

Cluster 1 Congestion Assessment

Southwest/Calgary Cluster [SWCAL-01]

Date: June 26, 2024

Version: V1

Classification: Public

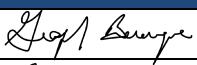


Role	Name	Date	Signature
Prepared	Geoff Bourque, P.Eng., M.Sc.	2024-06-26	
Reviewed	John Waenink, P.Eng.	June 26, 2024	
Approved	Jasmin Judge, P. Eng., MBA, PMP	June 26, 2024	

Table of Contents

Table of Contents	ii
1. Introduction.....	1
2. Method	1
3. Assumptions	2
3.1 Study Period.....	2
3.2 Scenarios	2
3.3 Generation and Demand	3
3.4 Transmission Topology	4
4. Results	4
4.1 Post-PIC Scenario.....	5
4.2 Pre-Cluster Scenario	7
4.3 Post-Cluster Scenario	9
4.4 Trends in Supply Surplus	11
5. Conclusions	12
Attachment A	13

1. Introduction

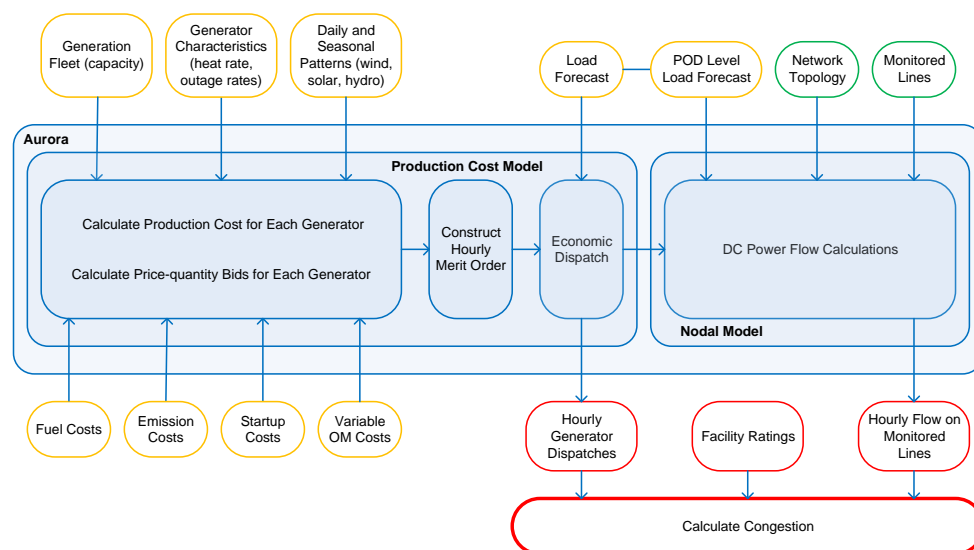
This report documents the Congestion Assessment for the projects in the Southwest/Calgary cluster region (the Region).

Congestion occurs when the transmission system cannot accommodate all in-merit generation, because the resulting power flows would contravene reliability standards and/or ISO rules.¹ This Congestion Assessment forecasts congestion that may occur in the Region under three scenarios. This report also summarizes observations regarding supply surplus within the congestion modelling.

2. Method

The congestion assessment combines a production cost model with a transmission system network model. The production cost model simulates the hourly energy market economic dispatches required to supply the forecasted hourly demand. Then, the transmission system network model calculates the hourly power flows on each transmission facility that result from the hourly energy market dispatches and demand. Finally, congestion is calculated by comparing the hourly power flows on each transmission facility with its respective facility rating. Figure 1 illustrates the inputs and processes involved in the congestion assessment.

Figure 1 - Congestion Assessment Process



The Congestion Assessment forecasts the potential congestion resulting from thermal violations of normal facility ratings under the Category A condition and pre-contingency curtailment to prepare for select Category B conditions (contingencies) of 924L and 927L. Generation is dispatched as if the transmission system had no constraints and then the resulting power flows are compared to their respective facility ratings to identify congestion. For select pre-contingency curtailment, the resulting post-contingency power flows are compared to adjusted facility ratings that estimate the post-contingency system performance.

Except for select contingencies, the assessment does not forecast the potential congestion caused by curtailment to prepare for contingencies, most severe single contingency limits, or congestion

¹ The reliability standards and ISO rules are available on the AESO website.

associated with voltage or transient stability criteria violations. These items could increase the risk of congestion.

3. Assumptions

The Congestion Assessment forecasts congestion that may occur in the Region for the following assumptions.

3.1 Study Period

The Congestion Assessment studied all 8784 hours in the study year of 2028 to forecast congestion.

The Congestion Assessment assumes any modelled generating unit or transmission system project are in service prior to January 1st, 2028. Thus, every modelled generating unit and transmission system project were simulated as in-service for all of calendar year 2028.

3.2 Scenarios

The Congestion Assessment forecasts congestion that may occur in the Region within three scenarios:

- i) **Post-PIC:** assumes projects that have met the project inclusion criteria² (PIC) across the entire province are energized;
- ii) **Pre-cluster:** assumes post-PIC plus all Connection Assessment (CA) modelled projects³ within the Region are energized; and
- iii) **Post-cluster:** assumes pre-cluster plus Cluster 1 projects within the Region are energized.

Projects were included in the different scenarios as per the *AESO Connection Project List*^{4 5} from April 2024. The scenarios are reiterated in Table 1.

Table 1 – Projects Included in each Scenario

Scenario	In-flight Projects ⁶		Cluster Projects ⁷
	Projects that have met PIC across the province	CA Modelled Projects in the Region	Cluster Projects in the Region
Post-PIC	Yes	No	No
Pre-Cluster	Yes	Yes	No
Post-Cluster	Yes	Yes	Yes

² The definition of project inclusion criteria is available in the Connection Project List Guide on the AESO website.

³ For the purpose of this assessment, CA Modelled projects are the non-Cluster 1 projects which are included in the assessment. The definition of CA modelled projects is available in the Connection Project List Guide on the AESO website.

⁴ The AESO Connection Project List is available on the AESO website.

⁵ P2441 Halkirk 2 had not reached project inclusion criteria as of the April connection project list, but met the criteria in mid-April. It is included in post-PIC results.

⁶ CA Modelled projects outside the Region are not included in any scenario in this report.

⁷ Cluster projects outside the Region are not included in any scenario in this report.

3.3 Generation and Demand

Generation

Table 2 provides the total, province wide installed generation capacity modelled in each scenario. The post-PIC scenario includes all existing generators. However, the pre-cluster and post-cluster scenarios only add generating units to the Region.

Table 2 – Assumed Installed Generation Capacity

Technology	Post-PIC (MW)	Pre-Cluster (MW)	Post-Cluster (MW)
Wind ⁸	6,064	+610	+153
Solar ⁹	3,535	+2,008	+894
Energy Storage ¹⁰	383	+280	+954
Thermal	14,280	0	+51
Hydro	894	0	0
Other	444	0	0
Additions		+2,898	+2,052
Total	25,600	28,498	30,550

Wind generating units were dispatched following forecasted hourly wind profiles which account for varying weather patterns and geographic locations.

Solar generating units were dispatched following forecasted hourly solar profiles which account for varying solar irradiance, weather patterns, geographic locations, and solar panel characteristics.

Energy storage assets were divided into three groups:

1. Hybrid assets, i.e. energy storage co-located with another generating unit. These storage units were modelled to only charge from their respective co-located generating units and discharge based on pool price.
2. Storage assets that are assumed to provide ancillary services. These storage generating units were modelled to not dispatch in the energy market.
3. Storage assets that are assumed to provide energy market dispatches. These storage generating units were modelled to optimize charging and discharging based on pool price arbitrage.

Each remaining generating unit was dispatched using production cost modelling which accounts for the costs and characteristics of its technology type.

⁸ This includes wind generating units with hybrid storage. The storage, which charges from the wind generating unit, is not included in the total generation capacity.

⁹ This includes solar generating units with hybrid storage. The storage, which charges from the solar generating unit, is not included in the total generation capacity.

¹⁰ This includes the storage component of hybrid generating units with either wind and energy storage or solar and energy storage.

In the event of supply surplus, partial volume dispatches of \$0 offers were assigned pro-rata to the generating units according to Section 202.5 of the ISO Rules, *Supply Surplus*.¹¹

Demand

Demand was modelled at each point of delivery following the *2024 Long Term Outlook*.¹²

3.4 Transmission Topology

The transmission system topology was modelled as per the existing transmission system with the following additions:

1. Connection projects were included using the AESO-preferred connection alternative.
2. *Central East Transfer-Out Transmission Development*¹³ (CETO) Stage 2 was included.
3. *Vauxhall Area Transmission Development*¹⁴ (VATD) was included.

All of the above transmission system topology additions were assumed in-service before January 1st, 2028.

The existing facility ratings, provided by the legal owners of transmission facilities, were assumed in the transmission system model, except for the facility ratings that will be modified by any of the above additions.

Congestion is reported for transmission facilities in the Region that operate at 69 kV and above. Transformers are only reported if both sides of a transformer's voltage are at 69 kV and above.

4. Results

The Congestion Assessment forecasts the potential congestion resulting from thermal violations of normal facility ratings under the Category A condition and pre-contingency curtailment to prepare for select Category B conditions of 924L and 927L. Except for select contingencies, the assessment does not forecast the potential congestion caused by pre-contingency curtailment, most severe single contingency limits, or congestion associated with voltage or transient stability criteria violations.

The Congestion Assessment provides forecasted congestion frequency, congested energy, and the maximum loading on lines within the Region.

Note: The total amount of congested energy in a region is not the sum of all of the congested energy on the transmission facilities. This is because when a generating unit is curtailed, it may affect flows on multiple lines with different effectiveness. For example, 1,000 MWh of curtailed energy at a specific generator may prevent overloads on two transmission facilities that report 1,000 MWh and 500 MWh of congested energy. In this hypothetical example, taking 1,000 MWh of action at a generator leads to 1,500 MWh of Congested Energy relief on transmission facilities.

The Congestion Assessment does not consider which generating units would be curtailed; all real-time curtailments are subject to Section 302.1 of the ISO Rules, *Real Time Transmission Constraint Management*.¹⁵

¹¹ ISO Rule 202.5 – *Supply Surplus* is available on the AESO website.

¹² The *2024 LTO* is available on the AESO website.

¹³ AUC Decision 25469-D01-2021

¹⁴ AUC Decision 27776-D01-2023

¹⁵ ISO Rule 302.1 – *Real Time Transmission Constraint Management* is available on the AESO website.

The results are provided in the following sections for the three scenarios (as defined in Section 3.2): post-PIC, pre-cluster, and post-cluster. In addition, this report also summarizes observations regarding supply surplus within the congestion modelling.

4.1 Post-PIC Scenario

Figure 2 illustrates the forecasted congestion frequency and Figure 3 illustrates the forecasted congested energy. The results are provided in tabular format in Attachment A.

In this scenario, congestion is observed on 924L/927L (102S Langdon – 356S Milo), a transfer-out path for generation in the Southeast and Southwest. Congestion is also observed on 225L (229S Glenwood – 385S Spring Coulee) in the Glenwood area, as well as on 180L (15S Fort Macleod – 180AL Tap).

Figure 2 – Post-PIC Congestion Frequency Heatmap

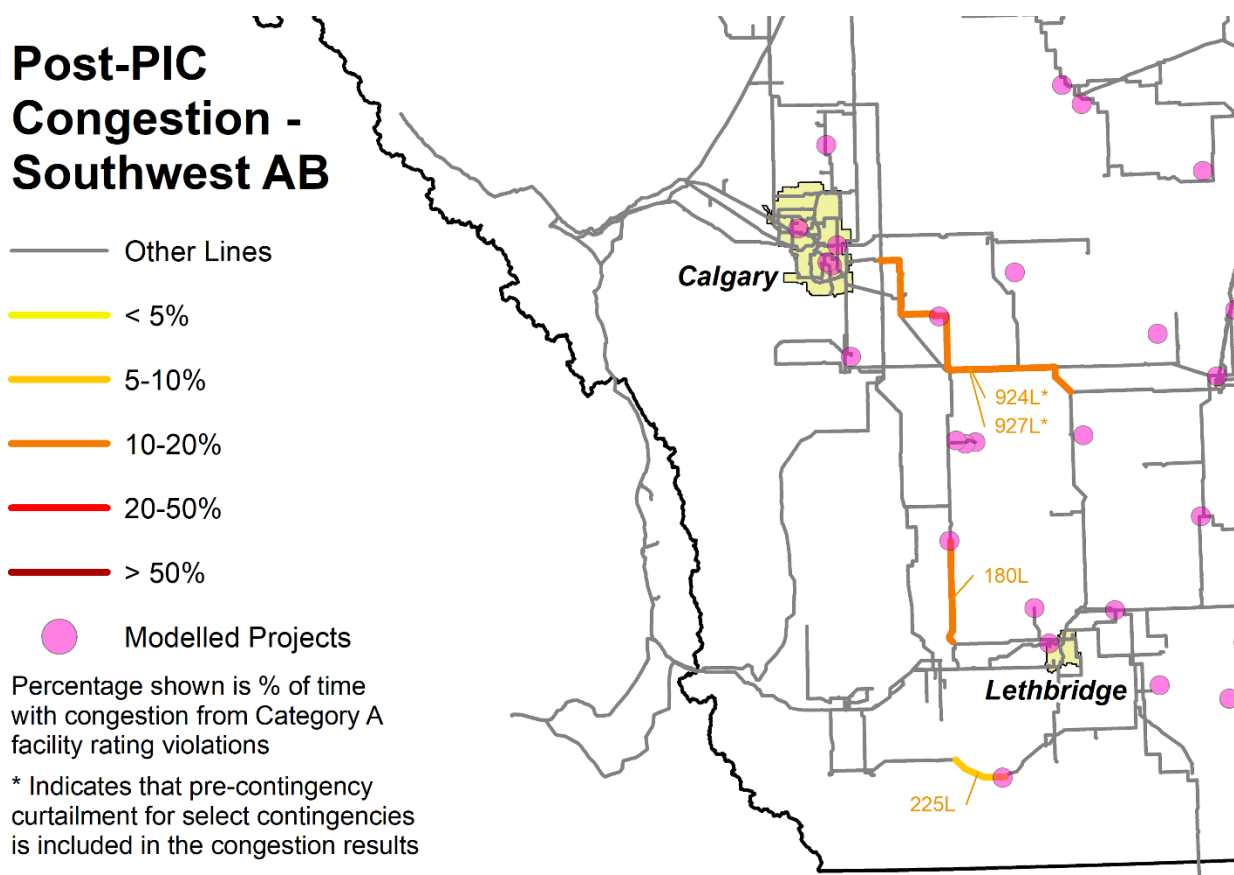
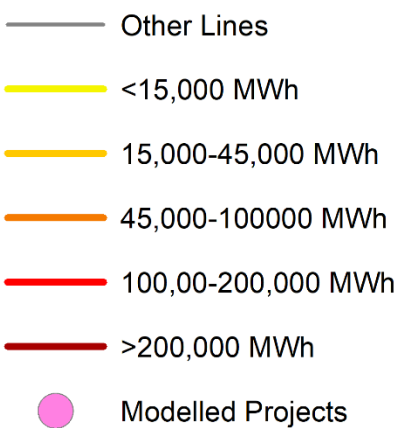


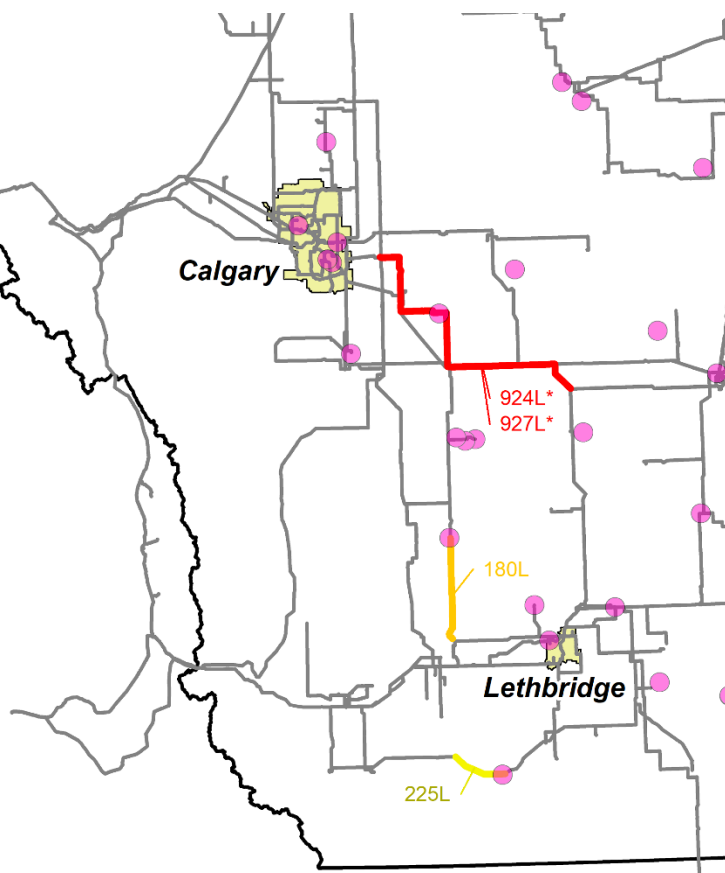
Figure 3 – Post-PIC Congested Energy Heatmap

Post-PIC Congestion - Southwest AB



Congested energy (MWh) is the energy exceeding the facility rating with congestion from Category A facility rating violations

* Indicates that pre-contingency curtailment for select contingencies is included in the congestion results



4.2 Pre-Cluster Scenario

Figure 4 illustrates the forecasted congestion frequency and Figure 5 illustrates the forecasted congested energy. The results are provided in tabular format in Attachment A.

In this scenario, when compared to the post-PIC scenario, congestion increases on the 924L/927L path, and is observed on transmission lines entering Calgary. This includes 138 kV transmission lines 733L (151S Strathmore - 428S Namaka) and 765L (151S Strathmore - 419S Chestermere) in the Strathmore/Blackie area, as well as on the 1080L/1109L (SS-65 - SS-25 Shepard) path. Congestion is also observed on 1005L (356S Milo - 1005AL Tap) in this scenario.

Figure 4 – Pre-Cluster Congestion Frequency Heatmap

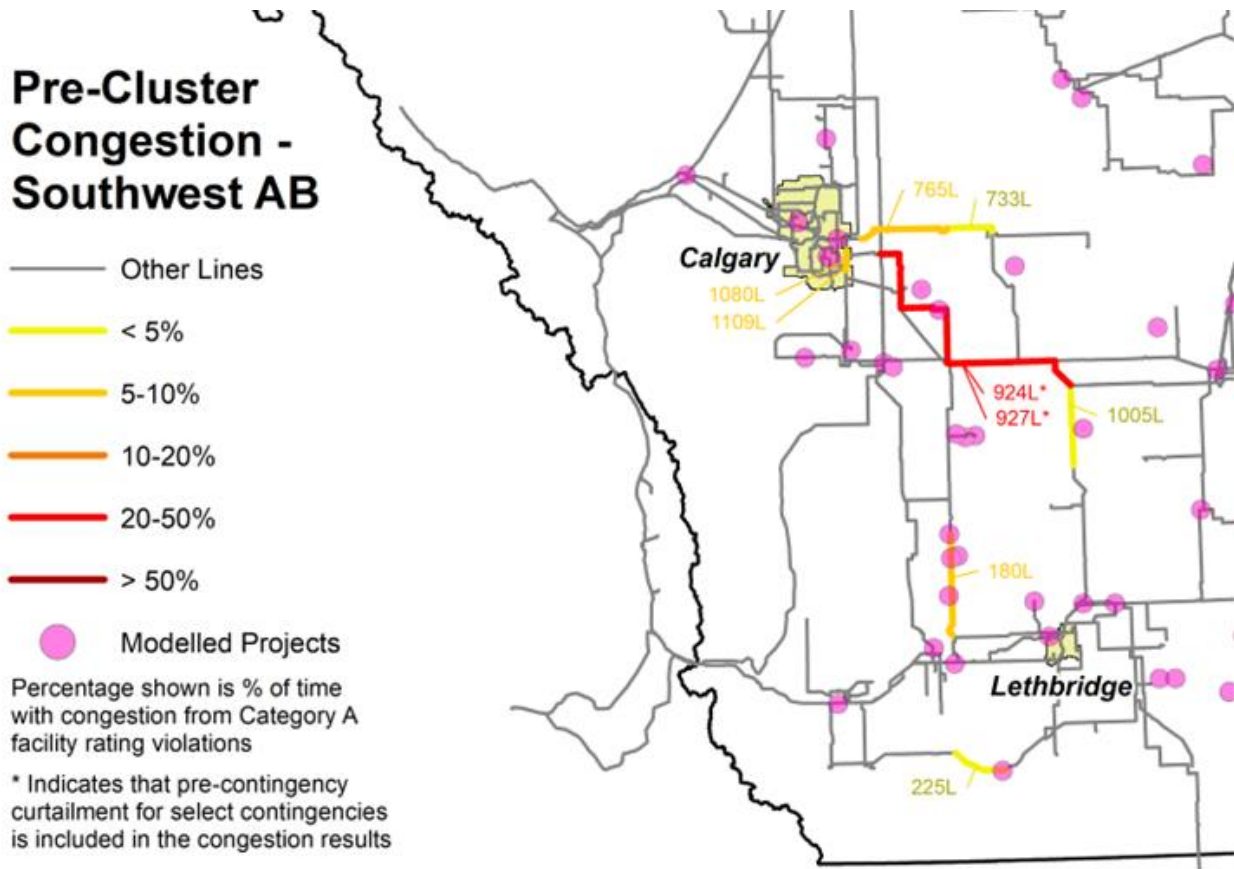
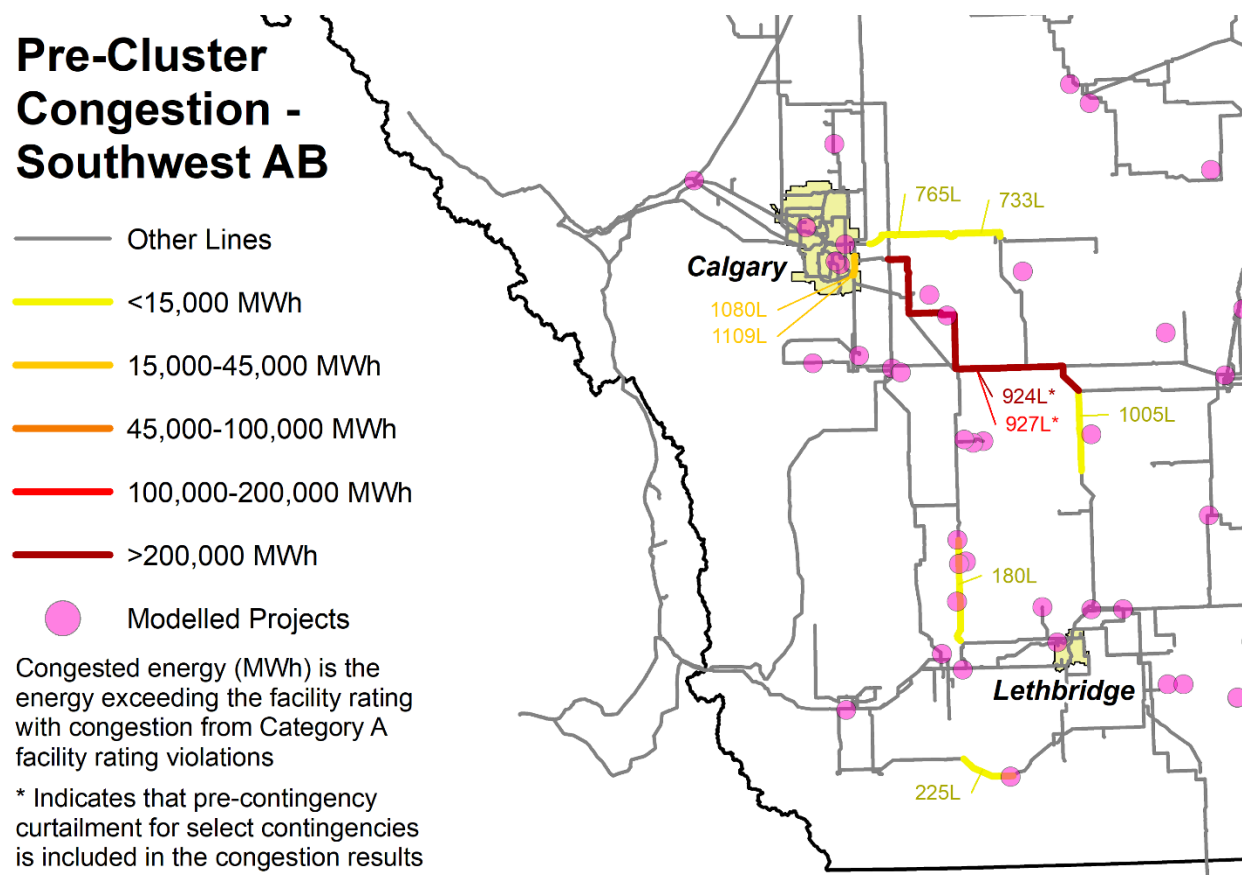


Figure 5 – Pre-Cluster Congested Energy Heatmap



4.3 Post-Cluster Scenario

Figure 6 illustrates the forecasted congestion frequency and Figure 7 illustrates the forecasted congested energy. The results are provided in tabular format in Attachment A.

In this scenario, when compared to pre-cluster, congestion is observed on additional 138 kV and 240 kV transmission lines entering the Calgary area. This includes additional transmission lines in the Strathmore/Blackie area as well as the 240 kV path from the south including 1106L/1107L (SS-65 – 237S Foothills) and 1038L (237S Foothills – 266S SC1). Due to projects connecting in planning areas 53 – Fort Macleod and 55 – Glenwood, congestion is also observed at the 138 kV to 240 kV transformer at 59S Peigan.

Figure 6 – Post-Cluster Congestion Frequency Heatmap

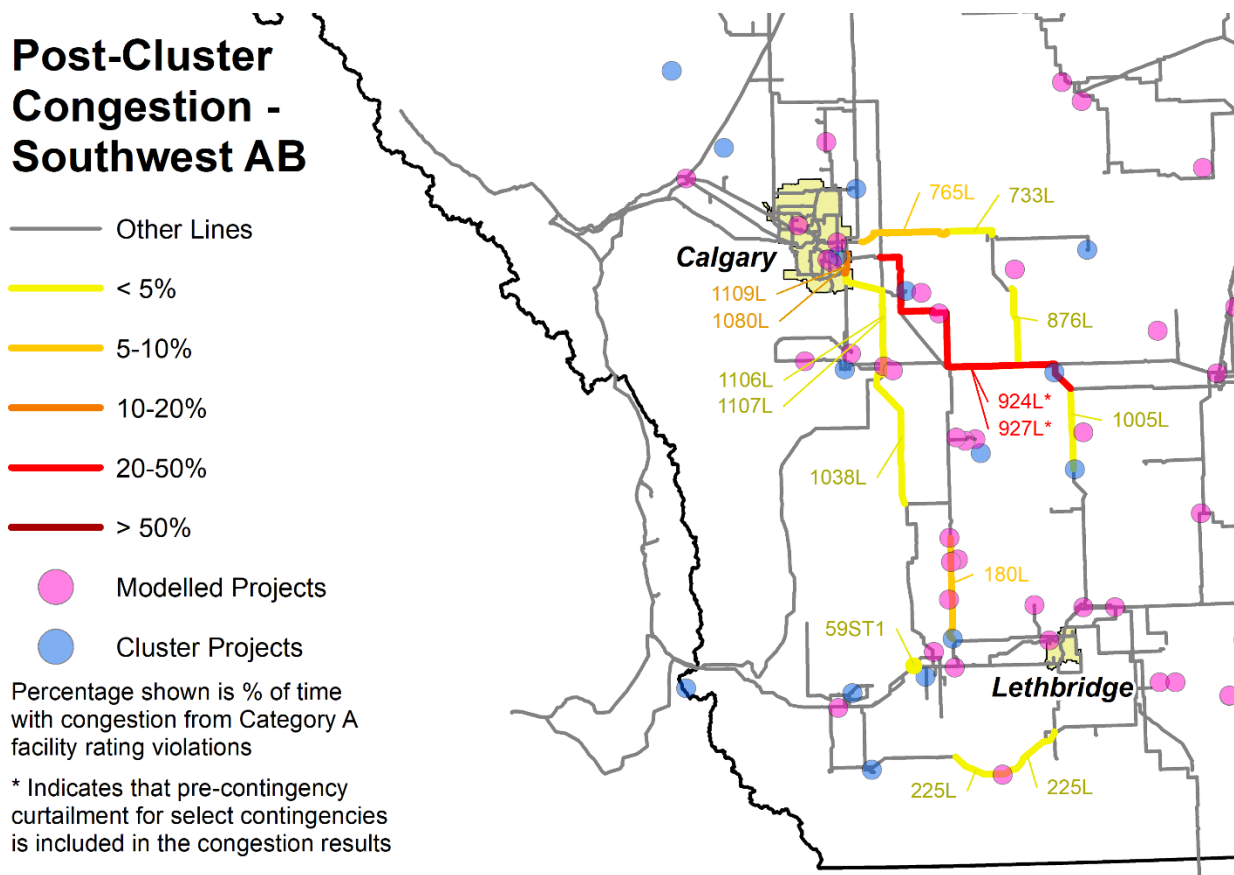


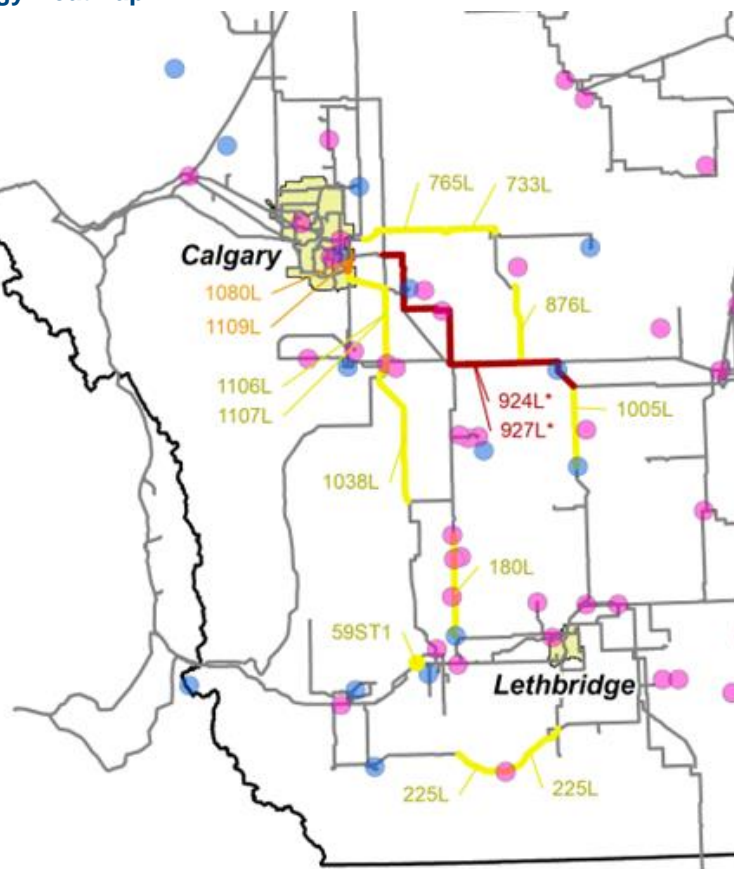
Figure 7 – Post-Cluster Congested Energy Heatmap

**Post-Cluster
Congestion -
Southwest AB**

- Other Lines
- <15,000 MWh
- 15,000-45,000 MWh
- 45,000-100,000 MWh
- 100,000-200,000 MWh
- >200,000 MWh
- Modelled Projects
- Cluster Projects

Congested energy (MWh) is the energy exceeding the facility rating with congestion from Category A facility rating violations

* Indicates that pre-contingency curtailment for select contingencies is included in the congestion results



4.4 Trends in Supply Surplus

Supply surplus occurs when there is more \$0 energy offered into the market than what is required to meet demand (including exports). Supply surplus results in partial-volume dispatches of flexible \$0 offers. In contrast, congestion occurs when in-merit generation cannot be dispatched due to constraints on the transmission system, which results in generation curtailment.

Both supply surplus and congestion can impact a generating unit's ability to provide energy to the market. In order to forecast congestion, the assessment completes an economic dispatch, which includes calculating partial-volume dispatches of \$0 offers during conditions of supply surplus. Energy that has only been partially dispatched during a supply surplus condition is not recorded as congested energy. Rather, these partial-volume dispatches decrease the generation that would make it to the local transmission system and potentially be congested. **Therefore, supply surplus influences congestion results and potentially understates the forecasted congestion if the supply surplus does not occur.**

Supply surplus results are sensitive to the assumptions of load and generation growth and are therefore provided for understanding of how these will affect congestion results. Supply surplus does not depend on the configuration or capability of the transmission system. Within the models for all cluster regions, the occurrence of supply surplus events and the volume of energy partially dispatched increases as the growth of supply that offers at \$0 exceeds the growth of demand. This directional increase of supply surplus with variable renewable generation growth is shown in Table 3.

Table 3 – Supply Surplus Frequency and Foregone Energy

Installed Capacity (MW)	Technology	% of Time	% of Energy Foregone
Total: 25,600 Wind: 6,000 Solar: 3,500	Solar	3	1
	Wind	3	1
	Total	3	1
Total: 29,300 Wind: 6,700 Solar: 6,500	Solar	12	5
	Wind	12	2
	Total	12	3
Total: 32,600 Wind: 7,400 Solar: 8,000	Solar	16	8
	Wind	17	4
	Total	18	6
Total: 38,800 Wind: 9,000 Solar: 10,900	Solar	31	26
	Wind	41	14
	Total	41	19
Total: 56,900 Wind: 11,500 Solar: 20,100	Solar	39	48
	Wind	61	33
	Total	61	40

5. Conclusions

The Congestion Assessment forecasts the congestion for three scenarios: post-PIC, pre-cluster, and post-cluster.

- Congestion is forecasted in post-PIC scenario, primarily on the 924L/927L path from 356S Milo to 102S Langdon.
- The addition of in-flight and cluster projects increases congestion compared to the post-PIC scenario and introduces new congestion risks on lines in the Region. These results introduce localized congestion risks as well as increased risk of congestion on transfer-out paths.
- The occurrence of supply surplus events and foregone energy increases with additional generating units.

Attachment A

Table A1 – Congestion Assessment Detailed Results

Transmission Line	Nominal Rating (MW) ¹⁶		Post-PIC		Pre-Cluster		Post-Cluster	
	Sum.	Wint.	Frequency (%)	Energy (MWh)	Frequency (%)	Energy (MWh)	Frequency (%)	Energy (MWh)
1005L (356S Milo – 1005ALTap)	523	647			1	1,700	1	2,000
1038L (237S Foothills – 266S SC1)	924	1148					1	2,200
1080L (SS-65 – SS-25 Shepard)	463	574			5	25,000	11	72,000
1106L (SS-65 – 237S Foothills)	922	1147					1	2,900
1107L (SS-65 – 237S Foothills)	922	1147					1	2,100
1109L (SS-65 – SS-25 Shepard)	463	574			5	25,000	11	74,000
180L (15S Fort Macleod – 180ALTap)	114	141	11	29,000	7	11,000	6	9,600
225L (229S Glenwood – 385S Spring Coulee)	21	25	9	2,700	1	300	1	400
225L (385S Spring Coulee – 225S Magrath)	23	23					1	200
59ST1 (59S Peigan)	170	170					1	700
733L (151S Strathmore - 428S Namaka)	114	141			1	700	2	1,200
765L (151S Strathmore – 419S Chestermere)	114	141			5	3,800	7	6,500
876L (253S Blackie – 179S Gleichen)	105	118					1	500
924L* (102S Langdon – 356S Milo)	520	642	17	180,000	25	260,000	30	350,000
927L* (102S Langdon – 356S Milo)	547	675	13	130,000	21	200,000	27	270,000

* For these lines, pre-contingency curtailment for select contingencies is included in the congestion results. The results for 924L include pre-contingency curtailment in the event of a 927L contingency; the results for 927L include pre-contingency curtailment for a 924L contingency.

¹⁶ Facility ratings are converted from MVA to MW assuming a power factor of 0.95.