BC hydro
FOR GENERATIONS

[redacted]

Wart and Pothole Wind Farm Project
(Point of Interconnection on circuit 1L244)

Interconnection Feasibility Study

Report No: T&S Planning 2016-055

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British Columbia Hydro and Power Authority

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EXECUTIVE SUMMARY

[redacted] the Interconnection Customer (IC), is proposing to develop the Wart and Pothole Wind Farm facility (WPWX) to inject energy into the BC Hydro (BCH) system. The wind project, which consists of twenty 3.0 MW Vestas – Type 4 turbines, will be located in the Nicola – Thompson area of British Columbia.

The IC proposed two separate interconnection options for this wind farm, one connected on the 138 kV line, 1L244, between Nicola substation (NIC) and West Bank substation (WBK), and the other on 1L251 between NIC and Copper Mountain Mine substations (SCO/CUM). These two interconnection options are mutually exclusive and treated as two separate interconnection projects.

This report identifies the required system modifications at a preliminary level for interconnecting the wind farm to the BCH system on 1L244 only. The Point of Interconnection (POI) is a distance approximately 26.6 km from NIC and will be at a new (to-be-built) BCH owned three circuit-breaker station called Wart and Pothole Terminal Station (WPTX). The maximum power injection from WPWX into the BCH system at the POI is 58.3 MW and the proposed Commercial Operation Date (COD) is January 01, 2019.

The study of the WPWX project interconnection to the BCH Transmission System at the proposed POI has resulted in the following conclusions and requirements:

- A 138 kV three circuit breaker station with associated equipment is required at the POI to accommodate the WPWX project;
- No unacceptable transmission equipment overloads or unacceptable voltage conditions in the transmission system were observed in the power flow simulations due to the WPWX wind farm facility under pre-contingency (N-0) and post-contingency (N-1) steady-state scenarios;
- New line protection at WPTX terminal station is required. Modification of existing line protection at NIC station and another customer's wind farm station, Pennask and Shinnish (PSW), is required;
- Primary (PY) and Standby (SY) WECC Class-2 telecommunication is required between stations:
  - NIC and WPTX (1L244);
  - WPTX and PSW (1L258);
  - WPTX and WBK (1L258);
  - WPTX and WPWX (1L259);
- Islanded operation with existing BCH customers is not allowed for the Wart and Pothole Wind project. Power Quality protection (i.e. under and over voltage/frequency protection) is required at the WPWX facility.

Direct Transfer Trips (DTTs) to remove the IC's generation source may be required to minimize any potential impacts to WBK customers during the islanding conditions. Mitigation methods of the IC's transformer energization inrush current may also be needed. Both of these conditions will be studied in greater detail at the next SIS stage.

The non-binding good faith cost estimate for the above Network Upgrades necessary to interconnect the proposed combined project to the BCH Transmission System for a maximum injection of 58.3 MW is $26.5M. The estimated time to implement the identified Network Upgrades is up to 30-36 months.

The above estimate and schedule do not include the work associated with Revenue Metering nor does it include the work required within the IC's facilities. Within the WPWX facility, the IC is required to provide protection in accordance with "60 kV to 500 kV Technical Interconnection Requirements for Power Generators."

Additional Network Upgrade requirements may be identified in the System Impact Study (SIS) or Facilities Study (FS) stages. The Interconnection SIS and FS reports will provide greater details of the Interconnection Network Upgrade requirements and associated cost estimates and estimated construction timeline for this project.

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1.0 INTRODUCTION

The project reviewed in this Interconnection Feasibility Study report is as described in Table 1 below.

Table 1: Summary Project Information

Project Name	Wart and Pothole Wind Farm	
Interconnection Customer	[redacted]	
Point of Interconnection	Three circuit-breaker station on 1L244, 26.6 km from NIC	
IC Proposed COD	January 01, 2019	
Type of Interconnection Service	NRIS ☒	ERIS ☐
Maximum Power Injection at POI (MW)	58.3 (Summer)	58.3 (Winter)
Number of Generator Units	20	
Plant Fuel	Wind	

[redacted] the Interconnection Customer (IC), is proposing to develop a 60 MW wind generating facility near the Nicola – Thompson area in the South Interior region. The IC has requested two different Points of Interconnection (POIs) for their facility in two separate submissions, one on 1L244 and the other on 1L251. Both projects are mutually exclusive with each other and are treated separately.

The Wart and Pothole Wind Station (WPWX) has a total of 20 Wind Turbine Generators (WTGs), each with a capacity of 3.0 MW. All 20 WTGs are Vestas turbines proposed with Type 4 technology, i.e. Full Converter Units. Five WTGs are allocated to individual feeders with a total of four feeders that will bring in the maximum power (60 MW) generated from all 20 turbine units to a 34.5 kV bus. From the 34.5 kV bus, the power is stepped up to the 138 kV system through a single 83 MVA, 138/34.5 kV (high side Y-gnd) station transformer unit. The power will then be transmitted through an IC owned 8.1 km, 138 kV transmission line (designated temporarily as 1L259) into a new (to-be-built) BC Hydro (BCH) owned station called Wart and Pothole Terminal Station (WPTX). The WPTX switching station is the official Point of Interconnection (POI) and will be located approximately 26.6 km from Nicola Station (NIC) on 1L244 (NIC – WBK). The IC's proposed maximum injection into the BCH system at the POI, after accounting for station load and line losses, is 58.3 MW. The proposed Commercial Operation Date (COD) for this project is January 01, 2019.

Westbank station (WBK), located at the end of the 80 km circuit, 1L244, is BCH's second largest radially supplied load. There is presently an undergoing project called 'The West Kelowna Transmission Project' which will build a second 138 kV transmission circuit from an undetermined nearby station into Westbank (WBK) for providing N-1 supply capability. The estimated In-Service-Date (ISD) for the WBK project is Fall 2020. For the purposes of the feasibility study, the WBK transmission reinforcement project (i.e. second source at WBK) is assumed to be in service with the tie normally closed at all times.

This assumption will need to be reviewed in greater detail at the next study stage. Prior to the WBK 138 kV reinforcement project coming into service in 2020, the WPWX project will be radially connected on 1L244.

Appendix A illustrates the Nicola - Thompson electrical system with the proposed IC connection as well as higher priority queued projects in the area.

2.0 STUDY PURPOSE AND SCOPE

The Feasibility Study is a preliminary evaluation of the system impact and cost of interconnecting the proposed project to the BCH Transmission System. The study scope is restricted to power flow and short circuit analysis and investigates potential system constraints associated with the interconnection of the proposed project.

3.0 TERMS OF REFERENCE

This study investigates voltage and overloading issues of the transmission networks in the vicinity as a result of the proposed interconnection. BCH planning methodology and criteria in compliance with the North America Reliability Corporation (NERC) Mandatory Reliability Standards are used in the studies.

The Feasibility Study does not include stability analysis, harmonic mitigation, or electro-magnetic transient analysis. Operating restrictions and other factors for possible second contingency outages are also not studied at this stage. Subsequent system impact/facilities studies and internal network studies will determine the requirements for reinforcements or operating restrictions/instructions for the above mentioned types of events.

4.0 STUDY ASSUMPTIONS

The study is carried out based on the latest data and information submitted by the IC in April 2016 and the latest BC Hydro Interconnection Queue information. Reasonable assumptions are made to complete the study and the report, whenever such information is unavailable.
The power flow conditions studied include generation, transmission facilities, and load forecasts representing the queue position applicable to this project. Applicable seasonal conditions and the appropriate study years for the study horizon are also incorporated. The 2019 summer and winter system configurations were selected for this study.

The following assumptions were applied to the feasibility study base cases:

- Existing generation and higher priority queued projects in the Nicola - Thompson area such as Pennask and Shinnish Wind project (PSW) and Mount Mabel Wind project (MMWX) are included in the study.
- A second 138 kV transmission line into WBK from a nearby station is assumed. At the time of this study, the nearby station providing the source of the second line was not finalized. For the purposes of this WPWX feasibility study only, the station is assumed to be in the Fortis B.C. system with the tie at WBK assumed to be normally closed. This assumption will need to be reviewed and updated when this interconnection project moves to the next SIS stage.

Appendix B contains the power flow single line drawing reflecting the electrical orientation of the project within the BCH system. Appendix C provides other study assumptions.

5.0 STUDY RESULTS AND REQUIRED UPGRADES

The second 138 kV source at WBK, along with a higher queued, tap connected, wind project (Pennask & Shinnish Wind Farm - PSW) on 1L244, makes it necessary to build a new BCH owned three circuit breaker station called Wart and Pothole Terminal Station (WPTX) at the POI to accommodate the WPWX wind farm facility. With the addition of the new WPTX switching station, circuit 1L244 (NIC-WBK) will be sectionalized into two 138 kV lines, one between NIC and WPTX which will still be designated as 1L244 and one between WPTX and WBK which will be designated as 1L258.

The BC Hydro Stations summary of work is as follows:

- Design, supply, install and commission a new 138 kV switching station;
- Station initially to be built in a 2000 A rated, three breaker ring configuration. Provision will be made to expand the ring by one breaker.

The following protection work is required at BCH stations:

- New line protection is required at WPTX terminal station. Protection modifications are required at NIC and PSW stations;
- Primary (PY) and Standby (SY) WECC Class-2 telecommunication circuits are required between stations:
  - NIC and WPTX (1L244);
  - WPTX and PSW (1L258);
  - WPTX and WBK (1L258);
  - WPTX and WPWX (1L259).

Before and after the WBK 138 kV reinforcement project comes into service, there are no pre-contingency (N-0) or single contingency (N-1) steady-state transmission equipment over-loading problems or voltage violation conditions identified for the proposed maximum power injection from Wart and Pothole Wind project into the BCH system. Thus, other than the new WPTX station, there are no further upgrades of transmission elements required elsewhere at this study stage.

The IC is required to provide entrance protection and redundant protection for the IC's line, 1L259, in accordance with BC Hydro's "60 kV to 500 kV Technical Interconnection Requirements for Power Generators." Also required at WPWX are 138 kV Voltage Transformers (VTs) for power quality protection.

Islanded operation of the WPWX facility with existing loads, WBK and BDM, is not allowed. The loss of circuit 1L244 (prior to the WBK second source in service) or loss of both 1L244 and WBK second source will cause an islanded condition with WPWX and existing BCH customers. In addition to Power Quality protection, Direct Transfer Trips (DTTs) may likely also be needed and will be studied in greater detail at the next SIS stage.

Mitigation of the IC's transformer energization inrush current may be required to avoid potential voltage sag and power quality impacts on other BCH customers. At the next SIS stage, BCH will review and provide comments on the IC's proposed solution/configuration to meet the power quality requirements.

At this study stage, there are no Remedial Action Schemes (RAS) or special protection and control facilities specified to address or mitigate potential problems that may be identified as a result of future stage studies.

6.0 COST ESTIMATE AND PROJECT SCHEDULE

Table 2 below lists the facilities and system upgrades required in the BCH system to interconnect the proposed project to the system. It also provides a non-binding good faith cost estimate for the Network Upgrades that would be the responsibility of the IC. The cost estimate or the project schedule does not include any of the work on Revenue Metering.

Table 2: Cost Estimate for the Required System Upgrades

Work Definition	**Facilities**	Estimated Cost
Stations, P&C, and Telecommunication	Build a new 138 kV three circuit breaker station. Addition, modification, and review of protection at various sites with associated upgrades.	
	Estimated Interconnection Network Upgrade Cost:	**$28.2M**

The estimated time to implement the Network Upgrades required to interconnect the project to the BCH system is indicated in Table 3 below. This estimate assumes subsequent study work has been completed and a Standard Generator Interconnection Agreement has been executed.

Table 3: Estimated Project Schedule

0 - 6 months	☐	36 - 42 months	☐
6 -12 months	☐	42 -48 months	☐
12- 18 months	☐	48- 54 months	☐
18 - 24 months	☐	54 - 60 months	☐
24 – 30 months	☐	60 – 66 months	☐
30 - 36 months	☒	66 – 72 months	☐

7.0 CONCLUSIONS & DISCUSSION

The interconnection of the WPWX project to the BCH Transmission System at the proposed POI, WPTX, has resulted in the following conclusions and requirements:

- A 138 kV three circuit breaker station with associated equipment is required at the POI to accommodate the WPWX project;
- Before and after the WBK reinforcement project comes into service, no unacceptable transmission equipment overloads or unacceptable voltage conditions in the transmission system were observed in the power flow simulations due to the WPWX wind farm facility under pre-contingency (N-0) and post-contingency (N-1) steady-state scenarios;
- New line protection at WPTX terminal station and modification of existing line protection at NIC (BCH) and PSW (another customer's) stations is required to accommodate the addition of the WPWX facility;
- Primary (PY) and Standby (SY) WECC Class-2 telecommunication is required between stations:
  - NIC and WPTX (1L244);
  - WPTX and PSW (1L258);
  - WPTX and WBK (1L258);
  - WPTX and WPWX (1L259);

- Islanded operation with existing BCH customers is not arranged for the Wart and Pothole Wind project. Inadvertent islanding conditions will be caused by:
  - Protective or non-protective tripping of the NIC or WPTX terminal breakers for 1L244 (and WBK 138 kV second circuit is out-of-service or prior to coming in-service) or;
  - Protective or non-protective tripping of the NIC or WPTX terminal breakers for 1L244 and loss of WBK 138 kV second circuit or;
  - Protective or non-protective tripping of WBK 138 kV second circuit (with 1L244 out-of-service).

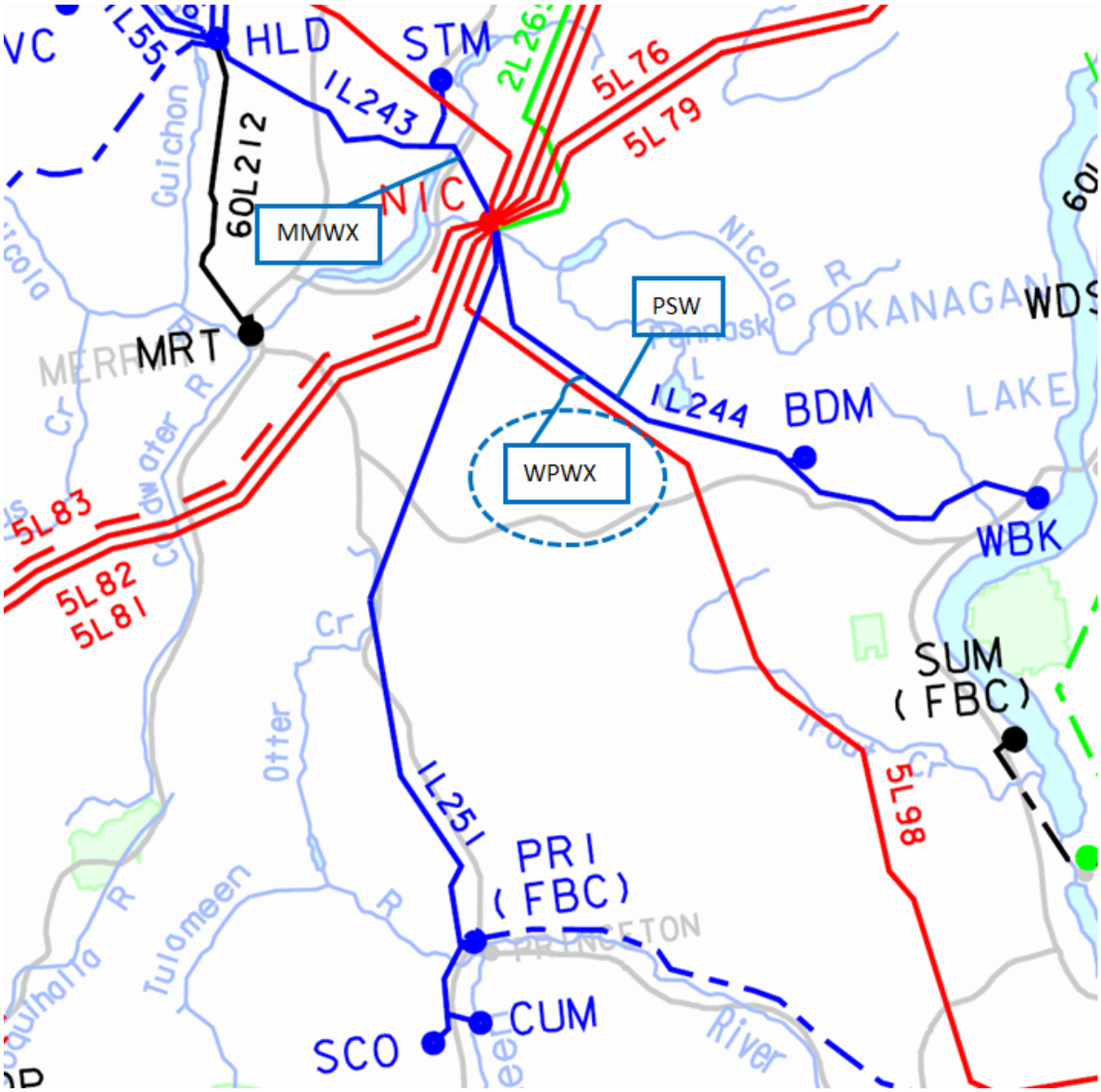
Direct Transfer Trips (DTTs) to remove the IC's generation source may be required to minimize any potential impacts to WBK customers during the islanding conditions. Mitigation methods of the IC's transformer energization inrush current may also be needed. Both of these conditions will be studied in greater detail at the next SIS stage.

The IC is required to provide entrance protection and redundant protection for the IC's line, 1L259, in accordance with BC Hydro's "60 kV to 500 kV Technical Interconnection Requirements for Power Generators." At the WPWX facility, 138 kV Voltage Transformers (VTs) are required for power quality protection.

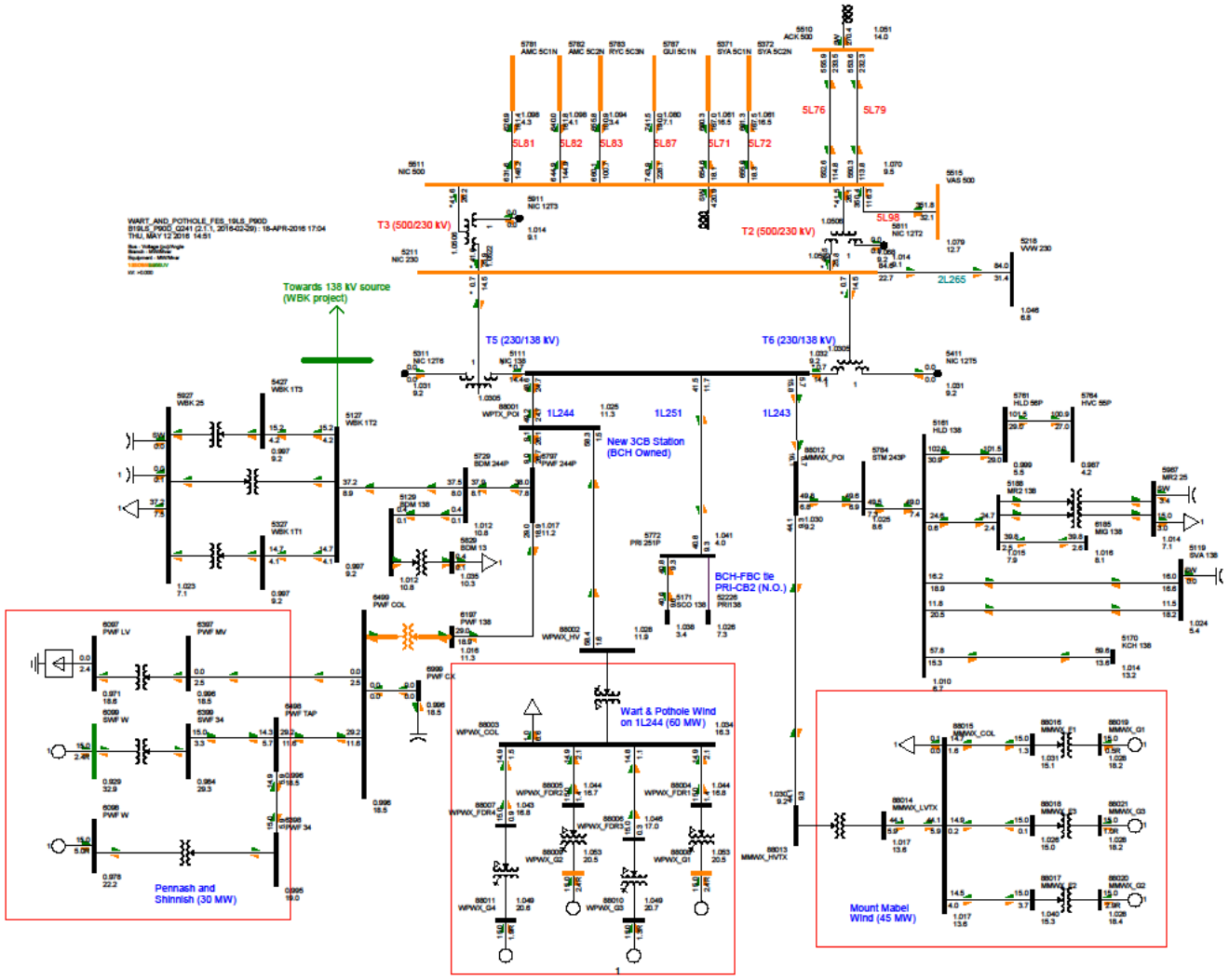
Please note that the above conclusions are based on the steady state power flow study results. Other system performance measures such as transient stability, transient overvoltage, etc., have yet to be determined. Those issues will be dealt with in the System Impact Study stage and may indicate the need for additional network upgrades. This study does not include stability analysis, harmonic mitigation, electro-magnetic transient analysis, and other analytical studies or calculations or site visits. Equipment that may be determined during future stage studies is not included in the cost estimate nor considered in the estimated schedule provided herein.

Additional Network Upgrade requirements may be identified in the System Impact Study (SIS) or Facilities Study (FS) stages. The Interconnection SIS and FS reports will provide greater details of the Interconnection Network Upgrade requirements and associated cost estimates and estimated construction timeline for this project.

APPENDIX A – PROJECT LOCATION MAP



APPENDIX B – SINGLE LINE DIAGRAM



APPENDIX C – OTHER ASSUMPTIONS

Assumptions related to the BCH transmission system:

Power Flow

Power flow study is based upon the base case that includes generation, transmission facilities, and load forecast representing the queue position applicable to the study of this project. Applicable seasonal conditions and the appropriate number of study years for the study horizon have also been incorporated.

Short Circuit

Short circuit study is based upon the complete short circuit model of BC Hydro System including contributions from the interconnecting utilities and private power generators. The model not only includes the existing facilities but also all those under construction.

Financial and Estimating Assumptions

Cost estimates are based on an order of magnitude assumption and are non-binding and provided in good faith. The cost estimate included in this report does not and cannot account for a variety of issues not under the control of BCH including, but not limited to:

- The impact of additional equipment required as the result of more detailed studies;
- Actual equipment specified during engineering design;
- Fluctuations in costs over time;
- First Nation considerations;
- Property-related costs and issues;
- Any Certificate of Public Convenience and Necessity (CPCN) required from the British Columbia Utilities Commission (BCUC);
- Physical space constraints in network facilities.

