CHALEUR VENTUS WIND ENERGY PROJECT

REGISTRATION DOCUMENT

CHALEUR VENTUS LIMITED PARTNERSHIP

September 2019

CHALEUR VENTUS WIND ENERGY PROJECT

REGISTRATION DOCUMENT

CHALEUR VENTUS LIMITED PARTNERSHIP

WSP PROJECT NO.: 181-07802
DATE: SEPTEMBER 5, 2019

WSP
1 SPECTACLE LAKE DRIVE
DARTMOUTH, NS, CANADA B3B 1X7

T +1 902-935-9955
F +1 902-835-1645
WSP.COM

September 5, 2019

New Brunswick Department of Environment and Local Government, Environmental Impact Assessment
P.O. Box 6000
Fredericton, New Bruswick E3B 5H1Chaleur Ventus Limited Partnership

Subject: **Chaleur Ventus Wind Energy Project Environmental Impact Assessment**

To Whom It May Concern,

Chaleur Ventus Limited Partnership is proposing the development of the Chaleur Ventus Wind Energy Project. The proposed Project is located on privately owned land south of route 303 in Anse-Bleue, Gloucester County, New Brunswick, and will have an aggregate electrical generation capacity of 20 megawatts. The Project will consist of five wind energy converters, access roads, collection system, substation, and associated temporary construction laydown areas. Construction of the Project is scheduled to begin in early 2020, with wind turbine generator delivery and commissioning commencing in late 2020 pending receiving all required approvals and permits.

This Project is considered to be an "Undertaking" as defined in Schedule A of *Environmental Impact Assessment Regulation 87-83*, as described by item (b) of Schedule "A" ("all electric power generating facilities with a production rating of three megawatts or more").

The following document includes a Project description, an overview of existing conditions, a screening of identified Project-Valued Environmental Component interactions, and the approach for completing the assessment of any residual effects and their significance. A complete assessment of residual effects is not included in this document as baseline field studies are currently underway for the Project. Once the baseline surveys are completed, any site-specific mitigations that may be required from the identification of sensitive features in the Project area will be included in the final Impact Assessment that will be submitted at a later date.

Yours sincerely,

Sean Cassidy, P.Eng.
Director – Atlantic Environment (NS)

SIGNATURES

CONTRIBUTORS

Brady Leights B.Et, Dip.R.M. E.Pt., Technician- Environment
Tiffany MacAulay, M.Sc., Biologist
Tanya Morehouse, B.Sc.F., Senior GIS Specialist

PREPARED BY

Jennifer Fernet, M.Sc., P.Ag. (SK)
Environmental Scientist

REVIEWED BY

Andrew Roberts, M.A.Sc.
Team Leader – Approvals and Permitting, Environment (ON)

REVIEWED BY

Sean Cassidy, P.Eng.
Director – Atlantic Environment (NS)

This report was prepared by WSP for the account of CHALEUR VENTUS LIMITED PARTNERSHIP, in accordance with the professional services agreement. The disclosure of any information contained in this report is the sole responsibility of the intended recipient. The material in it reflects WSP's best judgement in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This limitations statement is considered part of this report.

The original of the technology-based document sent herewith has been authenticated and will be retained by WSP for a minimum of ten years. Since the file transmitted is now out of WSP's control and its integrity can no longer be ensured, no guarantee may be given with regards to any modifications made to this document.

EXECUTIVE SUMMARY

Chaleur Ventus Limited Partnership is proposing the development of the Chaleur Ventus Wind Energy Project. The limited partners of Chaleur Ventus Limited Partnership are Windforce Investment Inc. and Association Mieux-Être Bathurst Wellness Association Inc. Teksuk Management Inc., in its capacity as general partner of Chaleur Ventus Limited Partnership, will be responsible for supporting the development, construction, and operation of the Project as well as continuing to be involved in all First Nations engagement and stakeholder consultations. Teksuk Management Inc. is a wholly-owned subsidiary of Naveco Power Inc.

The Project is located on lands in Gloucester County in northern New Brunswick, and will have an aggregate electrical generation capacity of 20 megawatts. This Project is considered to be an "Undertaking" as defined in Schedule A of *Environmental Impact Assessment Regulation 87-83*. Schedule A of the Regulation identifies the types of undertakings that must be submitted for registration with the Environment and Local Government, Environmental Science and Protection Division, Environmental Impact Assessment Branch.

The Project will consist of five wind energy converters, access roads, collection system, substation, and associated temporary laydown areas required for construction. The Project is expected to consist of Enercon EP3-126 wind energy converters with a nominal power of 4 megawatts. Each assembly will consist of the tower, hub, nacelle, rotor blades, and controller, with a total height of 179.5 to 194.5 metres. The total wind energy converter rotor diameter will be 127 metres. It is anticipated that each wind energy converter will be erected on a concrete foundation. The dimensions, depth, and type of foundation will depend on an evaluation of the local soil and geology characteristics, wind forces, and site-specific details of each location.

The proposed schedule for the Project is dependent on receiving all necessary approvals. It is expected that site preparation and construction will begin in early 2020, and take approximately eight months to complete. Construction will be scheduled to occur during daytime hours. It is expected the Project will be in operation by late 2020 pending receiving all required approvals and permits. The anticipated life of the Project is estimated to be 30 years, which is consistent with the wind energy converter life expectancy.

Chaleur Ventus Limited Partnership has and will continue to engage First Nations communities in proximity to the Project site throughout its development, construction, and operation to ensure that all questions and concerns are addressed in an appropriate fashion.

To date, Chaleur Ventus Limited Partnership has commenced engagement with several stakeholders. Throughout the Project's life, Chaleur Ventus Limited Partnership will continue to engage community members regarding Project construction information and safety measures, as well as educational sessions that familiarize community members with the operation of a wind energy project. Chaleur Ventus Limited Partnership will engage the appropriate local authorities and agencies regarding construction timing and important road use information to ensure the Project's construction and operation meet the highest safety standards.

Chaleur Ventus Limited Partnership has and will continue to hold focused meetings with government representatives and key stakeholders to ensure that they are kept apprised of all Project-specific information and planning activities. Chaleur Ventus Limited Partnership has been proactive by engaging New Brunswick Members of Parliament, members of the legislative assembly, and other government officials to inform them of the potential development in the Project area. In addition, consultation with federal agencies including Navigation Canada, Transport Canada, the Royal Canadian Mounted Police, Environment Canada Radar, Canadian Coast Guard, and the Department of National Defence has also been completed.

Additional site-specific baseline information is currently being collected to support the assessment of effects in the final Impact Assessment. Once the information is collected and associated reports are completed they will be submitted to the New Brunswick Department of Environment and Local Government.

A review of Project activities, applicable legislation, and previous assessment experience identified Valued Environmental Components because of their potential sensitivity to effects from the Project. The Valued Environmental Components selected for this assessment are:

- Terrain and Soils
- Surface Hydrology
- Fish and Fish Habitat
- Wetlands
- Terrestrial Vegetation
- Terrestrial Wildlife including Birds and Bats
- Species of Conservation Concern
- Heritage and Archaeological Resources
- Land Use
- Noise
- Shadow Flicker
- Visual Aesthetics
- Electromagnetic Interference
- Local Economy
- Aviation

This registration document provides an overview of the approach for completing the Impact Assessment and the Project-Valued Environmental Component screening step. A complete impact assessment is not included in this document because baseline data currently available is insufficient to complete a confident and scientifically defendable assessment of effects. Baseline surveys are ongoing, and once completed, any site-specific mitigations that may be required from the identification of sensitive features in the Project area will be included in the final reports and will be considered in the residual effects assessments that will be submitted at a later date.

From the results of the Project-VEC screening, it is expected that the majority of Project-Valued Environmental Component interactions will not result in residual effects. The Project will incorporate appropriate mitigation measures to avoid or reduce potential effects. Further analysis will be completed to determine the significance of the following Project effects and submitted once site-specific baseline data is available to complete the assessment.

- Operation of the Project may result in birds and bats colliding with wind energy converters
- Construction and operation of the Project may cause birds to alter their migration flyways
- Construction and operation of the Project may displace birds and bats from previously used habitats in the Project area

An assessment of employment and business opportunities has been completed in this document. The Project will have a significant positive residual effect on the social environment in relation to employment and business opportunities. For the Project to proceed, people are required to staff the Project which will result in income and training opportunities. Project construction and operations will create jobs and generate income. Employees typically spend their incomes where they live and therefore indirect benefits will also occur during the Project lifetime. It is anticipated that most of the construction workforce will be hired locally. The Project will result in increased training and experience in the labour force, which will have a positive effect on future opportunities. Project spending will result in increased gross domestic product and Project operations will generate tax revenue for municipal, provincial, and federal governments.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

A TURBINE MODEL DATASHEETS

LIST OF ABBREVIATIONS

ABBREVIATION	DEFINITION
ACCDC	Atlantic Canada Conservation Data Centre
Agency	Canadian Environmental Assessment Agency
ASNB	Archeological Services New Brunswick
Bathurst	Association Mieux-Être Bathurst Wellness Association Inc.
CAAQS	Canadian Ambient Air Quality Standards
CCG	Canadian Coast Guard
CEAA	*Canadian Environmental Assessment Act*
CO_2e	CO_2-equivalents
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CVLP	Chaleur Ventus Limited Partnership
DND	Department of National Defense
DTI	Department of Transport and Infrastructure
DU	Ducks Unlimited
EIA	Environmental Impact Assessment
ESA	Environmentally Significant Area
GHGs	Greenhouse gases
HRIA	Heritage Resource Impact Assessment
IBA	Important Bird Area
MET tower	meteorological tower
Naveco	Naveco Power Inc.
NB SARA	New Brunswick *Species at Risk Act*(
Project	Chaleur Ventus Wind Energy Project

ABBREVIATION	DEFINITION
SARA	*Species at Risk Act*
SFA	Salmon Fishing Area
SOCC	Species of Conservation Concern
Teksuk	Teksuk Management Inc.
VECs	Valued Environmental Components
WAWA	Watercourse and Wetland Alteration
WEC	wind energy converter
Windforce	Windforce Investment Inc.

UNITS OF MEASUREMENT

UNIT	DEFINITION
%	percent
ºC	degrees Celsius
dBA	A-weighted decibels
km	kilometres
km/hr	kilometres per hour
kV	kilovolt
L	Litres
m	metres
m/s	metres per second
m^2	square metres
mm	millimetres
MVA	Mega Volt Ampere
MW	megawatts
ppb	parts per billion
rpm	revolutions per minute
$\mu g/m^3$	micrograms per cubic metre

1 INTRODUCTION

Chaleur Ventus Limited Partnership (CVLP) is proposing the development of the Chaleur Ventus Wind Energy Project (Project). The limited partners of CVLP are Windforce Investment Inc. (Windforce) and Association Mieux-Être Bathurst Wellness Association Inc. (Bathurst). Bathurst will have a 51% interest in the Project and Windforce will have a 49% interest. Teksuk Management Inc. (Teksuk), in its capacity as general partner of CVLP, will be responsible for supporting the development, construction, and operation of the Project as well as continuing to be involved in all First Nations engagement and stakeholder consultations. Teksuk is a wholly-owned subsidiary of Naveco Power Inc (Naveco). The Project will be located in the northern part of the province in Gloucester County.

1.1 PROPONENT

1.1.1 *NAME AND ADDRESS OF PROPONENT*

The proponent is as follows:

Chaleur Ventus Limited Partnership
320 Queen Street, Suite # 100
Fredericton, New Brunswick, E3B 1B2
1-(506)-804-1080 ext. 106
EIA@naveco.ca

1.1.2 *PRINCIPAL PROPONENT CONTACT*

The principal proponent contact for the Project is as follows:

Tarek Abbasi, Operations Director
Naveco Power Inc.
320 Queen Street, Suite # 100
Fredericton, New Brunswick, E3B 1B2
1-(506)-804-1080 ext. 106

1.1.3 *ENVIRONMENTAL ASSESSMENT CONTACT*

The consultant contact for this Project is as follows:

Sean Cassidy, P.Eng., Director – Atlantic Environment

WSP Canada Inc.
1 Spectacle Lake Drive
Dartmouth, Nova Scotia, B3B 1X7
1-(902)-536-0963
sean.cassidy@wsp.com

1.1.4 *PROPERTY OWNERSHIP*

CVLP has secured lease-option contracts on 47 private properties in the Project vicinity, which encompass 1,062 hectares (ha). The Project will require approximately 9 kilometres (km) of new transmission line that runs south and southwest from the Project area to a proposed substation that will be located on Crown land approximately 2.8 km southeast of Saint-Leolin. The Project will also make use of an existing road from Route 320 to the Project area.

1.2 REGULATORY FRAMEWORK

There are a number of federal and provincial regulations and local municipal by-laws that are applicable to the planning and execution of renewable energy projects. This section is intended to describe the regulatory framework within which the Environmental Impact Assessment (EIA) for the Project will be completed.

1.2.1 *FEDERAL*

The federal Environmental Assessment process and requirements are outlined in the *Canadian Environmental Assessment Act* (*CEAA*). The federal process is triggered if the project is a "designated project" as defined by the Regulations Designating Physical Activities. Based on the current understanding of the Project, the federal process will not be triggered because this type of project is not listed in the Regulations Designating Physical Activities.

Other federal legislation, such as the *Fisheries Act*, *Species at Risk Act* (*SARA*), and *Migratory Bird Conventions Act* may apply to the Project. Federal agencies such as Transport Canada, Environment Canada, Canadian Coast Guard (CCG), and the Department of National Defense (DND) were consulted during the early stages of planning.

1.2.2 *PROVINCIAL*

The New Brunswick EIA process involves three primary steps; a registration document, a Determination Review, and a Comprehensive Review that requires the submission of an EIA Report.

The first step in the EIA process is to determine whether a project is likely to be an "Undertaking" as defined in Schedule A of *Environmental Impact Assessment Regulation 87-83.* Schedule A of the Regulation identifies the types of undertakings that must be submitted for registration. Because the Project is an electric power generating facility with a production rating of 3 megawatts (MW) or more it is an Undertaking for the purposes of the Regulation and must be registered with the Environment and Local Government, Environmental Science and Protection Division, Environmental Impact Assessment Branch.

Section 5 (2) of the Regulation requires that proponents deliver a completed registration document to the Minister. It is understood that final engineering details of a project will typically not be available at the time of project registration, however, full and accurate descriptions of the project location, proposed activities, the existing environment, potential impacts, and proposed mitigation are required. This can partially be completed for the Project using a high-level desktop review of potential environmental and socio-economic effects for the Project location. It is recommended that the registration document be submitted early in the planning process so that the ability to modify the project to address government and stakeholder concerns is maintained.

Once the Project is registered, it must undergo a Determination Review. The Determination Review is used to identify and evaluate the environmental issues surrounding the proposed Project. The review is coordinated by the Environmental Impact Assessment Branch of the Department of Environment and Local Government. A specially constituted Technical Review Committee comprised of experts and specialists from federal agencies, various departments of the New Brunswick Government and the rural district planning commission or municipality having jurisdiction over the project location will assist in the review. The purpose of this Review is to determine whether or not a Comprehensive Review is required.

If the Minister decides that a Comprehensive Review is required, the following would be required prior to proceeding with the Undertaking.

- Review Committee formulates draft guidelines for the Comprehensive Review
- Completion of an EIA study and the preparation of a report describing the results
- Technical Review Committee completes detailed examination of the draft EIA Report
- Public Review and Comment on the EIA Report
- Ministry issues or denies an approval for the Undertaking

It is important to note that if the Minister determines that a Comprehensive Review is not required, all relevant environmental regulations such as the *Clean Environment Act*, *Clean Air Act*, or any other relevant provincial or federal legislation must be complied with, and all required permits and approvals must be obtained. In addition, the Minister may attach conditions to the Project, aimed at addressing or mitigating concerns raised during the Determination Review. The Lieutenant-Governor in Council may suspend or revoke an approval if the proponent violates the terms and conditions imposed for the Project.

1.2.3 *MUNICIPAL*

It is not expected any municipal by-laws and policies apply to this Project.

1.2.4 *APPROVALS AND PERMITTING*

Like any project in New Brunswick, provincial, and federal approvals and permits are required before the Project can proceed. Permitting occurs after ministerial determination or approval of the EIA report. Permitting can include submission of applications to obtain specific construction and operating approvals. All supporting infrastructure will likely require specific permits for construction (e.g., temporary and permanent roads and the collection system may require a provincial permit such as a Watercourse and Wetland Alteration [WAWA] permit and federal review if crossing fish bearing watercourses).

Table 1.2-1 presents the Acts, Regulations, permits, and approvals that may apply to the Project. Many of these requirements are site specific and are dependent upon existing environmental and socio-economic conditions in the proposed Project area and existing infrastructure.

Table 1.2-1 Federal and Provincial Acts, Regulations, Permits, and Approvals That May be Required

ACTS	RELATED REGULATIONS	APPROVALS OR PERMITS REQUIRED
Federal		
Canadian Environmental Protection Act	No specific regulations related to this *Act*	No specific permit required. The Project will prevent pollution and protect the environment and human health to contribute to sustainable development.
Fisheries Act	Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations	It is anticipated that no in water work will be required. If any destruction to fish or fish habitat will occur as a result of the Project, Authorization For Work that May Result in Serious Harm to Fish is required.
Species At Risk Act	No specific regulations related to this Act	No specific permit required. Adhere to species specific activity restrictions and recovery initiatives
Migratory Bird Conventions Act	Migratory Birds Regulations	No specific permit required. Notification only.
Aeronautics Act	Canadian Aviation Regulations	No specific permit, but must comply with lighting and marking requirements specified by Transport Canada.
Provincial		
Clean Environment Act	Environmental Impact Assessment Regulation	Registration with the Environment and Local Government, Environmental Science and Protection Division, Environmental Impact Assessment Branch Authority of permission to discharge contaminant into waters during construction (i.e., site run-off).
Clean Environment Act	Water Quality Regulation	Permit for a WAWA if within 30 metres (m) of a watercourse or wetland.

ACTS	RELATED REGULATIONS	APPROVALS OR PERMITS REQUIRED
Provincial (continued)		
Protected Natural Areas Act	No specific regulations related to this *Act*	Permits for Activity in Protected Natural Areas if required for the Project.
Electricity Act	Electricity from Renewable Resources Regulation	Approval for construction of a new energy generation facility.
Crown Lands and Forests Act	No specific regulations related to this *Act*	A Wind Farm Lease and Licence of Occupation for Access and Distribution authorizing the construction and operation of a wind farm is required from Department of Energy and Resource Development.
Occupational Health and Safety Act	Occupational Health and Safety Regulations	No specific permit required.
Community Planning Act	Provincial Building Regulation	Building permits for construction and operation of the Project.
Species at Risk Act	No specific regulations related to this *Act*	Notification to Department of Environment and Local Government, authorization may be required for clearing and site preparation.
Heritage Conservation Act	General Regulation - Heritage Conservation Act	Site alteration permit and Heritage Impact Assessment.
Electrical Installation and Inspection Act	Electrical Installation and Inspection Regulations	Approval for electrical installation.
Motor Vehicle Act	Vehicle Dimensions and Mass Regulation	Permits for moving large structures on provincial highways.
Highway Act	Highway Usage Regulation	Application for public property easements for installation of utilities along public highways from the Department of Transport and Infrastructure (DTI).
Topsoil Preservation Act	General Regulation - Topsoil Preservation Act (N.B. Reg. 95-66)	Permit required for removal of topsoil from a site.
Transportation of Primary Forest Products Act	No specific regulations related to this *Act*	Compliance with specified documentation requirements for the transportation of primary forest products within New Brunswick.
Transportation of Dangerous Goods Act	No specific regulations related to this *Act*	Permit required for the transportation of dangerous goods.
Clean Environment Act	Petroleum Product Storage and Handling Regulation	Permit required for the storage of two thousand litres or more of petroleum products onsite.

1.3 DOCUMENT STRUCTURE

The scope of this report includes a Project description that includes proposed construction and reclamation activities. The intent of this report is to support CVLP's registration to provincial agencies. A summary of the content of this report is as follows:

- Section 1 – Introduction
- Section 2 – First Nations and Public Involvement
- Section 3 – Project Description
- Section 4 – Description of Existing Environment

- Section 5 – Identification of Environmental Effects and Mitigation
- Section 6 – Classification of Residual Environmental Effects and Determination of Significance
- Section 7 – Summary of Proposed Mitigation
- Section 8 – Follow-up Monitoring
- Section 9 – Bibliography
- Appendix A – Turbine Model Datasheets

Site-specific baseline information is currently being collected to support the assessment of residual effects in the final report submissions. Once the information is collected and associated reports are completed they, will be submitted as follows:

- Appendix B – Clearances and Approvals
- Appendix C – Noise Impact Assessment
- Appendix D – Shadow Flicker Assessment
- Appendix E – Electromagnetic Interference Study
- Appendix F – Visual Impact Assessment
- Appendix G – Avian Survey Report, Residual Environmental Effects and Determination of Significance
- Appendix H – Bat Survey Report, Residual Environmental Effects and Determination of Significance
- Appendix I – Aquatic Resources Report
- Appendix J – Wildlife Survey Report
- Appendix K – Vegetation and Habitat Report
- Appendix L – Archaeological Resource Assessment
- Appendix M - Public Consultation Report
- Appendix N – Traditional Knowledge Study

2 FIRST NATIONS AND PUBLIC INVOLVEMENT

The New Brunswick EIA process requires First Nations and public engagement as outlined in Section 6 of the Guide to Environmental Impact Assessment in New Brunswick (GNB, 2018a). The overall goal of involvement during the EIA process is to inform those potentially affected by the Project are aware of the proposal and to provide them with information about the Project so that they are able to express any concerns they may have.

CVLP is committed to effective stakeholder consultation and gaining ongoing acceptance and approval of the Project by local community members and other stakeholders to maximize support of the Project. CVLP will engage in several activities to ensure that this goal is achieved, and the details of these activities are explained below. All First Nations and public engagement completed for the Project will be summarized in a Public Consultation Report and submitted at a later date.

2.1 FIRST NATION ENGAGEMENT

CVLP has and will continue to engage First Nations communities in proximity to the Project site throughout its development, construction, and operation to ensure that all questions and concerns are addressed in an appropriate fashion. In addition, CVLP intends to include First Nation community members with applicable traditional knowledge to assist the Partners during the EIA process, Project development and construction.

The nearest First Nation band to the site is Pabineau First Nation, found in Pabineau Falls, New Brunswick which is roughly 64 km southeast of the Project site. Population of the First Nation is thought to be roughly 200 individuals, with a land base of approximately 427 ha. This First Nation is part of the Mi'kmaq First Nation Band government. Esgenoopetitj First Nation is found near the community of Burnt Church, New Brunswick, which is roughly 70 km from the Project site. Population at this First Nation is approximately 1,060. Eel River Bar First Nation is found approximately 100 km to the west of the Project site, and consists of 733 registered members, with 350 people living at the community.

2.2 PUBLIC CONSULTATION

As outlined in Section 6 of the Guide, "public" includes all stakeholders (individuals, companies, agencies, organizations, and interest groups) who may be affected by the proposed Project and includes those who may have local knowledge of the location that may assist in siting or design.

To date, CVLP has commenced engagement with a number of stakeholders. Throughout the construction and operation of the Project, CVLP will continue to engage community members regarding Project construction information and safety measures, as well as educational sessions that familiarize community members with the operation of a wind energy project. In addition, CVLP will engage the appropriate local authorities and agencies regarding construction timing and important road use information as required.

2.2.1 *PUBLIC MEETINGS AND INFORMATION SESSIONS*

A public open house was held in May 2017 and another to be held in 2019 to invite members of the public, First Nations communities, and other stakeholder groups to meet the Project staff, learn more about the Project, and provide comments and feedback on the Project and EIA documentation. Additional public information meetings will be held in the local community to share accurate information about the Project, gather useful ideas from knowledgeable community members, and to respond to questions and concerns of local citizens.

2.2.2 *NOTIFICATIONS*

Notifications for the Project will be placed in local newsletters and/or newspapers to offer information regarding the Project. Notification letters will be sent to First Nations and other key stakeholders. In addition, information about the Project can be accessed with the following link: https://www.chaleurventus.ca.

2.2.3 *COMMUNITY LIAISON COMMITTEE*

A Community Liaison Committee has been established for the Project. It is headed by members of CVLP and locally, Mr. Daniel Brassard, who has been a member of the local community for over ten years. This committee has been created so that residents in the Project area are able to voice their concerns and recommendations, the government is informed and kept up-to-date with progress, and to allow for successful engagement and execution of the Project.

This committee will meet on a call on a weekly basis, have direct contact to development personnel, be available during specific periods of the typical work week for residents who wish one-on-one conversations and be in the community on a monthly basis.

2.3 REGULATORY CONSULTATION

CVLP will continue to hold focused meetings with government representatives and key stakeholders to ensure that they are kept apprised of all Project-specific information and planning. CVLP has engaged members of parliament, members of the legislative assembly, and other government officials to inform them of the potential development in the Project area. In addition, consultation with federal agencies including NAV Canada, Transport Canada, Environment and Climate Change Canada, Canadian Wildlife Service, and the DND has also been completed.

3 PROJECT DESCRIPTION

3.1 PROJECT NAME

The Name of the Project is the Chaleur Ventus Energy Project (Project).

3.2 PROJECT OVERVIEW

The Project is located on privately owned land south of route 303 in Gloucester County, northern New Brunswick, and will have an aggregate electrical generation capacity of 20 MW (Figure 3.2-1). The Project will consist of five wind energy converters (WECs), access roads, collection system, substation, and associated temporary laydown areas required for construction (Figure 3.2-2 and Figure 3.2-3). An approximate 9 km transmission line is proposed that runs south and southwest from the Project area to a proposed substation that will be located on Crown land.

The Project is expected to consist of Enercon EP3-126 WECs with a nominal power of 4 MW. Each assembly will consist of the tower, hub, nacelle, rotor blades, and controller, with a total height of 179.5 to 194.5 m. The total WEC rotor diameter will be 127 m. It is anticipated that each WEC will be erected on a concrete foundation. The dimensions, depth, and type of foundation will depend on an evaluation of the local soil and geology characteristics, wind forces at the location, and site-specific details of each location.

The Enercon WECs are to be equipped with an ice detection and blade heating system, which sends heated air down the interior of the turbine blades to help melt ice which may accumulate on the WECs. The EP3-126 is capable of 100 percent (%) energy output at temperatures as low as -20 degrees Celsius (^{o}C).

The EP3-126 also has variable-pitch blades, which means that this system can operate in windspeeds higher, and lower than that of a system with static blade pitches, by changing the angle of the blades. These turbines will also be fitted with aviation lights and markings on the blades with an Obstacle Collision Avoidance System which is a low-energy radar system that detects aircraft to switch the aviation lights on and off as needed.

The proposed schedule for the Project is dependent on receiving all necessary approvals. It is expected that site preparation and construction will begin in early 2020, and take approximately eight months to complete. Construction will be scheduled to occur during daytime hours. It is expected the Project will be in operation by late 2020 pending receiving all required approvals and permits. The anticipated life of the Project is estimated to be 30 years, which is consistent with the WEC life expectancy.

KEY MAP:

LEGEND:

PROJECT LOCATION

DISCLAIMER:
THIS DRAWING AND DESIGN IS COPYRIGHT PROTECTED WHICH SHALL NOT BE USED, REPRODUCED OR REVISED WITHOUT WRITTEN PERMISSION BY WSP CANADA INC.. THE CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS AND UTILITY LOCATIONS AND REPORT ALL ERRORS AND OMISSIONS PRIOR TO COMMENCING WORK.

PROJECT:

PROJECT: **CHALEUR VENTUS WIND ENERGY PROJECT**

PROJECT NO.: **181-07802**

CLIENT: **CHALEUR VENTUS LIMITED PARTNERSHIP**

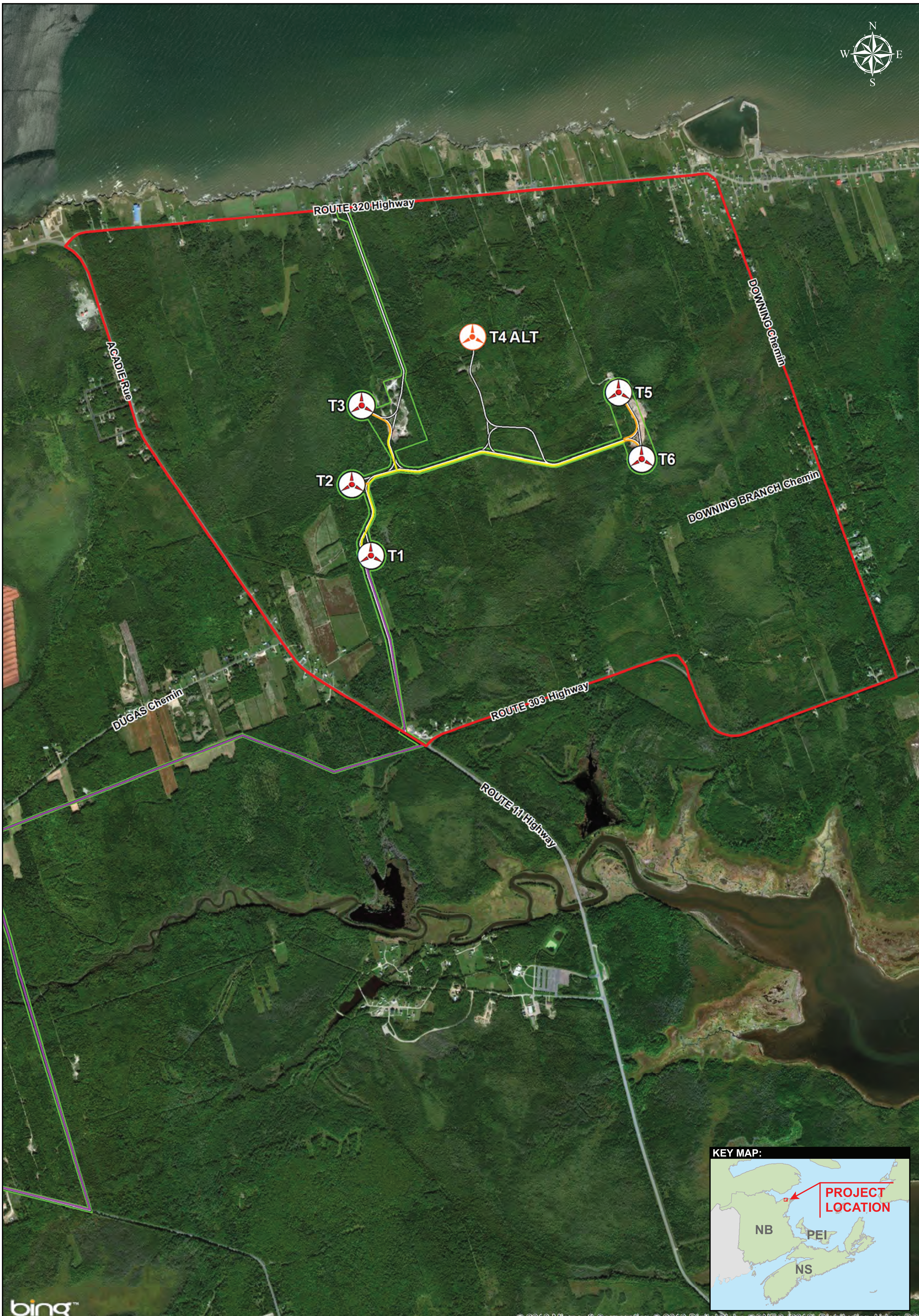
FIGURE:

TITLE: **PROJECT LOCATION**

FIGURE NO.: **3.2-1**	REVISION NO.: **0**
SCALE: 1:2,100,000 (0, 25, 50, 100 Kilometres)	
DATUM: NAD 83 CSRS	PROJECTION: NB Stereographic
DRAWN BY: T. MOREHOUSE	CHECKED BY: J. FERNET
CREATED DATE: (YYYY-MM-DD) 2019-08-18	REVISION DATE: (YYYY-MM-DD) 2019-08-18

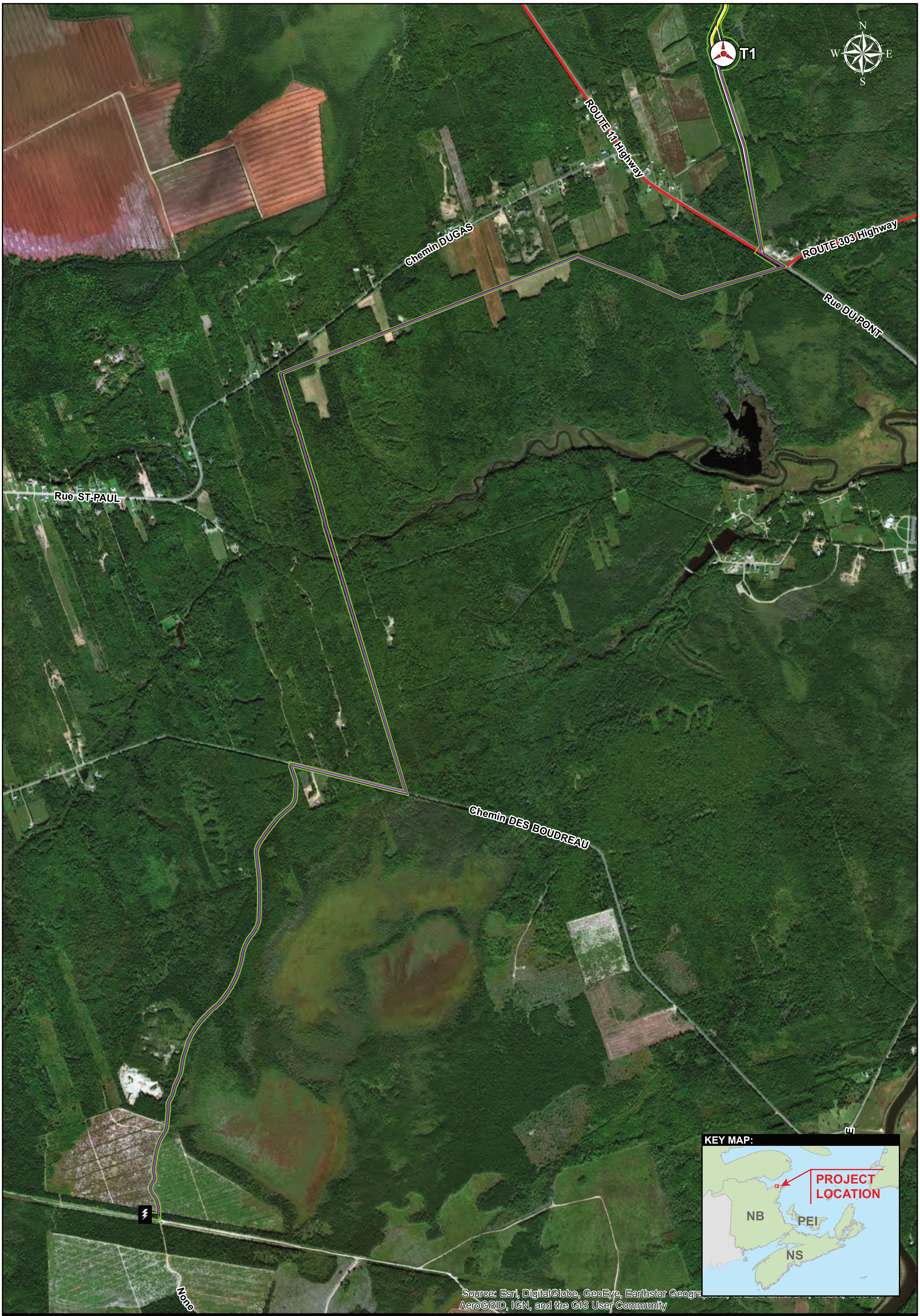
WSP Canada Inc.
1 Spectacle Lake Drive,
Dartmouth, Nova Scotia
www.wsp.com

Document Path: S:\GIS\2_PROJECTS\2018\181_07802_Naveco_WindEnergy_AnseBlue_NB\8_MXD\20190818_181_07802_FIG3_2_1_ProjectLocation.mxd



PROJECT:	FIGURE:			LEGEND:
PROJECT: CHALEUR VENTUS WIND ENERGY PROJECT	TITLE: PROJECT FOOTPRINT		DATUM: NAD 83 CSRS	TURNING LAYOUT / ALTERNATE TURBINE LAYOUT
			PROJECTION: UTM ZONE 20 NORTH	OVERHEAD LINE / ACCESS ROADS
PROJECT NO.: 181-07802	FIGURE NO.: 3-2-2	REVISION NO.: 0	DRAWN BY: T. MOREHOUSE	TAPLINE / CONSTRUCTION LIMITS
CLIENT: CHALEUR VENTUS LIMITED PARTNERSHIP	WSP Canada Inc. 1 Spectacle Lake Drive, Dartmouth, Nova Scotia www.wsp.com		CHECKED BY: J. FERNET	UNDERGROUND LINE
			CREATED DATE: (YYYY-MM-DD) 2019-08-18	PROJECT AREA
DISCLAIMER: THIS DRAWING AND DESIGN IS COPYRIGHT PROTECTED WHICH SHALL NOT BE USED, REPRODUCED OR REVISED WITHOUT WRITTEN PERMISSION BY WSP CANADA INC.. THE CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS AND UTILITY LOCATIONS AND REPORT ALL ERRORS AND OMISSIONS PRIOR TO COMMENCING WORK.			REVISION DATE: (YYYY-MM-DD) 2019-09-04	SCALE: 1:20,000 — 0 200 400 800 1,200 Metres

Document Path: S:\GIS\2_PROJECTS\2018\181_07802_Naveco_WindEnergy_AnseBlue_NB\8_MXD\20190904_181_07802_FIG3_2_2_ProjectFootprint_10_3.mxd



PROJECT:	FIGURE:			LEGEND:
PROJECT: **CHALEUR VENTUS WIND ENERGY PROJECT**	TITLE: **WIND ENERGY COLLECTION SYSTEM SITE PLAN**		DATUM: NAD 83 CSRS	TURBINE LAYOUT; ALTERNATE TURBINE LAYOUT
			PROJECTION: UTM ZONE 20 NORTH	SUBSTATION; ACCESS ROADS; CONSTRUCTION LIMITS
PROJECT NO.: **181-07802**	FIGURE NO.: **3-2-3**	REVISION NO.: **0**	DRAWN BY: T. MOREHOUSE	OVERHEAD LINE
CLIENT: **CHALEUR VENTUS LIMITED PARTNERSHIP**	wsp	**WSP Canada Inc.** 1 Spectacle Lake Drive, Dartmouth, Nova Scotia www.wsp.com	CHECKED BY: J. FERNET	TAPLINE; UNDERGROUND LINE
			CREATED DATE: (YYYY-MM-DD) 2019-08-18	
DISCLAIMER: THIS DRAWING AND DESIGN IS COPYRIGHT PROTECTED WHICH SHALL NOT BE USED, REPRODUCED OR REVISED WITHOUT WRITTEN PERMISSION BY WSP CANADA INC.. THE CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS AND UTILITY LOCATIONS AND REPORT ALL ERRORS AND OMISSIONS PRIOR TO COMMENCING WORK.			REVISION DATE: (YYYY-MM-DD) 2019-09-04	SCALE: 1:17,500; 0 100 200 400 600 800 Metres

Document Path: S:\GIS\2_PROJECTS\2018\181_07802_Naveco_WindEnergy_AnseBlue_NB\8_MXD\20190904_181_07802_FIG3_2_3_CollectionLineSitePlan_10_3.mxd

3.3 PURPOSE, RATIONALE, AND NEED FOR THE UNDERTAKING

3.3.1 *NEED FOR THE PROJECT*

In 2016, New Brunswick Power released a solicitation for 40 MW of transmission-connected renewable energy projects to be majority owned by Local Entities. The solicitation, otherwise known as the Locally Owned Renewable Energy Projects that are Small Scale (LORESS) program, was developed with the intent of contributing to New Brunswick Power's obligation to produce 40% of its electricity with renewable energy sources by the year 2020. As such, a project submission detailing the Project was submitted to New Brunswick Power in response to the LORESS solicitation.

3.3.2 *BENEFITS*

The development of this Project has numerous benefits to the Chaleur region, environmental benefits, benefits to communities, and positive economic effects.

- Environmental Benefits
  - Inexhaustible source of renewable energy
  - Reduces the use of fossil fuels
  - Doesn't generate waste or contaminate water
  - Chaleur Ventus's annual energy production is equivalent to 10,522 passenger vehicles driven for one year
- Community Benefits
  - Provides steady income to property owners and farmers
  - Increase revenue for service businesses (hotels, restaurants, etc.) during planning, construction, and operation
  - Enhancement to tourism
  - Strengthens local tax base
  - Partnerships with City of Bathurst ensure the Project has a sizeable regional economic impact from the beginning until termination in 2050
  - 20 MW wind farm powering almost 9,000 homes in local area
- Economic Benefits
  - Job creation, 100 jobs during the construction phase, 10 direct and indirect jobs created to maintain the turbines over the next 30 years
  - Contributes to a sustainable development
  - Supports the local economy
  - Quick to install and low maintenance once in place

3.4 PROJECT LOCATION

The proposed Project is located in the Gloucester County, New Brunswick, and consists of 47 plots of land leased by CVLP, with several of these plots located adjacent to one another. The five WECs are tentatively placed in a currently forested area surrounded on all sides by roads including Route 320, Chemin Downing, Route 303, and Route 11. The preliminary locations of the WECs are summarized in Table 3.4-1 and shown on Figure 3.2-2. A collection system will also be part of the Project.

Table 3.4-1 Proposed Wind Energy Converter Locations

WIND ENERGY CONVERTER NUMBER	EASTING	NORTHING
T1	342289	5297227
T2	342184	5297620
T3	342237	5298055
T4 ALT	342853	5298434
T5	343654	5298125
T6	343781	5297760

3.5 SITING CONSIDERATIONS

3.5.1 *ENVIRONMENTAL AND LAND USE CONSIDERATIONS*

Many environmental impacts associated with wind projects can be avoided or reduced through proper planning. As such, CVLP completed a preliminary evaluation as part of the initial screening when siting the WECs for the Project.

The minimum suggested setback distances summarized in the New Brunswick Environmental Assessment Guidelines applies to the Project (Table 3.5-1.5-1). Wind power development is not allowed in National or Provincial Parks, operational quarries and mine sites, economically viable peatlands, Deer Wintering Areas, Old Growth Forest Communities and Habitats, Eastern Habitat Joint Venture sites, RAMSAR sites (wetlands of international importance) and International Shorebird Reserves and any other site-specific fish, wildlife and environmental areas identified during the review process or during the EIA. It is important to note that where wildlife or other concerns are identified, a site-specific setback buffer may be applied.

Table 3.5-1 Applicable Setbacks for Wind Turbines

LAND USE/COVER	SETBACK
• Crown lands boundaries, lakes, watercourses, and wetlands. • Protected Natural Areas and candidate Protected Natural Areas.	A minimum of 150 m, or 1.5 x height of turbine, **whichever is greatest**
• Industrial areas (e.g., industrial parks, mines, quarries, etc.). • Crown woods access roads.	Assessed on a case-by-case basis, typically 150 m, or 1.5 x height of turbine, **whichever is greatest**
• Public highways, roads and streets (including roads and streets within the boundaries of a city, town, or village), designated as highways under the Highways Act; and areas designated for those purposes in a plan adopted under the *Community Planning Act*. • Telecommunication, fire, airport and other tower structures. • Archaeological and Historical Sites listed by the Department of Tourism, Heritage and Culture. • Other wind exploration area boundaries, meteorological test towers, wind turbines and associated infrastructure either existing or under application review.	500 m, or 5 x height of turbine, **whichever is greatest**
• Existing recreational, institutional and residential areas, and areas designated for those purposes in a plan adopted under the *Community Planning Act*.	A minimum of 500 m

LAND USE/COVER	SETBACK
• Coastal features (e.g., coastal wetlands, estuaries, beaches and dunes). • Endangered species habitat (*Endangered Species Act*). • National Wildlife Areas and Migratory Bird Sanctuaries.	500 m
• Important migratory bird nesting sites and migration routes (*Migratory Birds Convention Act*). • Important water-bird breeding colonies (*Fish and Wildlife Act*).	1,000 m
• Known bat migration routes and hibernacula.	5 km

All the proposed WEC locations are within the above recommended setback distances. However, the following deviations of the guidelines are recommended for the Project to maintain responsible development.

- Reduce the setback from wooded wetlands from 1.5x total turbine height (270 m) to 100 m. Forested wetlands do not provide adequate habitat to allow for staging of large flocks of waterfowl or shorebirds during migration which would be the main reason for requiring a 270 m setback distance.
- Reduce the setback from roads from 5x total turbine height (900 m) to 350 m. The suggested setback of 350 m is intended to avoid ice throw onto a roadway. A de-icing system will be used for each of the five (5) WECs to minimize the potential and distance of ice throw. In addition, the distance more conservative than other jurisdictions within Canada including Ontario and Alberta which legislate an equivalent setback of 79 m and 200 m from the road boundary for an equivalent turbine, respectively.
- Reduce the setback from residences from 5x to total turbine height (900 m) to 350 m or a sound power level 40 A-weighted decibels (dBA) at the receptor in compliance with the Additional Information Requirements for Wind Turbines calculated using ISO 9613-2, whichever is greater.

Four vascular plant Species of Conservation Concern (SOCC) have been historically and recently observed within 5 km of the Project (Section 4.7.1). No records of nonvascular plant SOCC have been documented within 5 km. A field study is currently being completed for the Project and these results will be submitted at a later date.

A total of 28 wildlife SOCC have been previously recorded within 5 km of the Project. Of these, none are mammals, 25 are birds, and 3 are invertebrates. Although many SOCC ranked by the Atlantic Canada Conservation Data Centre (ACCDC) are considered rare in New Brunswick, those protected or designated by federal and provincial legislation are of particular concern. These included nine bird species, and three invertebrates. Of these, six are listed under the federal *SARA*, five are listed under New Brunswick *Species at Risk Act* (*NB SARA*), and seven designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

The ACCDC identified two saltwater marsh/upland areas managed by Ducks Unlimited (DU) within 5 km of the Project area and are located at the same spot. These areas are named The Village Acadien DU, and the Riviere du Nord DU and are about 2.6 km south of the Project and cover about 13 ha. The Village Acadien/Riviere du Nord Environmentally Significant Area (ESA 080) is found roughly 1.5 km south of the Project area, in the community of Riviere du Nord (342383 E, 5295238 N). This area encompasses 10 ha (ACCDC, 2018). The Nature Trust of New Brunswick has identified a significant salt marsh area in Grand-Anse called the Grande Anse Salt Marsh Environmentally Significant Area (ESA077). The area consists of coastal cliffs intermixed with peatland. This management area is found roughly 5 km west of the Project area (ACCDC, 2018). An Important Bird Area (IBA) was identified at Pokeshaw Rock, which is found approximately 10 km west of the Project area. This IBA consists of a large rock mostly devoid of vegetation found near the coast, and is host to greater than a thousand nesting pairs of Double-crested Cormorants, which represents approximately 1.5% of the Atlantic coast population of this species (IBA Canada, 2018).

The Project will be sited on disturbed areas and use existing roads as much as possible and has been sited to avoid environmentally sensitive areas. It is anticipated that the existing land use in the area would be continued.

3.5.2 *ALTERNATIVE LOCATIONS*

The Project location was selected based on a number of factors including but not limited to:

- Proximity to the New Brunswick Power transmission grid and available capacity on the electrical circuit
- Indicative wind speeds within the region based on atmospheric model data
- Mapped environmental features procured from Geo New Brunswick's GIS data repository
- Available land for wind energy development
- Existing roads to serve as Project access roads
- Potential archeological areas
- Potential important bat habitat
- Important bird habitat

In general, the Project was designed to use existing roads as access roads to minimize the need for additional clearing and road construction. Other potential locations were considered for this Project; however, the proposed site represented an optimal balance between project economics and potential impacts on the environment, thus resulting in a net benefit from the commissioning of the Project.

Throughout the Project site, additional WEC locations were considered throughout the development process. Six sites are being studies, but only five will be included in the Project. Based on mapped and site-verified environmental features, the locations presented in Figure 3.2 2 proved to be the most suitable.

3.6 PHYSICAL COMPONENTS AND DIMENSIONS OF THE PROJECT

3.6.1 *PROJECT INFRASTRUCTURE*

The various Project features required to support the Project is summarized in Table 3.6-1. The maximum area of clearing required for Project features is summarized in Table 3.6-2 and presented on Figure 3.2-2 and Figure 3.2-3.

Table 3.6-1 Approximate Length of Project Roads and Proposed Collection System

PROJECT FEATURE	LENGTH	ADDITIONAL INFORMATION
Access road on existing road from Route 320 to the Project area	1 km	Upgrades and widening of road to accommodate WEC delivery.
Access roads (new construction on private land)	3.4 km	Tree clearing required in most areas. Up to 6 m wide access road to crane pads needed to erect WECs.
Overhead transmission line	2.1 km	Length may change depending on final siting of the Project
Underground transmission line	860 m	Length may change depending on final siting of the Project
Tapline	8.9 km	Length may change depending on final siting of the right-of-way.

Table 3.6-2 Approximate Area of Clearing Required for Project Features

PROJECT FEATURE	AREA OF CLEARING	ADDITIONAL INFORMATION
Crane pads for WEC erection	1,200 square metres (m^2) per pad	Some areas that will be used for crane pads have previously been cleared.
New access road construction	10 ha	Approximately 2.5 km of new area will need to be cleared for construction of access roads.
Tapline	12 ha	Approximately 4.9 km of the proposed transmission line route is cleared. About 4 km of new areas will need to be cleared for construction of the transmission line.

3.6.2 *BLASTING*

It is unlikely that blasting will be required for the Project.

3.6.3 *WATER SUPPLY*

It is anticipated that most of the water will come from water trucks, however if required, an on-site water supply may be used. There is no current plan for an on-site concrete batch plant so the use of on-site water for that process will not be needed. The daily estimated amount would be around 22,000 liters (L).

3.6.4 *ELECTRICAL WORKS AND INTERCONNECTION TO THE GRID*

Electrical transmission lines will be overhead from the proposed substation location (approximately 2.8 km southeast of Saint-Leolin) to the WECs. The last 70 m to 100 m to each WEC will be underground buried cable for safety and clearance reasons.

The 8.9 km of overhead 34.5 kilovolt (kV) electrical lines will run south and southwest from the WECs to the proposed substation. The overhead line will then be connected to a main power step-up transformer (20 Mega Volt Ampere [MVA]) at the substation to raise the voltage to the 69 kV transmission line voltage. Finally, a 69 kV line will extend 20 m to 30 m from the substation to the tap point on New Brunswick Power's Line.

3.6.5 *WIND ENERGY CONVERTERS AND METEOROLOGICAL TOWER*

The WEC specifications are summarised in Table 3.6-3 and details about the meteorological tower is summarized in Table 3.6 4. Full data sheets on the EP3-126 are included in Appendix A.

Table 3.6-3 Proposed Wind Energy Converter Specifications

WIND ENERGY CONVERTER INFORMATION	MEASUREMENT
Rotor Diameter	127 m
Hub Height	116 m to 132 m
Tip Height (ground to maximum height at blade tip)	179.5 m to 194.5 m
Sound Power Level at Hub Height at Maximum Output	88.1 dBA to 106.1 dBA (dependant on hub height)
Rotational Speed	4.4 to 11.8 revolutions per minute (rpm)
Cut-out Wind Speed	24 to 30 metres per second (m/s)
Swept Area	12,667.0 square metres (m^2)

Table 3.6-4 Project Meteorological Tower Summary

DESCRIPTION	CONFIGURATION
Commissioned	October 24, 2015
Meteorological Tower Height	60 m
Location (Easting, Northing)	343724 E, 5296890 N, UTM Zone 20, NAD83

To operate the Project in a safe manner, CVLP has procured the Enercon de-icing system for each of the five WECs which will detect whether the blades are collecting ice. In the event that icing is detected, the WEC rotor is halted at a point where one of the three blades is pointing downward, perpendicular to the ground; the blade is then heated until the icing no longer remains. The rotor is then rotated until the next blade is in this downward position and the process is repeated until all ice has been removed.

In extreme wind conditions, the Project's WEC monitoring system will automatically ensure the WEC blades are feathered (i.e., pitched) such that the blade surface is no longer positioned to capture incoming wind. This change of pitch ensures the extreme winds cannot cause the rotor to rotate.

Based on Transport Canada's Standard 621, WEC's that have an overall height of more than 150 m must have two CL-864 lights mounted to the top of the nacelle, in addition to at least three CL-810 lights mounted at half of the nacelle height up the WEC tower. Only one of the nacelle-mounted lights is to be operating for a single period while the second light remains on standby. All lights mounted on the WEC must flash at the same rate.

3.7 CONSTRUCTION ACTIVITIES

3.7.1 *SITE CLEARING AND CONSTRUCTION OF ACCESS ROADS*

Clearing includes the removal of all trees, brush, stumps, or other obstacles lying within the construction area that may potentially impair construction activities, vehicle movement, and/or threaten the safety of construction personnel.

The resulting material will be salvaged and stored in piles or windrows. No material will be pushed into or against standing live trees adjacent to construction areas. Likewise, no material will be placed or stored in any wetland or watercourse.

Where safe to do so, low shrub stands and small or regenerating trees will not be cleared. Rather, heavy equipment and trucks will simply drive over or "walk down" this woody growth to limit disturbance to the roots, sod layer, and associated grass/forb cover. Any trees that are cleared will be removed following standard forestry practices using equipment such as fellers. Bulldozers and excavators will be used for grubbing and to clear smaller vegetation.

Existing roads will be upgraded and new access roads will be constructed to transport equipment to the construction sites. There will be a 45 m wide area for construction of the site-specific access roads. The access road will be sited in consultation with landowners and taking into consideration potential environmental effects. Typically, the access roads will be 4 m wide during the construction phase to accommodate the large cranes (with an additional 1 m clearance on each side for ROW and clearance). The road length will be different for each WEC according to its location.

The construction of the access road will typically require clearing and grubbing of any vegetation, excavation of the upper soil material (A-horizon plus a portion of the B-horizon to a depth based on site-specific conditions) layer and adding a layer of compacted material to a typical thickness of 300 to 600 millimetres (mm), depending upon site specific geotechnical conditions. Clean granular material (typically "A" or "B" gravel) will be brought to the site as needed and will not be stockpiled onsite. The upper soil material will be kept and re-used on site and appropriate mitigations will be applied as per the Erosion and Sedimentation Control Plan that will be implemented for the

Project. The access road to each WEC will typically require one to three days of construction time. Depending on the length of the access roads, construction may require approximately 400 to 800 truckloads of gravel.

New culverts may be required to maintain drainage in ditches at junctions with roadways and these will be constructed to support the construction equipment and delivery trucks. The details of culverts and their installation in addition to erosion control measures will be determined in conjunction with the appropriate regulatory authorities as part of the permitting process.

Equipment will include, at a minimum, trucks, graders, and bulldozers. Municipal and provincial roads will also be used for transporting equipment, and minor modifications may be required to some of the existing roads (e.g., widening the turning radius) to handle the oversized loads. Any road damages will be repaired prior to the completion of the construction phase. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.7.14.

3.7.2 *GRADING*

In general terms, grading includes upper soil material removal, installation of ramps, two-toning, and other work required to facilitate the movement of equipment onto and within construction areas.

Upper soil material stripping is the most important step in maintaining the growth medium for successful reclamation and post disturbance land use. Upper soil material will be stripped to a predetermined depth and stored for use during clean-up and reclamation. Where the Project crosses sensitive habitats, only the areas required for the Project width will be stripped to minimize disturbance to the plant communities and limit the creation of suitable growing sites for non-endemic, weedy species.

Grading of subsoil may be required to establish a level and safe working surface for equipment operation and travel. It is anticipated that localized grading will be required where site-specific micro-relief variations (e.g., side slopes or low knolls) are traversed by the Project.

3.7.3 *INSTALLATION OF TEMPORARY FACILITIES*

A laydown area may also be constructed for the temporary storage of construction material and would be roughly 100 m by 100 m and would likely be located at the existing gravel/sand pit within the Project area. The laydown area will include staging areas for construction materials, construction trailers and associated facilities and a temporary electrical service line to provide power to the construction trailers.

Equipment will include, at a minimum, trucks, graders, and bulldozers. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.7.14.

3.7.4 *CONSTRUCTION OF TURBINE SITES AND CRANE PADS*

Prior to construction, the construction area will be cleared and grubbed. To provide sufficient space for the laydown of the WEC components and its assembly, a 60 m by 70 m area must be cleared, levelled, and be accessible during the construction phase. The upper soil material is generally removed with some soil stabilizing material (i.e., crushed gravel or clean back fill) added depending upon site specific geotechnical conditions. Where the site laydown areas are close to watercourses, erosion control measures will be implemented, as described in the Erosion and Sedimentation Control Plan.

Crane pads will be constructed at the same time as the road, and will be located adjacent to WEC locations. The crane pads will typically be 30 m by 40 m in area. The upper soil material at the crane pad will be removed and approximately 600 mm of clean compacted crushed gravel will be imported as needed. The salvaged upper soil material will be re-used on site as feasible. Once the WEC erection is complete, the crane pad will be removed and will be restored to prior use.

Equipment will include, at a minimum, trucks, graders, and bulldozers. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.7.14.

3.7.5 *DELIVERY OF EQUIPMENT*

Equipment will be delivered by truck and trailer throughout the construction phase and stored at the temporary lay-down sites surrounding each WEC. A Traffic Management Plan will be developed and discussed with Department of Environment and Local Government and New Brunswick DTI. Alternative traffic routes will be prepared to address traffic congestion, as needed. The DTI has already been engaged and has provided a list of requirements that will be fulfilled.

3.7.6 *CONSTRUCTION OF TURBINE FOUNDATIONS*

Excavators will be used to excavate an area approximately 3 m deep by 20 m by 20 m (the precise size of excavation area to be determined by geotechnical analysis of the soil) with the material being stockpiled for future backfilling. Stockpiled material will have upper soil material and subsoil separated out and surplus excavated material will be used on site as aggregate to further reinforce and bury WEC foundations once they have been completed. The foundation, with an approximate footprint of 400 m^2, will be constructed of poured concrete and reinforced with steel rebar to provide strength. After construction the foundation will be backfilled and the surface will be landscaped for drainage. Any wood-waste generated will be removed from the site and recycled. Spent welding rods will be disposed of as hazardous waste by a licensed contractor.

Typical construction equipment will include:

- Excavator for removing material
- Flatbed trucks (four to six) for delivery of rebar, turbine mounting assembly and forms
- Truck mounted crane or rough terrain forklift for unloading and placement of rebar and forms
- Concrete trucks for delivery of concrete (300 to 500 loads)
- Construction trucks (three to four vehicles with multiple visits)
- Dozer, loader and trucks to backfill and compact foundation and remove surplus excavated materials

The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The chemicals required for this task are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.7.14.

3.7.7 *WIND TURBINE ASSEMBLY AND INSTALLATION*

Turbine components will arrive on-site using flat bed and other trucks and will be temporarily stored on-site in the immediate vicinity of the base prior to assembly. Typically, two cranes will be used to install the WECs. The larger crane is usually a crawler type with a capacity of 400 tonnes or larger, and is used for the higher lifts.

Clearing and grubbing will be required for the erection area. The erection cranes and crew will follow the foundation crew and erect the WECs once the foundations are completed and the concrete has set. This will typically be in five lifts (three for the towers, one for the nacelle and one for the rotor) over a period of two to three days. The lower tower sections may be installed several days before the upper tower sections and the turbine to optimize installation sequence. The lower tower section will also include electrical and communications equipment. Total WEC assembly and installation will typically require four to five days for each WEC.

Packing frames for the WEC components are returned to the turbine vendor. Following commissioning, the surrounding area will be returned to its original use.

Equipment will include, at a minimum, trucks, two cranes, graders, and bulldozers. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The larger track mounted crane can move from WEC site to WEC site; however, it will need to be disassembled to move it along roadways and from the Project site. Alternatively, cranes may be moved between WEC sites without disassembly along crane paths. The chemicals required for this phase are oils, gasoline, hydraulic fluid, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.7.14.

3.7.8 *CONSTRUCTION OF THE ELECTRICAL COLLECTION SYSTEM*

The electrical collection system will consist of overhead and underground cabling and a buried collection system. Cables and connection lines from each WEC to the transformer substation will be buried and will be located adjacent to the WEC access roads where feasible, and in municipal road right of ways when necessary. Above ground electrical junction boxes will be installed where necessary to connect sections of the underground cabling. The excavated soil will be stored temporarily and then reused as backfill. Power conductors will be approximately 0.9 m below grade and the location will be marked. Equipment will include trenchers or diggers (depending on soil type) and construction will require a crew of six people. Overhead crossings and/or directional boring under watercourse or wetland crossed by the collection system will be considered for the Project. The construction timeframe is dependent upon the required length of the lines.

The chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment, and the polymer used for directional drilling. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.7.14.

3.7.9 *CONSTRUCTION OF THE ELECTRICAL INTERCONNECTION*

An overhead electrical line will connect the transformer substation to an existing transmission line. An overhead 3-phase 34.5 kV circuit will extend north of the substation, and continuing north and northeastward approximately 9 km to the Project area. This electrical line will include the installation of a number of poles to support the circuit. The poles are proposed to be constructed of wood, concrete or steel and will be typically be between 18 m and 30 m tall.

Holes for new poles are typically augured into the ground using a truck mounted auger device. The poles will then be inserted using cranes to a typical depth of 2 m to 3 m below grade. The poles are typically "dressed" (made ready to accept conductors) on the ground prior to installation. Once the poles are in place and dressed, cables will be strung in place using boom trucks and special cable reel trucks. Some packing-material waste may be generated. All recyclable materials will be separated from non-recyclable materials and both streams will be removed from the site and disposed of at an approved and licensed facility.

Equipment will include, at a minimum, a truck mounted crane, flatbed trailers and a truck mounted auger. The chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. A lubricant is likely to be used when the cables are pulled in through the conduit. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.7.14.

3.7.10 *CONSTRUCTION OF THE TRANSFORMER SUBSTATION*

Generally, less than 0.05 ha, the transformer substation will include equipment such as an isolation switch, a circuit breaker, a step-up power transformer, transmission switchgear, instrument transformers, grounding and metering equipment as well as a control housing which will be supplied with power from the local distribution line. Substation grounding will meet the local electrical codes. The substation area will be gravelled with clean material imported to the site on an as needed basis and sloped to facilitate drainage. A secondary containment system will be installed around the transformer in the event of an oil leak to prevent any soil, groundwater, or surface water contamination.

During construction of the substation, topsoil and subsoils will be stripped and stockpiled separately. Stripped topsoil and subsoil will be placed in a temporary storage facility area and topsoil stripped from the substation area will be distributed on other Project properties. An electrical service line and associated poles will likely be connected to the existing distribution line adjacent to the substation for the purpose of providing house service power to the substation control building. Some packing-material waste may be generated. All recyclable materials will be separated from non-recyclable materials and both streams will be removed from the site and disposed of at an approved and licensed facility.

Construction equipment will include small trenchers, a small crane, forklifts, concrete trucks and a bulldozer. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment and transformer oil. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.7.14.

3.7.11 *METEOROLOGICAL TOWERS*

CVLP installed a 60 m meteorological tower (MET) at the Project site at 343724 E 5296890 N, UTM Zone 20, NAD83 to collect raw meteorological data. The 60 m MET mast was instrumented with NRG #40C anemometer pairs mounted at 330°T and 220°T at 60 m, 50 m, and 40 m heights. They were oriented to best capture the wind speed data of the region and reduce the effect of the tower shadow. The installation of the tower did not require tree clearing or the placement of a foundation.

3.7.12 *CLEANUP AND RECLAMATION*

Site clean-up will occur throughout the construction phase and site reclamation will occur after construction has been completed. Waste and debris generated during the construction activities will be collected by a licensed operator and disposed of at an approved facility. Reasonable efforts will be made to minimize waste generated and to recycle materials including returning packaging material to suppliers for reuse/recycling.

Stripped soil will be replaced and re-contoured in the construction areas and disturbed areas will be re-seeded, as appropriate. Erosion control equipment will be removed once inspections have determined that the threat of erosion has diminished to the original land use level or lower. High voltage warning signs will be installed at the transformer substation and elsewhere, as appropriate. At the conclusion of construction, vehicles and construction equipment will be removed from the site.

3.7.13 *TURBINE COMMISSIONING*

Turbine commissioning will occur once the WECs and substation are fully installed and regulatory authorities are ready to accept grid interconnection. The commissioning activities will consist of testing and inspection of electrical, mechanical and communications systems. Some packing-material waste may be generated. All recyclable materials will be separated from non-recyclable materials and both streams will be removed from the site and disposed of at an approved and licensed facility.

Temporary portable generator sets may be used to electrically commission the WECs prior to connection to the grid. The generators are required for approximately one day per WEC. The generators are supplied with a Certificate of Approval to the owners. Following the commissioning phase, the portable generators will be removed from the site and returned to the owners.

Equipment will include support trucks which will be driven to the construction site. The chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment and portable generators, gearbox oil, and lubricants. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.7.14.

3.7.14 *FUEL HANDLING*

Should it be necessary to do so, the contractor will set-up temporary fuel storage tanks at designated staging areas or their temporary office/storage yards. The storage facilities will be subject to provincial environmental and health and safety regulations. Fuel would be transported to machinery using a standard tank truck. Spill response plans will be filed with local authorities, as required.

Alternatively, local bulk dealers would be employed to transport fuel to Project equipment. These persons and/or firms are subject to provincial legislation respecting these activities. The majority of the equipment is refuelled at the Project site, with light vehicles typically obtaining fuel in nearby cities and towns.

All fuelling, particularly at watercourse/wetland crossings, will take place in a designated area at a minimum of 50 m from the edge of the delineated feature. Particular attention will be given to avoid the inadvertent release of fluids.

3.7.15 *WASTE MANAGEMENT*

Contractors are required to comply with all applicable legislation in the handling, storage, transport, and disposal of wastes. Construction is expected to result in relatively little waste material. Typically, refuse and other non-hazardous waste (e.g., packaging) is collected and disposed of in local landfills. All wastes (i.e., engine gas, waste gas, grease, etc.) will be collected in containers and transported to an approved disposal sites. Fuel barrels or other liquid containers will be stored on level sites (expected to be located in the lay-down area) and all drilling chemicals will be clearly marked as per Workplace Hazardous Materials Information Systems requirements, and stored in a dry, secure place prior to use.

Waste requiring greater attention would include used or surplus primer, epoxy coating, oil and lubricants, and associated empty product containers. All such waste would be collected and disposed of in accordance with applicable legislation. Generally, these functions would be subcontracted to waste management firms.

Good housekeeping practices will be maintained during all phases of the construction program. The construction areas will be kept free of trash and litter, and all Project related garbage will be collected in secure containers for eventual transfer to the nearest landfill or other approved disposal facility.

3.8 OPERATION AND MAINTENANCE

The following section describes Project operation and maintenance, including daily operations activities and routine and unplanned maintenance activities.

3.8.1 *WIND TURBINE OPERATION*

The wind energy centre will require full time technical and administrative staff to maintain and operate the facility. The primary workers will be wind technicians (i.e., technicians who carry out maintenance on the WECs) along with a site supervisor. The Project will be operated by a staff of two to three people who will work out of the offsite Operations and Maintenance Building.

The WECs will be operating (i.e., in “Run” mode and generating electricity) when the wind speed is within the operating range for the WEC and there are no component malfunctions. Each WEC has a comprehensive control system that monitors the subsystems within the WEC and the local wind conditions to determine whether the conditions are suitable for operation. If an event occurs which is outside the normal operating range of the WEC (such as low hydraulic pressures, unusual vibrations or high generator temperatures), the WEC will immediately take itself out of service and report the condition to the Operations Centre, located in the off-site Operations and Maintenance Building. A communication line connects each WEC to the Operations Centre, which closely monitors and, as required, controls the operation of each WEC. The WEC system will be integrated with the electric interconnection Supervisory Control and Data Acquisition to ensure that critical controls, alarms and functions are properly co-ordinated for safe, secure and reliable operation. The WEC will also report to CVLP’s Operations Facility during non-working hours.

3.8.2 *ROUTINE TURBINE MAINTENANCE*

Routine preventative maintenance activities will be scheduled at six-month intervals with specific maintenance tasks scheduled for each interval. Maintenance involves removing the WEC from service and having two to three wind technicians climb the tower to spend a full day carrying out maintenance activities.

Consumables such as the various greases used to keep the mechanical components operating and oil filters for hydraulic systems will be used for routine maintenance tasks. Following all maintenance work on the WEC, the area is cleaned up. All surplus lubricants and grease-soaked rags are removed and disposed of as required by applicable regulations. All maintenance activities will adhere to the same spill prevention protocols undertaken during the construction phase.

3.8.3 *UNPLANNED TURBINE MAINTENANCE*

Modern WECs are very reliable and the major components are designed to operate for approximately 30 years. However, there is a possibility that certain component failures may occur despite the high reliability of the WEC fleet-wide. Most commonly, the failure of small components such as switches, fans, or sensors will take the WEC out of service until the faulty component is replaced. These repairs can usually be carried out by a single crew visiting the WEC for several hours.

Events involving the replacement of a major component such as a rotor are rare. If they do occur, the use of large equipment, sometimes as large as that used to install the WECs, may be required.

It is possible that an access road, built for construction and returned to previous existing conditions when the construction phase is completed, will need to be rebuilt to carry out repairs to a damaged WEC. Typically, only a small percentage of WECs will need to be accessed with large equipment during their operating life.

3.8.4 *ELECTRICAL SYSTEM MAINTENANCE*

The collection system and substation will require periodic preventative maintenance activities. Routine maintenance will include condition assessment for above-ground infrastructure and protective relay maintenance of the substation, in addition to monitoring of the secondary containment system for traces of oil. Finally, vegetation control will be required around the transmission line to prevent any damage to the line and ensure safe operation.

3.8.5 *WASTE MANAGEMENT*

Waste generated during the operations phase will be removed by a licensed operator and disposed of at an approved facility. Any lubricants or oils resulting from WEC maintenance will be drummed on site and disposed of in accordance with applicable regulations. All reasonable efforts will be made to minimize waste generated and to recycle materials including returning packaging material to suppliers for reuse/recycling. The spill prevention protocols followed during construction will continue to be observed throughout the facility’s operations and maintenance activities.

3.8.6 *ENVIRONMENTAL MONITORING*

Monitoring activities including post-construction bird and bat mortality monitoring will be carried out at the Project during its operation. The specific monitoring activities will be developed with Department of Environment and Local Government as part of the overall permitting and approvals phase of the Project.

3.9 DECOMMISSIONING

The anticipated life of the Project is estimated to be 30 years. The following describes how the Project will be decommissioned. The decommissioning process will involve removing the WEC, including the tower, generator, auxiliary equipment, above ground cables/poles, fixtures, and otherwise restoring the premises to its original condition. If it is agreed upon with Environment and Local Government, access roads and underground cables may be left in place. Foundations shall be removed to original soil depth or 1.2 m below grade, whichever is the lesser. Within 12 months of initiating the decommissioning process, the Project owner will have removed the relevant components from the leased land.

The decommissioning of the Project will be undertaken in compliance with the appropriate Health and Safety regulation. As with construction, a manager responsible for safety will be present on site for the duration of the work.

3.9.1 *DECOMMISSIONING AFTER CEASING OPERATIONS*

Properly maintained WECs have an expected life of at least 30 years. At the end of the Project life, depending on market conditions and project viability, the WECs may be 're-powered' with new nacelles, towers, and/or blades, thus extending the useful life of the Project and delaying any decommissioning activities. Alternatively, the WECs may be decommissioned.

The following activities for the removal of the components will be undertaken once decommissioning is initiated:

- Remove above-ground collection system including substation and point of connection
- Remove WECs
- Partial removal of WEC foundations
- Remove WEC access roads, if required by landowners

The following anticipated decommissioning plan is based on current procedures and experience. The specifics of these procedures may be adjusted to reflect additional decommissioning experience in the future.

WIND TURBINES

The first stage of the disassembly will be to have wiring crews disconnect the tower from the collection system and disconnect the wiring between WEC sections. A disassembly crew will then use a crane to remove the blades, the rotor, nacelle and then the towers section by section. The lubricating oil will be drained from the gearbox once it has been placed on the ground, and the oil will be disposed of in accordance with applicable regulations. As the WEC is being disassembled, the various components will be transported off-site.

WIND TURBINE FOUNDATIONS

Once all the WEC components have been cleared from a site, the top metre of overburden around the foundation will be excavated and stockpiled. Once cleared, the top 1.2 m of the foundation (or to bedrock) will be demolished. The resulting concrete and rebar will be hauled off-site and disposed of at a licensed facility. Afterwards, the stockpiled soil materials will be used to replace the now cleared area. The disturbed area will be feathered out and graded. No off-site soil is predicted to be needed.

ACCESS ROAD REMOVAL

New access roads will be left at the Department of Environment and Local Government's request or graded to restore terrain profiles (as much as possible), and re-vegetated. Upgraded access roads will not be removed.

CABLE WIRE DECOMMISSIONING

At the time of decommissioning, if appropriate, the underground cables will be left in place. The lines will be cut and the ends buried to 1.2 m below grade. Above ground junction boxes will be removed.

ELECTRICAL SUBSTATION DECOMMISSIONING

The substation electrical components will be either removed as a whole or disassembled, pending reuse or recycling. Once cleared, the gravel around the yard will be reclaimed (unless the landowner wishes to keep the area as is) and the fence removed. As with the WEC foundation, the substation foundation will be excavated and the top 1.2 m of concrete (or to bedrock) will be demolished and hauled off-site to be disposed of at a licensed facility. The excavated area will then be filled in with native soil and re-graded. Any material that has been used as a sound attenuating berm will be levelled and replanted to the requirements of the landowner.

CRANE PAD DECOMMISSIONING

The crane pad aggregate will be removed and areas will be filled unless the landowner requests it to remain.

3.9.2 *PROCEDURES FOR DECOMMISSIONING*

Decommissioning procedures will be similar to the construction phase and will include:

- The creation of temporary work areas. To provide sufficient area for the lay-down of the disassembled WEC components and loading onto trucks, an area must be cleared, levelled and made accessible. The topsoil will be removed and some material may need to be added.
- The creation of crane pads. The crane pads will typically be 15 m by 35 m in size and will be located within the temporary work area around each WEC. The topsoil at the crane pad will be removed and approximately 600 mm of compacted crushed gravel will be added. Once the WEC disassembly is complete, the gravel area around each WEC will be removed and the area will be restored to prior use using stockpiled topsoil.
- The use of cranes to remove the blades, hub and tower segments.
- The use of trucks for the removal of WECs, towers and associated equipment.
- The removal of the top 1.2 m of the WEC foundations and replacement with clean fill and stockpiled topsoil. The fill and topsoil will be contoured to allow cultivation in the case of agricultural lands.
- Road bedding material will be removed and replaced with clean subsoil and topsoil for reuse by the landowner for agricultural purposes. It is proposed to leave culverts in place following the operations phase.
- Cutting underground electrical lines, burying the ends to 1.2 m below grade, and leaving the lines in place. Above-ground lines and poles will be removed and the holes will be filled with clean fill.
- The substation will be demolished. This will be decommissioned in a manner appropriate to and in accordance with the standards of the day. All materials will be recycled, where possible, or disposed off-site at an approved and appropriate facility.

3.9.3 *RESTORATION OF LAND AND WATER NEGATIVELY AFFECTED BY THE PROJECT*

Once the WECs and ancillary facilities are removed, the remaining decommissioning work will consist of shaping and grading the areas to, as near as practicable, the original contour prior to construction of the WECs and access roads. All areas, including the access roads, transformer pads and crane pads will be restored to, as near as practical, their original condition with native soils and seeding. If there is insufficient material onsite, topsoil and/or subsoil will be imported from a source acceptable to the landowner.

3.10 FUTURE MODIFICATIONS, EXTENSIONS, OR ABANDONMENT

There are no future phases planned for the Project. The Project will be in operation for 30 years, which is consistent with the WEC life expectancy. Prior to the end of the Project, decommissioning and site reclamation plans will begin or a new registration may be obtained to extend the life of the Project.

4 DESCRIPTION OF THE EXISTING ENVIRONMENT

This section provides a description of the existing environmental conditions for the biophysical and human components that may be influenced by the Project. The information provided in this section is based on existing secondary data sources, data bases, and mapping available for the location. Information presented in this section pertains to the Project footprint and the surrounding biophysical environment. The Project footprint includes the five proposed WEC locations, access to WECs, and access to the site using an existing road from Route 320.

For the purposes of this report, SOCC are identified as floral or faunal species that are ranked by the ACCDC, protected by the *NB SARA*, designated by COSEWIC as threatened, endangered, or special concern or protected by the federal *SARA*. Although many SOCC ranked by the ACCDC are considered rare in New Brunswick, those protected or listed by federal and provincial legislation are of particular concern.

4.1 ATMOSPHERIC ENVIRONMENT

4.1.1 *CLIMATE*

Most of the climate in New Brunswick is considered to be continental as a result of westerly air flows passing over the interior of the continent, as opposed to a Maritime Climate that is impacted by flows over a temperature-moderating ocean. The closest Canadian Climate Station that meets the United Nations' World Meteorological Organization standard is found in Bertrand (47°45' N, 65°04' W), and is approximately 8 km south of the Project. The next closest weather station with available climate normals data from 1981 to 2010 is located in Haut-Shippagan (47°45'N, 64°46' W) which is approximately 25 km southeast of the Project area. Climate normals data for each station are presented in Table 4.1-1 and 4.1-2. No weather stations are found in the Project area. Climate data from Bertrand and Haut-Shippagan are expected to be representative of the conditions in the Project area due to the close proximity, and similar physical conditions. The climate normals are calculated from data between 1981 and 2010.

Table 4.1-1 1981 to 2010 Canadian Climate Normals Station Data - Bertrand, New Brunswick

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
Daily Average (°C)	-10.1	-9.4	-3.8	2.5	9.2	15.6	18.7	18.5	14.0	7.3	1.1	-5.3	4.9
Rainfall (mm)	19.5	23.3	28.8	51.9	93.5	74.4	89.7	98.7	84.0	112.9	80.2	37.0	793.9
Snowfall (cm)	71.1	60.3	69.8	33.3	4.1	0.0	0.0	0.0	0.0	1.7	27.2	72.3	339.6
Precipitation (mm)	90.6	83.5	98.6	85.2	97.6	74.4	89.7	98.7	84.0	114.6	107.4	109.3	1133.5

Source: Government of Canada, 2019a

Table 4.1-2 1980 to 2010 Canadian Climate Normals Station Data - Haut-Shippagan, New Brunswick

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
Daily Average (°C)	-9.8	-9.7	-4.1	1.9	8.8	15.0	18.7	18.6	14.2	7.6	1.3	-5.1	4.8
Rainfall (mm)	23.6	20.1	28.7	48.1	81.0	74.9	80.9	95.0	73.8	106.2	76.3	35.5	744.1
Snowfall (cm)	73.7	58.9	62.5	34.5	4.6	0.0	0.0	0.0	0.0	1.7	26.1	71.1	333.2
Precipitation (mm)	97.3	79.0	91.2	82.6	85.6	74.9	80.9	95.0	73.8	108.0	102.4	106.6	1077.2

Source: Government of Canada, 2019b

Reviewing the climate normals station data from Bertrand, the warmest month is July, with an average temperature of 18.5ºC, and the coldest is January, with an average temperature of -10.1ºC. The mean annual precipitation approximately 1,133.5 mm, with approximately 793.9 mm falling as rain (Government of Canada, 2019a).

Reviewing the climate normals station data from Haut-Shippagan, the warmest month is July, with an average temperature of 18.7ºC, and the coldest is January, with an average temperature of -9.8ºC. The mean annual precipitation approximately 1,077.2 mm, with approximately 744.1 mm falling as rain (Government of Canada, 2019b).

4.1.2 *VISIBILITY AND FOG*

In general, autumn is the foggiest season in New Brunswick with occurrences on four or five days of each month (ECCC, 1990). This is true for the Acadian peninsula, where the Project area is located. Ceiling heights of 300 to 500 feet or below are common in this area throughout most of the year, as cloud cover forms over the Bay of Chaleur and is advected inland by north or northeast winds (Robichaud and Mullock, 2001). Freezing rain and flurries are common over the Acadian peninsula in the fall months, with blizzard conditions apparent commonly in the winter months. Peak hours of fog are thought to be early to mid-morning, as well as mid to late afternoon and evening (Robichaud and Mullock, 2001). Thunderstorms occur between 10 and 20 days per year in the province (ECCC, 1990). The eastern coast of New Brunswick is usually relatively colder than the inland portion of the province, due to the coastal breeze. Severe winds approaching hurricane force are recorded a few hours each year along the coast (ECCC 1990).

4.1.3 *WIND RESOURCE*

The nearest weather station with wind data is Bathurst A which is approximately 45 km to the southwest of the Project area. Most frequent direction and maximum hourly speed data are available between 1981 and 2010 (Government of Canada, 2019c). The maximum hourly wind speed is between 41 and 65 km/h with the prevailing wind direction from the west and southwest. The maximum gust recorded was 87 km/h.

CVLP installed a MET tower at the Project site at 343724, 5296890, UTM Zone 20, NAD83 in October 2015. An assessment of the wind resource was completed. The average wind speed recorded was 7.67 m/s at a hub height of 116 m. The prevailing wind direction is from the west. Total net energy peaks in January at the site. The assessment of the wind data has illustrated that the wind resource may be classified as an IEC 61400-12-1 Class IIA site.

4.1.4 *AMBIENT AIR QUALITY*

The Air Quality Regulation in New Brunswick's *Clean Air Act* details the maximum permissible ground level concentrations of several parameters for air quality in New Brunswick. The Air Quality Regulation states that a stationary "source" that releases air contaminants to the environment must obtain approvals to release those air contaminants.

The ambient air quality is monitored by Environment and Local Government at established monitoring stations throughout the province. The Project is in the New Brunswick's "northern air zone". The closest air quality monitoring station to the Project Area is located in Bathurst, approximately 45 km southwest of the Project. The most recent annual report for Bathurst is 2015, which provides the current data summarized below.

OZONE

In 2015, the ground level ozone concentration measured over an 8-hour averaging time was 50 parts per billion (ppb) at Bathurst, which is below the Canadian Ambient Air Quality Standards (CAAQS) of 63 ppb.

FINE PARTICULATE MATTER – DAILY

In 2015, the daily fine particulate matter levels recorded at Bathurst were 17 micrograms per cubic metre ($\mu g/m^3$), which is below the CAAQS standard of 28 $\mu g/m^3$.

FINE PARTICUALTE MATTER – ANNUAL

In 2015, the annual fine particulate matter metric calculated an average of 7.2 $\mu g/m^3$ at Bathurst. This is below the CAAQS standard of 10 $\mu g/m^3$ averaged over a year.

Air quality exceedances were identified at Belledune, New Brunswick, which is located approximately 54 km to the west. These exceedances are thought to be caused by heavy industrial operations in the area.

NITROGEN DIOXIDE

No Exceedances of nitrogen dioxide were recorded in Bathurst in 2015.

GREENHOUSE GAS EMISSIONS

Greenhouse gases (GHGs) include carbon dioxide, methane, and nitrous oxide, perfluorocarbons, hydrofluorocarbons, sulphur hexafluoride, and nitrogen trifluoride and can be emitted from a variety of natural and anthropogenic sources. GHGs emitted from natural sources generally exhibit little variation from one year to the next, and are considered to be nominal when compared to those resulting from the combustion of fossil fuels. Total GHG emissions are normally reported as CO_2-equivalents (CO_2e) which considers the global warming potential of the GHGs.

Emissions vary by province, because of factors such as population, energy sources and economic base. In 2015, New Brunswick released its "Guidelines for Greenhouse Gas Management for Industrial Emitters in New Brunswick". New Brunswick's goal is to reduce greenhouse gas emissions to 10% below 1990 levels by 2020 and 75% to 85% below 2001 levels by 2050. In 1990, New Brunswick's GHG emissions were 16.3 megatonnes of CO_2e. In 2015, New Brunswick's GHG emissions were 14.1 megatonnes of CO_2e (ECCC, 2018b). The majority (88%) of New Brunswick's GHG emissions are from the energy sector, of which stationary combustion sources (58%) was the main source; transport (29%) and fugitive sources (1%) were also contributors to the energy sector emissions. The remainder of the emission sources are from industrial processes and product use (4%), agriculture (4%) and waste (5%) (ECCC, 2018b).

4.1.5 *AMBIENT NOISE LEVELS*

A Noise Impact Assessment is being completed for the Project and will be submitted at a later date.

4.2 GEOLOGY, TERRAIN, AND SOILS

The Caraquet Ecodistrict is described as a crescent shaped strip of land, which rims the Acadian peninsula coastline, beginning at the mouth of the Nepisiguit River, curves around Miscou Island, and ends at the mouth of the Miramichi River. Geology of the area consists of late carboniferous sedimentary rock. Bedrock in this ecodistrict is mostly Pennsylvanian non-calcareous red and grey sand stone, interbedded with mudstone and conglomerate. A thin band of red, slightly calcareous Pennsylvanian conglomerate and sandstone is apparent near the Nepisiguit River (NBDNR, 2007).

The terrain within the Project area is mapped as predominantly level to gently sloping (slope gradients of less than 2% to 5%) (CanSIS, 2012). The soils within the Project area are dominantly within the Baie du Vin, Gagetown, and Upper Caraquet soil associations (CanSIS, 2012). Baie du Vin soils are predominantly Orthic Sombric Brunisol, Gleyed Sombric Brunisol Orthic Gleysols developed on glaciofluvial, marine, or lacustrine sediments overlying sandstone bedrock. Gagetown soils are Orthic Humo-Ferric Podzols developed on glaciofluvial or marine sediments. Upper Caraquet soils are predominantly Orthic Sombric Brunisol and Orthic Gleysols developed on glaciofluvial, marine, or lacustrine sediments over marine clay sediments.

4.3 GROUNDWATER RESOURCES

No protected well fields are found within the Project area. The closest protected wellfield is found in the town of Caraquet approximately 7 km southeast of the Project area and is protected under the Wellfield Protection Area Designation Order. However, it is outside of the Project footprint and will not be affected by Project construction. A query of the Online Well Log System identified two potable water wells and four non-potable water wells within 1 km of the Project (Environment and Local Government, 2019). One potable water well is located about 150 m south of WEC T4 ALT and the other 750 m southwest of WEC T1. Geotechnical studies and a private well survey will be completed before construction if required. A monitoring and contingency plan will be completed if any potable water wells are affected by the Project.

4.4 SURFACE HYDROLOGY

The Project is found within the Acadian Peninsula Composite level 1 watershed, which encompasses a 3,118,845 ha drainage area, and the Baie De Caraquet Composite level 2 watershed. The Baie De Caraquet Composite level 2 watershed is approximately 95,103 ha (NBDNR, 2007) and can be divided further into the respective watercourse drainage areas found within this watershed. The division of each watercourse's drainage area is as follows:

- Bass River – 19,820 ha
- Teague's Brook – 23,731 ha
- Riviere Caraquet – 37,308 ha
- St. Simone Riviere Composite – 13,826 ha
- "West Of Bass River" Composite – 418 ha

None of the named watercourses outlined above intersect with the proposed Project area. A review of available watershed and watercourse mapping shows only 2 small unnamed shore-direct tributaries near the Project area. These tributaries originate in the northern section of the area proposed for construction and run northwards, eventually draining into the Baie des Chaleurs. Mapping also shows one ponded wetland area which could have potential for fish, but is not located on lands owned by CVLP. One tributary is found on lands owned by CVLP, and this tributary seems to originate approximately 400 m north of WEC T2.

4.5 FISH AND FISH HABITAT

The Project is within the Chaleur Recreational Fishery Area (GNB, 2019). Salmon catch data for Salmon Fishing Area (SFA) 15 are divided into three smaller sections as follows:

- **SFA 15A** – This area calculates data only from the Restigouche River watershed.
- **SFA 15B** – This area calculates data only from the Nepisiguit River watershed.
- **SFA 15C** – This area includes the small point of land that the Project is located on, however no data are available for Salmon catches in this sub-section.

A review of available catch data from Fisheries and Oceans Canada for SFA-15 in the year of 2011 is available in Table 4.5-1.

Table 4.5-1 Catch Data for Salmon Fishing Area 15

SALMON FISHING AREA	# SMALL SALMON 2011	# LARGE SALMON 2011
SFA-15A	1,570	3,711
SFA-15B	No Data	1,600 to 2,060
SFA-15C	No Data	No Data

It appears that Salmon populations are found in SFA-15 in general, however these populations are focused in SFA-15A, and SFA-15B. SFA-15C lacks large permanent streams which have Salmon potential, except for the Caraquet River, found south of the Project area. Tributary channels found near or within the Project area are thought to be of inadequate size and condition for proper Atlantic Salmon use. Other species identified in the area which may use the small tributaries found near the Project area are presented in Table 4.5-2.

Table 4.5-2 Species Identified that may be Present in Tributaries near the Project Area

SCIENTIFIC NAME	COMMON NAME	COSEWIC	*SARA*	PROVINCIAL RARITY RANK[(a)]	PROVINCIAL GENERAL STATUS RANK[(b)]
Anguilla rostrata	American Eel	Threatened	Threatened	S4	Secure
Catostomus commersonii	White Sucker	-	-	S5	Secure
Rhinichthys atratulus	Blacknose Dace	-	-	S5	Secure
Luxilus cornutus	Common Shiner	-	-	S5	Secure
Notemigonus crysoleucas	Golden Shiner	-	-	S5	Secure
Couesius plumbeus	Lake Chub	-	-	S5	Secure
Fundulus heteroclitus	Mummichog	-	-	S5	Secure
Microgadus tomcod	Atlantic Tomcod	-	-	S5	Secure
Gasterosteus aculeatus	Threespine Stickleback	-	-	S5	Secure
Osmerus mordax	Rainbow Smelt	-	-	S5	Secure
Morone saxatilis	Striped Bass	Special Concern	-	S2	May Be At Risk
Salvelinus fontinalis	Brook Trout	-	-	S4	Secure
Salmo salar pop. 12	Atlantic Salmon	Special Concern	Special Concern	S2S3	May Be At Risk?

(a) Provincial Rarity Rank, where:
S2 - Rare in province.
S2S3 - A numeric range rank is used to indicate any range of uncertainty about the status of the species or community. S2 - Rare in province. S3 - Uncommon in province
S4 - Widespread, common and apparently secure in province
S5 - Widespread, abundant and demonstrably secure in province
(b) Provincial General Status Rank, where
? - Inexact or Uncertain - Denotes inexact or uncertain numeric rank

Species with a high probability of population in the unnamed tributaries on site are likely restricted to those with tolerance of a large range of water quality and temperature. As these watercourses are small in size, without defined headwater lakes or inundated wetlands, it is plausible to assume that these watercourses are intermittent, and may experience dry sections at times throughout the year. Depending on water temperature and condition or function of the wetland found near one of the unnamed tributaries, Brook Trout populations may be apparent. American Eel is a likely inhabitant of the tributaries found on site, as this species is a habitat generalist and can be found in nearly any waterbody during their freshwater stage. Species such as the Blacknose Dace, Common Shiner, Golden Shiner, Mummichog, and Threespine Stickleback are often found in small, first order streams akin to the ones found at the Project area. As such, these species are potential inhabitants of the on-site watercourses.

4.6 WETLANDS

Wetland ecosystems provide important habitat for a variety of SOCC and important ecological services for the environment and people. Several wetland areas (approximately 30) were delineated by WSP biologists and sub-contracted specialists. These wetlands were a mix of spruce bogs, and treed swamps. One wetland is located near WEC T6. The transmission line locations have potential to cross wetland areas; however, the final line locations are yet to be determined. A Vegetation and Habitat report is being completed for the Project and will be submitted at a later date.

4.7 TERRESTRIAL VEGETATION

The Project area is found in the Atlantic Maritime Ecozone. This Ecozone encompasses Quebec's Gaspe peninsula, as well as the entirety of Nova Scotia, Prince Edward Island, and New Brunswick. The ecozone is heavily influenced by the Atlantic Ocean, which provides cooler summers and warmer winters than many areas found inland. Agriculture and forestry are popular in this ecozone, contributing to the lack of old growth forest.

The ecoregion inside the Atlantic Maritime ecozone is called the Eastern Lowlands. This Ecoregion is a broad wedge of flat to gently rolling terrain. The region extends from Bathurst in the north, to Sackville in the south. The coastal area has a fringe of sand dunes, salt marshes, and lagoons which provide habitat for a distinct mix of flora and fauna. Further inland, peatlands are considered extensive, and host both common and rare plant species. Forests in this area are conifer-dominant, and resemble a boreal-type forest, which is a stark contrast from the deciduous-dominated valley lowlands found adjacent to this ecoregion. Due to the low local relief of the area, extensive peatlands and wet areas are found throughout, with discontinuous stands of black spruce and tamarack. Ericaceous shrubs are common in this low-lying area, and this ecoregion contains more wetland area than any other ecoregion in New Brunswick.

The local plant communities found in the Project area include bog type habitats, along with some areas of shrub, softwood, and to a lesser extent, hardwood stands. Species commonly identified in the area include eastern white cedar (*Thuja occidentalis*), black spruce (*Picea mariana*), balsam fir (*Abies balsamea*), and tamarack (*Larix laricina*) in the tree stratum, however red maple (*Acer rubrum*), and trembling aspen (*Populus tremuloides*) may occur. Shrub species included speckled alder (*Alnus incana*), sheep laurel (*Kalmia angustifolia*), choke cherry (*Prunus virginiana*), mountain holly (*Nemopanthus mucronatus*), blueberry (*Vaccinium* spp.), wild raisin *(Viburnum nudum*), and rhodora (*Rhododendron canadense*). Herbaceous vegetation identified include cottongrass (*Eriophorum* spp.), three seeded sedge (*Carex trisperma*), cinnamon fern (*Osmunda cinnamomea*), sensitive fern (*Onoclea sensibilis*), yellow bluebead lily (*Clintonia borealis*), starflower (*Trientalis borealis*), and twinflower (*Linnaea borealis*). A Vegetation and Habitat report is being completed for the Project and will be submitted at a later date.

4.7.1 *PLANT SPECIES OF CONSERVATION CONCERN*

Four vascular plant SOCC have been historically and recently observed within 5 km of the Project (Table 4.7-1). No records of nonvascular plant SOCC have been documented within 5 km.

Table 4.7-1 Plant Species of Conservation Concern Species Identified within 5 km of Chaleur Ventus

COMMON NAME	SCIENTIFIC NAME	PROVINCIAL RARITY RANK[(a)]	PROVINCIAL GENERAL STATUS RANK	NUMBER OF RECORDS	HABITAT PREFERENCE; LOCATION SIGHTING
Twisted Whitlow-grass	*Draba incana*	S1	May be at Risk	2	Rocky seashore, dry sloping juniper forests, riverside meadows. Found 2.8 km northwest of Project area
Northern Comandra	*Geocaulon lividum*	S3S4	Secure	1	Moist, boreal type forest. Found 3.7 km east of Project area
Dwarf Alkali Grass	*Puccinella ambigua*	S1	Undetermined	1	Wetland areas. Found 3.3 km northwest of the Project area
Cloudberry	*Rubus chamaemorus*	S3S4	Secure	2	Swamps, bogs, peaty moors, wet areas. Found 3.3 km east of the Project area.

(a) Provincial Rarity Rank, where:
S1 - Extremely rare in province
S3S4 - A numeric range rank is used to indicate any range of uncertainty about the status of the species or community. S3 Uncommon in province. S4 Widespread, common and apparently secure in province

4.8 TERRESTRIAL WILDLIFE

The province of New Brunswick is home to 57 species of mammals, over 350 resident and migratory bird species, as well as roughly 25 species of reptiles and amphibians. Several of these species have potential to be present on or near the Project area intermittently throughout the year.

To date, terrestrial mammal species which have been identified on site through visual observation or other evidence by field staff include Moose (*Alces americanus*), Eastern Coyote (*Canis latrans*), Red Squirrel (*Tamiasciurus hudsonicus*), Snowshoe Hare (*Lepus americanus*), and Black Bear (*Ursus americanus*).

Several amphibious species have potential to inhabit wetland areas at the Project site. Species potentially present include Eastern Redback Salamander (*Plethodon cinereus*), Spring Peeper (*Pseudacris crucifer*), Northern Leopard Frog (*Lithobates pipiens*), American Toad (*Anaxyrus americanus*), and Pickerel Frog (*Lithobates palustris*). A Wildlife Survey Report is being completed for the Project and will be submitted at a later date.

4.8.1 *BIRDS*

Timing and patterns of migration will typically vary on an annual basis and be species-specific, but generally peak migration for birds would likely be expected during May and September. Many individuals of certain species will also remain in the Project area to breed during the summer, including numerous songbird species. Although there are no IBA or RAMSAR sites (wetlands of international importance) within the Project area, there is an IBA located at Pokeshaw Rock, which is found approximately 10 km from the Project area. A Bird Study is currently being completed for the Project and the full report will be submitted at a later date.

4.8.2 *BATS*

A Bat Survey is currently being completed for the Project and the full report will be submitted at a later date.

4.8.3 *WILDLIFE SPECIES OF CONSERVATIONAL CONCERN*

The majority of the Project crosses existing roads and forest that is currently disturbed by harvesting activities and has been sited to avoid environmentally sensitive areas. A total of 28 wildlife SOCC have been previously detected within 5 km of the Project (Table 4.8-1). Of these, none are mammals, 25 are birds, and 3 are invertebrates. Although many SOCC ranked by the ACCDC are considered rare in New Brunswick, those protected or designated by federal and provincial legislation are of particular concern. Seven are listed under the federal *SARA*, five are listed under *NB SARA*, and seven designated by COSEWIC.

Table 4.8-1 Wildlife Species of Conservation Concern Species Identified within 5 km of Chaleur Ventus

SCIENTIFIC NAME	COMMON NAME	COSEWIC	*SARA*	*NB SARA*	PROVINCIAL RARITY RANK[(a)]	PROVINCIAL GENERAL STATUS RANK
Birds						
Actitis macularius	Spotted Sandpiper				S3S4B, S5M	Secure
Aegolius funereus	Boreal Owl	Not At Risk	-	-	S1S2B, SUM	May Be At Risk
Anas acuta	Northern Pintail	-	-	-	S3B, S5M	Sensitive
Buteo lineatus	Red-shouldered Hawk	Not At Risk	Special Concern	-	S2B, S2M	May Be At Risk
Cepphus grylle	Black Guillemot	-	-	-	S3	Secure
Charadrius vociferus	Killdeer	-	-	-	S3B, S3M	Sensitive
Chordeiles minor	Common Nighthawk	Threatened	Threatened	Threatened	S3B, S4M	At Risk
Coccothraustes vespertinus	Evening Grosbeak	Special Concern	-	-	S3B, S3S4N, SUM	Sensitive
Contopus virens	Eastern Wood-Pewee	Special Concern	Special Concern	Special Concern	S4B, S4M	Secure
Dendroica tigrina	Cape May Warbler	-	-	-	S3B, S4S5M	Secure
Dolichonyx oryzivorus	Bobolink	Threatened	Threatened	Threatened	S3B, S3M	Sensitive
Eremophila alpestris	Horned Lark	-	-	-	S1B, S4N, S5M	May Be At Risk
Hirundo rustica	Barn Swallow	Threatened	Threatened	Threatened	S2B, S2M	Sensitive
Melanitta nigra	Black Scoter	-	-	-	S3M, S1S2N	Sensitive
Mergus serrator	Red-breasted Merganser	-	-	-	S3B, S5M, S4S5N	Secure
Mimus polyglottos	Northern Mockingbird	-	-	-	S2B, S2M	Sensitive
Morus bassanus	Northern Gannet	-	-	-	SHB, S5M	Secure
Nycticorax nycticorax	Black-crowned Night-heron	-	-	-	S1S2B, S1S2M	Sensitive
Petrochelidon pyrrhonota	Cliff Swallow	-	-	-	S2S3B, S2S3M	Sensitive
Rallus limicola	Virginia Rail	-	-	-	S3B, S3M	Sensitive
Riparia riparia	Bank Swallow	Threatened	Threatened	-	S2S3B, S2S3M	Sensitive
Rissa tridactyla	Black-legged Kittiwake			-	S1S2B, S4N, S5M	Secure
Tringa semipalmata	Willet	-	-	-	S3B, S3M	Sensitive

SCIENTIFIC NAME	COMMON NAME	COSEWIC	*SARA*	*NB SARA*	PROVINCIAL RARITY RANK[(a)]	PROVINCIAL GENERAL STATUS RANK
Tringa solitaria	Solitary Sandpiper	-	-	-	S2B, S5M	Secure
Wilsonia canadensis	Canada Warbler	Threatened	Threatened	Threatened	S3B, S3M	At Risk
Invertebrates						
Lycaena dospassosi	Salt Marsh Copper	-	-	-	S3	Secure
Plebejus idas	Northern Blue	-	-	-	S3	Secure
Speyeria aphrodite	Aphrodite Fritillary	-	-	-	S3	Secure

(a) Provincial Rarity Rank, where:
S1 - Extremely rare in province
S2 – Rare in province
S3 – Uncommon in province
S4 – Widespread, common and apparently secure in province
S5 – Widespread, abundant and demonstrably secure in province
S1S2 - A numeric range rank is used to indicate any range of uncertainty about the status of the species or community.
SU – Status unknown
SH - Historically occurring but currently undetected in province
B - Breeding - Conservation status refers to the breeding population of the species in the province
M - Migrant - Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating transient population of the species in the province.
N - Nonbreeding - Conservation status refers to the non-breeding population of the species in the province

4.9 ENVIRONMENTALLY SENSITIVE AND PROTECTED AREAS

The ACCDC identified 2 saltwater marsh/upland areas managed by Ducks Unlimited within 5 km of the Project area and are located on the same spot. These areas are named The Village Acadien DU, and the Riviere du Nord DU and are approximately 2.6 km south of the Project and cover about 13 ha.

The Village Acadien/Riviere du Nord Environmentally Significant Area (ESA 080) is found roughly 1.5 km south of the Project area, in the community of Riviere du Nord (342383 E, 5295238 N). This area encompasses 10 ha (ACCDC, 2018).

The Nature Trust of New Brunswick has identified a significant salt marsh area in Grand-Anse called the Grande Anse Salt Marsh Environmentally Significant Area (ESA077). The area consists of coastal cliffs intermixed with peatland. This management area is found roughly 5 km west of the Project area (ACCDC, 2018).

An IBA was identified at Pokeshaw Rock, which is found approximately 10 km west of the Project area. This IBA consists of a large rock mostly devoid of vegetation found near the coast, and is host to greater than a thousand nesting pairs of Double-crested Cormorants, which represents approximately 1.5% of the Atlantic coast population of this species (IBA Canada, 2018).

4.10 SOCIAL AND CULTURAL ENVIRONMENT

4.10.1 *EXISTING LAND USES*

Land use in the area is mainly residential, with homes and cottages scattered mainly around the coastline. A handful of local businesses are found in the area as well. Two large peat farms are found within 5 km of the Project area, however one of the two is currently being decommissioned. Land uses on site consist of a small gravel pit, and some scattered commercial thinning.

An unofficial all-terrain vehicle track is found within the Project area on lands currently used by a community member. This track is created out of fill material, and consists of several turns, jumps, and banked corners. This area of the site also includes two structures, one is a semi-permanent residence, and the other is a storage container for scrap metal. A significant amount of construction debris is found piled near the storage building, and several derelict vehicles are found near the semi-permanent residence.

4.10.2 *RECREATION AND TOURISM*

Several non-serviced all-terrain vehicle trials are found near the Project area, and these trails may also be purposed for walking and hiking, bicycling, snowshoeing, cross-country skiing, or dog walking.

The Acadian Peninsula is a tourist destination, with several festivals and events taking place in towns such as Caraquet and Tracadie. Acadian heritage is very important to residents of the Anse-Bleue area, and an Acadian heritage museum is found roughly 3.3 km from the Project area. Several restaurants and other seaside attractions are found along route 11 near Anse-Bleue.

4.10.3 *ECONOMY*

According to the 2016 Census, there were 78,444 people residing in Gloucester County New Brunswick, with a population density of 16.77 persons per square kilometer (Statistics Canada, 2017). A significant portion of the population of the county is found in population centers such as Tracadie (16,114), Bathurst (15,557), Caraquet (4,248), and Shippagan (2,130), for a total of roughly 38,049 persons. The population of Anse-Bleue was estimated at 347 in 2016. 2015 Statistics Canada data reports the median household income of Anse-Bleue at approximately $47,744, roughly 19.6 percent lower than the average for the province of New Brunswick ($59,347). A review of 2012 government of New Brunswick Statistics on unemployment indicates that the northeast economic region had an unemployment rate of 16.8%, which was 6.6% higher than the average for the province in that year.

4.10.4 *HERITAGE AND ARCHEOLOGICAL RESOURCES*

WSP contracted Stratis Consulting Inc. to complete a Heritage Resource Impact Assessment (HRIA) for the Project. The full report will be submitted at a later date.

4.10.5 *VISUAL LANDSCAPE*

A Visual Impact Assessment is being completed for the Project. The full report will be submitted at a later date.

5 IDENTIFICATION OF ENVIRONMENTAL EFFECTS AND MITIGATION

5.1 APPROACH TO THE ASSESSMENT

The proposed Project is considered an "Undertaking" under Schedule A of *Environmental Impact Assessment Regulation 87-83*, and therefore subject to the provincial EIA process. The EIA process for this Project followed the outline provided in "A Guide to Environmental Impact Assessment in New Brunswick" (Environment and Local Government, 2018) and the associated Additional Information Requirements for Wind Turbines document.

The purpose of the EIA is to gather information about the Project and assess potential interactions between the environment and Project activities. The approach considers how each Project activity may interact with the existing environment and result in an environmental effect on one or more of the biophysical and socio-economic components of the environment. The assessment considers the Project description (Section 3) and the existing environment (Section 4).

The approach involves the consideration of how the Project may interact with Valued Environmental Components (VECs) and result in an effect. Where potential adverse effects are identified, mitigation is applied to avoid or minimize (limit) the effects. The assessment includes the analysis of cumulative effects that could be a result of the Project in combination with other developments.

The steps to the assessment include the following:

- Identify VECs
- Define the spatial and temporal boundaries for the assessment
- Provide the description of existing conditions for each VEC
- Identify all possible interactions and effects that the Project may have on VECs
- Describe plans to mitigate the potential effects from the Project
- Evaluate and determine the significance of any residual environmental impacts (i.e., effects that remain after mitigation)
- Discuss follow-up monitoring that may be required

5.2 VALUED ENVIRONMENTAL COMPONENTS

VECs represent physical, biological, cultural, social, and economical properties of the environment determined to be important by the proponent, the public, community groups and stakeholders, the scientific community, First Nations and Métis communities, and government agencies. The value of a component not only relates to its role in the ecosystem, but also to the value placed on it by humans. Examples of physical properties that may be considered VECs include air quality, groundwater, and surface water. Aquatic and terrestrial habitats represent biological properties that may be considered VECs. Access to recreational opportunities and other biophysical properties (e.g., ecological services or resources) can be VECs of the socioeconomic environment. The VECs have been selected for the assessment because of their value and their potential sensitivity to effects from the Project.

The VECs selected for this assessment are:

- Terrain and Soils
- Surface Hydrology
- Fish and Fish Habitat
- Wetlands
- Terrestrial Vegetation
- Terrestrial Wildlife including Birds and Bats
- Species of Conservation Concern
- Heritage and Archaeological Resources
- Land Use
- Noise
- Shadow Flicker
- Visual Aesthetics
- Electromagnetic Interference
- Local Economy
- Aviation

Air quality was not selected as a VEC because air quality in the Project area is expected to be better than that recorded in Bertrand and Hault-Shippagan given its location (Section 4.1). Construction and operation of the Project is expected to contribute a small amount of dust and vehicle emissions, however, through the use of mitigation (e.g., dust suppression and not idling vehicles), the Project is not expected to cause exceedances of emissions over guideline values. Wind projects are constructed to offset GHG emissions from other types of power generation. Therefore, air quality will not be carried through the assessment.

Environmentally sensitive and protected areas were not selected as VECs because these areas are not present within the Project footprint and the nearest sensitive area is 1.5 km from the southernmost WEC (Section 4.9). Construction and operation of the Project is not expected to cause direct effects to environmentally sensitive and protected areas because of the distance from the features. Therefore, environmentally sensitive and protected areas will not be carried through the assessment.

5.3 SPATIAL AND TEMPORAL BOUNDARIES

The assessment boundaries define the geographic and temporal scope or limits of the analysis for the determination of significance of effects from the Project and other developments. The boundaries encompass the areas within (spatial boundaries) and time periods (temporal boundaries) that the Project and other developments is expected to interact with VECs.

5.3.1 *SPATIAL BOUNDARIES*

The selection of the spatial boundaries for the assessment is based on the physical and biological properties of VECs. The spatial boundaries have been defined to be large enough to encompass enough area to complete the evaluation of potential effects that all Project components and infrastructure may have on the environment (e.g., power lines, access roads, WEC pads). Effects from the Project on the environment are typically stronger at a local scale. For example, VECs with limited movement such as vegetation will likely be restricted to local changes from the Project footprint. For VECs that have larger distributions (e.g., a river system) or are mobile (e.g., wildlife), the Project effects have a higher likelihood to combine with effects with other developments or activities at a larger scale.

LOCAL ASSESSMENT AREA

For the purpose of this assessment, a Local Assessment Area is defined. For most of the identified VECs, Project effects will be limited to the Project footprint plus a 1 km buffer. The 1 km buffer is defined to encompass the maximum spatial extent of direct effects from within the Project footprint and small-scale indirect effects. The 1 km buffer is defined because it encompasses the majority of the minimum setback distances recommended for wind Projects in New Brunswick (Section 3.5).

REGIONAL ASSESSMENT AREA

WECs need to be spaced hundreds of metres apart to avoid interference between the turbulence wakes of adjacent WECs resulting in large footprints even from projects with a small number of WECs. Habitat loss or degradation from WECs and associated infrastructure can impact all species in a Project area, not only those that are affected by direct effects (i.e., mortality from collisions with WECs or other structures) but also indirect effects through the loss of habitat. Construction of associated infrastructure (e.g., access roads, towers, WEC pads) can affect suitable habitat and/or displace species from otherwise suitable habitat near a wind energy project. Therefore, the Regional Assessment Area is defined as the Project footprint plus a 5 km buffer. The Regional Assessment Area is defined so that it encompasses an area large enough so that an analysis of incremental and cumulative effects from the Project and other developments can be completed and is also large enough so that it contains reference areas (i.e., areas not expected to be affected by the Project). In addition, the 5 km buffer that encompasses the maximum setback distance recommended for wind Projects in New Brunswick (Section 3.5).

5.3.2 *TEMPORAL BOUNDARIES*

The temporal boundaries for this Project is based on the phases of the Project and include construction (2020), operation (2020 to 2050), and decommissioning and abandonment (2050 and beyond). For all VECs, residual effects are assessed for all phases of the Project, and not for each specific phase. For example, effects on wildlife begin during the construction phase with the removal of habitat and continue through until a period after the decommissioning and abandonment phase until effects are reversed (i.e., until habitat is reclaimed), unless the effects are determined to be irreversible or permanent.

5.4 POTENTIAL EFFECTS AND MITIGATION

The first step is to identify all potential interactions between the Project and VECs. Identification of potential interactions is then followed by the identification of mitigation that can be incorporated into the Project to avoid or reduce potential effects of the Project on VECs. Mitigation has been developed for the Project according to the following hierarchy outlined in "A Guide to Environmental Impact Assessment in New Brunswick" (Environment and Local Government, 2018): 1) Impact avoidance 2) Impact reduction; 3) Impact compensation.

Where a potential interaction between the Project and VECs was identified, mitigation is proposed. Where possible, mitigation measures are incorporated into the Project design and implemented to avoid or reduce potential adverse effects. The key mitigation options available for the Project were site selection, choice of construction techniques, and timing of construction activities. The Project siting avoids wetlands, drainages, steep terrain, and unique habitats to the extent practical, and follows existing disturbance corridors where feasible.

Interactions where mitigation can be used to avoid an effect are not considered further in the assessment because the mitigation will remove the interaction and result in no measurable change to a VEC. Interactions where mitigation reduces potential effects, but the changes to a VEC are small, are also not considered further because they are not expected to result in significant effects to a VEC. Where mitigation cannot remove an interaction and residual effects to a VEC are expected, further analysis is required to determine the significance of those Project effects on a VEC (Section 6). For interactions where positive effects are anticipated, opportunities were determined for maximizing the positive effects.

The identification of all potential interactions between the Project and VECs can be completed in advance of receiving information from baseline studies being completed for the Project. Project activities, potential interactions, and identified mitigations are summarized in Table 5.4-1. Standard mitigations for activities during wind projects are included. Once baseline surveys are completed, any site-specific mitigations that may be required from the identification of sensitive or other important features in the Project area will be considered in the final residual effects assessments that will be submitted at a later date.

Table 5.4-1 Potential Interactions, Proposed Mitigation, and Predicted Residual Effects

VALUED ENVIRONMENTAL COMPONENT(S)	POTENTIAL INTERACTION AND ENVIRONMENTAL EFFECT	PROPOSED MITIGATION	PREDICTED RESIDUAL EFFECT
Terrain and Soils	Construction on unstable lands may increase potential for erosion.	• All necessary permits and approvals will be obtained and on-site. • The Project will be sited on existing roads and disturbed areas as much as possible, thereby minimizing the need to disturb new areas. • Pre-project geotechnical surveys are being completed to identify locations for avoidance or mitigation. • When feasible, transporting equipment and material will be postponed during adverse weather or wet ground conditions to mitigate rutting, admixing, and compaction. • Upper soil materials and organic material (containing seed bank and propagules) will be salvaged for replacement during reclamation. • Upper soil materials and organic material will be stripped carefully to a selected depth to reduce admixing. • Stripped soil materials will be stored separate from excavated or graded subsoils to mitigate admixing, loss, and changes to soil quality. • Soil material replacement will be completed when the soil condition is suitable (i.e., dry condition) to be evenly spread over disturbed areas. • During reclamation, if soil compaction has occurred, the areas may be deep ripped to alleviate compacted soils prior to soil material replacement.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to the VEC.
	Changes to soil quality through disturbance to soils (i.e., soil loss, admixing, compaction) from site clearing, excavation, and grading.		No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to the VEC.
Surface Hydrology Wetlands	On-site water withdrawal for pressure washing and dust control during construction.	• Pre-project surveys will be completed to identify locations for avoidance. • All necessary permits and approvals will be obtained and on-site. • It is anticipated that most of the water will come from water trucks, however if required, an on-site water supply may be used. If an on-site water supply is determined to be required for the Project, a WAWA will be obtained prior to withdrawing any on-site water during Project construction.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to VECs.
Surface Hydrology Fish and Fish Habitat Wetlands	Disturbance to natural drainage profiles and drainage patterns can cause effects to fish and fish habitat and wetlands.	• Pre-project surveys will be completed to identify locations for avoidance or mitigation. • All necessary permits and approvals will be obtained and on-site. • To the extent practical, existing surface drainage patterns will be maintained in the Project area. • If alteration is required for the wetland near WEC 6, then a WAWA Permit application will be submitted. • Access roads that cross watercourses and wetlands will follow the guidelines from the Watercourse and Wetland Alteration Technical Guidelines and the conditions as listed on the WAWA. • Disturbances to wetland and drainage edges will be minimized to the extent possible. • To the extent practical, construction in wetlands will be scheduled to occur under dry or frozen ground conditions if wetlands cannot be avoided. • Any extra workspace required near drainage edges will be separated from the top of bank by a minimum of 30 m. • Culverts will be installed as necessary to maintain drainage. • Use temporary diversion berms or other methods, as required, to regulate drainage from construction areas.	No significant residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to VECs.
Fish and Fish Habitat	Alteration to fish habitat from increased sediment loading from increases in erosion.	• All necessary permits and approvals will be obtained and on-site. • The Project will be sited on existing roads and disturbed areas as much as possible, thereby minimizing the need to disturb new areas. • Prior to construction, a Grading Plan, Storm Drainage Plan, and an Erosion and Sedimentation Control Plan will be developed, approved, and implemented for the Project. • The Erosion and Sediment Control Plan will be designed so that landscape features outside of the Project footprint will not be altered. • Salvaged materials will be stored away from waterbodies and watercourses above the high-water mark. • Erosion and sediment control measures including silt fence, straw bale check dams and diversion channels will be installed in accordance with manufactures specifications, as appropriate. • Erosion and sediment control measures shall be inspected and maintained during construction.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to the VEC.

VALUED ENVIRONMENTAL COMPONENT(S)	POTENTIAL INTERACTION AND ENVIRONMENTAL EFFECT	PROPOSED MITIGATION	PREDICTED RESIDUAL EFFECT
Wetlands Vegetation Wildlife Species of Conservation Concern Land Use	Alteration to wetlands, vegetation, wildlife habitat, SOCC, and land uses from increased erosion following construction.	• Remove silt and other accumulated debris from site drainage ditches in order to keep them free-flowing at all times. Dispose of removed sediment as per an Erosion and Sedimentation Control Plan. • Erosion and sediment control measures will not be removed until there is unlikely to be further erosion. • Dust control methods (i.e., watering roads) will be employed during construction of the Project to limit wind erosion. • Weather forecasts shall be regularly monitored for extreme weather conditions during the construction period when exposed soils have not been fully stabilized. • A visual inspection of the worksite shall be conducted, during and after each significant rainfall event, for signs of erosion, and implement appropriate mitigation measures if required. • Additional sediment control and erosion control materials must be on-site and readily available in the event of a sudden and significant rainfall event or the forecast of such event. • Construction activities will be reduced or stopped during heavy precipitation events. Heavy precipitation events are those considered hindering access and clearing activities, causing rutting and compaction of soils and those which may cause a threat of local flooding.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to VECs.
Birds	Destruction of migratory bird nests can affect bird populations.	• Clearing of vegetation will be completed outside of the breeding and nesting season for birds (i.e., April to August) where possible. If vegetation removal is proposed within the nesting season, a pre-construction nesting bird survey and mitigation plan would be required in order to avoid the inadvertent harming, killing, disturbance or destruction of migratory birds, nests and eggs. • If clearing of vegetation cannot be completed outside of the breeding bird window, pre-project surveys will be completed to identify locations for avoidance or mitigation.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to the VEC.
Wetlands Vegetation Wildlife Species of Conservation Concern	Loss/alteration of vegetation and wildlife habitat from Project construction.	• The Project will be sited on existing roads and disturbed areas as much as possible, thereby minimizing disturbance to undisturbed areas. • Siting and construction of the Project has been planned to avoid environmentally sensitive areas (e.g., critical wildlife habitat, listed plant species, wetlands, waterbodies, and watercourses, and other identified key habitat areas for bats, other SOCC, or sensitive wildlife species). • Construction will be scheduled to occur during periods of lowest sensitivity to wildlife, birds, bats and SOCC, where practical. • If a plant SOCC is encountered that was not expected, appropriate mitigation will be applied prior to further construction activities. • If a wildlife SOCC is encountered that was not expected, appropriate mitigation will be applied prior to further construction activities. • Disturbed areas not required for Project operation will be revegetated with an approved, weed free mix, as soon as practical following construction.	No residual effect is anticipated because mitigation reduces potential effects, but the changes to VECs are predicted to be small and are not expected to result in significant effects to VECs.
Heritage and Archeological Resources	Destruction or alteration of heritage and/or archaeological sites.	• A HRIA is being completed for the Project and will be submitted at a later date. Any required mitigation for Heritage and Archeological Resources will be included in the final report. • If accidental discovery of heritage resources and/or archaeological materials are encountered, Archeological Services New Brunswick (ASNB) will be notified and any ASNB protocols related to accidental discovery will be followed.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to the VEC.
Fish and Fish Habitat Wetlands Vegetation Wildlife Species of Conservation Concern	Use of explosives can cause changes to wetlands, vegetation, wildlife, SOCC, and land use.	• If blasting is required for construction, a detailed Blasting Plan will be developed for the Project and will describe the type of explosives used and the method of detonation and follow activity restriction guidelines.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to VECs.
Noise Wildlife Land Use	Increased noise levels from construction and operation of the Project.	• The predicted sound pressure for the Project will be described in the Noise Impact Assessment being completed for the Project. • The Project will conform to existing municipal, local, and regional by-laws and regulatory requirements. • Construction will be scheduled to occur during daytime hours. • Machines will be kept in good working order and comply with applicable provincial and federal requirements. • Heavy equipment will be outfitted with mufflers to dampen noise. • Work will be conducted in a respectful manner using necessary notifications and communications regarding temporary and intermittent increases in noise during project construction. • Construction activities will follow activity restriction guidelines and set-back distances for wildlife.	Changes to VECs are predicted to be small. No significant residual effect is anticipated because mitigation reduces potential effects.

VALUED ENVIRONMENTAL COMPONENT(S)	POTENTIAL INTERACTION AND ENVIRONMENTAL EFFECT	PROPOSED MITIGATION	PREDICTED RESIDUAL EFFECT
Wildlife Land Use	Sensory effects from the presence of the WECs, lights, noise, blasting, and vehicles.	• Construction will be scheduled to occur during daytime hours. • Project personnel will be instructed to keep a clean work area and to not harass animals encountered. • Drivers instructed to be aware of wildlife and slow speed limits will be enforced on the Project, where appropriate. • Equipment and vehicles will yield the right-of-way to wildlife. • Food wastes will be collected in suitable receptacles that limit attraction or impact to wildlife. • Littering and feeding of wildlife will be prohibited. • Recyclable and waste hazardous materials will be stored on-site in appropriate containers to prevent exposure and shipped off-site to an approved facility.	Changes to VECs are predicted to be small. No significant residual effect is anticipated because mitigation reduces potential effects

Birds and Bats	Operation of the Project may result in migratory birds and bats colliding with WECs and other Project infrastructure.	• Bird and Bat studies are being completed for the Project and the associated reports will be submitted at a later date.
		• Siting and construction of the Project has been planned to avoid environmentally sensitive areas (e.g., critical wildlife habitat, listed plant species, wetlands, waterbodies, and watercourses, and other identified key habitat areas for bats)
		• Transmission lines will avoid travelling over top of any high use habitat areas, such as wetlands and waterbodies, as much as practical. If these areas are unavoidable and risk of collisions is identified as high, collision mitigation (e.g., bird diverters) will be installed at and along these areas.
		• Because fog hinders the ability of birds to avoid collisions with obstacles, WECs may cease operating under foggy conditions during periods of bird migration throughout the Project area.
		• The Project will comply with lighting and marking requirements specified by Transport Canada.
		• Prior to the dismantling of a building or other installation, an inspection will be completed to determine use as a maternity or a roosting site by bats. If necessary, protective measures will be taken to avoid disruption to the survival of bats.
		• A Post-Construction Monitoring program for birds and bats will be implemented (Section 9). If the Project is found to be causing significant mortality during post-construction monitoring, additional mitigation will be evaluated.
		• If follow-up surveys indicate significant effects to birds and bats, additional mitigations may be required and may include the following:
		  • Application of emerging bat aversion technologies or other innovative measures;
		  • Selective shutdown of WECs during periods of high bat activity/concentrations (e.g., swarming, late summer/fall migration) or under certain weather conditions (e.g., during periods of low wind when power generation is low and bat activity levels are high);
		  • Selective shutdown of WECs during periods of key times of year for bird activity or migration;
		  • Changes to lighting on WECs.
			Potential residual effects are anticipated.

Birds and Bats	Construction and operation of the Project may cause birds to alter their migration flyways.	• A Noise Impact Assessment is being completed for the project and will be submitted at a later date. • Construction will be scheduled to occur during daytime hours. • The Project will be sited on existing roads and disturbed areas as much as possible, thereby minimizing disturbance to undisturbed areas. • Bird and Bat studies are being completed for the Project and the associated reports will be submitted at a later date • Clearing of vegetation will be completed outside of the breeding and nesting season for birds (i.e., April to August) and outside the calving and rearing period for bats (i.e., May to August) where possible. • Where possible, placement of Project infrastructure in habitats significant to bird species will be avoided. These include wetlands, mature forests, and areas with large, hollow trees. • A Post-Construction Monitoring program for birds and bats will be implemented (Section 8). If the Project is found to be causing significant mortality during post-construction monitoring, additional mitigation will be evaluated.	Potential residual effects are anticipated.
	Construction and operation of the Project may displace birds and bats from previously used habitats in the Project area.		Potential residual effects are anticipated.
Visual Aesthetics	Construction and operation of the Project can cause changes to the visual landscape.	• A Visual Impact Assessment is being completed for the Project and will be submitted at a later date.	No residual effect is anticipated.
Electromagnetic Interference	WEC operation may interfere with telecommunication and/or radar communication infrastructure	• An Electromagnetic Interference Study is being completed for the Project and will be submitted at a later date. • Consultation with Navigation Canada, Environment Canada Weather Radar, RCMP, and Transport Canada has been complete for the Project and approvals/clearances for the Project and will be submitted at a later date. • Other telecommunication and/or radar could be affected by the Project, therefore if other agencies are identified, they will be contacted to address any interference concerns as required.	No residual effect is anticipated.
Shadow Flicker Land Use	Operation of the Project may cause nuisances from shadow flicker in the Project area.	• A Shadow Flicker Assessment is being completed for the Project and will be submitted at a later date.	No residual effect is anticipated.

VALUED ENVIRONMENTAL COMPONENT(S)	POTENTIAL INTERACTION AND ENVIRONMENTAL EFFECT	PROPOSED MITIGATION	PREDICTED RESIDUAL EFFECT
Birds, Bats and Other Wildlife Visual Aesthetics Land Use	Lighting on WECs may be visible during night time hours.	• Use of lighting during construction and on WEC hubs and blades will be limited to minimum levels while still meeting requirements of Transport Canada. • Lighting will be designed to limit off-site light disturbances.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to the VEC.
Aviation	WEC operation may interfere with aviation.	• Consultation with federal agencies including NAV Canada, Transport Canada, and the DND has been completed for the Project. • The Project will comply with lighting and marking requirements specified by Transport Canada.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to the VEC.
Local Economy	Employment and business opportunities.	• Local communities will benefit from the development, construction, and operation of the Project as outlined in Section **Error! Reference source not found.**. • Local and regional business communities and labour organizations will be informed of the opportunities arising from the construction, operation and maintenance of the Project.	A positive residual effect is anticipated.
Land Use	Construction and operation of the Project can have effects on traditional land use.	• Early and meaningful engagement with First Nations communities and all potential stakeholders was completed for the Project and will continue during the Project. • If discovery in regard to settlement or land use occurs during the Project, activities will cease in the immediate area and the appropriate regulatory agencies will be contacted, as appropriate.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to the VEC.
Land Use	Construction and operation of the Project can cause disruptions to current land use.	• Traffic flow provincial highways or access roads may periodically be affected by construction activities. • Appropriate signage will be erected and traffic directing personnel will be used where required. • Good housekeeping practices will be employed and maintained through the duration of the Project activities. • All litter, garbage, and other debris generated by the Project will be collected and transported to approved disposal locations or facilities. • Disturbed areas will be recontoured and reclaimed to a stable profile to permit existing land uses. • A traffic management program will be developed for the Project and will include a detailed schedule, detailing the volume, timing and density of construction traffic • Project activities will follow applicable local and provincial traffic regulations. • Road cones may be placed at designated areas and warning signs posted in roadways as required. • Heavy goods vehicles will not arrive or leave the Project except between agreed hours. • During construction, the approved traffic route will be kept free of mud and debris resulting from construction and operation of the Project. • A wheel wash system will be provided on the internal access road to remove debris from vehicles before they leave site. • Debris found on the local roads will be removed regularly using road brushes and vacuum road sweepers.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to the VEC.
Fish and Fish Habitat Wetlands Terrestrial Vegetation Wildlife including Birds and Bats Species of Conservation Concern Land Use	Contamination from spills and wastes from materials such a fuels and hydraulic fluids.	• A Fuel and/or Hazardous Materials Spills Contingency Plan will be developed. • Dangerous goods will be stored, handled, and transported according to the New Brunswick *Clean Environment Act* and the *Transportation of Dangerous Goods Act* • Appropriately sized spill kits will be available on-site for clean-up efforts. • All work-site activities will be conducted in a manner that minimizes the potential for spills or leaks, including the regular inspection and maintenance of machinery and equipment, and providing spill containment structures for onsite fuel and oil storage, if applicable. • No fueling and servicing of equipment will be completed within 50 m of any watercourse or wetland. • In case of a spill, the Fuel and/or Hazardous Materials Spills Contingency Plan will be followed.	No residual effect is anticipated because mitigation will remove the interaction and result in no measurable change to VECs

5.4.1 *RESIDUAL ENVIRONMENTAL EFFECTS*

The following Project-VEC interactions have been identified as having potential to result in residual effects because mitigation cannot remove the interaction. Therefore, further analysis is required to determine the significance of these Project effects (Section 6).

- Operation of the Project may result in birds and bats colliding with WECs
- Construction and operation of the Project may cause birds to alter their migration flyways
- Construction and operation of the Project may displace birds and bats from previously used habitats in the Project area
- Employment and business opportunities

The analysis for birds and bats will be completed when baseline information has been submitted. The baseline data is required to complete a confident and scientifically defendable assessment of effects and to determine the significance of both incremental and cumulative effects.

Further analysis of employment and business opportunities is presented in Section 7.

6 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Several environmental factors could have adverse effects on the Project. This section examines the interactions between the surrounding environment and the main environmental conditions that can affect the Project. Mitigation, contingency plans, and Project design can reduce risks to the Project.

6.1 SEVERE WEATHER

Severe weather events include extreme winds, extreme rainfall and flooding, extreme snowfall, ice storms, and lightning. In general, New Brunswick can experience anywhere between 10 to 20 days of severe weather events with the more severe events occur during the winter months. Winter storm events can result in strong winds with rain, freezing rain, and extreme snowfall. Severe weather in summer months can also result in strong winds, but also extreme rainfall and flooding, hail, and lightning. Effects of the environment on the Project would result in a short-term delay in construction schedule, frequent short-term disruptions in service, and increased operating or maintenance costs. An environmental management plan will be developed to ensure mitigation measures are in place to ensure the protection of the environment and minimize delays. Contingency plans will be included in case of extreme weather events.

6.1.1 *EXTREME WIND*

WECs are equipped with a high wind operation control feature. This feature allows the WEC to operate up to the extended cut-out wind species (27.5 m/s or 99.0 kilometres per hour [km/hr]). In extreme wind conditions, the Project's WEC monitoring system will automatically ensure the WEC blades are feathered (i.e., pitched) such that the blade surface is no longer positioned to capture incoming wind. This change of pitch ensures the extreme winds cannot cause the rotor to rotate.

6.1.2 *EXTREME RAINFALL AND FLOODING*

Extreme rainfall of 218.8 mm was recorded at Bertrand in February of 1998, and 217.1 mm in May of 1994 (Government of Canada 2019a). Heavy rain can result in stoppages of outdoor work, particularly during construction. If unusual wet periods or excessive rain do occur, this can result in Project delays and additional cost. Heavy rainfall events may also cause erosion on-site. A potential exists for failure of erosion and sediment control structures due to extreme precipitation events. Such a failure could result in the release of a large quantity of sediment-laden runoff to receiving wetlands, waterbodies, or watercourses with potential adverse environmental effects on fish and fish habitat. Local flooding may occur at work sites during extreme precipitation events. Construction may temporarily be halted in the event of extreme rainfall and flooding. Appropriate erosion control measures will be used and inspected during the Project especially in areas where erosion potentials are high and are adjacent to sensitive habitats.

6.1.3 *EXTREME SNOWFALL*

It is not uncommon to experience over 100 cm of snowfall in a month during the winter season on the Acadian peninsula. Environment Canada historic data for the Bertrand weather station revealed that the area experienced 110 cm of snowfall in February of 2002, 123.3 cm of snowfall in December of 1989, 86.8 cm of snowfall in December of 2004, and 85.8 cm of snowfall in December of 2005. Extreme snowfall can affect winter construction or contribute to unusual flooding during snowmelt. Extreme snowfall in early fall or late spring could delay construction and result in additional work for snow clearing and removal and could increase Project costs. Early snow cover can minimize or prevent ground freezing and this may also affect winter construction intended at improving work progress and accessibility. Construction may temporarily be halted in the event of extreme snowfall events. Workers will follow Project specific and relevant safe work practices as necessary.

6.1.4 *ICE STORMS AND TURBINE ICING*

Icing conditions can be expected during winter months. An icing study completed for the Project indicates that icing is more substantial at the beginning and the end of winter, with its highest peak during the month of December (Nergica, 2018). WECs will be equipped with a rotor blade de-icing system. When ice build-up is detected and the turbine has been stopped, the de-icing system, which is operated with hot air circulation starts. The fan heater that is installed at the root of the rotor blade circulates hot air to the blade tip until the ice build-up melts off. Once thawing is complete, the turbine is automatically restarted.

6.1.5 *LIGHTNING*

WECs are equipped with a lightning protection system that will help protect the WEC against physical damage caused by lightning strikes. The lightning protection system consists of the following:

- Moulded aluminum rotor blade tip and lightning conductor – the conductor links the blade tip with an aluminum ring around the blade root at a sufficient distance from the metal parts in the blade connection area. This prevents flashover and the lightning current will be properly dissipated.
- Nacelle – Lightning rods on the nacelle and the aluminum ring on the blades form spark gaps that dissipates lightning currents. The lightning current is conducted from the rotor casing via another ring and another spark gap to the nacelle.
- Protection against overvoltage and overcurrent.
- Shielding against magnetic and electrical fields.
- Earthing system.

6.2 CLIMATE CHANGE

Climate change can affect the Project by increasing the frequency and intensity of extreme weather events. Changes to the frequency and intensity of extreme weather events are difficult to predict. Although many climate models have been developed to estimate changes to climate, the local changes to the magnitude and frequency of extreme weather events are unknown. Therefore, appropriate conservatism will be incorporated into the Project design to address these changes.

7 CLASSIFICATION OF RESIDUAL ENVIRONMENTAL EFFECTS AND DETERMINATION OF SIGNIFICANCE

7.1 APPROACH TO DETERMINATION OF SIGNIFICANCE

The assessment or determination of the significance of potential effects is based on the framework/criteria provided in Canadian Environmental Assessment Agency (Agency) guidance document “Responsible Authorities Guide” (Agency, 1994) which summarizes the requirements that have been applied to similar projects in the past. An updated version is now available for Projects designated under CEAA 2012 (Agency, 2015). These documents are similar in nature and are widely accepted as guidance documents used by government and regulatory agencies in Canada are used as the basis for determining the significance of identified potential effects. This consists of the following steps:

- Determining whether the residual environmental effect is adverse
- Determining whether the adverse environmental effect is significant
- Determining whether a significant environmental effect is likely

For the purposes of the EIA, an effect is defined as the change to VECs as a result of Project activities. A project-induced change may affect specific groups, populations, or species, resulting in modification of VECs in terms of an increase or decrease in its nature (characteristics), abundance, or distribution. Effects are categorized as either negative (adverse) or positive. Any adverse effects are then determined to be significant or non-significant in consideration of assessment criteria discussed below. The detailed residual effects assessment focuses on those interactions between VECs and Project activities which are likely to cause residual effects.

7.2 CLASSIFICATION OF RESIDUAL EFFECTS AND DETERMINATION OF SIGNIFICANCE

The residual effects classification is based on the magnitude, geographic extent, duration/frequency, reversibility and ecological context and is to describe residual effects predicted for the Project. The criteria are used to describe the nature and type of an effect on VECs. The residual effects classification is then used to determine the environmental significance of Project effects to VECs. The definitions of the criteria are presented below.

Magnitude is a measure of the intensity of a residual effect or the degree of change caused by a Project on a VEC relative to the existing conditions. Geographic extent and duration of an effect is important in classifying magnitude for a VEC. For magnitude, the criteria are defined as follows:

- **High**: A residual environmental effect affecting a whole stock, population, habitat or ecosystem, outside the range of natural variation that may be near or exceed the resilience limits of a population or community, such that communities do not return to pre-Project levels for multiple generations. For social environment VECs, the residual effect is expected to substantially enhance or interfere with existing conditions in communities in the local area and beyond.
- **Moderate**: A small, measurable residual environmental effect affecting a portion of a population or habitat, or ecosystem, returns to pre- Project levels in one generation or less, rapid and unpredictable change, temporarily outside range of natural variability. For social environment VECs, the residual effect is noticeable and may be potentially beneficial or detrimental to individuals and communities in the local area but not beyond.

- **Low**: A negligible residual environmental effect affecting a specific local group, habitat, or ecosystem, returns to pre-Project levels in one generation or less, within natural variation. For social environment VECs, the residual effect is limited to a slight positive effect or nuisance to individuals or communities in the local area.
- **Nil**: No discernable change to a VEC.
- **Unknown**: A residual environmental effect affecting an unknown portion of a population or group or where the changes in a specific parameter are unknown.

Geographic extent refers to the spatial extent of the area affected and is related to the spatial distribution and movement of a VEC. When considering geographic extent in the determination of magnitude, it is important to understand that local scale effects are less severe than those that extend to the regional scale or beyond. Geographic extent is broken into local, regional, and beyond regional as defined as follows:

- **Local scale** effects are those largely associated with direct effects from the Project footprint (i.e., removal of vegetation for construction of Project components) and project specific small-scale indirect changes (i.e., within the Local Assessment Area).
- **Regional scale** effects are those that are associated with incremental and cumulative changes from the Project and other developments but are restricted to within the Regional Assessment Area.
- **Beyond regional** includes cumulative residual effects from the Project and other developments that extend beyond the Regional Assessment Area.

Frequency refers to how often a residual effect will occur but is not to be confused with the frequency of the activity that causes a residual effect. Frequency is explained by identifying when the source of change and residual effect occurs. Frequency is broken into the following categories:

- **Infrequent** – isolated or confined to a discrete period.
- **Frequent** – occur repeatedly over the assessment period.
- **Continuous** – occurs continuously over the assessment period.

Duration is defined as the amount of time from the beginning of a residual effect to when that effect on a VEC is reversed. Duration is the results of two factors, the amount of time between the start and end of a project activity that causes stress on a VEC and the time required for the effect to be reversible. The duration of individual Project activities and the period in which the residual effect may occur are considered. Some effects are reversible shortly after the stress has been removed (e.g., changes in the distribution of some wildlife species following the removal of noise after decommissioning and abandonment), while others may take longer to be reversed (e.g., the change in abundance of some species until revegetation has occurred). In some cases, a prediction of duration may be well beyond the temporal boundary of the Project, it is not known when those effects may be reversed, and a VEC may never return to a state that was unaffected by the Project. In these cases, the likelihood of reversibility is so low that the effect is classified as irreversible. Therefore, duration is broken into the following categories:

- **Short-term** – the residual effect is reversible at the end of construction.
- **Medium-term** – the residual effect is reversible at the end of operation of the Project.
- **Long-term** – the residual effect is reversible within a defined length of time where prediction certainty can predict the effect is reversible after decommissioning and abandonment.
- **Permanent** – the residual effect is predicted to influence a VEC indefinitely. This is applied when an effect is determined to be irreversible.

Reversibility is considered the likelihood that the Project will no longer affect a VEC and as the ability of a VEC to return to an equal or improved condition once the interaction with the Project has ended. Reversibility has two alternatives, reversible or irreversible. Reversible is applied to short- medium- and long-term duration residual effects where the Project no longer causes changes to a VEC. Irreversible is applied when the residual effect is predicted to influence a VEC indefinitely or the duration of an effect is unknown.

For adverse residual effects, the evaluation for the individual criteria will be combined into an overall prediction of significance as follows:

- **Significant**: Potential residual effect could jeopardize the long-term sustainability and decrease the resilience of the resource, such that the residual effect is considered sufficient in magnitude, geographic extent, duration, and frequency, as well as being considered irreversible. Additional research, monitoring, and/or recovery initiatives should be considered.
- **Not-significant**: Potential impact could result in a decline of a resource in terms of quality/quantity, such that the impact is considered measurable at the local level in its combination of magnitude, geographic extent, duration, and frequency, but does not affect or increase risk to the long-term sustainability (that is, it is considered reversible). Additional research, monitoring, and/or recovery initiatives may be considered.

For residual effects of the Project to have a significant effect on VECs, individuals would have to be affected to the extent that there would be a permanent adverse change to survival and reproduction at the population or community level.

7.2.1 *RESIDUAL EFFECTS ON BIRDS*

The evaluation of residual effects and determination of significance will be completed following the completion of baseline studies for birds and the report will be submitted at a later date.

7.2.2 *RESIDUAL EFFECTS ON BATS*

The evaluation of residual effects and determination of significance will be completed following the completion of baseline studies for birds and the report will be submitted at a later date

7.2.3 *RESIDUAL EFFECTS TO LOCAL ECONOMY*

The Project will have a significant positive residual effect on the social environment in relation to employment and business opportunities (Table 7.2-1). For the Project to proceed, people are required to staff the Project which will result in income and training opportunities. Project construction and operations will create jobs and generate income. Employees typically spend their incomes where they live and therefore indirect benefits will also occur during the Project. It is anticipated that most of the construction workforce will be hired locally. The Project will result in increased training and experience in the labour force, which will have a positive effect on future opportunities. Project spending will result in increased gross domestic product and Project operations will generate tax revenue for municipal, provincial, and federal governments.

Table 7.2-1 Summary of Residual Effects Classification and Predicted Significance

POTENTIAL INTERACTION AND RESIDUAL ENVIRONMENTAL EFFECT	MAGNITUDE	GEOGRAPHIC EXTENT	FREQUENCY	DURATION	REVERSIBILITY	SIGNIFICANCE
Employment and business opportunities	Moderate	Regional	Continuous	Long-term	Irreversible	Significant positive effect

7.3 CUMULATIVE RESIDUAL EFFECTS

Cumulative residual environmental effects are defined as the sum of residual environmental effects from all past, current, and reasonably foreseeable projects and/or activities on the physical, biological, social and cultural components of the environment. In addition, natural disturbances such as fire, floods, insects, disease, and climate change can contribute to cumulative residual environmental effects.

The Project will implement mitigation practices to limit incremental environmental effects from the Project that will occur. Implementation of the mitigation for this Project is expected to result in minor changes to the biophysical and socio-economic environments from the Project relative to baseline conditions. Effects on VECs from surrounding land use and peat harvesting operations are not expected to overlap with effects on VECs in the local area. As such, no cumulative residual environmental effects are expected. As the Project progresses, CVLP will develop site-specific mitigation to further reduce the potential for cumulative environmental effects as required.

8 SUMMARY OF PROPOSED MITIGATION

GENERAL

- All necessary permits and approvals will be obtained and on-site.
- Pre-project surveys will be completed to identify locations for avoidance, where required.
- Prior to construction a Grading Plan, Storm Drainage Plan, and an Erosion and Sedimentation Control Plan will be developed, approved, and implemented for the Project.
- The Erosion and Sediment Control Plan will be designed so that landscape features outside of the Project footprint will not be altered.

SOILS, UNSTABLE TERRAIN, AND EROSION

- Pre-project geotechnical surveys are being completed to identify locations for avoidance or mitigation.
- When feasible, transporting equipment and material will be postponed during adverse weather or wet ground conditions to mitigate rutting, admixing, and compaction.
- Upper soil materials and organic material (containing seed bank and propagules) will be salvaged for replacement during reclamation.
- Upper soil materials and organic material will be stripped carefully to a selected depth to reduce admixing.
- Stripped soil materials will be stored separate from excavated or graded subsoils to mitigate admixing, loss, and changes to soil quality.
- Soil material replacement will be completed when the soil condition is suitable (i.e., dry condition) to be evenly spread over disturbed areas.
- During reclamation, if soil compaction has occurred, the areas may be deep ripped to alleviate compacted soils prior to soil replacement.
- Salvaged materials will be stored away from waterbodies and watercourses above the high-water mark.
- Erosion and sediment control measures including silt fence, straw bale check dams and diversion channels will be installed in accordance with manufactures specifications, as appropriate.
- Erosion and sediment control measures shall be inspected and maintained during construction
- Remove silt and other accumulated debris from site drainage ditches in order to keep them free-flowing at all times. Dispose of removed sediment as per an Erosion and Sedimentation Control Plan.
- Erosion and sediment control measures will not be removed until there is unlikely to be further erosion.
- Dust control methods (i.e., watering roads) will be employed during construction of the Project to limit wind erosion.
- Weather forecasts shall be regularly monitored for extreme weather conditions during the construction period when exposed soils have not been fully stabilized.

- A visual inspection of the worksite shall be conducted, during and after each significant rainfall event, for signs of erosion, and implement appropriate mitigation measures if required.
- Additional sediment control and erosion control materials must be on-site and readily available in the event of a sudden and significant rainfall event or the forecast of such event.
- Construction activities will be reduced or stopped during heavy precipitation events. Heavy precipitation events are those considered hindering access and clearing activities, causing rutting and compaction of soils and those which may cause a threat of local flooding.

SURFACE DRAINAGE AND WATERCOURSES

- It is anticipated that most of the water will come from water trucks, however if required, an on-site water supply may be used. If an on-site water supply is determined to be required for the Project, a WAWA will be obtained prior to withdrawing any on-site water during Project construction.
- To the extent practical, existing surface drainage patterns will be maintained in the Project area.
- Access roads that cross watercourses and wetlands will follow the guidelines from the Watercourse and Wetland Alteration Technical Guidelines and the conditions as listed on the WAWA.
- Any extra workspace required near drainage edges will be separated from the top of bank by a minimum of 30 m.
- Culverts will be installed as necessary to maintain drainage.
- Use temporary diversion berms or other methods, as required, to regulate drainage from construction areas

WETLANDS

- If alteration is required for the wetland near WEC 6, then a WAWA Permit application will be submitted.
- Disturbances to wetland and drainage edges will be minimized to the extent possible.
- To the extent practical, construction in wetlands will be scheduled to occur under dry or frozen ground conditions if wetlands cannot be avoided.
- Siting and construction of the Project has been planned to avoid environmentally sensitive areas including wetlands as much as practical.

VEGETATION AND WILDLIFE HABITAT

- Siting and construction of the Project has been planned to avoid environmentally sensitive areas (e.g., critical wildlife habitat, listed plant species, wetlands).
- The Project will be sited on existing roads and disturbed areas as much as possible, thereby minimizing the need to disturb new areas.
- Disturbed areas not required for Project operation will be revegetated with an approved, weed free mix, as soon as practical following construction.

WILDLIFE IN GENERAL

- Project personnel will be instructed to keep a clean work area and to not harass animals encountered.
- Drivers instructed to be aware of wildlife and slow speed limits will be enforced on the Project, where appropriate.
- Equipment and vehicles will yield to wildlife.
- Food wastes will be collected in suitable receptacles that limit attraction or impact to wildlife.
- Littering and feeding of wildlife will be prohibited.
- Construction activities will follow activity restriction guidelines and set-back distances for wildlife.

SPECIES OF CONSERVATION CONCERN

- Siting and construction of the Project has been planned to avoid environmentally sensitive areas (e.g., critical wildlife habitat, listed plant species, wetlands, waterbodies, and watercourses, sensitive wildlife species).
- Construction will be scheduled to occur during periods of lowest sensitivity to wildlife, birds, bats and SOCC, where practical.
- If a plant SOCC is encountered that was not expected, appropriate mitigation will be applied prior to further construction activities.
- If a wildlife SOCC is encountered that was not expected, appropriate mitigation will be applied prior to further construction activities.

BIRDS AND BATS

- Bird and Bat studies are being completed for the Project and the associated reports will be submitted at a later date.
- Clearing of vegetation will be completed outside of the breeding and nesting season for birds (i.e., April to August) and outside the calving and rearing period for bats (i.e., May to August) where possible. If vegetation removal is proposed during these times, a pre-construction survey and mitigation plan would be required to avoid the inadvertent harming, killing, disturbance or destruction of migratory birds, nests and eggs and disturbance to maternal roosting sites of bats.
- Siting and construction of the Project has been planned to avoid environmentally sensitive areas (e.g., critical habitat, listed plant species, wetlands, waterbodies, and watercourses, sensitive wildlife species).
- Construction will be scheduled to occur during periods of lowest sensitivity to birds and bats, where practical.
- Transmission lines will avoid travelling over top of any high use habitat areas, such as wetlands and waterbodies, as much as practical. If these areas are unavoidable and risk of collisions is identified as high, collision mitigation (e.g., bird diverters) will be installed at and along these areas.
- Because fog hinders the ability of birds to avoid collisions with obstacles, WECs may cease operating under foggy conditions during periods of bird and bat migration throughout the Project area.
- The Project will comply with lighting and marking requirements specified by Transport Canada.
- Prior to the dismantling of a building or other installation, an inspection will be completed to determine use as a maternity or a roosting site by bats. If necessary, protective measures will be taken to avoid disruption to the survival of bats.
- A Post-construction Monitoring program for birds and bats will be implemented. If the Project is found to be causing significant mortality during post-construction monitoring, additional mitigation will be evaluated.

AVIATION

- Consultation with federal agencies including NAV Canada, Transport Canada, and the DND has been completed for the Project.
- The Project will comply with lighting and marking requirements specified by Transport Canada.

BLASTING

- If blasting is required for construction, a detailed Blasting Plan will be developed for the Project and will describe the type of explosives used and the method of detonation and follow activity restriction guidelines.

NOISE

- A Noise Impact Assessment is being completed for the project and will be submitted at a later date
- The Project will conform to existing municipal, local, and regional by-laws and regulatory requirements.

- Construction will be scheduled to occur during daytime hours.
- Machines will be kept in good working order and comply with applicable provincial and federal requirements
- Heavy equipment will be outfitted with mufflers to dampen noise.
- Work will be conducted in a respectful manner using necessary notifications and communications regarding temporary and intermittent increases in noise during Project construction.

WASTE MANAGEMENT

- Recyclable and waste hazardous materials will be stored on-site in appropriate containers to prevent exposure and shipped off-site to an approved facility.
- All litter, garbage, and other debris generated by the Project will be collected and transported to approved disposal locations or facilities.

ACCIDENTS AND UNPLANNED EVENTS

- A Fuel and/or Hazardous Materials Spills Contingency Plan will be developed.
- Dangerous goods will be stored, handled, and transported according to the New Brunswick *Clean Environment Act* and the *Transportation of Dangerous Goods Act*.
- Appropriately sized spill kits will be available on-site for clean-up efforts.
- All work-site activities will be conducted in a manner that minimizes the potential for spills or leaks, including the regular inspection and maintenance of machinery and equipment, and providing spill containment structures for onsite fuel and oil storage, if applicable.
- No fueling and servicing of equipment will be completed within 50 m of any watercourse or wetland.
- In case of a spill, the Fuel and/or Hazardous Materials Spills Contingency Plan will be followed.

TRAFFIC

- Appropriate signage will be erected and traffic directing personnel will be used where required.
- Good housekeeping practices will be employed and maintained through the duration of the Project activities.
- A traffic management program will be developed for the Project and will include a detailed schedule, detailing the volume, timing and density of construction traffic.
- Project activities will follow applicable local and provincial traffic regulations.
- Road cones may be placed at designated areas and warning signs posted in roadways as required
- Heavy goods vehicles will not arrive or leave the Project except between agreed hours.
- During construction, the approved traffic route will be kept free of mud and debris resulting from construction and operation of the Project.
- A wheel wash system will be provided on the internal access road to remove debris from vehicles before they leave site.
- Debris found on the local roads will be removed regularly using road brushes and vacuum road sweepers.

LOCAL ECONOMY

- Local communities will benefit from the development, construction, and operation of the Project as outlined in Sections 3.3.2 and 7.2.3.
- Local and regional business communities and labour organizations will be informed of the opportunities arising from the construction, operation and maintenance of the Project.

LAND USE

- Early and meaningful engagement with First Nations communities and all potential stakeholders was completed for the Project and will continue during the Project.
- If discovery in regards to settlement or land use occurs during the Project, activities will cease in the immediate area and the appropriate regulatory agencies will be contacted, as appropriate.
- Disturbed areas will be recontoured and reclaimed to a stable profile to permit existing land uses.

HERITAGE AND ARCHEOLOGICAL RESOURCES

- A HRIA is being completed for the Project and will be submitted at a later date. Any required mitigation for Heritage and Archeological Resources will be included in the final report.
- If accidental discovery of heritage resources and/or archaeological materials are encountered, ASNB will be notified and any ASNB protocols related to accidental discovery will be followed

9 FOLLOW-UP MONITORING

9.1 POST-CONSTRUCTION SURVEY

Areas disturbed by construction of the Project will be periodically inspected following completion to assess success of any reclamation efforts completed during the Project and to assess effectiveness of applied mitigation measures (e.g., erosion control). This will determine the necessity for any immediate remedial or follow-up work (e.g., additional erosion control in unstable areas). If any additional work is required, additional inspection may be required.

9.2 BIRD AND BAT POST-CONSTRUCTION MONITORING PLAN

A Post-Construction Monitoring Plan is expected to be required for the Project. This Plan will be prepared for the Project following the Post-Construction Bat and Bird Mortality Survey Guidelines for Wind Farm Development in New Brunswick (ERD, 2011) and the Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds (CWS, 2007). Consultation with the of Environment and Local Government and Canadian Wildlife Service will be completed as part of Plan development. The Post-Construction Monitoring Plan will be submitted for review by the Fish and Wildlife Branch and Department of Environment and Local Government prior to implementation of the monitoring program. The Plan will be designed to collect information to reduce uncertainty in effects predictions and inform and direct mitigation for the Project when necessary. Post-construction monitoring will begin with the commencement of operation of the Project and will be completed for a minimum of two years. It is understood that the Department of Environment and Local Government has the option to extend the post-construction monitoring period for operators depending on survey results.

Post-construction monitoring for bats will include, but not limited to, mortality surveys, carcass removal trials, and searcher efficiency trials and will be combined with the required post-construction bird mortality studies. An annual Post-Construction Monitoring Report that will include all raw data, results, and analysis of the monitoring program will be submitted to the Fish and Wildlife Branch at Department of Environment and Local Government. If the Project is found to be causing significant bird and bat mortality or causing barrier or exclusion effects during post-construction monitoring, additional mitigation may be required for the Project and the monitoring program may be extended based on requirements determined from consultation with the Department of Environment and Local Government and Canadian Wildlife Service.

10 BIBLIOGRAPHY

- ACCDC (2018). Data Report 6083: Anse-Bleue, NB. Prepared 14 May 2018 by J. Churchill, Data Manager.
- Agency (1994). Responsible Authorities Guide. Hull: Government of Canada.
- Agency (2015). Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the Canadian Environmental Assessment Act, 2012. Hull: Government of Canada.
- CanSIS (2012). Soil Survey Reports for New Brunswick. Available at: http://sis.agr.gc.ca/cansis/publications/surveys/nb/index.html. Accessed July 2019.
- CWS (2007). Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds
- ECCC (1990). The Climates of Canada. Government of Canada. 181 pp
- Environment and Local Government (2019). Online Well Log System. Available at: https://www.elgegl.gnb.ca/0375-0001/index.aspx. Accessed July 2019.
- Environment and Local Government, 2018. A Guide to Environmental Impact Assessment in New Brunswick. January 2018. Department of Environment and Local Government. Available at: https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/EIA-EIE/GuideEnvironmentalImpactAssessment.pdf. Accessed July 2019.
- ERD (2011). Post-Construction Bat and Bird Mortality Survey Guidelines for Wind Farm Development in New Brunswick. Available at: http://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/Wildlife/WindPower-PostConstructionBatAndBirdMortalitySurveyGuidelinesForWindFarmDevelopment.pdf. Accessed April 2018.
- GNB (2019). Fish 2019. Available at: https://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/Fish/Fish.pdf. Accessed July 2019.
- Government of Canada (2019a). Canadian Climate Normals 1981-2010 Station Data, Bertrand New Brunswick. Available at: http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=6175&autofwd=1#wb-info. Accessed July 2019.
- Government of Canada (2019b). Canadian Climate Normals 1981-2010 Station Data, Haut-Shippagan New Brunswick. Available at: http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=6175&autofwd=1. Accessed July 2019.
- Government of Canada (2019c). Canadian Climate Normals 1981-2010 Station Data, Bathurst A New Brunswick. Available at: http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnProv&lstProvince=NB&wbdisable=true&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=6916&dispBack=0. Accessed July 2019.
- NBDNR (2007). Our Landscape Heritage. Available at: https://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/ForestsCrownLands/ProtectedNaturalAreas/OurLandscapeHeritage/Chapter12-e.pdf. Accessed July 2019.
- Robinchaud, B., and J. Mullock (2001). The Weather of Atlantic Canada and Eastern Quebec, Graphic Area Forecast 34. NavCanada, Ottowa, Ontario. Available at: http://www.navcanada.ca/EN/media/Publications/Local%20Area%20Weather%20Manuals/LAWM-Atlantic-EN.pdf. Accessed July 2019.

A TURBINE MODEL DATASHEETS

Technical Description

ENERCON Wind Energy Converter
E-126 EP3

ENERCON
ENERGY FOR THE WORLD

Publisher

ENERCON GmbH ▪ Dreekamp 5 ▪ 26605 Aurich ▪ Germany
Phone: +49 4941 927-0 ▪ Fax: +49 4941 927-109
E-mail: info@enercon.de ▪ Internet: http://www.enercon.de
Managing Directors: Hans-Dieter Kettwig, Simon-Hermann Wobben
Local court: Aurich ▪ Company registration number: HRB 411
VAT ID no.: DE 181 977 360

Document details

Document ID	D0617713-1
Note	Original document. Source document of this translation: D0612033-1/2017-07-26

Date	**Language**	**DCC**	**Plant/department**
2017-08-03	en	DA	WRD Management Support GmbH / Documentation Department

Table of contents

1 Overview of ENERCON E-126 EP3

The ENERCON E-126 EP3 wind energy converter is a direct-drive wind energy converter with a three-bladed rotor, active pitch control, variable speed operation and a nominal power output of 3500 kW. It has a rotor diameter of 127 m and can be supplied with hub heights of 86 m, 116 m and 135 m.

Fig. 1: Overall view

2 ENERCON wind energy converter concept

Gearless

The E-126 EP3 drive system comprises very few rotating components. The rotor hub and the rotor of the annular generator are directly interconnected to form one solid unit. This reduces the mechanical strain and increases technical service life. Maintenance and service costs are reduced (fewer wearing parts, no gear oil change, etc.) and operating expenses are also minimised. Since there are no gears or other fast rotating parts, the energy loss between generator and rotor as well as noise emissions are considerably reduced.

Active pitch control

Each of the 3 rotor blades is equipped with a pitch unit. Each pitch unit consists of an electrical drive, a control system, and a dedicated emergency power supply. The pitch control drive for each rotor blade consists of two direct-current compositely excited motors with a gear. The pitch units limit the rotor speed and the amount of power extracted from the wind. This way, the maximum output of the E-126 EP3 can be accurately limited to nominal power, even at short notice. By pitching the rotor blades into the feathered position, the rotor is stopped without any strain on the drive train caused by the application of a mechanical brake.

Indirect grid connection

The power produced by the annular generator is fed into the distribution or transport grid via the ENERCON grid feed system. The ENERCON grid feed system, which consists of a rectifier, a DC link and a modular inverter system, ensures maximum energy yield with excellent power quality. The electrical properties of the annular generator are therefore irrelevant to the behaviour of the wind energy converter in the distribution or transport grid. Rotational speed, excitation, output voltage and output frequency of the annular generator may vary depending on the wind speed. This way, the energy contained in the wind can be optimally exploited even in the partial load range.

3 E-126 EP3 components

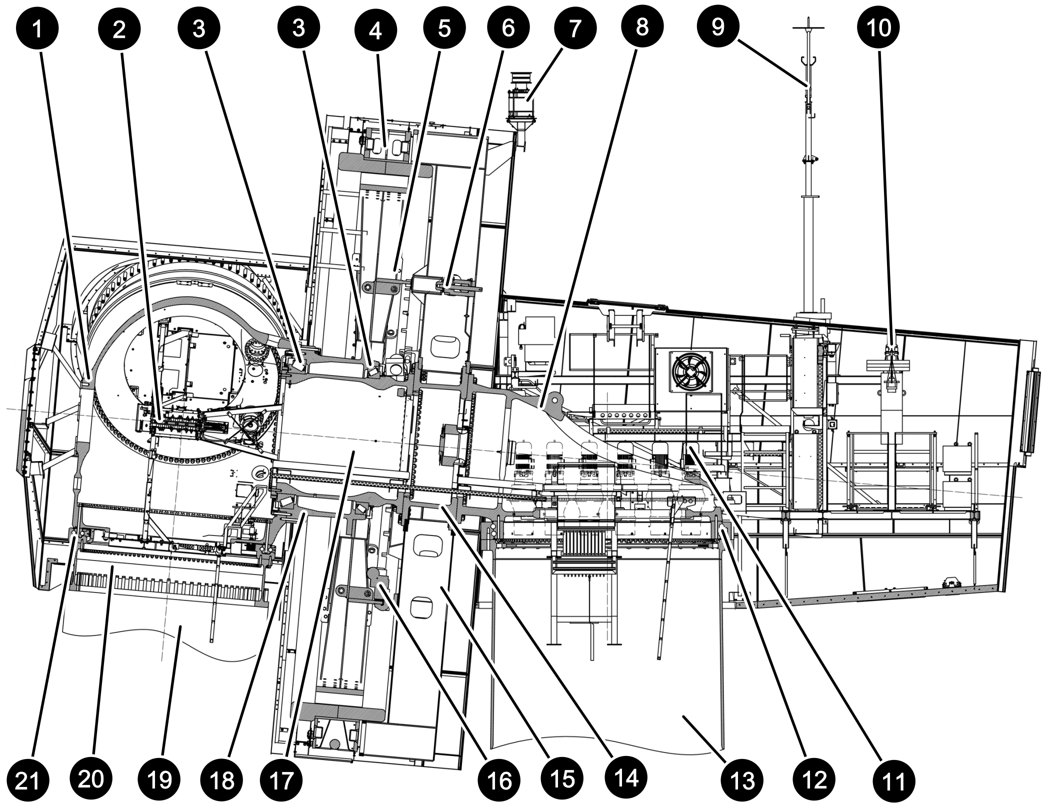


Fig. 2: Sectional view of nacelle

1	Hub	2	Slip ring unit
3	Rotor bearing	4	Generator stator
5	Generator rotor	6	Rotor lock
7	Beacon system (optional)	8	Main carrier
9	Wind measuring unit with lightning rods	10	Winch
11	Yaw drive	12	Yaw bearing
13	Tower	14	Stator support star
15	Jib	16	Rotor brake
17	Axle pin	18	Rotor support
19	Rotor blade	20	Blade adapter
21	Blade flange bearing		

3.1 Nacelle

The hub rotates around the fixed axle pin on 2 rotor bearings. Among other components, the rotor blades and the generator rotor are attached to the hub. The slip ring unit is located at the tip of the axle pin. It transmits electrical energy and data between the stationary and the rotating parts of the nacelle via sliding contacts.

The stator support with its 6 jibs is the load-bearing element of the fixed generator stator. The stator support star permanently connects the stator support to the main carrier. Mounted on the ends of the jibs is the stator ring that is fitted with the aluminium windings in which electric current is induced.
The main carrier is the central load-bearing element of the nacelle. All rotor and generator components are attached to it either directly or indirectly. The main carrier rotates on the tower head by means of the yaw bearing. The entire nacelle can be rotated by the yaw drives so that the rotor is always optimally aligned with the wind.
The nacelle casing is made of aluminium. It consists of multiple sections and is attached to the generator stator, the frame (in the machine house) and the hub (in the rotor area) by means of extruded profiles.

3.2 Rotor blades

The rotor blades made of glass-fibre reinforced plastic (GRP; glass fibre and epoxy resin), balsa wood and foam have a major influence on the wind energy converter's yield and its noise emission. The rotor blade is manufactured using half shells and the vacuum infusion method. The shape and profile of the E-126 EP3 rotor blades were designed with the following criteria in mind:

- High power coefficient
- Long service life
- Low noise emissions
- Low mechanical strain
- Efficient use of material

The rotor blades of the E-126 EP3 were specially designed to operate with variable pitch control and at variable speeds. The polyurethane based surface coating protects the rotor blades from environmental impacts such as UV radiation and erosion. This coating is visco-hard and highly resistant to abrasion.

Microprocessor-controlled pitch units that are independent of one another adjust each of the three rotor blades. Two blade angle measurements in each rotor blade constantly monitor the set blade angle and ensure blade angle synchronisation across all three blades. This enables quick, precise adjustment of blade angles according to the prevailing wind conditions.

Optionally, and in some cases as standard, the rotor blades have a serrated profile in part of the trailing edge. This trailing edge serration (TES) reduces the turbulence on the trailing edge and thus lowers the sound emission of the WEC.

Vortex generators are mounted on the inside of the rotor blades on the suction face. The vortex generators delay the breakaway of the boundary layer flow from the rotor blade surface. Thus the aerodynamic properties of the WEC are less sensitive to temporary surface changes and wind conditions. The power of the WEC increases and the noise emissions decrease.

3.3 Tower

The tower of the E-126 EP3 wind energy converter is either a steel tower or a hybrid tower made of precast concrete segments and a steel section.
All towers are painted and equipped with weather and corrosion protection at the factory.

This means that no work is required in this regard after assembly except for repairing any defects or transport damage. By default, the paintwork on the bottom of the tower has a graded colour scheme (can be omitted if desired).

Steel towers are steel tubes that taper linearly towards the top. They are pre-fabricated and consist of a small number of large sections. Flanges with drill holes for bolting are welded to the ends of the sections.

The tower sections are simply stacked on top of each other and bolted together at the installation site. They are linked to the foundation by means of a bolt cage.

The hybrid tower is assembled from the precast concrete elements at the installation site. As a rule, segments are dry-stacked; however, a compensatory grout layer can be applied. Vertical joints are bolted. As a final step, the top steel section is placed on the tower and bolted.

Towers are prestressed vertically by means of prestressing steel tendons. The prestressing tendons run vertically either through ducts in the concrete elements or externally along the interior tower wall. They are anchored to the foundation.

For technical and economic reasons, the slender top part of the hybrid tower is made of steel. It is not possible, for example, to install the yaw bearing directly on the concrete elements and the considerably thinner wall of the steel section provides for more space in the tower interior.

4 Grid Management System

Annular generator and energy flow

The E-126 EP3 is equipped with a multi-polar, separately excited synchronous generator (annular generator). The wind energy converter operates at variable speeds in order to fully exploit the wind energy potential at all wind speeds. The magnetic field generated by the excitation current in the generator rotor induces an alternating current with varying voltage, frequency and amplitude in the generator stator.
The stator windings form 4 3-phase alternating current systems that are independent of each other. These 4 alternating current systems are rectified separately in the nacelle. The DC voltage systems are connected to the power cabinets via the tower cables. After it has been converted to three-phase current whose voltage, frequency and phase position conform to the grid, the current is transmitted to the medium-voltage transformer via a busbar system and adjusted to the voltage level (e.g. 20 kV) of the utility company's grid. Consequently, the annular generator is not directly connected to the receiving power grid of the utility company; instead, it is completely decoupled from the grid by the ENERCON grid feed system.

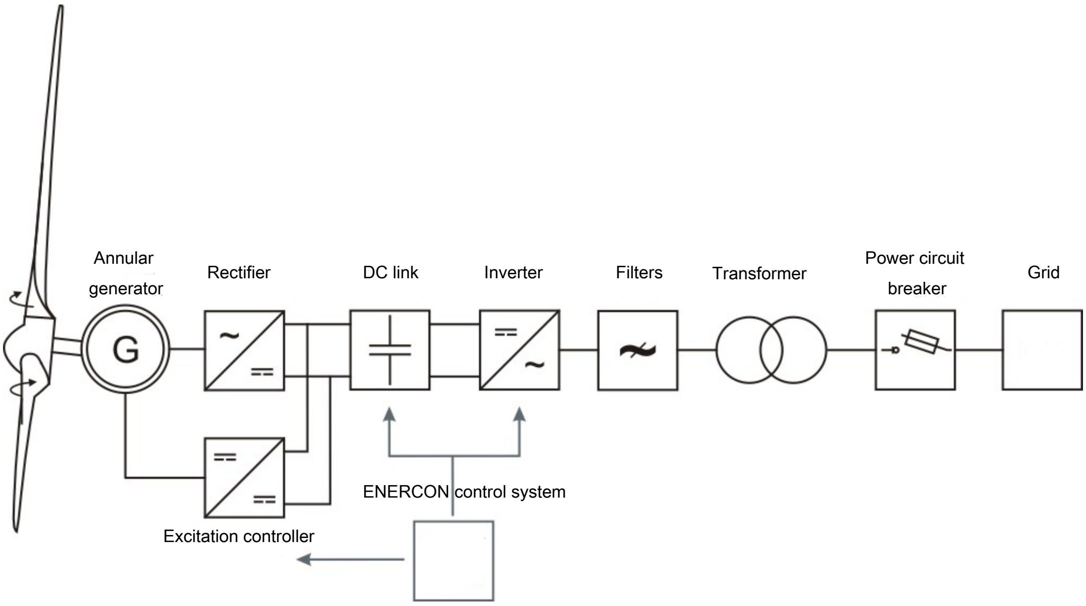


Fig. 3: Simplified electric diagram of an ENERCON wind energy converter

Decoupling the annular generator from the grid guarantees ideal power transmission conditions. Sudden changes in wind speed are translated into controlled change in order to maintain stable grid feed. Conversely, possible grid faults have virtually no effect on the mechanics of the wind energy converter. The power injected by the E-126 EP3 can be precisely regulated from 0 kW to 3500 kW.

In general, the features required for a specific wind energy converter or wind farm to be connected to the receiving power grid are predefined by the operator of that grid. To meet different requirements, ENERCON wind energy converters are available with different configurations.

The inverter system in the tower base is dimensioned according to the particular configuration of the wind energy converter. As a rule, a transformer inside or near the wind energy converter converts 400 V low voltage to the desired medium voltage.

FACTS

If necessary, an E-126 EP3 equipped with standard FACTS (Flexible AC Transmission System) control can supply reactive power in order to contribute to reactive power balance and to maintaining voltage levels in the grid. The maximum reactive power range is available at an output as low as 10 % of the nominal active power. The maximum reactive power range varies, depending on the configuration of the wind energy converter.

FT configuration

FACTS Transmission (FRT)

By default, the E-126 EP3 comes equipped with FACTS technology that meets the stringent requirements of specific grid codes. It is able to ride through grid faults (undervoltage, overvoltage, automatic reclosing, etc.) of up to 5 seconds (FT = FACTS + FRT [Fault Ride Through]) and to remain connected to the grid during these faults.

If the voltage measured at the reference point exceeds a defined limit value, the ENERCON wind energy converter changes from normal operation to a specific fault operating mode.

Once the fault has been cleared, the wind energy converter returns to normal operation and feeds the available power into the grid. If the voltage does not return to the operating range admissible for normal operation within an adjustable time frame (5 seconds max.), the wind energy converter is disconnected from the grid.

While the system is riding through a grid fault, various fault modes using different grid feed strategies are available, including feeding in additional reactive current in the event of a fault. The control strategies include different options for setting fault types.

Selection of a suitable control strategy depends on specific grid code and project requirements that must be confirmed by the particular grid operator.

FTS configuration

FACTS Transmission (FRT) with STATCOM option

Same as FT configuration; however, the STATCOM (**Stat**ic **Com**pensator) option additionally enables the wind energy converter to output and absorb reactive power regardless of whether it generates and feeds active power into the grid. It is thus able to actively support the power grid at any time, similar to a power plant. STATCOM includes a special electrical cabinet that is typically installed close to the transformer. Whether or not this configuration can be used needs to be determined on a project-specific basis.

FTQ configuration

FACTS Transmission (FRT) with Q+ option

The FTQ configuration comprises all features of the FT configuration. In addition, it has an extended reactive power range.

FTQS configuration

FACTS Transmission (FRT) with Q+ and STATCOM options

The FTQS configuration comprises all features of the FTQ and FTS configurations.

Frequency protection

ENERCON wind energy converters can be used in grids with a nominal frequency of 50 Hz or 60 Hz.

The range of operation of the E-126 EP3 is defined by a lower and upper frequency limit value. Overfrequency and underfrequency events at the reference point of the wind energy converter trigger frequency protection and cause the wind energy converter to shut down after the maximum delay time of 60 seconds has elapsed.

Power-frequency control

If temporary overfrequency occurs as a result of a grid fault, ENERCON wind energy converters can reduce their power feed dynamically to contribute to restoring the balance between the generating and transmission networks.
As a pre-emptive measure, the active power feed of ENERCON wind energy converters can be limited during normal operation. During an underfrequency event, the power reserved by this limitation is made available to stabilise the frequency. The characteristics of this control system can be easily adapted to different specifications.

5 Safety system

The E-126 EP3 comes with a large number of safety features whose purpose is to permanently keep the wind energy converter inside a safe operating range. In addition to components that ensure safe stopping of the wind energy converter, these include a complex sensor system. It continuously captures all relevant operating states of the wind energy converter and makes the relevant information available through the ENERCON SCADA remote monitoring system.

If any safety-relevant operating parameters are out of the permitted range, the wind energy converter continues running at limited power, or is stopped.

5.1 Safety equipment

Emergency stop button

In an ENERCON wind energy converter there are emergency stop buttons in the vicinity of the tower door, on the control cabinet in the tower base, on the nacelle control cabinet and, if required, on further levels of the E-module. Actuating an emergency stop button at the tower base activates emergency pitching of the rotor blades. This brakes the rotor aerodynamically. Actuating an emergency stop button in the nacelle activates the rotor brake in addition to emergency pitching. This stops the rotor as quickly as possible.

The following are still supplied with power:

- Rotor brake
- Beacon system components
- Lighting
- Sockets

Main switch

In an ENERCON wind energy converter, main switches are installed on the control cabinet and the nacelle control cabinet. When actuated, they de-energise virtually the entire wind energy converter.

The following are still supplied with power:

- Beacon system components
- Service hoist
- Sockets
- Lighting
- Medium-voltage area

5.2 Sensor system

A large number of sensors continuously monitor the current status of the wind energy converter and the relevant ambient parameters (e.g. rotor speed, temperature, blade load, etc.). The control system analyses the signals and regulates the wind energy converter such that the wind energy available at any given time is always optimally exploited and at the same time operating safety is ensured.

Redundant sensors

To be able to check plausibility by comparing the reported values, redundant sensors are installed for some operating states. This applies to temperature measurement in the generator, wind speed measurement or measuring the current rotor blade angle. Defective sensors are reliably detected and can be repaired or replaced by activating spare sensors. This way, the wind energy converter can safely continue its operation without having to replace major components.

Sensor checks

Proper functioning of all sensors is either regularly checked by the WEC control system itself during normal WEC operation or, where this is not possible, in the course of WEC maintenance work.

Speed monitoring

The control system of the ENERCON wind energy converter regulates the rotor speed by adjusting the blade angle such that the speed does not significantly exceed rated speed even during very high winds. However, pitch control may not be able to react quickly enough to sudden events such as strong gusts of wind or a sudden drop of the generator load. If nominal speed is exceeded by more than 15 %, the control system stops the rotor. After 3 minutes, the wind energy converter automatically attempts to restart. If this fault occurs more than five times within a 24 hour period, a defect is assumed. No further restarts are attempted.

In addition to the electronic monitoring system there are 3 electromechanical overspeed switches in the rotor head. They are spaced evenly along the circumference of the rotor. Each of these switches can stop the wind energy converter by means of emergency pitching. The switches respond if the rotor speed exceeds the nominal speed by more than 25 %. To enable the wind energy converter to restart, the overspeed switches must be reset manually after the cause of the overspeed has been identified and eliminated.

Air gap monitoring

Microswitches distributed along the rotor circumference monitor the width of the air gap between the rotor and the stator of the annular generator. If any of the switches are triggered because the distance has dropped below the minimum distance, the wind energy converter stops and restarts automatically after a brief delay.

If the fault recurs within 24 hours, the wind energy converter remains stopped until the cause has been eliminated.

Oscillation monitoring

Oscillation monitoring detects excessive oscillation or excursion of the wind energy converter tower top. Sensors detect the acceleration of the nacelle along the direction of the hub axis (longitudinal oscillation) and perpendicular to this axis (transverse oscillation). The control system uses this input to calculate the tower excursion compared to its idle position.
In addition, excessive vibrations and shocks such as those that may occur e.g. in the event of a fault in the rectifier are detected by an integrated oscillation monitoring function. If the oscillations or excursion exceed the permissible limit, the wind energy converter stops. It restarts automatically after a short delay. If non-permissible vibrations are detected or if non-permissible tower oscillations occur repeatedly, the wind energy converter stops and does not make any further restart attempts.

Temperature monitoring

Some components in ENERCON wind energy converters are cooled. For this purpose, temperature sensors continuously measure the temperature of the components of the wind energy converter that need to be protected from excessive heat.

In the event of excessive temperatures, the power output of the wind energy converter is reduced. If necessary, the wind energy converter stops. The wind energy converter cools down and generally restarts automatically as soon as the temperature falls below a predefined limit.

Some measuring points are equipped with additional overtemperature switches. These also initiate a stop of the wind energy converter once the temperature exceeds a specific limit, in certain cases without an automatic restart after cooling down.

At low temperatures, some assemblies such as the hazard beacon energy storage and the generator are heated in order to keep them operational.

Nacelle-internal noise monitoring

Sensors located in the rotor head respond to loud knocking sounds such as might be caused by loose or defective components. If any of these sensors detect noise and there is nothing to indicate a different cause, the wind energy converter stops.

In order to rule out exterior causes for the noise (mainly the impact of hail during a thunderstorm), the signals from all wind energy converters in a wind farm are matched against each other. For stand-alone WECs, an additional noise sensor in the machine house is used. If the sensors in multiple WECs or the noise sensor in the machine house detect noise simultaneously, an exterior cause is assumed. The noise sensors are deactivated briefly so that none of the wind energy converters in the wind farm stop.

Cable twist monitoring

If the nacelle of the wind energy converter has turned around its own axis more than three times and twisted the cables running down inside the tower, the WEC control system uses the next opportunity to automatically untwist the cables.

The cable twist monitoring feature is equipped with sensors which cut the power supply to the yaw motors if the permitted control range is exceeded.

6 Control system

The E-126 EP3 control system is based on a microprocessor system developed by ENERCON and uses sensors to query all WEC components and collect data such as wind direction and wind speed. Using this information, it adjusts the operating mode of the E-126 EP3 accordingly. The WEC display of the control cabinet in the tower base shows the current status of the wind energy converter and any fault that may have occurred.

6.1 Yaw system

The yaw bearing with an externally geared rim is mounted on top of the tower. The yaw bearing allows the nacelle to rotate, thus providing for yaw control.

If the difference between the wind direction and the rotor axis direction exceeds the maximum permissible value, the yaw drives are activated and adjust the nacelle position according to the wind direction. The yaw motor control system ensures smooth starting and stopping of the yawing motion. The WEC control system monitors the yaw system. If it detects any irregularities it deactivates yaw control and stops the wind energy converter.

6.2 Pitch control

Functional principle

The pitch system modifies the angle of attack, that is the angle at which the air flow meets the blade profile. Changes to the blade angle change the lift at the rotor blade and thus the force with which the rotor blade turns the rotor.

During normal operation (automatic mode) the blade angle is adjusted in a way that ensures optimal exploitation of the energy contained in the wind while avoiding overload of the wind energy converter. Wherever possible, boundary conditions such as noise optimisation are also fulfilled in the process. In addition, blade angle adjustment is used to decelerate the rotor aerodynamically.

If the wind energy converter achieves nominal power output and the wind speed continues to increase, the pitch system turns the rotor blades just far enough out of the wind to keep the rotor speed and the amount of energy extracted from the wind and to be converted by the generator, within or just slightly above the nominal limits.

Design

Each rotor blade is fitted with a pitch unit. The pitch unit consists of a pitch control box, a blade relay box, tow pitch motors and a capacitor unit. The pitch control box and the blade relay box control the pitch motors. The capacitor unit stores the energy required for emergency pitching; during WEC operation, it is kept charged and tested continually.

Blade angle

Special rotor blade positions (blade angles) of the E-126 EP3:

A: 0° Normal position during partial load operation: maximum exploitation of available wind.

B: ≥60° Idle mode (wind energy converter does not feed any power into the grid because the wind speed is too low): Depending on the wind speed, the rotor spins at low speed or stands still (if there is no wind at all).

C: 92° Feathered position (rotor has been stopped manually or automatically): The rotor blades do not generate any lift even in the presence of wind; the rotor stands still or moves very slowly.

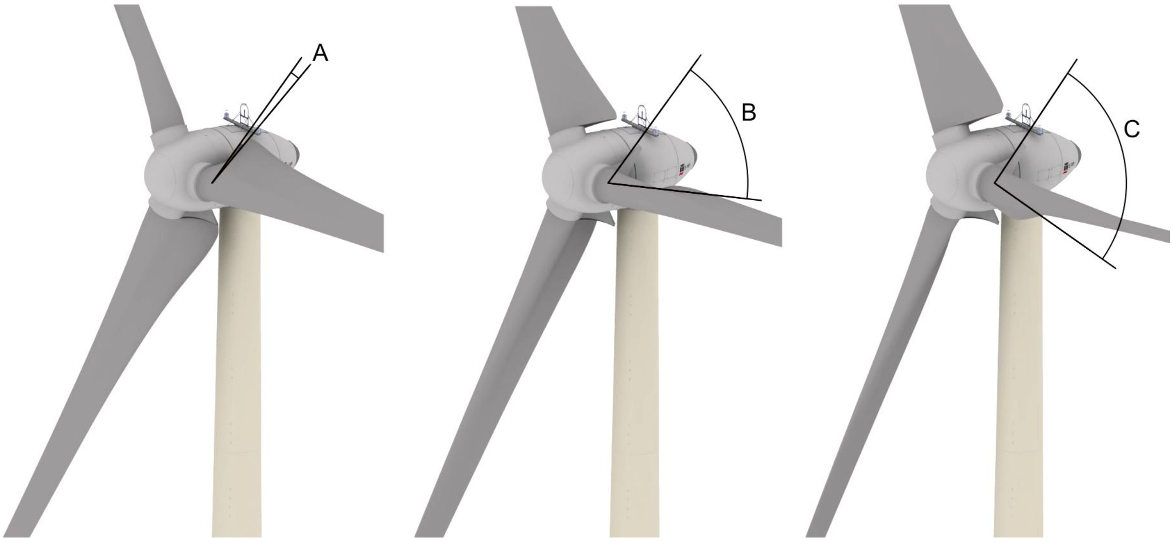


Fig. 4: Special blade positions

6.3 WEC start

6.3.1 Start lead-up

As long as the main status is > 0, the wind energy converter remains stopped. As soon as the main status changes to 0, the wind energy converter is ready and the start-up procedure is initiated. If certain boundary conditions for start-up, e.g. charging of the capacitor units of the emergency pitching capacitor units, have not yet been fulfilled, status `0:3 – Start lead-up` is displayed.

During start lead-up, a wind measurement and alignment phase of 150 seconds begins.

6.3.2 Wind measurement and nacelle alignment

After completing start lead-up, status `0:2 – Turbine operational` is displayed.

If the control system is in automatic mode, the average wind speed is above 1.8 m/s and the wind direction deviation is sufficient for yawing, the wind energy converter starts alignment with the prevailing wind direction. 60 seconds after completing start lead-up the wind energy converter goes into idle mode. The rotor blades are slowly pitched in while a check is performed on the emergency pitching capacitor units.

If the wind energy converter is equipped with load control sensors, the rotor blades stop at an angle of 70° and adjust the load measurement points, which may take several minutes. During this time, status `0:5 – Calibration of load control` is displayed.

If the mean wind speed during the wind measurement and alignment phase of 150 seconds is above the current cut-in wind speed (about 2.0 m/s), the start-up procedure is initiated (status `0:1`). Otherwise, the wind energy converter remains in idle mode (status `2:1 – Lack of wind : Wind speed too low`).

Power consumption

As the wind energy converter is not generating any active power at that moment, the electrical energy consumed by the wind energy converter is taken from the grid.

6.3.3 Generator excitation

Once the rotor reaches a certain rotational speed that depends on the wind turbine type, generator excitation is initiated. The electricity required for this purpose is temporarily taken from the grid. Once the generator reaches a sufficient speed the wind energy converter supplies itself with power. The electricity for self-excitation is then taken from the DC link; the energy taken from the grid is reduced to zero.

6.3.4 Power feed

As soon as the DC link voltage is sufficient and the excitation controller is no longer connected to the grid, power feed is initiated. After the rotational speed has increased due to sufficient wind and with a power setpoint $P_{set} > 0$, the line contactors on the low-voltage side are closed and the E-126 EP3 starts feeding power into the grid at approx. 2.5 rpm.

The number of activated inverters is gradually increased, depending on the number necessary for the power generated by the generator. Power control regulates the excitation current so that power is fed according to the required power curve.

The power increase gradient (dP/dt) after a grid fault or a regular start-up can be defined within a certain range in the control system. For more detailed information, see the *Grid Performance* data sheet for the particular ENERCON wind energy converter type.

6.4 Operating modes

After completion of the E-126 EP3 start-up procedure the wind energy converter switches to automatic mode (normal operation). While in operation, the wind energy converter constantly monitors wind conditions, optimises rotor speed, generator excitation and generator power output, aligns the nacelle position with the wind direction, and records all sensor statuses.

In order to optimise power generation under highly diverse wind conditions when in automatic mode, the wind energy converter changes between 3 operating modes, depending on the wind speed. In certain circumstances the wind energy converter stops if provided for by the configuration of the wind energy converter (e.g. shadow casting). In addition, the utility company into whose grid the generated power is being fed can be given the option to directly intervene in the operation of the wind energy converter by remote control, e.g. for temporary reduction of the power feed.

The E-126 EP3 switches between the following operating modes:

- Full load operation
- Partial load operation
- Idle mode

6.4.1 Full load operation

Wind speed
v ≥ 10.22 m/s

With wind speeds at and above the rated wind speed, the wind energy converter uses pitch control to maintain rotor speed at the setpoint (approx. 11.8 rpm) and thus limits the power to its nominal value of 3500 kW.

Storm control enabled (normal case)

Storm control enables WEC operation even at very high wind speeds; however, the rotor speed and the power output are reduced.

If wind speeds exceed approx. 24 m/s (12-second average) and keep increasing, the rotational speed will be reduced linearly from 11.8 rpm to idle speed at about 30 m/s by pitching the rotor blades out of the wind accordingly. The power fed into the grid decreases in accordance with the speed/power curve in the process.

At wind speeds above 30 m/s (10-minute average) the rotor blades are almost in the feathered position. The WEC runs in idle mode and without any power output; it does, however, remain connected to the receiving grid. Once the wind speed falls below 30 m/s, the WEC restarts its power feed.

Storm control is enabled by default and can only be deactivated by remote control or on site by ENERCON Service.

Storm control disabled

If, by way of exception, storm control is disabled, the wind energy converter will be stopped for safety reasons if the wind speed exceeds 25 m/s (3-minute average) or 30 m/s (15-second average). If none of the above events occurs within 10 minutes after stopping, the wind energy converter will be restarted automatically.

6.4.2 Partial load operation

Wind speed
2.5 m/s ≤ v < 10.22 m/s

During partial load operation (i.e., the wind speed is between the cut-in wind speed and the rated wind speed) the maximum possible power is extracted from the wind. Rotor speed and power output are determined by the current wind speed. Pitch control already starts as the WEC approaches full load operation so as to achieve a smooth transition.

6.4.3 Idle mode

Wind speed
v < 2.5 m/s

At wind speeds below 2.5 m/s no power can be fed into the grid. The wind energy converter runs in idle mode, i.e., the rotor blades are turned almost completely out of the wind (blade angle ≥ 60°) and the rotor turns slowly or stops completely if there is no wind at all.

Slow movement (idling) puts less strain on the rotor bearings than longer periods of complete standstill; in addition, the WEC can resume power generation and power feed more quickly as soon as the wind picks up.

6.5 Safe stopping of the wind energy converter

The ENERCON wind energy converter can be stopped by manual intervention or automatically by the control system.

The causes are divided into groups by risk.

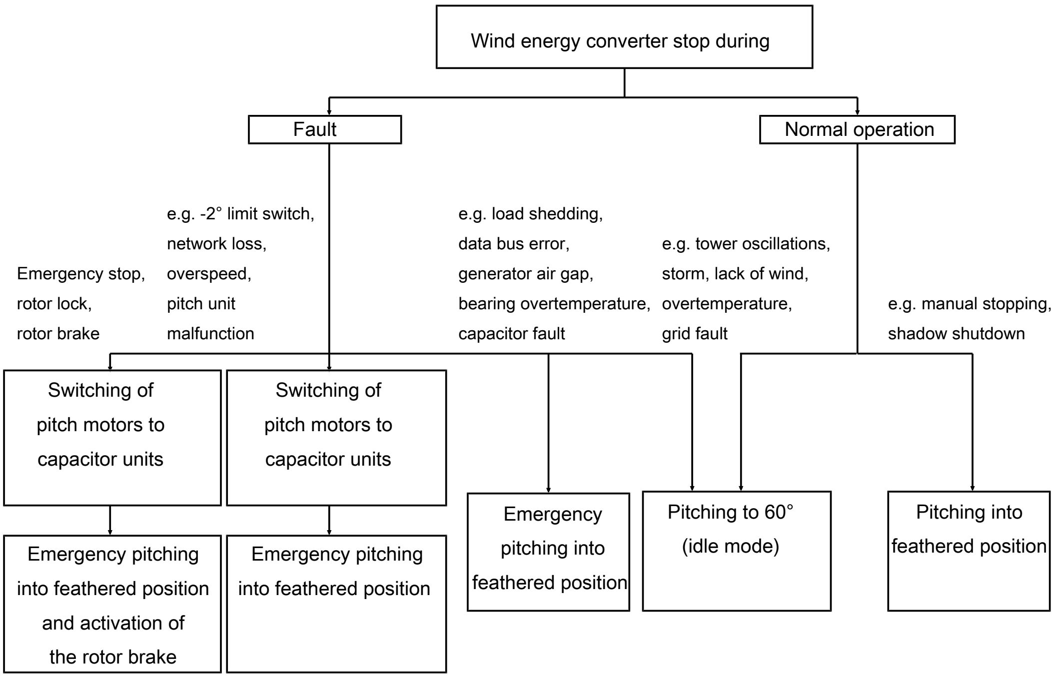


Fig. 5: Overview of shutdown procedures

Stopping the wind energy converter by means of pitch control

In the event of a fault that is not safety-relevant, the wind energy converter control system pitches the rotor blades out of the wind, causing the rotor blades not to generate any lift and bringing the wind energy converter to a safe stop.

Emergency pitching

The pitch unit's energy storage system provides the energy required for emergency pitching. During operation of the wind energy converter, it is kept charged and continually tested. For emergency pitching, the drive units are supplied with power from the corresponding energy storage. The rotor blades move automatically and independently of each other into a position in which they do not generate any lift; this is called the feathered position.

Since the 3 pitch units are interconnected but also operate independently of each other, if one component fails, the remaining pitch units can still function and stop the rotor.

Emergency braking

If a person presses an emergency stop button, or if the rotor lock is used while the rotor is turning, the control system initiates an emergency braking procedure.

This means that in addition to the emergency pitching of the rotor blades, the rotor brake is applied. The rotor is decelerated from rated speed to a standstill within 10 to 15 seconds.

7 Remote monitoring

By default, all ENERCON wind energy converters are equipped with the ENERCON SCADA (Supervisory Control And Data Acquisition) system that connects them to Technical Service Dispatch. Technical Service Dispatch can retrieve each wind energy converter's operating data at any time and instantly respond to any irregularities or malfunctions.

The ENERCON SCADA system also transmits all status messages to Technical Service Dispatch, where they are permanently stored. This ensures that the practical experience gained through the long-term operation of ENERCON wind energy converters is taken into account for their continued development.

Connection of the individual wind energy converters is through a dedicated personal computer (ENERCON SCADA Server), which is typically located in the transmission substation or in the associated substation. There is one ENERCON SCADA Server in every wind farm.

The ENERCON SCADA system, its properties and its operation are described in separate documentation.

At the operator/owner's request, monitoring of the wind energy converters can be performed by a third party.

8 Maintenance

In order to ensure optimum and safe long-term operation of the wind energy converter, maintenance is required at regular intervals.

ENERCON wind energy converters are regularly serviced at least once a year, depending on requirements.
During maintenance, all safety-relevant components and features are inspected, e.g. pitch control, yaw control, safety systems, lightning protection system, anchorage points, and safety ladders. The bolt connections are checked on load-bearing joints (main components). All other components are visually inspected to check for any irregularities or damage. Lubrication systems are refilled.
Maintenance intervals may deviate, depending on regional regulations and standards.

9 Technical specifications E-126 EP3 3.5 MW

General	
Manufacturer	ENERCON GmbH Dreekamp 5 26605 Aurich Germany
Type designation	E-126 EP3
Nominal power	3500 kW
Hub heights	86 m; 116 m; 135 m
Rotor diameter	127 m
IEC wind class (ed. 3)	IIA
Extreme wind speed at hub height (10-minute mean)	42.5 m/s
	Corresponds to a load equivalent of approx. 59.5 m/s (3-second gust)
Annual average wind speed at hub height	8.5 m/s

Rotor with pitch control	
Type	Upwind rotor with active pitch control
Rotational direction	Clockwise
Number of rotor blades	3
Rotor blade length	61.09 m
Swept area	12668 m²
Rotor blade material	GRP/epoxy resin/balsa wood/foam
Lowest power feed speed to nominal speed	4.4 - 11.5 rpm
Tip speed at speed setpoint	Up to 78.5 m/s
Power reduction wind speed	24 - 30 m/s (with optional ENERCON storm control)
Conical angle	2.5°
Rotor axis angle	7°
Pitch control	One independent electrical pitch system per rotor blade with dedicated emergency power supply

Drive train with generator	
Wind energy converter concept	Gearless; variable speed; full-scale converter
Hub	Rigid
Storage	2 tapered roller bearings
Generator	Direct-drive ENERCON annular generator
Grid feed	ENERCON inverters with high clock speed and sinus-oidal current
IP Code/insulation class	IP 23/F

Brake system	
Aerodynamic brake	Three independent pitch systems with emergency power supply
Rotor brake	Electromechanical
Rotor lock	Latching every 10°

Yaw control	
Type	Electrical with yaw motors
Control system	Active via yaw gears

Control system	
Type	Microprocessor
Grid feed	ENERCON inverter
Remote monitoring system	ENERCON SCADA
Uninterruptible power supply (UPS)	Integrated

Tower variants			
Hub height	Total height	Type	Wind class
86 m	149.5 m	Steel tower with foundation basket	IEC IIA[1] DIBt WZ4 GK I + II[2]
116 m	179.5 m	Hybrid tower	IEC IIA[1] DIBt WZ3 GK I + II[2]
135 m	198.5 m	Hybrid tower	IEC IIA[1] DIBt WZ3 GK I + II[2]

[1]Edition 3

[2]Edition 2012

Subject to technical change without prior notice.

Data Sheet

ENERCON Wind Energy Converter
E-126 EP3 / 3500 kW / FTQ
Grid Performance

ENERCON
ENERGY FOR THE WORLD

Publisher

ENERCON GmbH ▪ Dreekamp 5 ▪ 26605 Aurich ▪ Germany
Phone: +49 4941 927-0 ▪ Fax: +49 4941 927-109
E-mail: info@enercon.de ▪ Internet: http://www.enercon.de
Managing Directors: Hans-Dieter Kettwig, Simon-Hermann Wobben
Local court: Aurich ▪ Company registration number: HRB 411
VAT ID no.: DE 181 977 360

Copyright notice

Registered trademarks

Reservation of right of modification

Document details

Document ID	D0613050-0
Note	Original document. Source document of this translation: D0610597-0a/2017-06-21

Date	Language	DCC	Plant/department
2017-06-26	en	DA	WRD GmbH / Validation

Related documents

The titles of the documents listed are the titles of the original language versions, with translations of these titles in ( ) where applicable. Document IDs always refer to the original language versions. If the document ID does not contain a revision, the most recent revision of the document applies.

Higher-level standards and guidelines

Document ID	Title
IEC 61400-21:2008	Windenergieanlagen - Teil 21: Messung und Bewertung der Netzverträglichkeit von netzgekoppelten Windenergieanlagen (Wind turbines - Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines)
IEC 60034-3:2007	Drehende elektrische Maschinen - Teil 3: Besondere Anforderungen an Synchrongeneratoren angetrieben durch Dampfturbinen oder Gasturbinen (Rotating electrical machines - Part 3: Special requirements for synchronous generators powered by steam turbines or gas turbines)

Related documents

Document ID	Title
D0429929	Datenblatt ENERCON Windenergieanlagen Netztechnische Leistungsmerkmale - FACTS 2.0 (Data sheet ENERCON wind energy converters, grid performance - FACTS 2.0)
D0563163	Datenblatt ENERCON Windenergieanlagen Netztechnische Leistungsmerkmale - FACTS 1.1 (Data sheet ENERCON wind energy converters, grid performance - FACTS 1.1)
D0563134	Datenblatt ENERCON Windenergieanlagen Netztechnische Leistungsmerkmale - FACTS 1.0 (Data sheet ENERCON wind energy converters, grid performance - FACTS 1.0)

List of abbreviations

FACTS	Flexible Alternating Current Transmission System
FRT	Fault Ride Through
FTQ	FACTS Transmission with Q+ option
IEC	International Electrotechnical Commission
SCADA	Supervisory Control and Data Acquisition

Table of contents

1 General information

The grid performance and characteristics of the ENERCON wind energy converter are distributed on two document types.

The present wind energy converter-specific document includes the grid performance dependent on wind energy converter type and electrical configuration.

In the corresponding applicable document independent of wind energy converter, the functions and grid performance applicable for all wind energy converters and electrical configurations are documented.

2 Characteristics

All characteristics of the wind energy converter refer to the reference point specified in ch. 5, p. 13. The electrical properties can only be achieved with the corresponding control system.

An excerpt from the power quality measurements according to IEC 61400-21:2008 is available upon request.

Tab. 1: Wind energy converter characteristics

Characteristics		Value
Control system	-	CS101b
Nominal frequency	f_n	50 Hz
		60 Hz
Nominal active power	P_n	3500 kW
Nominal reactive power	Q_n	2300 kvar
Rated apparent power	S_{max}	4200 kVA
Nominal voltage	U_n	400 V
Nominal current	I_n	5052 A
Rated current	I_{max}	6650 A
Maximum initial symmetrical short-circuit current	$I_k"_{,max}$	7000 A
Maximum peak symmetrical short-circuit current	$I_{p,max}$, $\sqrt{2} \times I_k"_{,max}$	9899 A
Maximum symmetrical breaking current	$I_{b,max}$	7000 A
Maximum continuous short-circuit current	$I_{k,max}$	7000 A
Number of power cabinets	-	14

3 Reactive power range

The wind energy converter features a reactive power range that provides for the discharge of reactive power (Q_{export}) into the grid and the intake of reactive power (Q_{import}) from the grid.

Tab. 2: Reactive power values (export/import)

Parameter		Value
Maximum reactive power (export)	Q_{max}	2300 kvar
Minimum reactive power (import)	Q_{min}	-2300 kvar

Reactive power export corresponds to the behaviour of an overexcited synchronous machine. Reactive power import corresponds to the behaviour of an under excited synchronous machine (acc. to IEC 60034-3:2007).

The chart below illustrates the reactive power range as determined by active power and grid voltage.

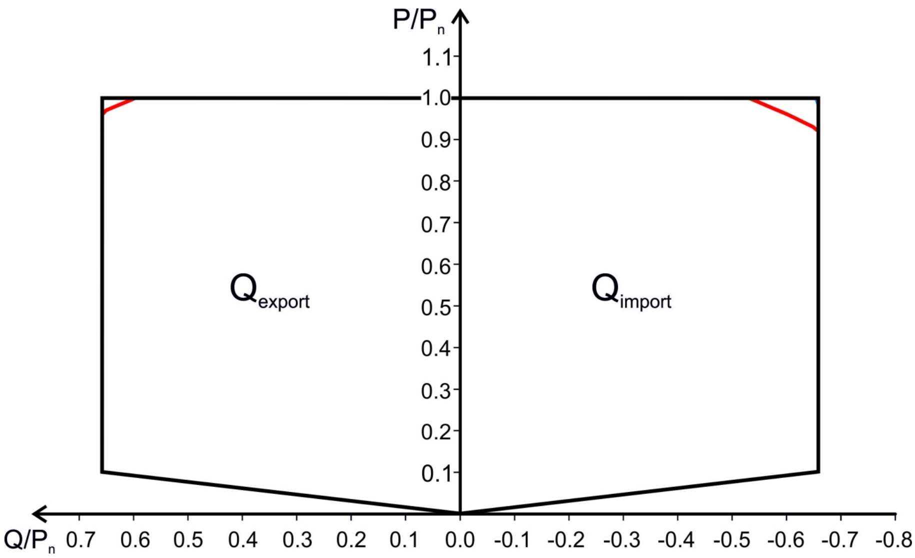


Fig. 1: Reactive power range as determined by active power and grid voltage

red line	90 % U_n
blue line	95 % U_n
black line	≥100 % U_n

The chart is given in table format below.

Tab. 3: Reactive power range as determined by the active power and grid voltage (≥ 100 % U_n)

P/P_n	≥ 100 % U_n	
	Q/P_n (Q_{export})	Q/P_n (Q_{import})
1	0.65	-0.65
0.1	0.65	-0.65
0	0	0

Tab. 4: Reactive power range as determined by the active power and grid voltage (< 100 % U_n)

	95 % U_n		90 % U_n		85 % U_n		80 % U_n	
P/P_n	Q/P_n (Q_{export})	Q/P_n (Q_{import})	Q/P_n (Q_{export})	Q/P_n (Q_{import})	Q/P_n (Q_{export})	Q/P_n (Q_{import})	Q/P_n (Q_{export})	Q/P_n (Q_{import})
0.42	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.44	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.46	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.48	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.50	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.52	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.54	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.56	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.58	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.60	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.65
0.62	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.64
0.64	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.63
0.66	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.65	-0.61
0.68	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.64	-0.60
0.70	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.62	-0.58
0.72	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.61	-0.57
0.74	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.59	-0.55
0.76	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.57	-0.53
0.78	0.65	-0.65	0.65	-0.65	0.65	-0.65	0.55	-0.51
0.80	0.65	-0.65	0.65	-0.65	0.65	-0.64	0.53	-0.49
0.81	0.65	-0.65	0.65	-0.65	0.65	-0.63	0.52	-0.48
0.82	0.65	-0.65	0.65	-0.65	0.65	-0.62	0.51	-0.47
0.83	0.65	-0.65	0.65	-0.65	0.65	-0.61	0.50	-0.45

	95 % U_n		90 % U_n		85 % U_n		80 % U_n	
P/P_n	Q/P_n (Q_{export})	Q/P_n (Q_{import})	Q/P_n (Q_{export})	Q/P_n (Q_{import})	Q/P_n (Q_{export})	Q/P_n (Q_{import})	Q/P_n (Q_{export})	Q/P_n (Q_{import})
0.84	0.65	-0.65	0.65	-0.65	0.65	-0.60	0.48	-0.44
0.85	0.65	-0.65	0.65	-0.65	0.64	-0.58	0.47	-0.43
0.86	0.65	-0.65	0.65	-0.65	0.62	-0.57	0.46	-0.42
0.87	0.65	-0.65	0.65	-0.65	0.61	-0.56	0.44	-0.40
0.88	0.65	-0.65	0.65	-0.65	0.60	-0.55	0.43	-0.39
0.89	0.65	-0.65	0.65	-0.65	0.58	-0.53	0.41	-0.37
0.90	0.65	-0.65	0.65	-0.65	0.57	-0.52	0.40	-0.36
0.91	0.65	-0.65	0.65	-0.65	0.55	-0.50	0.38	-0.34
0.92	0.65	-0.65	0.65	-0.65	0.54	-0.49	0.36	-0.32
0.93	0.65	-0.65	0.65	-0.64	0.52	-0.47	0.34	-0.30
0.94	0.65	-0.65	0.65	-0.63	0.51	-0.45	0.32	-0.28
0.95	0.65	-0.65	0.65	-0.61	0.49	-0.44	0.30	-0.26
0.96	0.65	-0.65	0.65	-0.60	0.47	-0.42	0.28	-0.24
0.97	0.65	-0.65	0.64	-0.58	0.45	-0.40	0.25	-0.21
0.98	0.65	-0.65	0.63	-0.56	0.43	-0.38	0.22	-0.18
0.99	0.65	-0.65	0.61	-0.54	0.41	-0.36	0.18	-0.14
1.00	0.65	-0.65	0.59	-0.52	0.39	-0.33	0.13	-0.09

Reactive power points between two adjacent table values of voltage or active power must be determined through linear interpolation.

Reactive power controller

The reactive power of the wind energy converter is configurable. The setpoint below can be configured directly in the wind energy converter control system.

Tab. 5: Reactive power regulator adjustment range

Parameter	Range	Increment
Q	Q_{min} … Q_{max}	5 kvar
Q/P (tan phi)	-3 … 3	0.005

Alternatively, a setpoint to the wind energy converter can be specified for the specific project through a superordinate control system at the wind farm level to use the reactive power range shown.

The tolerance of the reactive power feed in is < ±2.5 % of nominal active power over a 10-minute average.

4 Active power gradients

The wind energy converter can, in specific operating states, increase or decrease its active power with configurable gradients.

4.1 Positive active power gradients

Tab. 6: Active power gradients

Parameter	Range	Default setting	Increment
Active power gradient (normal start-up)	1 kW/s to 350 kW/s	80 kW/s	1 kW/s
Active power gradient (after mains fail.)	1 kW/s to 350 kW/s	80 kW/s	1 kW/s
Active power gradient (during operation)	1 kW/s to 880 kW/s	230 kW/s	1 kW/s
Active power gradient (stop switch)	1 kW/s to 900 kW/s	900 kW/s	1 kW/s
Active power gradient (external stop)	1 kW/s to 900 kW/s	900 kW/s	1 kW/s
Active power gradient (after over freq.)	1 kW/s to 900 kW/s	900 kW/s	1 kW/s

The *Active power gradient (normal start-up)* parameter is active if the wind energy converter start-up is not preceded by a reset of the wind energy converter control system; for example, after a “Lack of wind” status.

The *Active power gradient (after mains fail.)* parameter becomes active after the wind energy converter control system has been reset; for example, after a network loss. Operation in the FRT range does not count as network loss.

The *Active power gradient (during operation)* parameter for limiting positive active power gradients is deactivated by default.

The *Active power gradient (stop switch)* parameter is activated by actuating the stop switch on the control cabinet.

The *Active power gradient (external stop)* parameter is activated by an external stop command via the ENERCON SCADA system.

The *Active power gradient (after over freq.)* parameter is active if the static power frequency control is selected in the wind energy converter control system.

> Detailed information on the parameter *Active power gradient (after over freq.)* and FRT mode can be found in the “Datenblatt ENERCON Windenergieanlagen Netztechnische Leistungsmerkmale - FACTS” (Data sheet ENERCON wind energy converters, grid performance - FACTS), *Applicable documents*, p. 3.

4.2 Negative active power gradient

An externally specified setpoint can be used to limit active power feed. After the control system of the wind energy converter has received the active power reduction signal, active power is reduced using the parameter *Active power gradient (during operation)*. This does not take into account the delay of transmission to the wind energy converter from the ENERCON SCADA system, which depends on the wind farm configuration.

5 Reference point

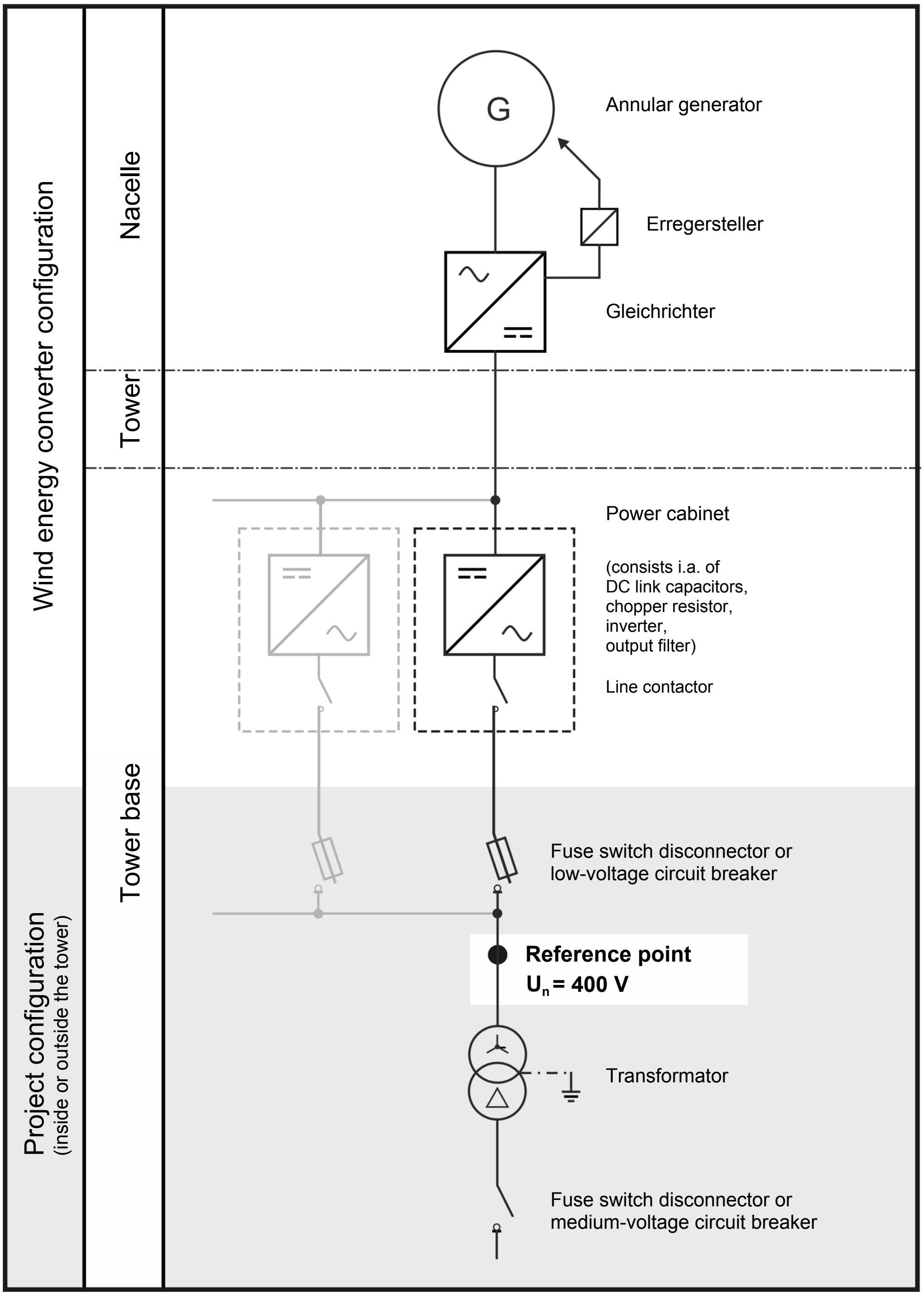


Fig. 2: Reference point

Subject to technical change without prior notice.

List of symbols

Tab. 7: Symbol

Symbol	Designation
f_n	Nominal frequency
$I_{b,max}$	Maximum symmetrical breaking current
$I_{k,max}$	Maximum continuous short-circuit current
$I_k''_{,max}$	Maximum initial symmetrical short-circuit current
I_{max}	Rated current
I_n	Nominal current
$I_{p,max}$	Maximum peak symmetrical short-circuit current
P_n	Nominal active power
Q_{export}	Reactive power (export)
Q_{import}	Reactive power (import)
Q_{max}	Maximum reactive power (export)
Q_{min}	Minimum reactive power (import)
Q_n	Nominal reactive power
S_{max}	Rated apparent power
U_n	Nominal voltage

Glossary of terms

Rated current

Maximum continuous output current under normal operating conditions for which a wind energy converter is designed (based on EN 61400-21:2008).

Reactive power

Electrical power that "commutes" between generators and consumers in a grid. It puts load on the grid without actually being used up. Reactive power is the result of phase shift between current and voltage due to inductive and capacitive consumers (e.g. electric motors) in a grid running with alternating or three-phase current. For this reason, power stations must be able to provide and absorb reactive power in addition to active power.

Data Sheet

ENERCON Wind Energy Converters

Grid Performance

FACTS 2.0

ENERCON
ENERGY FOR THE WORLD

Publisher

ENERCON GmbH ▪ Dreekamp 5 ▪ 26605 Aurich ▪ Germany
Phone: +49 4941 927-0 ▪ Fax: +49 4941 927-109
E-mail: info@enercon.de ▪ Internet: http://www.enercon.de
Managing Directors: Hans-Dieter Kettwig, Simon-Hermann Wobben
Local court: Aurich ▪ Company registration number: HRB 411
VAT ID no.: DE 181 977 360

Document details

Document ID	D0613156-2
Note	Original document. Source document of this translation: D0429929-2/2017-07-03

Date	Language	DCC	Plant/department
2017-07-25	en	DA	WRD GmbH / Validation

Related documents

The titles of the documents listed are the titles of the original language versions, with translations of these titles in ( ) where applicable. Document IDs always refer to the original language versions. If the document ID does not contain a revision, the most recent revision of the document applies.

Higher-level standards and guidelines

Document ID	Title
VDE-AR-N 4120	Technische Bedingungen für den Anschluss und Betrieb von Kundenanlagen an das Hochspannungsnetz (TAB Hochspannung) (Technical conditions for the connection and operation of customer systems in the high voltage grid (TAB high voltage))

Related documents

Document ID	Title
D0432722[1]	Datenblatt ENERCON Windenergieanlage E-141 EP4 / 4200 kW / FTQS – Netztechnische Leistungsmerkmale[1] (Data Sheet ENERCON Wind Energy Converter E-141 EP4 / 4200 kW / FTQS - Grid Performance)

[1] A separate data sheet is provided for each system and configuration. The specified document ID is an example only.

Table of contents

List of abbreviations

FACTS	Flexible Alternating Current Transmission System
FRT	Fault Ride Through
IGBT	Insulated-gate bipolar transistor
OVRT	Over voltage ride through
SCADA	Supervisory Control and Data Acquisition
STATCOM	Static compensator
UVRT	Under voltage ride through
ZPM	Zero Power Mode (no active or reactive current injection)

1 General information

The grid performance and characteristics of the ENERCON wind energy converter are distributed on two document types.

The functions and grid performance characteristics applicable to all wind energy converters and electrical configurations are described in the corresponding wind energy converter-independent document.

The grid performance characteristics depend on the wind energy converter type and electrical configuration and are provided in the corresponding jointly applicable wind energy converter-specific document.

2 Operating range

Tab. 1: Operating voltages

Parameter		Value
Maximum continuous operating voltage	U_{max}	120 % of U_n
Minimum continuous operating voltage	U_{min}	85 % of U_n
Temporary minimum voltage	$U_{min,temp}$	80 % of U_n

The wind energy converter can operate for up to 60 s in the range between the temporary minimum voltage ($U_{min, temp}$) and the minimum continuous operating voltage (U_{min}).

The voltage is determined at a reference point on the wind energy converter side at the low-voltage level (see ch. 9, p. 50). The nominal voltage (U_n) of the wind energy converter serves as the reference voltage at the reference point.

For details on operation in which the voltage is less than the temporary minimum voltage or greater than the maximum continuous operating voltage, refer to ch. 5, p. 17.

If the voltage drops to a value below the nominal voltage (U_n), the current limit of the converters can be reached so that the rated apparent power (S_{max}) can no longer be provided. In this case the system's default settings prioritise active power and reduce reactive power accordingly. This configuration can be adjusted so that active power is reduced and reactive power is kept at a constant level during an undervoltage event.

Grid short-circuit power

For grid feed of maximum active power and reactive power as specified by the reactive power range and operating voltage, the short-circuit power of the grid at the network connection point must be at least four times the sum of the nominal active power of all connected wind energy converters.

Project-specific solutions must be examined if this ratio is less than four.

3 Apparent power/frequency chart

Tab. 2: Nominal grid frequency = 50 Hz

Parameter		Value
Maximum frequency	f_{max}	57 Hz
Nominal frequency	f_n	50 Hz
Minimum frequency	f_{min}	43 Hz

Tab. 3: Nominal grid frequency = 60 Hz

Parameter		Value
Maximum frequency	f_{max}	67 Hz
Nominal frequency	f_n	60 Hz
Minimum frequency	f_{min}	53 Hz

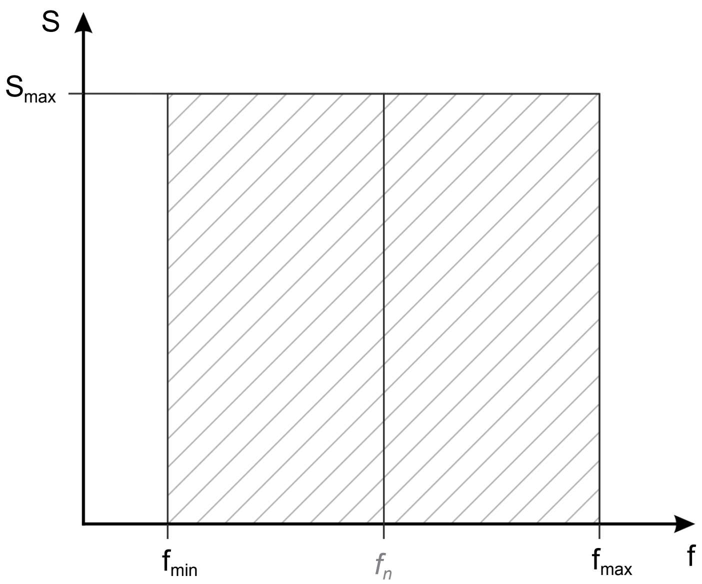


Fig. 1: Apparent power/frequency chart

In the event of grid frequency changes due to grid faults the wind energy converter can continue operating permanently up to a frequency gradient of 4 Hz/s. The wind energy converter continuously synchronises the frequency of the power fed into the grid with the grid frequency at the reference point.

4 Protection features

The wind energy converter has the following protection features:

- Protective disconnection
- Self-protection
- Other protection features

If any of the protection features is triggered, the wind energy converter shuts down. The shutdown of the wind energy converter occurs in several stages:

- Opening the grid protection circuit
- Opening the line contactors (galvanic isolation of the converters from the grid) and termination of grid injection by disabling the IGBT pulse
- Generator excitation stops
- Generator stops

The grid protection features are implemented on an autonomous protective protection printed circuit board powered by an auxiliary power supply independent of the grid. This means the protection features are maintained for at least 6 s in the event of a network loss.

4.1 Protective disconnection

4.1.1 Frequency protection

Overfrequency and underfrequency events at the wind energy converter reference point trigger frequency protection and cause the wind energy converter to shut down after the delay time has elapsed.

Tab. 4: Nominal grid frequency = 50 Hz

Parameter	Range	Increment
Overfrequency protection f>	50 Hz ... 57 Hz	0.01 Hz
Delay of overfrequency protection f>	0.1 s … 60 s	0.01 s
Overfrequency protection f>>	50 Hz ... 57 Hz	0.01 Hz
Delay of overfrequency protection f>>	0.1 s ... 60 s	0.01 s
Underfrequency protection f<	43 Hz ... 50 Hz	0.01 Hz
Delay of underfrequency protection f<	0.1 s ... 60 s	0.01 s
Underfrequency protection f<<	43 Hz ... 50 Hz	0.01 Hz
Delay of underfrequency protection f<<	0.1 s ... 60 s	0.01 s

Tab. 5: Nominal grid frequency = 60 Hz

Parameter	Range	Increment
Overfrequency protection f>	60 Hz ... 67 Hz	0.01 Hz
Delay of overfrequency protection f>	0.1 s ... 60 s	0.01 s
Overfrequency protection f>>	60 Hz ... 67 Hz	0.01 Hz
Delay of overfrequency protection f>>	0.1 s ... 60 s	0.01 s
Underfrequency protection f<	53 Hz … 60 Hz	0.01 Hz
Delay of underfrequency protection f<	0.1 s ... 60 s	0.01 s
Underfrequency protection f<<	53 Hz ... 60 Hz	0.01 Hz
Delay of underfrequency protection f<<	0.1 s ... 60 s	0.01 s

Response times of switching devices

The tripping time in the event of underfrequency or overfrequency events is the sum of the inherent delays of the switching devices (line contactors) of up to 0.05 s and the delay time of the respective frequency protection feature. The response time of the protection equipment is included in the delay time.

ENERCON
ENERGY FOR THE WORLD

4.1.2 Overvoltage protection

The trigger time of the overvoltage protection can be configured so that the overvoltage protection triggers when at least one phase exceeds the value of the *Overvoltage protection* parameter or when all three phases exceed the value of the *Overvoltage protection* parameter. The *Overvoltage protection U>* and *Overvoltage protection U>>* settings can be selected independently.

The overvoltage protection can be configured to monitor the line-line voltage or the line-to-earth voltage. This selection applies to *Overvoltage protection U>* and *Overvoltage protection U>>*.

Overvoltage protection U>

If the root mean square (RMS) voltage value of at least one phase or all phases exceeds the specified *Overvoltage protection U>* parameter value, overvoltage protection U> is triggered. This causes the wind energy converter to shut down after the time period specified by the *Delay of overvoltage protection U>* parameter has elapsed.

Tab. 6: Overvoltage protection U>

Parameter	Range	Increment
Overvoltage protection U>	100 % … 130 %	0.5 %
Delay of overvoltage protection U>	0.05 s … 60 s	0.01 s

Overvoltage protection U>>

If the RMS voltage value of at least one phase or all phases exceeds the specified *Overvoltage protection U>>* parameter value, overvoltage protection U>> is triggered. This causes the wind energy converter to shut down after the time period specified by the *Delay for overvoltage protection U>>* parameter has elapsed.

Tab. 7: Overvoltage protection U>>

Parameter	Range	Increment
Overvoltage protection U>>	100 % … 130 %	0.5 %
Delay of overvoltage protection U>>	0.05 s … 60 s	0.01 s

The wind energy converter shutdown during overvoltage is also affected by the OVRT (ch. 5, p. 17) parameter selection.

Voltages above 120 % of $U_n/\sqrt{3}$

Overvoltage protection parameters are configured so that, with voltages above 120 % of $U_n/\sqrt{3}$, the wind energy converter remains in continuous operation, i.e., not in OVRT operation, for a maximum of 2 s.

Tripping time

The tripping time for overvoltage events is the sum of the response time of the switching devices (line contactors), which is up to 0.05 s, and the delay of the respective overvoltage protection device. The response time of the protection equipment is included in the delay time.

4.1.3 Undervoltage protection

The trigger time of the undervoltage protection can be configured so that the undervoltage protection triggers when at least one phase drops below the value of the *Undervoltage protection* parameter or when all three phases drop below the value of the *Undervoltage protection* parameter. The *Undervoltage protection U<* and *Undervoltage protection U<<* settings can be selected independently.

The undervoltage protection can be configured to monitor the conductor-conductor voltage or the line-to-earth voltage. This selection applies to *Undervoltage protection U<* and *Undervoltage protection U<<*.

Undervoltage protection U<

If the RMS voltage value of at least one phase or all phases falls below the specified *Undervoltage protection U<* parameter value, undervoltage protection U< is triggered. This causes the wind energy converter to shut down after the time period specified by the *Delay of undervoltage protection U<* parameter has elapsed.

Tab. 8: Undervoltage protection U<

Parameter	Range	Increment
Undervoltage protection U<	5 % … 100 %	0.5 %
Delay of undervoltage protection U<	0.05 s … 60 s	0.01 s

Undervoltage protection U<<

If the RMS voltage value of at least one phase or all phases falls below the specified *Undervoltage protection U<<* parameter value, undervoltage protection U<< is triggered. This causes the wind energy converter to shut down after the time period specified by the *Delay of undervoltage protection U<<* parameter has elapsed.

Tab. 9: Undervoltage protection U<<

Parameter	Range	Increment
Undervoltage protection U<<	5 % ... 100 %	0.5 %
Delay of undervoltage protection U<<	0.05 s … 60 s	0.01 s

The wind energy converter shutdown during undervoltage is also affected by the UVRT (ch. 5, p. 17) parameter selection.

Tripping time

The tripping time for undervoltage events is the sum of the response time of the switching devices (line contactors) of up to 0.05 s and the delay time of the respective undervoltage protection device. The response time of the protection equipment is included in the delay time.

4.2 Self-protection

The wind energy converter is equipped with a self-protection feature that protects it against damage from grid events. This includes hardware protection from excessive voltages, the voltage protection and the frequency protection.

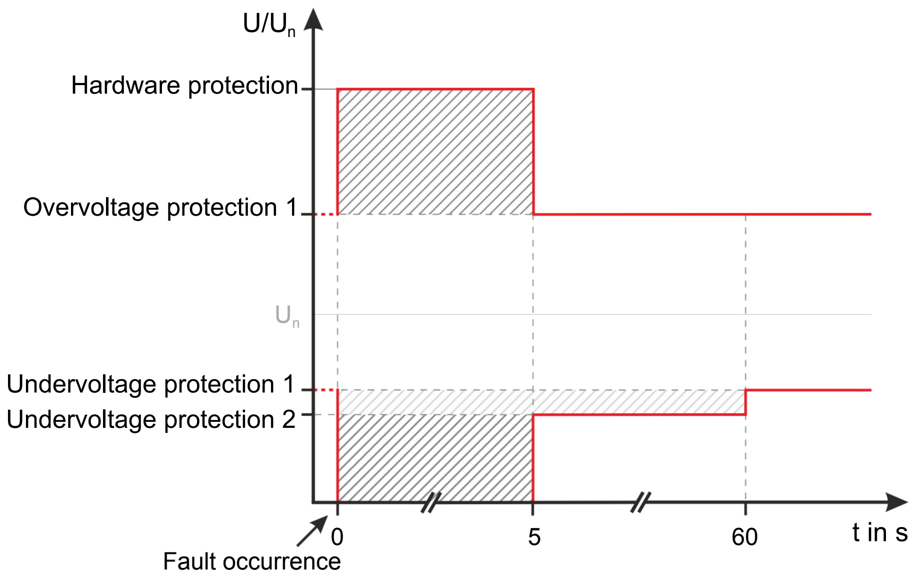


Fig. 2: Self-protection voltage limits

4.2.1 Hardware protection

This protection feature provided hardware protection of the wind energy converter and causes the wind energy converter to shut down after the period specified in *max. OVRT time* has elapsed.

If the instantaneous value of at least one phase voltage exceeds 145 % of $\sqrt{2}xU_n/\sqrt{3}$, the wind energy converter automatically enters Zero Power Mode; it can be configured to either remain connected to the grid or disconnect by opening the line contactors.

Tab. 10: Hardware protection

Parameter	Range	Increment
Hardware protection	145 % of $\sqrt{2}xU_n/\sqrt{3}$ (fixed)	-
Hardware protection response time	0.001 s (fixed)	-
Max. OVRT time	0.05 s … 5 s	0.01 s

4.2.2 Voltage protection

The wind energy converter is equipped with a self-protection feature that protects it against damage from overvoltage or undervoltage.

When the RMS voltage value of at least one phase drops below the preset value, undervoltage protection is triggered. When the RMS voltage value of at least one phase rises above the preset value, overvoltage protection is triggered. The grid feed self-protection thus opens the grid safety circuit and stops the wind energy converter from feeding energy into the grid. This causes the wind energy converter to shut down after the preset shutdown delay has elapsed.

Tab. 11: Voltage protection

Protective function	Value	Delay
Undervoltage protection 1	85 % of $U_n/\sqrt{3}$	60 s
Undervoltage protection 2	80 % of $U_n/\sqrt{3}$	5 s
Overvoltage protection 1	120 % of $U_n/\sqrt{3}$	5 s

4.2.3 Frequency protection

The wind energy converter is equipped with a self-protection feature that protects it against damage from overfrequency or underfrequency.

Overfrequency and underfrequency events at the wind energy converter reference point trigger frequency protection and cause the wind energy converter to shut down after the delay time has elapsed.

Tab. 12: Nominal grid frequency = 50 Hz

Protective function	Value	Delay
Underfrequency protection	43 Hz	60 s
Overfrequency protection	57 Hz	60 s

Tab. 13: Nominal grid frequency = 60 Hz

Protective function	Value	Delay
Underfrequency protection	53 Hz	60 s
Overfrequency protection	67 Hz	60 s

4.3 Other protection features

Active power reduction during overvoltage

The maximum active power of the wind energy converter is limited as soon as the grid voltage exceeds the value set for the Limitation voltage P(U>). This feature can be used to limit the voltage at the network connection point by temporarily reducing active power.

This function is deactivated by default.

Tab. 14: Limitation voltage

Parameter	Range	Increment
Limitation voltage	100 % ... 125 % of $U_n/\sqrt{3}$	0.5 % of $U_n/\sqrt{3}$

5 Fault ride-through behaviour

The wind energy converter feeds the maximum possible amount of power into the energy system depending on the prevailing wind conditions. The wind energy converters are equipped with a Fault Ride Through facility which allows them to remain in operation in the event of voltage drops due to faults, Under Voltage Ride Through (UVRT) and voltage surges, Over Voltage Ride Through (OVRT). Depending on the grid codes and the operating status of the energy system, the FACTS 2.0 control system is able to influence the output current of the wind energy converter.

To meet the various grid codes, the FACTS 2.0 control system offers various operating strategies. The operating strategies consist of several modes which react to different grid states.

The individual operating modes are activated when voltage exceeds or falls below applicable limit values (here: U_1 to U_4) that are based on the specifications at the respective network connection point and can be parameterised (see ch. 5.3, p. 22). An appropriate operating strategy and its parameter configuration must be selected on a project-specific basis before commissioning the wind energy converter. Here is an example of the QU2 strategy operating mode:

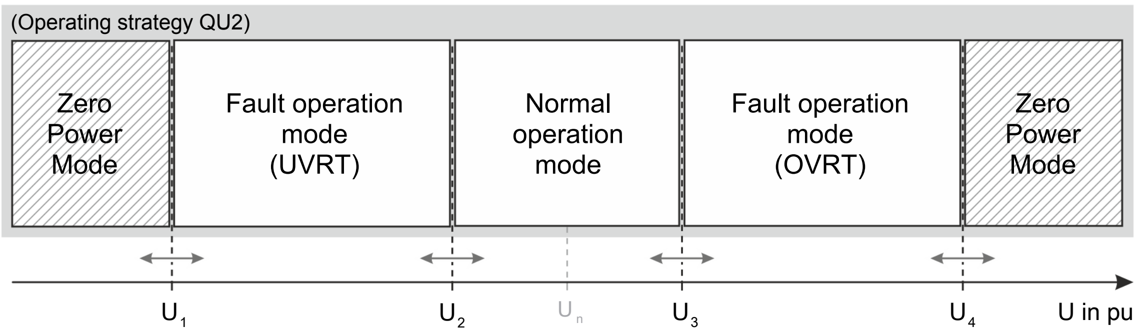


Fig. 3: Operating modes of the operating strategies depending on voltage (e.g.: QU2)

U_1	U_{UVRT_ZPM}	U_2	U_{UVRT}
U_3	U_{OVRT}	U_4	U_{OVRT_ZPM}

Fault operation mode

The FACTS 2.0 control system switches to a “fault operation” mode when voltage (see fig. 3, p. 17) exceeds or falls below the defined limits (voltage is outside of the normal operating limits). In these modes, current being fed into the grid by the wind energy converter is modified in order to achieve a strategy-dependent reaction to certain situations in the grid. Thus for instance in the event of a fault, grid voltage can be supported by grid feed of additional reactive current. As soon as grid voltage has returned to the normal operation range, the FACTS 2.0 control system returns to this mode. Detailed information on the strategy-dependent modes can be found is the individual sections of the operating strategies (ch. 5.3, p. 22).

Normal operation mode

Normal operation mode remains activated as long the voltage does not exceed or fall below the defined limits (voltage is within the range of normal operation). Depending on the wind, the wind energy converter feeds the available active power and reactive power into the grid according to the specified setpoint.

Abrupt change in voltage mode

The QU3 operating strategy, which complies with the VDE-AR-N 4120 requirements, also contains an "Abrupt change in voltage" mode in addition to the "Fault operation" mode. This is characterised by the fact that it can already react by providing additional reactive current in the positive-sequence and negative-sequence component when abrupt changes in voltage occur in the normal operation range (amplitudes as well as phase angles) (ch. 5.3.1, p. 24).

Zero Power Mode

All QU operating strategies are equipped with an underlying Zero Power Mode. In the event of a fault situation, the wind energy converter rides through without injecting active and reactive current into the grid. As soon as grid voltage has returned to the normal operation range, the FACTS 2.0 control system returns to this mode.

5.1 Operating ranges

The maximum times for riding through grid faults can be set for voltage drops (UVRT) and voltage surges (OVRT) independently from one another. Suitable FRT parameters and/or protection parameters can be configured accordingly if continued operation during and after grid faults is undesirable.

Further information on the protection parameters is provided in ch. 4, p. 10.

5.1.1 Limits in cases of faults (QU operating strategies)

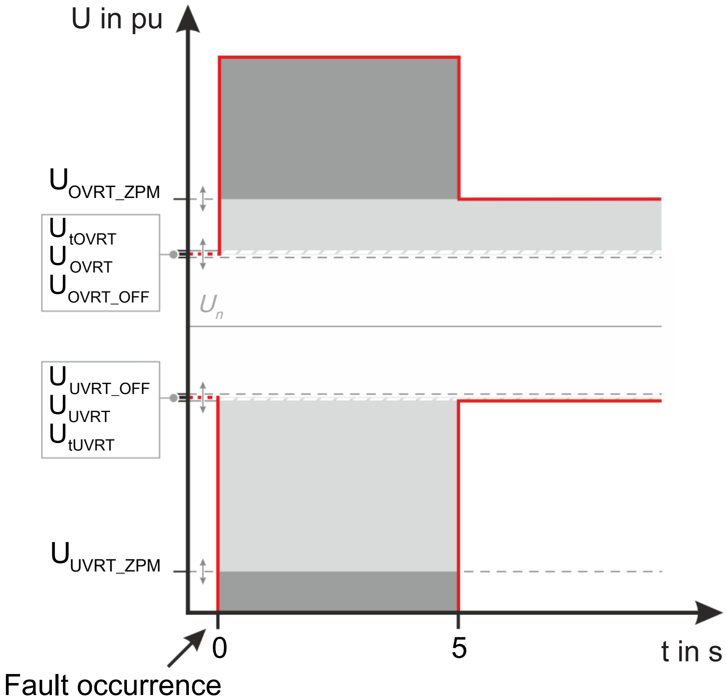


Fig. 4: Parameterisable limits for riding through grid faults for QU operating strategies

(white/hatched box)	Normal operation/continuous operation
(light grey box)	Fault operating mode (OVRT/UVRT)
(dark grey box)	Fault operation mode (Zero Power Mode)
(red line)	Limits

A grid fault is detected as soon as the voltage at the wind energy converter reference point drops below U_{UVRT} or rises above U_{OVRT}. The FACTS control system determines an additional or absolute reactive current for supporting the grid voltage that is additionally available during the fault. All operating strategies of the QU series are equipped with the Zero Power Mode. This means that it is possible to stop the power injection in the event that voltages fall below or exceed defined levels for up to a maximum of 5 s.

The wind energy converter continues operating if the voltage of all phases at the reference point remains within the range marked by the red boundary curve during and after the grid fault. If the voltage at any phase is outside this range, the wind energy converter can shut down. Grid feed of active and reactive current is possible for the duration of the grid fault. The reference value for injecting current can be found in the corresponding description of the respective operating strategy.

If a grid fault is detected at a moment when the wind energy converter's active power is less than 2.5 % of P_n, the wind energy converter can then shut down.

More detailed information regarding individual operating strategies and their parameter limits can be found in ch. 5.3, p. 22.

5.1.2 Limits in cases of faults (Zero Power operating strategy)

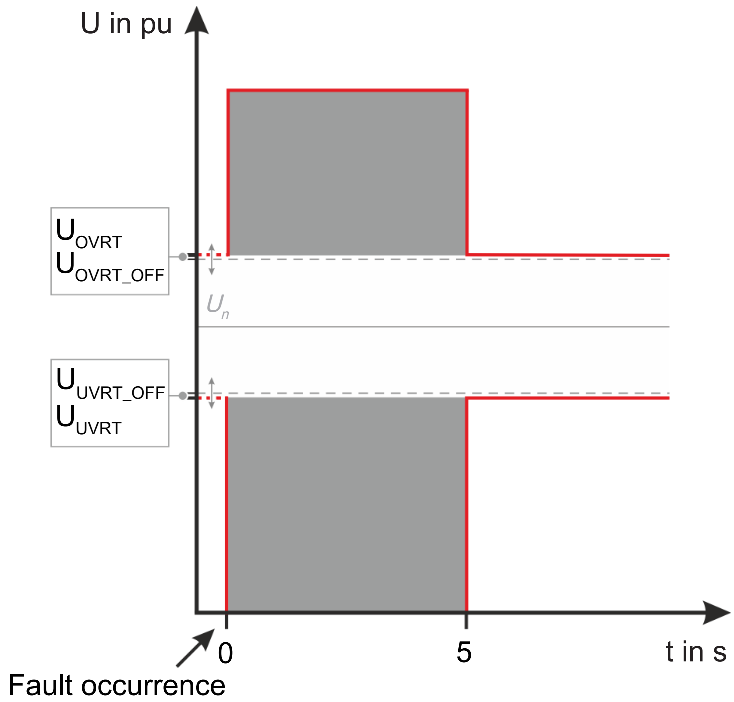


Fig. 5: Parameterisable limits for riding through grid faults (ZP operating strategy)

(white box)	Normal operation
(grey box)	Fault operation mode
(red line)	Limits

A grid fault is detected as soon as the voltage at the wind energy converter reference point drops below U_{UVRT} or rises above U_{OVRT}. The wind energy converter does not inject any active or reactive power into the grid for the duration of the grid fault.

The wind energy converter continues operating if the voltage of all phases at the reference point remains within the range marked by the red boundary curve during and after the grid fault. If the voltage at any phase is outside this range, the wind energy converter can shut down.

If a grid fault is detected at a moment when the wind energy converter's active power is less than 2.5 % of P_n, the wind energy converter can then shut down.

More detailed information on the operating strategy and its parameter limits can be found in ch. 5.3.5, p. 42.

5.2 Overview of operating strategies in FACTS 2.0

Tab. 15: Operating strategies

	Operating strategies FACTS 2.0				
	QU3	QU2	QU(ABS)	QU(UK)	ZP
Brief description	Grid feed of additional reactive current in fault operation mode	Grid feed of additional reactive current in fault operation mode	Grid feed of absolute reactive current in fault operation mode	Grid feed of additional reactive current in fault operation mode	No grid feed of active or reactive current in fault operation mode
	ch. 5.3.1, p. 24	ch. 5.3.2, p. 30	ch. 5.3.3, p. 34	ch. 5.3.4, p. 38	ch. 5.3.5, p. 42
Available operating mode					
Normal operation	X	X	X	X	X
Fault operation mode	X	X	X	X	-
Abrupt change in voltage	X	-	-	-	-
Zero Power	X	X	X	X	X
Reactive current injection in the event of a fault					
Positive-sequence component	X	X	X	X	-
Negative-sequence component	X	-	-	-	-
Proportionality factor K (0-10) - M = positive-sequence component; G = negative-sequence component					
FRT	M/G	-	-	-	-
Abrupt change in voltage	M/G	-	-	-	-
UVRT	-	M	M	M	-
OVRT	-	M	M	M	-
Prioritisation in the event of a fault; I_B = Reactive current; I_W = Active current					
	I_B	I_B	I_B	I_W	-

5.3 Operating strategies

Fundamental behaviour during grid overvoltages due to faults

If the reference voltage rises above the set limit of the *OVRT trigger voltage* parameter, the FACTS control system switches over to the fault mode of the selected operating strategy automatically after no more than 0.015 s. A suitable operating strategy and its parameter configuration must be selected on a project-specific basis.

If the reference voltage within the time specified in the *maximum time OVRT operation* parameter falls below the specified limit of the *OVRT voltage start timer* parameter by 2 %, then the time recording by the timer is stopped. If the voltage does not fall below the *OVRT voltage start timer* limit by 2 % within the specified time, the wind energy converter shuts down. If the level falls below the limit of the *OVRT return voltage* parameter, the FACTS control system will exit the fault operating mode and return to normal operation.

If the limit of the *OVRT trigger voltage ZPM* parameter is exceeded in connection with a correspondingly selected operating strategy, the FACTS control system switches over to Zero Power Mode and can either remain connected to the grid or disconnect by opening the line contactors.

If overvoltages with instantaneous values exceeding the hardware protection (145 % of $\sqrt{2}xU_n/\sqrt{3}$) occur for at least 0.001 s (response time of the hardware protection), the FACTS control system will automatically enter Zero Power Mode and the wind energy converter can either remain connected to the grid or disconnect by opening the line contactors.

Tab. 16: Behaviour during grid overvoltage due to faults

Parameter		Range
OVRT trigger voltage	U_{OVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT return voltage	U_{OVRT_OFF}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT voltage start timer	U_{tOVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT trigger voltage ZPM[1]	U_{OVRT_ZPM}	110 % … 150 % of $U_n/\sqrt{3}$
Increment OVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time OVRT operation	t_{dOVRT}	0.1 s … 60 s
Maximum time ZPM operation	t_{dZPM}	0.1 s … 5 s
Increment maximum time	-	0.1 s

[1] The parameter is simultaneously also the limit for ending the ZPM.

Fundamental behaviour during grid undervoltages due to faults

If the reference voltage falls below the setting value of the *UVRT trigger voltage* limit, the FACTS control system will switch over to the fault mode of the selected operating strategy automatically after no more than 0.015 s. A suitable operating strategy and its parameter configuration must be selected on a project-specific basis.

If the reference voltage within the time specified in the *maximum time UVRT operation* parameter exceeds the specified limit of the *UVRT voltage start timer* parameter by 2 %, then time recording by the timer is stopped. If the reference voltage does not fall below the *UVRT voltage start timer* limit by 2 % within the specified time, the wind energy converter shuts down. If the level exceeds the limit of the *UVRT return voltage* parameter, the FACTS control system will exit the fault operating mode and return to normal operation.

If the limit of the *UVRT trigger voltage ZPM* parameter is exceeded in connection with a correspondingly selected operating strategy, the FACTS control system switches over to Zero Power Mode and can either remain connected to the grid or disconnect by opening the line contactors.

Tab. 17: Behaviour during grid undervoltages due to faults

Parameter		Range
UVRT trigger voltage	U_{UVRT}	80 % ... 95 % of $U_n/\sqrt{3}$
UVRT return voltage	U_{UVRT_OFF}	80 % ... 95 % of $U_n/\sqrt{3}$
UVRT voltage start timer	U_{tUVRT}	80 % ... 95 % of $U_n/\sqrt{3}$
UVRT trigger voltage ZPM[1]	U_{UVRT_ZPM}	0 % ... 80 % of $U_n/\sqrt{3}$
Increment UVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time UVRT operation	t_{dUVRT}	0.1 s … 5 s
Maximum time ZPM operation	t_{dZPM}	0.1 s … 5 s
Maximum time increment parameter	-	0.1 s

[1] The parameter is simultaneously also the limit for ending the ZPM.

Maximum number of faults

Multiple grid faults or voltage drops can be ridden through per hour. The maximum number depends on the temperature of the chopper resistors. The chopper resistors, in which electrical energy is transformed into thermal energy during a grid fault, are protected against overtemperature. If the temperature of the chopper resistors exceeds the maximum value, the wind energy converter remains inoperative until the temperature of each chopper resistor drops below the maximum permissible operating temperature.

5.3.1 QU3 operating strategy

The QU3 operating strategy enables the wind energy converter to ride through temporary symmetrical and asymmetrical grid faults without the wind energy converter disconnecting itself from the grid. The QU3 operating strategy distinguishes between the following different grid events.

Abrupt change in voltage

An abrupt change in voltage is detected as soon as the instantaneous value of the first fundamental of voltage of a line-to-earth voltage deviates by more than 5 % from the 1-second average value of this line-to-earth voltage.

Depending on the voltage changes to the pre-fault voltage, and depending on proportionality factor K, the wind energy converter injects additional reactive current into the grid for 5 s, in addition to the reactive current injected into the grid at the present, according to the applicable setpoint specifications. The additional reactive current, if necessary, is injected into the energy system both in the positive-sequence component and in the negative-sequence component. In addition to the selected K-factors, this also depends on the voltage fluctuation that is present and the external Q setpoint specification, which continues to be taken into consideration during the abrupt change in voltage. If the wind energy converter is in STATCOM operation, then there will be no reaction to an abrupt change in voltage.

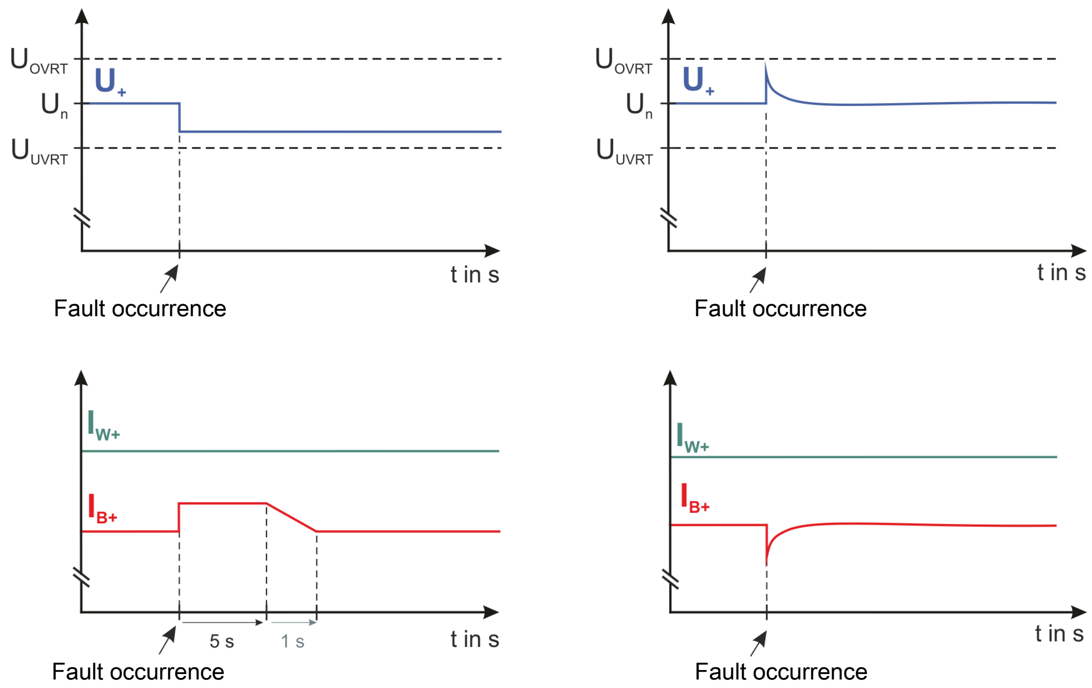


Fig. 6: Exemplary behaviour under fault conditions in connection with an abrupt change in voltage (depiction of the positive-sequence components)

After 5 s, the FACTS control system exits the fault of the abrupt change in voltage and the reactive power is transferred to its associated value for normal operation with a gradient within a specified time period of 1 s.

If an additional abrupt change in voltage is detected during the fault time, then the time (5 s) will begin running again. This operating state can be maintained up to a maximum of 20 s. If the FACTS control system is still in fault operating mode when this maximum permissible fault time (20 s) is exceeded, then the wind energy converter will shut down.

Voltage deviations

A voltage deviation is detected as soon as the root mean square of a line-line voltage exits the specified voltage range around the nominal voltage (U_{OVRT} or U_{UVRT}).

Depending on the fault and the amount of the voltage deviation, and depending on proportionality factor K, the wind energy converter injects an additional reactive current into the grid for a period of up to 5 s in addition to the reactive current injected into the grid immediately prior to the onset of the fault. Changes to the external Q setpoint are not taken into account during this time period. The additional reactive current is, if necessary, determined and injected into the energy system, both in the positive-sequence component and in the negative-sequence component.

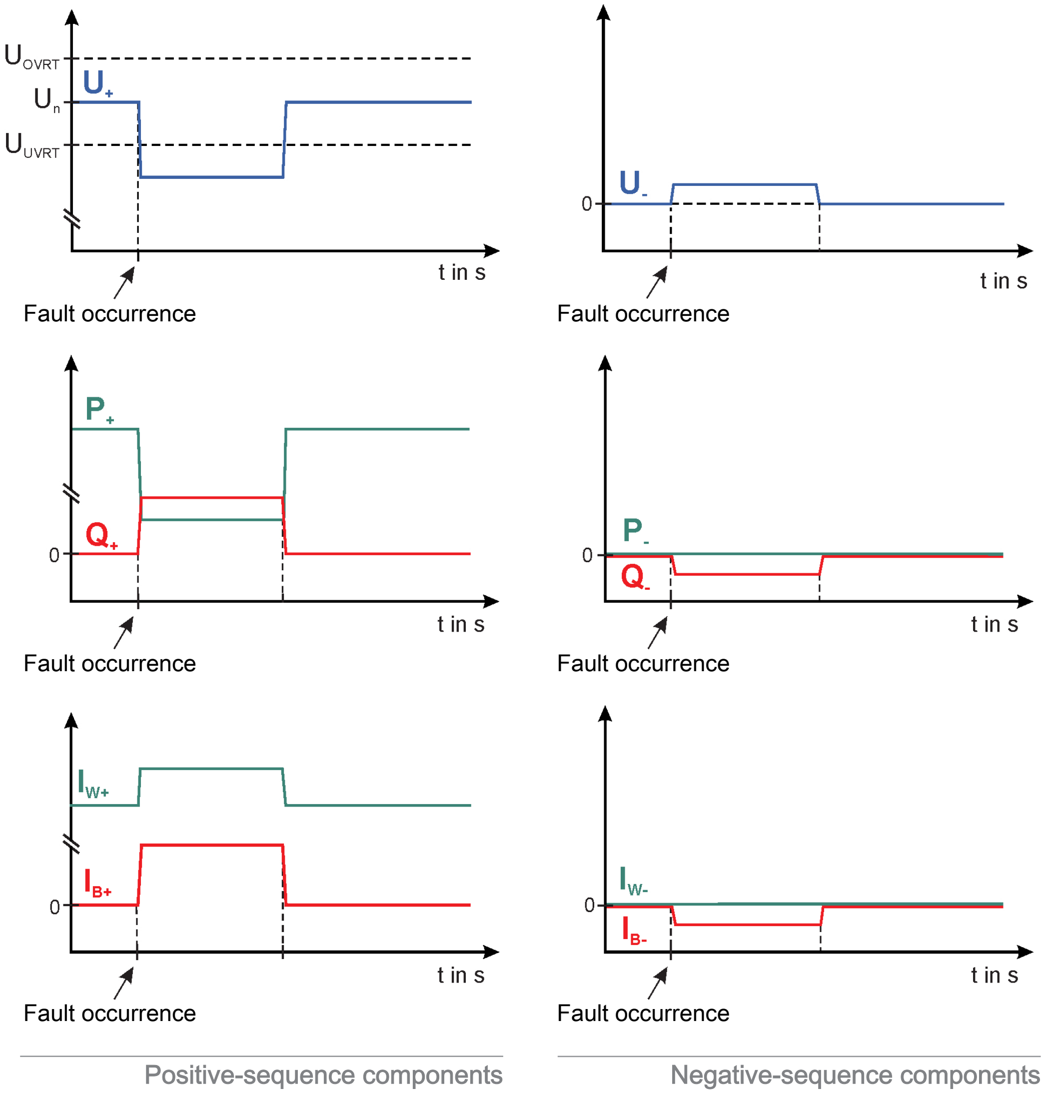


Fig. 7: Exemplary behaviour under fault conditions in connection with an asymmetrical abrupt drop in voltage (positive-sequence component (left) and in the negative-sequence component (right))

After the fault has been cleared, the FACTS control system exits the fault mode of the QU3 operating strategy and the wind energy converter injects the available active power and reactive power based on the setpoint, depending on the wind conditions. If the voltage does not return to the permissible range within the defined time period (t_{dUVRT} or

t_{dOVRT}), the wind energy converter will shut down. It will start up automatically as soon as the start parameters configured in the wind energy converter are fulfilled once again through the measured grid characteristics.

Further information on the start parameters is provided in ch. 6, p. 44.

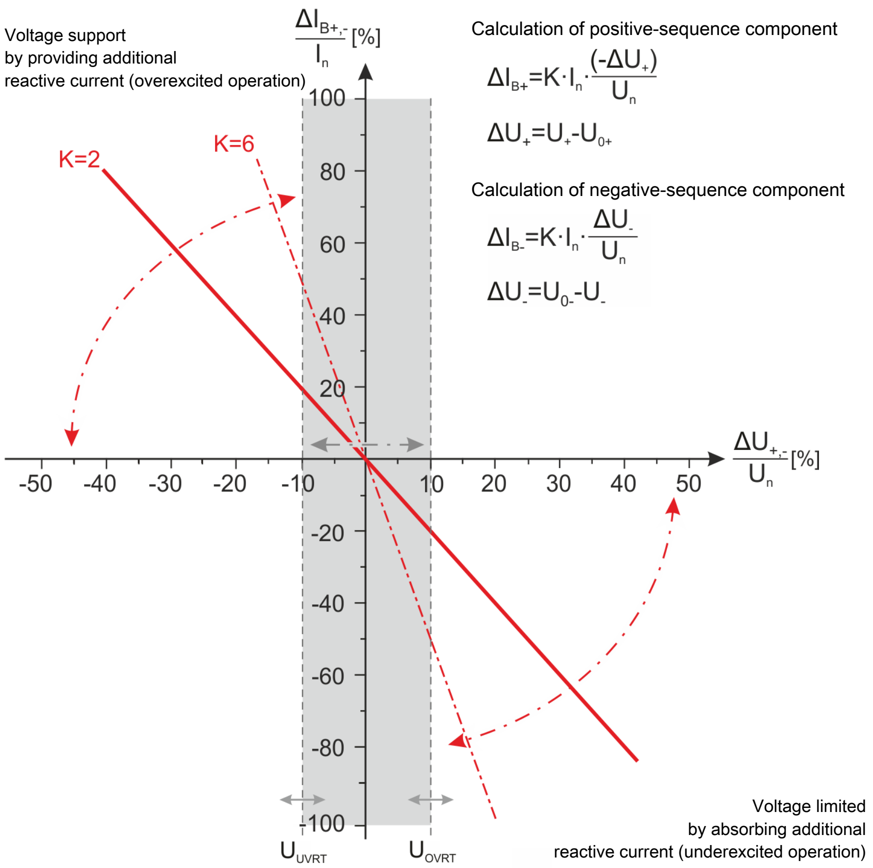


Fig. 8: Supporting/limiting grid voltage in the operating strategy QU3

The proportionality factor K for calculating the additional reactive current can be set separately, not only for the voltage deviation fault types and abrupt voltage change, but also for the positive and negative-sequence components. The additional reactive current in fault conditions can lead to a situation in which the technical current limitation of the wind energy converter is reached. Consequently, a reduction must be undertaken so that the active current can be lowered during FRT operation.

In order to provide an additional reactive current once again in accordance with the QU3 operating strategy, it is necessary to implement a return to voltage levels in the normal operating range of U_{UVRT_OFF} and U_{OVRT_OFF} beforehand.

If the positive-sequence voltage falls below or exceeds the limit U_{tUVRT} or U_{tOVRT}, respectively, then an additional reactive current will be injected in for a maximum period of t_{dUVRT} or t_{dOVRT}, respectively, in accordance with the proportionality factor K that has been configured. If the voltage does not return to the range above or below the limits within the permitted time range, the wind energy converter will shut down.

Zero Power Mode

The QU3 operating strategy is furnished with the option of an underlying Zero Power Mode (ZPM).

If the positive-sequence voltage drops below the configured voltage threshold U_{UVRT_ZPM}, then the FACTS control system will switch over to ZPM. In the event that the configured voltage threshold U_{OVRT_ZPM} is exceeded by the root mean square of a line-to-earth voltage, the FACTS control system will also switch to the ZPM. During the ZPM, the IGBTs of the inverters are blocked, which means that neither active nor reactive current is injected into the grid. The FACTS control system can remain in ZPM for a period of up to a maximum of 5 s (t_{dZPM}). The wind energy converter will shut down if the voltage does not return to the range above or below the voltage threshold value U_{UVRT_ZPM} or U_{OVRT_ZPM} respectively, within this permitted time period.

As soon as the positive sequence voltage once again exceeds the limit U_{UVRT_ZPM} or as soon as all line-to-earth voltages fall below the value U_{OVRT_ZPM} within the permitted duration (t_{dZPM}), the active and reactive currents will be returned to their values for normal operation or FRT operation in accordance with their configurations in the QU3 operating strategy. Activation of the underlying ZPM does not lead to any extension of the permitted time period (t_{dUVRT} or t_{dOVRT}), respectively, in FRT operation.

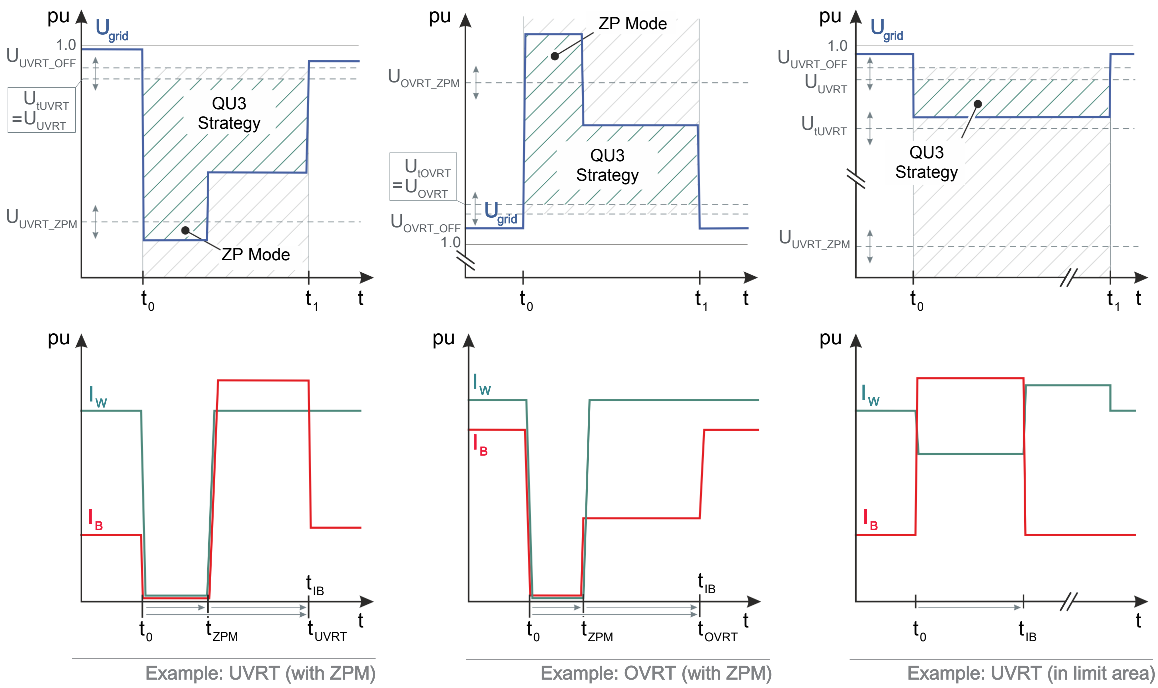


Fig. 9: Configurable limits of the QU3 operating strategy and of the ZPM as depicted with exemplary fault curves

t_0	Start of the grid fault	t_1	End of the grid fault
t_{UVRT}	End of time recording in fault mode (UVRT)	t_{OVRT}	End of time recording in fault mode (OVRT)
t_{ZPM}	End of the ZPM	t_{IB}	End of additional reactive current injection

For operation in ZPM, $I_{k,ZPM}$ is 0 during the grid fault. The other short-circuit currents listed in the wind energy converter-specific “Grid Performance” data sheets go to zero as soon as the ZPM is activated.

If the wind energy converter does not inject in any active power into the grid when a grid fault is detected, then the FACTS control system switches over to ZPM.

After the fault has been cleared, the FACTS control system exits the fault mode and the wind energy converter injects the available active power and reactive power based on the setpoint, depending on the wind conditions.

Tab. 18: QU3 operating strategy parameters

Parameter			Range
K-factor (positive-sequence component)			
	Abrupt change in voltage	K	0 … 10
	FRT (voltage deviation)	K	0 … 10
K-factor (negative-sequence component)			
	Abrupt change in voltage	K	0 … 10
	FRT (voltage deviation)	K	0 … 10
Increment K-factor		-	0.1
Maximum time ZPM operation		t_{dZPM}	0.1 s … 5 s
Increment maximum time		-	0.1 s
Undervoltage			
UVRT trigger voltage		U_{UVRT}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT return voltage		U_{UVRT_OFF}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT voltage start timer		U_{tUVRT}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT trigger voltage ZPM[1]		U_{UVRT_ZPM}	0 % … 80 % of $U_n/\sqrt{3}$
Increment UVRT voltage		-	0.5 % of $U_n/\sqrt{3}$
Maximum time UVRT operation		t_{dUVRT}	0.1 s … 5 s
Increment maximum time		-	0.1 s
Overvoltage			
OVRT trigger voltage		U_{OVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT return voltage		U_{OVRT_OFF}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT voltage start timer		U_{tOVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT trigger voltage ZPM[1]		U_{OVRT_ZPM}	110 % … 150 % of $U_n/\sqrt{3}$
Increment OVRT voltage		-	0.5 % of $U_n/\sqrt{3}$
Maximum time OVRT operation		t_{dOVRT}	0.1 s … 60 s
Increment maximum time		-	0.1 s
Zero Power Mode gradients			
Active power gradient (after ZPM)		dP_{ZPM}/dt	0.05 MW/s … 99 MW/s
Active power gradient increment (after ZPM)		-	0.05 MW/s
Reactive power gradient (after ZPM)		dQ_{ZPM}/dt	0.05 Mvar/s … 99 Mvar/s
Reactive power gradient increment (after ZPM)		-	0.05 Mvar/s

[1] The parameters are simultaneously also the limit for ending the ZPM.

5.3.2 QU2 operating strategy

The QU2 operating strategy enables the wind energy converter to ride through temporary symmetrical and unsymmetrical grid faults of up to 5 s without disconnecting from the grid.

A grid fault is detected as soon as the deviation of the positive-sequence voltage at the reference point (U_+) from the 1-minute average value of the positive-sequence voltage (U_0) is greater than or less than, respectively, the specified voltage range (U_{OVRT} or U_{UVRT}), respectively.

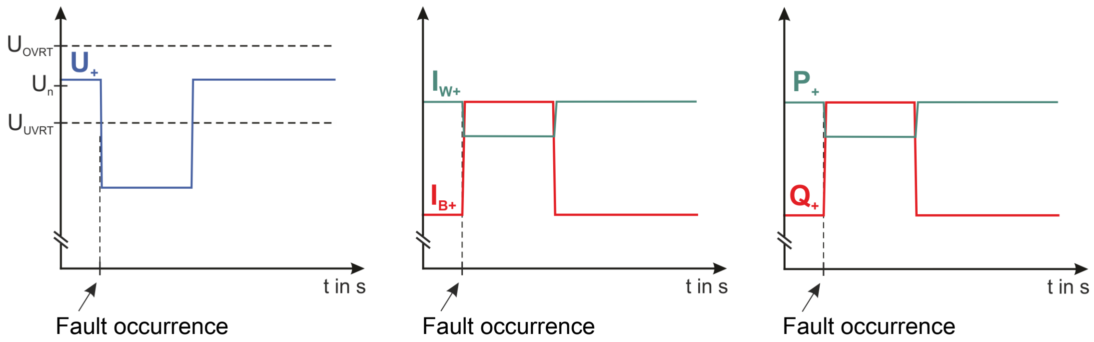


Fig. 10: Exemplary behaviour in the event of a fault in connection with a voltage drop (positive-sequence component)

Depending on the voltage deviation and the configured proportionality factor K, the wind energy converter injects additional reactive current into the positive-sequence component into the grid in addition to the reactive current that was injected immediately prior to the start of the fault.

If the positive-sequence voltage falls within the configured range of U_{UVRT} and U_{tUVRT} with undervoltage or U_{OVRT} and U_{tOVRT} with overvoltage, respectively, then an additional reactive current is deployed, depending on the fault curve, (see ch. 5.1.1, p. 19). Changes to the external Q setpoint are not taken into account for a fault duration of up to 5 s. Following completion of the duration, the external Q setpoints are taken into account once again and the wind energy converter injects the available active power, depending on the wind. An additional reactive current continues to be deployed. This operating state can be maintained indefinitely.

If the positive-sequence voltage falls below or exceeds the limit U_{tUVRT} or U_{tOVRT}, respectively, then the FACTS control system will remain in the fault mode of the operating strategy for a maximum period of t_{dUVRT} or t_{dOVRT}, respectively. If the voltage does not return to the range above or below the limits within the permitted time range, the wind energy converter will shut down. It will start up automatically as soon as the start parameters configured in the wind energy converter are fulfilled once again through the measured grid characteristics.

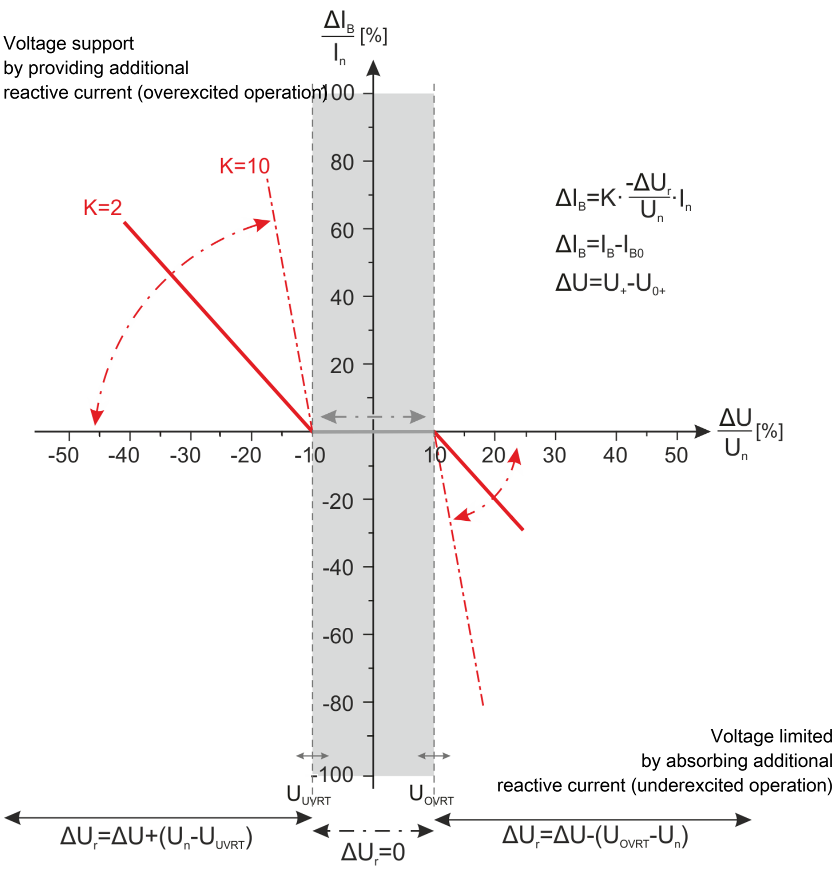


Fig. 11: Supporting/limiting grid voltage in the operating strategy QU2

The injection of additional reactive current can be deactivated (K = 0).

The additionally required reactive current can lead to a situation in which the technical current limitation of the wind energy converter is reached. Consequently, a reduction must be undertaken so that the active current can be lowered during FRT operation.

Zero Power Mode

The QU2 operating strategy is furnished with the option of an underlying Zero Power Mode (ZPM).

If the positive-sequence voltage drops below the configured voltage threshold U_{UVRT_ZPM}, then the FACTS control system will switch over to ZPM. In the event that the configured voltage threshold U_{OVRT_ZPM} is exceeded by the root mean square of a line-to-earth voltage, the FACTS control system will also switch to the ZPM. During the ZPM, the IGBTs of the inverters are blocked, which means that neither active nor reactive current is injected into the grid. The FACTS control system can remain in ZPM for a period of up to a maximum of 5 s (t_{dZPM}). The wind energy converter will shut down if the voltage does not return to the range above or below the voltage threshold value U_{UVRT_ZPM} or U_{OVRT_ZPM} respectively, within this permitted time period.

As soon as the positive sequence voltage once again exceeds the limit U_{UVRT_ZPM} or as soon as all line-to-earth voltages fall below the value U_{OVRT_ZPM} within the permitted duration (t_{dZPM}), the active and reactive currents will be returned to their values for normal operation or FRT operation in accordance with their configurations in the QU2 operating strategy. Activation of the underlying ZPM does not lead to any extension of the permitted time period (t_{dUVRT} or t_{dOVRT}), respectively, in FRT operation.

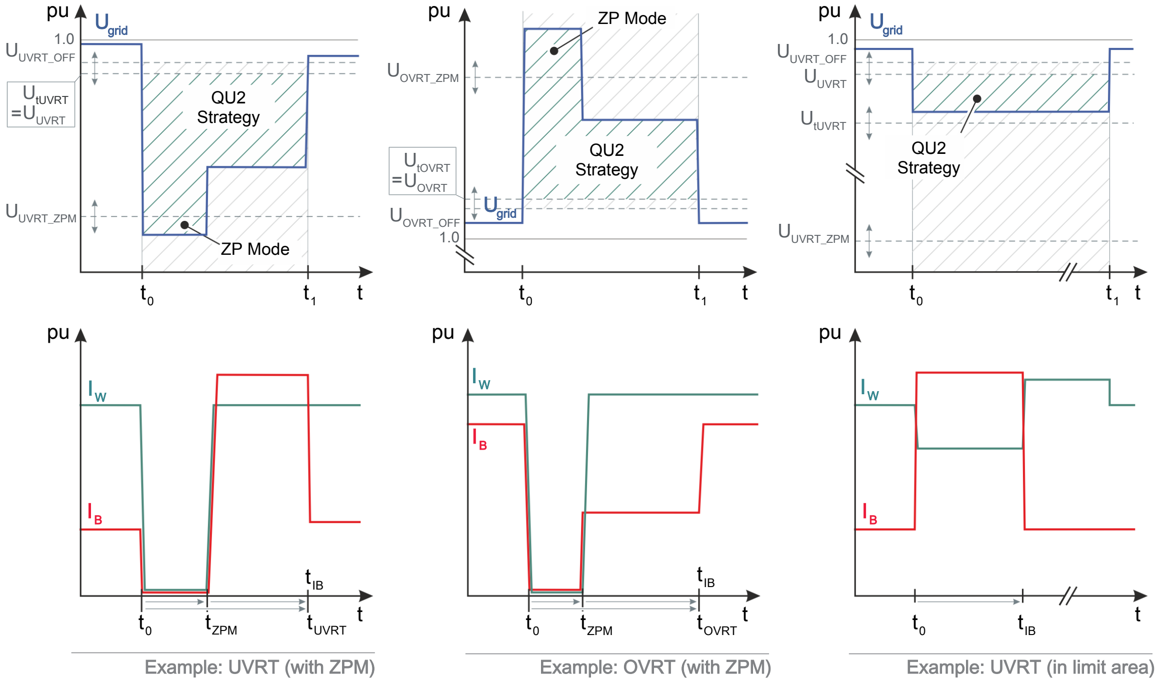


Fig. 12: Configurable limits of the QU2 operating strategy and of the ZPM as depicted with exemplary fault curves

t_0	Start of the grid fault	t_1	End of the grid fault
t_{UVRT}	End of time recording in fault mode (UVRT)	t_{OVRT}	End of time recording in fault mode (OVRT)
t_{ZPM}	End of the ZPM	t_{IB}	End of additional reactive current injection

For operation in ZPM, $I_{k,ZPM}$ is 0 during the grid fault. The other short-circuit currents listed in the wind energy converter-specific “Grid Performance” data sheets go to zero as soon as the ZPM is activated.

If the wind energy converter does not inject in any active power into the grid when a grid fault is detected, then the FACTS control system switches over to ZPM.

After the fault has been cleared, the FACTS control system exits the fault mode and the wind energy converter injects the available active power and reactive power based on the setpoint, depending on the wind conditions.

Tab. 19: QU2 operating strategy parameters

Parameter		Value
K-factor OVRT (positive-sequence component)	K	0 … 10
K-factor UVRT (positive-sequence component)	K	0 … 10
Increment K-factor	-	0.1
Maximum time ZPM operation	t_{dZPM}	0.1 s … 5 s
Increment maximum time	-	0.1 s
Undervoltage		
UVRT trigger voltage	U_{UVRT}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT return voltage	U_{UVRT_OFF}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT voltage start timer	U_{tUVRT}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT trigger voltage ZPM[1]	U_{UVRT_ZPM}	0 % … 80 % of $U_n/\sqrt{3}$
Increment UVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time UVRT operation	t_{dUVRT}	0.1 s … 5 s
Increment maximum time	-	0.1 s
Overvoltage		
OVRT trigger voltage	U_{OVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT return voltage	U_{OVRT_OFF}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT voltage start timer	U_{tOVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT trigger voltage ZPM[1]	U_{OVRT_ZPM}	110 % … 150 % of $U_n/\sqrt{3}$
Increment OVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time OVRT operation	t_{dOVRT}	0.1 s … 60 s
Increment maximum time	-	0.1 s
Gradient ZPM		
Active power gradient (after ZPM)	dP_{ZPM}/dt	0.05 MW/s … 99 MW/s
Active power gradient increment (after ZPM)	-	0.05 MW/s
Reactive power gradient (after ZPM)	dQ_{ZPM}/dt	0.05 Mvar/s … 99 Mvar/s
Reactive power gradient increment (after ZPM)	-	0.05 Mvar/s

[1] The parameters are simultaneously also the limit for ending the ZPM.

5.3.3 QU(ABS) operating strategy

The QU(ABS) operating strategy enables the wind energy converter to ride through temporary symmetrical and unsymmetrical grid faults of up to 5 s without disconnecting from the grid.

A grid fault is detected as soon as the deviation of the positive-sequence voltage at the reference point (U_+) from the 1-minute average value of the positive-sequence voltage (U_0) is greater than or less than, respectively, the specified voltage range (U_{OVRT} or U_{UVRT}), respectively.

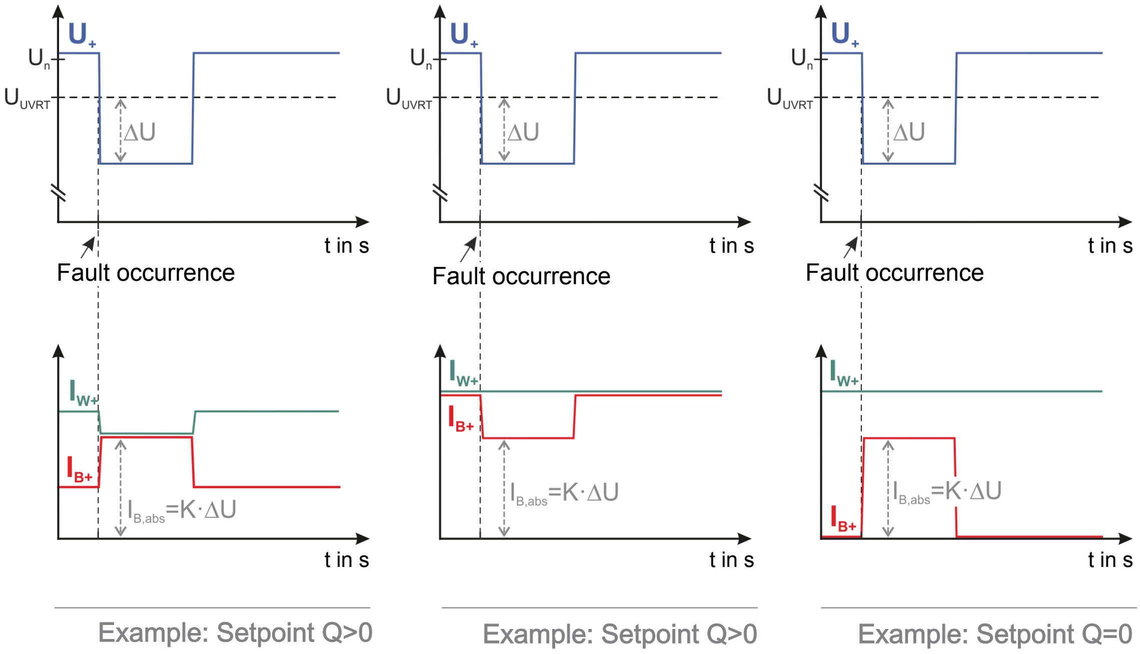


Fig. 13: Sample behaviour during grid voltage drop due to faults (positive-sequence component)

Depending on the voltage deviation and the configured proportionality factor K, the wind energy converter injects absolute reactive current into the positive-sequence component in the grid. In the case of a fault, the magnitude of the pre-fault reactive current has no effect on the magnitude of the absolute reactive current.

If the positive-sequence voltage falls below U_{UVRT} in the case of undervoltage or above U_{OVRT} in the case of overvoltage then an additional reactive current is injected, depending on the fault curve. The maximum fault duration t_{dUVRT} or t_{dOVRT} is up to 5 s. If the positive-sequence voltage returns to normal operation before the maximum fault duration has expired, the external Q setpoints are once more permitted and the wind energy converter injects the available active power, depending on the wind.

If the voltage does not return to the range above the limit value U_{UVRT} below the limit value U_{OVRT} within the permitted time range, the wind energy converter will shut down. It will start up automatically as soon as the start parameters configured in the wind energy converter are fulfilled once again through the measured grid characteristics.

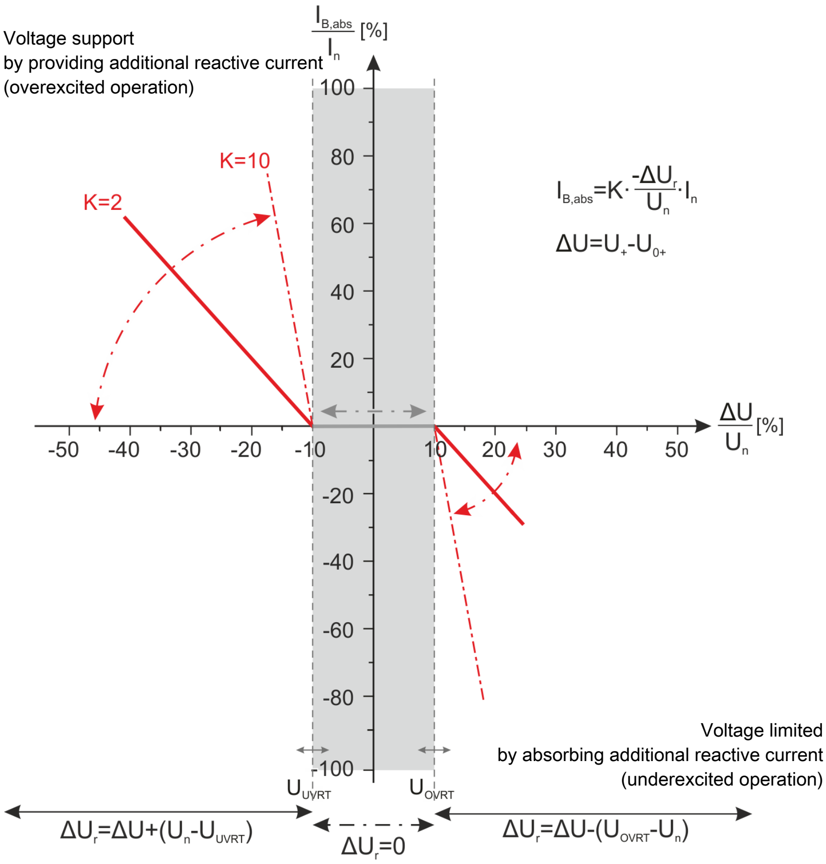


Fig. 14: Supporting/limiting grid voltage in the QU(ABS) operating strategy

The injection of additional reactive current can be deactivated (corresponds to K = 0).

The additionally required reactive current can lead to a situation in which the technical current limitation of the wind energy converter is reached. Consequently, a reduction must be undertaken so that the active current can be lowered during FRT operation.

Zero Power Mode

The QU(ABS) operating strategy is furnished with the option of an underlying Zero Power Mode (ZPM).

If the positive-sequence voltage drops below the configured voltage threshold U_{UVRT_ZPM}, then the FACTS control system will switch over to ZPM. In the event that the configured voltage threshold U_{OVRT_ZPM} is exceeded by the root mean square of a line-to-earth voltage, the FACTS control system will also switch to the ZPM. During the ZPM, the IGBTs of the inverters are blocked, which means that neither active nor reactive current is injected into the grid. The FACTS control system can remain in Zero Power Mode for a period of up to a maximum of 5 s (t_{dZPM}). The wind energy converter will shut down if the voltage does not return to the range above or below the voltage threshold value U_{UVRT_ZPM} or U_{OVRT_ZPM} respectively, within this permitted time period.

As soon as the positive-sequence voltage once again exceeds the limit U_{UVRT_ZPM} or as soon as all line-to-earth voltages fall below the value U_{OVRT_ZPM} within the permitted duration (t_{dZPM}), the active and reactive currents will be returned to their values for normal operation or FRT operation in accordance with their configurations in the QU(ABS) operating strategy. Activation of the underlying ZPM does not lead to any extension of the permitted time period (t_{dUVRT} or t_{dOVRT}), respectively, in FRT operation.

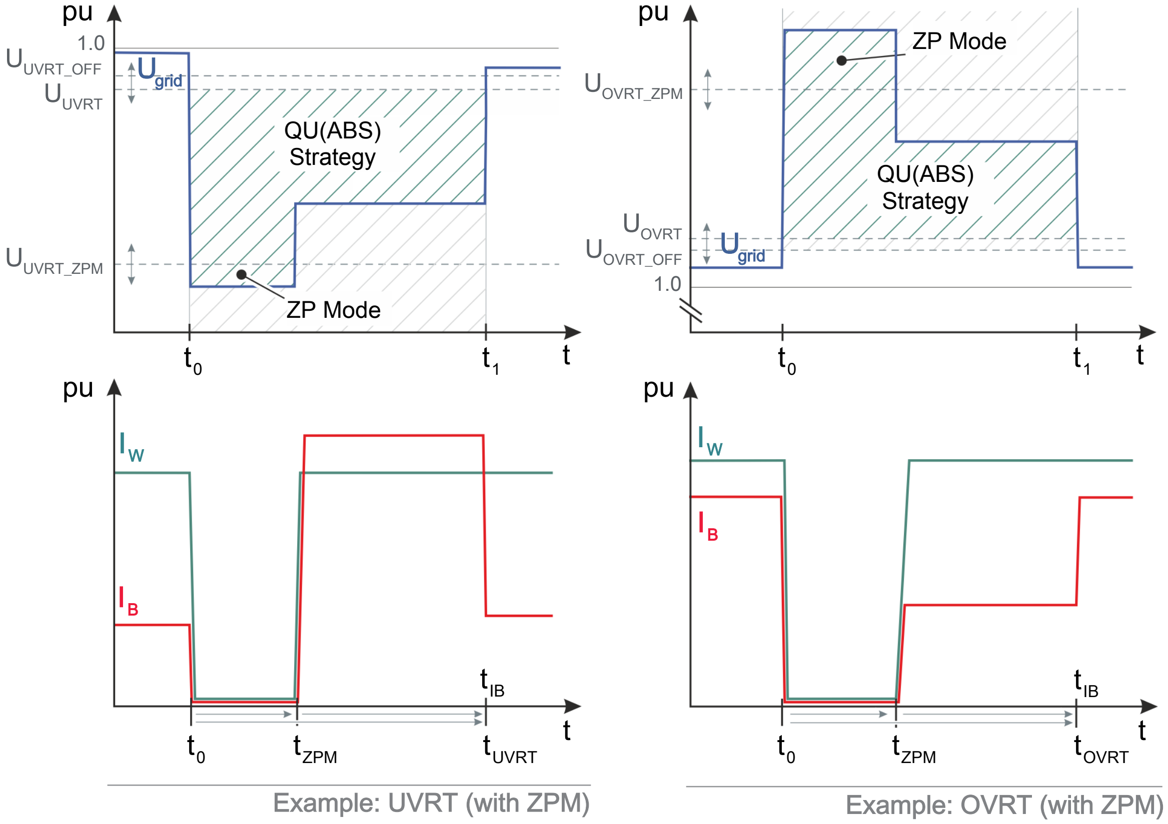


Fig. 15: Configurable limits of the QU(ABS) operating strategy and of the ZPM as depicted with exemplary fault curves

t_0	Start of the grid fault	t_1	End of the grid fault
t_{UVRT}	End of time recording in fault mode (UVRT)	t_{OVRT}	End of time recording in fault mode (OVRT)
t_{ZPM}	End of the ZPM		

For operation in ZPM, $I_{k,ZPM}$ is 0 during the grid fault. The other short-circuit currents listed in the wind energy converter-specific “Grid Performance” data sheets go to zero as soon as the ZPM is activated.

If the wind energy converter does not inject in any active power into the grid when a grid fault is detected, then the FACTS control system switches over to ZPM.

After the fault has been cleared, the FACTS control system exits the fault mode and the wind energy converter injects the available active power and reactive power based on the setpoint, depending on the wind conditions.

Tab. 20: QU(ABS) operating strategy parameters

Parameter		Value
K-factor OVRT (positive-sequence component)	K	0 … 10
K-factor UVRT (positive-sequence component)	K	0 … 10
Increment K-factor	-	0.1
Maximum time ZPM operation	t_{dZPM}	0.1 s … 5 s
Increment maximum time	-	0.1 s
Undervoltage		
UVRT trigger voltage	U_{UVRT}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT return voltage	U_{UVRT_OFF}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT trigger voltage ZPM[1]	U_{UVRT_ZPM}	0 % … 80 % of $U_n/\sqrt{3}$
Increment UVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time UVRT operation	t_{dUVRT}	0.1 s … 5 s
Increment maximum time	-	0.1 s
Overvoltage		
OVRT trigger voltage	U_{OVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT return voltage	U_{OVRT_OFF}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT trigger voltage ZPM[1]	U_{OVRT_ZPM}	110 % … 150 % of $U_n/\sqrt{3}$
Increment OVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time OVRT operation	t_{dOVRT}	0.1 s … 60 s
Increment maximum time	-	0.1 s
Gradient ZPM		
Active power gradient (after ZPM)	dP_{ZPM}/dt	0.05 MW/s … 99 MW/s
Active power gradient increment (after ZPM)	-	0.05 MW/s
Reactive power gradient (after ZPM)	dQ_{ZPM}/dt	0.05 Mvar/s … 99 Mvar/s
Reactive power gradient increment (after ZPM)	-	0.05 Mvar/s

[1] The parameters are simultaneously also the limit for ending the ZPM.

5.3.4 QU(UK) operating strategy

The QU(UK) operating strategy enables the wind energy converter to ride through temporary symmetrical and unsymmetrical grid faults of up to 5 s without disconnecting from the grid.

A grid fault is detected as soon as the deviation of the positive-sequence voltage at the reference point (U_+) from the 1-minute average value of the positive-sequence voltage (U_0) is greater than or less than, respectively, the specified voltage range (U_{OVRT} or U_{UVRT}), respectively.

Depending on the voltage deviation and the configured proportionality factor K, the wind energy converter injects additional reactive current into the positive-sequence component in the grid in addition to the reactive current that was injected immediately prior to the start of the fault.

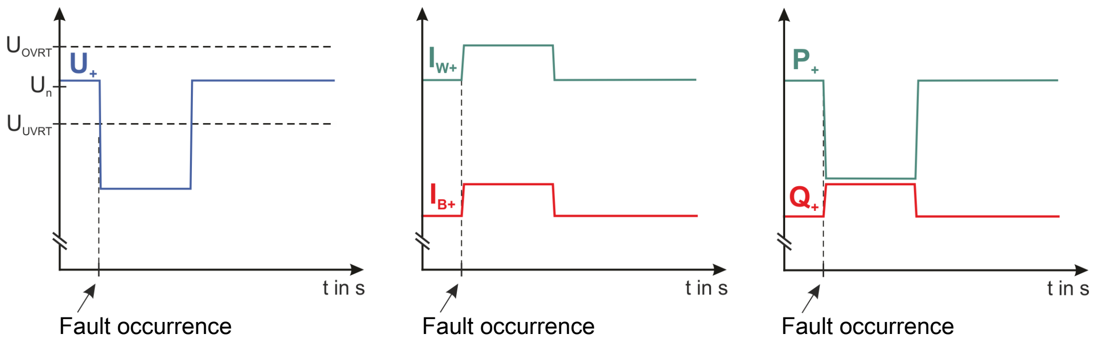


Fig. 16: Exemplary behaviour in the event of a fault in connection with a voltage drop (positive-sequence component)

The injection of additional reactive current can be deactivated (K = 0).

The additionally required reactive current can lead to a situation in which the technical current limitation of the wind energy converter is reached. In this event, prioritisation must be performed. In the QU(UK) operating strategy, the active current is prioritised in the case of a fault, so that a minimum of the pre-fault value is injected during FRT operation and the reactive current is thus reduced when the current limit is reached.

If the positive-sequence voltage falls within the configured range of U_{UVRT} and U_{tUVRT} with undervoltage or U_{OVRT} and U_{tOVRT} with overvoltage, respectively, then an additional reactive current is deployed, depending on the fault curve, (see ch. 5.1.1, p. 19). Changes to the external Q setpoint are not taken into account for a fault duration of up to 5 s. Following completion of the duration, the external Q setpoints are taken into account once again and the wind energy converter injects the available active power, depending on the wind. An additional reactive current continues to be deployed. This operating state can be maintained indefinitely.

If the positive-sequence voltage falls below or exceeds the limit U_{tUVRT} or U_{tOVRT}, respectively, then the FACTS control system will remain in the fault mode of the operating strategy for a maximum period of t_{dUVRT} or t_{dOVRT}, respectively. If the voltage does not return to the range above or below the limits within the permitted time range, the wind energy converter will shut down. It will start up automatically as soon as the start parameters configured in the wind energy converter are fulfilled once again through the measured grid characteristics.

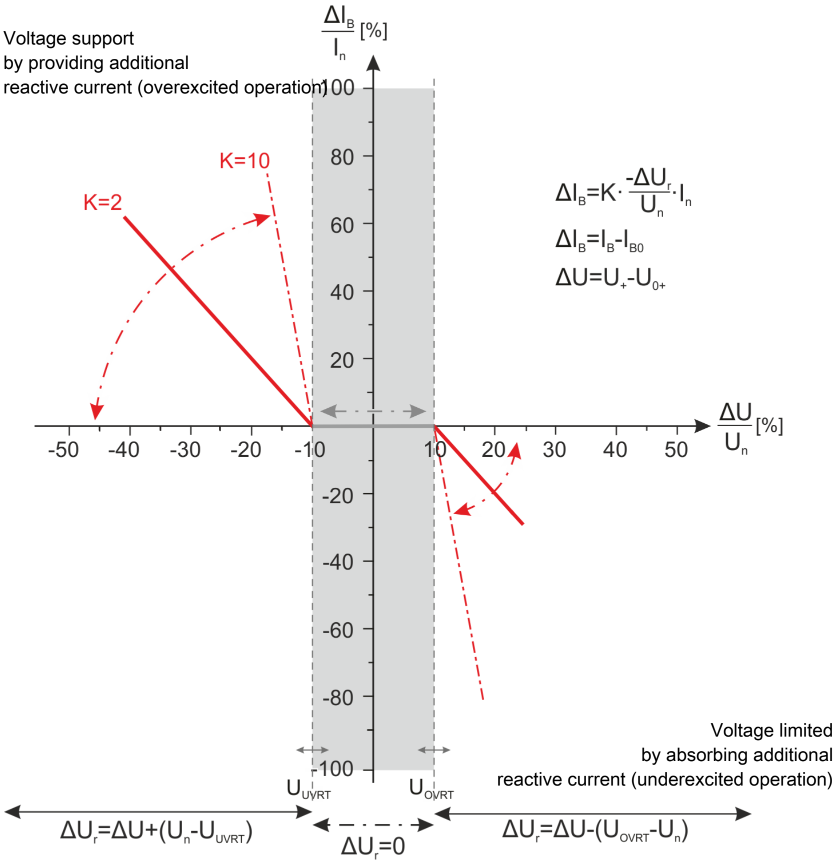


Fig. 17: Supporting/limiting grid voltage in the QU(UK) operating strategy

Zero Power Mode

The QU(UK) operating strategy is furnished with the option of an underlying Zero Power Mode (ZPM). The activation has the effect that the FACTS control system will switch to ZPM when the level exceeds a configurable voltage limit for a duration of up to a maximum of 5 s (t_{dZPM}).

If the positive-sequence voltage drops below the configured voltage threshold U_{UVRT_ZPM}, then the FACTS control system will switch over to ZPM. In the event that the configured voltage threshold U_{OVRT_ZPM} is exceeded by the root mean square of a line-to-earth voltage, the FACTS control system will also switch to the ZPM. During the ZPM, the IGBTs of the inverters are blocked, which means that neither active nor reactive current is injected into the grid. The FACTS control system can remain in ZPM for a period of up to a maximum of 5 s (t_{dZPM}). The wind energy converter will shut down if the voltage does not return to the range above or below the voltage threshold value U_{UVRT_ZPM} or U_{OVRT_ZPM} respectively, within this permitted time period.

As soon as the positive sequence voltage once again exceeds the limit U_{UVRT_ZPM} or as soon as all line-to-earth voltages fall below the value U_{OVRT_ZPM} within the permitted duration (t_{dZPM}), the active and reactive currents will be returned to their values for normal operation or FRT operation in accordance with their configurations in the QU(UK) operating strategy. Activation of the underlying ZPM does not lead to any extension of the permitted time period (t_{dUVRT} or t_{dOVRT}), respectively, in FRT operation.

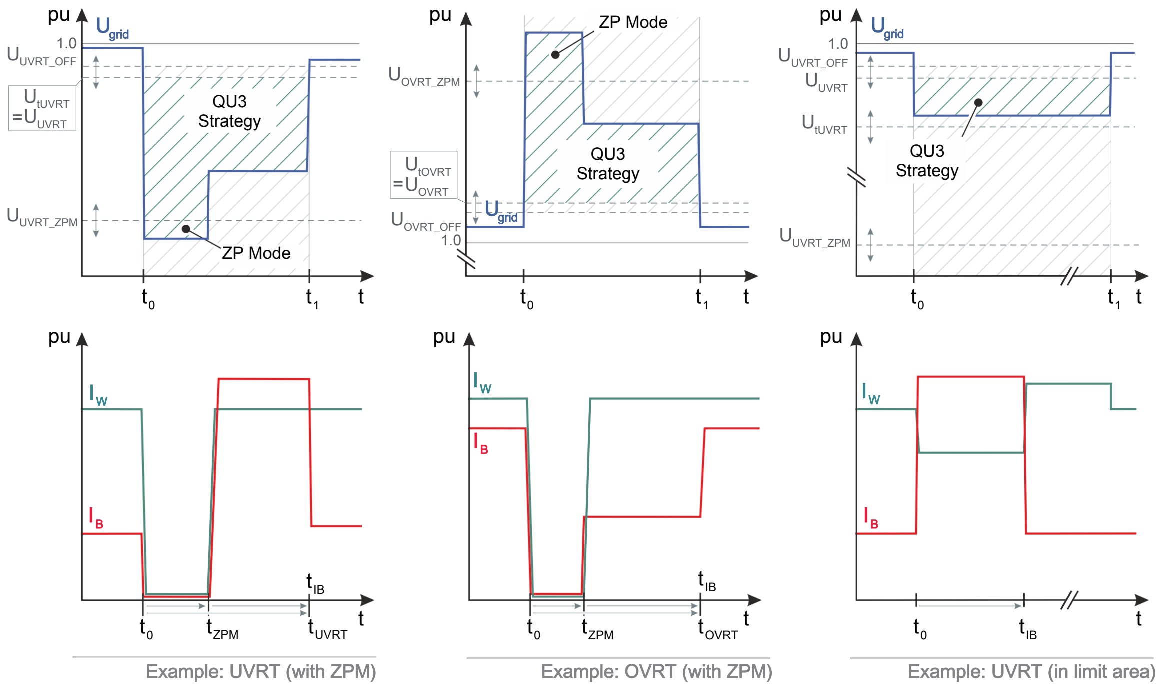


Fig. 18: Configurable limits of the QU(UK) operating strategy and of the ZPM as depicted with various fault curves

t_0	Start of the grid fault	t_1	End of the grid fault
t_{UVRT}	End of time recording in fault mode (UVRT)	t_{OVRT}	End of time recording in fault mode (OVRT)
t_{ZPM}	End of the ZPM	t_{IB}	End of additional reactive current injection

For operation in ZPM, $I_{k,ZPM}$ is 0 during the grid fault. The other short-circuit currents listed in the wind energy converter-specific “Grid Performance” data sheets go to zero as soon as the ZPM is activated.

If the wind energy converter does not inject in any active power into the grid when a grid fault is detected, then the FACTS control system switches over to ZPM.

After the fault has been cleared, the FACTS control system exits the fault mode and the wind energy converter injects the available active power and reactive power based on the setpoint, depending on the wind conditions.

Tab. 21: QU(UK) operating strategy parameters

Parameter		Value
K-factor OVRT (positive-sequence component)	K	0 … 10
K-factor UVRT (positive-sequence component)	K	0 … 10
Increment K-factor	-	0.1
Maximum time ZPM operation	t_{dZPM}	0 s … 5 s
Increment maximum time	-	0.1 s
Undervoltage		
UVRT trigger voltage	U_{UVRT}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT return voltage	U_{UVRT_OFF}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT voltage start timer	U_{tUVRT}	80 % … 95 % of $U_n/\sqrt{3}$
UVRT trigger voltage ZPM[1]	U_{UVRT_ZPM}	0 % … 80 % of $U_n/\sqrt{3}$
Increment UVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time UVRT operation	t_{dUVRT}	0.1 s … 5 s
Increment maximum time	-	0.1 s
Overvoltage		
OVRT trigger voltage	U_{OVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT return voltage	U_{OVRT_OFF}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT voltage start timer	U_{tOVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT trigger voltage ZPM[1]	U_{OVRT_ZPM}	110 % … 150 % of $U_n/\sqrt{3}$
Increment OVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time OVRT operation	t_{dOVRT}	0.1 s … 60 s
Increment maximum time	-	0.1 s
Gradient ZPM		
Active power gradient (after ZPM)	dP_{ZPM}/dt	0.05 MW/s … 99 MW/s
Active power gradient increment (after ZPM)	-	0.05 MW/s
Reactive power gradient (after ZPM)	dQ_{ZPM}/dt	0.05 Mvar/s … 99 Mvar/s
Reactive power gradient increment (after ZPM)	-	0.05 Mvar/s

[1] The parameters are simultaneously also the limit for ending the ZPM.

5.3.5 Zero Power operating strategy

The Zero Power operating strategy enables the wind energy converter to ride through temporary symmetrical and unsymmetrical grid faults of up to 5 s without disconnecting from the grid.

If the deviation of the instantaneous value of the positive-sequence voltage from the 1-minute average value of the positive-sequence voltage greater than or less than the specified voltage limits U_{OVRT} or U_{UVRT}, respectively, the FACTS control system will switch to Zero Power Mode (ZPM). The wind energy converter remains in operation although it no longer injects any current into the grid. The wind energy converter can either remain galvanically connected to the grid or be disconnected from the grid by opening the power contactors. If the voltage returns to the defined permissible range within a specified time period, the wind energy converter increases the active and reactive power by means of the separately configurable gradients dP_{ZPM}/dt and dQ_{ZPM}/dt to the available active power depending on the wind and the reactive power in accordance with the setpoint. The duration of the active and reactive power increase is not included in the maximum duration of the UVRT or OVRT mode (t_{dZPM}). When configuring the active and reactive power gradient a very low configuration value can lead to excessive temperature of the chopper resistors, and the wind energy converter will shut down.

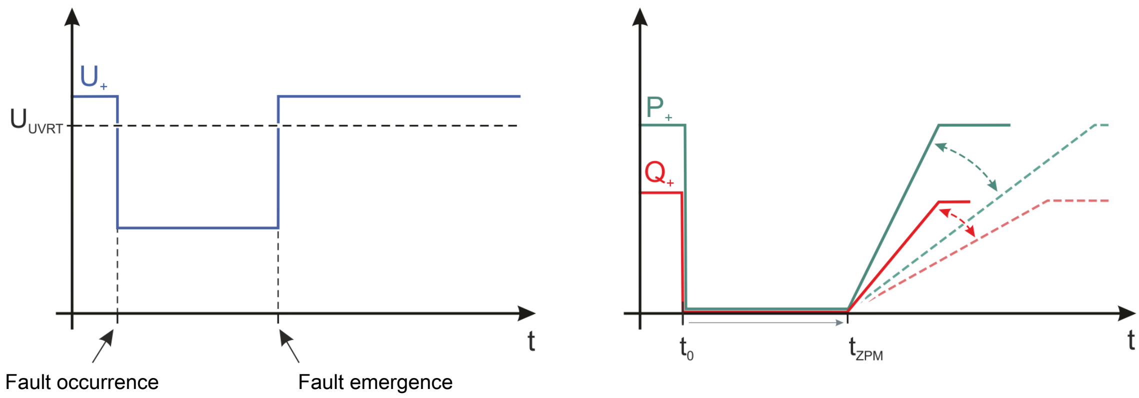


Fig. 19: Exemplary behaviour in the event of a fault in connection with a voltage drop (positive-sequence component)

If the voltage does not return to the permissible range within the specified time period, the wind energy converter will shut down. It will start up automatically as soon as the start parameters configured in the wind energy converter are fulfilled once again through the measured grid characteristics.

In the Zero Power operating strategy, $I_{k,ZPM}$ = 0 during a grid fault. The other short-circuit currents listed in the wind energy converter-specific “Grid Performance” data sheets fall to zero.

Tab. 22: Parameters of the Zero Power operating strategy

Parameter		Value
Undervoltage		
UVRT trigger voltage	U_{UVRT}	80 % ... 95 % of $U_n/\sqrt{3}$
UVRT return voltage	U_{UVRT_OFF}	80 % … 95 % of $U_n/\sqrt{3}$
Increment UVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time ZPM operation	t_{dZPM}	0.1 s … 5 s
Increment maximum time	-	0.1 s
Overvoltage		
OVRT trigger voltage	U_{OVRT}	100 % … 125 % of $U_n/\sqrt{3}$
OVRT return voltage	U_{OVRT_OFF}	100 % ... 125 % of $U_n/\sqrt{3}$
Increment OVRT voltage	-	0.5 % of $U_n/\sqrt{3}$
Maximum time ZPM operation	t_{dZPM}	0.1 s … 5 s
Increment maximum time	-	0.1 s
Gradient ZPM		
Active power gradient (after ZPM)	dP_{ZPM}/dt	0.05 MW/s … 99 MW/s
Active power gradient increment (after ZPM)	-	0.05 MW/s
Reactive power gradient (after ZPM)	dQ_{ZPM}/dt	0.05 Mvar/s … 99 Mvar/s
Reactive power gradient increment (after ZPM)	-	0.05 Mvar/s

6 Start-up parameters

Prior to each start-up, the wind energy converter control system verifies whether the RMS voltage values of all three phases as well as the grid frequency are within a configurable permissible range.
If the RMS voltage value of any phase or the grid frequency is out of range, the wind energy converter does not start up.

Tab. 23: Start-up parameters

Parameter	Range	Increment
Mains undervoltage level for restart	80 % … 100 % of $U_n/\sqrt{3}$	0.5 % of $U_n/\sqrt{3}$
Mains overvoltage level for restart	100 % … 125 % of $U_n/\sqrt{3}$	0.5 % of $U_n/\sqrt{3}$
Mains underfrequency threshold for restart (f_n=50 Hz)	43 Hz … 50 Hz	0.01 Hz
Mains underfrequency threshold for restart (f_n=60 Hz)	53 Hz … 60 Hz	0.01 Hz
Mains overfrequency threshold for restart (f_n=50 Hz)	50 Hz … 57 Hz	0.01 Hz
Mains overfrequency threshold for restart (f_n=60 Hz)	60 Hz … 67 Hz	0.01 Hz

Start delay

Following shutdown of a wind energy converter as a result of a power failure and an associated reset of the wind energy converter control system, the start-up of the wind energy converter can be delayed.

Tab. 24: Start delay

Parameter	Range	Increment
Start delay	0:00:00 h … 2:00:00 h	10 s

7 Power-frequency control

In the event of overfrequency in the grid, static or dynamic power-frequency control can be used to reduce the active power of the wind energy converter. The power-frequency control can be static or dynamic, with static power-frequency control is the default for the wind energy converter.

For both options (static or dynamic), the reference value for power-frequency control can be configured to be either the current active power or the nominal active power of the wind energy converter.

If power-frequency control uses the current active power as a reference, active output power is reduced immediately if the frequency exceeds limitation frequency f3 or f_{limit}. The reference value for the power limitation is the current active power at the time when limitation frequency f3 is reached, even if the grid frequency continues to drop.

If power-frequency control uses the wind energy converter's nominal active power as a reference, there is a delay in reducing active power if the current active power is less than the wind energy converter's nominal active power.

To reduce active power, the wind energy converter adjusts the blade angles.

7.1 Static power-frequency control

Static power-frequency control reduces active power depending on the current grid frequency.

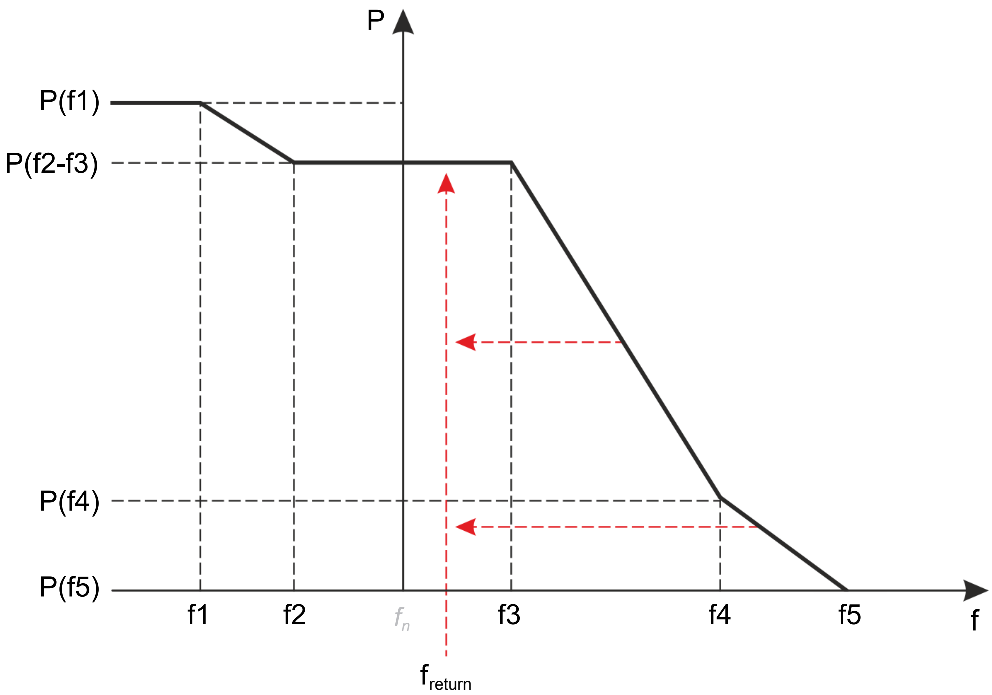


Fig. 20: Static power-frequency control

By default, active power is not limited below nominal frequency f_n (P(f2-f3) = 100 % P_n or 100 % P_{actual}). If a limitation of active power at the nominal frequency f_n is required, the corresponding setting can be made via the ENERCON SCADA system.

Tab. 25: Static power-frequency control

Parameter	Range	Increment
Limitation frequency f1	f1 < (f2 – 0.1 Hz)	0.01 Hz
Max. available active power at f_{grid} ≤ f1 (P(f1))	100 % (fixed)	-
Limitation frequency f2	(f_n – 2 Hz) … f_n	0.01 Hz
Reserved power (f2-f3) (P(f2-f3))	50 % … 100 %	1 %
Limitation frequency f3	f_n … (f4 – 0.1 Hz)	0.01 Hz
Limitation frequency f4	(f3 + 0.1 Hz) … (f5 – 0.1 Hz)	0.01 Hz
Limitation power (f4) (P(f4))	0 % … P(f2-f3)	1 %
Limitation frequency f5	(f4 + 0.1 Hz) … (f_n + 7 Hz)	0.01 Hz
Limitation power (f5) (P(f5))	0 % … P(f4)	1 %
Return frequency (f_{return})	f_n … f_n + 7 Hz	0.01 Hz

The rise times when increasing the grid frequency are ≤2 s.

If the grid frequency decreases again after previously exceeding f3, and if f_{return} ≥ f5 the active power increases according to the specified characteristic (see fig. 20, p. 45). If the f_{return} value is smaller, active power remains limited until f_{grid} ≤ f_{return}. At that point, the wind energy converter resumes injecting the maximum available active and reactive power.

If the grid frequency exceeds the preset limitation frequency f3 value for at least 1 s, the *Active power gradient (after over freq.)* parameter is activated. If a return frequency f_{return} is activated in the control system, the active power increase with the parameter does not take effect until the grid frequency is lower than the set return frequency f_{return}.

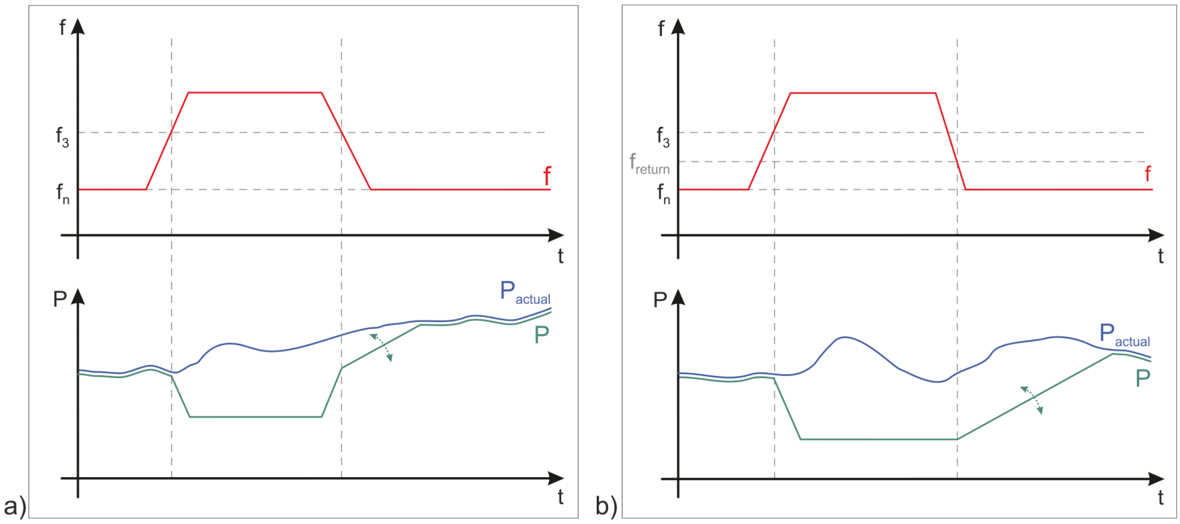


Fig. 21: Limitation of active power range

a)	Limitation of active power increase with return frequency
b)	Limitation of active power increase after dropping below the limitation frequency f3

The *Active power gradient (after over freq.)* parameter is deactivated as soon as dynamic power frequency control is selected in the wind energy converter control system. The controller is also deactivated when the wind energy converter's line contactors are open and no power is being fed into the grid.

If the grid frequency drops below the set value of limitation frequency f2 the controller reacts to an underfrequency in the grid with the configurable gradients of the *Active power gradient (during operation)* parameter.

7.2 Dynamic power-frequency control

The wind energy converter's active power is reduced by means of a configurable limiting gradient as soon as the grid frequency exceeds the limitation frequency (f_{limit}). Active power continues to be reduced for as long as the grid frequency is higher than the limitation frequency. If the frequency drops below the limitation frequency again, active power is increased using the same gradient that was used for the previous reduction (provided the wind speed is high enough). Reactive power is reduced and increased using the same gradient.

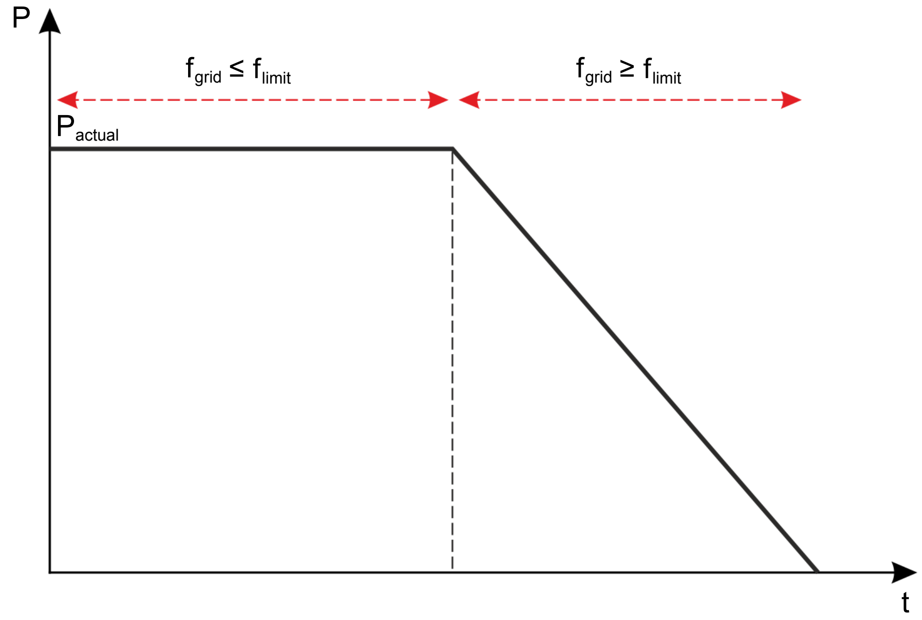


Fig. 22: Dynamic power-frequency control

Tab. 26: Dynamic power-frequency control

Parameter	Range	Increment
Limitation frequency (f_{limit})	f_n ... f_n + 7 Hz	0.01 Hz
Limitation gradient	1 %/s … 25 %/s	1 %

8 Reactive power gradient

The reactive power Q of the wind energy converter is configurable. After the wind energy converter has received a new reactive power setpoint, reactive power is modified linearly during normal operation (see fig. 23, p. 49).

The new reactive power setpoint is used for the duration of the setpoint cycle time. The cycle time is the time that passes between receipt of the current and the preceding setpoint. It cannot be configured and depends on several factors such as delays in communication between a wind farm controller and the wind energy converter. The time required to reach the new setpoint therefore depends on the point in time the preceding setpoint was received. It is 100 ms at maximum and 10 ms at minimum. If the preceding setpoint was received more than 100 ms ago, the cycle time is set to 100 ms. In this way the actual reactive power value reaches the current setpoint after 100 ms at the latest.

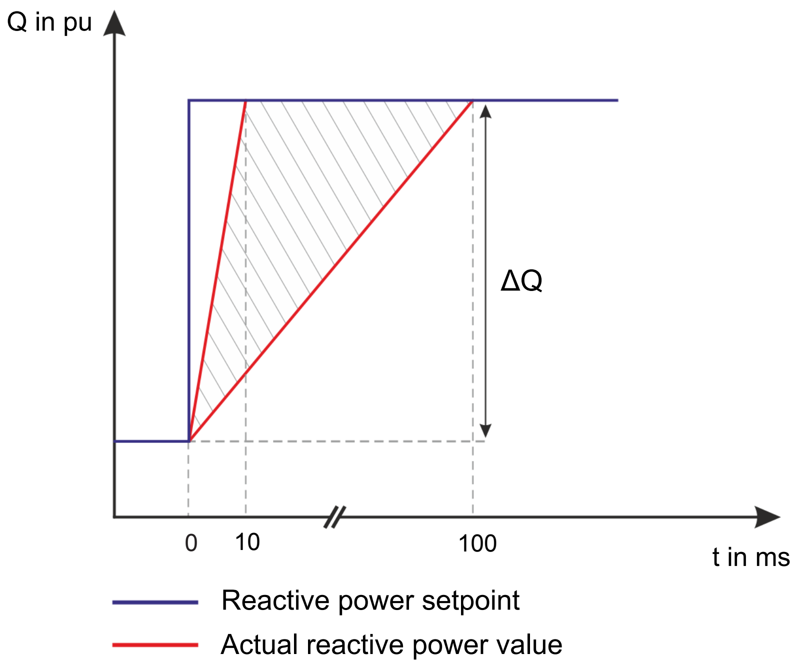


Fig. 23: Reactive power gradient

Cycle time during normal operation

Maximum value	100 ms
Minimum value[1]	10 ms

[1]Can be implemented in accordance with the setpoint change cycle time

9 Reference point

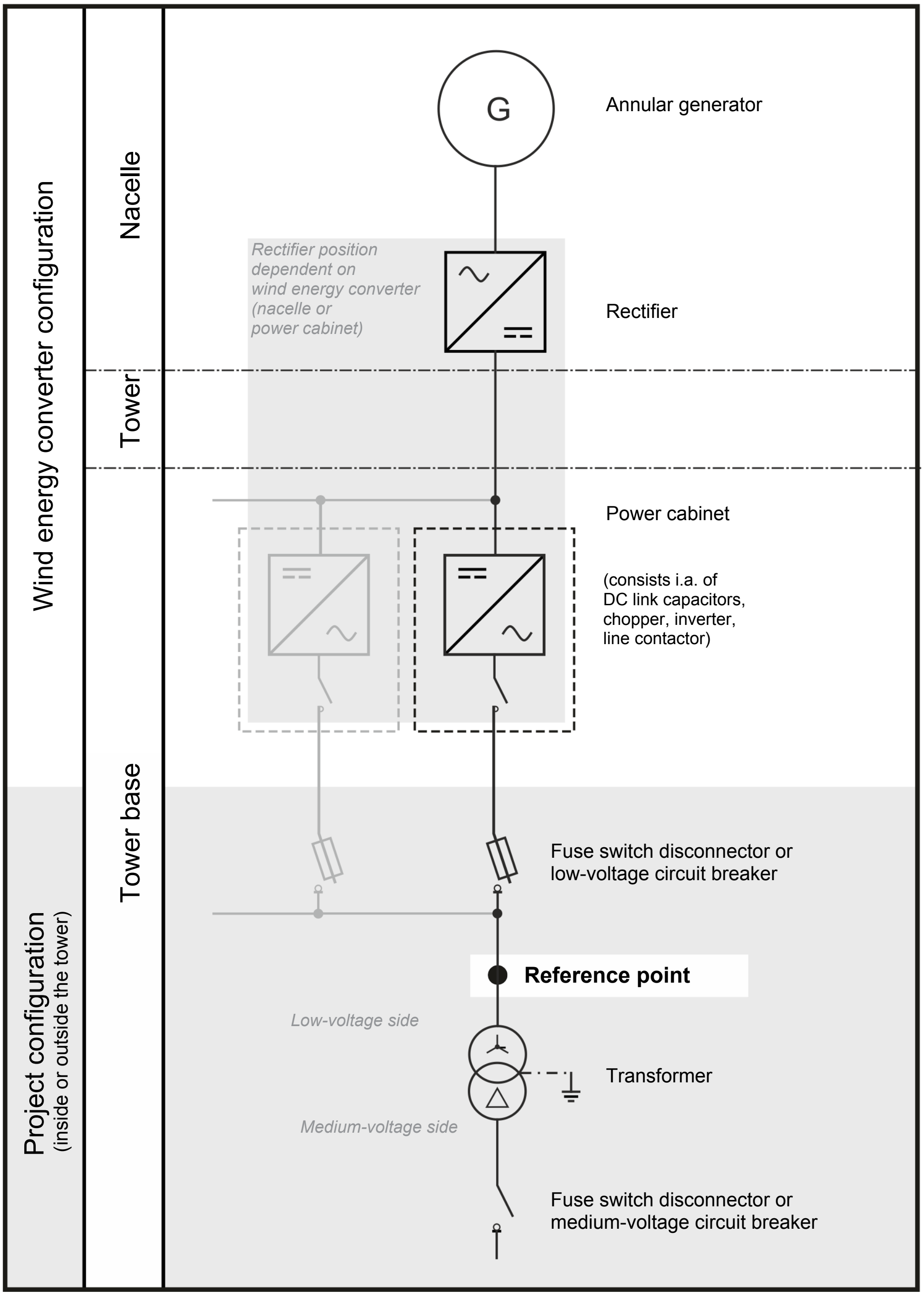


Fig. 24: Reference point

The ENERCON E-126 EP4 and E-141 EP4 wind energy converters feed power into the medium-voltage grid through two converter groups with two transformers.

These two systems are not interconnected on the low-voltage side of the transformers. The connection is made on the medium-voltage side. This is therefore a virtual reference point that does not exist physically.

List of symbols

Tab. 27: Symbol

Symbol	Designation
dP_{ZPM}/dt	Active power gradient (after ZPM)
dQ_{ZPM}/dt	Reactive power gradient (after ZPM)
f<	Underfrequency protection f<
f<<	Underfrequency protection f<<
f>	Overfrequency protection f>
f>>	Overfrequency protection f>>
f1	Limitation frequency f1
f2	Limitation frequency f2
f3	Limitation frequency f3
f4	Limitation frequency f4
f5	Limitation frequency f5
f_{grid}	Grid frequency
f_{limit}	Limitation frequency
f_{max}	Maximum frequency
f_{min}	Minimum frequency
f_n	Nominal frequency
f_{return}	Return frequency
$I_{k,ZPM}$	Short-circuit current during Zero Power Mode
I_W	Active current
I_{W+}	Positive-sequence active current
I_{W-}	Negative-sequence active current
I_B	Reactive current
I_{B+}	Positive-sequence reactive current
I_{B-}	Negative-sequence reactive current
$I_{B,abs}$	Absolute reactive current in the event of fault (positive-sequence component)
K	Proportionality factor
P_{actual}	Currently available active power
P(f1)	Maximum available active power at $f_{grid} \leq$ f1
P(f2-f3)	Active power reduction with reference to P_{actual} or P_n between f2 and f3
P(f4)	Active power reduction with reference to P_{actual} or P_n at f4
P(f5)	Active power reduction with reference to P_{actual} or P_n at f5

Symbol	Designation
P_n	Nominal active power
P(U>)	Limitation voltage P(U>)
S_{max}	Rated apparent power
U_{OVRT}	OVRT trigger voltage
U_{OVRT_OFF}	OVRT return voltage
U_{OVRT_ZPM}	OVRT trigger voltage ZPM
U_{tOVRT}	OVRT voltage start timer
U_{UVRT}	UVRT trigger voltage
U_{UVRT_OFF}	UVRT return voltage
U_{UVRT_ZPM}	UVRT trigger voltage ZPM
U_{tUVRT}	UVRT voltage start timer
U<	Undervoltage protection U<
U<<	Undervoltage protection U<<
U>	Overvoltage protection U>
U>>	Overvoltage protection U>>
U_-	Negative-sequence voltage
U_+	Positive-sequence voltage
U_{0+}	1-minute average value of the positive-sequence voltage
U_{0-}	1-minute average value of the negative-sequence voltage
U_{eff}	RMS voltage value
U_{grid}	Grid voltage
U_n	Nominal voltage
U_{max}	Maximum continuous operating voltage
U_{min}	Minimum continuous operating voltage
$U_{min,temp}$	Temporary minimum voltage
t_0	Fault occurrence
t_{dOVRT}	Maximum time OVRT operation
t_{dUVRT}	Maximum time UVRT operation
t_{dZPM}	Maximum time ZPM operation
t_{IB}	End of additional reactive current injection
$t_{UVRT/OVRT}$	End of time recording in fault mode
t_{ZPM}	End of Zero Power Mode

Glossary of terms

Abrupt change in voltage	Deviation of the measured first fundamental voltage value of a voltage by an amount that is at least 5 % of the peak value of the nominal voltage of the instantaneous value of the continued pre-fault voltage(as per VDE-AR-N 4120:2015-01).
Delay	Configurable time period between detection of a grid fault by the protection equipment and giving the shutdown command to the switching device.
Fault Ride Through	Capability of the wind energy converter to remain connected to the grid for a limited period of time in the event of overvoltage or undervoltage in the utility's grid.
Over voltage ride through	Capability of the wind energy converter to remain connected to the grid for a limited period of time in the event of overvoltage in the utility's grid.
Pre-fault voltage	The pre-fault voltage is a voltage u(t), the amplitude, frequency and phase position of which are the result of the averaging of the first fundamental voltage of the last 50 periods.
Response time	Time period between receiving a command to execute an action and completing that action.
Safety equipment	Electronic system for activating switching devices for protection against undesired events.
Switching device	Electromechanical device for switching electrical power.
Tripping time	Time period from the occurrence of a grid fault to shutdown of the wind energy converter by opening the switching device.
Under voltage ride through	Capability of the wind energy converter to remain connected to the grid for a limited period of time in the event of undervoltage in the utility's grid.
VDE-AR-N 4120:2015	Application rule with the title "Technical conditions for the connection and operation of customer systems in the high voltage grid". This is part of the VDE regulations and defines new requirements placed on the grid connection of wind farms.
Zero Power Mode	In Zero Power Mode, the wind energy converter blocks the IGBTs but remains in operation. There is no power feed to or power consumption from the grid.