BC Hydro
Power smart

6911 Southpoint Drive (B03)
Burnaby, BC
V3N 4X8

July 30, 2024

[redacted]

[redacted]

[redacted]

RE: CEAP IR 97 - St George Wind Project - Interconnection Feasibility Study Report

Enclosed is the Interconnection Feasibility study report for the proposed St George Wind Project submitted under Attachment M-2: Transmission Service and Interconnection Service Procedures for Competitive Electricity Acquisition Process (CEAP) of the Open Access Transmission Tariff (OATT). This letter provides a non-binding good faith estimate of the cost and time to construct the facilities required to interconnect your project to BC Hydro's Transmission System, being the Network Upgrades, based on the findings of the Interconnection Feasibility study.

Open Access Transmission Tariff

The OATT defines Network Upgrades as additions, modifications, and upgrades to BC Hydro's Transmission System required at or beyond the Point of Interconnection to accommodate the interconnection of the Generating Facility to the BC Hydro's Transmission System. Pursuant to the OATT, BC Hydro will design, procure, construct, install, and own the Network Upgrades. While BC Hydro will pay the costs for the Network Upgrades, the Interconnection Customer provides security for such costs.

Cost Estimate

Based on the Interconnection Feasibility study, the non-binding good faith estimated cost (typical accuracy range of +150%/-50%) for Network Upgrades required to interconnect your project is $11.2 M.

Major Scope of Work Identified:

- Supply and install one 230kV line position with the associated substation equipment at BC Hydro Williston (WSN) substation
- Supply and install protection relays and other required protection / telecom equipment

Exclusions:

- GST
- Right-of-Way or Property costs
- Permits

Key Assumptions:

- Construction will be done by contractor
- 2 years of construction is considered
- Early Engineering and Procurement
- No expansion of station or control building required to accommodate new equipment
- No piles or ground improvements will be required
- No contaminated soil will be encountered during construction

Key Risks:

- No defined supply chain strategy, construction costs may increase depending on delivery method
- Cost of construction may increase based on geotechnical condition of the actual project site
- Project schedule may be longer than expected, leading to increased costs
- Costs materials and major equipment be affected by market conditions and escalation

Please note that the Revenue Metering requirements and associated costs required to interconnect your project have not been determined at this stage and, therefore, not included in the above estimate. Revenue Metering costs that are attributable to the Interconnection Customer are to be paid in cash. For more details on Revenue Metering requirements and responsibilities, please refer to:

https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/distribution/standards/ds-rmr-complex-revenue-metering.pdf.

Schedule

Based on the Interconnection Feasibility study, the non-binding good faith estimated in-service date for your project's Network Upgrades is Quarter 3 2029 (calendar year). To achieve this timeline, we may need to expedite certain activities, including engineering design and procurement of long-lead equipment.

Timely actions required from you to minimize risks to the schedule:

- Submission of additional technical data required for the System Impact Study and Facilities Study
- Submission of any required information or document such as demonstration of Site Control
- Execution of Combined Study Agreement and Standard Generator Interconnection Agreement
- Financial commitments and securities

Please note that changes to your interconnection request, delays in data submission, or financial commitments may also impact the target in-service date.

Next Steps

In September 2024, we will issue a final invoice for the Feasibility Study costs. This invoice will reflect the total amount due, taking into account the $15,000 Feasibility Study deposit you have already paid and any remaining amount on the non-refundable $15,000 Interconnection request deposit that we did not spend in reviewing and validating your interconnection request.

If you have any questions, please contact the BC Hydro CEAP Team at ceap2024@bchydro.com.

Sincerely,

Senior Manager, Transmission Interconnections

BC Hydro

Encl.: CEAP2024_IR_97_St George Wind_FeS_Report_final.pdf

[redacted]

St. George Wind Project

Interconnection Feasibility Study

BC Hydro EGBC Permit to Practice No: 1002449

2024 CEAP IR # 97

Prepared for: [redacted]

[redacted]

Report Metadata

Header:	St. George Wind Project
Subheader:	Interconnection Feasibility Study
Title:	St. George Wind Project
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Additional Metadata:	Transmission Planning 2024-099 Filing Subcode 1350

[redacted]

Revisions

Revision	Date	Description
0	2024 Jul	Initial release

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Executive Summary

[redacted] the interconnection customer (IC), requests to interconnect its St.George Wind Project (2024 CEAP IR # 97) to the BC Hydro system. St.George Wind Project has forty-seven (47) [redacted] Type 4 wind turbine generator with total installed capacity of 197.4 MW. The IC's proposed Point of Interconnection (POI) is at the 230 kV bus of BC Hydro's Williston substation (WSN). The IC's project will connect to the POI via a 28 km customer-built 230 kV interconnection line. The proposed commercial operation date (COD) is Oct 8, 2028.

To interconnect the St. George Wind Project and its facilities to the BCH Transmission System at the proposed POI, this Feasibility Study has identified the following conclusions and requirements:

1. A new 230 kV line position at WSN is required to interconnect the proposed St. George Wind Project to the BC Hydro system.
2. The connection of St. George Wind Project does not cause any performance violation (i.e. thermal overload, voltage performance violation or voltage stability concern) under system normal conditions.
3. The connection of St.George Wind Project will exacerbate the existing thermal overloads on 500 kV lines under single 500 kV line contingencies or Williston (WSN) 500kV internal breaker faults, non-firm transfer conditions, and during the summer and winter load operations.

   IC is required to participate in the existing generation shedding RAS to mitigate the potential thermal overloads.
4. In addition to entrance protection and 2LXXX line protection, the IC is required to install anti-islanding protection within their facility to disconnect the IC's wind farm from the grid when an inadvertent island with the BC Hydro local loads forms.
5. The proposed IC owned interconnectiopn line 2LXXX will become an IC's Bulk Electric System (BES) line and the IC will be responsible for the compliance with applicable NERC MRS requirements.

6. According to BC Hydro's TIR, the IC's project must have sufficient reactive power capability over full MW operating range including at the zero MW output level. The St. George Wind farm as submitted does not meet the reactive capability requirement at 0 MW output level, which will need to be addressed.

7. BC Hydro will provide line protections for 2LXXX at BC Hydro's Williston Substation (WSN) (BC Hydro end only). As part of the line protection addition, telecommunication facilities will be required between WSN and St. George Wind (P97) to accommodate the new protection schemes. The IC shall provide required relays, telecom facility and associated equipment at its facilities to accommodate the new protection schemes.

The above conclusions are made based on the IC's input data and study assumptions listed in Section 4, which represent the best available information on May 22, 2024.

A non-binding good faith estimated cost and time to construct the Network Upgrades required to interconnect the proposed project will be provided in a separate letter to the IC.

Contents

Appendices

Acronyms

The following are acronyms used in this report.

BCH	BC Hydro
CEAP	Competitive Electricity Acquisition Process
COD	Commercial Operation Date
DTT	Direct Transfer Trip
ERIS	Energy Resource Interconnection Service
FeS	Feasibility Study
IBR	Inverter-Based Resources
IC	Interconnection Customer
LAPS	Local Area Protection Schemes
MPO	Maximum Power Output
NERC	North American Electric Reliability Corporation
NRIS	Network Resource Interconnection Service
OATT	Open Access Transmission Tariff
POI	Point of Interconnection
RAS	Remedial Action Scheme
TIR	BC Hydro “60 KV to 500 kV Technical Interconnection Requirements for Power Generators”
WECC	Western Electricity Coordinating Council
WTG	Wind Turbine Generator
GMS	Gordon M. Shrum
PCN	Peace Canyon
STC	Site C
EDM	Edmonds Office
FVO	Fraser Valley Office
HAM	Hamilton Microwave Repeater
SIC	South Interior Control
SIO	South Interior Office

1 Introduction

Table 1-1 below summarizes the project reviewed in this Feasibility Study.

Table 1-1 Summary of Project Information

Project Name	St.George Wind Project	
Name of Interconnection Customer (IC)	[redacted]	
Point of Interconnection (POI)	Williston substation 230 kV bus	
IC's Proposed COD	8th October 2028	
Type of Interconnection Service	NRIS ☒	ERIS ☐
Maximum Power Injection [1] (MW)	193 MW (Summer)	193 MW (Winter)
Number of Generator Units	47 x 4.2 MW	
Plant Fuel	Wind	
Note 1: The maximum achievable power injection at the POI is approx. 193 MW after accounting for MW losses and service load which is lower than the IC proposed 197.4 MW.		

[redacted], the interconnection customer (IC), requests to interconnect its St.George Wind Project (2024 CEAP IR # 97) to the BC Hydro system. St.George Wind Project has forty-seven (47) [redacted] Type 4 wind turbine generator with total installed capacity of 197.4 MW. The IC's proposed Point of Interconnection (POI) is at the 230 kV bus of BC Hydro's Williston substation (WSN), The IC's project will connect to the POI via a 28 km customer built 230 kV interconnection line. The proposed commercial operation date (COD) is Oct 8, 2028.

Figure 1-1 shows the G.M.Shrum-Williston transmission system diagram. Williston substation is a major substation in this area with two 500/230 kV transformers (WSN T2 & T4) and three 230/138 kV transformers (WSN T5, T6 & T7). WSN substation currently operates with total seven 500 kV transmission lines, three 500 kV transmission lines (5L1, 5L2, and 5L7) connecting to Gordon M. Shrum (GMS) station, one 500 kV line (5L61) linking to the Glennanan (GLN) substation in North Coast area and three 500 kV lines (5L11, 5L12, 5L13) supplying Kelly Lake (KLY) 500 kV substation.

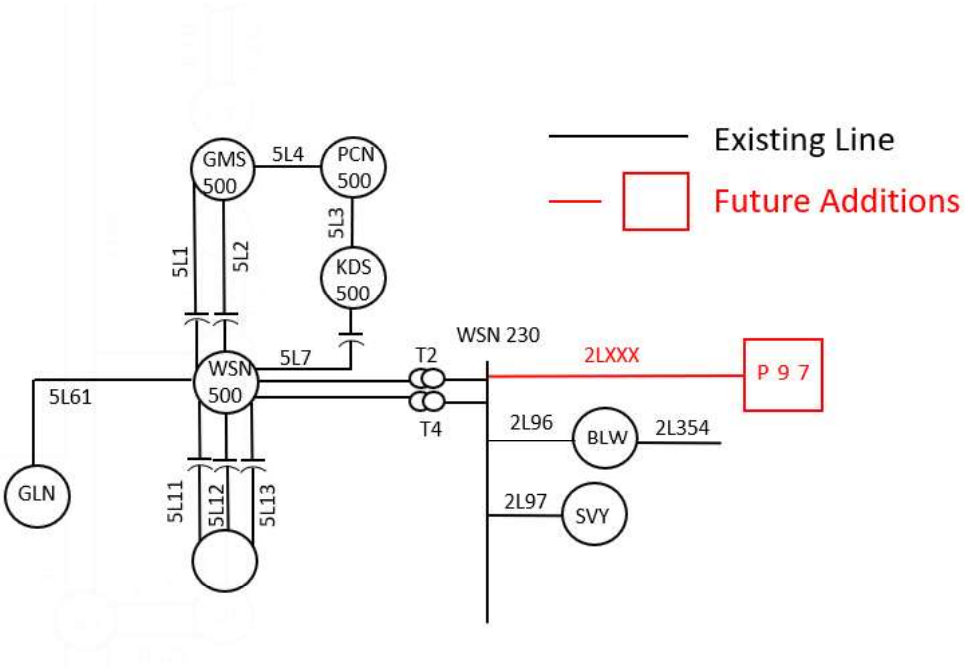

Figure 1-1: GMS-WSN Region 500/230 kV Transmission System Diagram in 2024 with the Proposed St.George Wind Project Interconnection

2 Purpose and Scopes of Study

This Feasibility Study is a preliminary evaluation of the system impact of interconnecting the proposed project to the BC Hydro system based on power flow and short circuit analysis in accordance with BCH's Open Access Transmission Tariff (OATT). A non-binding good faith estimated cost of required Network Upgrades and estimated time to construct will be provided.

Per OATT, the Feasibility Study is performed individually for each of the participating projects in the CEAP and focuses specifically on the BC Hydro regional transmission system where the proposed generating project is proposed to be constructed. An assessment of the incremental effect on the 500kV bulk transmission system is beyond this study scope.

This is a "limited scope" study which is restricted to power flow studies of P0, P1 and P2 planning events as defined in TPL-001-4 and short circuit analysis. The study does not address other technical aspects such as transient stability and switching transients and impact of multiple contingencies. These subjects would be addressed in subsequent System Impact Study if the project is a Successful Participant of the CEAP.

In case impact to the adjacent external systems to BC Hydro is observed, such impact would be addressed in subsequent detailed and coordinated studies with the relevant adjacent entities if the proposed interconnection proceeds further.

3 Standard and Criteria

The Feasibility Study is performed in compliance with the North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) reliability standards, and the BCH interconnection requirements in the TIR, and upon the ratings of the existing BCH transmission facilities described in Operating Orders, specifically:

- NERC standards: TPL-001-4 and FAC-002-3 relevant to the scope of this Feasibility Study.
- WECC criteria TPL-001-WECC-CRT-4 Transmission System Planning Performance, July 1, 2023.
- BC Hydro's 60 kV to 500 kV Technical Interconnection Requirements for Power Generators.
- BC Hydro Operating Order 5T-10, Ratings for All Transmission Circuits 60 kV or Higher, April 16, 2024.
- BC Hydro Operating Order 5T-14, Ratings for All Transmission and Distribution Transformer, November 8, 2022.
- BC Hydro System Operating Order 7T-22 System Voltage Control, September 19, 2023.

4 Assumptions and Conditions

This Feasibility Study is performed based on the IC's submitted data and information available to BC Hydro on May 22, 2024 for the study purpose. Appendix A shows the plant single line diagram for the IC's project used in the study model. Certain assumptions were, as set out below, made to the extent required.

The power flow study cases used in this Feasibility Study are established based upon the BC Hydro's base resource plan and load forecasts available at the time of performing the study, which includes existing and future generations, transmission facilities, and loads in addition to the subject interconnection project in this study. Applicable seasonal conditions and the appropriate study years for the study planning horizon are also incorporated.

Additional assumptions are listed as follows.

1) The regional generation are dispatched to the patterns that stress the transmission system in the study area. In these patterns, the regional generations are typically set to their Maximum Power Outputs (MPO) unless otherwise specified.
2) The study considers firm and non firm transmission service under system normal and single contingency conditions.

5 System Studies and Results

Based upon the IC's submitted information and the area system conditions, the proposed POI is at the 230 kV bus of WSN substation, approx. 28 km from the IC's substation. A new 230 kV line position at WSN with associated substation equipment is required to interconnect the IC's generating project to the BCH system. The proposed new line 2LXXX from WSN to IC's substation (P97) will become an IC's Bulk Electric System (BES) line and the IC will be responsible for the compliance with applicable MRS requirements.

5.1 Power Flow Study Results

Power flow studies were performed to evaluate whether the IC's generating project would cause any unacceptable system performance (e.g. equipment overloads, steady-state voltage violation and voltage instability) and to determine the reinforcement requirement based on steady state performance analysis.

The study focuses on the 2029 light summer (29 LS) system load condition which is typically a stressed condition for a generation interconnection project, taking into considerations of factors such as load conditions, seasons and generation patterns. The 2029 heavy summer (29HS) and 2028 heavy winter (28HW) cases are also checked at a high level to capture any possibility of performance violations under high load conditions.

5.1.1 Branch Loading Analysis

Table 5-1 shows a summary of branch loading analysis under system normal and single contingencies (P1, P2) for various load conditions.

The study finds no transformer or line overload under system normal operating conditions for all three load conditions studied.

Under system single contingencies, the following thermal overloads have been identified:

- The connection of St.George Wind farm will exacerbate the pre-existing thermal overload on the BC Hydro 500 kV lines 5L11/5L12/5L13 (Kelly Lake – Williston) under single 500 kV contingencies or WSN 500 kV breaker internal fault (WSN 5CB5, 5CB15, 5CB7, 5CB17, 5CB14, 5CB13),

with high generation outputs in the Peace River area and under non-firm transfer operations in both summer and winter conditions.

St. George wind farm is required to participate in the existing generation shedding RAS to mitigate the potential thermal overload issue. The overload detection mechanism and exact omitigation actions will be determined in discussion with BCH at the next study stage.

Table 5-1: Summary of Branch Loading Analysis Results

Case	IC's Plant Output	Contingency		Branch Loading	
				5L12	5L13
		Cat.	Description	WSN-KLY	WSN-KLY
Winter Rating				1950 A	1950 A
28HW	MaX	P0	System Normal	73%	74%
	Max	P2.3	WSN 5CB13	105%	107.1%
Summer Rating				1950 A	1950 A
29HS	Max	P0	System Normal	74%	75%
	Max	P2.3	WSN 5CB13	120.3%	122.9%
29LS	Max	P0	System Normal	86%	87%
	Max	P2.3	WSN 5CB13	122%	124.5%

5.1.2 Steady-State Voltage Analysis

With the connection of the IC's project, the voltage performance under system normal condition and single contingencies is acceptable for all the three load conditions (29LS, 29HS, 28HW). Table 5-2 shows a summery of steady-state voltage performance under various system conditions and contingencies.

Table 5-2: Summary of Steady-State Voltage Study Results

Case	IC's Plant Output	Contingency		Bus Voltage (P.U.)
		Cat.	Description	WSN 230
28HW	Max	P0	System normal	1.0
	0	P0	System normal	1.0
	Max	P2.3	WSN 5CB13	0.96
29HS	Max	P0	System normal	1.0
	0 MW	P0	System normal	1.0
	0 MW	P2.3	WSN 5CB13	0.95
29LS	Max	P0	System normal	1.0
	0 MW	P0	System normal	1.0
	Max	P2.3	WSN 5CB13	0.96

5.1.3 Reactive Power Capability Evaluation

The BC Hydro TIR requires IBR power plant to have the dynamic reactive power capability at a minimum of +/- 33% of its MPO at the high voltage side of the IC's switchyard over the full MW operating range.

Based on the PSS/E power flow data submitted by the IC, the proposed generating project would be capable to meet the BC Hydro's reactive capability requirement at the plant's maximum MW output, which is subjected to further verification in the next stage of interconnection study.

Furthermore, the BCH TIR requires the IC's project to provide sufficient reactive power capability over full MW operating range including at zero MW output level. The proposed wind farm does not meet this requirement at near zero MW output, which will need to be addressed.

5.1.4 Anti-Islanding Requirements

The IC is required to install anti-islanding protection within its facility to disconnect the IC's wind farm from the grid when an inadvertent island with the local load forms.

5.2 Fault Analysis

The short circuit analysis in the FeS is based upon the latest BC Hydro system model, which includes the generating facility information and associated impedance data provided by the IC. A more detailed study will be performed at the system impact study stage if needed.

5.3 Stations Requirements

A new 230 kV line position will be built at the proposed POI. The Point of Interconnection (POI) is on the 230 kV bus of BC Hydro's Williston Substation (WSN), approx. 28 km from customer's IC.

To interconnect this customer, the following is the station work required at WSN substation:

- Add one 230 kV line position with the associated substation equipment. Refer to the Appendix B one-line diagram for details.
- Terminate the St. George Wind customer line.

- Other associated station work.

5.4 Protection & Control Requirements

For successful integration of the new IPP, BC Hydro will provide line protections for 2LXXX at BC Hydro's Williston Substation (WSN) (BC Hydro end only). As part of the line protection replacements for each of the three lines, telecommunication facilities will be required between WSN and St. George Wind (P97) to accommodate the new protection schemes.

The IC is to provide the following for the interconnection of St. George Wind (P97):

- Entrance protection that complies with the latest version of the "60 kV to 500 kV BC Hydro Technical Interconnection Requirements for Power Generators."
- Provide two SEL-411L-1 relays (firmware and options specified by BC Hydro) relays at the entrance of St. George Wind (P97) to provide protection coverage for 2LXXX. BC Hydro P&C Planning will provide core protection settings for these relays to protect transmission line 2LXXX from WSN to the IC during a transmission line fault. Non-core protection such as local breaker failure, auto-reclosing, backup protection for station elements will not be provided by BC Hydro P&C Planning.
- The IC is responsible for NERC PRC-related tasks, settings to compliance standards within their facilities.
- The IC is responsible for providing a communications link for remote interrogation of the line protection relays and PPIS equipment by BCH servers.
- Provide anti-islanding protection as per Regional System Planning requirements.

The runback schemes or RAS requirements stated in Section 5.1 are mainly to address the overloading concerns under contingencies, which are preliminary. These RAS requirements may utilize the communication channels required for protection purposes included in the cost estimate. If the proposed project proceeds through the CEAP process, subsequent System Impact Studies may identify additional RAS requirements for this interconnection. These RAS functional requirements will include initiating events, control actions, and latency times. Depending on these supplementary requirements, additional telecommunication

facilities may be needed to facilitate signal transmission between the BC Hydro substations and customer facilities.

5.5 Telecommunications Requirements

BC Hydro performed a high-level feasibility assessment of a telecom solution to meet the following requirements.

Teleprotection Requirements for Telecom

- Provide WECC Level 3 64 kbps synchronous circuits between WSN and P97 for “WSN-P97 2LXXX PY DIGITAL TELEPROT” and “WSN-P97 2LXXX SY DIGITAL TELEPROT”. Physical interface shall be C37.94 optical over multimode fibre using ST connectors.

Telecontrol Requirements for Telecom

- Provide P97 SCADA circuits to FVO and SIO.

Other Requirements for Telecom

- None identified.

Certain assumptions were made for determining a potential telecom solution. Details of the telecom solution (e.g. assumptions made, alternatives investigated and work required for BCH and the IC) would be provided at the next study stage.

6 Cost Estimate and Schedule

The non-binding good faith estimated cost and time to construct the Network Upgrades required to interconnect the proposed project will be provided in a separate letter to the IC.

7 Conclusions

To interconnect the St. George Wind Project and its facilities to the BCH Transmission System at the POI, this Feasibility Study has identified the following conclusions and requirements:

1. A new 230 kV line position at WSN is required to interconnect the proposed St. George Wind Project to the BC Hydro system.

2. The connection of St. George Wind Project does not cause any performance violation (i.e. thermal overload, voltage performance violation or voltage stability concern) under system normal conditions.

3. The connection of St.George Wind Project will exacerbate the existing thermal overloads on 500kV lines under single 500 kV line contingencies or WSN 500kV breaker internal faults, non-firm transfer conditions, and during the summer and winter load operations.

   IC is required to participate in the existing generation shedding RAS to mitigate the potential thermal overloads.

4. In addition to entrance protection and 2LXXX line protection, the IC is required to install anti-islanding protection within their facility to disconnect the IC's wind farm from the grid when an inadvertent island with the BCH local loads forms.

5. The proposed new IC owned interconnecting line 2LXXX will become an IC's BES line and the IC will be responsible for the compliance with applicable NERC MRS requirements.

6. According to BC Hydro's TIR, the IC's project must have sufficient reactive power capability over full MW operating range including at the zero MW output level. The St. George Wind farm as submitted does not meet the reactive capability requirement at 0 MW output level, which will need to be addressed.

7. BC Hydro will provide line protections for 2LXXX at BC Hydro's Williston Substation (WSN) (BC Hydro end only). As part of the line protection addition, telecommunication facilities will be required between WSN and St. George Wind (P97) to accommodate the new protection schemes. The IC shall provide required relays, telecom facility and associated equipment at its facilities to accommodate the new protection schemes.

Appendix A
Plant Single Line Diagram Used for Power Flow Study

Figure A-1 shows St.GeoregWind Project single line diagram used for power flow study.

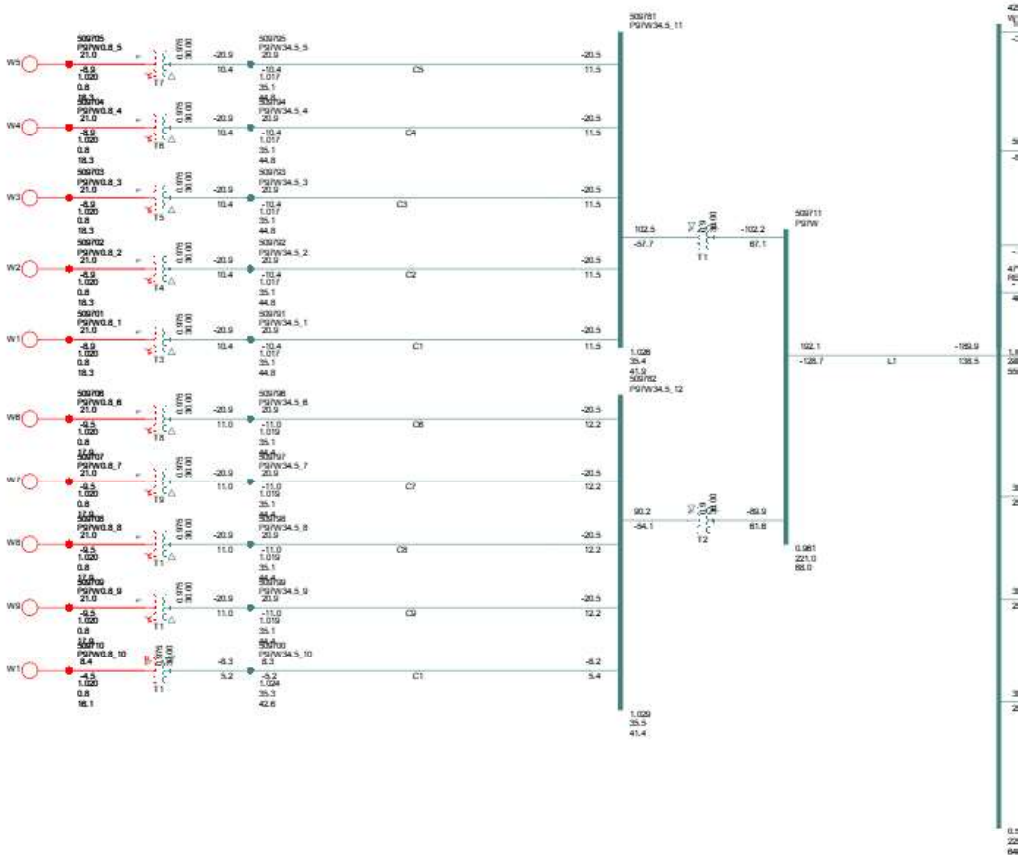

Figure A-1: St.George Wind Project Single Line Diagram for Power Flow Study.

As seen in the diagram, St.George Wind Project has two main power transformers dividing the plant into two parts.

- Part 1 has two (2) feeders connecting 25 wind turbines to the collector station.
- Part 2 has three (3) feeders connecting 22 wind turbines to the collector station.

Appendix B
One-Line Sketch at Williston Substation 230 kV

Figure B-1 shows the Stations Planning One-Line Sketch at WSN 230kV Substation.

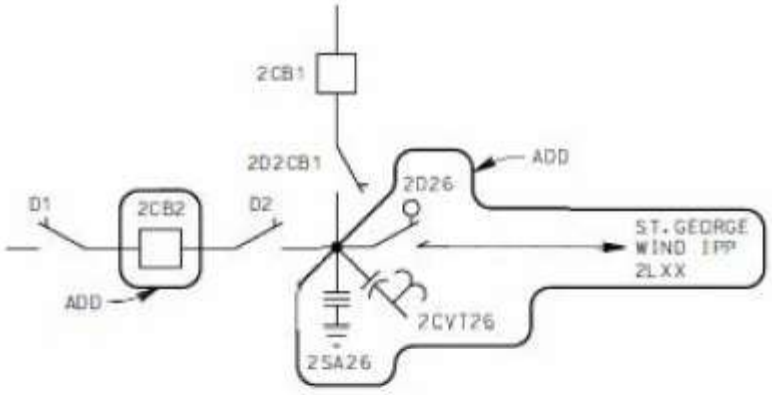

Figure B-1: WSN 230 kV Substation Planning One-Line Sketch

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