Provisional Interconnection Study Report for PI-2024-08

9/20/2024

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Table of Contents

List of Figures

List of Tables

1.0 Executive Summary

The PI-2024-08 project is a Provisional Interconnection request for a 90 MW solar plus 72 MW/288 MWh Battery Energy Storage System (BESS) Facility with a Point of Interconnection (POI) on the Alamosa Terminal – Blanca Peak 115 kV line. The PI-2024-08 is a Provisional Interconnection associated with Generation Interconnection Request 5RSC-2024-08 in the 5RSC cluster.

The total cost of the transmission system improvements required for PI-2024-08 to qualify for Provisional Interconnection Service is estimated to be $13.166 million (Table 9 and Table 10).

The initial maximum permissible output of the PI-2024-08 Generating Facility is 90 MW in grid discharging mode and 72 MW in grid charging mode. The maximum permissible output of the Generating Facility in the PLGIA[1] would be reviewed quarterly and updated, if there are changes to the system conditions assumed in this analysis, to determine the maximum permissible output.

Security: Based on 5RSC-2024-08 in the 5RSC selection of Energy Resource Interconnection Service (ERIS), the security associated with the Network Upgrades that might be identified at the conclusion of the 5RSC-2024-08 Large Generation Interconnection Procedure (LGIP) in the 5RSC cluster is $5 million.

The Interconnection Customer assumes all risk and liabilities with respect to changes between the PLGIA and the LGIA[2], including changes in output limits and Interconnection Facilities, Network Upgrades, Distribution Upgrades, and/or System Protection Facilities cost responsibility.

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

[1] **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.

[2] **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-2024-08 is the Provisional Interconnection Service[3] request for a 90 MW solar plus 72 MW/288 MWh BESS Facility located in Alamosa County, Colorado.

- The POI of this project is on the Alamosa Terminal – Blanca Peak 115 kV line.
- The Commercial Operation Date (COD) to be studied for PI-2024-08 as noted on the Provisional Interconnection request is July 31, 2027.

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

[3] **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.

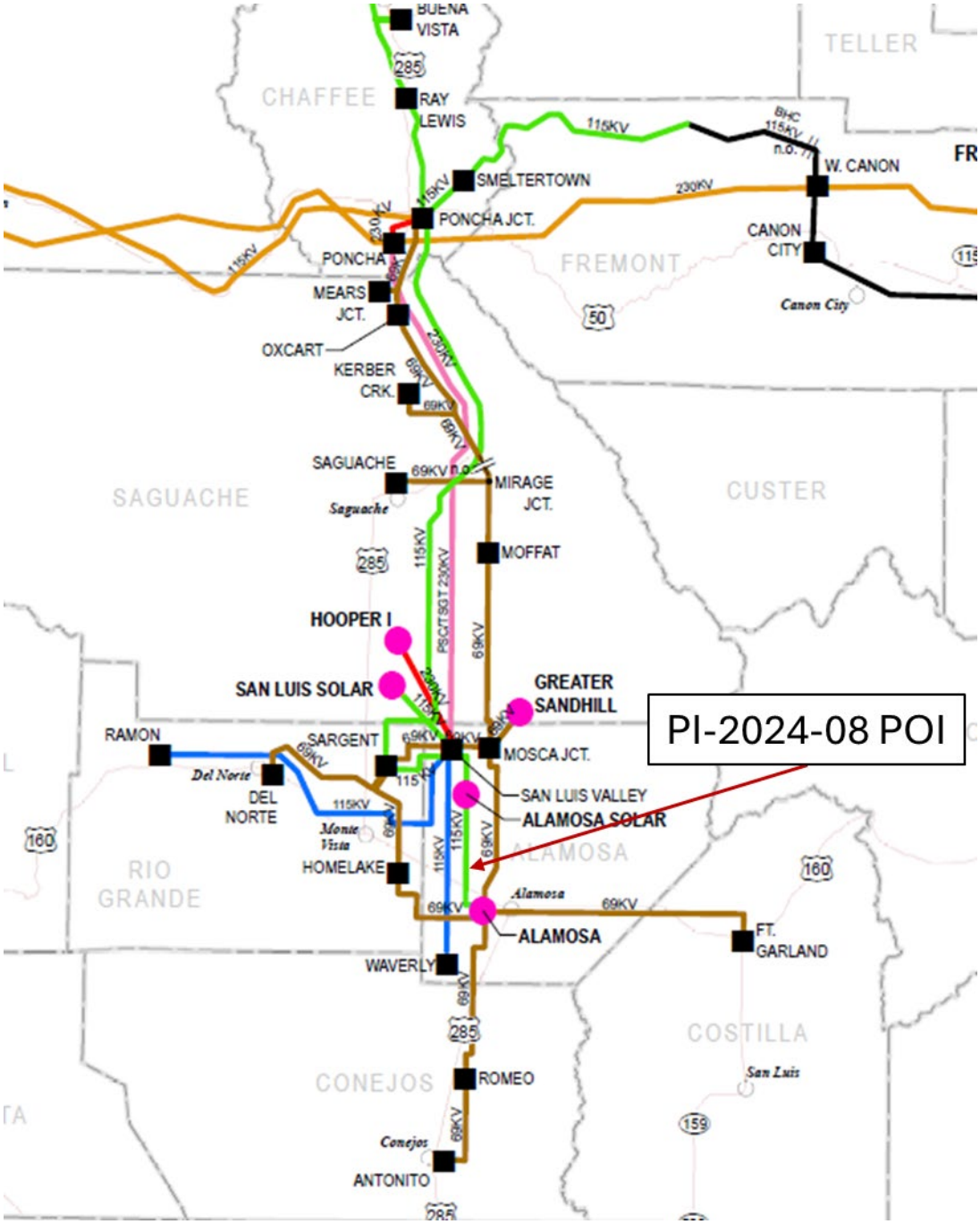

Figure 1: Point of Interconnection of PI-2024-08

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-2024-08 for Provisional Interconnection Service. Consistent with the assumption in the study agreement, PI-2024-08 selected Energy Resource Interconnection Service (ERIS)[4].

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

3.1 Steady-State Criteria

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

P0—System Intact conditions:

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

Voltage range: 0.95 to 1.05 per unit

P1 & P2-1—Single Contingencies:

Thermal Loading: <=100% Normal facility rating

Voltage range: 0.90 to 1.10 per unit

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

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

Thermal Loading: <=100% Emergency facility rating

Voltage range: 0.90 to 1.10 per unit

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

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

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

3.2 Transient Stability Criteria

The transient voltage stability criteria are as follows:

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

The transient angular stability criteria are as follows:

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

3.3 Breaker Duty Analysis Criteria

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

3.4 Study Methodology

For PSCo and non-PSCo 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	Fault Category	Outage(s)	Clearing Time (Cycles)
1	Alamosa Terminal - PI-2024-8 POI 115 kV Line	P1	Alamosa Terminal - PI-2024-8 POI 115 kV Line	6
2	PI-2024-8 POI - Blanca Peak 115 kV Line	P1	PI-2024-8 POI - Blanca Peak 115 kV Line	6
3	PI-2024-8 POI - PI-2024-8 115 kV Line	P1	PI-2024-8 POI - PI-2024-8 115 kV Line	6
4	Alamosa Terminal - PI-2024-8 POI 115 kV	P4	- Alamosa Terminal - PI-2024-8 POI 115 kV Line - PI-2024-8 POI - Blanca Peak 115 kV Line - Alamosa Terminal 115 kV Load P2 and P3 - Alamosa CT2 generation - PI-2024-8 generation	22
5	PI-2024-8 POI – Blanca Peak 115 kV	P4	- Alamosa Terminal - PI-2024-8 POI 115 kV Line - PI-2024-8 POI - Blanca Peak 115 kV Line - Blanca Peak - San Luis Valley 115 kV Line - Alamosa PV generation and SS load - PI-2024-8 generation	22

3.6 Study Area

The San Luis Valley (SLV) study area includes WECC designated zone 710. As described in Section 3.11 of the BPM, this study pocket is comprised of all generation within the SLV area, including:

- San Luis Solar (SLV 230 kV), 52 MW PV
- Iberdrola Solar (SLV 115 kV), 30 MW PV
- Cogentrix Solar (Blanca Peak 115 kV), 30 MW PV
- Greater Sandhills Solar (Mosca 69 kV), 19 MW PV
- Alamosa CTs, 37.3 MW Gas

The study did not identify any impacts to Affected Systems.

4.0 Base Case Modeling Assumptions

The 2029HS2a WECC case released on May 3, 2023, was selected as the Starting Case. The 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 800 A, 95 MVA – ISD 5/15/2026.
- Daniels Park-Prairie-Greenwood Uprate L5111 to 956 MVA – ISD 10/21/2026.
- Additional Harvest Mile to Smoky Hill 230 kV Line – ISD 5/14/2027.
- 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.
- Leetsdale-Harrison L9955 Uprate to 1900 A – ISD 11/16/2027.
- Uprate Line 9255 115kV from Poncha Junction to Otero Tap 1200A 239 MVA – ISD 5/1/2028.
- Cherokee-Federal Heights-Semper Line 9055 rebuild – ISD 6/1/2029.
- Semper-Broomfield Line 9464 rebuild – ISD 6/1/2029.
- Add Smoky Hill 345/230 T6 Transformer – ISD 9/27/2028.
- San Luis Valley – Blanca Peak Line 9431 115kV uprate to 800A, 159 MVA – ISD 6/20/2028.
- Poncha – San Luis Valley 230 kV L3006 Uprate to 478 MVA – ISD 5/11/2029.
- New Line (second circuit) 115kV from Alamosa Terminal - San Luis Valley 1200 A 239MVA – ISD 6/15/2028.
- Cherokee-Lacombe 230 kV L5057 Uprate to 1900 A, 756 MVA – ISD 9/13/2029.
- Daniels Park 345/230 kV Transformer #4 – ISD 9/13/2029.
- Add Chambers T3 230/115 Transformer – ISD 9/13/2029.
- Capital-Denver Terminal L9007 Uprate to 1900 A – ISD 9/13/2029.
- Havana-Chambers 115 kV L9543 & L9544 Uprate - ISD 9/13/2029.
- New double circuit from Cherokee-Sandown-Chambers-Harvest Mile 230 kV – ISD 9/13/2029.
- Sandown 230/115 kV Transformer #1 Uprate to 560/756 MVA – ISD TBD.
- New Fort Lupton 230/115 kV, 273/319 MVA Transformer #4 – ISD TBD.
- New Allison to Chatfield 230 kV transmission line rated at 283 MVA – ISD TBD.

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

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

The Base Case model includes the existing PSCo generation resources and all Affected Systems' existing resources.

While the higher-queued NRIS requests were dispatched at 100%, the higher-queued ERIS requests were modeled offline.

4.1 Benchmark Case Modeling

The Benchmark Case was created from the Base Case described in Section 4.0 by changing the study pocket generation dispatch to reflect heavy generation in the SLV study pocket. This was accomplished by adopting the stressed generation dispatch given in Table 2.

Table 2 – Generation Dispatch Used to Create the San Luis Valley Benchmark Case (MW is Gross Capacity)

Generator Bus No.	Name	kV	ID	Pgen (MW)	Pmax (MW)
70485	ALMSACT1	13.8	G1	17.28	19.20
70486	ALMSACT2	13.8	G2	16.29	18.10
70932	SLVS_IBRDRLA	34.5	S2	25.50	30.00
70933	ALAMOSA_PV	34.5	S3	25.50	30.00
70931	GSANDHIL_PV	34.5	S1	16.15	19.00
70935	SUNPOWER	34.5	S1	44.20	52.00
Total (MW)				**144.92**	**168.30**

4.2 Grid Charging Benchmark Case Modeling

The Grid Charging Benchmark Case was created from Base Case described in Section 4.0 by changing the study pocket generation dispatch to reflect a Grid Charging scenario as outlined in

Section 3.16 of the BPM. This was accomplished by adopting the stressed generation dispatch given in Table 3.

Table 3 – Generation Dispatch Used to Create the San Luis Valley Grid Charging Benchmark Case (MW is Gross Capacity)

Generator Bus No.	Name	kV	ID	Pgen (MW)	Pmax (MW)
70485	ALMSACT1	13.8	G1	17.28	19.20
70486	ALMSACT2	13.8	G2	16.29	18.10
70932	SLVS_IBRDRLA	34.5	S2	0.00	30.00
70933	ALAMOSA_PV	34.5	S3	0.00	30.00
70931	GSANDHIL_PV	34.5	S1	0.00	19.00
70935	SUNPOWER	34.5	S1	0.00	52.00
Total (MW)				**33.57**	**168.30**

4.3 Study Case Modeling

A Study Case was created from the Benchmark Case by turning on the PI-2024-08 generation. The additional 90 MW output from PI-2024-08 was balanced against PSCo generation outside of the SLV study pocket. As described in Section 3.11 of the BPM, this study pocket is comprised of all generation within the SLV area, including:

- San Luis Solar (SLV 230 kV), 52 MW PV
- Iberdrola Solar (SLV 115 kV), 30 MW PV
- Cogentrix Solar (Blanca Peak 115 kV), 30 MW PV
- Greater Sandhills Solar (Mosca 69 kV), 19 MW PV
- Alamosa CTs, 37.3 MW Gas

4.4 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 90 MW solar generating facility and a 72 MW Bess facility (PI-2024-08) at a station to be built that will divide the L8004 115 kV transmission line (Alamosa Terminal - Blanca Peak). The output will not exceed 90 MW at the POI.

This project assumes the use of twenty-nine (29) Sungrow SG3425UD PV generators rated at 3.425 MVA, and thirty-six (36) SMA SCS 2475-US BESS inverters, rated at 2.475 MVA, for PI-2024-08. Each of the PV generators is connected to a 0.6/34.5 kV collector transformer. Each of the BESS inverters is connected to a 0.48/34.5kV collector transformer. One 115/34.5/13.8 kV main GSU transformer rated at 60/75/100 MVA steps the voltage up from the collector transformer voltage to the POI voltage. A short generation tie line (less than 0.1 miles long) interconnects the project to the new PSCo 115 kV Switching Station.

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

5.0 Provisional Interconnection Service Analysis

5.1 Voltage and Reactive Power Capability Evaluation

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

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

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

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

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

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

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

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

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

The PI-2024-08 GIR is modeled as follows:

PV: Pgen = 48.83 MW, Pmax = 91.5 MW, Pmin = 0 MW, Qmax = 42.07 MVar, Qmin= -42.07 MVar

BESS: Pgen = 42.37 MW, Pmax = 79.4 MW, Pmin = -76.6 MW, Qmax = 42.37 MVar, Qmin= -42.37 MVar

The summary for the Voltage and Reactive Power Capability Evaluation for PI-2024-08 is:

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

The Voltage and Reactive Power Capability tests performed for PI-2024-08 are summarized in Table 4.

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Table 4 – Reactive Power Capability Evaluation for PI-2024-08

Reactive Power Capability Analysis - Project PI-2024-08 - MPT High Side PF Checks																	
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
48.8	16.3	42.1	-42.1	1.10	42.4	16.3	42.4	-42.4	1.10	90.0	33.7	1.03	0.9365	90.0	33.7	1.03	0.9365
48.8	-17.0	42.1	-42.1	0.97	42.4	-17.0	42.4	-42.4	1.02	90.0	-37.7	1.02	-0.9223	90.0	-37.7	1.02	-0.9223
91.5	32.6	42.1	-42.1	1.11	OFFLINE					90.0	32.7	1.03	0.9399	90.0	32.7	1.03	0.9399
OFFLINE					79.4	24.9	42.4	-42.4	1.11	78.1	27.7	1.05	0.9425	78.1	27.7	1.05	0.9425
91.5	-24.3	42.1	-42.1	0.97	OFFLINE					89.8	-30.0	1.01	-0.9485	89.8	-30.0	1.01	-0.9485
OFFLINE					79.4	-29.2	42.4	-42.4	0.96	77.8	-32.0	1.02	-0.9248	77.8	-32.0	1.02	-0.9248
0.0	-15.7	42.1	-42.1	0.98	0.0	-15.7	42.4	-42.4	0.98	-0.6	-18.8	1.02	-0.0319	-0.6	-18.8	1.02	-0.0319

5.2 Steady-State Analysis

Contingency analysis was performed on the SLV study pocket using the Study Case model.

- System Intact analysis showed no thermal or voltage violations attributed to PI-2024-08.
- Single Contingency analysis showed no thermal or voltage violations attributed to PI-2024-08.
- Multiple Contingency analysis:

  Thermal results:

  - For grid-discharging case: no thermal violations attributed to this project were identified.
  - For grid-charging case: Table 5 lists overloads attributed to this project. Multiple contingency overloads are mitigated using system adjustments, including generation redispatch and/or operator actions.
  - Four P7 contingencies were divergent in both the Benchmark and Study cases. The descriptions of these contingencies are shown below. The divergence is not caused by this project. Also, it was discussed previously that diverged multiples will be mitigated using system adjustments, including generation redispatch and/or operator actions.
    - P7_136 (Lines: 5467 7081): for grid-charging case only
    - P7_160 (Lines: Canal Crossing - Goose Creek): for grid-discharging and grid-charging cases
    - P7_166 (Lines: Tundra - Sandstone): for grid-charging case only
    - P7_167 (Lines: May Valley - Sandstone): for grid-discharging and grid-charging cases

  Voltage results:

  - For grid-discharging case: no voltage violations attributed to this project were identified.
  - For grid-charging case: Table 6 lists voltage violations attributed to this project. Multiple contingency violations are mitigated using system adjustments, including generation redispatch and/or operator actions.

Table 5 – Multiple Contingency Thermal Overloads, Grid Charging Study Case

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)	DFAX for PI-2024-8
1	STORY (73192) - PAWNEE (70311) 230 kV ckt 1	P7_161 (Lines: Canal Crossing - Ft St Vrain)	230	73/70	772	128.07	129.41	1.34	0.09

*Multiple contingency overloads are mitigated using system adjustments, including generation redispatch and/or operator actions.

Table 6 – Multiple Contingency Voltage Violations, Grid Charging Study Case

Bus #	Bus Name	Base kV	Area	Zone	Zone Name	Contingency Name	Min Volt Limit (p.u.)	Max Volt Limit (p.u.)	Benchmark Case Contingency Voltage (p.u.)	Study Case Contingency Voltage (p.u.)	Voltage Difference (p.u.)
70024	ALAMOSA	69	70	710	ZoneSL	P4: line_010, BF_008a	0.9	1.1	1.0169	1.1026	0.0857
70026	ALMSA_TM	69	70	710	ZoneSL	P4: line_010, BF_008a	0.9	1.1	1.0194	1.1045	0.0851
70186	ALAMOSA_TP	69	70	710	ZoneSL	P4: line_010, BF_008a	0.9	1.1	1.0169	1.1026	0.0857
70245	LAGARITA	69	70	710	ZoneSL	P4: line_010, BF_008a	0.9	1.1	1.0085	1.1029	0.0944
70325	PLAZA	69	70	710	ZoneSL	P4: line_010, BF_008a	0.9	1.1	1.0094	1.1036	0.0942
70511	ATER_TAP	69	70	710	ZoneSL	P4: line_010, BF_008a	0.9	1.1	1.0190	1.1042	0.0852
700006	5RSC_24_3	69	70	710	ZoneSL	P4: line_010, BF_008a	0.9	1.1	1.0194	1.1045	0.0851

*Multiple contingency overloads are mitigated using system adjustments, including generation redispatch and/or operator actions.

5.3 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 7. The transient stability plots are shown in Appendix A in Section 10.0 of this report.

Table 7 – Transient Stability Analysis Results

Ref. No.	Fault Location	Fault Category	Outage(s)	Clearing Time (Cycles)	Grid Discharging Case		Grid Charging Case	
					Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
1	Flat Run	P0	-	-	Stable	Stable	Stable	Stable
2	Alamosa Terminal - PI-2024-8 POI 115 kV Line	P1	Alamosa Terminal - PI-2024-8 POI 115 kV Line	6	Stable	Stable	Stable	Stable
3	PI-2024-8 POI - Blanca Peak 115 kV Line	P1	PI-2024-8 POI - Blanca Peak 115 kV Line	6	Stable	Stable	Stable	Stable
4	PI-2024-8 POI - PI-2024-8 115 kV Line	P1	PI-2024-8 POI - PI-2024-8 115 kV Line	6	Stable	Stable	Stable	Stable
5	Alamosa Terminal - PI-2024-8 POI 115 kV	P4	- Alamosa Terminal - PI-2024-8 POI 115 kV Line - PI-2024-8 POI - Blanca Peak 115 kV Line - Alamosa Terminal 115 kV Load P2 and P3 - Alamosa CT2 generation - PI-2024-8 generation	22	Stable	Stable	Stable	Stable
6	PI-2024-8 POI – Blanca Peak 115 kV	P4	- Alamosa Terminal - PI-2024-8 POI 115 kV Line - PI-2024-8 POI - Blanca Peak 115 kV Line - Blanca Peak - San Luis Valley 115 kV Line - Alamosa PV generation and SS load - PI-2024-8 generation	22	Stable	Stable	Stable	Stable

5.4 Short-Circuit and Breaker Duty Analysis Results

The fault currents at the POI for three-phase and phase-to-ground faults can be found in Table 8 below, along with the Thevenin impedance at the POI. Both the base case and the case with the GIR added are shown.

Table 8 – Short-Circuit Parameters at PI-2024-08 POI (New Switching Station on the Alamosa Terminal – Blanca Peak 115 kV line)

	Before the PI Addition	After the PI Addition
Three Phase		
Three Phase Current	4020A	3710A
Positive Sequence Impedance	2.91530 + j19.3800 ohms	2.91530 + j19.3800 ohms
Negative Sequence Impedance	3.10557 + j19.2239 ohms	3.10557 + j19.2239 ohms
Zero Sequence Impedance	3.08575 + j14.5669 ohms	1.01396 + j8.09009 ohms
Phase-to-Ground		
Single Line to Ground Current	4430 A	6230 A
Positive Sequence Impedance	2.91530 + j19.3800 ohms	2.91530 + j19.3800 ohms
Negative Sequence Impedance	3.10557 + j19.2239 ohms	3.10557 + j19.2239 ohms
Zero Sequence Impedance	3.08575 + j14.5669 ohms	1.01396 + j8.09009 ohms

A breaker duty study on the PSCo transmission system did not identify any circuit breakers that became over-dutied due to the addition of PI-2024-08.

5.5 Affected Systems

The study did not identify any impacts to Affected Systems.

5.6 Summary of Provisional Interconnection Analysis

The maximum allowable output of the GIR without requiring any additional System Network Upgrades is 90 MW grid discharging and 72 MW grid charging.

6.0 Cost Estimates

The total cost of the required Upgrades for PI-2024-08 to interconnect for Provisional Interconnection Service at a tap on the Alamosa Terminal – Blanca Peak 115 kV line is estimated to be **$13.166 million**.

- **Cost of Transmission Provider's Interconnection Facilities (TPIF) is $1.210 million** (Table 9)
- **Cost of Station Network Upgrades is $11.956 million** (Table 10)
- **Cost of System Network Upgrades is $0**

The list of improvements required to accommodate the Provisional Interconnection of PI-2024-08 are given in Table 9, and Table 10.

Since the POI is a new substation, a CPCN may be required to accommodate the interconnection.

Table 9 – Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (Million)
PSCo's New 5RSC-2024-08 115 kV Switching Station	Interconnection of 5RSC-2024-08 (PI-2024-8) at the new 115 kV Switching Station. The new equipment includes: • (1) 115 kV single bay dead end structure • (3) 115 kV lightning arresters • (1) 115 kV 1200A disconnect switch • (3) 115 kV 1-phase metering combo units • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying	$1.060
PSCo's New 5RSC-2024-08 115 kV Switching Station	Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead end structure, 3 conductors, insulators, hardware, jumpers and labor.	$0.150
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$1.210**

Table 10 – Station Network Upgrades

Element	Description	Cost Est. (Million)
PSCo's New 5RSC-2024-08 115 kV Switching Station	Install new 5RSC-2024-08 (PI-2024-8) 115 kV Switching Station tapping the Blanca Peak - Alamosa Terminal 115 kV line. The new equipment includes: • (2) 115 kV deadend structures • (3) 115 kV 3000A circuit breakers • (9) 115 kV 3000A disconnect switches • (6) 115 kV CCVTs • (2) 115 kV SSVTs • (6) 115 kV lightning arresters • (2) 115 kV 1600A wave traps • (1) Electrical Equipment Enclosure (EEE) • Site grading and fencing • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$7.967
PSCo's New 5RSC-2024-08 115 kV Switching Station	Install required communication in the EEE at the 5RSC-2024-08 (PI-2024-8) 115 kV Switching Station including (1) RTU panel, (1) PAC cabinet, and (1) communication panel.	$0.651
PSCo's Blanca Peak 115 kV Switching Station	Remote end upgrade at Blanca Peak 115 kV Switching Station including removal of existing line panel, installation of new line panel, and upgrades to breaker failure protection and line protection.	$0.792
PSCo's Alamosa Terminal 115 kV Substation	Remote end upgrade at Alamosa Terminal 115 kV Substation including removal of existing line panel with breaker fail, installation of new line panel with breaker fail, and upgrades to breaker failure protection and line protection.	$0.814
PSCO's CKT 8004	Segment CKT 8004 Blanca Peak - Alamosa Terminal to interconnect the new 5RSC-2024-08 (PI-2024-8) 115 kV Switching Station. Work to include removal of (1) H-frame structure and conductor, installation of (2) new 3-pole deadend structures, (2) mono-pole deadend structures conductor and hardware.	$1.482
PSCo's New 5RSC-2024-08 115 kV Switching Station	Siting and Land Rights land acquisition and permitting, no land purchase costs included	$0.250
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$11.956**

PSCo has developed cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of PI-2024-08 for Provisional Interconnection Service. The estimated costs provided in this report are based upon the following assumptions:

- The estimated costs are in 2024 dollars with escalation and contingencies applied.
- Allowances for Funds Used During Construction (AFUDC) is not included.

- The estimated costs include all applicable labor and overheads associated with the siting, engineering, design, and construction of these new PSCo facilities.
- The new PSCo 115 kV Switching Station for the interconnection facilities will be located in the northeast corner of the Interconnection Customer's development area adjacent to the PSCo transmission line 8004.
- Land for new switching station can be acquired from the property owner in fee at fair market value.
- Stormwater from the PSCo facilities will be managed within the Interconnection Customer's stormwater facilities.
- The estimated costs do not include the cost for any Interconnection 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:

- Interconnection Customer will install two (2) redundant fiber optic circuits (one primary circuit with a redundant backup) into the Transmission Provider's substation as part of its interconnection facilities construction scope.
- Power Quality Metering (PQM) will be required on the Customer's generation tie-line terminating into the POI.
- The Customer will be required to design, procure, install, own, operate and maintain a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer substation. PSCo will be provided with indications, readings, and data from the LF/AGC RTU.
- The Interconnection Customer will comply with the 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-2024-08 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 February 28, 2027. This is attainable by the Transmission Provider, based upon the current schedule developed for this interconnection request. The Transmission Provider proposes the milestones provided below in Table 11.

Table 11 – Proposed Milestones for PI-2024-08

Milestone	Responsible Party	Estimated Completion Date
LGIA Execution	Interconnection Customer and Transmission Provider	December 2024
In-Service Date for Transmission Provider Interconnection Facilities and Station Network Upgrades required for interconnection	Transmission Provider	February 28, 2027
In-Service Date & Energization of Interconnection Customer's Interconnection Facilities	Interconnection Customer	February 28, 2027
Initial Synchronization Date	Interconnection Customer	March 31, 2027
Begin trial operation & testing	Interconnection Customer and Transmission Provider	March 31, 2027
Commercial Operation Date	Interconnection Customer	July 31, 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 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) may be required for the construction of the Interconnection Facilities and Station Network Upgrades. The expected time to obtain a CPCN approval is 18 months, which could impact the start of construction for the interconnection facilities.

7.0 Summary of Provisional Interconnection Service Analysis

The total estimated cost of the PSCo transmission system improvements required for PI-2024-08 to qualify for Provisional Interconnection Service would be $13.166 million.

The initial maximum permissible output of PI-2024-08 Generating Facility is 90 MW grid discharging and 72 MW grid charging. 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.

Security: Based on 5RSC-2024-08 in the 5RSC selection of Energy Resource Interconnection Service (ERIS), the security associated with the Network Upgrades that might be identified at the conclusion of the 5RSC-2024-08 Large Generation Interconnection Procedure (LGIP) in the 5RSC cluster is $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-2024-08 include the TPIF and Station Network Upgrades identified in Table 9 and Table 10, respectively.

9.0 Preliminary One-Line Diagram and General Arrangement for PI-2024-08

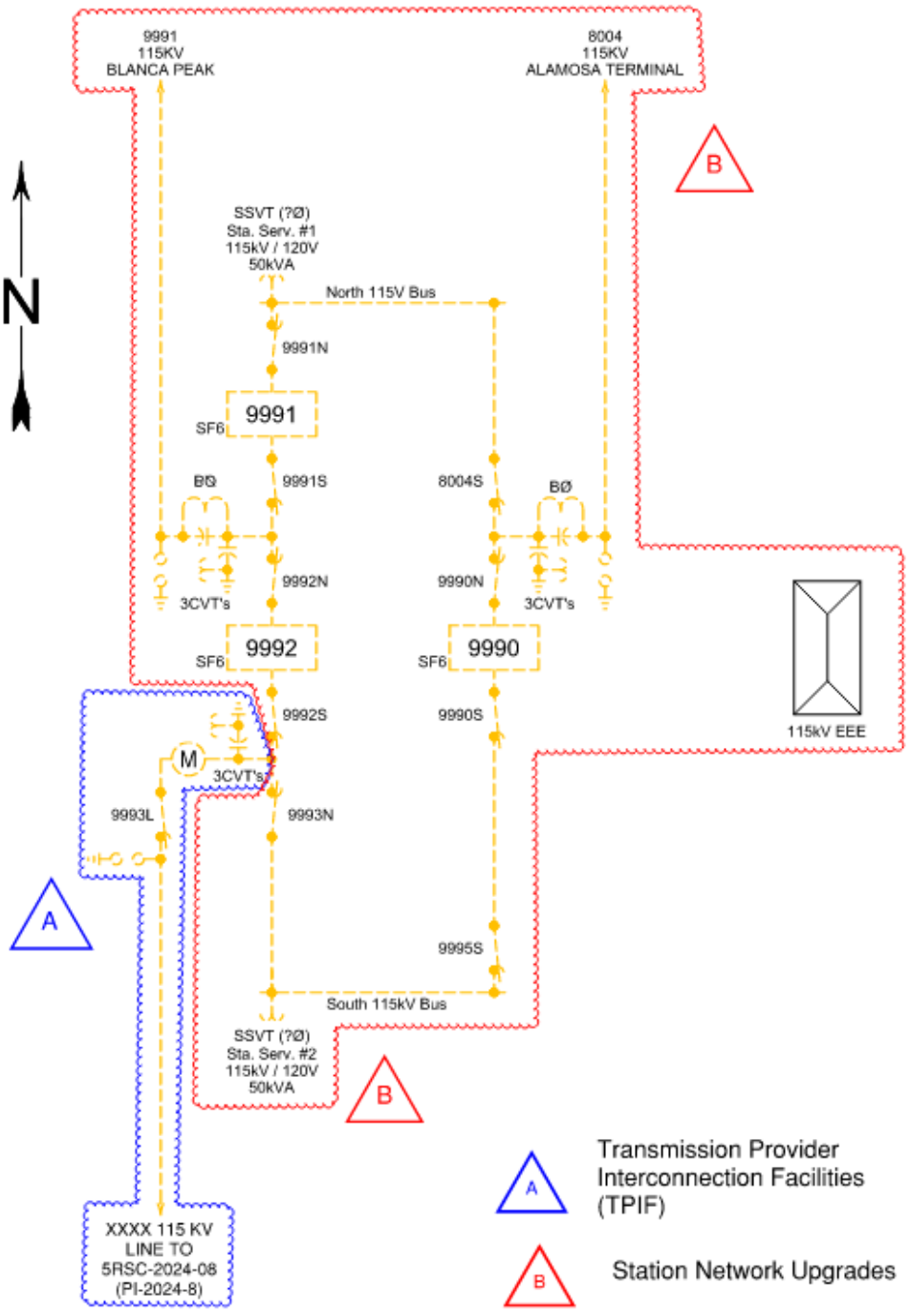


Figure 2: Preliminary One-Line PI-2024-08 Tapping Blanca Peak – Alamosa Terminal 115 kV Circuit

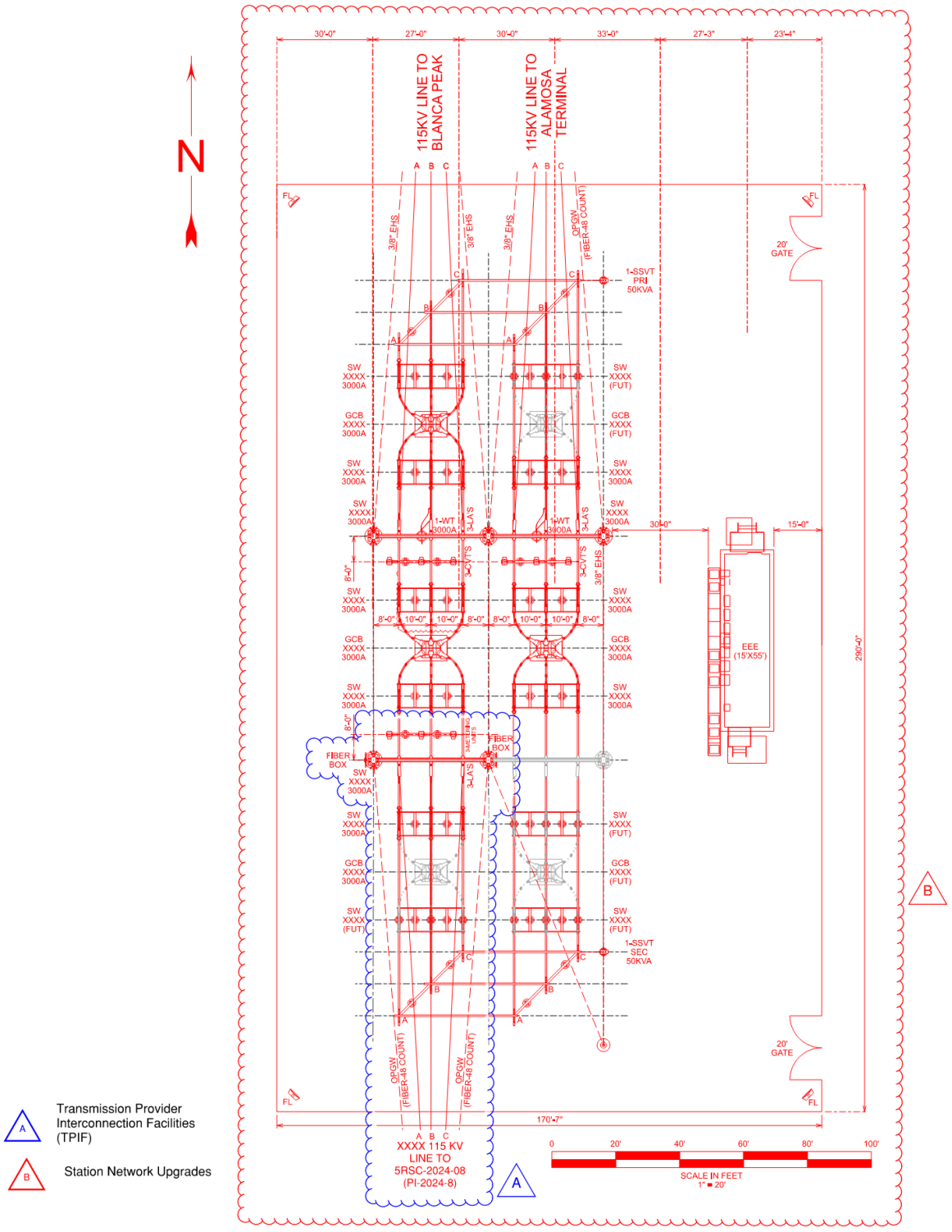
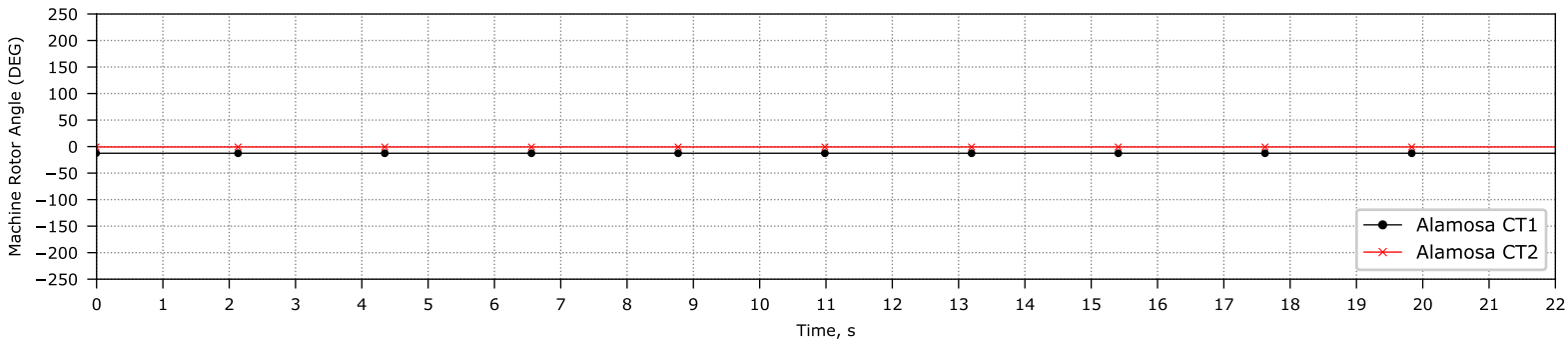


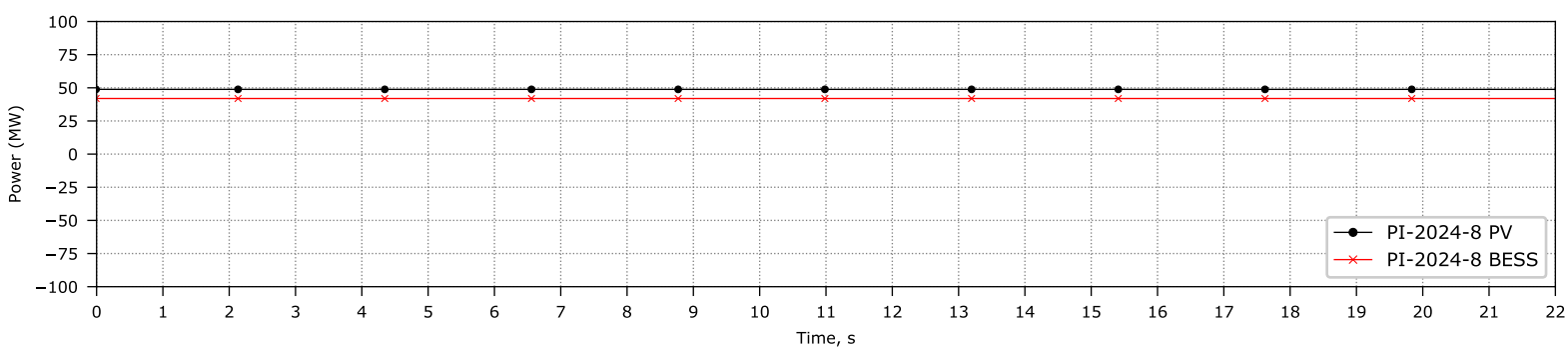
Figure 3: Preliminary General Arrangement for PI-2024-08 Tapping Blanca Peak – Alamosa Terminal 115 kV Circuit

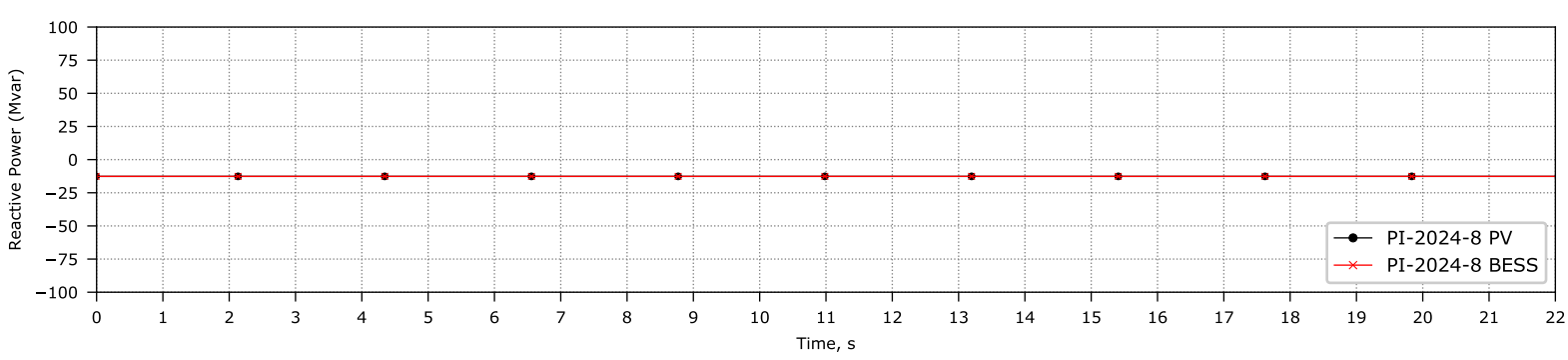
10.0 Appendices

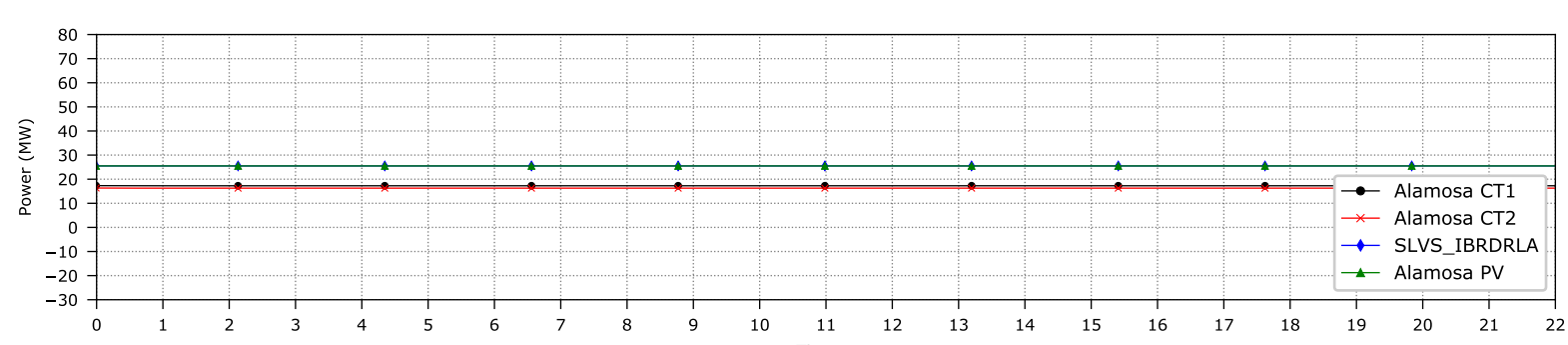
Appendix A: Transient Stability Plots	Grid Discharging.pdf Grid Charging.pdf

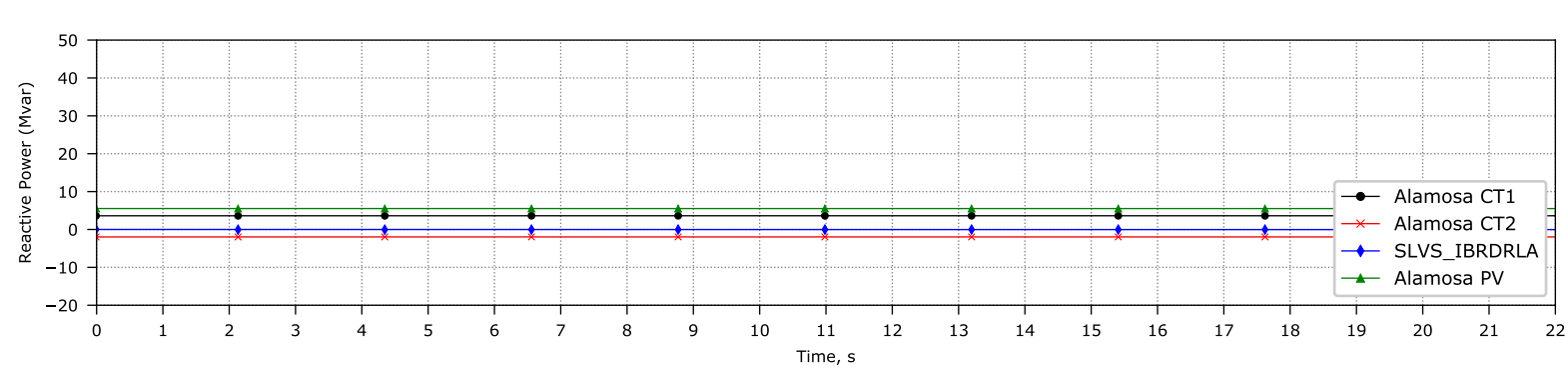
flatrun

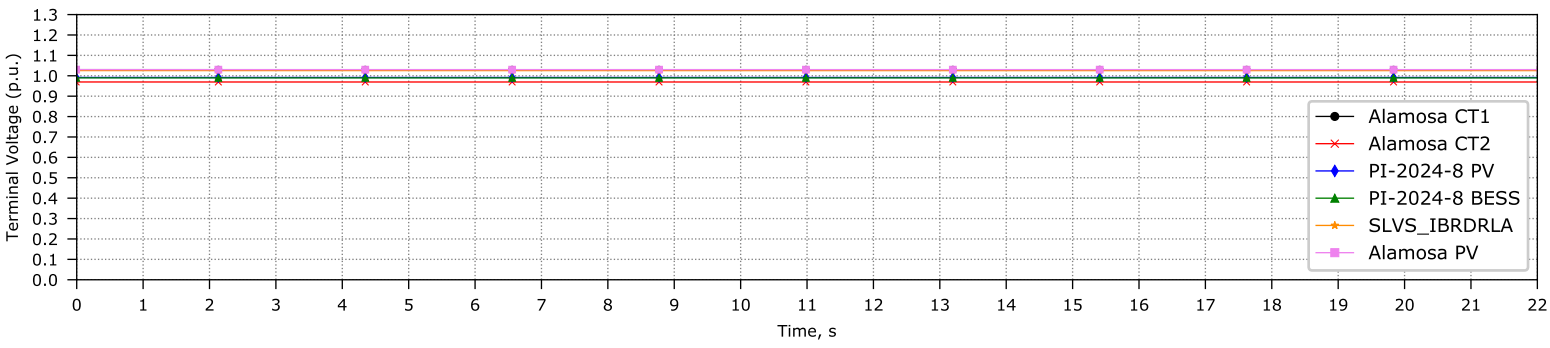

Machine Rotor Angle (DEG)
Time, s
Alamosa CT1
Alamosa CT2

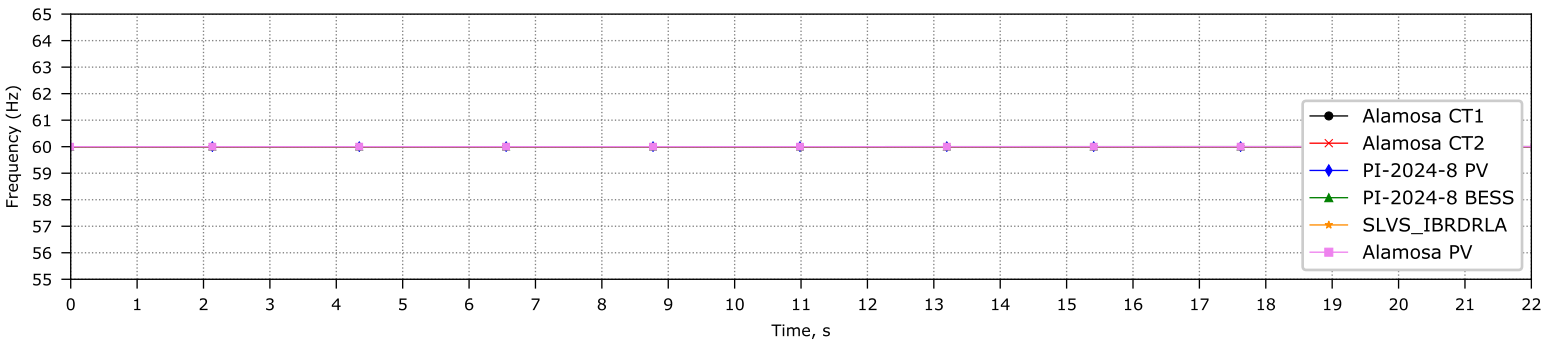

Power (MW)
Time, s
PI-2024-8 PV
PI-2024-8 BESS

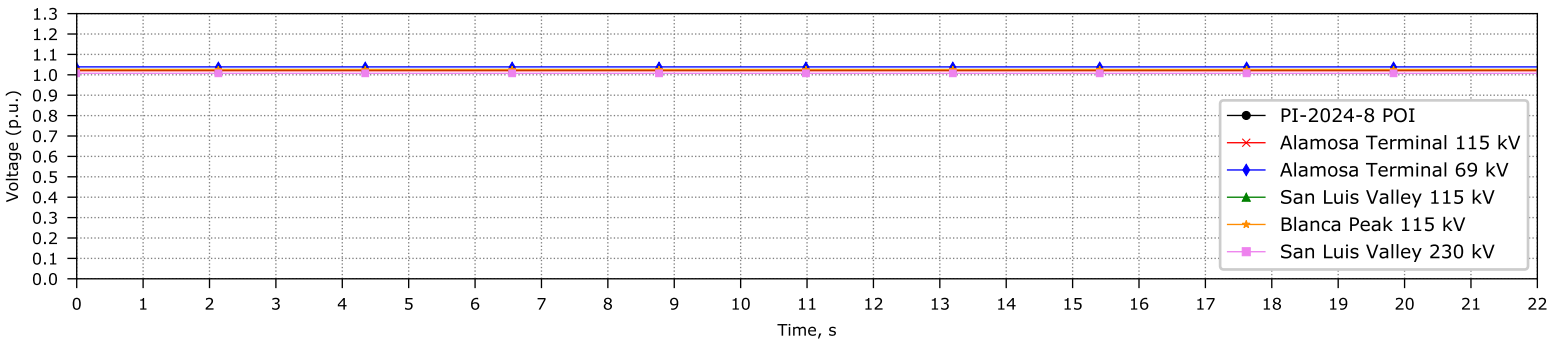

Reactive Power (Mvar)
Time, s
PI-2024-8 PV
PI-2024-8 BESS


Power (MW)
Time, s
Alamosa CT1
Alamosa CT2
SLVS_IBRDRLA
Alamosa PV

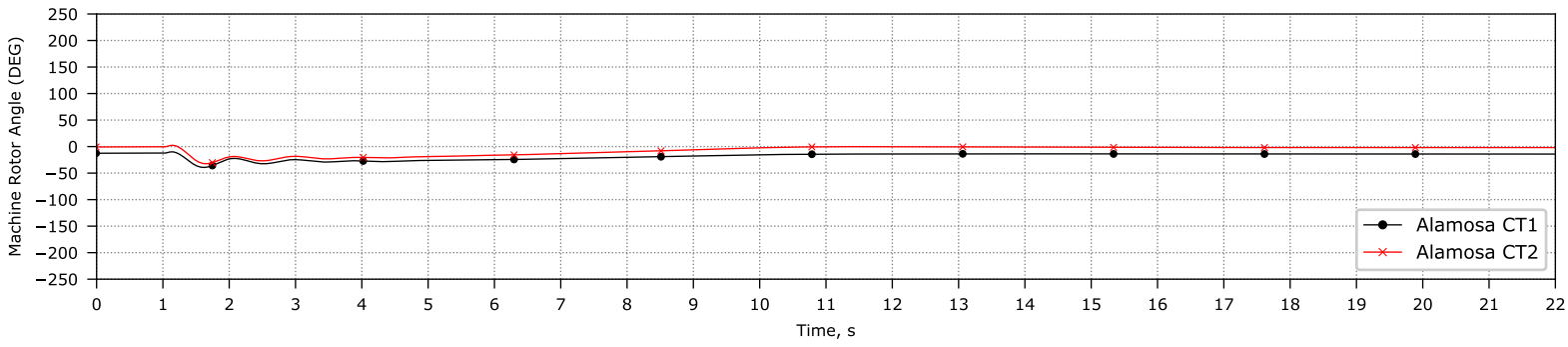

Reactive Power (Mvar)
Time, s
Alamosa CT1
Alamosa CT2
SLVS_IBRDRLA
Alamosa PV

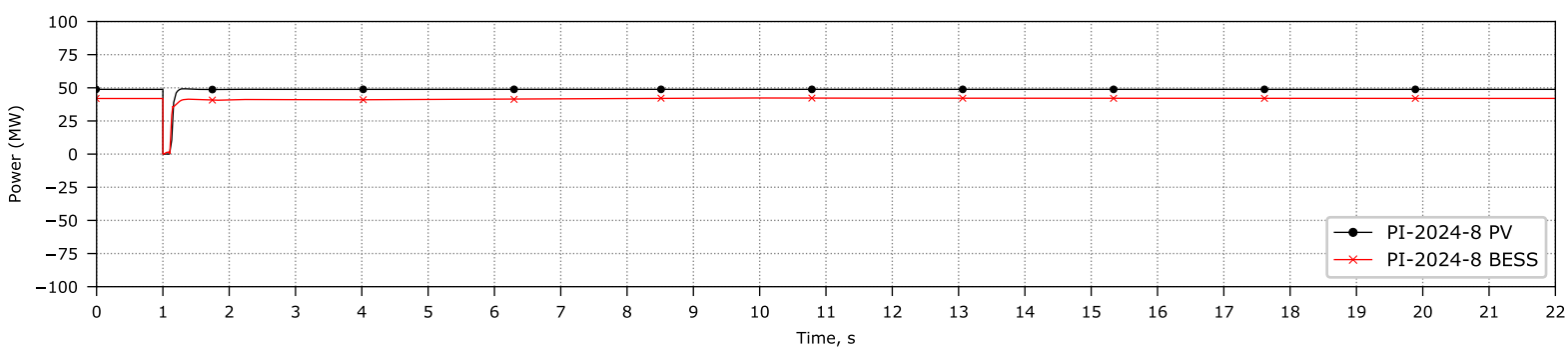

Terminal Voltage (p.u.)
Time, s
Alamosa CT1
Alamosa CT2
PI-2024-8 PV
PI-2024-8 BESS
SLVS_IBRDRLA
Alamosa PV

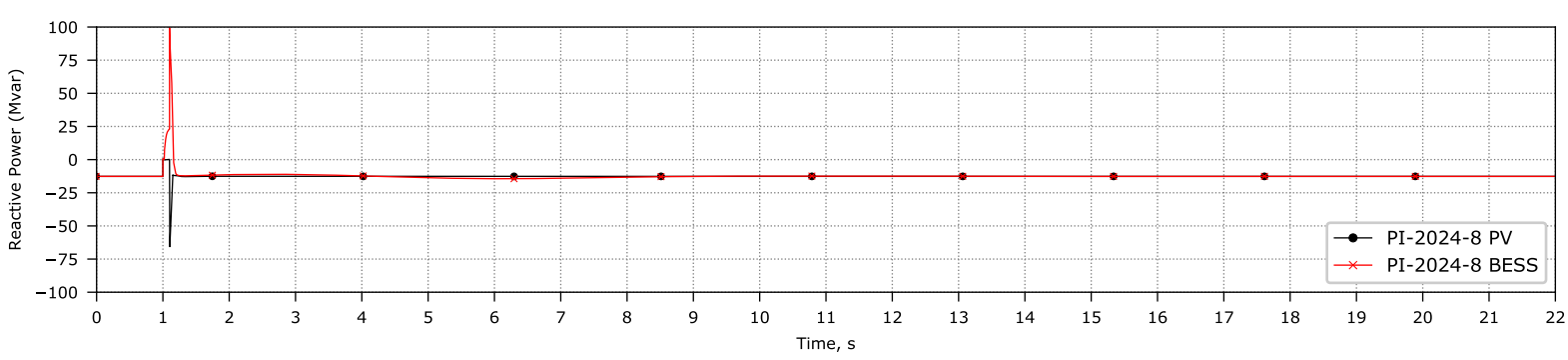

Frequency (Hz)
Time, s
Alamosa CT1
Alamosa CT2
PI-2024-8 PV
PI-2024-8 BESS
SLVS_IBRDRLA
Alamosa PV

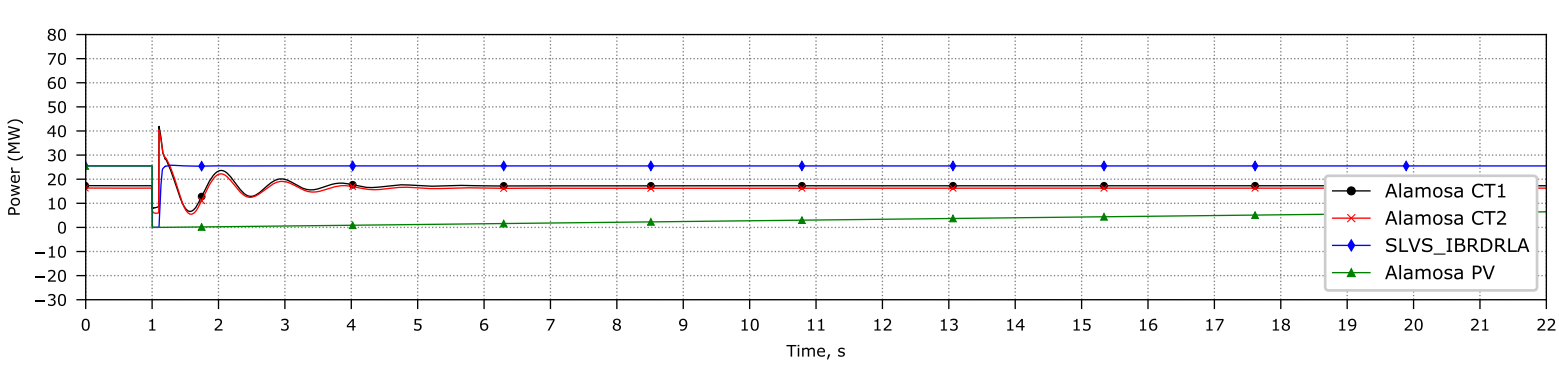

Voltage (p.u.)
Time, s
PI-2024-8 POI
Alamosa Terminal 115 kV
Alamosa Terminal 69 kV
San Luis Valley 115 kV
Blanca Peak 115 kV
San Luis Valley 230 kV

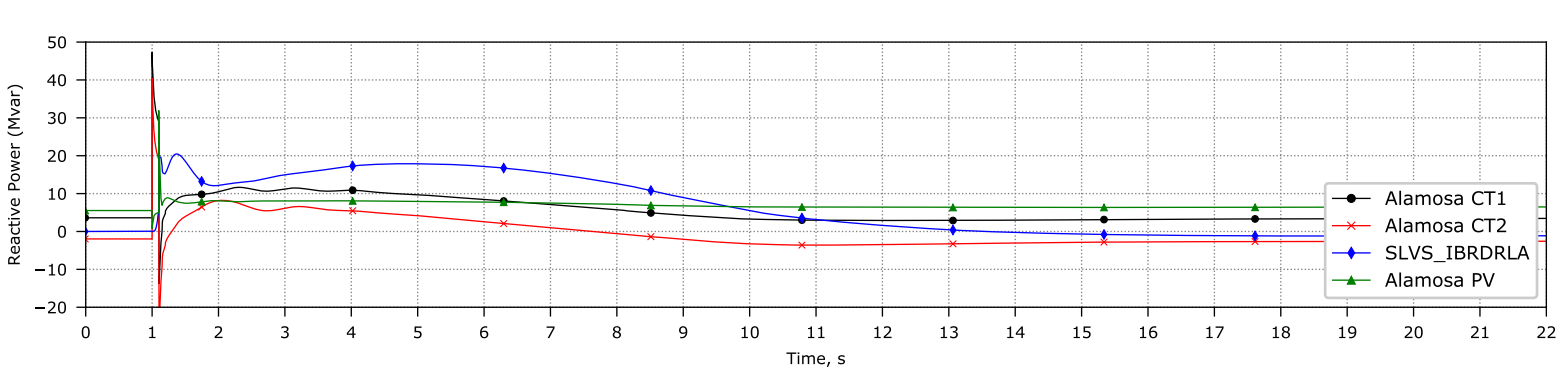
P1-POI-AlamosaTM 115kV

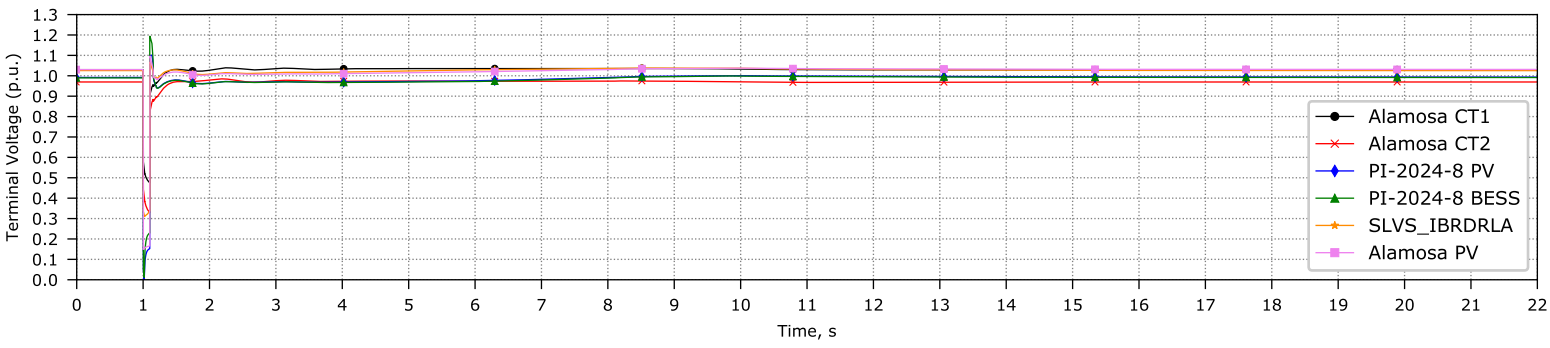


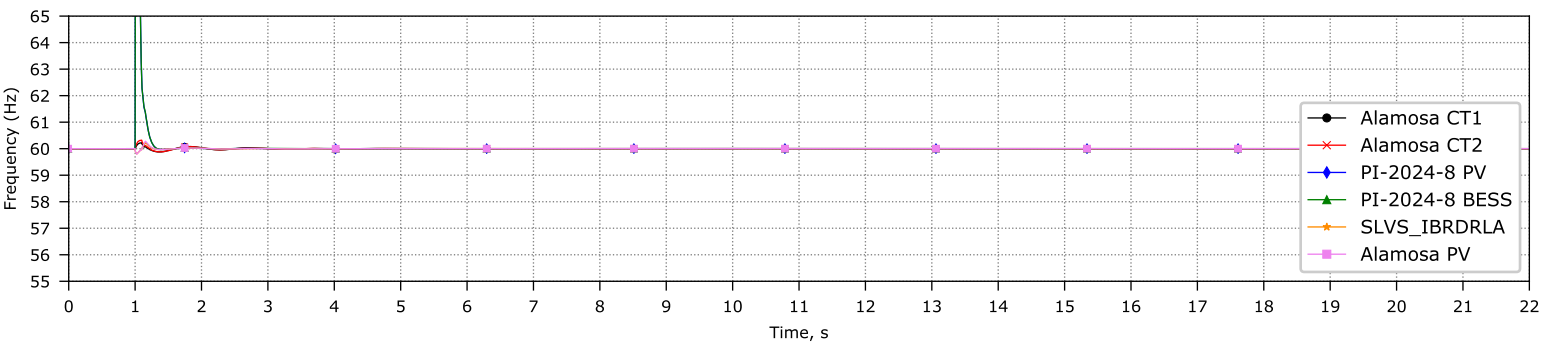


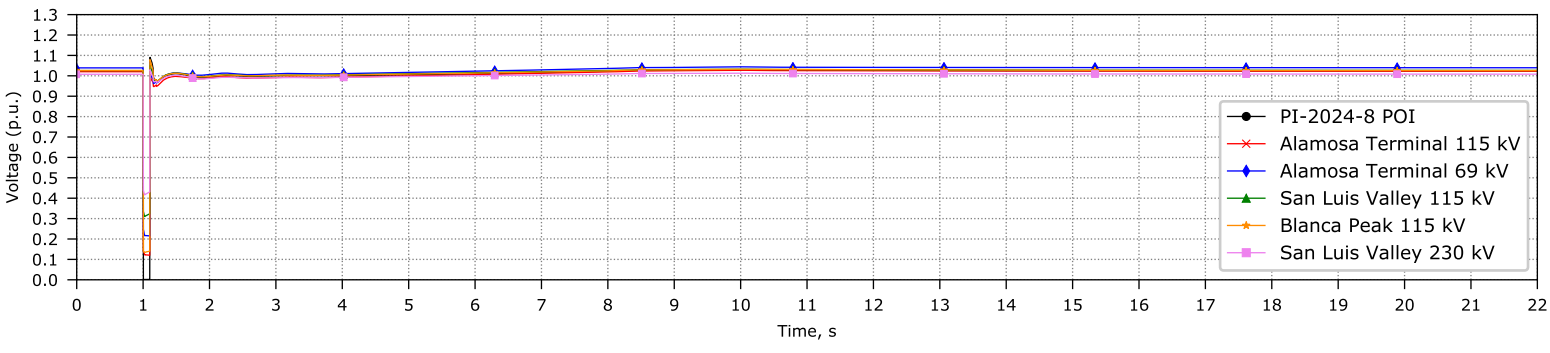




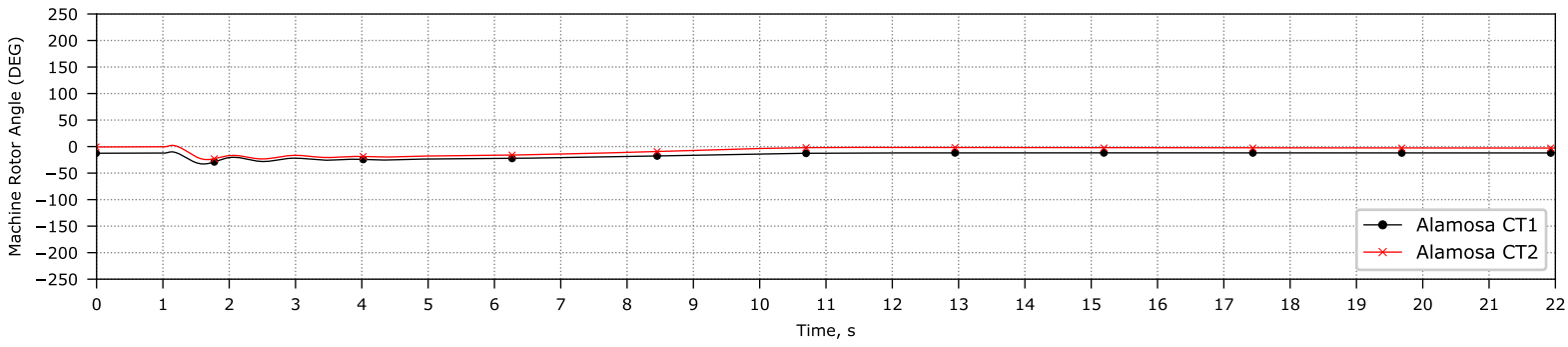


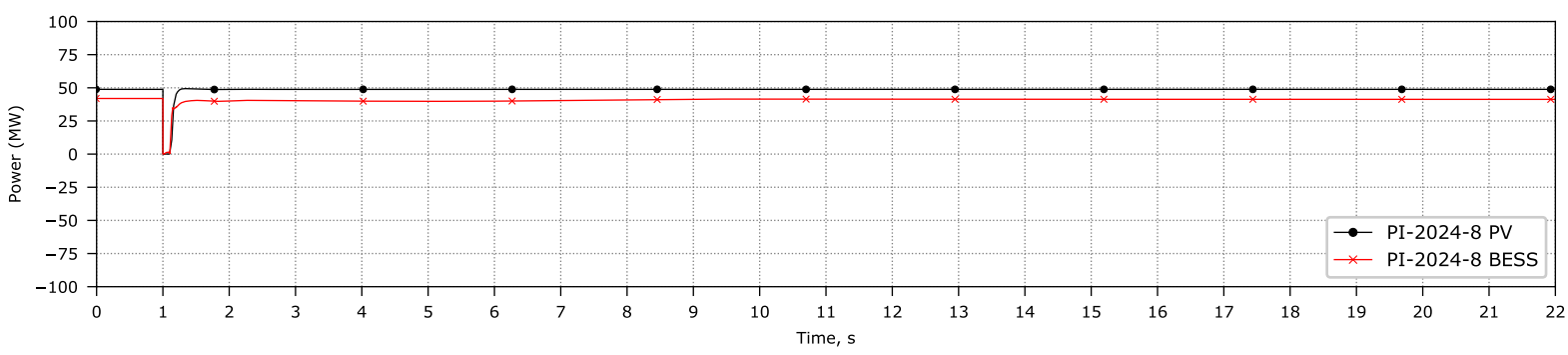


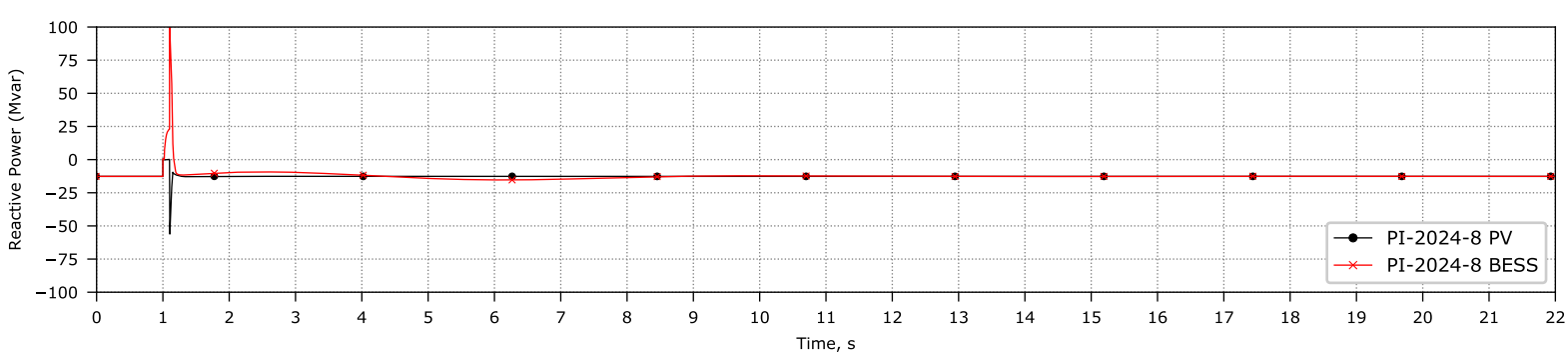


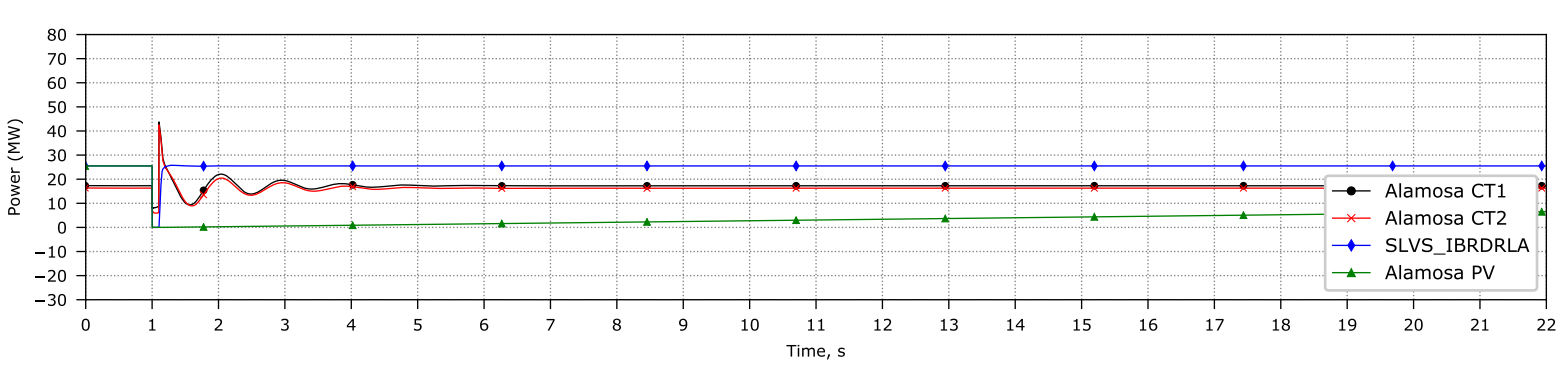


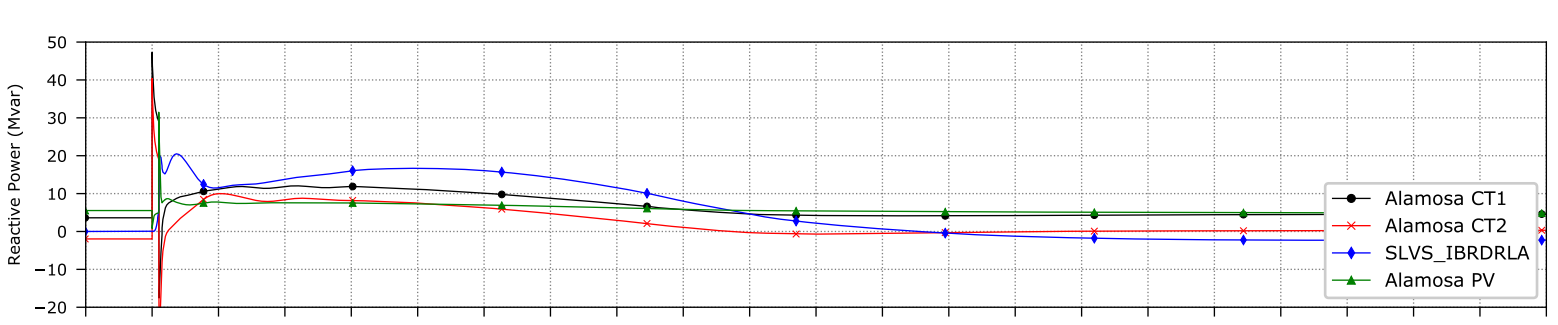
P1-POI-BlancaPeak 115kV

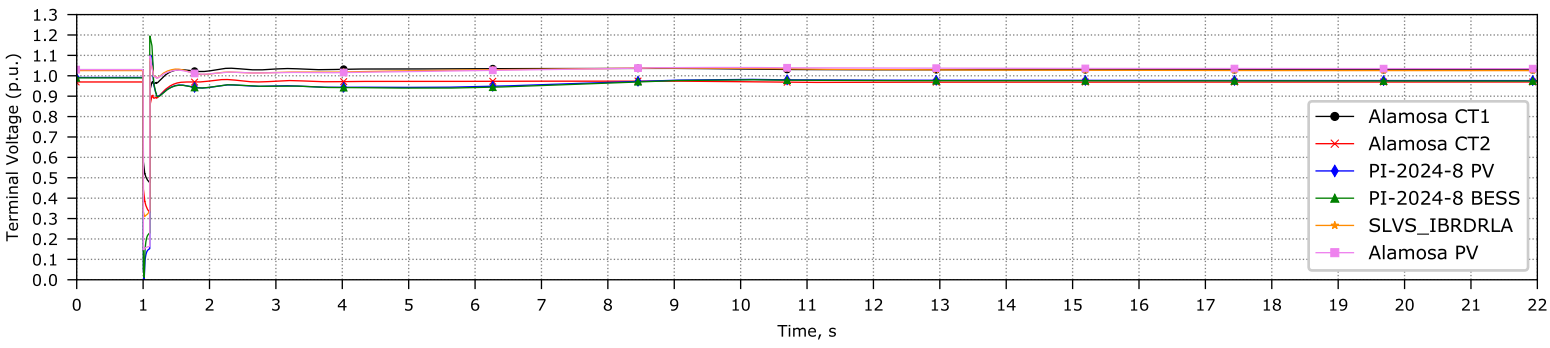


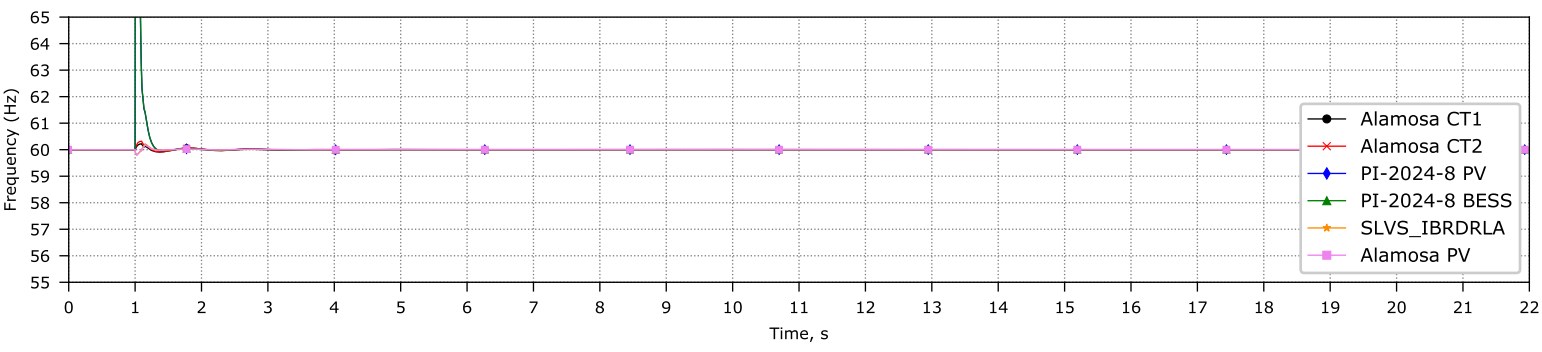


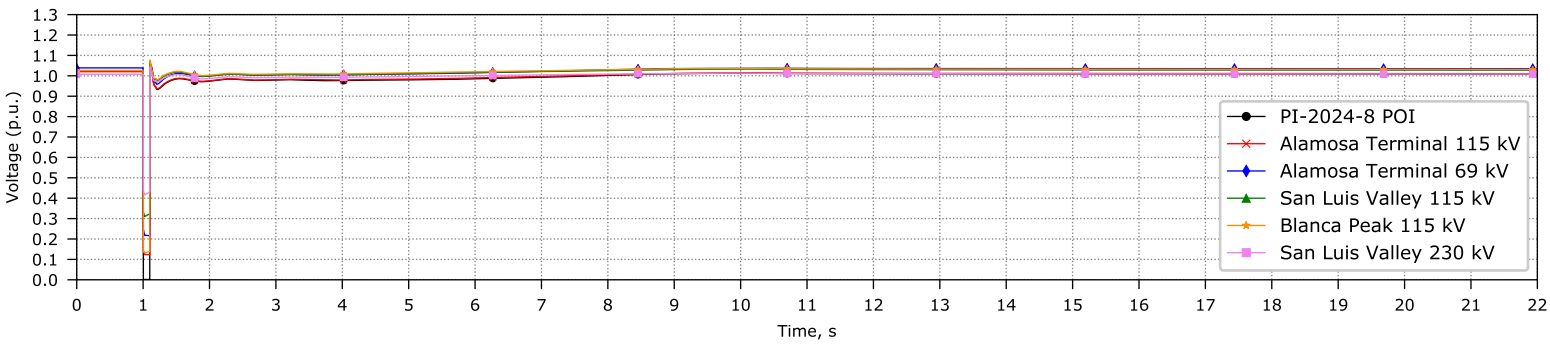




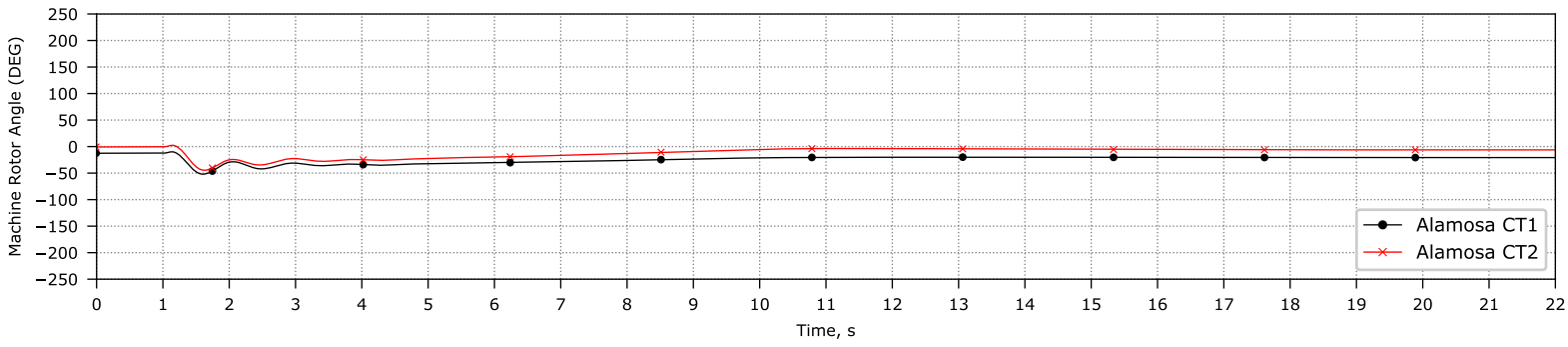


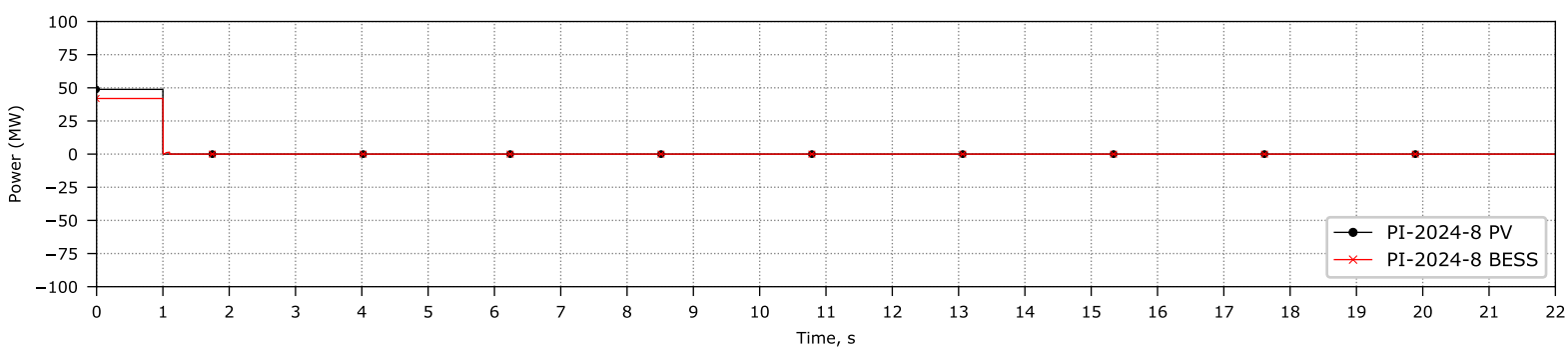


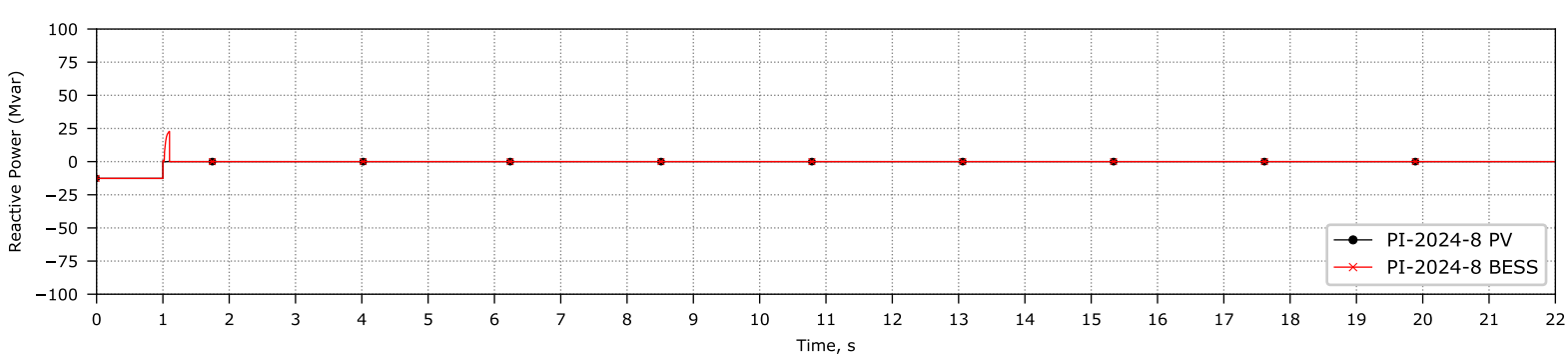


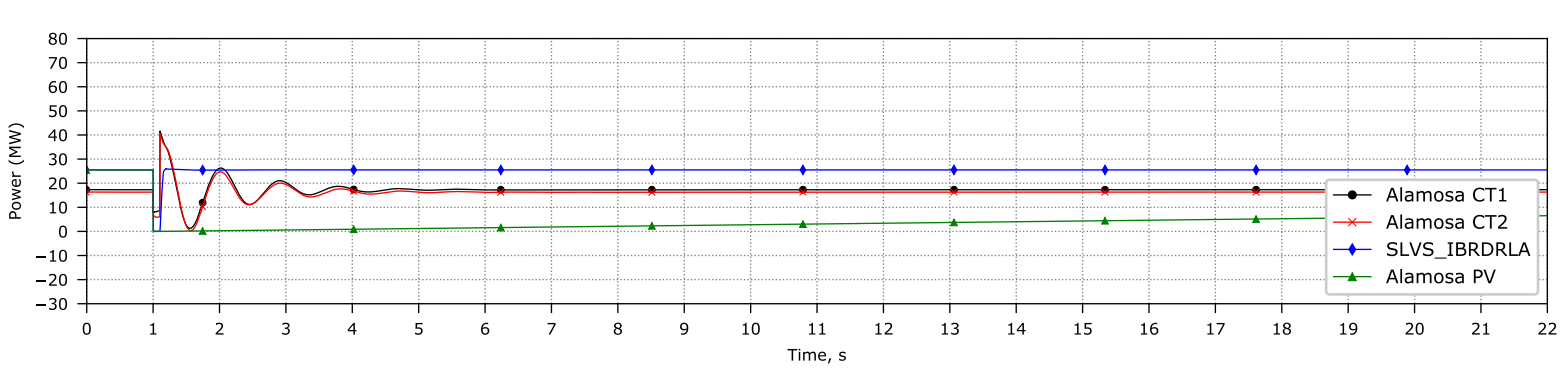


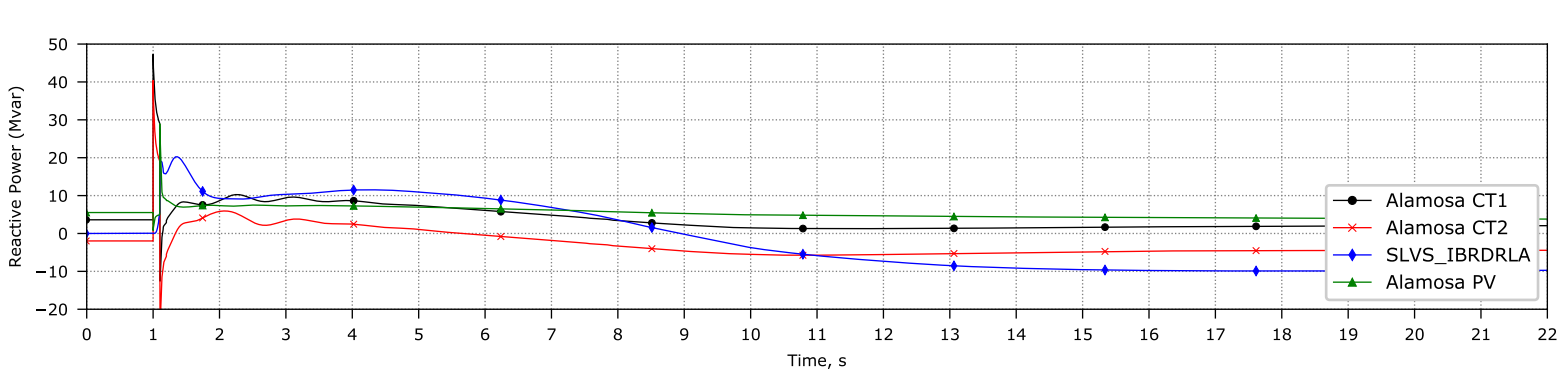
P1-POI-PI_2024_08 115kV

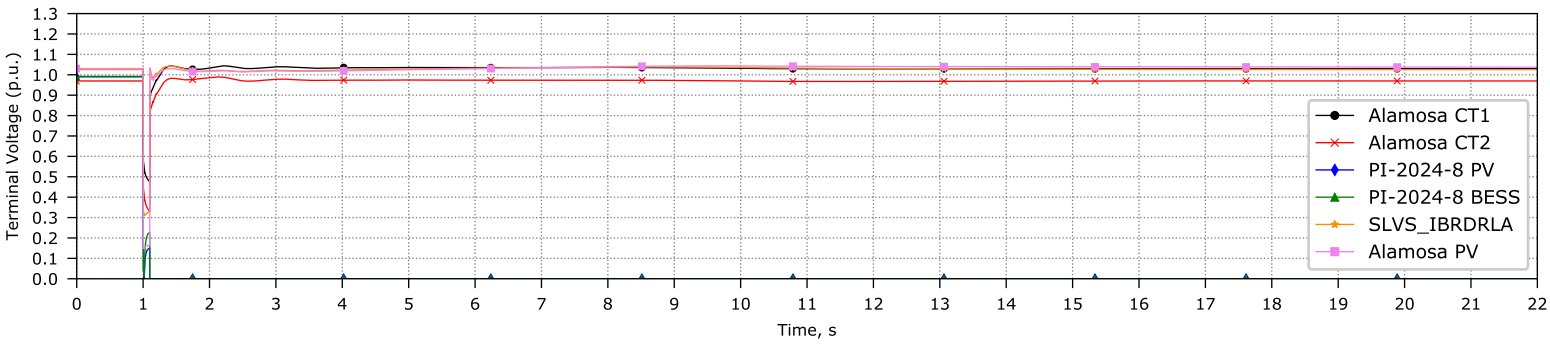


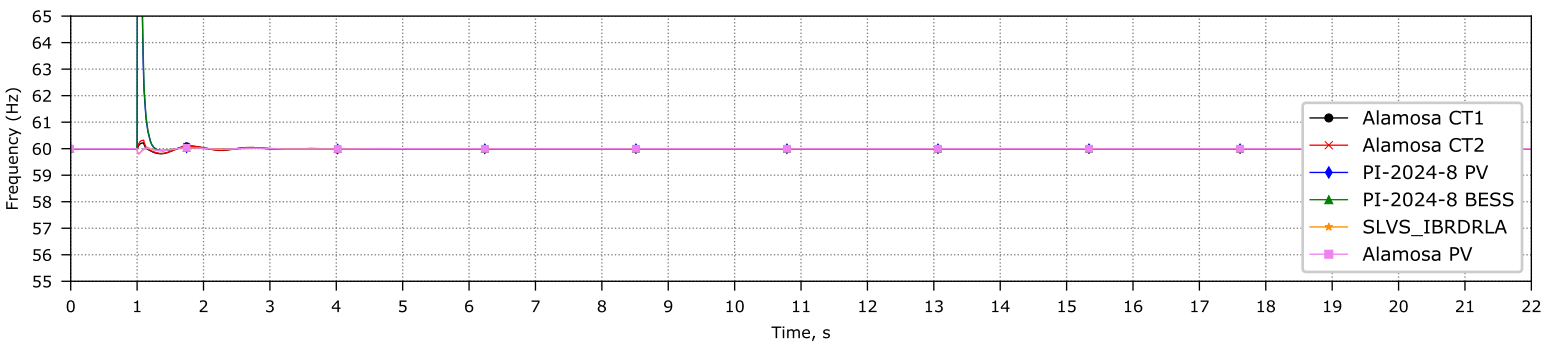


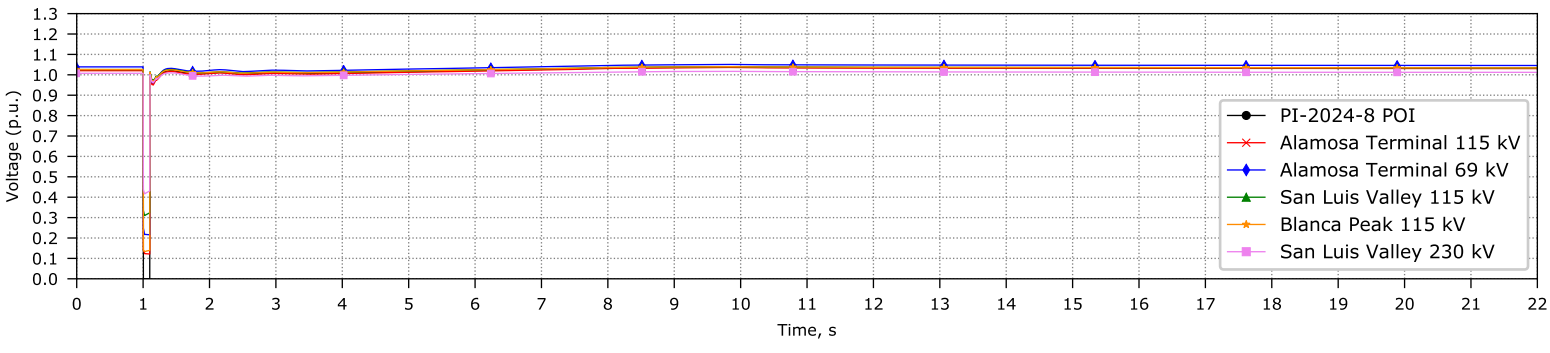












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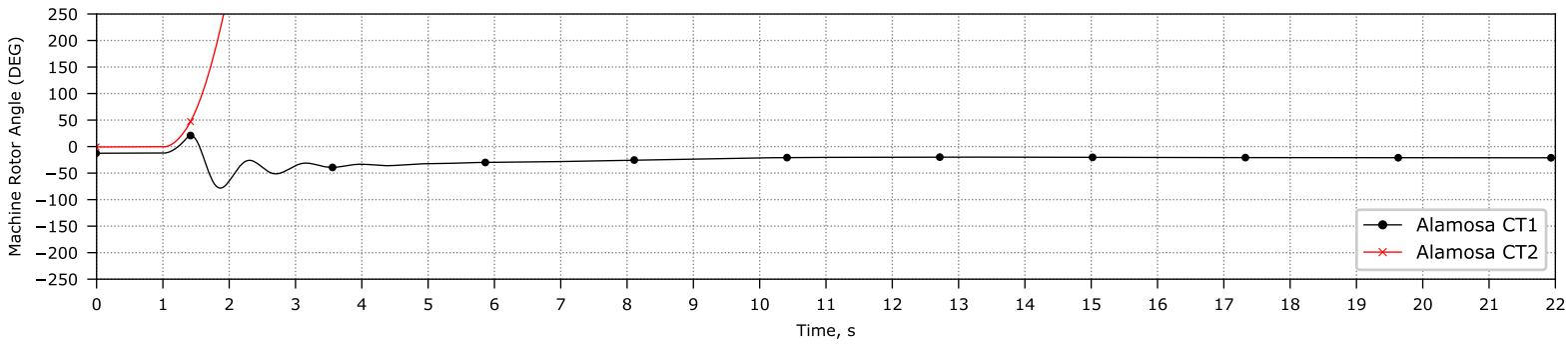

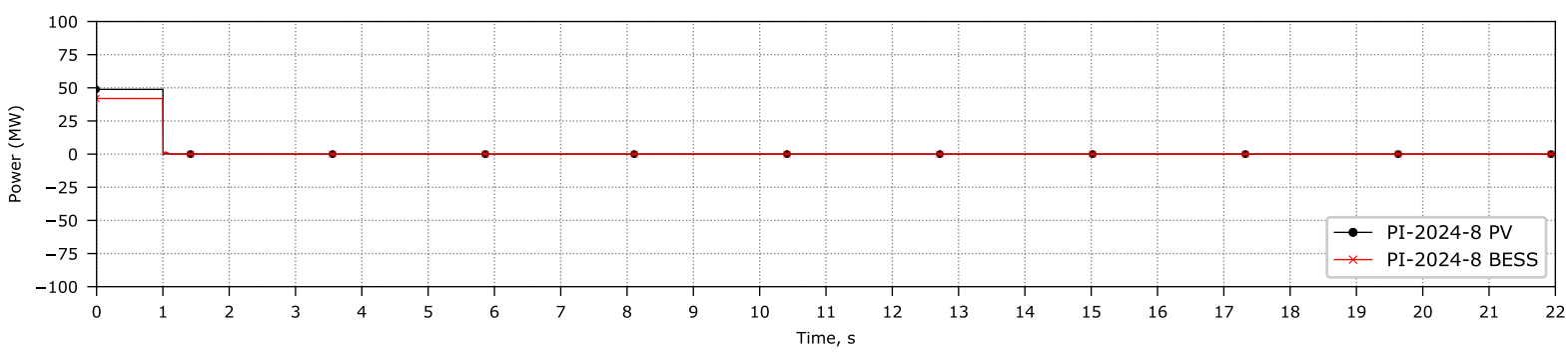

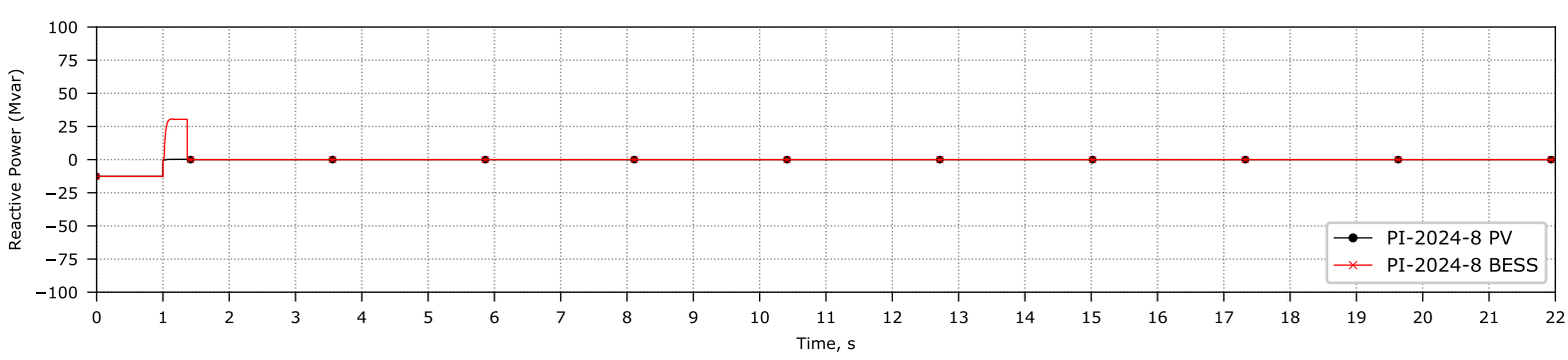

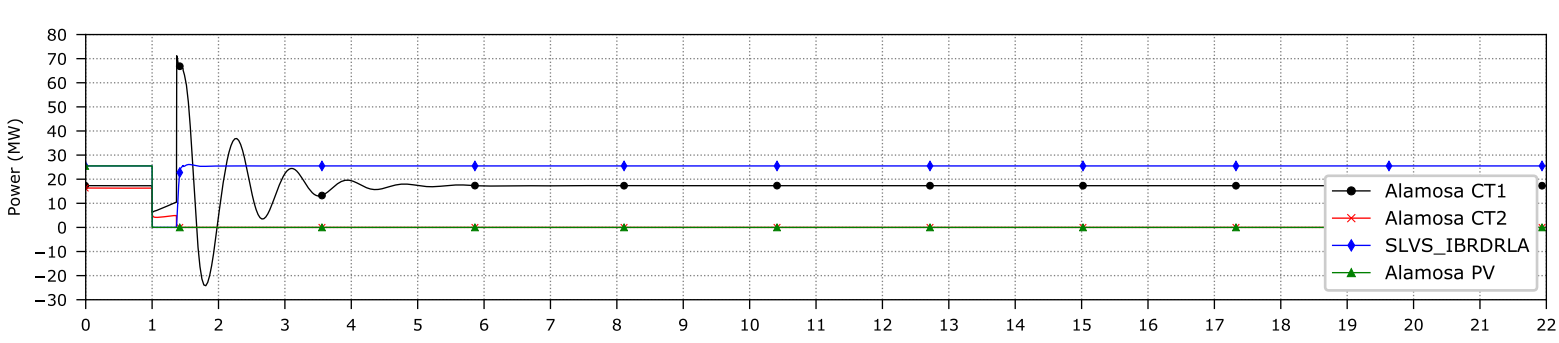

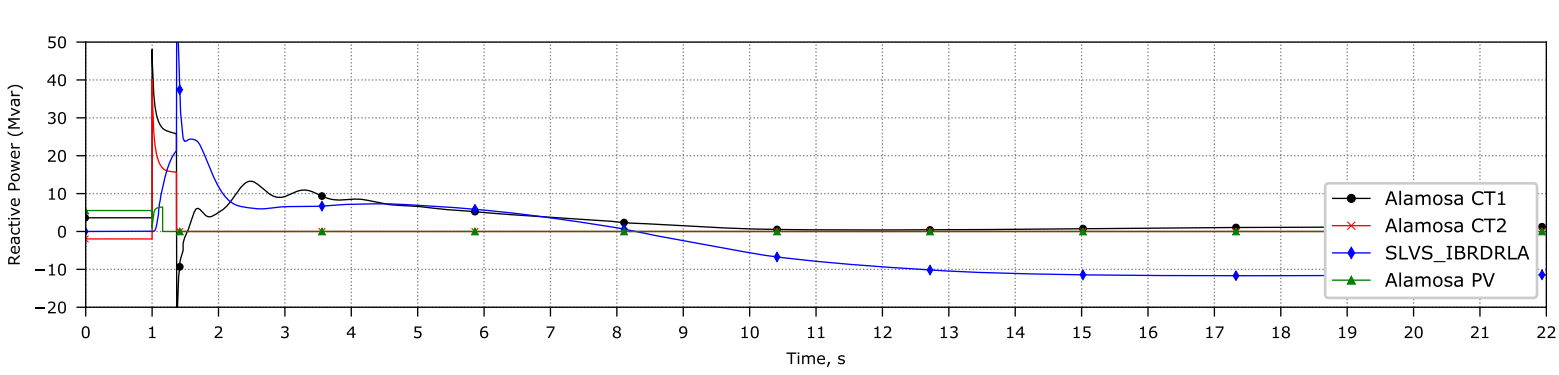

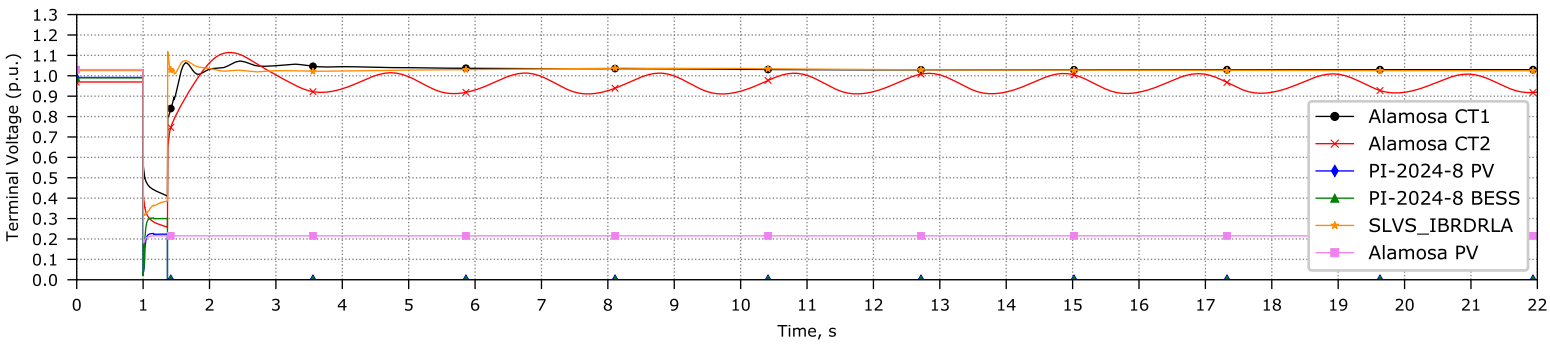

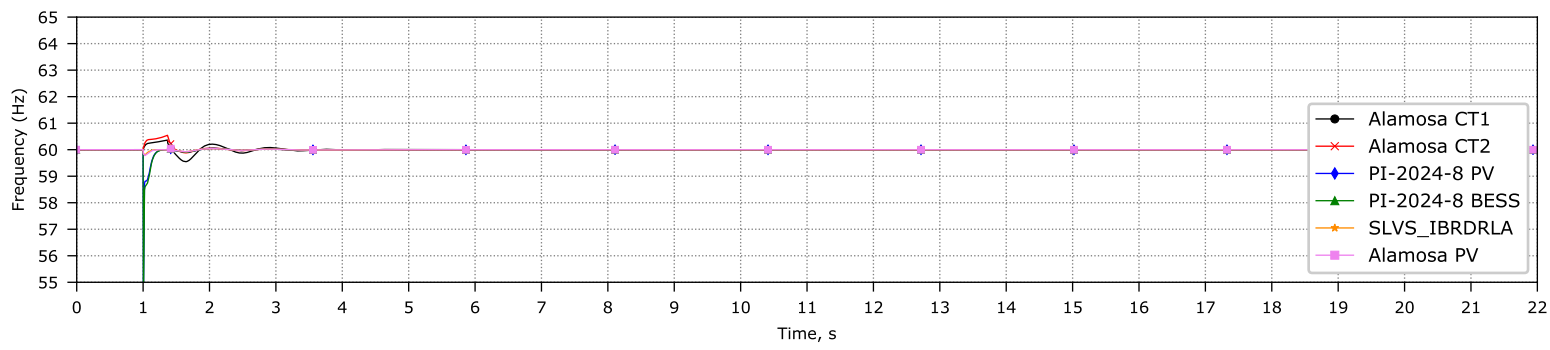

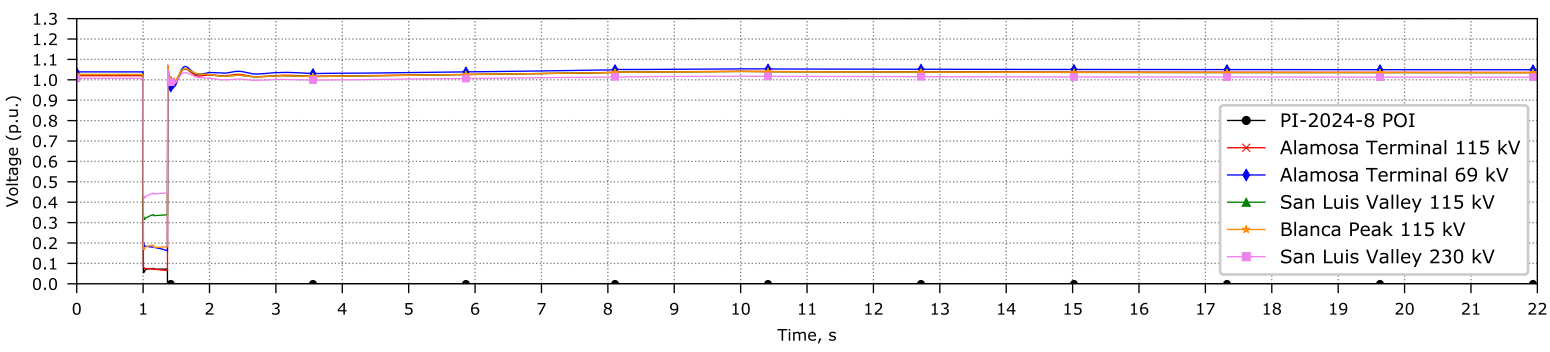

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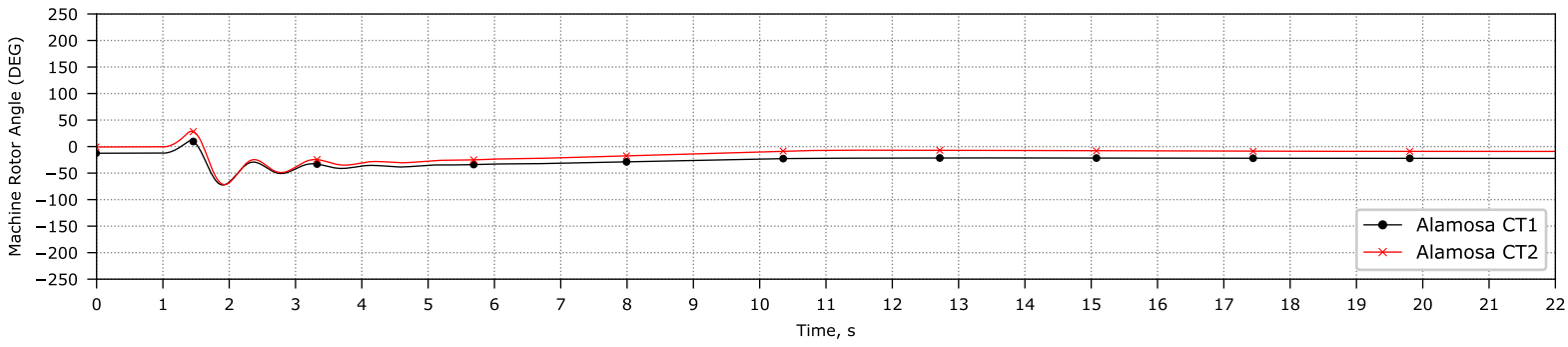

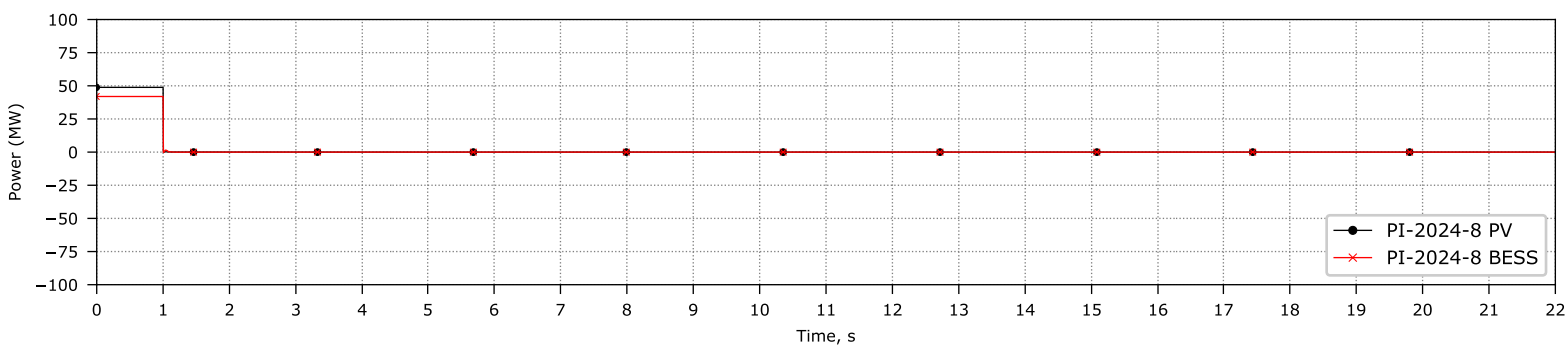

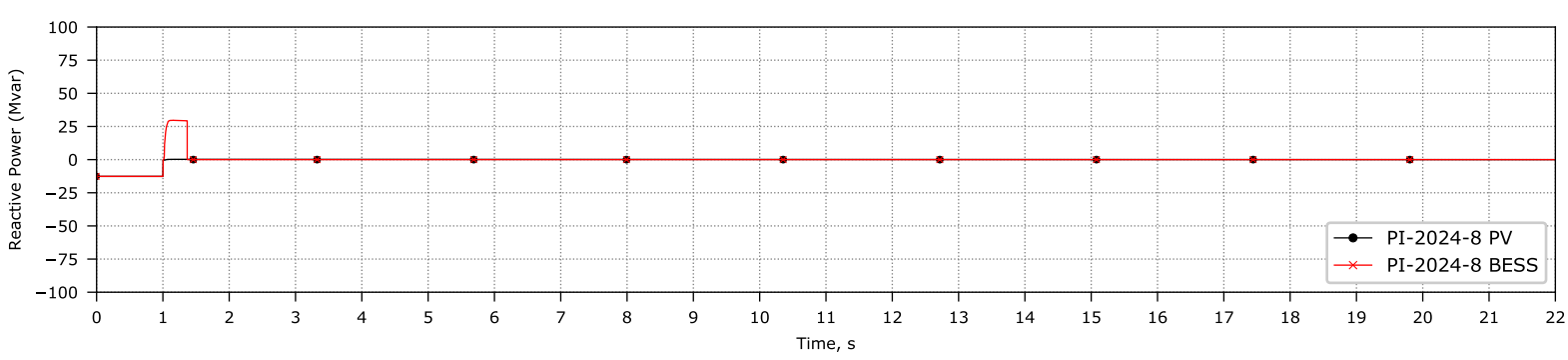

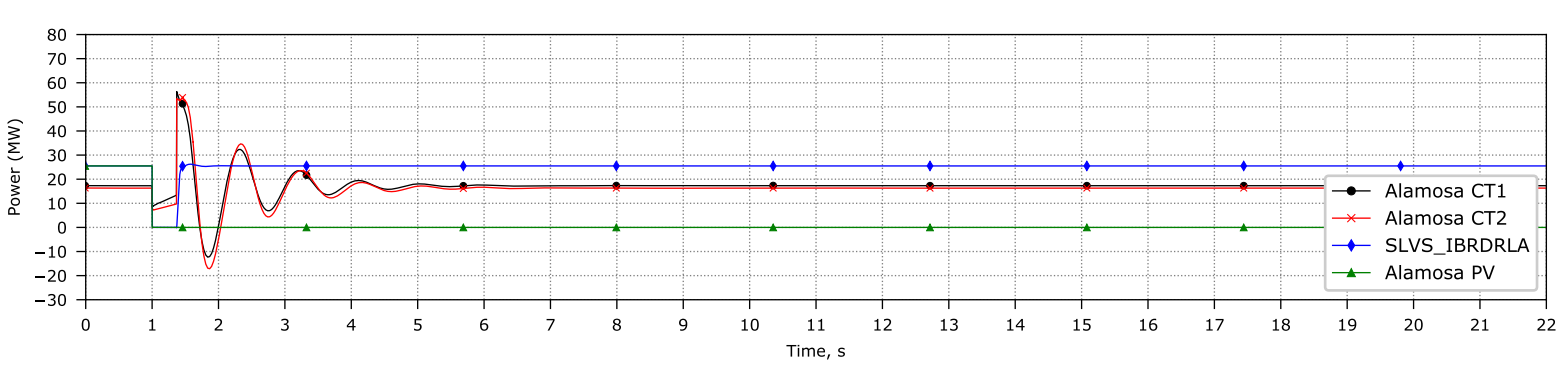

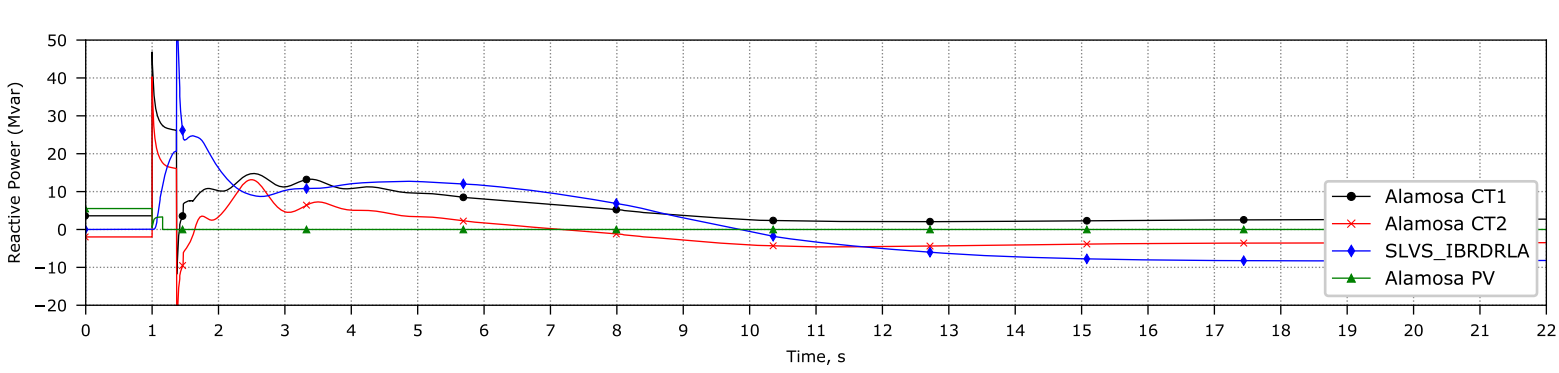

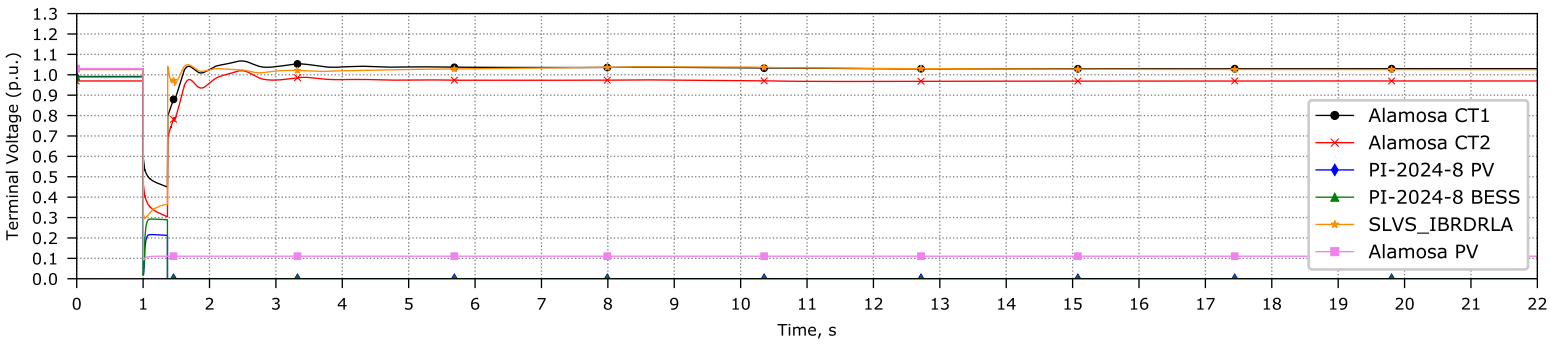

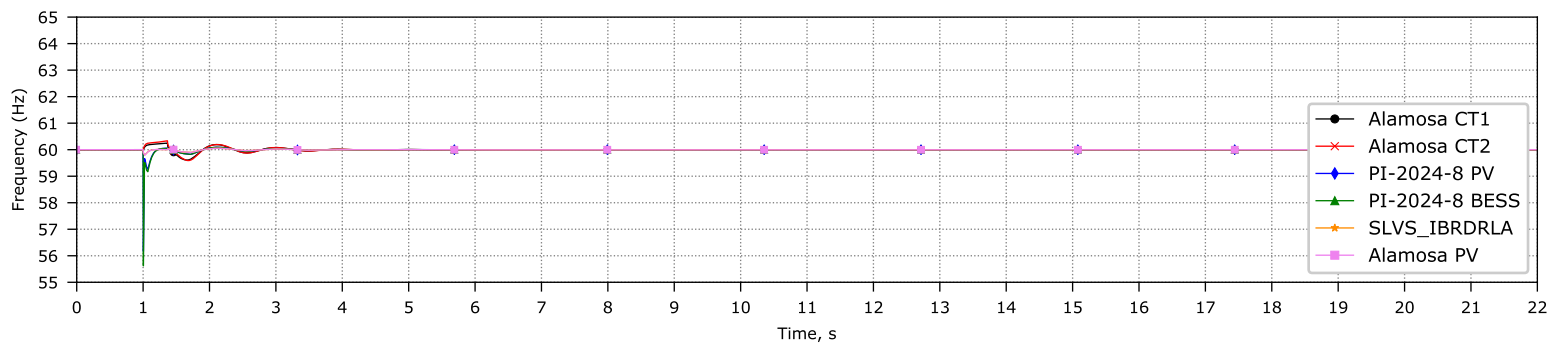

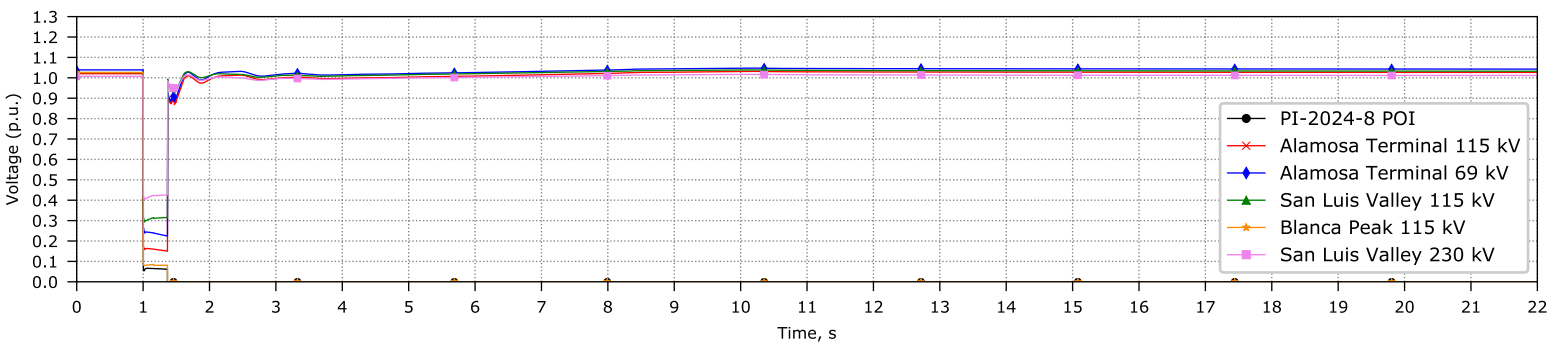

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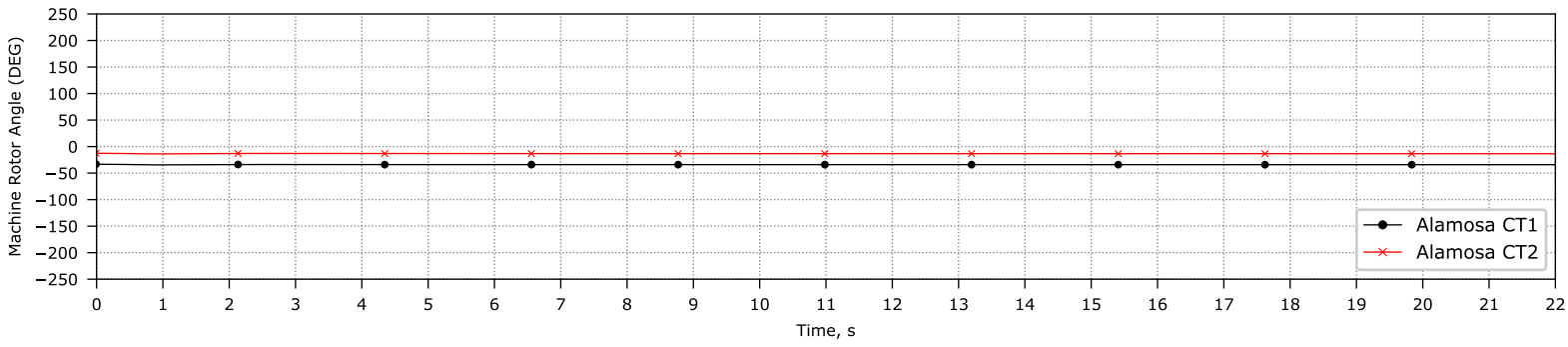
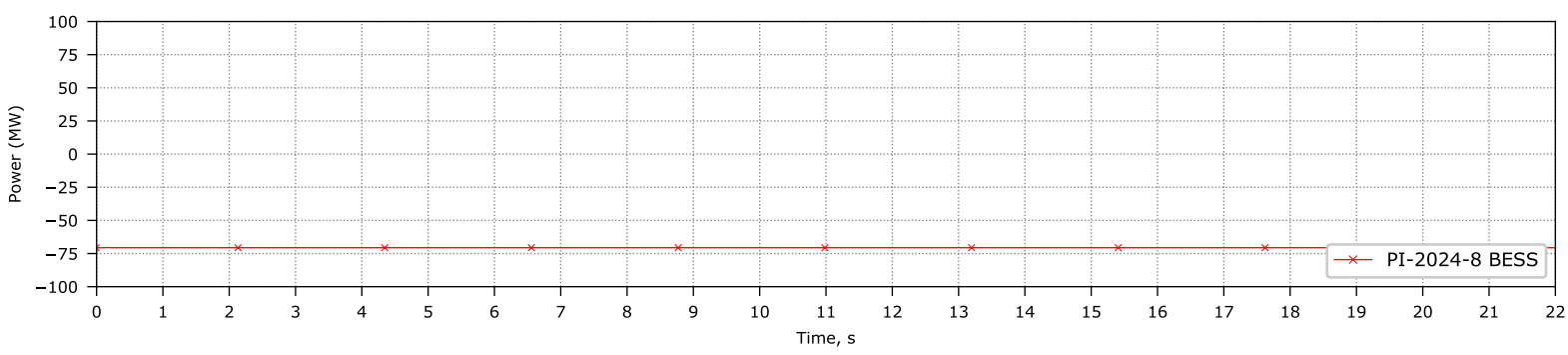
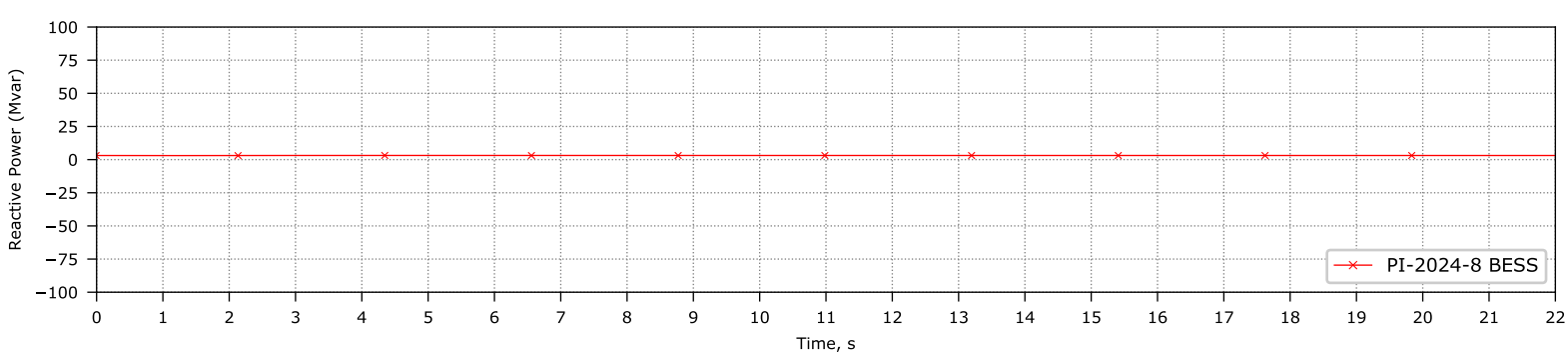
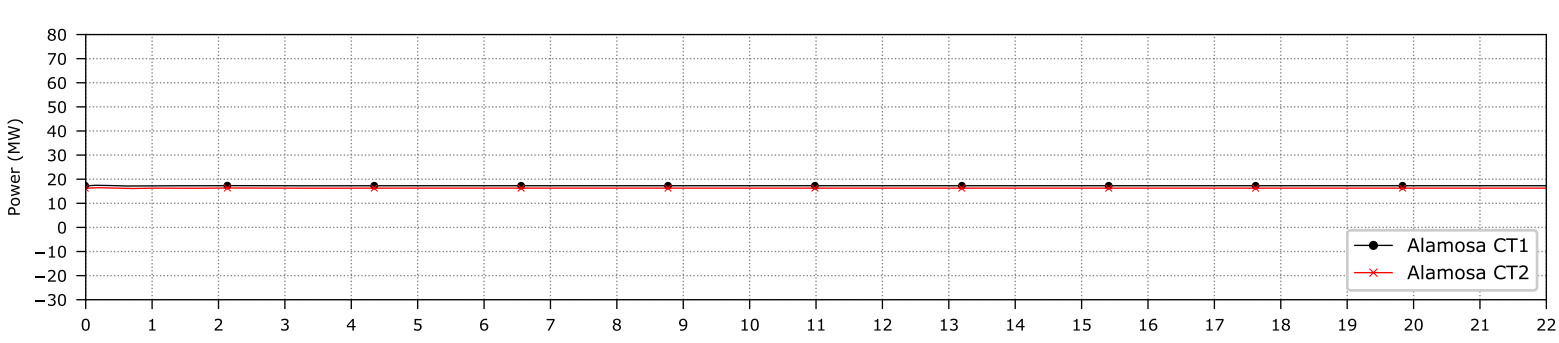
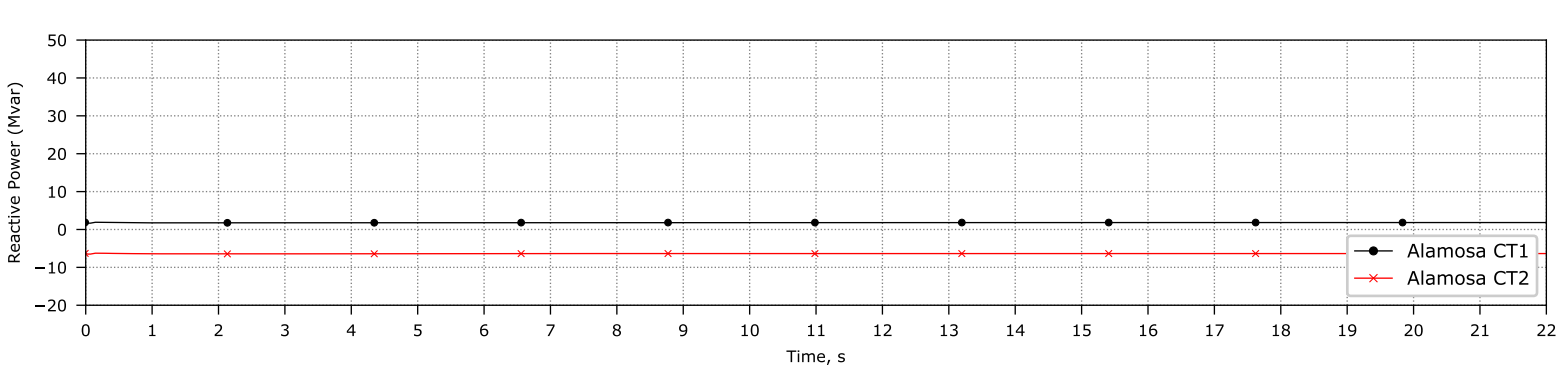
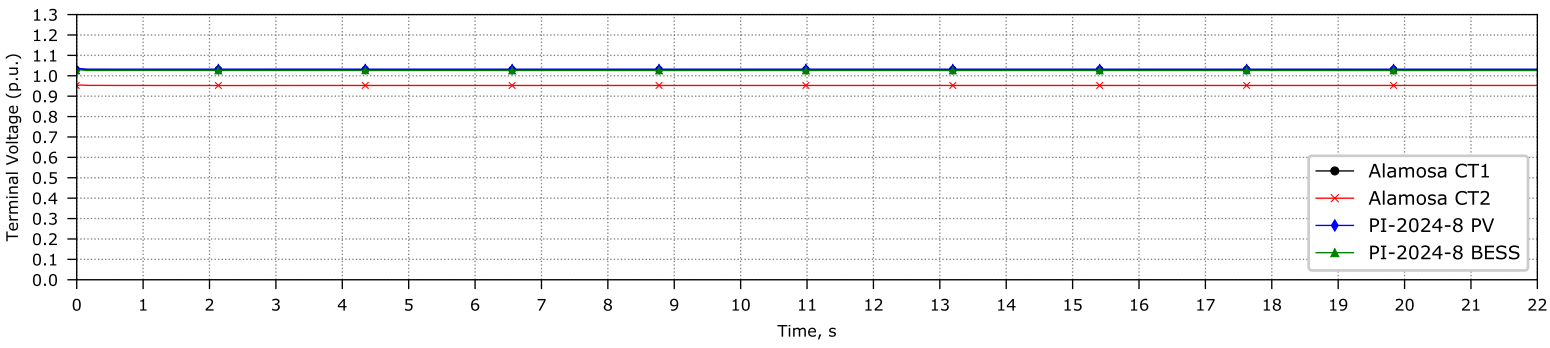

Machine Rotor Angle (DEG)
Time, s
Alamosa CT1
Alamosa CT2

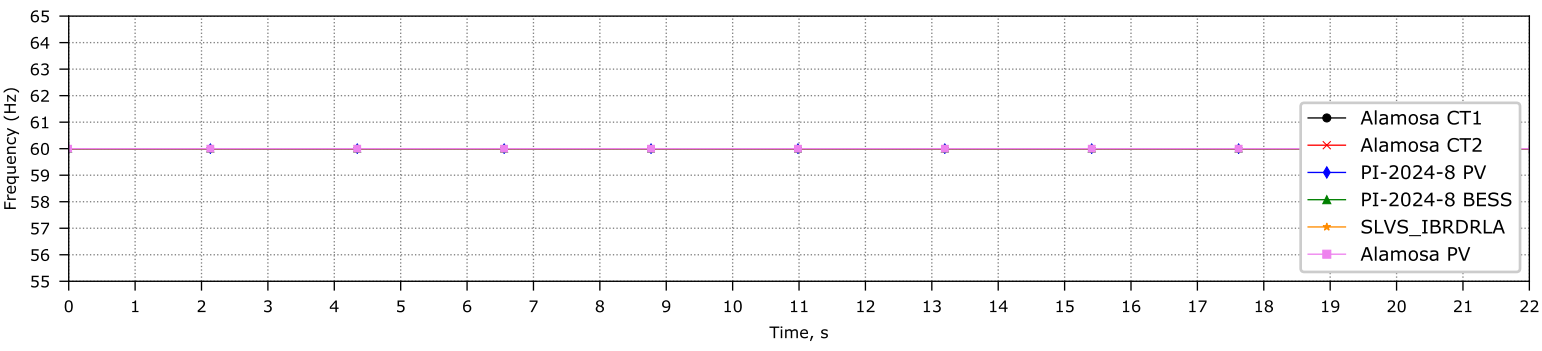

Power (MW)
Time, s
PI-2024-8 BESS

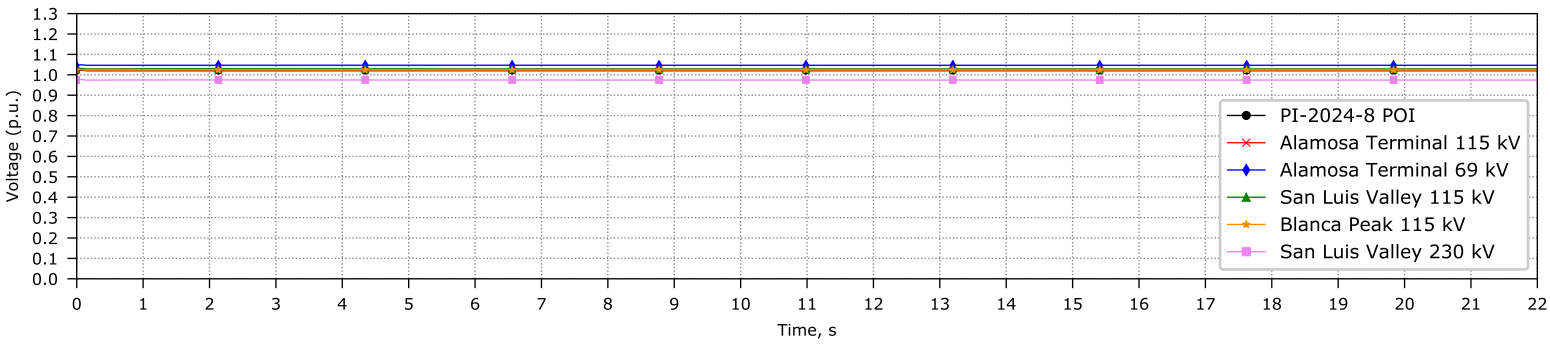

Reactive Power (Mvar)
Time, s
PI-2024-8 BESS


Power (MW)
Time, s
Alamosa CT1
Alamosa CT2

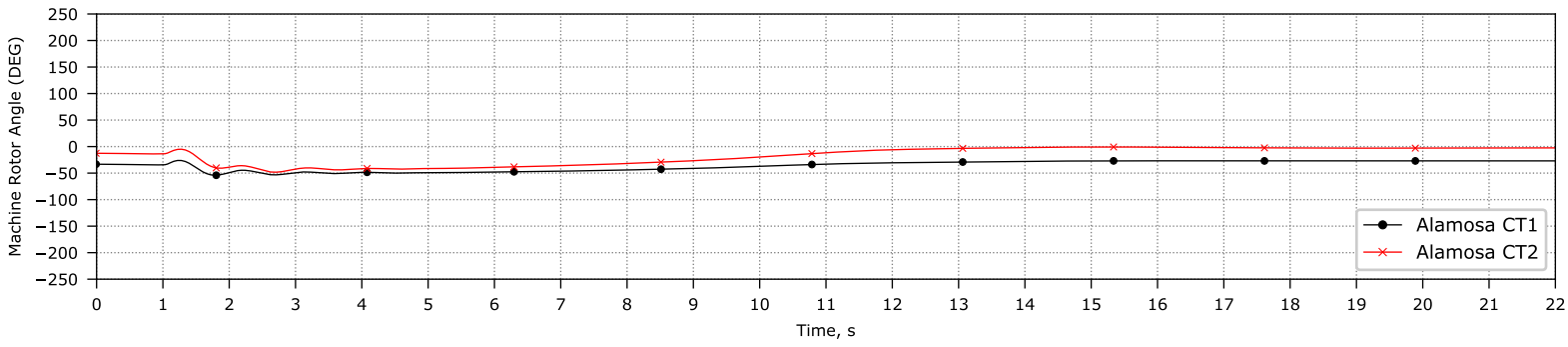

Reactive Power (Mvar)
Time, s
Alamosa CT1
Alamosa CT2

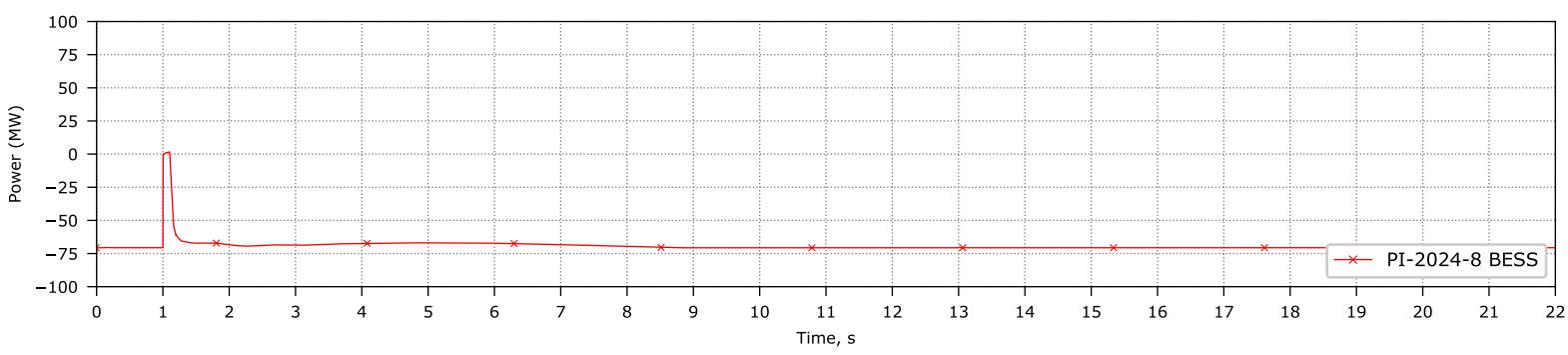

Terminal Voltage (p.u.)
Time, s
Alamosa CT1
Alamosa CT2
PI-2024-8 PV
PI-2024-8 BESS

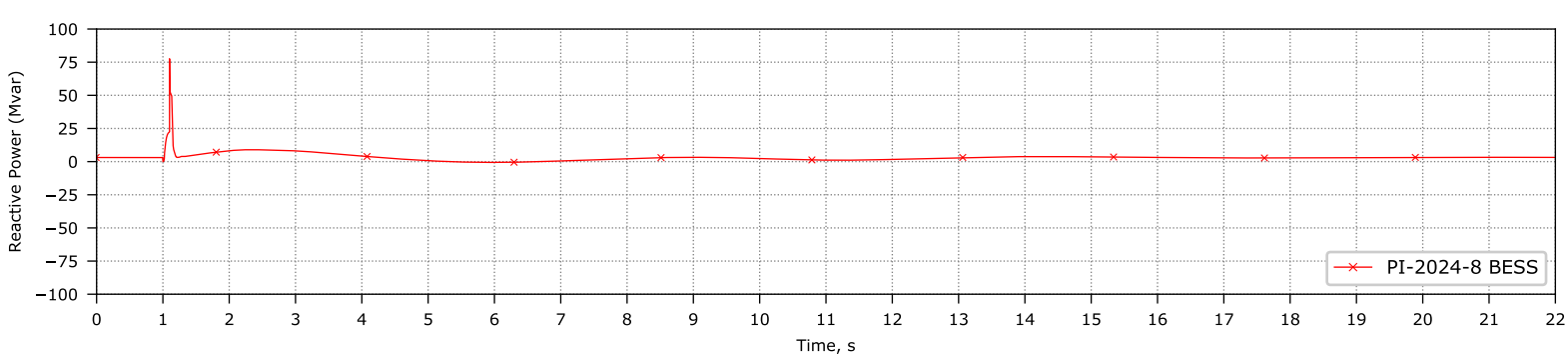

Frequency (Hz)
Time, s
Alamosa CT1
Alamosa CT2
PI-2024-8 PV
PI-2024-8 BESS
SLVS_IBRDRLA
Alamosa PV

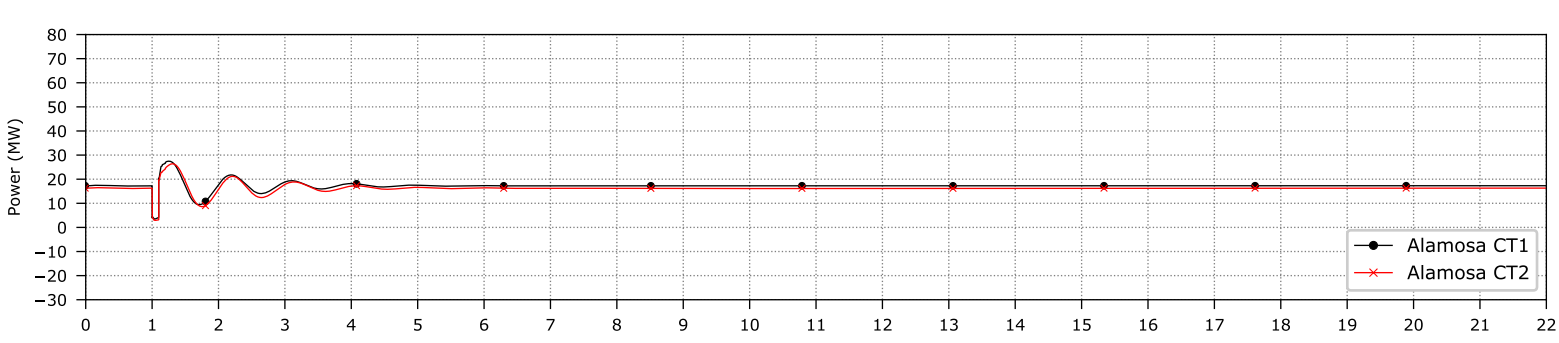

Voltage (p.u.)
Time, s
PI-2024-8 POI
Alamosa Terminal 115 kV
Alamosa Terminal 69 kV
San Luis Valley 115 kV
Blanca Peak 115 kV
San Luis Valley 230 kV

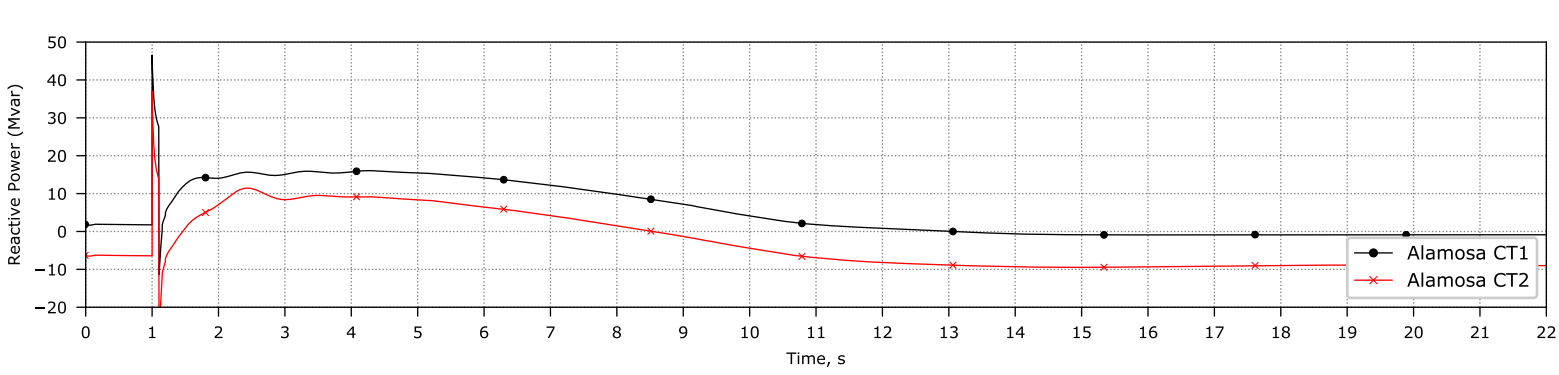
P1-POI-AlamosaTM 115kV

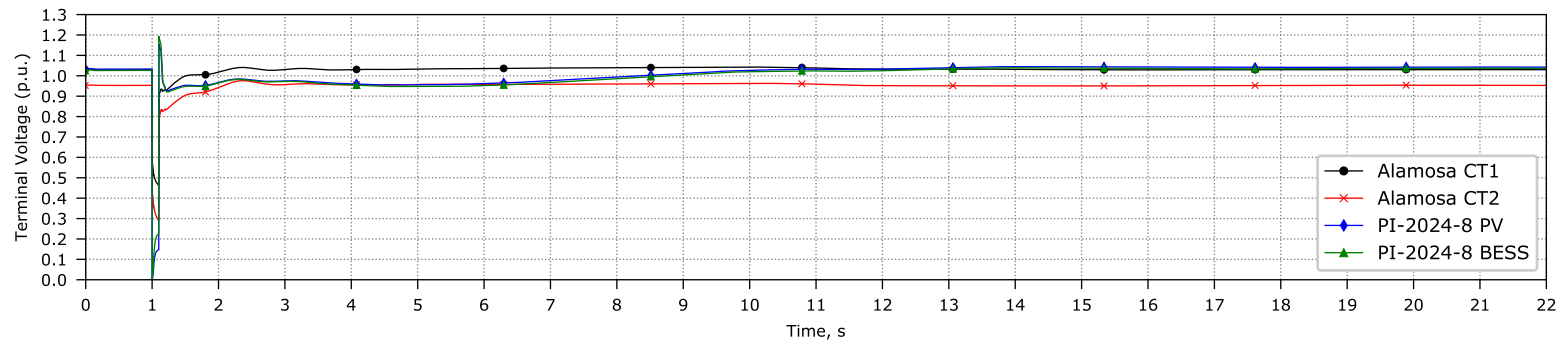


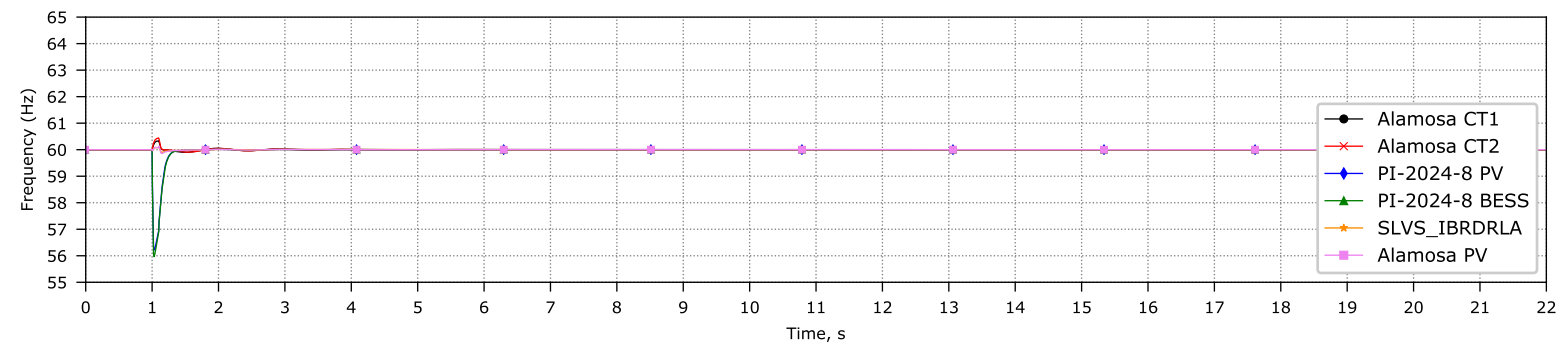


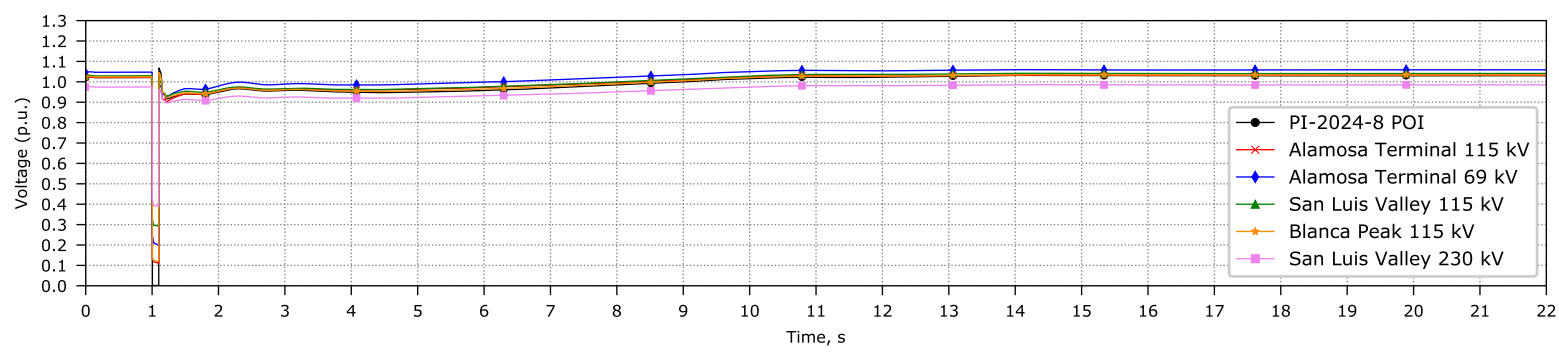




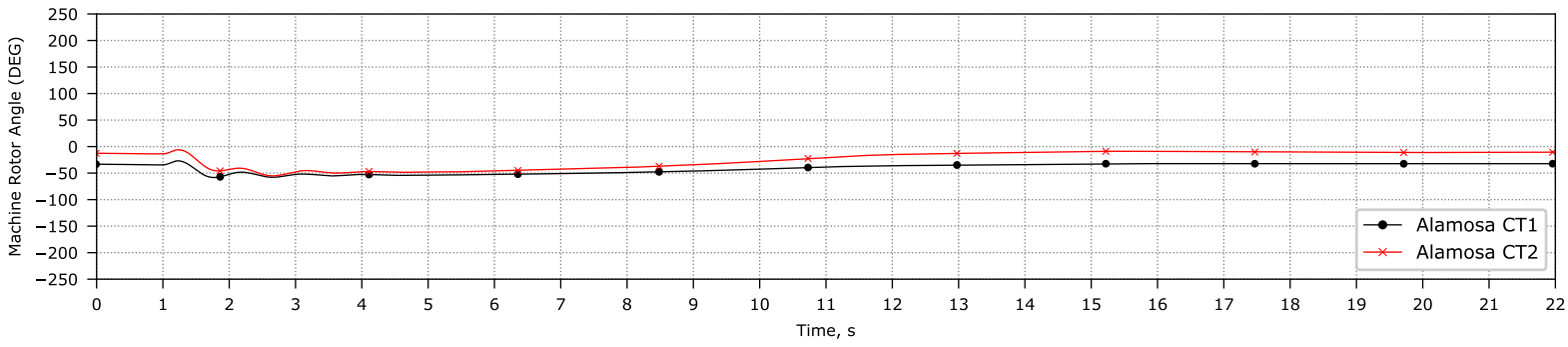


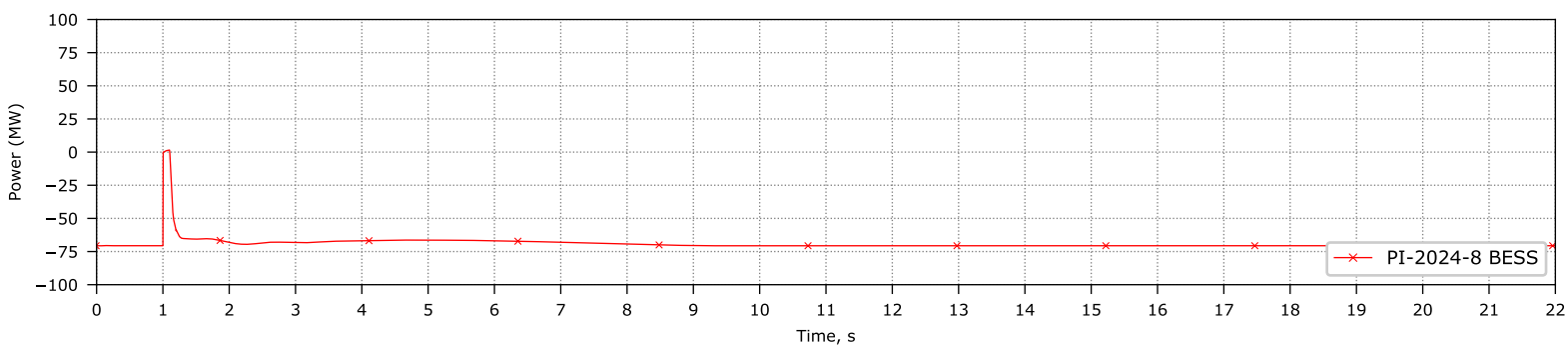


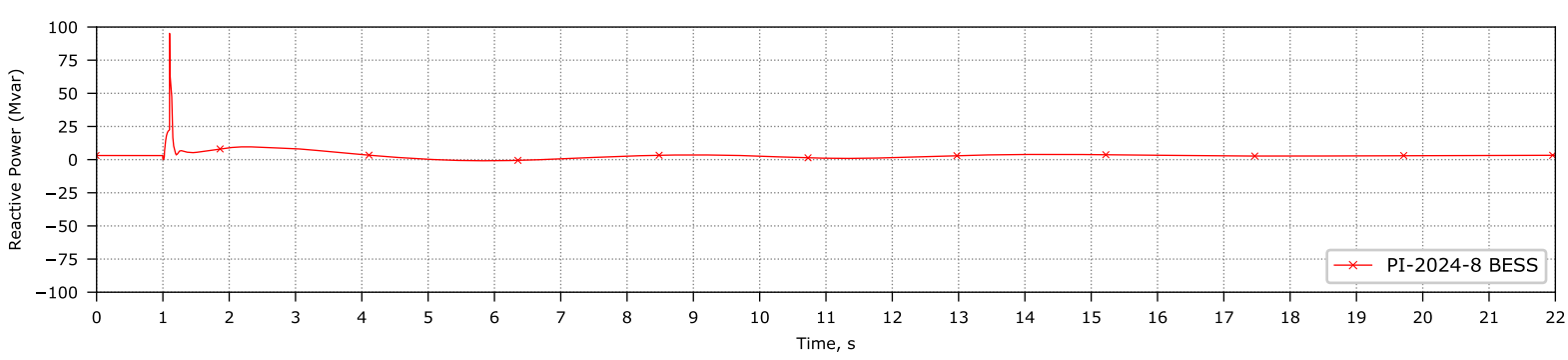


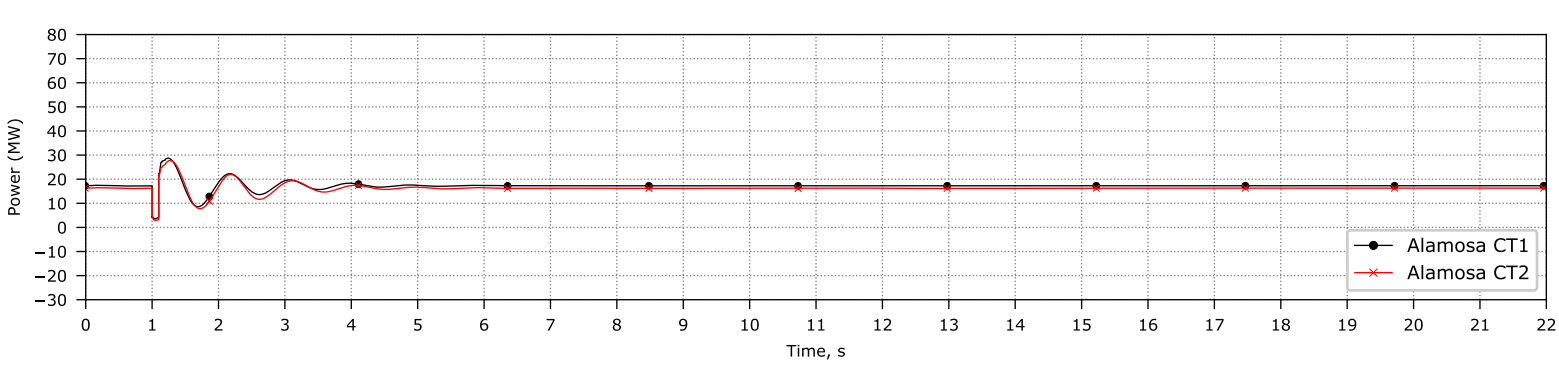


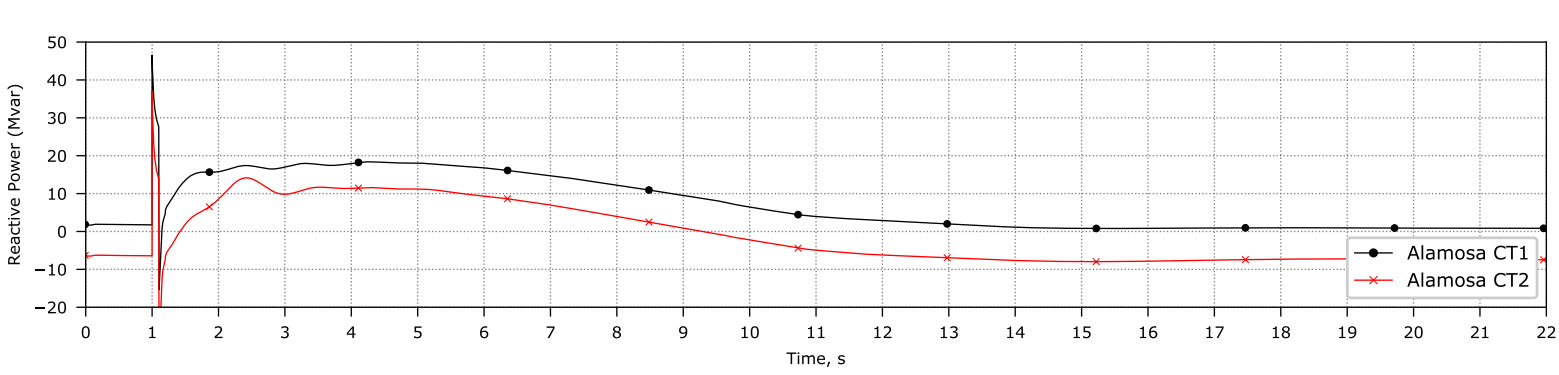
P1-POI-BlancaPeak 115kV

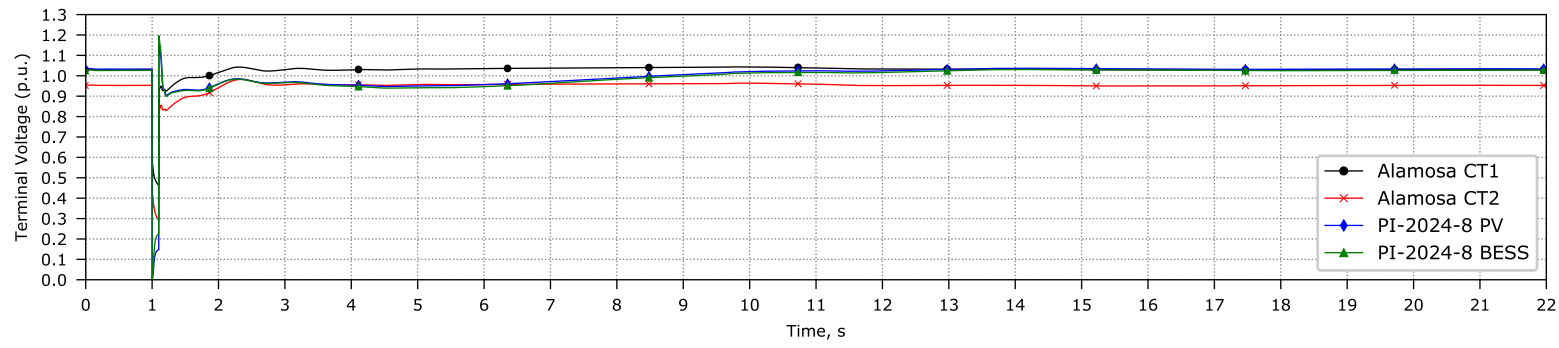


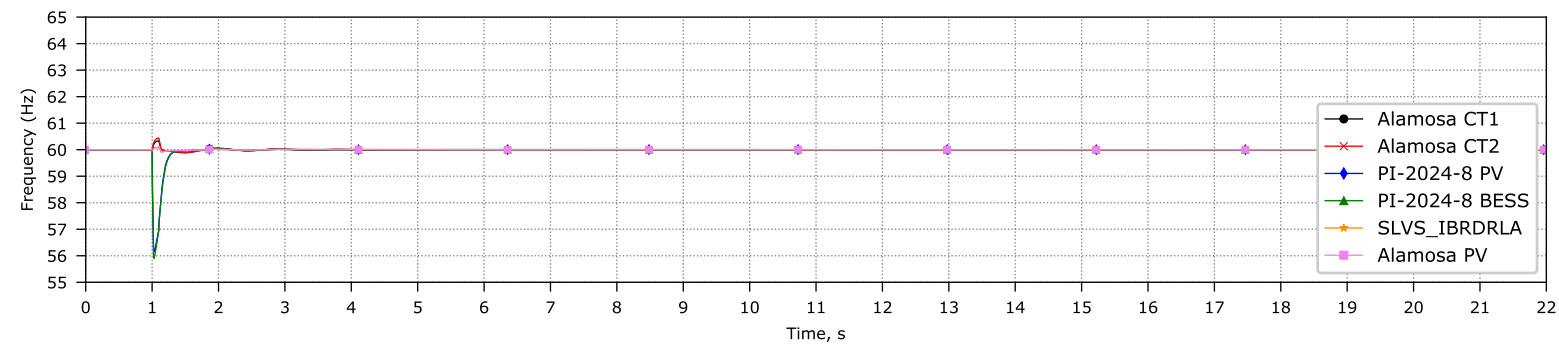


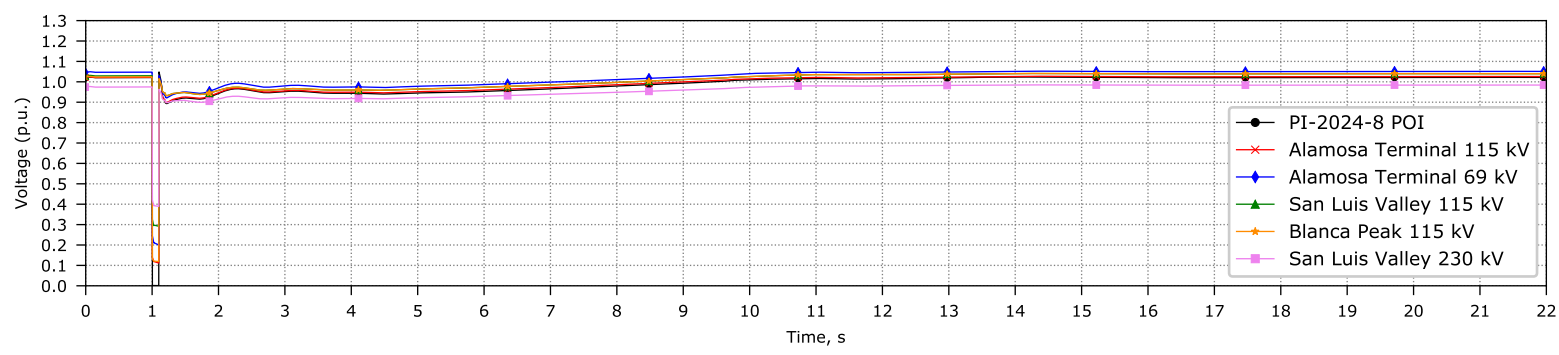




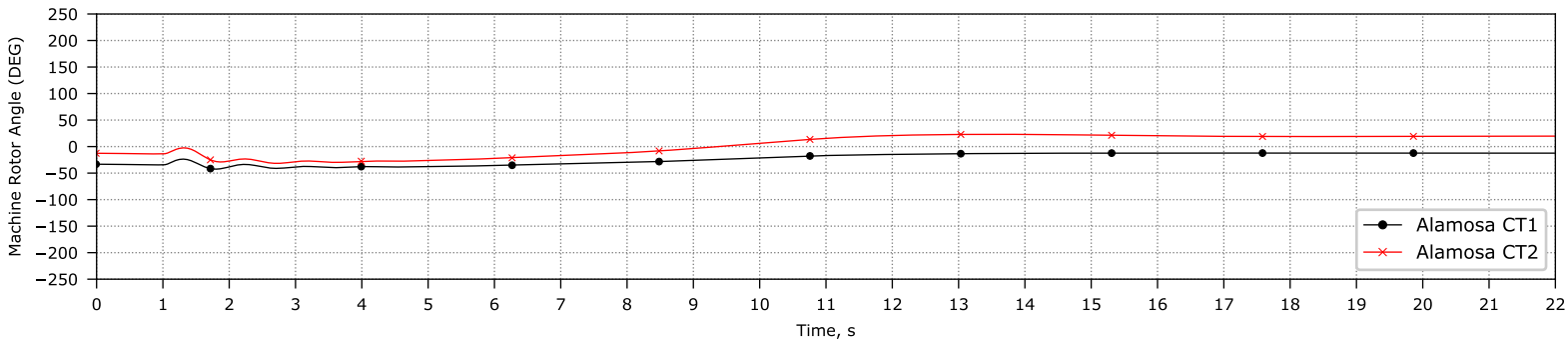


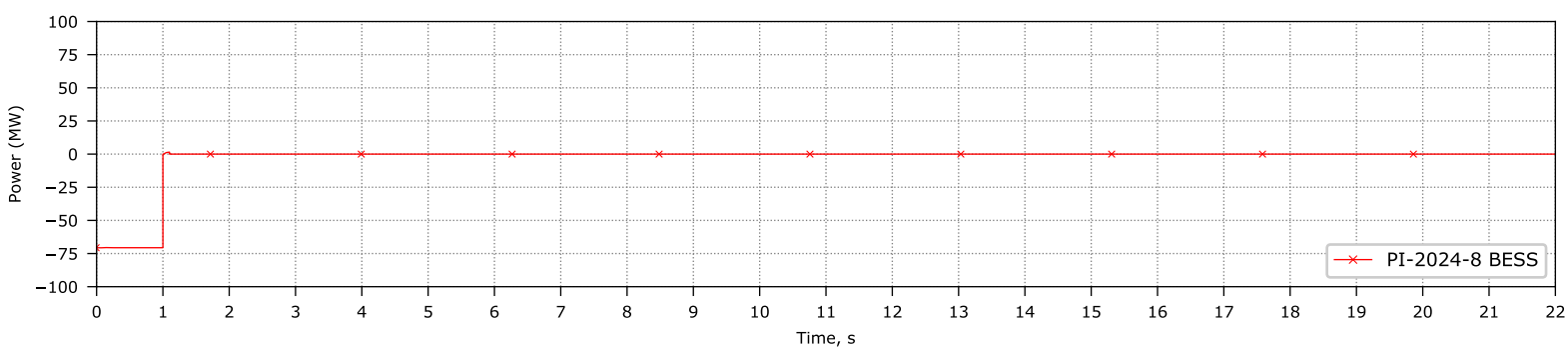


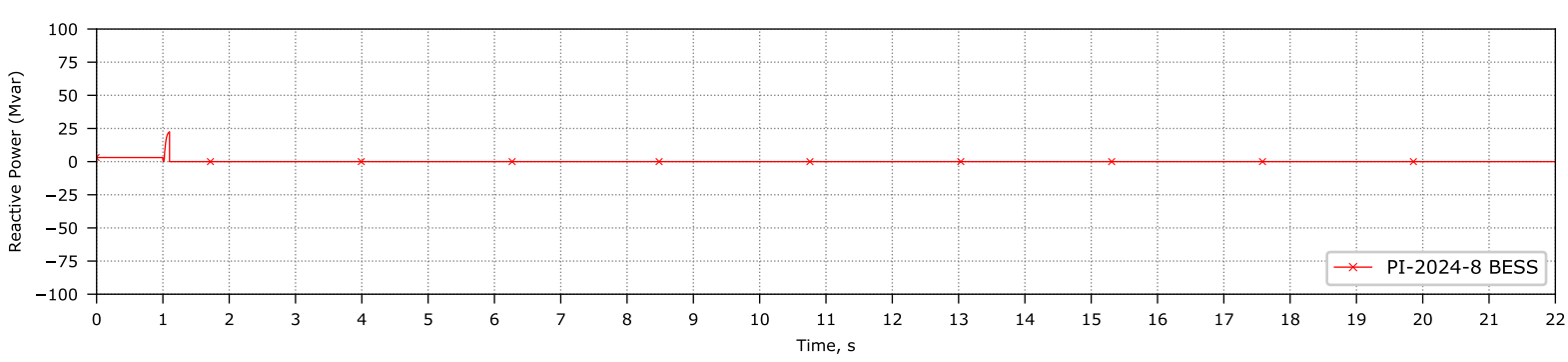


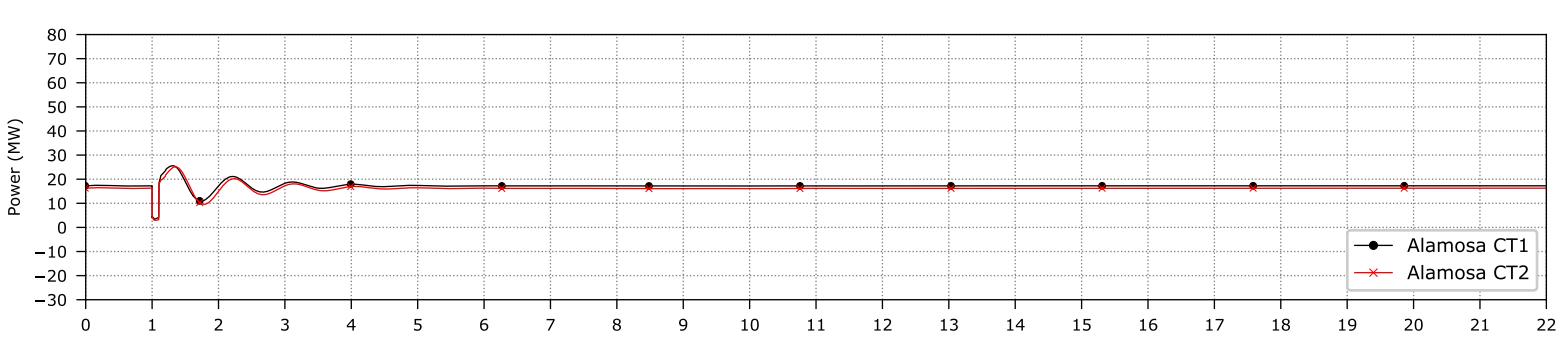


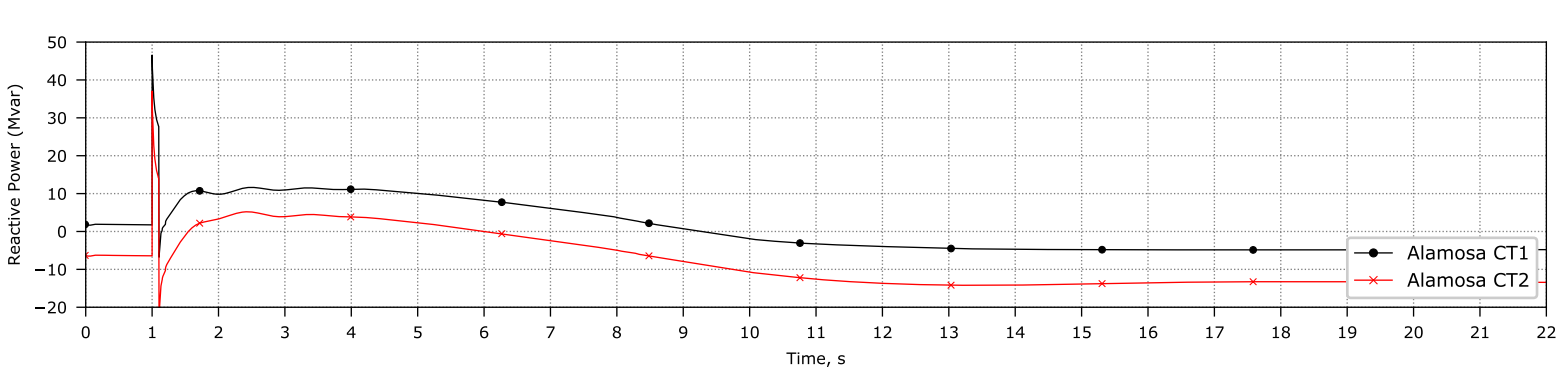
P1-POI-PI_2024_08 115kV

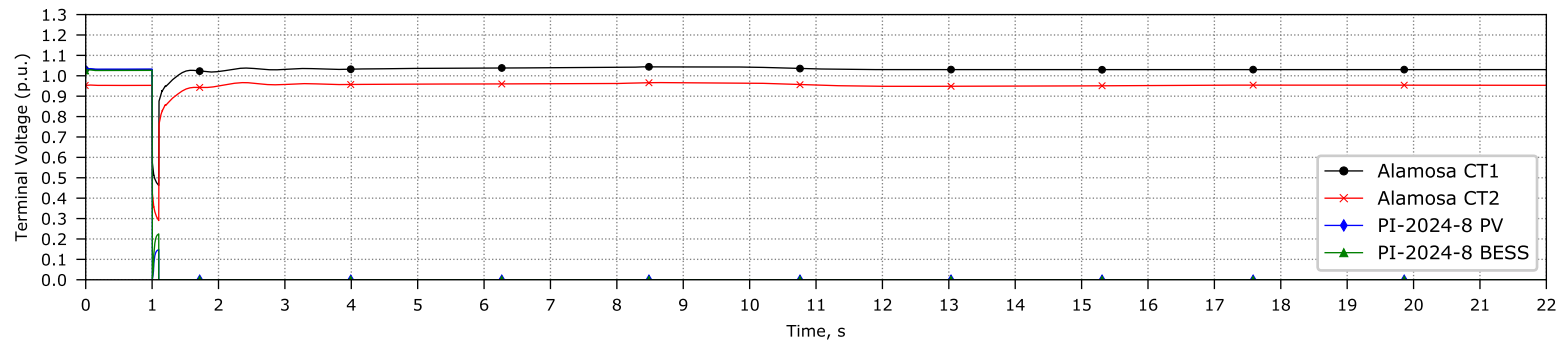


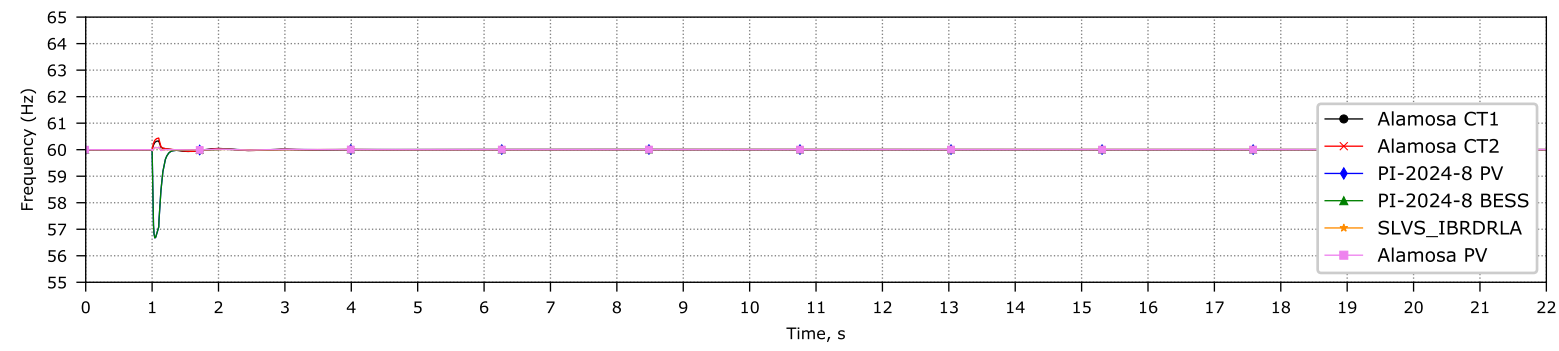


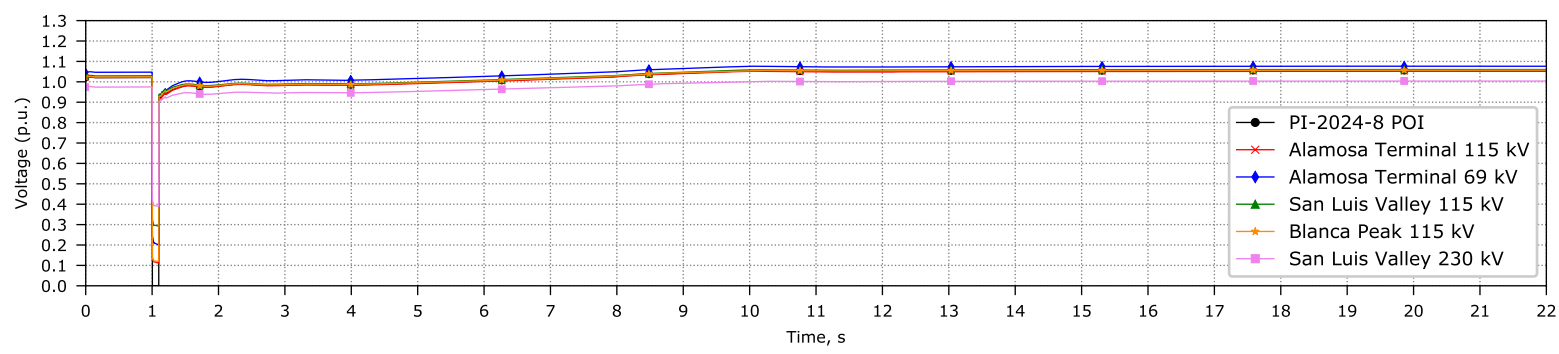












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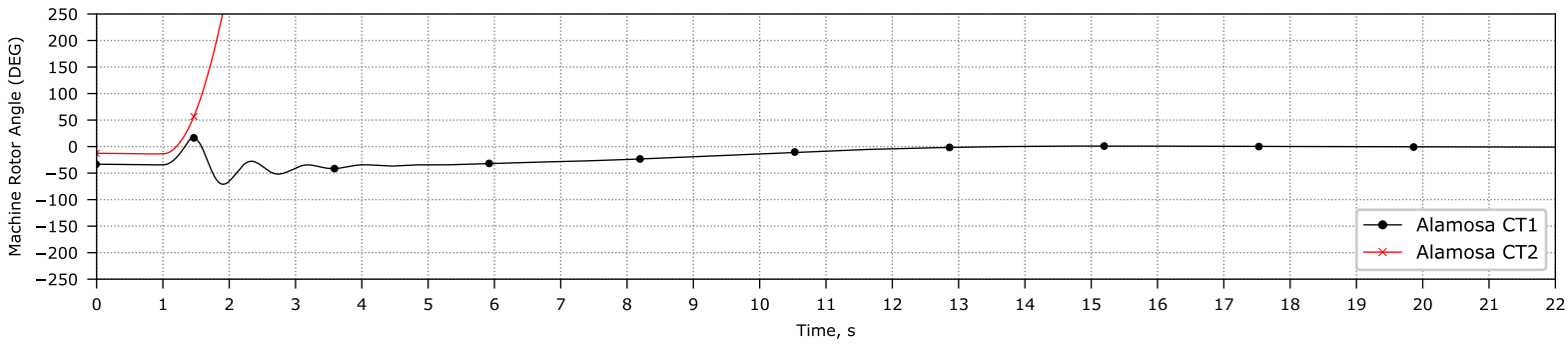

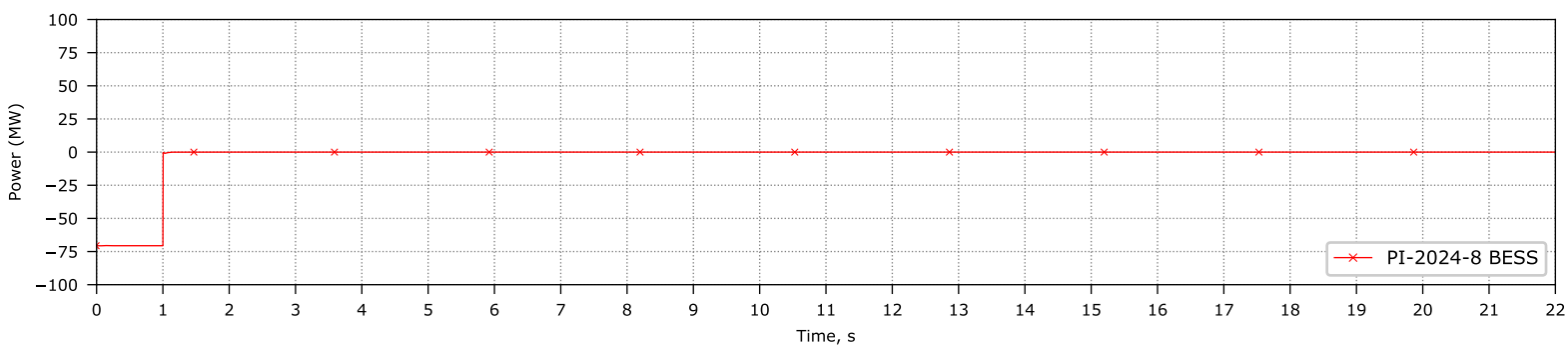

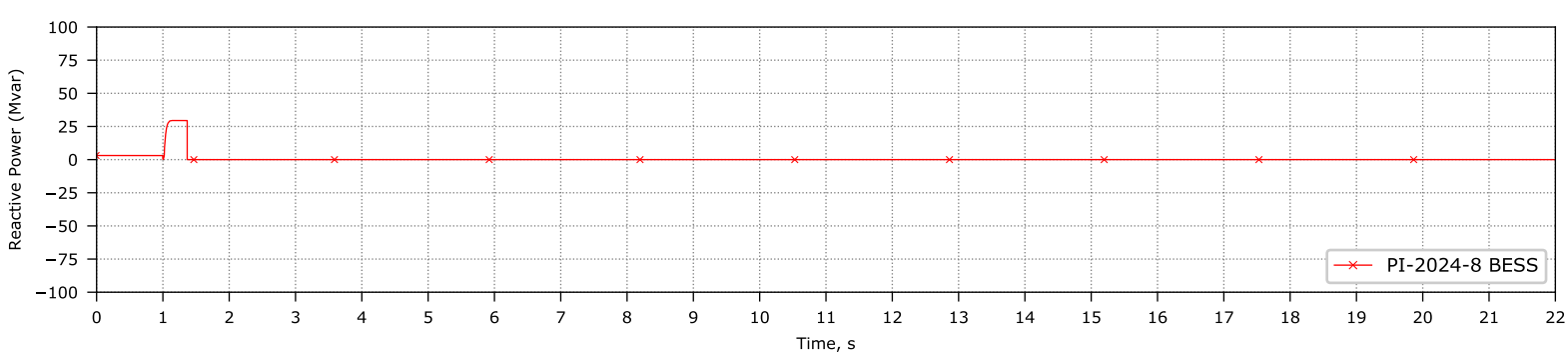

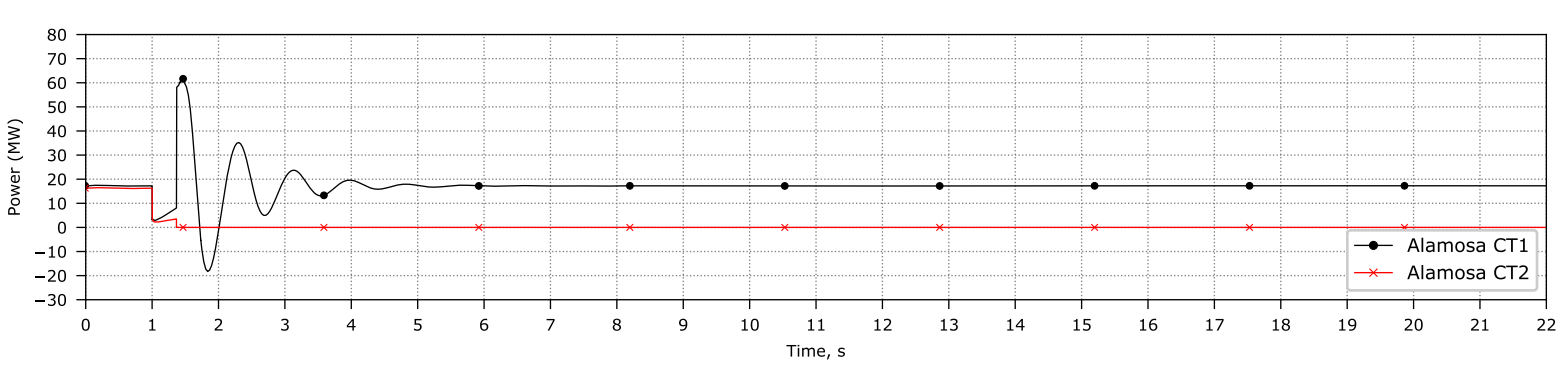

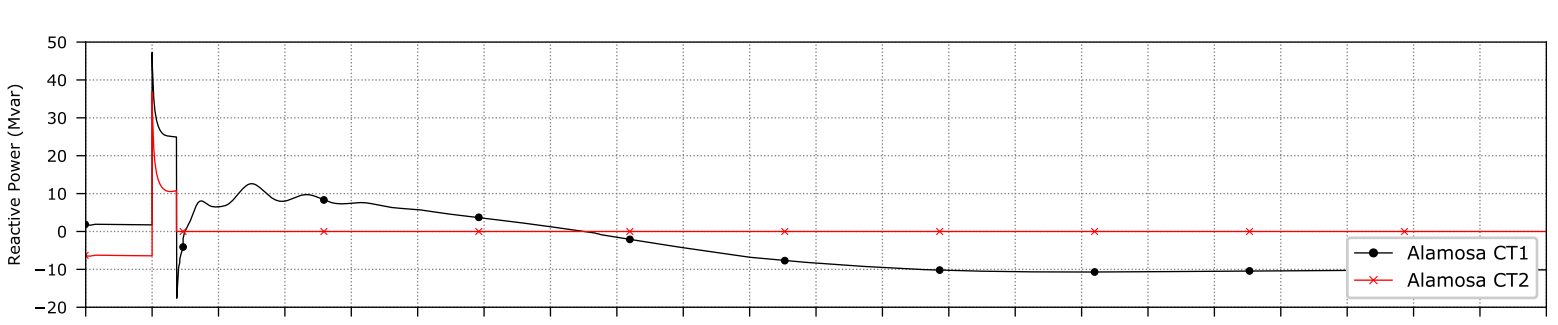

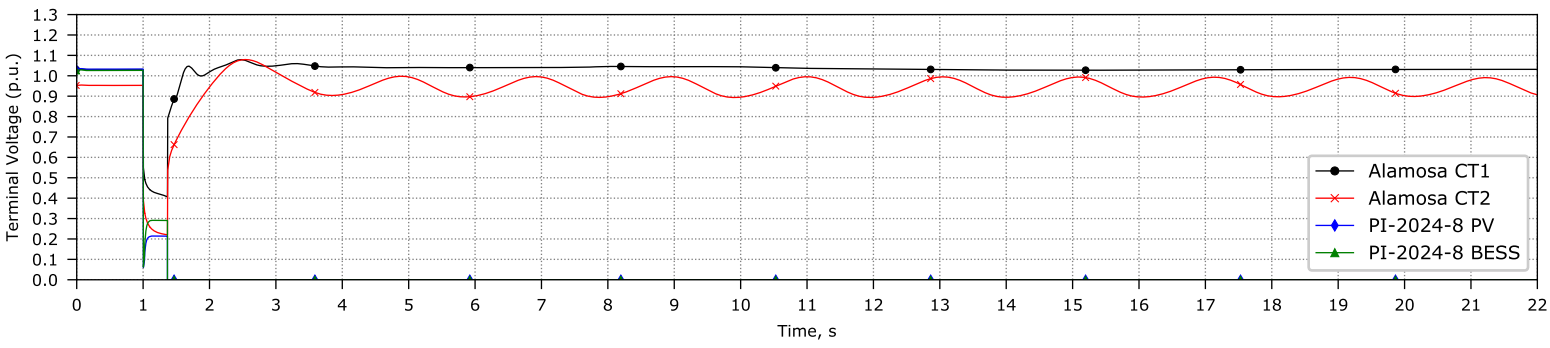

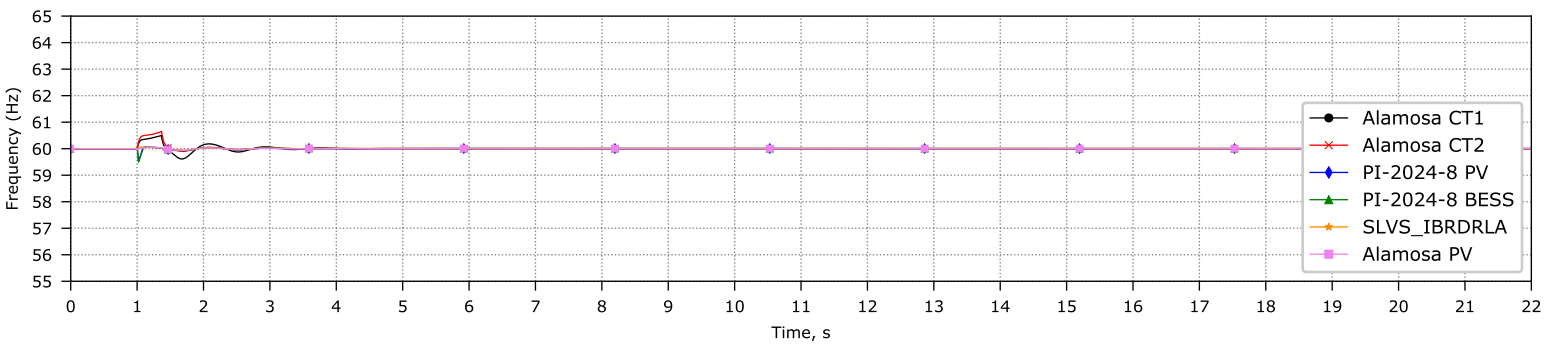

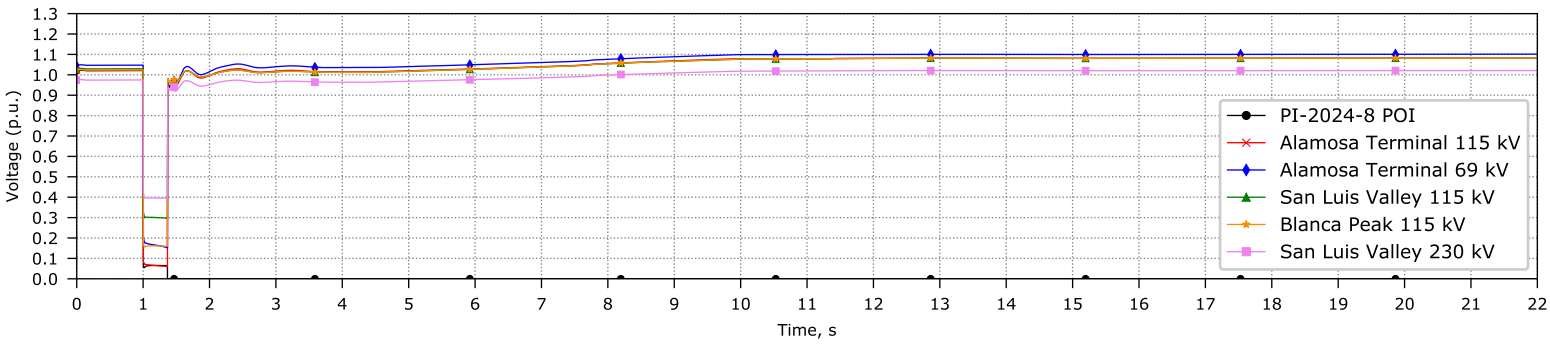

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