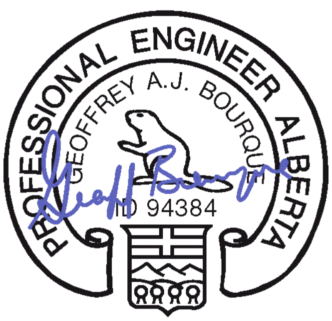
Cluster 1 Congestion Assessment

Northeast Cluster [NE-01]



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1. Introduction

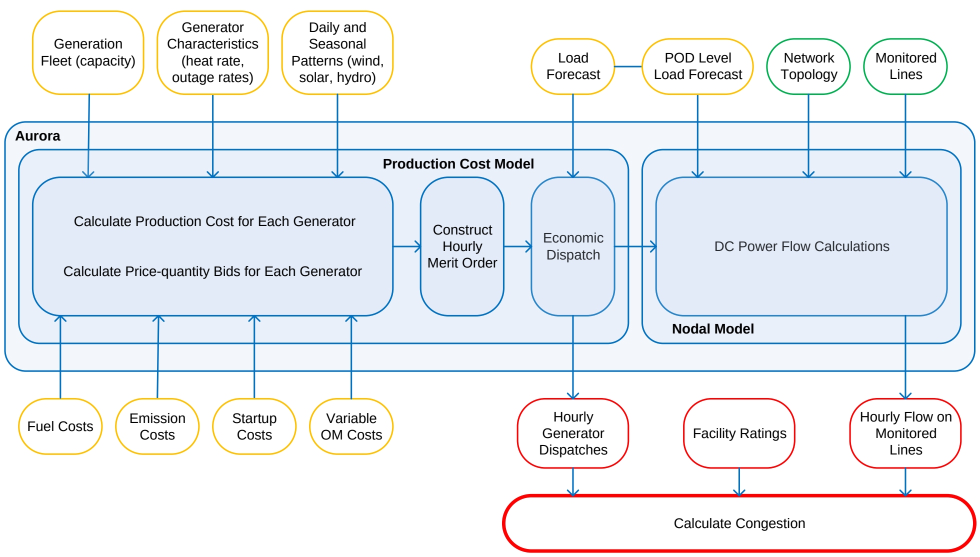
This report documents the Congestion Assessment for the projects in the Northeast cluster region (the Region).

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. 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.

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.

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

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 criteria[2] (PIC) across the entire province are energized;

ii) **Pre-cluster**: assumes post-PIC plus all Connection Assessment (CA) modelled projects[3] 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	0	0
Solar[9]	3,535	0	+400
Energy Storage[10]	383	0	+100
Thermal	14,280	+466	+964
Hydro	894	0	0
Other	444	0	0
Additions		+466	+1,464
Total	25,600	26,066	27,530

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. 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 the 138 kV transmission lines 728L (353S Plamondon - 157S Lac La Biche) and 728L (353S Plamondon - 405S Waupisoo).

Figure 2 – Post-PIC Congestion Frequency Heatmap

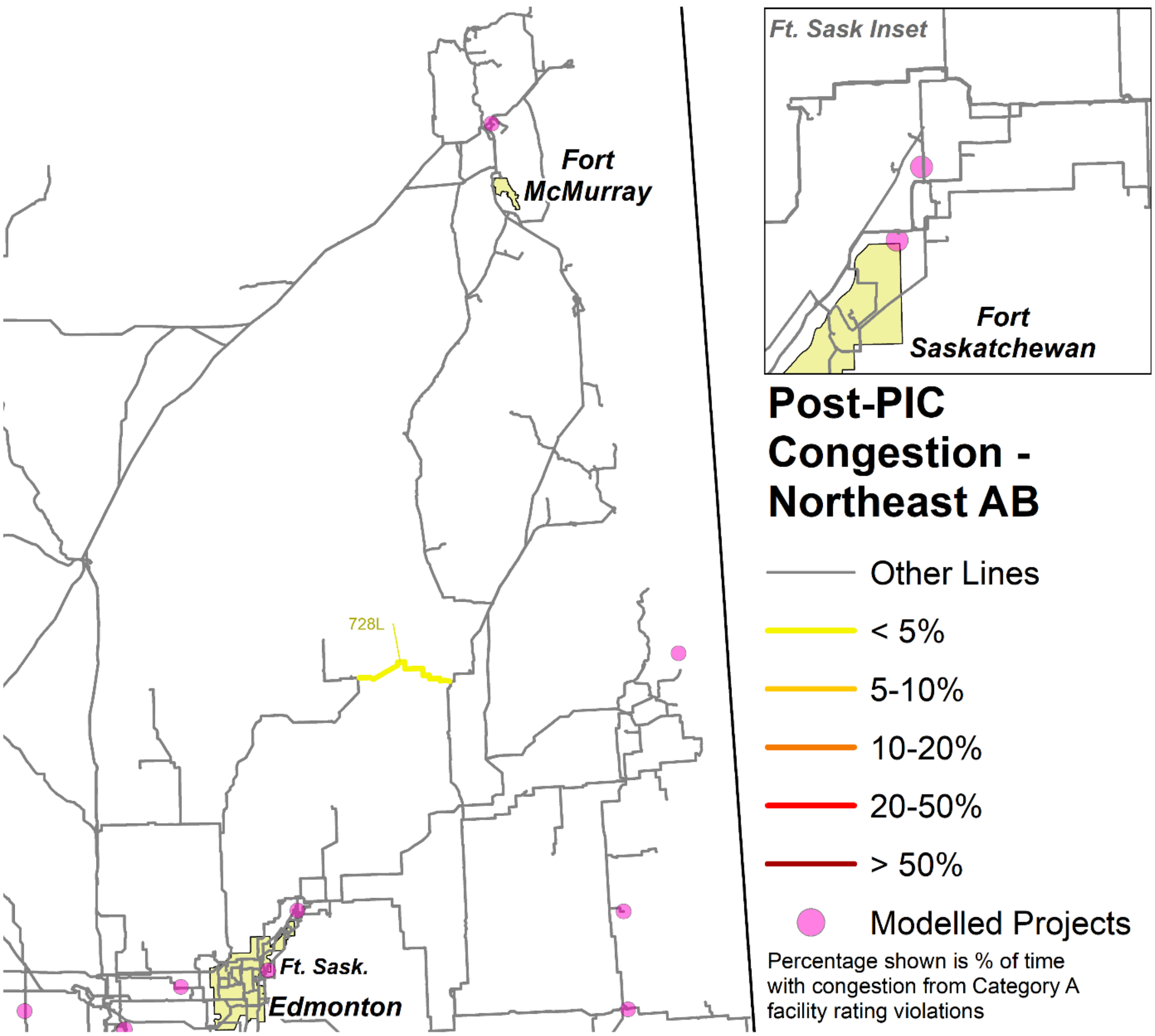
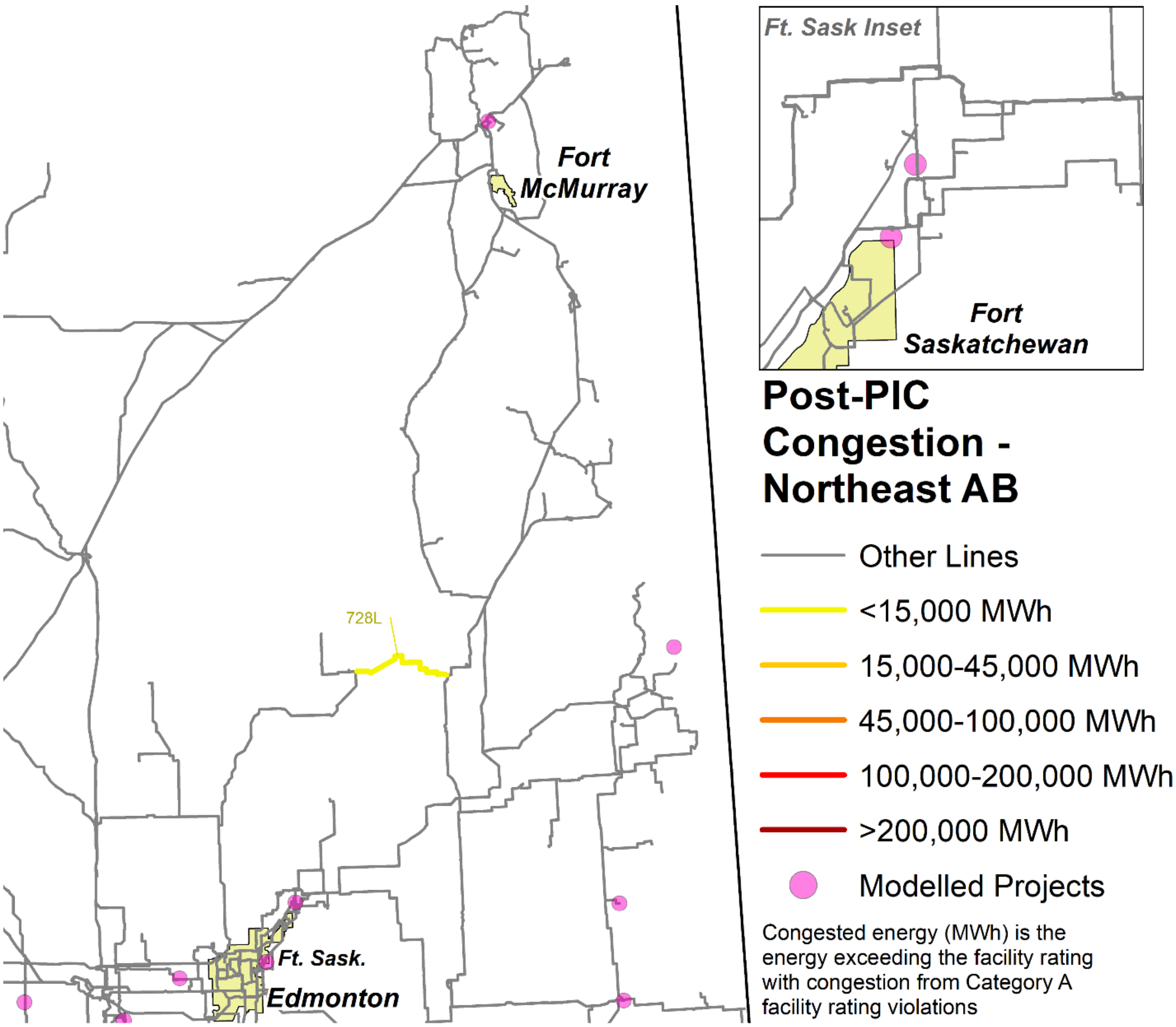


Figure 3 – Post-PIC Congested Energy Heatmap



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 this scenario, compared to the post-PIC scenario, congestion on 728L (353S Plamondon - 157S Lac La Biche) is reduced, and congestion on 728L (353S Plamondon - 405S Waupisoo) is no longer observed. However, congestion appears on 723L (438S Westlock - 150S Clyde) on the transfer path to the Edmonton region.

Figure 4 – Pre-Cluster Congestion Frequency Heatmap

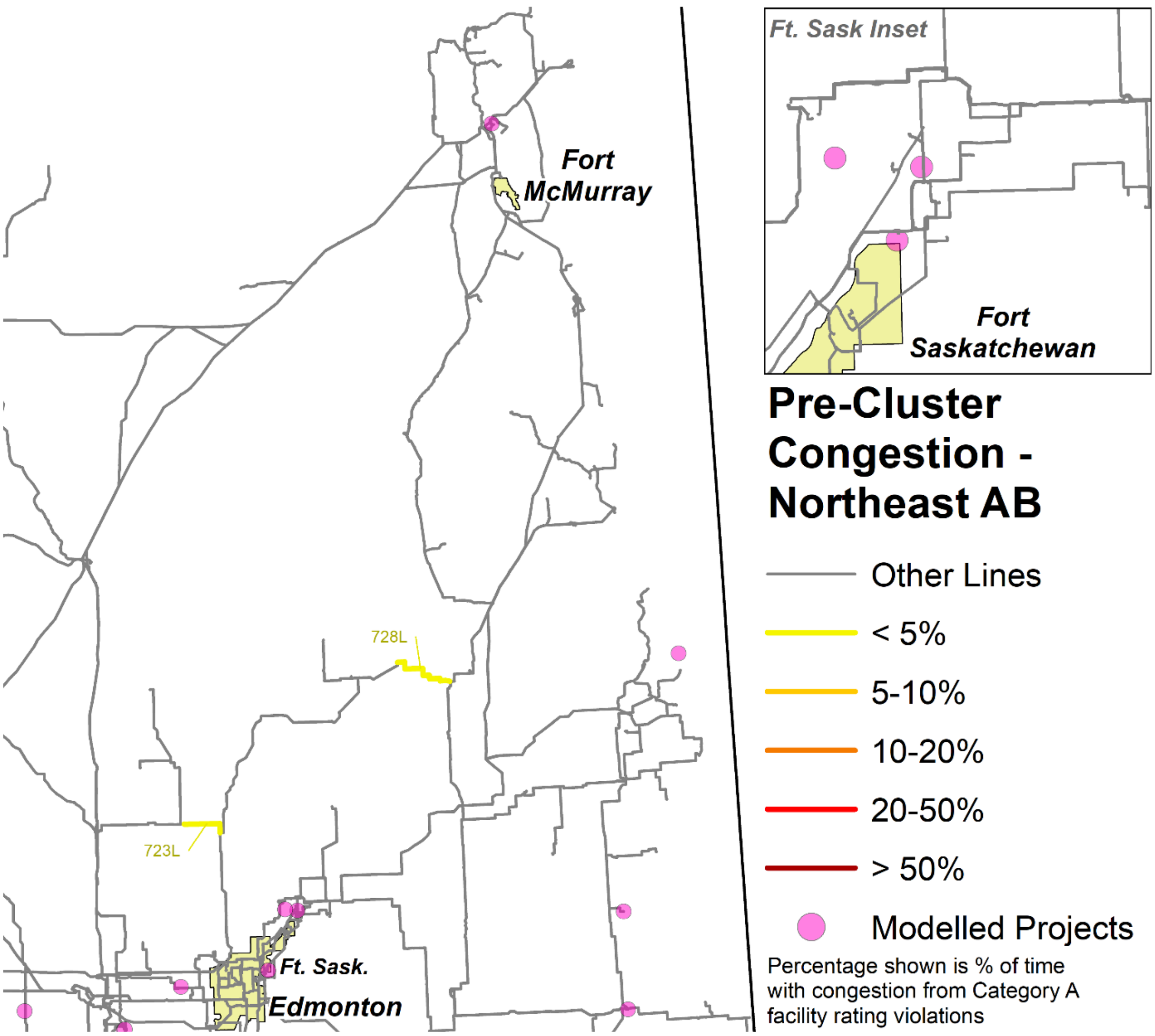
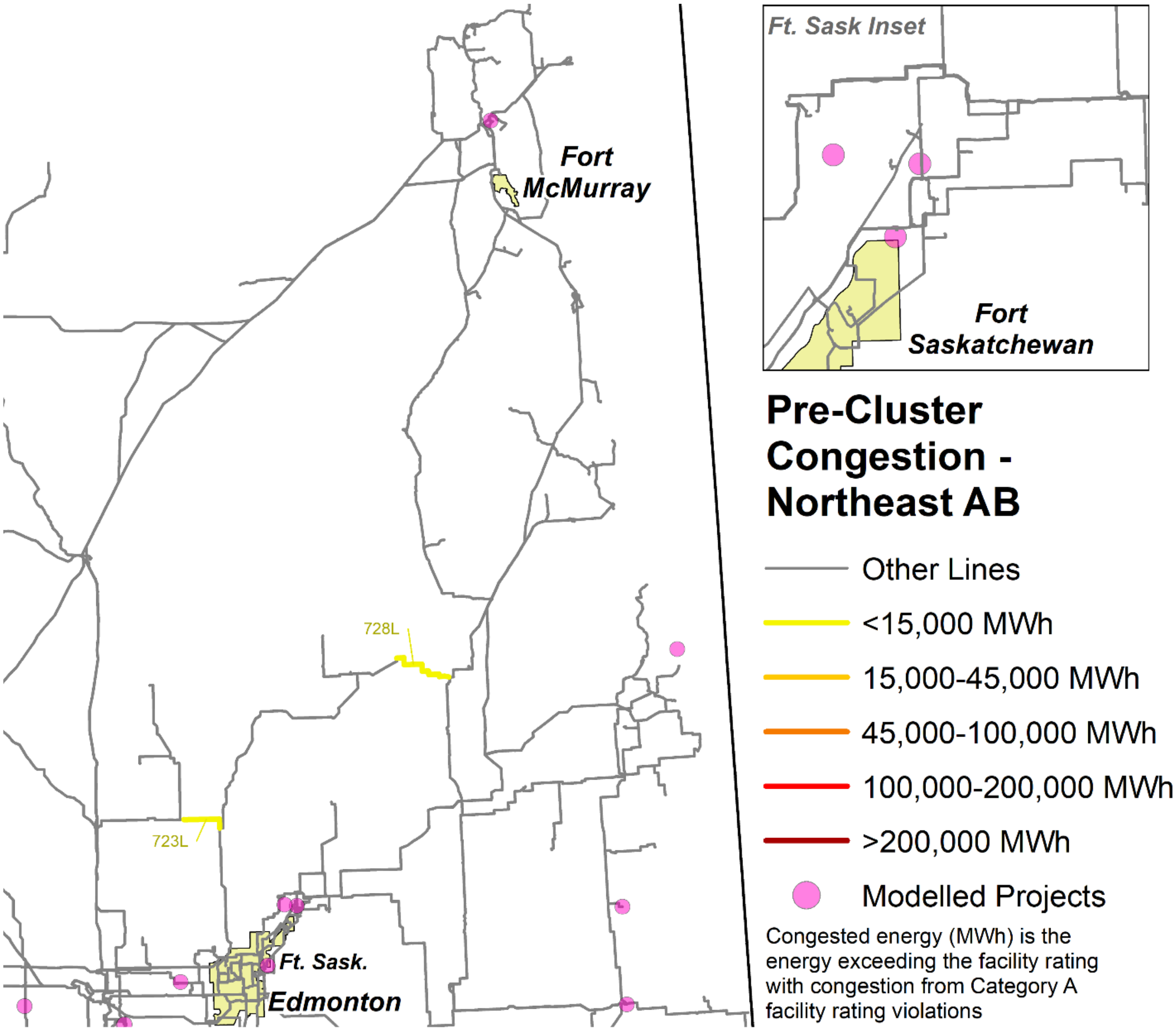


Figure 5 – Pre-Cluster Congested Energy Heatmap



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 the pre-cluster scenario, congestion is observed on additional transmission lines: 1054L (13S Deerland - 12S Heartland), and 943L (13S Deerland - 108S Amelia). In addition, congestion increases on 728L (353S Plamondon - 157S Lac La Biche), but is no longer observed on 723L (438S Westlock - 150S Clyde).

Figure 6 – Post-Cluster Congestion Frequency Heatmap

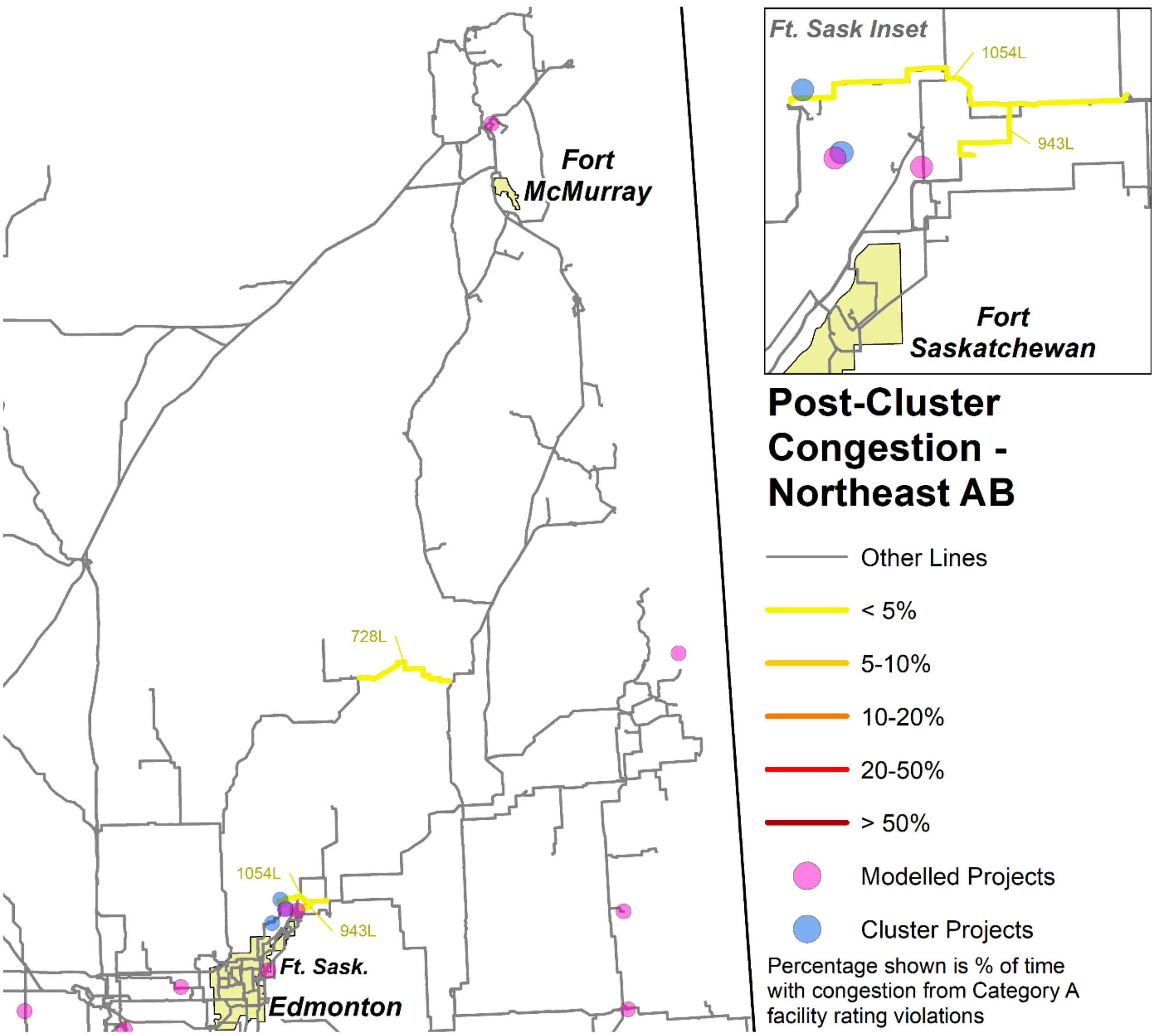
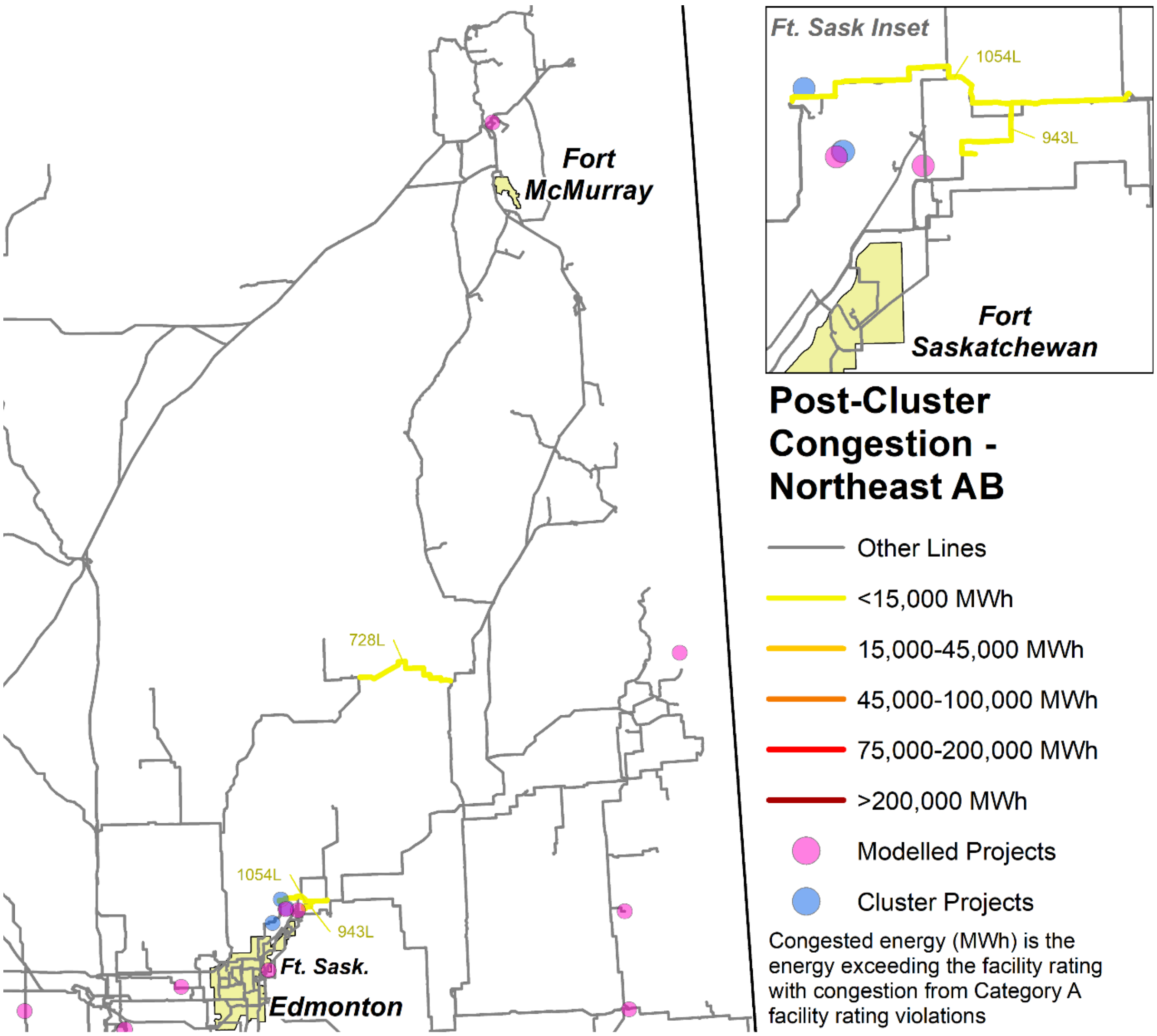


Figure 7 – Post-Cluster Congested Energy Heatmap



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 on line 728L in the post-PIC scenario.
- The addition of in-flight projects and cluster projects would increase and introduce new congestion risks to the Region.
- 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)
1054L (13S Deerland - 12S Heartland)	564	593					1	2,000
723L (438S Westlock - 150S Clyde)	68	68			3	1,300		
728L (353S Plamondon - 157S Lac La Biche)	68	68	3	1,900	2	700	3	2,500
728L (353S Plamondon - 405S Waupisoo)	68	68	1	100			1	200
943L (13S Deerland - 108S Amelia)	434	434					3	3,200

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