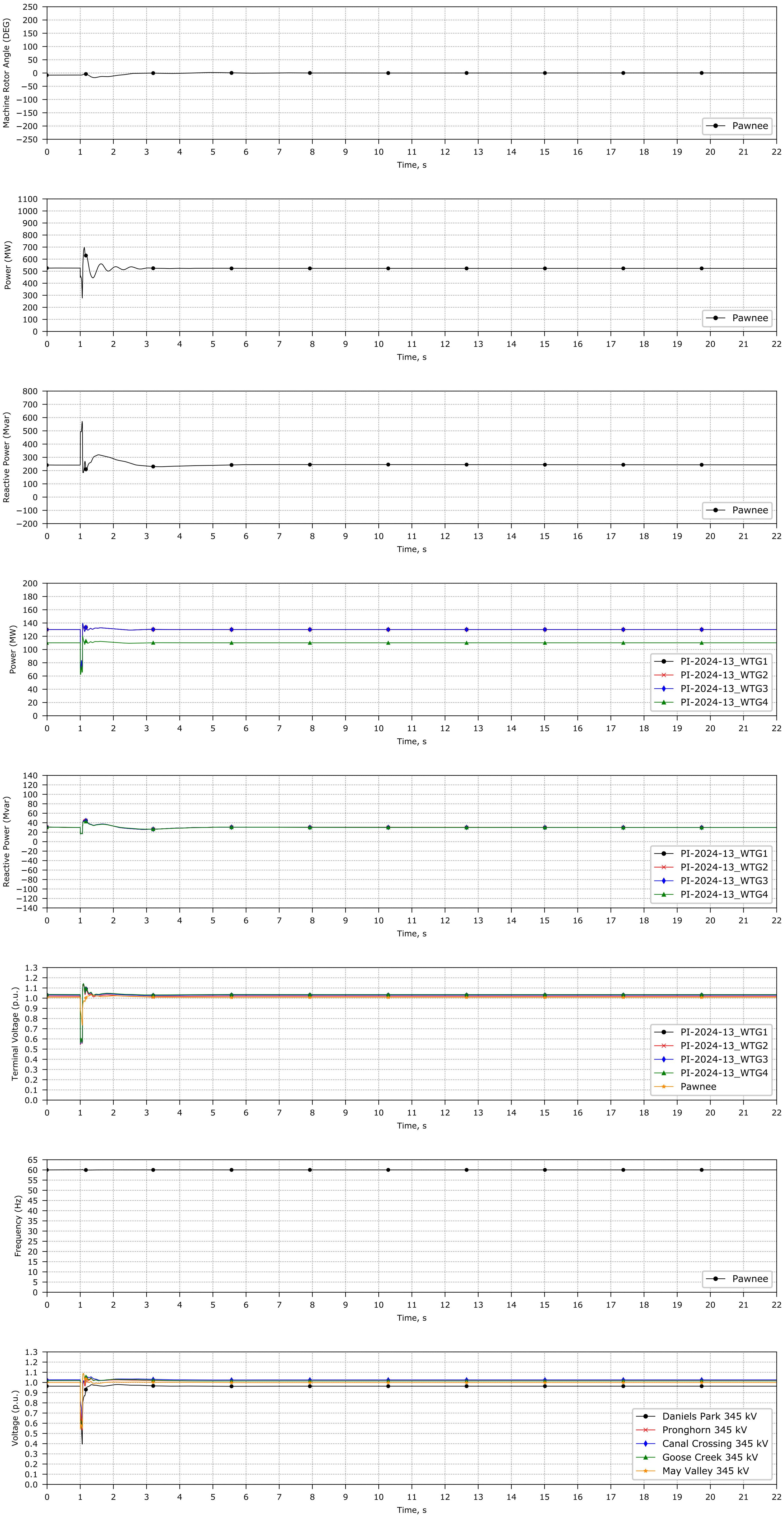

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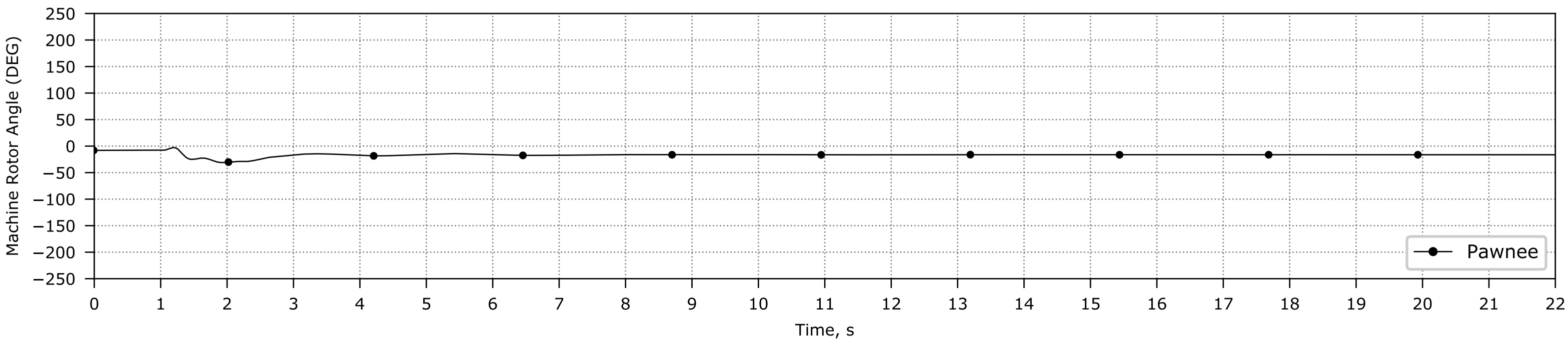

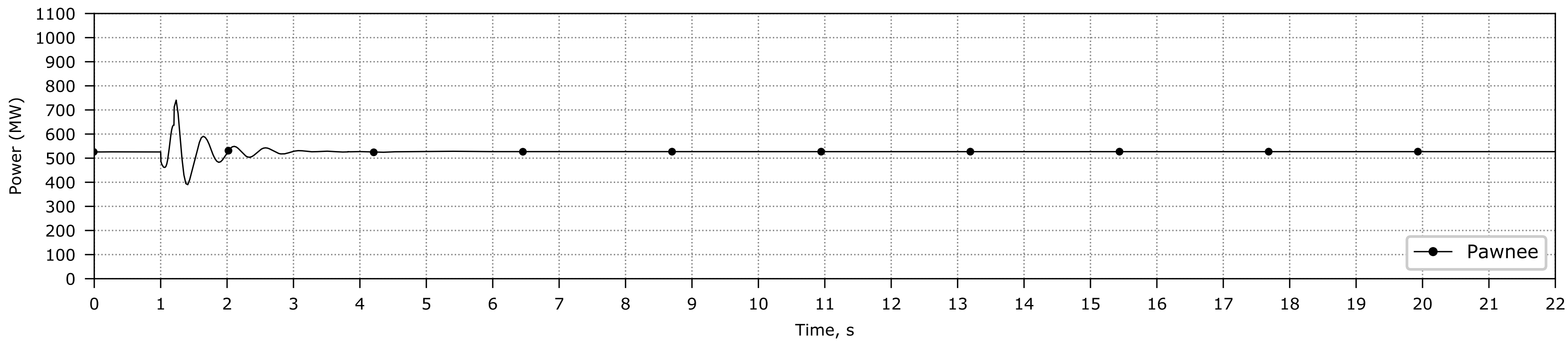

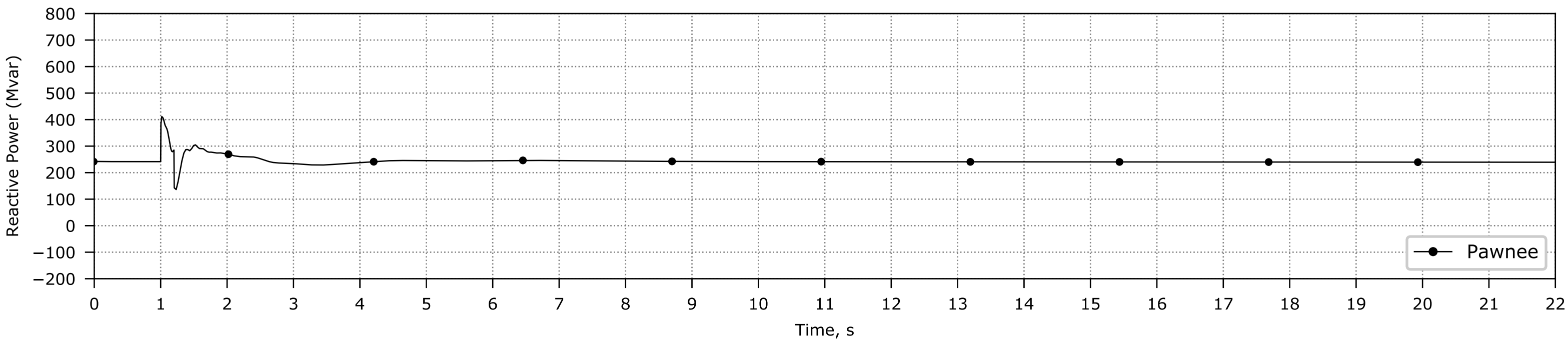

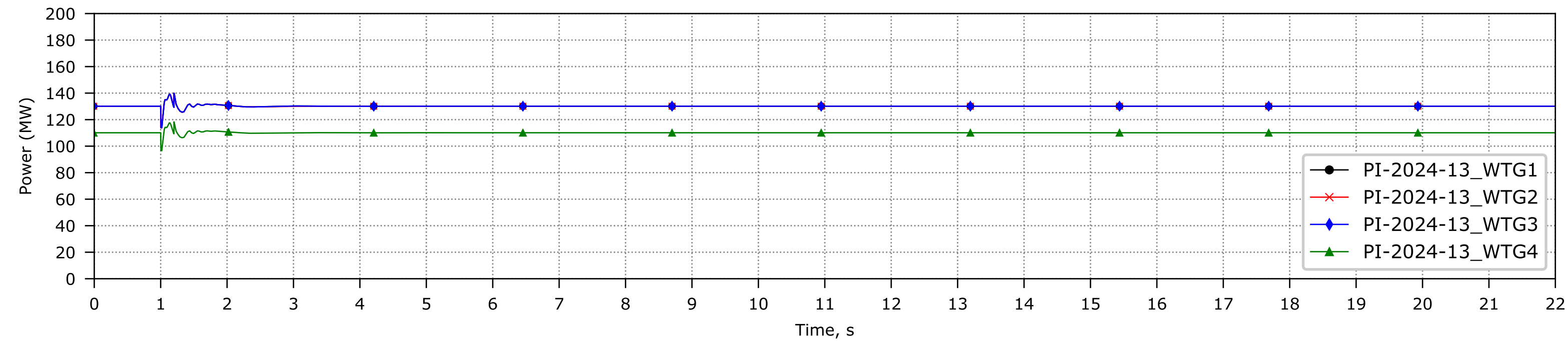

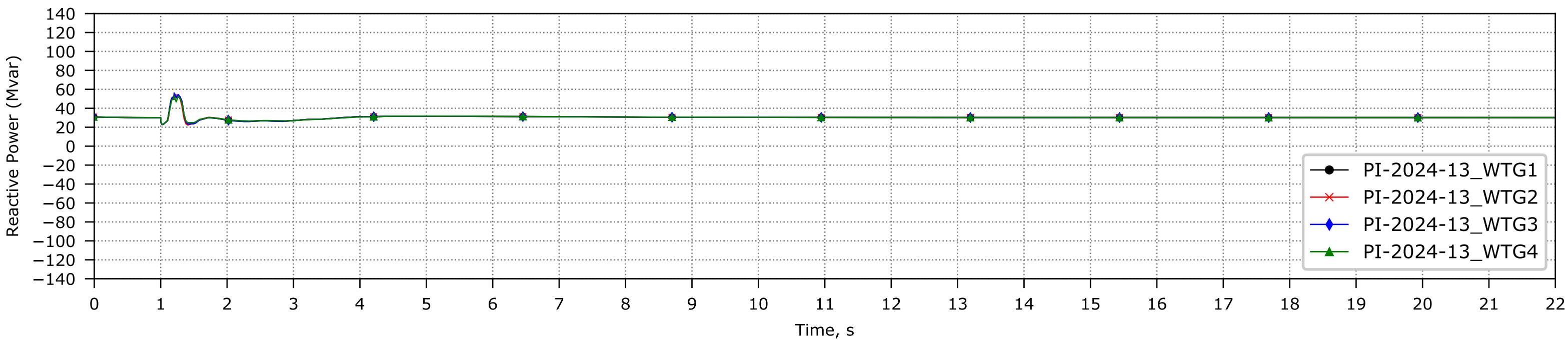

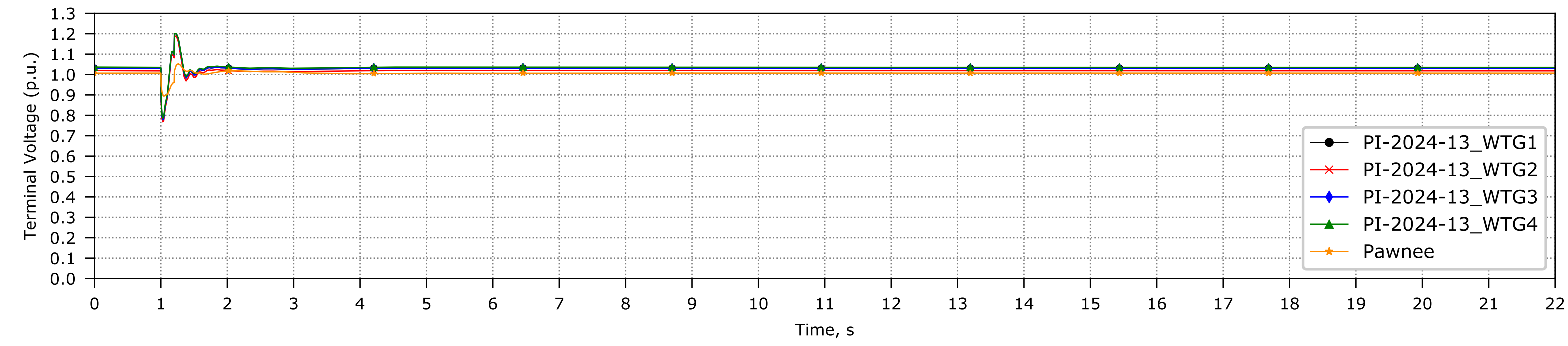

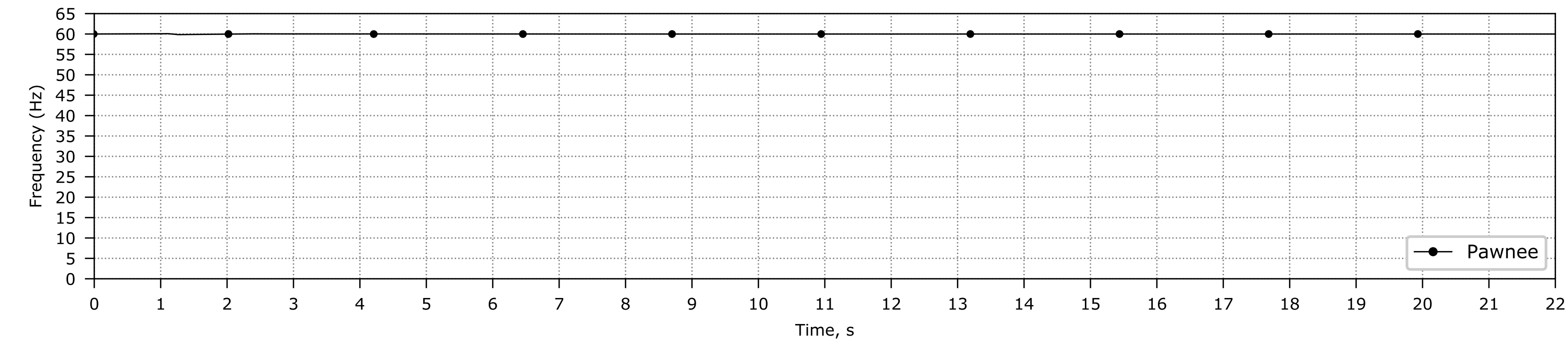

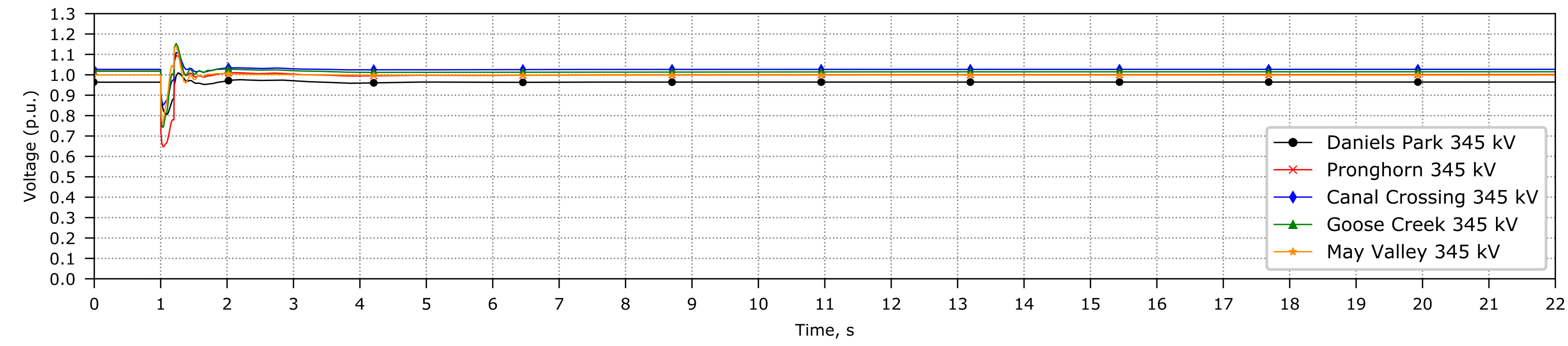

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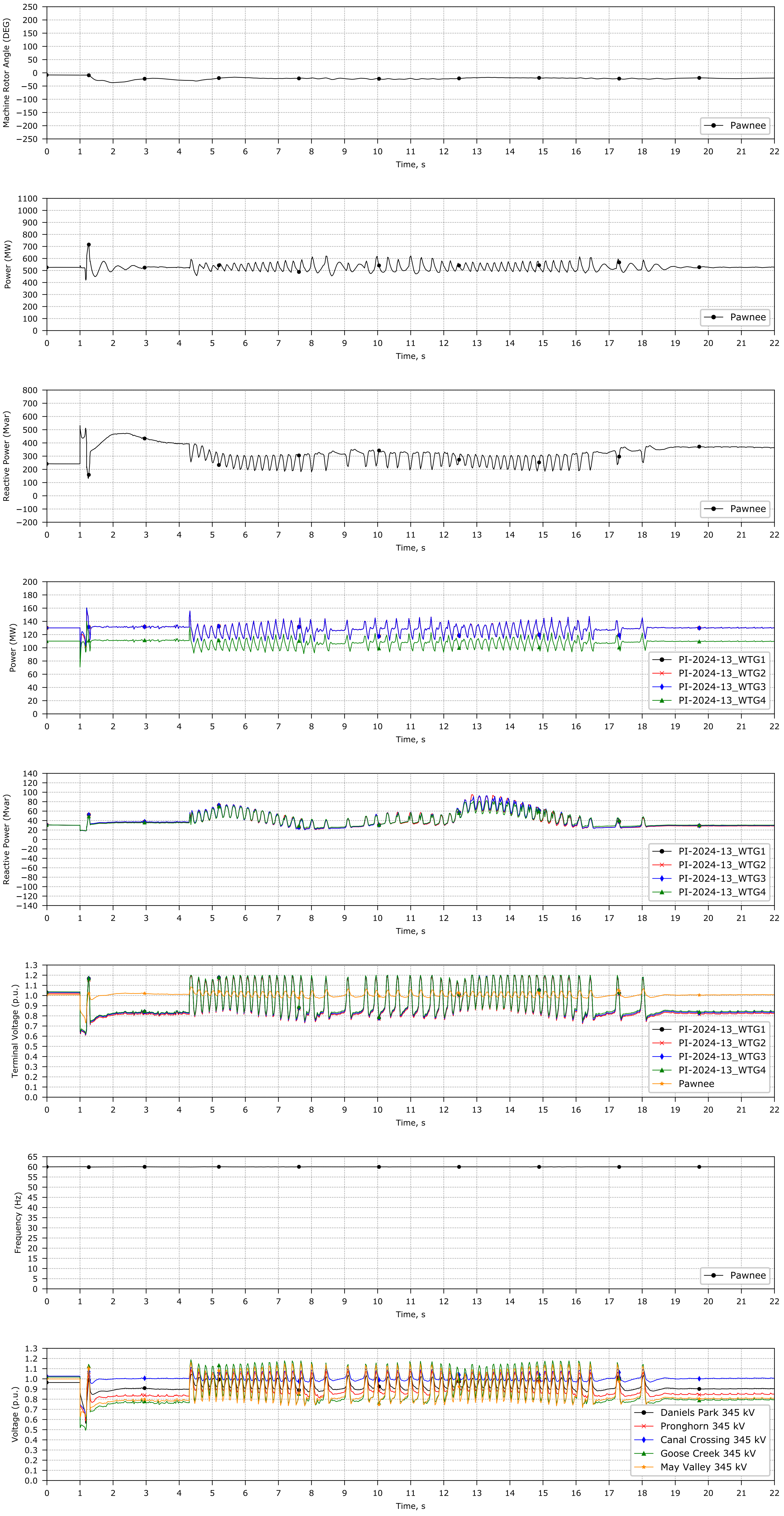

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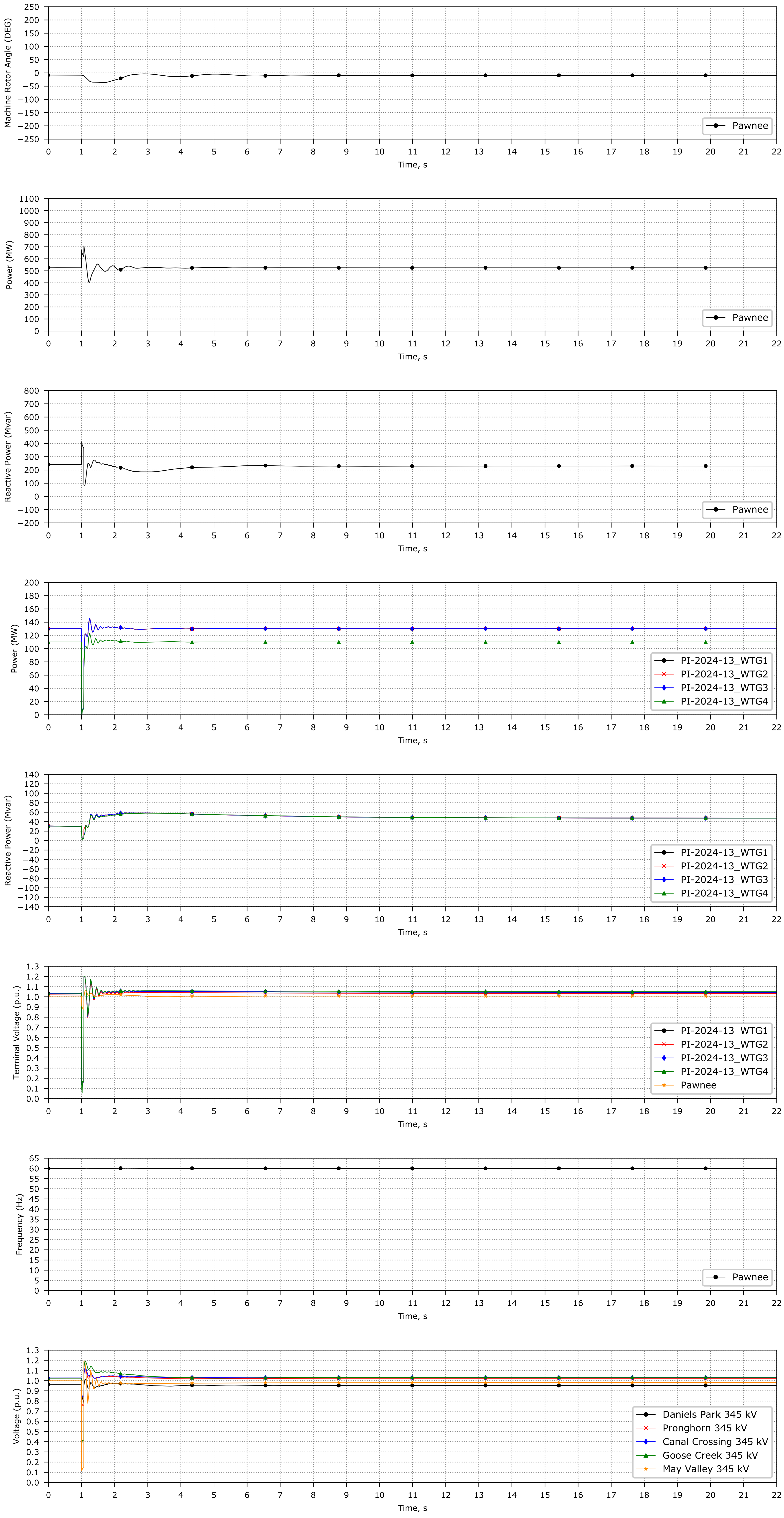

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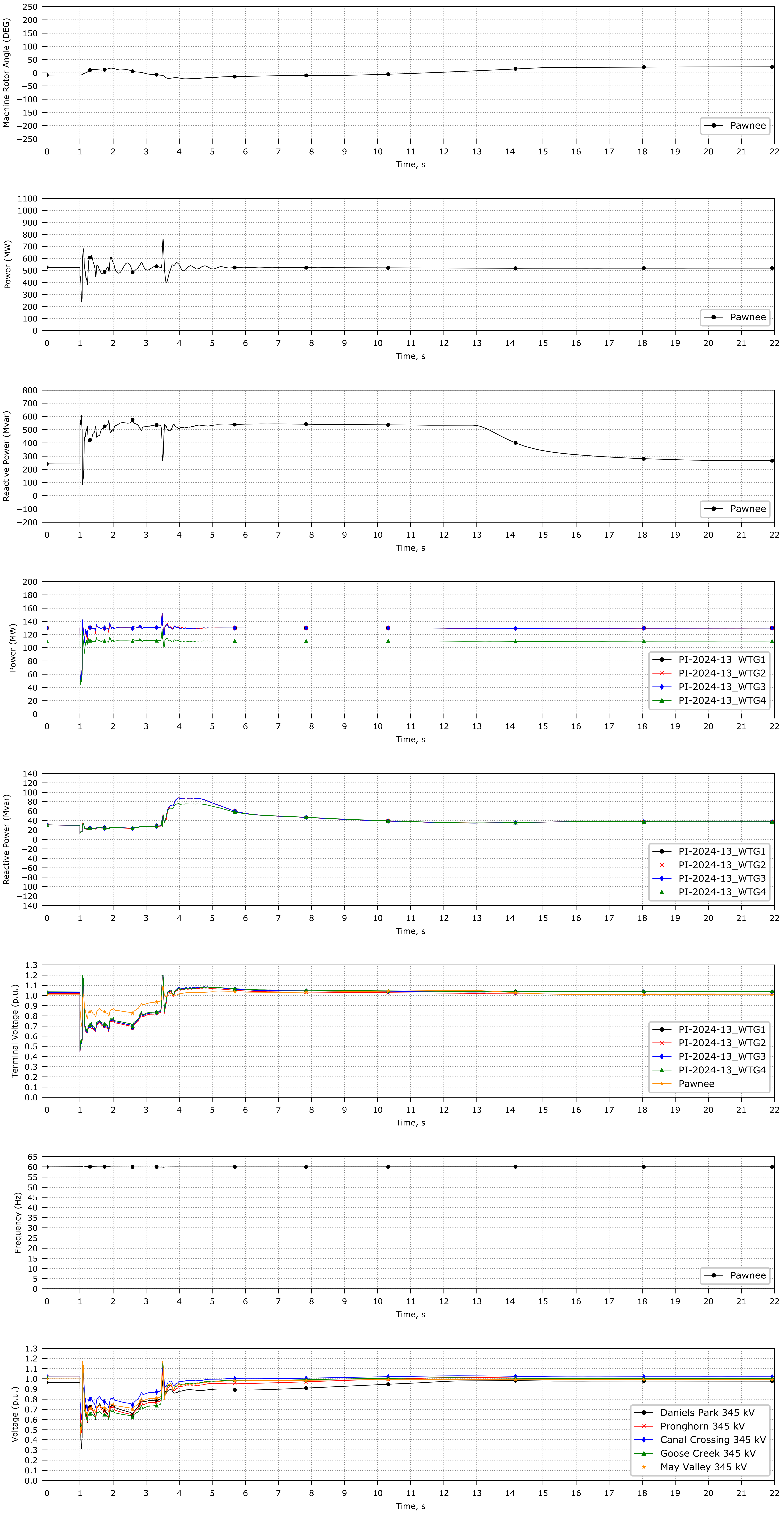

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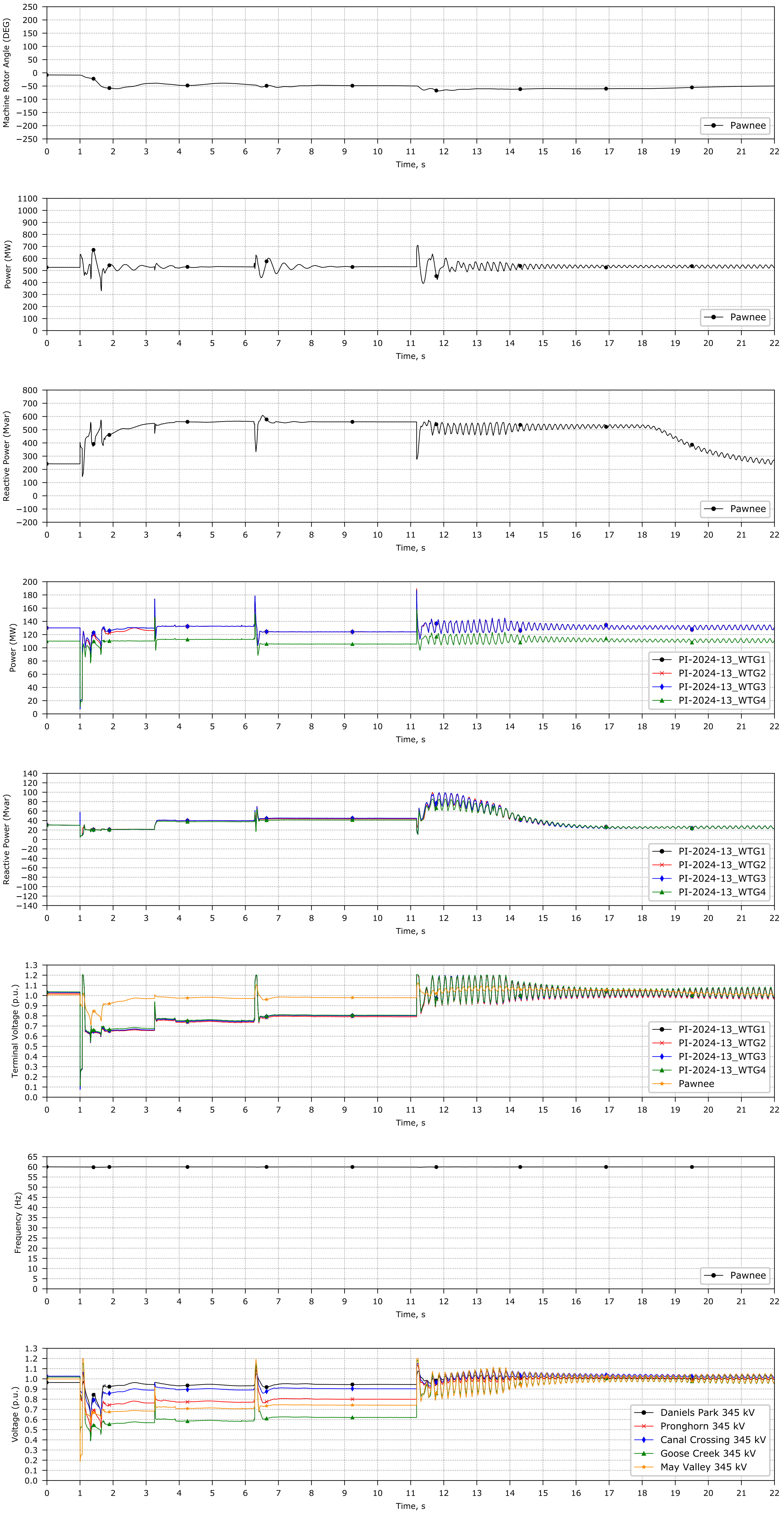

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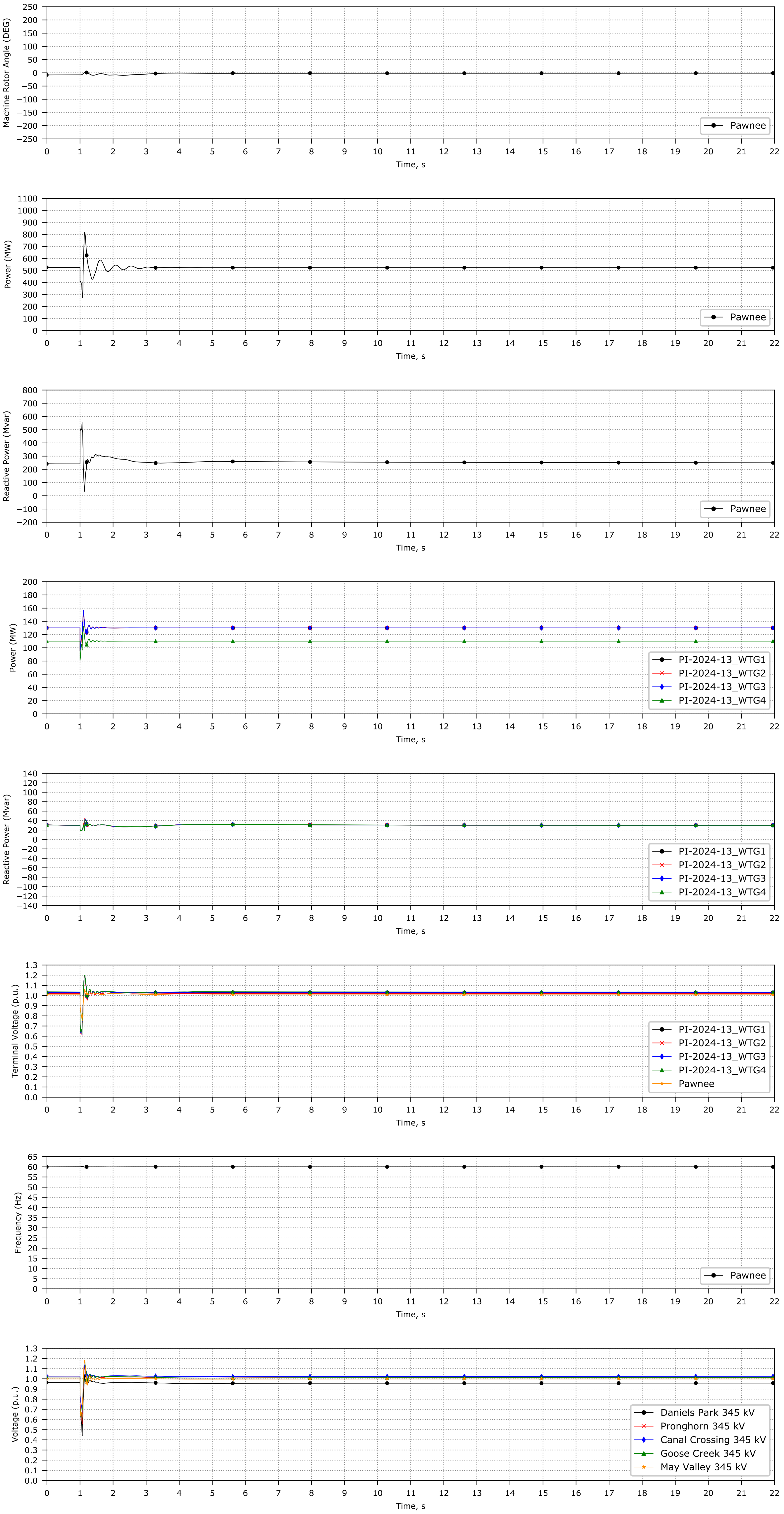

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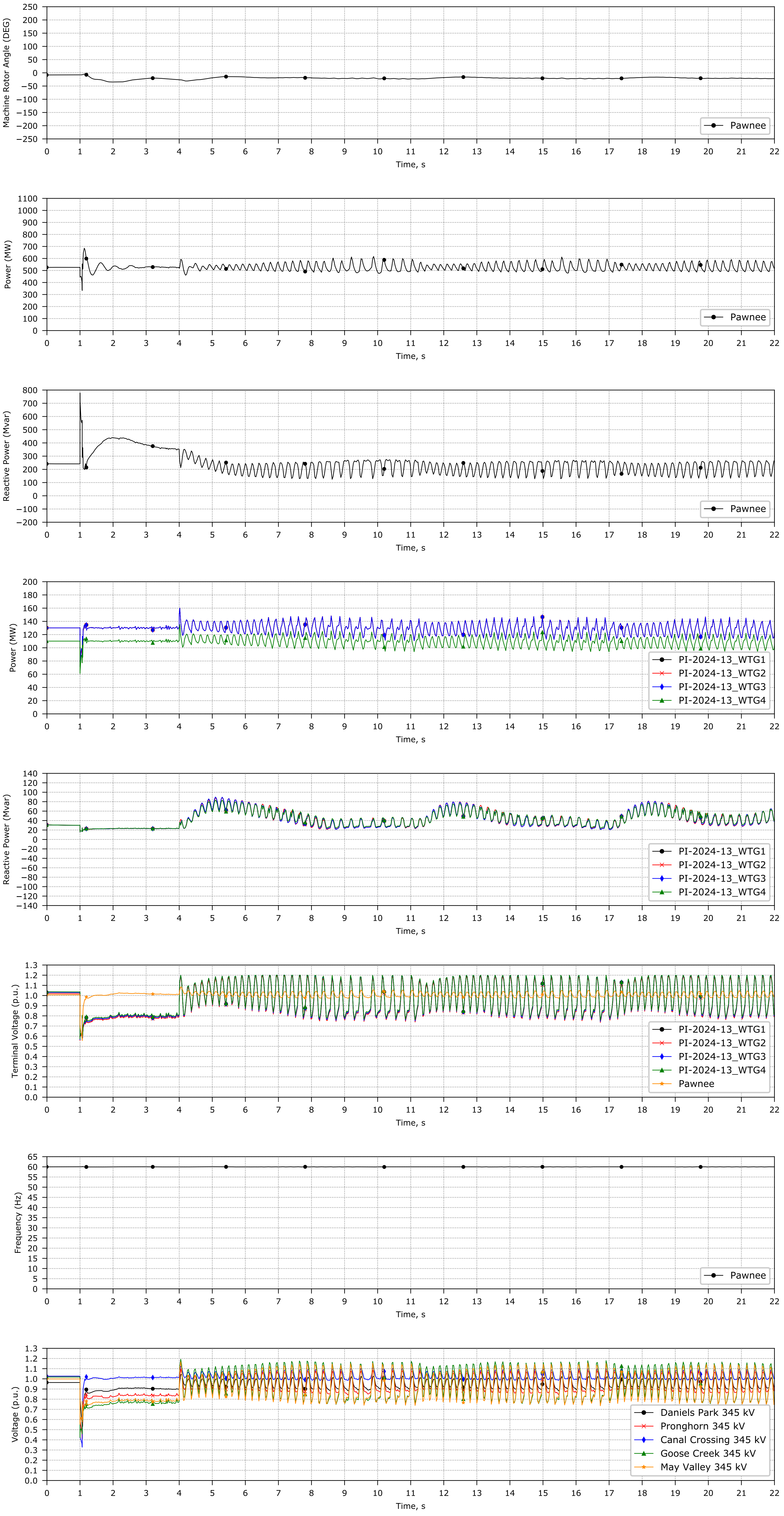

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