2019 Transmission Capability Assessment for Renewables Integration

Impacts of Renewable Electricity Program Rounds 2 and 3, and Selected System Projects

MARCH 2019

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1.0 Executive summary

The integration capability of the existing transmission system is determined to be approximately 470 MW. Optimal integration capability is 340 MW in the southwest and 130 MW in the southeast.

The Province of Alberta continues to make steady progress towards a goal legislated by the *Climate Leadership Plan*: by 2030, 30 per cent of electricity produced will be from renewable resources, and coal-generated emissions will be phased out (the 30 by 30 target).

The Alberta Electric System Operator (AESO) is facilitating progress towards this target through the Renewable Electricity Program (REP). High expectations for the program were set when REP Round 1 attracted the lowest renewable electricity pricing in Canada, at the time of the competition.

REP Rounds 2 and 3 also received significant competitive interest from local and international investors. Results were announced in December 2018, with Round 2 delivering five wind projects totaling 363 MW, and Round 3 delivering three wind projects totaling 400 MW, all at globally competitive prices.

Market participants and investors value receiving updates on where transmission capability is available, and optimal areas to seek connection to Alberta's grid.

In June 2018 the AESO published the inaugural *Transmission Capability Assessment for Renewables Integration* (2018 Assessment) as an update to the AESO's *2017 Long-term Transmission Plan* (2017 LTP). The 2018 Assessment described the system's capability to integrate additional renewables generation subsequent to the announcement of the projects selected for REP Round 1.

An Addendum to the 2018 Assessment was published in February 2019 that incorporated impacts on system capability from REP Rounds 2 and 3.

This 2019 Assessment includes results from the 2018 Addendum, captures the impacts of proposed system projects, leverages 2017 LTP results, and includes sensitivity studies to evaluate the impacts of distributed energy resources (DER), Red Deer 240 kilovolt (kV) and 138 kV system integration.

> Transmission capability identified in this report is subject to change if underlying planning assumptions change as new information becomes available.

KEY FINDINGS

- If the transmission system is optimized, there is an upper limit of 470 megawatts (MW) of remaining integration capability in the south.
- Optimal distribution of this 470 MW of integration capability in the south is 340 MW in the southwest and 130 MW in the southeast.
- To optimize use of the existing transmission system in renewables-rich areas of Alberta, the AESO assumes connection of new generation to 240 kV substations.
- Integration of new generation at 138 kV substations could reduce system capability, depending on project size and location.
- When the transmission system is optimized, capability in the central east area is 0 MW; however, a small quantity of generation can still be integrated into this area, recognizing that this could decrease overall system capability.
- The Provost-to-Edgerton and Nilrem-to-Vermilion Transmission Development (PENV) will add up to 360 MW to overall system capability.
- In addition to PENV, reconfiguration of existing Remedial Action Schemes (RAS) in the central east area may be required.
- Based on previous planning studies, the development of the Chapel Rock-to-Pincher Creek Transmission Development (CRPC) will add approximately 700 MW of generation integration capability in the southwest. The Central East Transfer-out Transmission Development (CETO) will add approximately 1,000 MW of incremental integration capability, depending on the replacement of existing coal-fired generation in the central east area.
- Integrating rooftop distributed energy resources (DER) results in reducing the capability of the transmission system by 60 MW for every 100 MW integrated in the City of Calgary, and by 100 MW for every 100 MW integrated in the southwest, southeast and central east areas.
- Integration of moderate DER in the cities of Edmonton and Red Deer up to a certain amount does not reduce the capability of the transmission system.

2.0 Introduction

Rounds 2 and 3 of the Renewable Electricity Program delivered eight new projects, procuring a total of 763 MW of wind generation at globally competitive prices.

By the end of 2019, 600 MW of renewable electricity generation from the REP Round 1 auction is scheduled to come online, with an additional 763 MW from REP Rounds 2 and 3 by June 30, 2021 (locations are shown in Figures 1 and 2).

This Assessment defines current integration capability in the south and central east areas of Alberta, where renewable electricity generation from REP projects is already allocated.

The AESO established the southwest, southeast and central east areas of Alberta as the Study Region for the *Transmission Capability Assessment for Renewables Integration* reports. These areas are the richest in wind and solar resources, and offer the most potential (as shown in Figures 3 and 4).

This 2019 Assessment:

- Includes results from the 2018 Addendum.
- Captures the impact of transmission system projects, including PENV.
- Addresses the potential need for reconfiguration of existing RAS in the central east area, in addition to PENV.
- Leverages results of the AESO's 2017 LTP for CRPC and CETO.
- Includes sensitivity studies to evaluate the impacts of DER, Red Deer 240 kV and 138 kV system integration.

While transmission system capability is documented in the AESO's LTP, which is updated every two years, the Capability Assessments will continue to be amended as significant new information becomes available.

Figure 1: Projects selected through REP Round 2

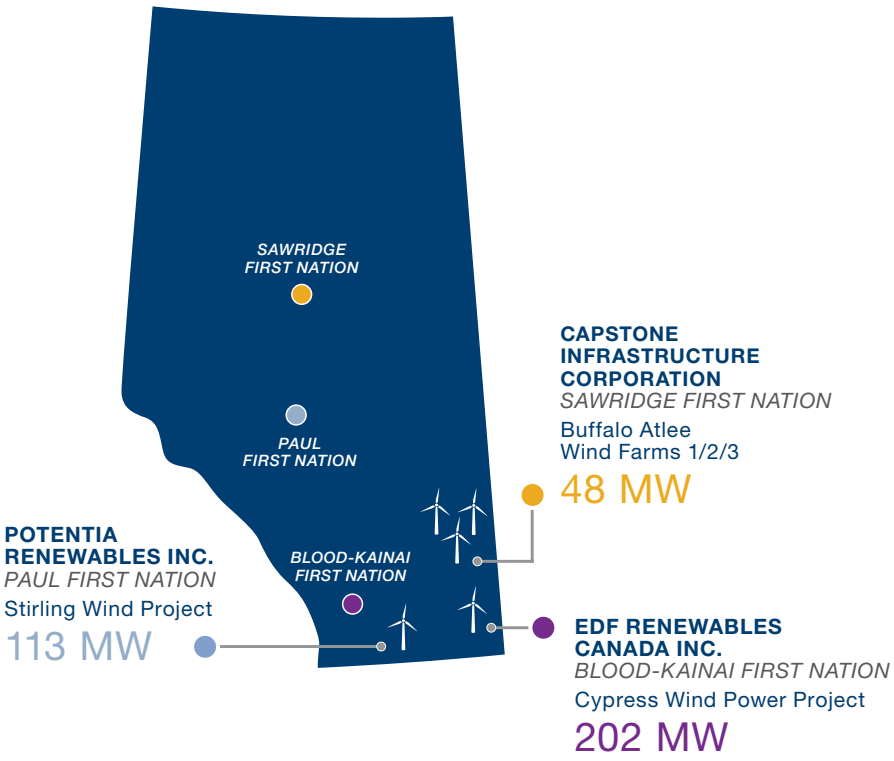


Figure 2: Projects selected through REP Round 3

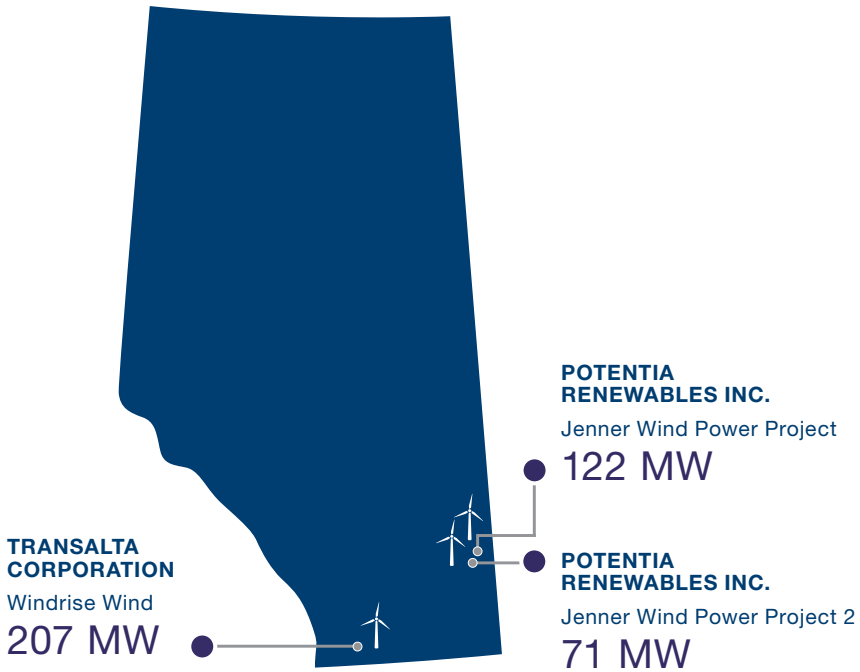
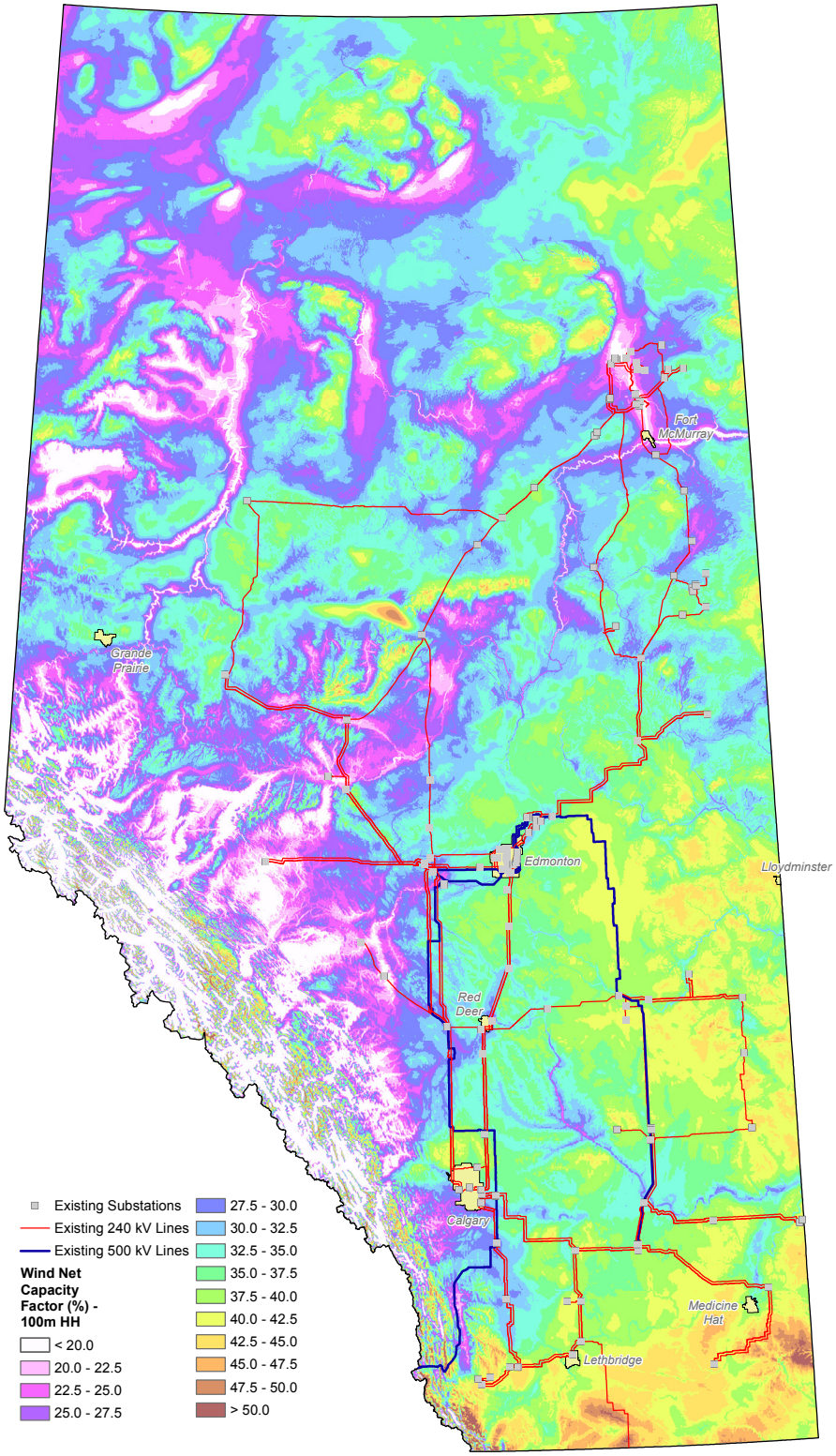
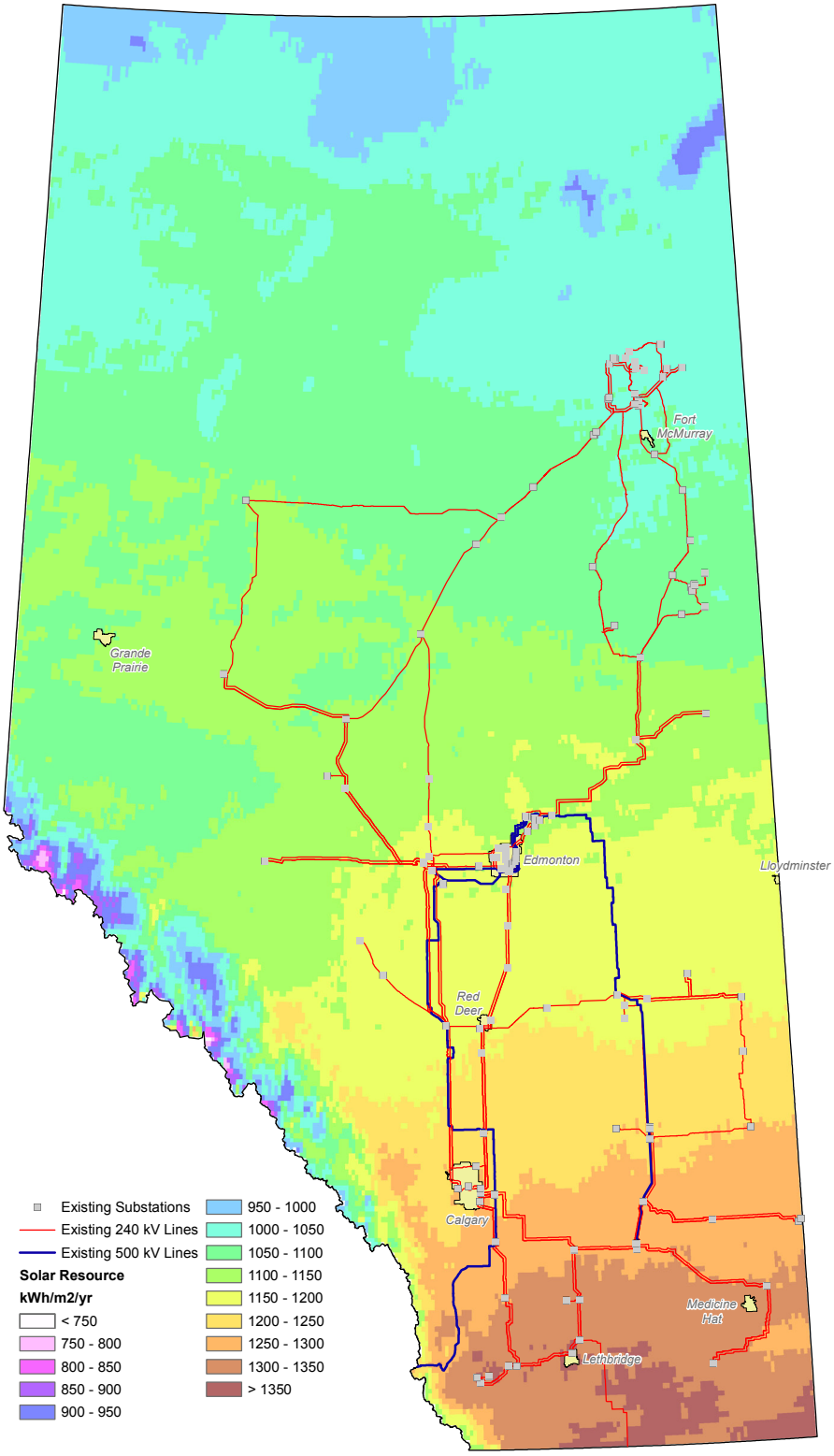


Figure 3: Alberta wind resource potential



Data source: AWS Truepower

Figure 4: Alberta solar resource potential



Data source: AWS Truepower

3.0 Study overview

The 2019 Assessment evaluates overall renewables integration capability in the Study Region, and the share carried by each of the southwest, southeast and central east areas.

STUDY OBJECTIVE AND SCOPE

The objective of the 2019 Assessment is to define integration capability in the southwest, southeast and central east areas of Alberta following the combined allocation of 763 MW of wind generation awarded through REP Rounds 2 and 3.

In addition, this assessment provides an update on the incremental system capability enabled by PENV.

STUDY REGION

The Study Region includes the southwest, southeast and central east areas of Alberta (as shown in Figure 5). The 2019 Assessment evaluates overall renewables integration capability in the Study Region, and the share carried by each area.

EXISTING SYSTEM

Southwest and southeast areas

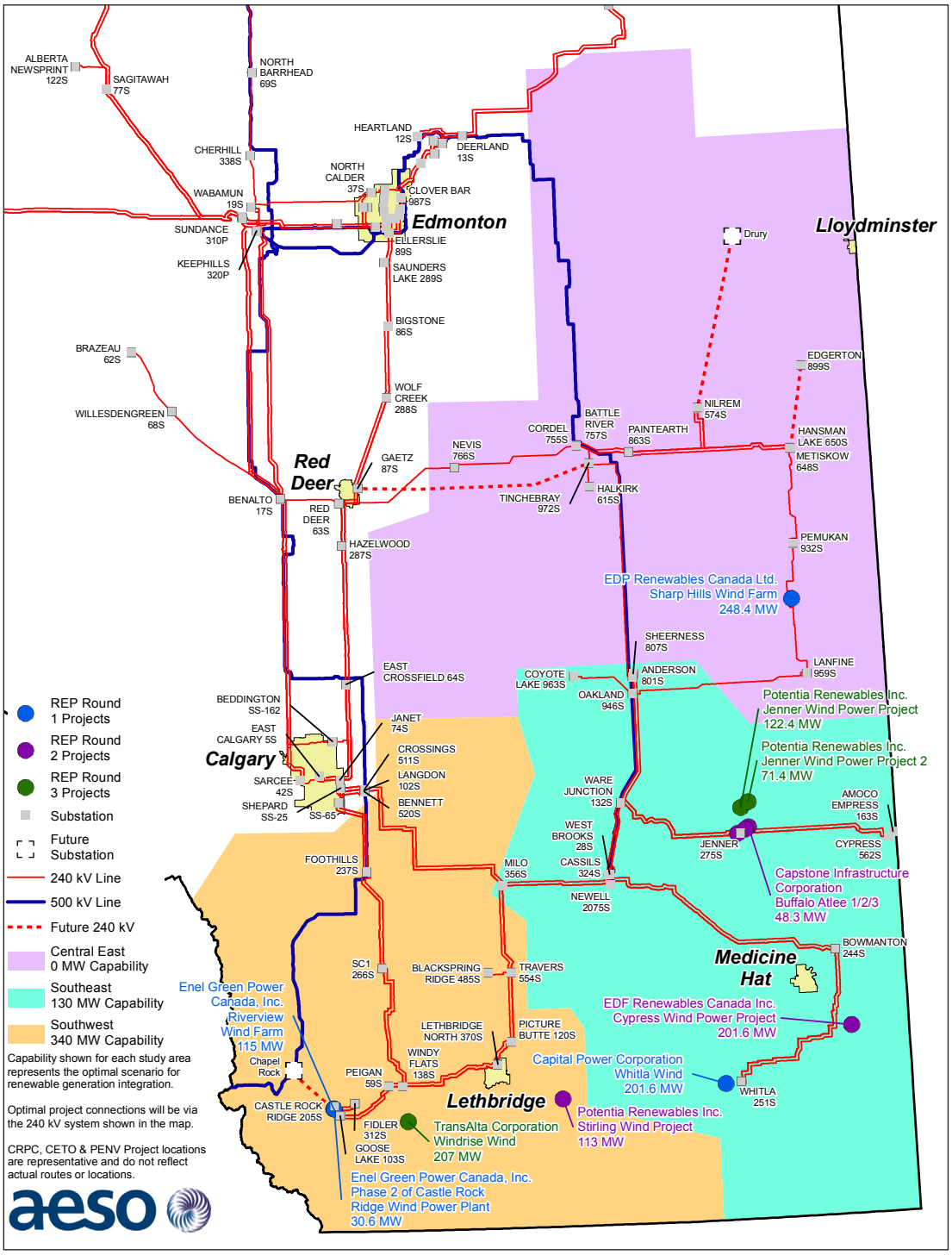
- Load is predominantly served through an extensive 138 kV transmission network supplied by a regional 240 kV network that connects the main area load centres with regional generation sources.
- Existing 240 kV lines extend from the Calgary area to Brooks and Medicine Hat.
- A 240 kV network delivers power from the Sheerness and Battle River areas south to the Brooks area.
- Several 240 kV circuits in the south act as strong collector systems for geographically dispersed wind-generation sources and move power into load centres:
  - Cassils-Bowmanton-Whitla and Cypress-Jenner path (southeast)
  - Pincher Creek to Windy Flats to North Lethbridge (southwest)
- The Western Alberta Transmission Line (WATL) carries power between Edmonton and Calgary.

Central east area

- Comprises the Hanna, Alliance/Battle River, Vegreville, Wainwright, Lloydminster, and Provost areas, including the lines connecting these planning areas to the rest of the Alberta Interconnected Electric System (AIES).
- Served by:
  - 240 kV, 138/144 kV, and 69/72 kV transmission systems
  - 240 kV collector system (Hanna network)
- Coal generation facilities at Alliance/Battle River and wind generation facilities at Hanna and Provost.
- The Cold Lake area is not included in the Study Region due to the lower potential for renewables generation.
- The Eastern Alberta Transmission Line (EATL) carries power between the northeast and south areas.

Integration capability is defined as the maximum incremental generation that can be accommodated in a particular study area without causing constraints on the transmission system.

Figure 5: Study region



4.0 System model & study assumptions

The 2019 Assessment was carried out for the year 2021, because REP Rounds 1 through 3 projects are all planned to be operational by the end of June 2021.

BASE CASE

In order to assess the existing capability available for renewables integration, a base case was prepared to describe the existing system. The base cases for the 2018 and 2019 Assessments are the same, with topology updates to represent REP Rounds 2 and 3 projects.

The following assumptions formulate the base case:

- Existing system topology including all approved system projects that are currently expected to be energized before 2021.
- Load forecast as per the AESO's 2017 Long-term Outlook for 2021.
- Load applications in the AESO connection queue:
  - with in-service dates earlier than December 1, 2021
  - that have already received permits and licenses in the Study Region
- Renewables generation dispatched close to its installed capacity.
- Forecast of existing conventional generator production based on an economic dispatch methodology.
- Supply capacity associated with any generation customer connection requests that have:
  - started construction
  - paid generator unit owner contributions
  - been awarded REP contracts

STUDY YEAR

The 2019 Assessment was carried out for the year 2021, which was chosen based on the following considerations:

- REP Round 1 projects are planned to be operational by the end of 2019.
- REP Rounds 2 and 3 projects are planned to be operational by the end of June 2021.

ASSUMED CONNECTION POINTS

Future renewables are assumed to be connected to 240 kV substations in order to efficiently use existing system capability and minimize impact on local constraints.

INTERTIES

The AIES is presently connected to each of British Columbia, Saskatchewan, and Montana via interties. This study focusses on zero interchange conditions, and fixed intertie flows for each scenario.

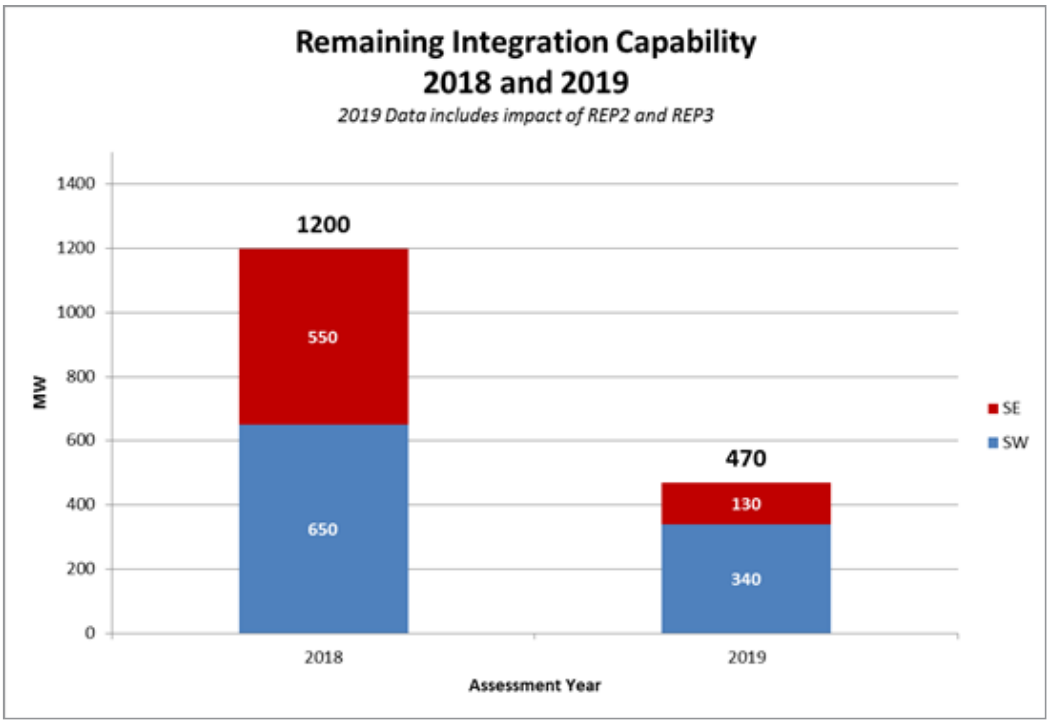
The 2018 Assessment indicated that the central east area is not the optimal location to integrate new generation. This conclusion is still valid.

5.0 Generation integration capability results

The AESO's interactive map allows market participants to easily identify optimal areas to site projects and locations for connection to 240 kV lines and substations.

The 2018 Assessment identified 1,200 MW of remaining capability after the addition of capacity awarded in REP Round 1. The 2019 Assessment identifies 470 MW of remaining capability utilizing RAS after the addition of capacity awarded in REP Rounds 2 and 3.

Figure 6: Comparison of remaining capability between the 2018 and 2019 Assessments



OPTIMAL INTEGRATION CAPABILITY INTERACTIVE MAP

The interactive map features:

- A customizable basemap allowing the user to choose between multiple map backgrounds including satellite imagery.
- A measuring tool allowing the user to calculate distances or areas on the map, such as the distance from a potential project location to the nearest transmission infrastructure.
- The Study Region (southwest, southeast and central east areas).
- 240 kV transmission lines and substations.
- The location of projects selected for REP Rounds 1 through 3.

> A Remedial Action Scheme (RAS) is designed to detect predetermined power system conditions and to automatically take corrective actions, such as adjusting generation or reconfiguring the power system, to protect equipment from damage and maintain grid stability.

6.0 Sensitivity studies

Integration of moderate distributed energy resources generation in the cities of Edmonton and Red Deer up to a certain amount does not reduce the capability of the transmission system.

Sensitivity assessments were performed to capture the impact of future system projects on overall system capability. The impact/limitation of connecting to locations such as the 138 kV network or the Red Deer 240 kV network was also assessed, as was integration of rooftop photovoltaics DER generation.

INTEGRATION OF DISTRIBUTED ENERGY RESOURCES

This study was undertaken to examine the impact and possible local constraints created by DER integration on transmission system capability at key urban areas within Alberta.

Key findings are as follows:

- There is a reduction of approximately 60 MW in transmission system capability for every 100 MW of DER integrated in the City of Calgary (up to 300 MW of DER generation was assessed).
- Integration of 100 MW of DER in the south and central east areas will use 100 MW of transmission system capability for renewables integration in these regions (up to 200 MW of DER generation was assessed).
- DER integration in the cities of Edmonton and Red Deer does not impact transmission system capability to integrate renewables generation in the south and central east areas (up to 300 MW and 70 MW of DER generation was assessed in the City of Edmonton and the City Red Deer, respectively).
  - the cites of Edmonton and Red Deer are both strong transmission hubs in the AIES and integration of additional generation on the distribution system in these areas will have minimal impact on existing transmission capability
- The location and size of future generation is an important factor to consider when integrating generation on the distribution system, as it may produce local system constraints.

INTEGRATION ON 138 KV SYSTEM

This study assessed the impact on overall system capability from renewables integration on the 138 kV system. Injection points were selected based on market participant interest:

- Southwest
  - Fort Macleod 15S
  - Magrath
  - Stirling 67S
- Southeast
  - Burdett 368S
  - Coaldale 254S
  - Vauxhall 158S

Key findings are as follows:

- Integrating generation on the 138 kV system at the selected injection substations could result in reducing total system capability.
- The impact on total system capability and the local 138 kV system depends on the location and the size of connected generation.

INTEGRATION ON RED DEER 240 KV SYSTEM

This study assessed the impact on overall system capability from renewables generation integration on the Red Deer 240 kV system.

Key findings are as follows:

- Power flow on the 240 kV paths from the central east to Red Deer area, i.e., 9L20 and 912L, is reduced, resulting in higher power flow on other 138 kV transfer-out paths, e.g., 701L and 174L.
- Depending on system conditions and scenarios, adding generation on the Red Deer 240 kV system could result in lower system capability in the southeast.
- The impact of Red Deer-area generation integration on system capability is dependent on the amount of generation added.

IMPACT OF FUTURE SYSTEM DEVELOPMENTS ON CAPABILITY

PENV

This study assessed the impact of PENV on overall system capability and identified that it will:

- Improve system capability by relieving constraints in the central east area.
- Add up to 360 MW to overall system capability and allow for certain injection points in central east to become optimized locations.

CRPC AND CETO

The 2017 LTP identified that:

- The CRPC project, which includes one 240 kV circuit from Chapel Rock to the Pincher Creek area, enables an additional 700 MW of generation integration capability in the southwest area.
- The CETO project includes two 240 kV circuits from the Tinchebray substation to the Gaetz substation. This project could increase the generation integration capability in the central east area by approximately 1,000 MW depending on existing coal-fired generation replacement in the area, i.e., Battle River and Sheerness.

Distributed Energy Resources (DER) are small physical and virtual devices that are deployed and connected across the grid or distribution system. DER systems are decentralized and flexible technologies, typically close to the load they serve, and usually behind the meter. They can be used individually or in aggregate to provide value to the grid, individual customers, or both.

7.0 Conclusions

The AESO's Capability Assessments are updated regularly, looking forward to 2021, monitoring and reporting the transmission system's capability to integrate new renewables generation in central east and southern Alberta.

The integration capability of the existing transmission system for the southwest and southeast areas is determined to be approximately 470 MW. Out of this 470 MW of incremental renewables integration capability, southwest and southeast area shares are is approximately 340 MW and 130 MW, respectively.

Key findings of the 2019 Assessment are as follows:

- If the transmission system is optimized, integration capability is approximately 470 MW in the south.
- Optimal distribution of this 470 MW of integration capability is 340 MW, 130 MW and 0 MW in the southwest, southeast and central east areas respectively.
- To optimize the use of the existing transmission system in renewables-rich areas of Alberta, the AESO assumes the connection of new generation to 240 kV substations. Integration at 138 kV substations, even in optimized locations, will reduce system capability by 30 MW for every 100 MW integrated.
- When the transmission system is optimized, capability in the central east area is 0 MW; however, a small amount of generation can still be integrated into this area, although this could decrease overall system capability.
- Existing transmission capability identified in this 2019 Assessment is subject to change if planning assumptions change, or as new information becomes available.
- PENV will add up to 360 MW to overall system capability.
- As indicated in AESO's 2017 LTP, CRPC will add approximately 700 MW of generation integration capability in southwest. CETO will add approximately 1,000 MW of incremental integration capability depending on the replacement of existing coal-fired generation in the central east area.
- Integrating rooftop DER results in reducing the capability of the transmission system by 60 MW for every 100 MW integrated in the City of Calgary, and by 100 MW for every 100 MW integrated in the south and central east areas.
- Integration of DER in the cities of Edmonton and Red Deer up to a certain amount does not reduce the capability of the transmission system.

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