Interconnection System Impact Study Report
Request # GI-2016-4
Final

300 MW Wind Generating Facility
Missile Site 345 kV Substation, Colorado

Public Service Company of Colorado
Transmission Planning
January 20, 2017

Executive Summary

Public Service Company of Colorado (PSCo) received an Interconnection Request (IR) on February 12, 2016 which was assigned GI-2016-4 queue position. GI-2016-4 is a wind generating facility rated at 300 MW gross electrical output that will be located in Elbert, Lincoln and Kit Carson Counties in Colorado. The point of interconnection (POI) requested for GI-2016-4 is the 345 kV bus within the PSCo Missile Site Substation.

The proposed 300 MW generating facility is expected to consist of approximately 150 wind turbine generators (WTG), where each WTG is rated 2.0 MW and is equipped with a 0.69/34.5 kV step-up transformer. Preliminary information on the wind generating facility's layout suggests that the 150 WTG's will be grouped into one or two 34.5 kV collector systems, each consisting of 75 WTG's (150 MW). Each 34.5 kV collector system will connect to a 34.5/345 kV main step-up transformer (MST). The one or two MST's will be connected to the POI by using the same ~90 miles long 345 kV radial transmission line (i.e. gen-tie) that is expected to be constructed for interconnecting the previously proposed (and now planned) GI-2016-3 600 MW wind generating facility.

The commercial operation date (COD) requested for the generating facility is December 31, 2018 and the requested back-feed date is August 1, 2018. The 300 MW output of GI-2016-4 is to be evaluated for both Network Resource Interconnection Service (NRIS) and Energy Resource Interconnection Service (ERIS). GI-2016-4 was studied as stand-alone interconnection request in addition to the planned GI-2016-3 interconnection – that is, the study excluded all other interconnection requests for the same POI (Missile Site) in the PSCo Interconnection Request queue.

Figure 1 (see page 11) is a conceptual one-line diagram of the proposed GI-2016-4 and the planned GI-2016-3 interconnections at the Missile Site Substation 345 kV bus (i.e. the POI).

The main purpose of this System Impact Study is to evaluate the system impacts of the aggregate 900 MW injection at the Missile Site 345 kV POI due to the 300 MW output of the proposed GI-2016-4 interconnection in addition to the 600 MW output of the planned GI-2016-3 interconnection based on steady state (power flow), short-circuit and

transient stability analyses. Towards this objective, the study identifies the transmission network upgrades needed to enable delivery of the aggregate 900 MW electrical output to the PSCo network loads – that is, for GI-2016-4 to qualify as NRIS with GI-2016-3 already in-service as NRIS.

The power flow analyses were performed using two power flow models developed for GI-2016-4, which are based on the WECC 2021 heavy summer (2021HS) base case. The two power flow models are:

- a Benchmark Case which models the transmission system prior to the GI-2016-4 interconnection (i.e. Before GI-2016-4 case).
  This model includes the previously proposed generator interconnection at the same POI (i.e. GI-2016-3) and the planned 2021 transmission system topology, which includes the network upgrades identified for GI-2016-3 (i.e. the Pawnee – Daniels Park 345 kV project.)
- a Study Case that includes the 300 MW generation under study (i.e. After GI-2016-4 case).

The Pawnee – Daniels Park 345 kV project[1] is a PSCo planned project for which the Colorado Public Utility Commission (CPUC) has approved a Certificate of Public Convenience and Necessity (CPCN) and has an in-service date of October 31, 2019. Studies for GI-2016-3 demonstrated that the Pawnee – Daniels Park project is the network upgrade needed to deliver its 600 MW output to the PSCo system. Therefore, this System Impact Study evaluated the sufficiency of Pawnee – Daniels Park 345 kV (P-DP) project's transmission facilities for the proposed 900 MW cumulative rated output of GI-2016-4 and GI-2016-3, and the need for additional network upgrades.

As is evident from the power flow analysis results provided in Table A.1 in the Appendix (see page 14), the Pawnee – Daniels Park 345 kV project's transmission facilities are sufficient as the network upgrades for delivery of the proposed 900 MW cumulative rated output of GI-2016-4 and GI-2016-3 interconnections. However, for the studied generation dispatch scenario, the 300 MW injection from GI-2016-4 will result in post-contingency overload of the Greenwood – Monaco line-section of the Greenwood – Leetsdale 230 kV line due to the forced outage of the Smoky Hill – Leetsdale 230kV line. Therefore, increasing the thermal rating of the Greenwood – Monaco 230 kV line-section by replacing limiting substation equipment at Monaco is identified as the network upgrade for GI-2016-4.

The short circuit analysis results based on the 2019 transmission topology (P-DP project's facilities are in-service) did not identify the need for any additional network upgrades (i.e. replacement of over-duty breakers) for the GI-2016-4 interconnection.

The transient stability analysis was performed using a 2020 heavy summer (2020HS) case and did not identify any unacceptable/degraded stability performance due to the proposed GI-2016-4 interconnection. This was determined by verifying acceptable

[1] More information at: http://www.transmission.xcelenergy.com/Projects/Colorado

angular stability as well as LVRT (Low Voltage Ride-Through) performance for the most severe three-phase fault disturbance at the Missile Site 345 kV bus resulting in the forced outage of two transmission facilities (NERC Category P7 event). Therefore, no network upgrades are necessary to achieve acceptable stability performance.

Based on the results noted above, this System Impact Study concludes that the GI-2016-4 interconnection may achieve 300 MW NRIS[2] (in addition to the 600 MW NRIS of GI-2016-3) provided the Pawnee – Daniels Park 345 kV project along with the Greenwood – Monaco 230 kV network upgrade identified for GI-2016-4 are in service. Prior to the Pawnee – Daniels Park 345 kV project being in-service, GI-2016-4 may be interconnected as ERIS[3] to deliver its output using the existing firm or non-firm transmission capacity on an "as available" basis.

Therefore, for GI-2016-4 interconnection:

Before Pawnee-Daniels Park project:

NRIS = 0 MW

ERIS = 0 to 300 MW on "as-available" basis

After Pawnee-Daniels Park project:

NRIS (before Monaco network upgrade) = 0 MW

ERIS (before Monaco network upgrade) = 0 to 299 MW on "as-available" basis

NRIS and/or ERIS (after Monaco network upgrade) = 300 MW

The estimated total cost for the transmission improvements needed for GI-2016-4 interconnection is **$14.057 million**.

As shown in **Tables 1 & 2** (see pages 13-14**)**, the $14.057 million cost includes:

- $14.035 million for PSCo-Owned, Interconnection Customer Funded Interconnection Facilities
- $0.022 million for PSCo Network Upgrades for Delivery

It is estimated that this work can be completed in approximately 48 months following receipt of authorization to proceed. The schedule assumes a Certificate of Public Convenience and Necessity (CPCN) would be required for construction of the 345 kV substation at the Rush Creek II site.

[2] Network Resource Interconnection Service allows Interconnection Customer 's Large Generating Facility to be designated as a Network Resource, up to the Large Generating Facility's full output, on the same basis as existing Network Resources interconnected to Transmission Provider's Transmission System, and to be studied as a Network Resource on the assumption that such a designation will occur. (*section 3.2.2 of Attachment N in Xcel Energy OATT*)

[3] Energy Resource Interconnection Service allows Interconnection Customer to connect the Large Generating Facility to the Transmission System and be eligible to deliver the Large Generating Facility's output using the existing firm or non-firm capacity of the Transmission System on an "as available" basis. Energy Resource Interconnection Service does not in and of itself convey any right to deliver electricity to any specific customer or Point of Delivery. (*section 3.2.1 of Attachment N in Xcel Energy OATT*)

The **$14.057 million** cost estimate is consistent with the conceptual one-line diagram shown in Figure 1 and is based on the following assumptions:

1. Interconnection Facilities and Network Upgrades for GI-2016-3 are in-service, and
2. GI-2016-4 will be constructed as a new Generating Facility and thus requires a dedicated 345kV bus position to interconnect to the existing GI-2016-3 Interconnection Facilities.

However, if the 300 MW generation capacity of GI-2016-4 is achieved with power uprate of the existing GI-2016-3 Generating Facility, then the second assumption above does not apply. Consequently, no new Interconnection Facilities will be needed and Table 1 would not be applicable for GI-2016-4. Consistent with the cost and schedule in Table 2, the total cost for GI-2016-4 interconnection would be **$0.022 million** and the work would be completed in approximately 18 months following receipt of authorization to proceed.

Power Flow N-1 Contingency Analysis

The 2021HS, 2017LS, and 2026 HS base cases were updated to dispatch the existing and planned generation within the Pawnee and Missile Site "generation pockets" (i.e. aggregate of generation in the local area) at their respective highest coincident output deemed appropriate for the planning of adequate transmission capacity. This was done in accordance with the generation dispatch assumptions practiced by PSCo Transmission Planning function to study the feasibility and system impact of generator interconnection requests as a Transmission Provider. Accordingly, the existing, planned and proposed generating plants at Pawnee and Missile Site stations were dispatched as noted below.

Pawnee local "generation pocket"

- ✓ Pawnee Fossil Fuel generation = 100% of rated capacity = 536 MW
- ✓ Manchief Gas generation = 90% of rated capacity = 252 MW
- ✓ Peetz Logan Wind generation = 40% of rated capacity = 230 MW

Aggregate Generation Dispatched at Pawnee in all Cases = 1018 MW

Missile Site local "generation pocket"

- ✓ Cedar Point (Missile Site 230kV) = 80% of rated capacity = 200 MW
- ✓ Limon I, II, III (Missile Site 345kV) = 80% of rated capacity = 480 MW
- ✓ GI-2016-3 (Missile Site 345kV) = 100% of rated capacity = 600 MW
- ✓ GI-2016-4 (Missile Site 345kV) = 100% of rated capacity = 300 MW

Aggregate Generation Dispatched at Missile Site in Benchmark Case = 1280 MW

Aggregate Generation Dispatched at Missile Site in Study Case(s) = 1580 MW

The GI-2016-4 *Benchmark Case* was derived from the 2021HS base case by changing the generation dispatch at Pawnee and Missile Site as noted above. Transmission facilities comprising the Pawnee – Daniels Park project were modeled in the case. Generation at Blue Spruce, Rocky Mountain Energy Center (RMEC), and Comanche was used to balance the PSCo area generation with the increased injection at Pawnee and Missile Site substations. The GI-2016-4 *Study Case* was created by adding the GI-2016-4 generation in the Benchmark Case and dispatching it at 300 MW rated output.

PSCo adheres to all applicable NERC Standards & WECC Criteria for Bulk Electric System (BES) acceptable performance, as well as its internal transmission planning criteria for all studies. During system intact (N-0) conditions, PSCo's steady-state performance criteria require the transmission bus voltages remain within 0.95 – 1.05 per unit of nominal and the power flows stay below the applicable normal ratings of the transmission facilities. Following a single contingency, the steady state bus voltages must remain within 0.90 – 1.05 per unit of nominal, and the power flows must continue to stay below the applicable normal facility ratings. For N-1 post-contingency system

conditions, the applicable normal rating is the seasonal continuous rating of the transmission facility – but PSCo allows use of eight-hour facility rating for transformers for which it is available. Further, PSCo does not rely on 30-minute emergency ratings of transmission facilities for meeting N-1 system performance in planning studies.

Based on the results of the steady-state power flow analyses provided in Table A.1 in the Appendix, it is evident that the Pawnee – Daniels Park 345 kV project's facilities are sufficient for delivery of the proposed 900 MW cumulative rated output of GI-2016-4 and GI-2016-3 interconnections. However, for the studied generation dispatch scenario, the 300 MW injection from GI-2016-4 will result in post-contingency overload of Greenwood – Monaco line-section of the Greenwood – Leetsdale 230 kV line due to the forced outage of the Smoky Hill – Leetsdale 230kV line. Therefore, increasing the thermal rating of the Greenwood – Monaco 230 kV line-section by replacing limiting substation equipment at Monaco is identified as the network upgrade for GI-2016-4.

Consequently, GI-2016-4 interconnection will achieve 300 MW NRIS[4] (in addition to the 600 MW NRIS of GI-2016-3) provided the Pawnee – Daniels Park 345 kV project and the Greenwood – Monaco 230 kV network upgrade are in service.
Prior to the Pawnee – Daniels Park 345 kV project being in-service, GI-2016-4 may be interconnected as ERIS[5] to deliver its output using the existing firm or non-firm transmission capacity on an "as available" basis.

Therefore, for GI-2016-4 interconnection:

Before Pawnee-Daniels Park project:

NRIS = 0 MW

ERIS = 0 to 300 MW on "as-available" basis

After Pawnee-Daniels Park project:

NRIS (before Monaco network upgrade) = 0 MW

ERIS (before Monaco network upgrade) = 0 to 299 MW on "as-available" basis

NRIS and/or ERIS (after Monaco network upgrade) = 300 MW

[4] Network Resource Interconnection Service allows Interconnection Customer 's Large Generating Facility to be designated as a Network Resource, up to the Large Generating Facility's full output, on the same basis as existing Network Resources interconnected to Transmission Provider's Transmission System, and to be studied as a Network Resource on the assumption that such a designation will occur. (*section 3.2.2 of Attachment N in Xcel Energy OATT*)

[5] Energy Resource Interconnection Service allows Interconnection Customer to connect the Large Generating Facility to the Transmission System and be eligible to deliver the Large Generating Facility's output using the existing firm or non-firm capacity of the Transmission System on an "as available" basis. Energy Resource Interconnection Service does not in and of itself convey any right to deliver electricity to any specific customer or Point of Delivery. (*section 3.2.1 of Attachment N in Xcel Energy OATT*)

Voltage Regulation and Reactive Power Capability

Interconnection Customers are required to interconnect their Large Generating Facilities with Public Service of Colorado's (PSCo) Transmission System in accordance with the *Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW* (available at: http://www.transmission.xcelenergy.com/staticfiles/microsites/Transmission/Files/PDF/Interconnection/Interconnections-POL-TransmissionInterconnectionGuidelineGreat20MW.pdf).
In addition, wind generating plant interconnections must also fulfill the performance requirements specified in FERC Orders 661-A and 827. Accordingly, the following voltage regulation and reactive power capability requirements at the POI are applicable to this interconnection request:

- To ensure reliable operation, all Generating Facilities interconnected to the PSCo transmission system are expected to adhere to the *Rocky Mountain Area Voltage Coordination Guidelines (RMAVCG)*. Accordingly, since the POI for this interconnection request is located within Northeast Colorado - Region 7 defined in the *RMAVCG*; the applicable ideal transmission system voltage profile range is 1.02 – 1.03 per unit at regulated buses and 1.0 – 1.03 per unit at non-regulated buses.
- Xcel Energy requires all Interconnection Customers to have the reactive capability to achieve +/– 0.95 power factor at the POI, with the maximum reactive capability (corresponding to rated output) available at all output levels. Furthermore, Xcel Energy requires all Generating Facilities to have dynamic voltage control capability and maintain the POI voltage specified by the Transmission Operator as long as the generating plant is on-line, producing power and it is not called upon to operate outside its 0.95 lag – 0.95 lead power factor range capability at the POI.
- 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 (34.5 kV or 345 kV bus) 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 and the 1.02 – 1.03 per unit voltage range standards at the POI. Further, for wind generating plants to meet the LVRT (Low Voltage Ride Through) performance requirements specified in FERC Order 661-A, an appropriately sized and located dynamic reactive power device (DVAR, SVC, etc.) may also need to be installed within the generating plant.
- 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 voltage ranges (noted above).

Short Circuit Analysis

The short circuit study results show that no circuit breakers in the Missile Site station (or any adjoining station) will be over-dutied by interconnecting the proposed GI-2016-4 wind generation facility.

GI-2016-4 Impact on Short Circuit Levels and Breaker Duty Margins at Missile Site 345 kV POI

System Condition	Three-Phase (3-Ph) Fault Level (Amps)	Single-Line-to-Ground (SLG) Fault Level (Amps)	Breaker Duty Margin for 3-Ph Fault	Breaker Duty Margin for SLG Fault
Before GI-2016-4 Y2019	17,000	16,020	73.0 %	74.6 %
After GI-2016-4 Y2019	17,341	16,220	72.5 %	74.25 %

Transient Stability Analysis

The transient stability analysis was performed using benchmark and study dynamics cases derived from the WECC 2020 Heavy Summer (2020HS) dynamics case created for use with the Siemens PTI PSSE software program. The benchmark dynamics case was updated to match the generation dispatch in the Pawnee and Missile Site area similar to the power flow cases discussed previously. The study dynamics case was developed by adding the GI-2016-3 and GI-2016-4 generating facilities and the transmission facilities comprising the Pawnee – Daniels Park project. Finally, the user model supplied by Vestas for its V110 VCSS 2.0MW wind turbine generators proposed to be installed in the GI-2016-3 and GI-2016-4 generating facilities was integrated into the study dynamics case.

The transient stability analysis consisted of verifying the stability performance for the most severe disturbance identified from the following eight normally cleared three-phase fault disturbances for which acceptable stability performance of the planned GI-2016-3 interconnection has already been verified.

A. NERC Category P1 (single contingency) Disturbances
   Three-phase, close-in fault at bus designated by asterisk (*) with normal clearing of 6 cycles
   1. Missile Site* – Pawnee #1 345 kV Line
   2. Missile Site* – Smoky Hill 345 kV Line
   3. Missile Site* – Daniels Park 345 kV Line
   4. Missile Site 345*/230 kV transformer

B. NERC Category P7 (common structure double contingency) Disturbances
   Three-phase, close-in fault at bus designated by asterisk (*) with normal clearing of 6 cycles
   1. Pawnee – Missile Site* #1 & #2 345 kV double circuit tower line

2. Missile Site* – Smoky Hill and Missile Site* – Daniels Park 345 kV double circuit tower line

Only one dynamic simulation was performed for disturbance B.2, which was identified as the most severe disturbance (i.e. worst contingency). The rationale for performing only one dynamic simulation is that if the GI-2016-4 interconnection demonstrates acceptable stability performance for the most severe disturbance, then it may be reasonably concluded that remaining seven disturbances must also exhibit acceptable stability performance. And dynamic simulations for these seven disturbances are only necessary if unacceptable stability performance is observed for the worst contingency.

The stability plot provided in Appendix C demonstrates that angular stability as well as LVRT (Low Voltage Ride-Through) performance of the GI-2016-4 interconnection is acceptable for the most severe disturbance B.2. Therefore, it is reasonable to conclude that none of the remaining seven normally cleared three-phase fault disturbances at Missile Site would result in tripping of the Vestas V110 VCSS 2.0MW wind turbine generators proposed for the GI-2016-4 generating facility. The transient stability results tabulated in Appendix B demonstrate that unacceptable/degraded stability performance does not occur due to the proposed GI-2016-4 interconnection.

Costs Estimates and Assumptions

Indicative level cost estimates (+/- 30% accuracy) for the Interconnection Facilities and Network Upgrades for Delivery were developed by Public Service Company of Colorado (PSCo) / Xcel Energy (Xcel) Engineering. Cost estimates are in 2016 dollars with escalation and contingency factors included. Cost estimates are developed assuming typical construction costs for previous completed projects. This cost estimate does not include the cost for any other Customer owned equipment and associated design and engineering.

Figure 1 below is the conceptual one-line of the GI-2016-4 interconnection to the Rush Creek—Missile Site 345kV Transmission Line (Gen-Tie) planned to be constructed and placed in-service for the planned GI-2016-3 interconnection.

Figure 2 below is the one-line drawing that depicts the transmission improvements comprising the Interconnection Facilities and the Network Upgrades at Missile Site Substation 345 kV switchyard planned to be constructed and placed in-service for the planned GI-2016-3 interconnection.

Tables 1 & 2 below list the transmission improvements needed to accommodate the interconnection and delivery of GI-2016-4 generation output as NRIS.
The estimated total cost for the needed transmission improvements is **$14.057M**

The **$14.057 million** cost estimate is consistent with the conceptual one-line diagram shown in Figure 1 and is based on the following assumptions:

1. Interconnection Facilities and Network Upgrades for GI-2016-3 are in-service, and
2. GI-2016-4 will be constructed as a new Generating Facility and thus requires a dedicated 345kV bus position to interconnect to the existing GI-2016-3 Interconnection Facilities.

However, if the 300 MW generation capacity of GI-2016-4 is achieved with power uprate of the existing GI-2016-3 Generating Facility, then the second assumption above does not apply. Consequently, no new Interconnection Facilities will be needed and Table 1 would not be applicable for GI-2016-4. Consistent with the cost and schedule noted in Table 2, the total cost for GI-2016-4 interconnection would be **$0.022 million** and the work would be completed in approximately 18 months following receipt of authorization to proceed.

The cost responsibilities associated with these facilities are as per current FERC guidelines. These cost estimates are subject to change upon a more detailed and refined design that will be developed as part of the Facilities Study.

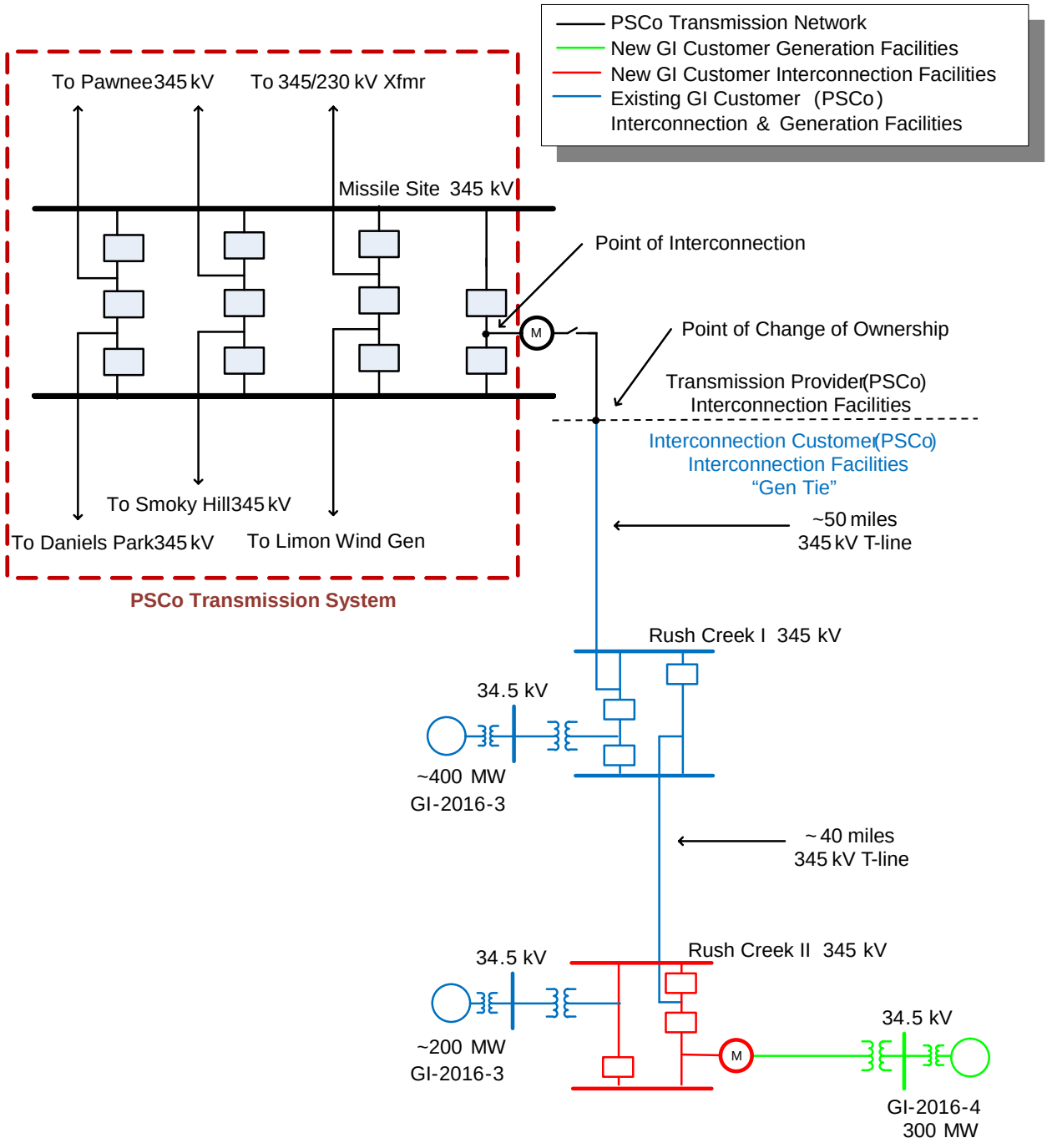


Figure 1 Conceptual One-Line for GI-2016-4 Interconnection

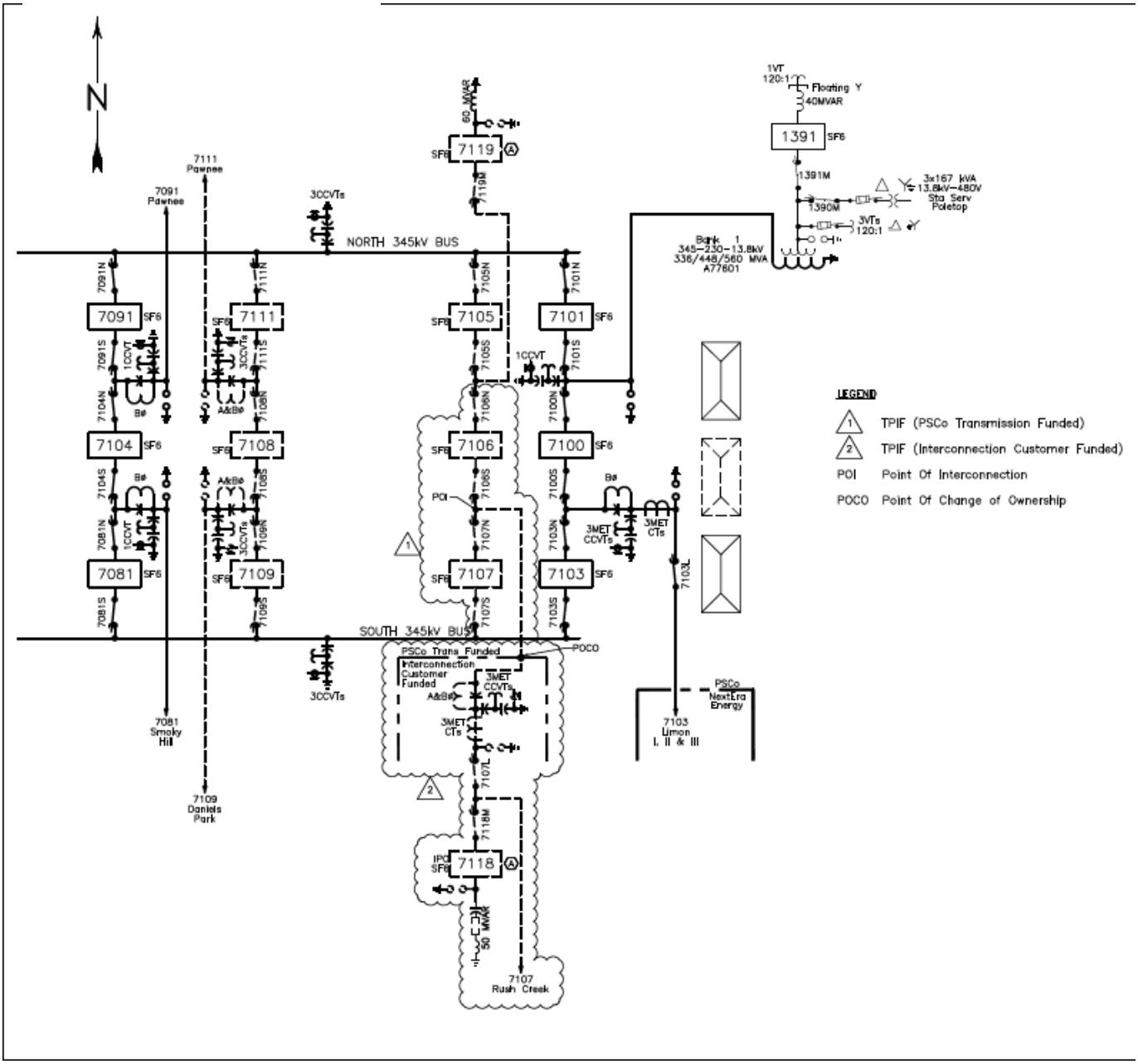


Figure 2 One-Line of Missile Site 345kV Transmission Facilities assumed to be In-Service for GI-2016-4

Table 1: PSCo Owned; Interconnection Customer Funded Interconnection Facilities

Facility	Description	Cost Estimate (Millions)
PSCo's New Rush Creek II 345 kV Station	Three-position ring-bus 345kV station needed to interconnect the new Generating Facility to the planned Rush Creek-Missile Site (L7132) 345kV Transmission Line. The new equipment includes: • Three 345kV circuit breakers • Six 115kV disconnect switches • Six 345kV CCVT's • Four 345kV line traps/tuner equipment • 345kV arresters • New Electric Equipment Enclosure (Control Bldg.) • New station battery system • Station controls • Associated communications, supervisory and SCADA equipment • Associated line relaying and testing • Associated bus, miscellaneous electrical equipment, cabling and wiring • Associated foundations and structures • Associated road and site development, fencing and grounding	**$12.03**
	Interconnect the last span of Transmission Line from new Generating Facility into the new 345 kV station. The new equipment includes: • Two 345kV disconnect switches • 345kV arresters • One set (of 3) 345kV CT/PT metering units • Two 345kV line traps/tuner equipment • Station controls • Instrument transformers • Associated bus, wiring and equipment • Associated site development, grounding, foundations and structures • Associated transmission line communications, relaying and testing	**$1.665**
	Load Frequency/Automated Generation Control (LF/AGC) RTU and associated equipment.	**$0.300**
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction.	**$0.040**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$14.035**
Time Frame	**Regulatory (CPCN), site, design, procure and construct**	**48 Months**

Table 2: PSCo Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
PSCo's Monaco 230kV Transmission Substation	Upgrade/replace limiting substation equipment to achieve required MVA ratings on circuit 5281 Monaco-Greenwood OH/UG Line: • Six - 1272 dual jumpers	**$0.022**
	Total Cost Estimate for PSCo Network Upgrades for Delivery Facilities	**$0.022**
Time Frame	**Design, procure and construct**	**18 months**

Cost Estimate Assumptions

- Indicative level project cost estimates for Interconnection Facilities and Infrastructure Upgrades for Delivery, PSCo Funded Network Upgrades for Delivery (with no level of accuracy) were developed by PSCo Engineering
- Estimates are based on 2016 and similar type projects.
- AFUDC has been excluded.
- Labor is estimated for straight time only – no overtime included.
- Lead times for materials were considered for the schedule.
- The Generation Facility is not in the PSCo retail service territory. Therefore, no costs for retail load (distribution) facilities and metering required for station service are included in these estimates. .
- Assuming the substation land acquisition (40 acres) planned for Xcel's project will be sufficient for this project substation expansion and build-out. No additional land required.
- Assuming a 3-breaker ring installation with required relaying, interconnection and communications facilities.
- PSCo (or our Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo-owned and maintained facilities.
- Assuming a CPCN will be required. The estimated time frame for regulatory activities (CPCN) and to site, design, procure and construct the interconnection and network delivery facilities (entire Project) is approximately 48 months after authorization to proceed has been obtained.
- 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 / Xcel will need indications, readings and data from the LFAGC RTU.
- The Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- Short Circuit Current study determined that no breaker replacements are needed in neighboring substations.

Appendix A – Power Flow N-1 Contingency Analysis Results

2021 Heavy Summer Case

High Coincidence Generation Dispatch at Pawnee & Missile Site:

Pawnee 230kV (100% Coal + 90% Gas + 40% Wind) = 1018 MW;
Missile Site 345kV Wind = 480 MW (80%); Missile Site 230kV Wind = 200 MW (80%)
600 MW output from GI-2016-3 is dispatched to sink at BlueSpruce (268 MW), RMEC (147 MW) & Comanche (185 MW)
300 MW output from GI-2016-4 is dispatched to sink at Spindle, RMEC & Comanche

Table A.1 – Differential Impact[6] of GI-2016-4 on Facility Loadings
With GI-2016-3 Network Upgrades (i.e. Pawnee – Daniels Park 345kV Project) In Service

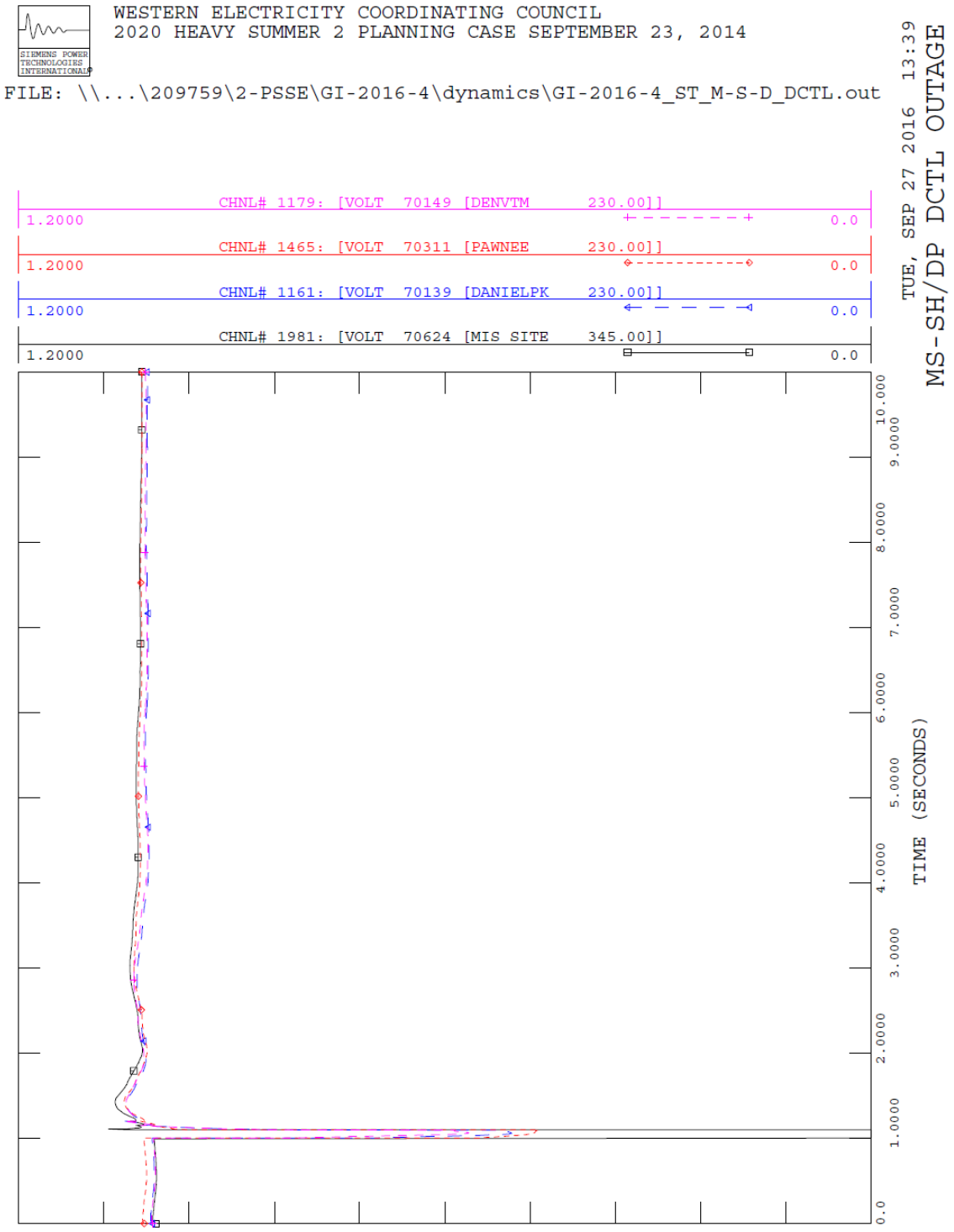
				Branch N-1 Loading Before 300 MW GI (600 MW Total Injection)		Branch N-1 Loading After 300 MW GI (900 MW Total Injection)			
Monitored Facility (Line or Transformer)	Type	Owner	Summer Normal (Continuous) Facility Rating in MVA	Flow in MVA	Flow in % of Summer Normal Rating	Flow in MVA	Flow in % of Summer Normal Rating	Differential Impact of GI-2016-4	N-1 Contingency Outage
Greenwood – Monaco 230kV	Line	PSCo	404	404.0	100.0%	440.4	109%	9%	Smoky Hill – Leetsdale 230 kV

[6] **Due to proposed 300 MW generation increase at Missile Site 345 kV Station**

Appendix B – Transient Stability Analysis Results

Stability Disturbances							
#	Fault Location	Fault Type	Facility Tripped	Clearing Time (cycles)	Stability Performance	Post-Fault Voltage Recovery	Angular Stability
1	Missile Site 345 kV	3ph	Missile Site – Smoky Hill and Missile Site – Daniels Park 345 kV double circuit tower lines (DCTL)	Primary (6.0)	Acceptable	Maximum transient voltage dips within WECC criteria	No generator tripped & positive damping
2	Missile Site 345 kV	3ph	Missile Site – Pawnee 345kV Line	Primary (6.0)	Acceptable*	Acceptable*	Acceptable*
3	Missile Site 345 kV	3ph	Missile Site – Smoky Hill 345kV Line	Primary (6.0)	Acceptable*	Acceptable*	Acceptable*
4	Missile Site 345 kV	3ph	Missile Site – Daniels Park 345kV Line	Primary (6.0)	Acceptable*	Acceptable*	Acceptable*
5	Missile Site 345 kV	3ph	Missile Site 345/230 kV Auto-Transformer	Primary (6.0)	Acceptable*	Acceptable*	Acceptable*
6	Missile Site 345 kV	3ph	Missile Site – Pawnee #1, #2 345 kV double circuit tower lines (DCTL)	Primary (6.0)	Acceptable*	Acceptable*	Acceptable*

Acceptable* denotes results are inferred by applying engineering judgment based on the verified stability simulation results for disturbance 1.


WESTERN ELECTRICITY COORDINATING COUNCIL
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