Interconnection System Feasibility Study

[redacted]
Zonnebeke Wind Project

Report No: T&S Planning 2015-053

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FINAL

British Columbia Hydro and Power Authority

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This report was prepared and reviewed by T&D, Interconnection Planning and approved by both Interconnection Planning and Transmission Generator Interconnections.

Revision Table

Revision Number	Date of Revision	Revised By

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EXECUTIVE SUMMARY

[redacted] the Interconnection customer (IC), is proposing to develop the Zonnebeke Wind Project in the Peace Region of British Columbia. The wind farm will have 10 Enercon [redacted] 3 MW [redacted] wind turbines, scattered in three clusters, with a total output of 30 MW. Three 34.5 kV feeders connect the three clusters to the Zonnebeke Wind station (ZBW). An IC built 8.2 km 230 kV transmission line connects ZBW to the Transmission System at BCH's Sukunka (SNK) station in the Peace Region. The project proposed Commercial Operation Date (COD) is December 31 2018.

In the Peace Region, BCH plans to develop the Site C generating project and the Peace Region Electricity Supply (PRES) Project, and the scheduled in-service dates for both projects are around 2024. With the two projects in service, the Peace Region power grid configuration will be substantially different from the present. The Feasibility Study for connecting Zonnebeke Wind Farm (ZBW) to SNK has been performed for both pre and post Site C and PRES scenarios. The study has concluded that:

- A new line terminal is required at SNK to terminate the IC's 230 kV line (2LXXX), and new line protections and associated telecom facilities would be added.
- No unacceptable voltage violation conditions in the Transmission System under system normal (N-0) and single contingency (N-1) conditions due to the interconnection of Zonnebeke Wind farm were observed in the power flow analysis.
- Zonnebeke is not observed to cause any equipment overload under system normal condition (N-0). Under single contingencies, Zonnebeke would exacerbate some pre-existing circuit overloads. Peace Region Load/Generation Shedding RAS (Remedial Action Scheme) is being implemented to resolve the pre-existing over-load conditions under contingencies. Zonnebeke Wind Farm may be required to participate in the generation shedding RAS.
- Wind Farm's protection should detect an islanding situation and disconnect itself from the Transmission System when such an event occurs.
- The IC shall provide entrance protection, power quality protection and line protection in accordance with the "60 kV to 500 kV BC Hydro Technical Interconnection Requirements for Power Generators".

The good faith non-binding cost estimate to complete the BCH Network Upgrades required for the Zonnebeke Wind Farm connection is $8.865 million. The cost to implement the requirements on the IC's side is not part of this estimate.

These upgrades can be expected to be completed in approximately 18-24 months after the Standard Generation Interconnection Agreement (SGIA) is executed and the implementation phase funding is approved.

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1.0 INTRODUCTION

[redacted] the Interconnection Customer (IC), is proposing to develop the Zonnebeke Wind Project in the South Peace Region of British Columbia. Ten Enercon [redacted] wind turbines will be installed. The maximum output from each wind turbine is 3 MW. The wind turbines will be installed in three clusters in groups of 5, 3 and 2 respectively.

The IC will built three 34.5 kV feeders to connect the clusters to a common collector station. The equivalent lengths of the three 34.5 kV feeders are 1.69 km, 3.28 km and 1.12 km respectively. At the collector station, voltage is stepped up from 34.5 kV to 230 kV for transmission purpose. The IC builds an 8.2 km 230 kV transmission line to connect to the Point of Interconnection (POI) at BCH Sukunka (SNK) station. The proposed Commercial Operation Date (COD) is December 31 2018. The following table provides a summary of the Zonnebeke Wind Project.

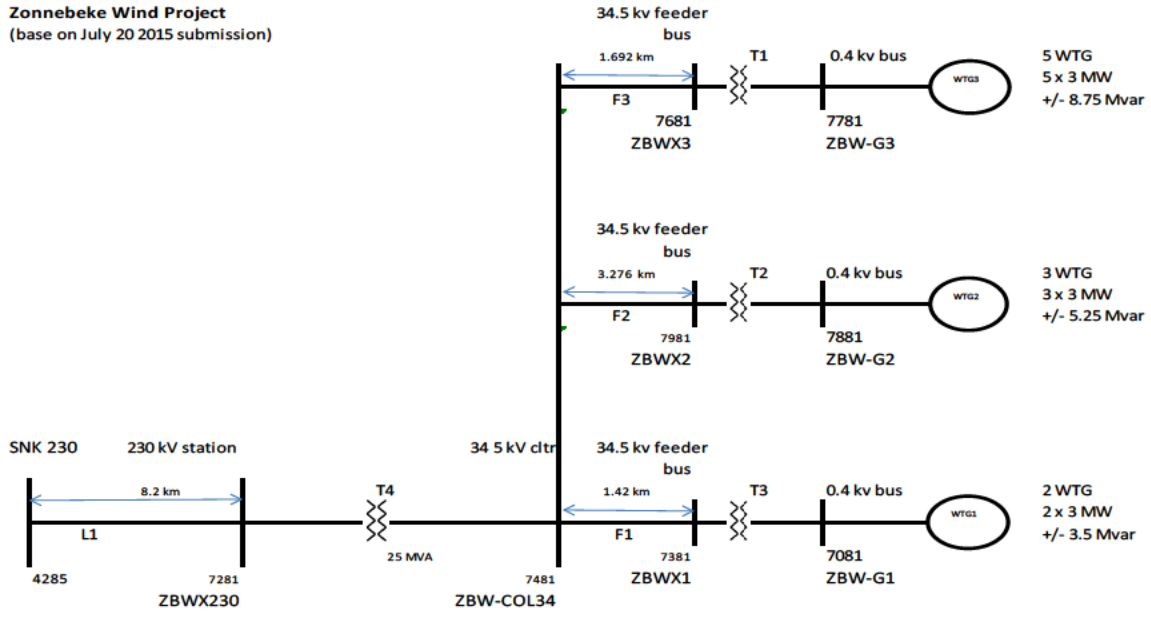
Table 1: Zonnebeke Wind Project Information

Project Name	Zonnebeke Wind Project (ZBW)	
Proponent Name	[redacted]	
Point of Interconnection	Sukunka substation (SNK)	
Applicant Proposed COD	Dec 31 2018	
Type of Interconnection Service	NRIS ☒	ERIS ☐
Maximum Power Injection (MW)	29 (Summer)	29 (Winter)
Number of Generator Units	Ten 3MW Enercon [redacted] wind turbines	
Plant Fuel	Wind	

* *Due to losses and the auxiliary loads, only a maximum of approximately 29.0 MW is available at the POI for injection into the grid.*

Figure 1 shows the layout of the ZBW wind farm:

Figure 1: ZBW Wind Farm Layout



To support significant load growth in the South Peace area, a major transmission upgrade project called Dawson-Chetwynd Area Transmission Project (DCAT) is planned and currently under construction. The scheduled in-service date for DCAT is November 2015. The DCAT project will build:

1. A new 230 kV Sundance station (SLS) at the existing intersection of 2L312 (Sukunka –Louisiana Pacific, or SNK – LAP) and 1L358 (Bear Mountain Terminal – Chetwynd, or BMT – CWD).
2. A new 230 kV double circuit from SLS to BMT and extended towards DAW. The 230 kV section from BMT – DAW will be operated at the 138 kV level.
3. The two existing 138 kV lines, 1L358 (section from SLS – BMT) and 1L362 (BMT – DAW) will be decommissioned. The existing 138 kV circuit from SLS to CWD will be renamed 1L349.

Figure 2 shows the Peace Region grid with the DCAT facilities:

Figure 2: Peace Region with DCAT

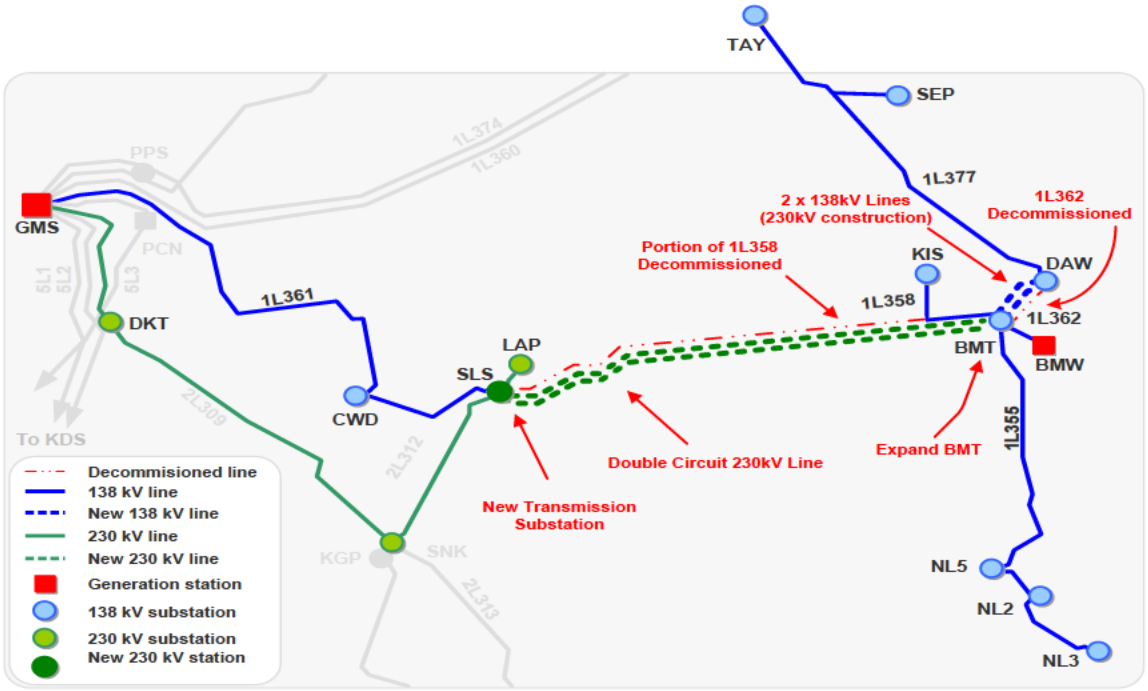
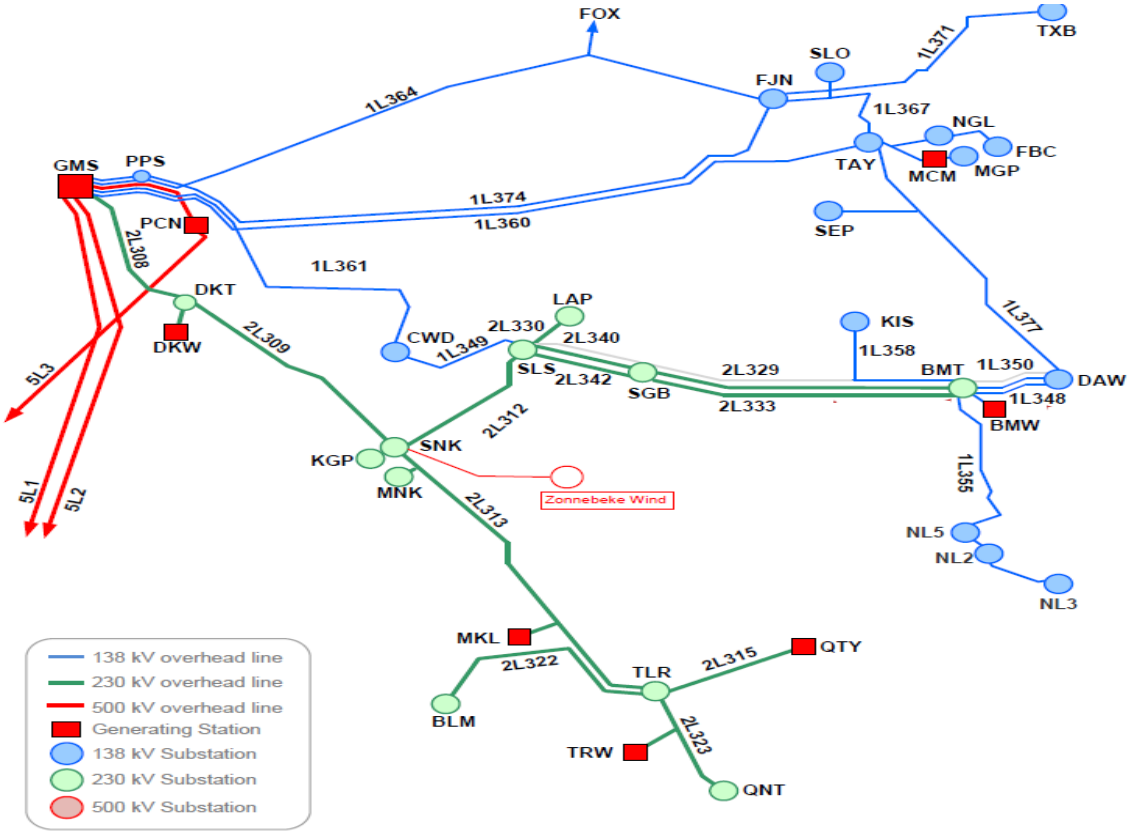


Figure 3 shows the geographic location of the Zonnebeke project in the Peace Region with DCAT in service.

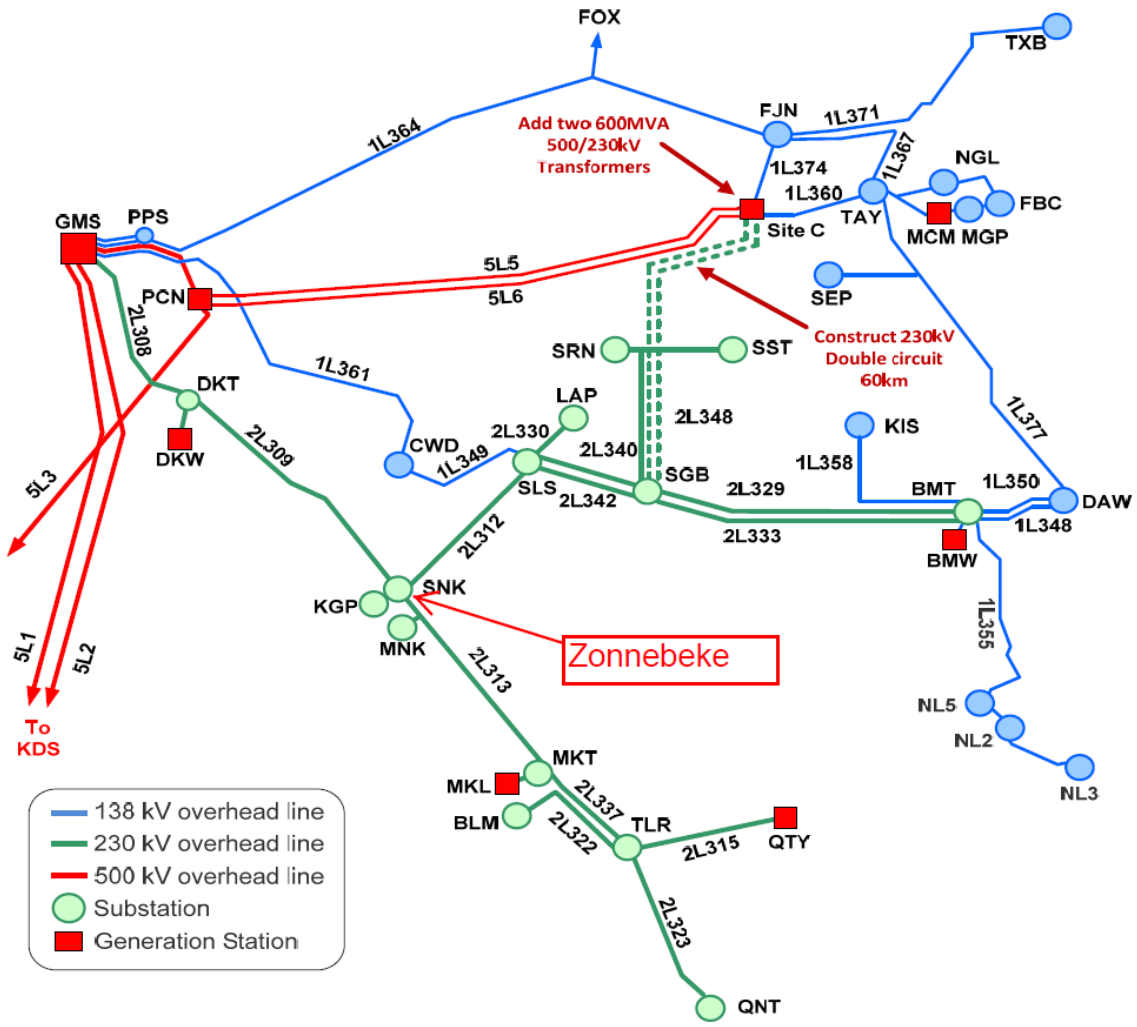
Figure 3: Wind Farm Regional Location



Another major project, Site C generating project, will add 1100 MW generating facility and build two 500 kV circuits (5L5 and 5L6) from the Site C switchyard (STC) to Peace Canyon (PCN) generating station. With continuous load additions anticipated in the Peace Region, a new transmission project, Peace Region Electricity Supply (PRES), has been initiated to support the anticipated growth. There are a number of reinforcement options under consideration for PRES. The most technically leading option at the time of this Feasibility Study is to build double 230 KV circuits from Site C (STC) to Shell Groundbirch (SGB). Site C and PRES are expected to be in service by 2024.

Figure 4 shows the Peace Region grid with DCAT, PRES, Site C and Zonnebeke Wind.

Figure 4: Peace Region with DCAT, Site C and Technically Leading PRES Option



2.0 PURPOSE OF STUDY

The purpose of this study is to assess the feasibility of connecting Zonnebeke Wind farm in the Peace region at a preliminary level. This study identifies transmission constraints and Network Upgrades required for interconnecting the wind farms in order to conform the North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) reliability standards, and the BCH transmission planning criteria.

3.0 TERMS OF REFERENCE

This feasibility study investigates and addresses the overloading, voltage deviation issues of the transmission network in the South Peace region as a result of interconnecting Zonnebeke Wind Farm. Topics studied include equipment thermal loading and rating requirements, and protection requirements. BCH planning methodology and criteria are used in the studies.

Transient stability, Electro Magnetic Transient (EMTP) studies and Revenue Metering requirements will be done in the System Impact Study, if requested by the IC.

The requirements described in this Feasibility Study Report may be further augmented with additional requirements that are discovered in the later study stages.

4.0 ASSUMPTIONS

This study relies on the data provided by the IC to BC Hydro in July 1015. Reasonable assumptions have been made to complete the study and the report whenever such information is unavailable.

BCH 2019 and 2024 summer light load, and 2019 and 2024 winter heavy load system configurations with high generation in the Peace region are used in the study. All projects ahead of Zonnebeke in the Interconnection Queue are included in the study model. The following key assumptions are also made for this study:

- The Site C project, with its 1100 MW generating plant and the two 500 kV circuits between STC and PCN, will be in service by 2024.
- The technically leading option of PRES (two 230 kV circuits between STC and SGB) will be built and be in service by 2024.
- Any pre-existing thermal overloads under single contingency conditions in the Peace region before the Zonnebeke interconnection will have been addressed by the Peace Region Load/Generation RAS.

5.0 SYSTEM STUDIES AND RESULTS

Power flow studies were carried out to evaluate the impact of the proposed interconnection. Studies were also performed to determine the station and protection/telecom requirements.

5.1 Steady State Power Flow Studies

In the South Peace region along the 230 kV circuits between GMS and TLR, Dokie Wind (144 MW) and Quality Wind (142 MW) are in operation, and Meikle Wind (185 MW) is currently under construction. A few other wind farms are also requested for interconnection studies, which are highly ranked on the BCH interconnection queue list than Zonnebeke Wind and need to be included in this SIS. With the wind farms connected to the grid, the 230 kV circuits (GMS-DKT-SNK-TLR) can be heavily loaded during high generation outputs and light load conditions.

On the other hand, significant load additions/increases are anticipated in the Chetwynd-Dowson area. With the proposed DCAD project in service, the increasing loads would offset the line loading on the 230 kV circuits mentioned above during high generation output periods. However, before the PRES and Site C project in service, loss of the 230 kV circuit connection to GMS via 2L308/2L309 with high generation outputs would cause overloading on some of the 138 kV circuits. Such overloading would occur even before Zonnebeke to be connected to the grid. It is expected that a transmission auto-scheme, Peace Region Generation Shedding RAS, will be in service by November 2015, which will address those pre-existing thermal overloads.

A series of pre and post contingency power flow analysis are performed in this study. It has been observed that the Zonnebeke connection would not cause overloading on any additional circuits or transformers, but would exacerbate some of the pre-existing overloading conditions. Zonnebeke Wind may need to be included in the generation shedding scheme stated above.

The study results also conclude that

- No abnormal voltage in the transmission network resulting from the interconnection of Zonnebeke Wind Farm under system normal and single contingency conditions has been identified, and

- No additional facility overload due to the interconnection of Zonnebeke Wind Farm under system normal and single contingency conditions has been identified.

- With the Site C and PRES projects, overloading on the 138 kV circuits under single contingencies would be removed but overloading on 2L312 or 2L308 would remain under single contingencies. The generation shedding scheme would be used to remove the constraints.

The single line diagrams illustrating the system configurations for both pre Site C and PRES and post Site C and PRES are shown in Appendix A.

5.2 Transient Stability Study

Transient stability study is not performed as a part of a Feasibility Study.

5.3 Fault Analysis

The short circuit analysis for the System Impact Study is based upon the latest BCH system model, which includes project equipment and impedances provided by the IC. The model included higher queued projects and planned system reinforcements but excluded lower queued projects. Thevenin impedances, including the ultimate fault levels at POI, are not included in this report but will be made available to the IC upon request.

BCH will work with the IC to provide accurate data as required during the project design phase.

5.4 Analytical Studies

Analytical (EMTP or PSCAD) study is not performed as a part of a Feasibility Study.

5.5 Transmission Line Upgrades

Due to the presence of Peace Region Load Shedding and Generation Shedding RAS, no transmission line upgrade requirement has been proposed.

5.6 BCH Station Upgrades or Additions

In order to interconnect Zonnebeke Wind farm, the following station upgrades are required at Sukunka substation (SNK):

- Addition of one 230kV line terminal for the new transmission line (2LXXX) to Zonnebeke Wind Station (ZBW) with associated circuit breaker and other equipment;
- Expand the substation on the eastern side to accommodate the additional facilities required to connect the Zonnebeke Wind Farm.

5.7 Protection & Control and Telecommunications

Protection Requirements:

BCH will perform the following work in the Transmission System:

- Provide new 2LXXX PY and SY protections using two new SEL-421-4 relays.
- Revise existing 2L366 (SNK-SUC, Sukunka Coal) PY and SY protection AC/DC connections and settings.
- Review, and revise if necessary, existing 2L309 (SNK-DKT)/2L312 (SNK-SLS)/2L313 (SNK-TLR) protection settings.

The IC is responsible for the following work at its ZBW station:

- Provide circuit breaker failure coverage for BC Hydro SNK 2CB1 and 2CB2.
- Provide entrance protection, power quality protection and line protection in accordance with the “60 kV to 500 kV BC Hydro Technical Interconnection Requirements for Power Generators”.

Telecommunication Requirements:

BCH will perform the following work in the Transmission System:

- Provide WECC Class 1 transfer trip facilities from GMS to ZBW for generation Shedding purpose.

- Install at GMS PY and SY Teleprotection terminals facing ZBW.
- Establish passive reflector (ZBWP6) between ZBW and Gwilliam Microwave Repeater Station (GWM)
- Install at GWM a mixed mode asynchronous 7 GHz radio and antenna facing ZBWP6

The IC is responsible for the following work at its ZBW station:

- Install a microwave tower with wave guide and an antenna facing ZBWP6.
- Install a mixed mode asynchronous 7 GHz radio compatible with the radio at GWM.
- Install a Class 1 DACS compatible with the signals coming from GMS.
- Install one PY and one SY Teleprotection terminals facing GMS.

5.8 Islanding

Islanded operation is not arranged for Zonnebeke Wind Farm. Zonnebeke Wind Farm needs to be disconnected from the Transmission System the line 1LXX (SNK-ZBW) is opened.

5.9 Black Start Capability

BCH does not require the proposed Zonnebeke Wind farm to have black start (self-start) capability.

However, if the IC desires their facilities to be energized from the BCH system, the IC is required to apply for an Electricity Supply Agreement.

5.10 Cost Estimate and Schedule

The good faith non-binding cost estimate to complete BCH Network Upgrades required for the Zonnebeke Wind Farm connection is $8.865 million.

This estimate does not include any costs associated with Revenue Metering. The work required within the IC facilities is not part of this estimate.

6.0 REVENUE METERING

Revenue metering requirement is not determined as a part of a Feasibility Study, and will be determined in the System Impact Study.

7.0 CONCLUSIONS & DISCUSSION

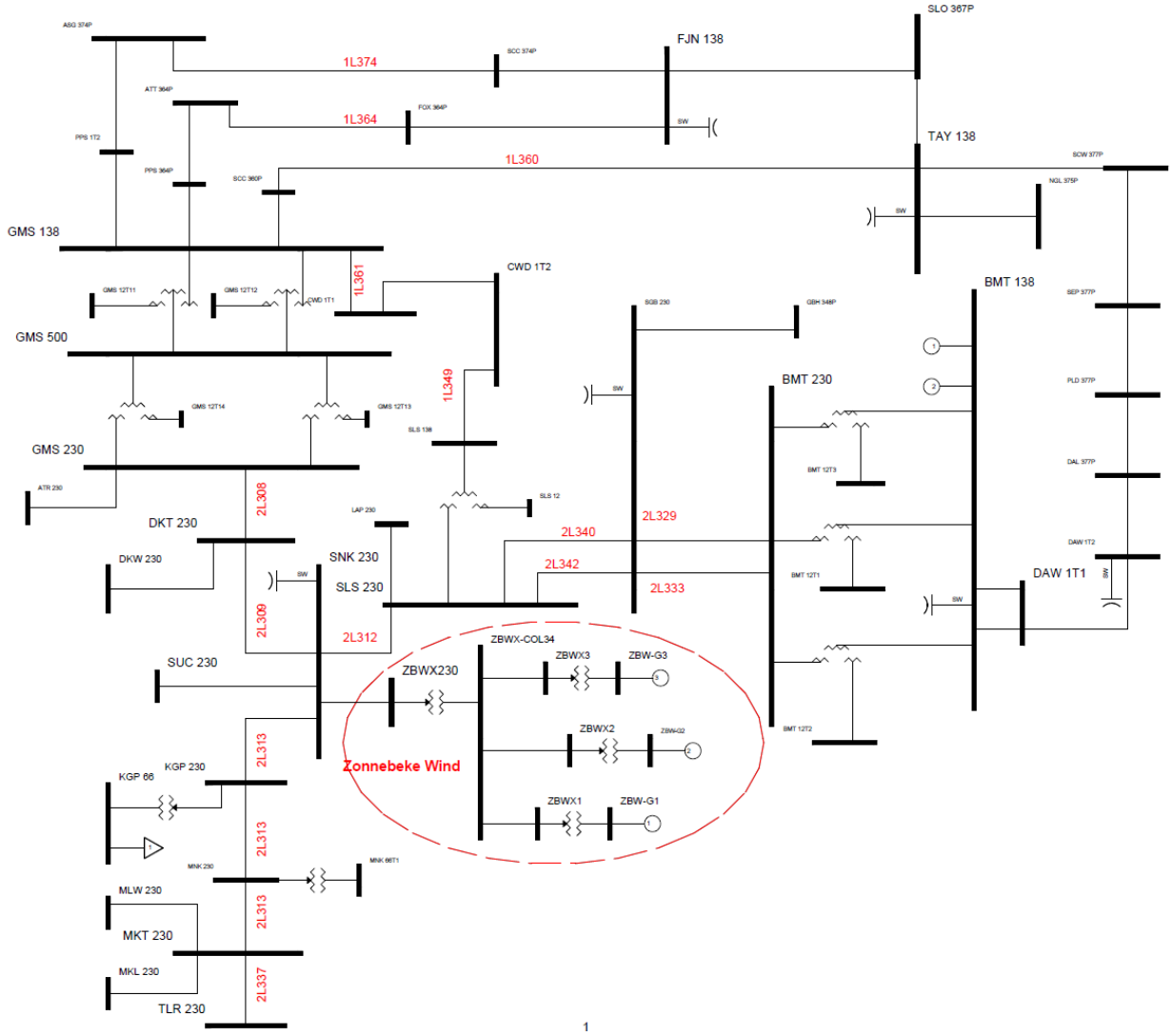
In power follow studies, Zonnebeke Wind Farm was not observed to cause any voltage violation under system normal and single contingencies conditions. However, Zonnebeke Wind Farm would exacerbate some of the pre-existing circuit overloads under certain single contingency conditions. It is expected that the Peace Region Load/Generation Shedding RAS will be in service before the COD of Zonnebeke Wind. Zonnebeke Wind Farm may need to participate in the RAS. Hence no transmission element upgrade for Zonnebeke interconnection has been proposed.

To connect Zonnebeke Wind to SNK via an IC's owned 230 kV line, a 230 kV line terminal and associated station equipment and protection/telecom devices would need to be added. Additional interconnection requirements may be identified during the System Impact Study stage.

If the project moves to the System Impact study stage, BCH may choose to explore with the IC for "relocating" the 230 kV transformer proposed by the IC in this application into SNK and connect the wind farm to SNK through the IC owned distribution feeders.

APPENDIX A – Area Single-line Diagram

Peace Region – 2019 with DCAT



Peace Region – 2024 with DCAT, Site C and PRES