

Cluster 1 Congestion Assessment

Southeast Cluster [SE-01]

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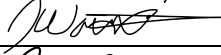

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1. Introduction

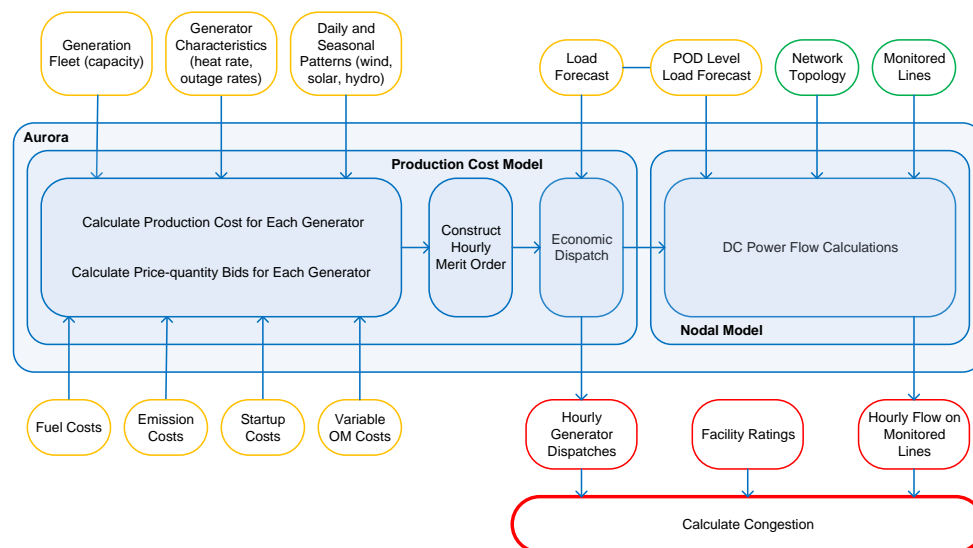
This report documents the Congestion Assessment for the projects in the Southeast cluster region (the Region).

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, 927L, 1034L, and 1035L. 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.

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

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 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 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	+620	+721
Solar ⁹	3,535	+2,960	+1,500
Energy Storage ¹⁰	383	+100	+1,096
Thermal	14,280	0	+47
Hydro	894	0	0
Other	444	0	0
Additions		+3,680	+3,364
Total	25,600	29,280	32,644

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, 927L, 1034L, and 1035L. 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 the post-PIC scenario, congestion is observed in the Region. The most material congestion is forecasted on the 240 kV transfer-out path comprised of transmission lines 1034L/1035L (244S Bowmanton - 324S Cassils/2075S Newell) and 924L/927L (102S Langdon – 356S Milo), for which both include congestion due to pre-contingency curtailment. Localized congestion is also observed on 138 kV transmission lines near generating units.

Figure 2 – Post-PIC Congestion Frequency Heatmap

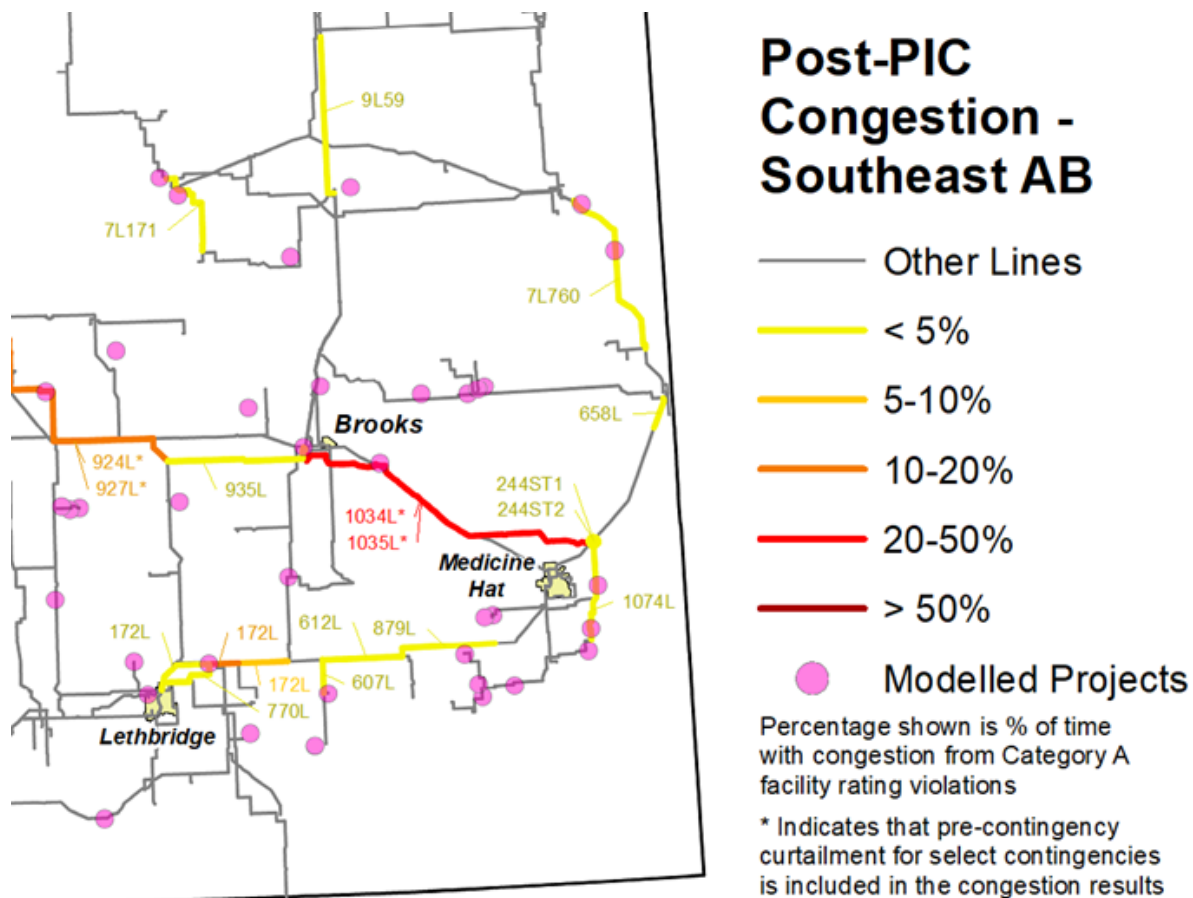
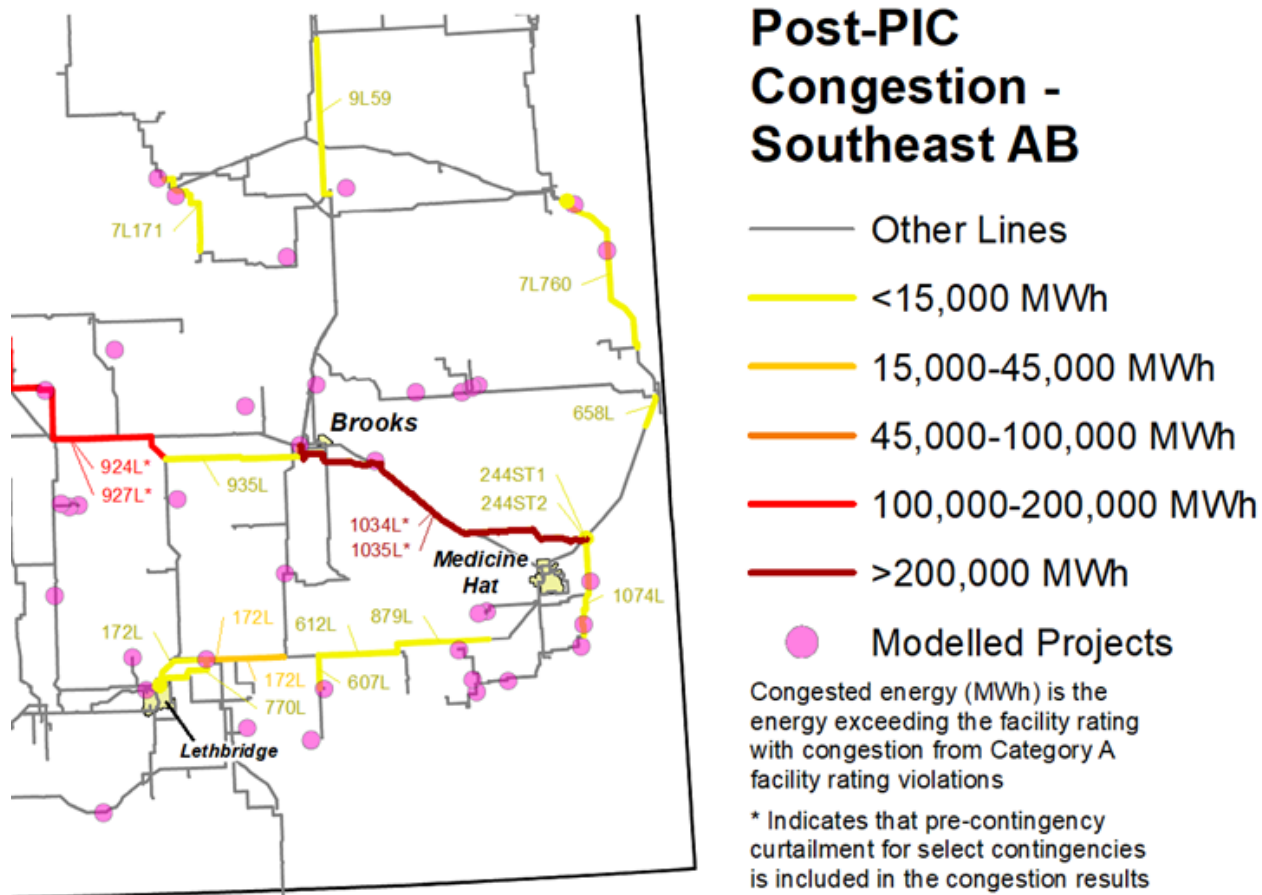


Figure 3 – Post-PIC Congested Energy Heatmap



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 the pre-cluster scenario, increased congestion is observed on most of the transmission lines identified in the post-PIC scenario. New congestion risks are also observed, most notably on the 240 kV transmission line 923L (356S Milo – 2075S Newell).

Figure 4 – Pre-Cluster Congestion Frequency Heatmap

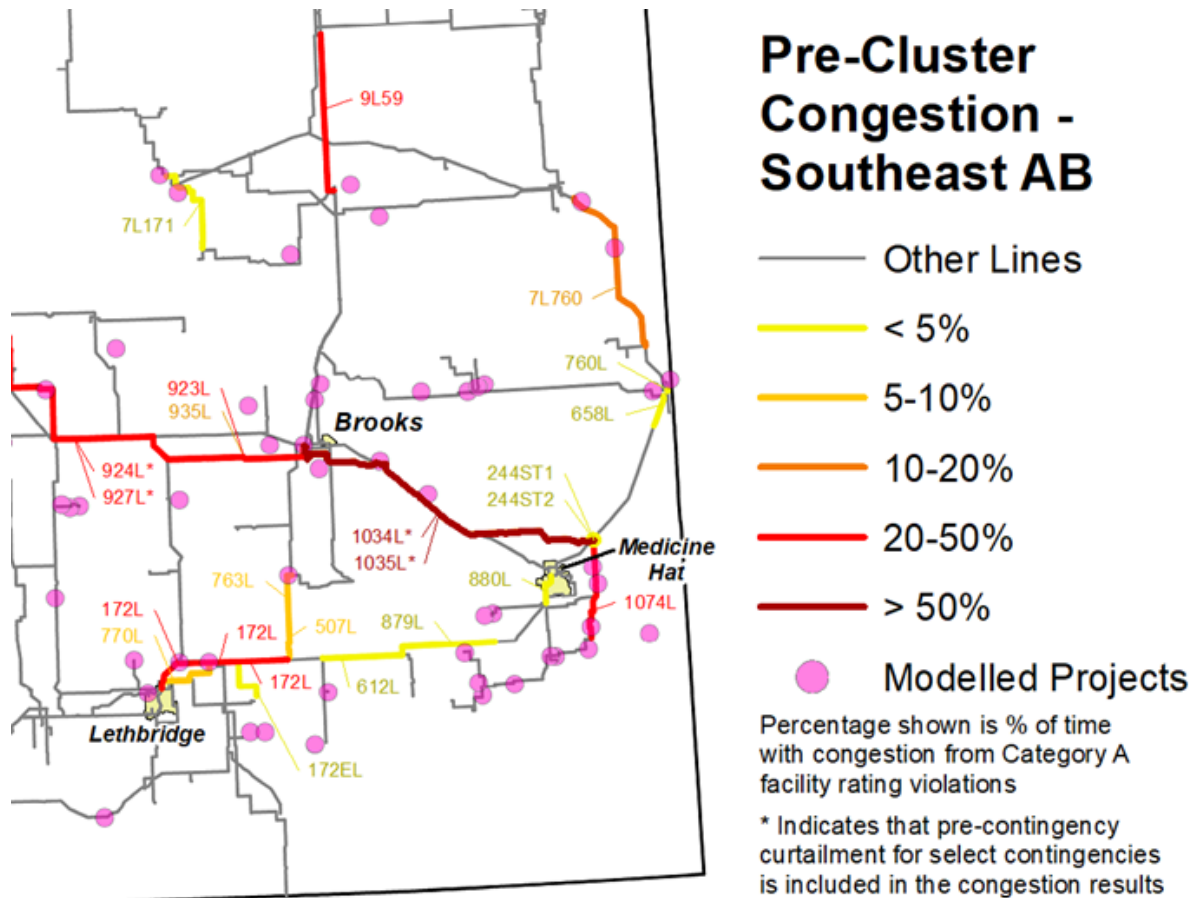
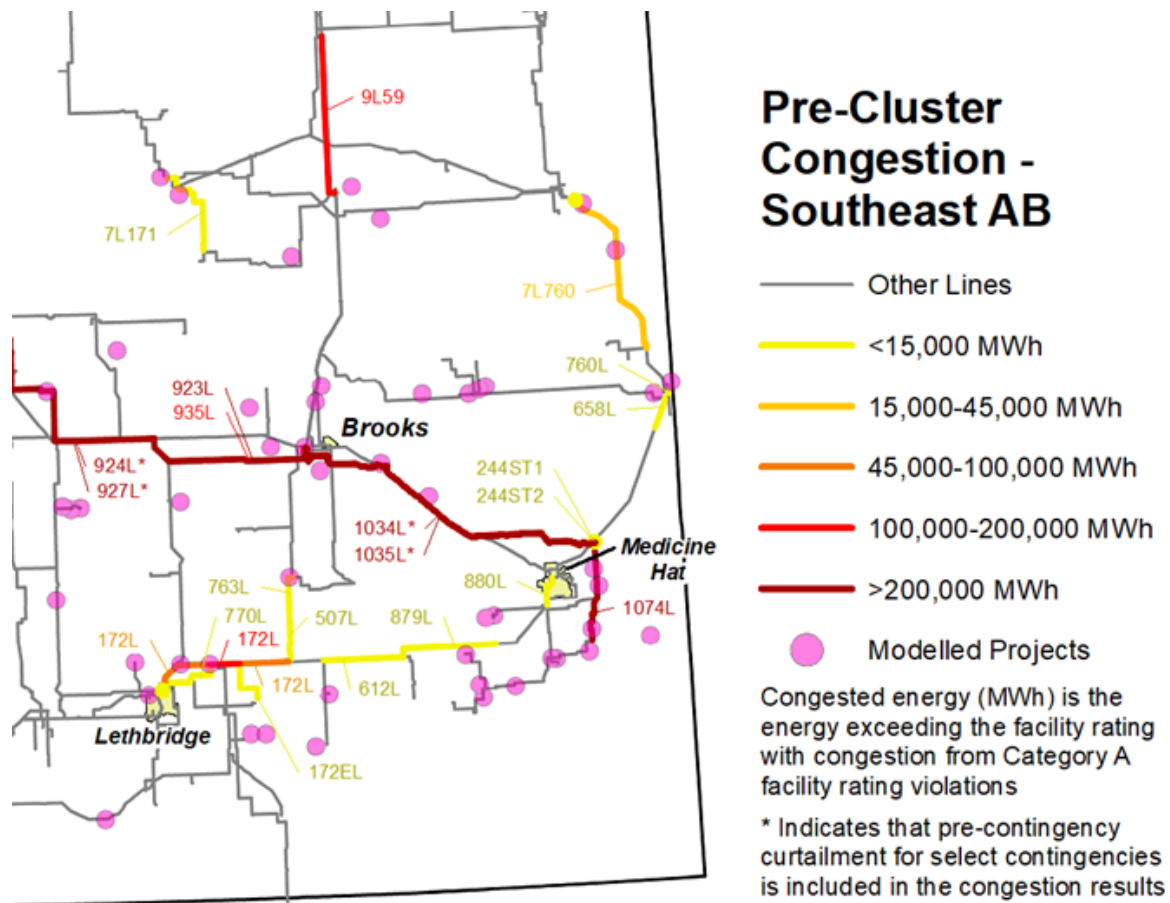


Figure 5 – Pre-Cluster Congested Energy Heatmap



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 the post-cluster scenario, further increasing congestion is forecasted both locally and on the transfer-out paths. Congestion most notable increases on 138 kV transmission lines 507L (83S Taber – 257S Hull) and 172L (83S Taber – 370S North Lethbridge), as well as the 240 kV transfer-out path to Calgary consisting of transmission lines 1034L/1035L (244S Bowmanton - 324S Cassils/2075S Newell), 923L/935L (356S Milo – 2075S Newell/324S Cassils), and 924L/927L (102S Langdon – 356S Milo). Additionally, new congestion risks are observed in the Region.

Figure 6 – Post-Cluster Congestion Frequency Heatmap

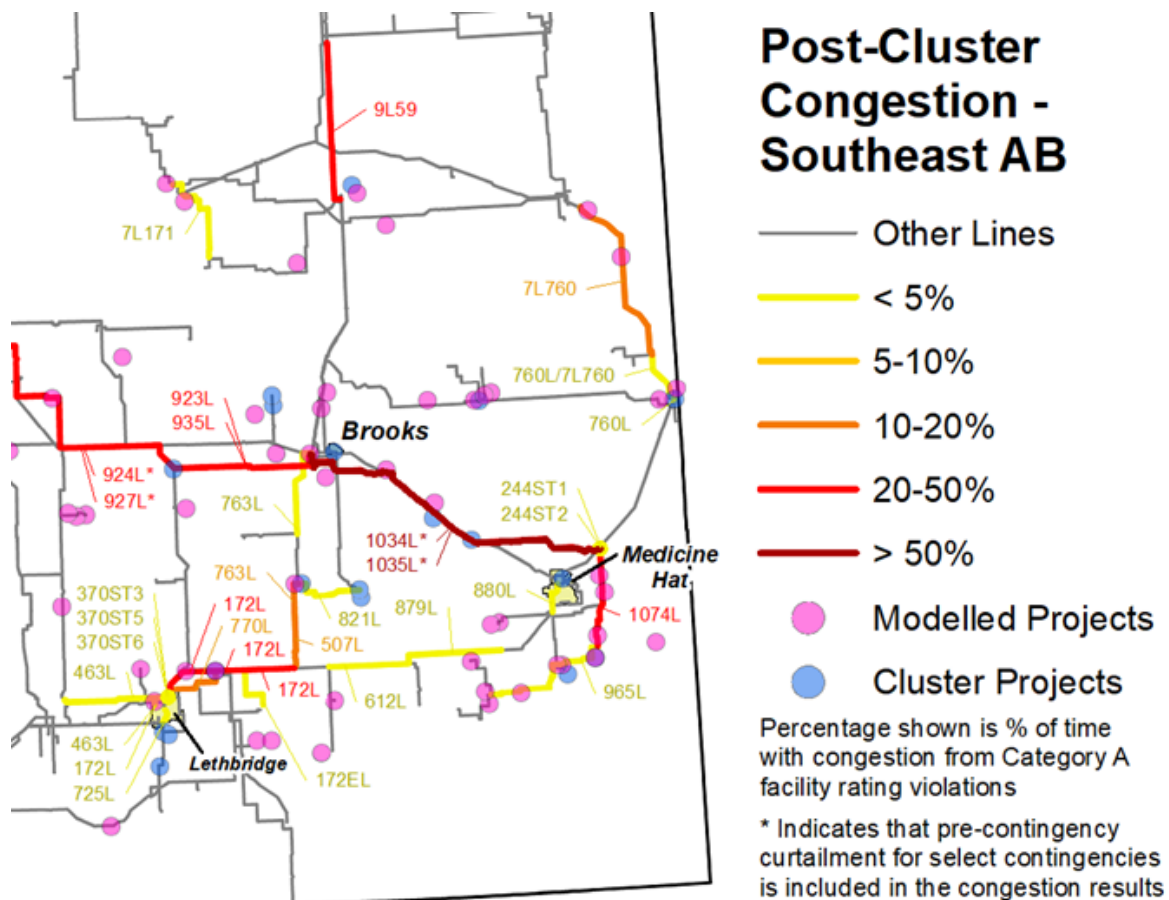
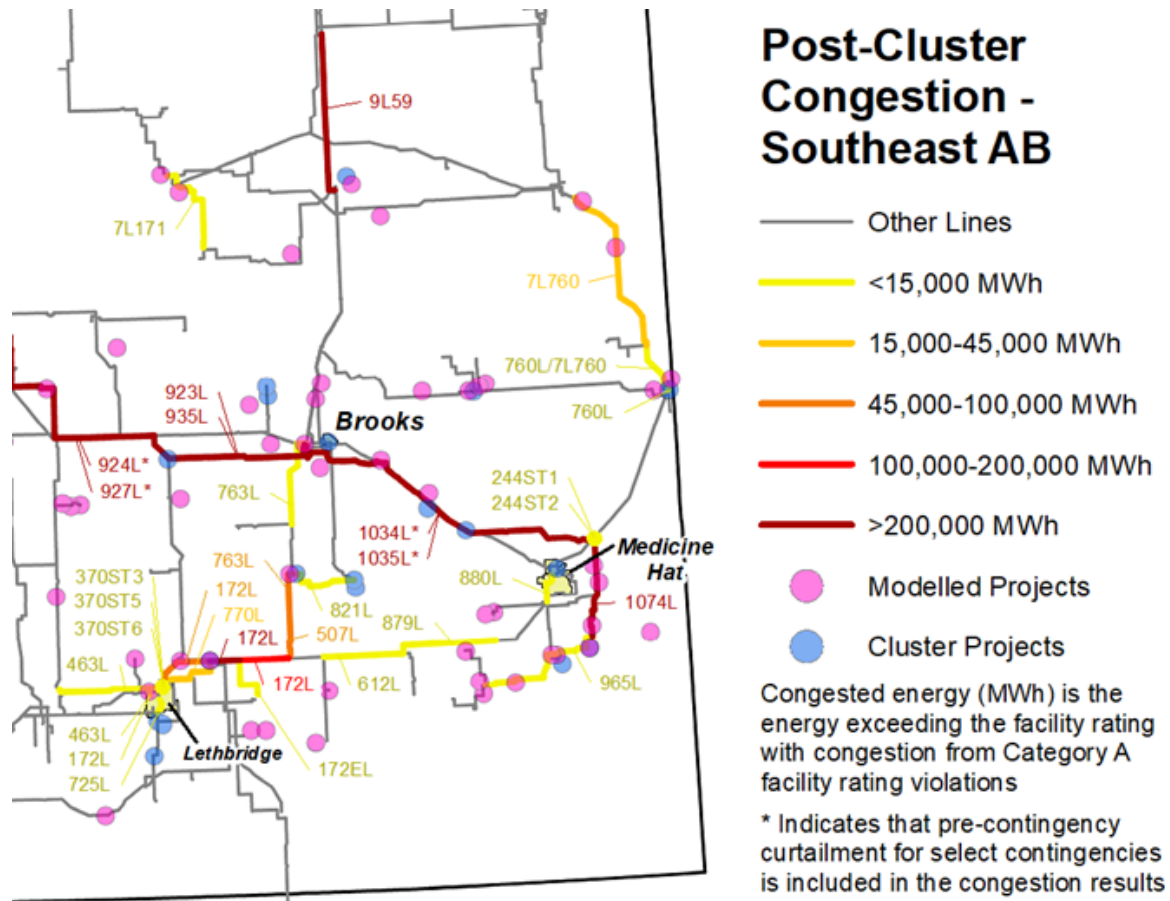


Figure 7 – Post-Cluster Congested Energy Heatmap



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 the post-PIC scenario, most notably on 240 kV lines 1034L, 1035L, 924L and 927L.
- The addition of in-flight projects and cluster projects would increase and introduce new congestion risks to the Region, notably on 138 kV lines in the Lethbridge and Vauxhall areas and 240 kV transfer-out path to Calgary.
- 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)
1034L/1035L* (CBW Path) ¹⁷	1,150	1,150	36	1,234,000	52	2,600,000	65	4,540,000
1034L* (244S Bowmanton - 324S Cassils)	885	1,061	N/A	604,000	N/A	1,300,000	N/A	2,340,000
1035L* (244S Bowmanton - 2075S Newell)	904	1,085	N/A	630,000	N/A	1,300,000	N/A	2,200,000
1074L (244S Bowmanton – 1074ALTap)	904	1,085	4	11,000	25	335,000	25	360,000
172EL (139S Hillridge – 172ELTap)	118	142			2	600	1	400
172L (83S Taber – 172ELTap)	113	139	8	22,000	21	87,000	26	150,000
172L (181S Chinook – 370S North Lethbridge)	111	138					1	600
172L (254S Coaldale – 172ELTap)	113	139	10	30,000	37	180,000	41	260,000
172L (254S Coaldale – 370S North Lethbridge)	113	139	2	2,100	23	52,000	30	93,000
244ST1 (244S Bowmanton)	190	190	2	1,400	4	4,700	1	1,800
244ST2 (244S Bowmanton)	190	190	2	1,400	4	4,700	1	1,800
370ST3 (370S North Lethbridge)	184	213					1	1,200
370ST5 (370S North Lethbridge)	190	190					2	1,400
370ST6 (370S North Lethbridge)	190	190					1	1,100
463L (15S Fort Macleod – 463ALTap)	102	131					2	1,000
463L (181S Chinook – 463ALTap)	111	137					1	500
507L (83S Taber – 257S Hull)	114	141			7	8,400	17	66,000
607L (336S Fincastle – 607ALTap)	117	117	1	900				

¹⁶ Facility ratings are converted from MVA to MW assuming a power factor of 0.95.¹⁷ For Cassils-Bowmanton-Whitla (CBW) Path limits, see P7083 Bowmanton 244S Substation Voltage Support Project's February 8, 2023 presentation (Posted February 9, 2023), available on the AESO website.

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Transmission Line	Nominal Rating (MW) ¹⁶		Post-PIC		Pre-Cluster		Post-Cluster	
	Sum.	Wint.	Frequency (%)	Energy (MWh)	Frequency (%)	Energy (MWh)	Frequency (%)	Energy (MWh)
612L (336S Fincastle – 368S Burdett)	81	86	1	600	2	1,000	1	400
658L (562S Cypress – 658ALTap)	115	142	1	500	1	300		
725L (111S Coalbanks – 725ALTap)	116	143					2	900
760L (394S Empress – 163S Amoco Empress)	113	139			2	2,200	1	500
760L/7L760 (760ALTap – 7LA760Tap)	105	135					1	900
763L (158S Vauxhall – 257S Hull)	114	141			5	5,900	17	63,000
763L (28S West Brooks – 763ALTap)	114	141					1	500
770L (254S Coaldale – 370S North Lethbridge)	114	141	1	400	7	8,200	16	23,000
7L171 (802S Michichi Creek – 804S Wintering Hills)	102	134	2	1,300	3	1,900	3	2,800
7L760 (7LA760 – 767S Oyen)	105	139	2	1,700	13	31,000	16	44,000
821L (158S Vauxhall – 421S Hays)	81	86					1	300
879L (368S Burdett – 879ALTap)	81	86	2	1,200	2	1,100	1	800
880L (523S Bullshead – 321S Al Rothbauer)	115	143			4	3,700	4	3,500
923L (356S Milo – 2075S Newell)	520	642			21	280,000	30	580,000
924L* (102S Langdon – 356S Milo)	520	642	16	160,000	36	660,000	47	890,000
927L* (102S Langdon – 356S Milo)	547	675	13	110,000	34	570,000	45	810,000
935L (324S Cassils – 356S Milo)	520	642	1	2,300	16	150,000	27	410,000
965L (244S Bowmanton – 326S Murray Lake)	904	1,085					1	5,000
9L59 (801S Anderson – 9LA59Tap)	474	474	1	2,800	20	170,000	29	340,000

* 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. The results for 1034L/1035L reflect the transfer limit on the 240 kV double-circuit 1034L/1035L path leaving the Cassils-Bowmanton-Whitla area.