SUNCOR ENERGY CEDAR POINT WIND POWER PROJECT
DECOMMISSIONING PLAN REPORT

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Prepared for:

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1.0 Introduction

1.1 PROJECT OVERVIEW

Suncor Energy Products Inc. (“Suncor”) is proposing to develop the Suncor Energy Cedar Point Wind Power Project (the Project) within the Town of Plympton-Wyoming, the Municipality of Lambton Shores, and Warwick Township all within Lambton County, Ontario. The proposed Project was awarded a Feed-In-Tariff (FIT) contract with the Ontario Power Authority (OPA) in July, 2011 for up to 100 MW (FIT Contract F-002175-WIN-130-601).

It is envisioned that the proposed Project will include up to 46 wind turbines. The proposed Project would also include access roads, meteorological towers (met towers), electrical collector lines, substation, and a 115 kV transmission line. A full description of Project infrastructure is provided in the **Project Description Report**.

The Project Location includes all land and buildings/structures associated with the Project and any air space in which the Project will occupy including temporary lands during construction (“constructible areas”). The current land use of the Project Location is generally agricultural.

1.2 REPORT REQUIREMENTS

The purpose of the Decommissioning Plan Report is to provide the public, Aboriginal communities, municipalities, and regulatory agencies with an understanding of the closure plan for the Project at the end of its useful life, and to describe how Suncor proposes to restore the Project Location to an acceptable condition for its intended use following Project closure.

This Decommissioning Plan Report is one component of the REA Application for the Project, and has been prepared in accordance with Item 3, Table 1 of O. Reg. 359/09 and the MOE’s *Technical Guide to Renewable Energy Approvals*. O. Reg. 359/09 sets out specific content requirements for the Decommissioning Plan Report as provided in the following table (**Table 1.1**).

Table 1.1: Decommissioning Plan Report Requirements: O. Reg. 359/09

Requirements	Completed	Section Reference
Set out a description of plans for the decommissioning of the renewable energy generation facility, including the following:		
1. Procedures for dismantling or demolishing the facility.	✓	3.3
2. Activities related to the restoration of any land and water negatively affected by the facility.	✓	3.4
3. Procedures for managing excess materials and waste.	✓	3.5

2.0 Decommissioning During Construction (Abandonment of Project)

In the unlikely event that Suncor cannot successfully complete the construction of the Project, the rights to the Project (and any associated liabilities and obligations) would be sold and the Project would be successfully constructed by the purchasing developer.

In the event that a delay occurs in the purchasing of the Project by another developer, Suncor would be responsible for interim environmental protection. In the event that the Project Location has been cleared and/or excavated in preparation for installation of project infrastructure, appropriate environmental protection measures would be implemented to prevent topsoil erosion and/or watercourse sedimentation. The extent of environmental protection measures required would be dependent on the progress made at the time of Project abandonment and would be determined through site investigations by qualified specialists. Possible measures would include, as appropriate, erosion and sediment control fencing, dust control measures, filling excavated areas, replacement of topsoil and/or reseeding and re-vegetation.

In the event that the Project is not purchased by another developer, Suncor will be responsible for decommissioning of the Project. In such a case the decommissioning process to be followed and the mitigation measures to be implemented will be the same as those detailed in **Section 3.0** for decommissioning after ceasing operation of the Project.

3.0 Decommissioning of Facility after Ceasing Operation

Project components are expected to be in service for the term of the 20 year Ontario Power Authority Feed-In Tariff contract. Following the term of the contract, a decision would be made to extend the life of the facility or to decommission. Decommissioning would entail removal of facility components and restoring the land to an acceptable condition for its intended use. The costs for removal of Project infrastructure will be the responsibility of the owner of the Project.

3.1 GENERAL ENVIRONMENTAL PROTECTION DURING DECOMMISSIONING

During decommissioning and restoration activities, general environmental protection and mitigation measures would be implemented. Many activities during decommissioning would be comparable to the construction phase; including restoring constructible areas around all Project infrastructure, such as widening access roads and constructing crane pads. General mitigation measures and best management practices, including natural heritage mitigation, erosion and sediment control, air quality and noise mitigation, and contingency plans for unexpected finds and spills, are provided in the **Construction Plan Report**. All decommissioning and restoration activities will be performed according to the requirements of relevant government agencies, and will be in accordance with all relevant statues in place at the time of decommissioning. In addition, all decommissioning activities will be restricted to the constructible areas as defined in the **Construction Plan Report** which have been previously assessed for natural heritage and archaeological/cultural heritage resources. Given that decommissioning of the Project will take place in a similar manner to the construction of the Project and that decommissioning works will be restricted to previously assessed areas, the potential effects documented within the **Construction Plan Report** could be considered similar to the potential effects associated with decommissioning.

Where complete removal of Project infrastructure is not proposed, partial removal will minimize the potential effects associated with complete removal which would exceed the potential effects (e.g., erosion, sedimentation, noise, and ground and vegetation disturbance) of leaving the buried infrastructure in place. In addition, partial removal of infrastructure to a depth of approximately 1 m below grade, which is the current standard management approach, will permit the intended future use of the site (agricultural). Further, the Project components remaining in the subsurface, these would be inert and would not pose a risk to the surrounding environment.

3.2 PRE-DISMANTLING ACTIVITIES

At the end of the Project's useful life, it will first be de-energized and isolated from all external electrical lines.

Prior to any dismantling or removal of equipment, staging areas would be delineated at each turbine site and at the substation property. All decommissioning activities would be conducted within designated areas; this includes ensuring that vehicles and personnel stay within the demarcated areas. Crane pads would be re-installed at each turbine site as part of the pre-dismantling activities. This involves site grading and the use of geotextile with a granular surface. Following turbine removal, the crane pads would be removed and the areas restored to pre-existing conditions.

3.3 EQUIPMENT DISMANTLING AND REMOVAL

3.3.1 Staging Areas

A temporary staging area at each turbine location would be used for temporary storage of the turbine components, parking, and excavated foundation. The staging area would not exceed the 140 m x 140 m constructible area identified on the Site Plan contained in the **Project Description Report**. Portions of this area would be cleared of top soil which would be temporarily stored onsite during decommissioning activities. The area would be graded and gravelled to provide a level surface for temporary storage for turbine components as they are disassembled and loaded on transport trucks for removal from site. The staging areas would be restored to pre-existing conditions at the end of the decommissioning phase by removal of all granular material and replacement of top soil.

3.3.2 Turbines

The turbines would be disassembled into their original component parts. A heavy-lift crawler and mobile cranes would be used to carry out the reverse sequence of steps that occurred during turbine assembly (detailed in the **Construction Plan Report**).

The turbine components would be temporarily stored at the staging areas until removed from the site by truck. Transportation of the dismantled turbine components will be completed in consideration of any road user agreement the project may have entered into with the local governments. Once the components are disassembled and at ground level, the materials will be transported to various salvage facilities. Prior to salvaging material, materials will be sorted to determine which items have useful life and can be sold to other operating wind farms with the same technology. The main sources of salvage material are steel, copper, fibreglass and plastic, which may be sold to recycling facilities. All non-salvageable components will be processed and safely transported to an MOE-approved disposal facility.

3.3.3 Turbine Transformers

The small transformer associated with each turbine will be removed for resale, reuse, reconditioning, or disposal.

3.3.4 Turbine Foundations

Turbine foundations will be removed as per Suncor's lease agreement with the landowner. Concrete foundations will be removed to a minimum depth of 1 m below ground surface. Partial removal will enable natural area restoration and normal agricultural practices to be conducted over the foundation areas. The concrete would be removed from the site by dump truck. A permit will be required if blasting is to be used to facilitate the removal of the foundation.

3.3.5 Crane pads

Crane pads built for turbine disassembly will be decommissioned, including the geotextile material beneath the pads and granular material. All granular and geotextile materials would be removed from the site by dump truck.

3.3.6 Electrical Infrastructure

Electrical Collector Lines and Transmission Line

Underground lines on leased property may remain in place, with both ends that come to the surface excavated to approximately 1 m below grade, in consultation with the landowner and in accordance with the land lease agreements. Should collector lines be removed via excavation, top soils would be segregated, the cable would be removed and subsoil and topsoil replaced. Damage to drainage tiles during the excavation process would be recorded and fixed by an approved drainage contractor. Overhead power lines may be sold to a licenced transmitter for the use of distributing of power to customers. In the event they are not sold, they would be removed and recycled. Collector lines installed in the road allowances would be removed, if required by the agreements with the Municipalities and County.

Substation and Operation and Maintenance Facility

The substation and operations and maintenance facility would be dismantled as agreed to, or as necessary, in accordance with the land lease agreement. The transformers, fencing, switchgear, and grounding grid would be removed, and the concrete foundation would be completely removed. All granular and geotextile materials would be removed from the site by dump truck. All electrical system components would be taken off-site by truck.

In the event that the substation is sold to a licensed transmitter, the facilities may be redesigned for the distribution of power to customers.

3.3.7 Access Roads

In consultation with landowners, access roads would be removed, including culverts, the geotextile material beneath the roads and granular material. The access roads would be returned to a similar condition as prior to Project commencement. Excavated areas on agricultural land would be brought to grade with fill and topsoil to be taken from surrounding land. All materials would be removed from the site by dump truck. Where the landowner sees it advantageous to retain access roads, these would be left in place. Leaving in place the access roads is not expected to result in adverse impacts to the future use of the land (agricultural).

3.3.8 Meteorological Towers

The above ground structure of the meteorological towers would be dismantled by first removing all meteorological equipment including sensors, data loggers and battery charging and communication equipment. The bare tower would then be dismantled in sections lowering the top sections first. The tower would be loaded onto a flatbed truck and removed for use at another location or sold. The concrete pedestal at the base of the tower would be removed and disposed of in a landfill. Site restoration would be completed in accordance with lease agreements executed with the landowner.

3.4 SITE RESTORATION PLAN

3.4.1 Natural Heritage Features

Natural heritage features such as woodland and water bodies which may be impacted by the removal of facility components would be reviewed with the Ministry of Natural Resources (MNR) prior to removal. Mitigation and monitoring measures may also be required including plans for replanting and restoration of natural features and would also be reviewed and implemented in consultation with the MNR.

3.4.2 Agricultural Lands

Areas that may have compacted due to decommissioning activities would be restored through the use of deep ploughing equipment.

Any agricultural drainage tile damaged during decommissioning would be repaired by a drainage tile contractor. Land owner approval will be obtained as per Suncor’s lease agreement. All repairs will be recorded and photographed.

Topsoil stockpiled during decommissioning will be replaced above restored subsoil.

3.4.3 Municipal Road Allowances

Where Project infrastructure has been removed, roadside ditches would be seeded with quick growing native species to prevent topsoil erosion; the seed mixture would be determined at that time in consultation with the Municipality and/or Conservation Authority. Erosion and sediment control measures at the ditch would be left in place until seed is fully established, as determined by an environmental advisor.

3.4.4 Potential Contamination

During the construction and operation of the Project, environmental management practices would be in effect, such as secure containment of potential hazardous materials, to minimize the potential for spills and thus the need for removal of contaminated lands. Should soil contamination be noted, the impacted soils will be delineated, excavated, and removed, to the standards of the day. The contaminated material will be disposed at an MOE-approved and appropriate facility, and will be replaced with appropriately compatible material.

3.5 MANAGING EXCESS MATERIALS & WASTE

All wastes would be managed in accordance with *Ontario Regulation 347, General – Waste Management* (O.Reg.347) and with reference to *Ontario Provincial Standard Specification 180 - General Specification For The Management of Excess Materials* (OPSS 180), or relevant regulations and specifications in effect at that time.

Major pieces of equipment may be sold, recycled or reused. The steel towers may be sold for scrap. Electrical equipment could either be salvaged for reuse or recycled. According to a 2011 Garrad Hassan study, components such as the generators and cabling are likely to have a high resale value due to copper and aluminum content (see **Appendix A**). Concrete from footings will be separated from the reinforcement steel, and could be crushed and recycled as granular fill material. The steel will then be sold as scrap metal. Spent oils could be recovered for recycling through existing oil reprocessing companies.

As much of the facility would consist of reusable or recyclable materials, there would be minimal residual waste for disposal as a result of decommissioning the facility. Small amounts of registerable waste materials would be managed in accordance with O. Reg. 347 or subsequent applicable legislation. Residual non-hazardous wastes would be disposed at a licensed landfill in operation at the time of decommissioning.

3.6 MONITORING

Follow-up monitoring may be conducted following site restoration based on the requirements identified by the MNR at the time of decommissioning. For municipal road allowances, a review may occur of the establishment and health of re-vegetation. Additional monitoring activities may also be conducted, depending upon the site conditions at the time of decommissioning. If negative impacts are noted during monitoring activities, appropriate remediation measures would be implemented as necessary, and additional follow-up monitoring would be conducted, as determined by an environmental advisor.

3.7 OTHER APPROVALS

Prior to decommissioning activities commencing (six months prior), Suncor will update the **Decommissioning Plan** and submit it to the MOE for approval. Suncor will commit to work with regulatory bodies to determine the appropriate decommissioning requirements in affect at the time of decommissioning. For example, Nav Canada and Transport Canada will be notified regarding the removal of the wind turbines for the purposes of updating aeronautical databases. In addition, conservation authority permits may also be required for decommissioning activities within regulated areas. Given it is anticipated that the future land use will remain agricultural, a Record of Site Condition would not be required.

4.0 Emergency Response and Communications Plans

The Project's Emergency Response Plan and Communications and Complaint Response Protocol (as discussed in the **Design and Operations Report**) would be in effect for all phases of the Project including decommissioning. In addition, the programs, plans, and procedures (such as personnel training and a public safety plan) described within the **Design and Operations Report** will be carried forward during the decommissioning of the Project.

4.1 DECOMMISSIONING NOTIFICATION

Prior to decommissioning (six months prior), Suncor will consult with interested parties regarding the details of decommissioning and would amend this **Decommissioning Plan** to meet regulatory requirements in effect at that time. Notification of decommissioning will follow the Emergency Response Plan and Communications and Compliant Response Protocol as well as be provided to Project stakeholders (including public, municipal and aboriginal communities) prior to undertaking decommissioning activities. Notification may be in the form of letters, newspaper notices, or direct communications.

5.0 Conclusion and Signatures

This **Decommissioning Plan Report** for the Suncor Energy Cedar Point Wind Power Project has been prepared by Stantec for Suncor in accordance with Item 3, Table 1 of Ontario Regulation 359/09 and the MOE's *Technical Guide to Renewable Energy Approvals*.

This report has been prepared by Stantec for the sole benefit of Suncor, and may not be used by any third party without the express written consent of Suncor. The data presented in this report are in accordance with Stantec's understanding of the Project as it was presented at the time of reporting.

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Appendix A

Garrad Hassan Study

Wind Farm Decommissioning Costs
A Look at End of Life Scenarios

Antonio Giustino
GL Garrad Hassan

Abstract

GL Garrad Hassan has observed that requests for project decommissioning studies have been increasing in North America. Many of these studies are mandated by local governmental authorities to ensure that a plan and security are posted prior to project acceptance for disposing of the project infrastructure at the end of its service or design life. Other inquiries for decommissioning analyses stem from asset retirement obligation stipulations within lease structures. Lastly, some of this increased interest is attributable to a NIMBY component accompanying the penetration of wind into more opposition-prone regions. Until recently, little attention has been placed on end of life scenarios and future wind farm net decommissioning costs.

Having performed to date various decommissioning studies throughout North America and around the world, GL Garrad Hassan is able to make a number of conclusions. First, each decommissioning scenario is unique to its respective project. Which infrastructure components are mandated to be removed as well as the type of such infrastructure are important variables. The dismantling and removal of any portion of a project's infrastructure are direct costs. These costs are indirectly offset by salvage or scrap values which are time dependent. For shorter time horizons (within the current industry design life), some projects could see a positive net decommissioning value. For decommissioning dates farther into the future, dismantling and removal costs will be offset by scrap values, but still register a net cost. The author notes that while commodity prices will greatly influence eventual scrap values, the estimates presented in the paper are based on present day values. Lastly, going concern beyond design life and repowering scenarios will need to be taken into account when making an ultimate decommissioning decision.

Objectives and Methods

The objective of this presentation is to present to the reader the likely scenarios that a wind project will encounter once it reaches the end of its design life. The goal is to present the challenges and cost to benefit analysis with which the project owner will have to contend. The reader will have an appreciation for the issues and financial ramifications that end-of-life scenarios present for a wind project.

The author began by analyzing three possible scenarios that a wind farm could face at the end of its design life. Some of the scenarios, once vetted, can lead to the adoption of another. Every wind project is unique and contains its own parameters which include, but are not limited to: investor expectations for service life, site conditions and their impact on the plant, wind resource and power sales, limits on the operational expense burden which can be incurred, and type of equipment and its prospects for resale. Generic—but not atypical—values are used in the analysis. Decommissioning operations were divided into three phases: 1) disassembly, 2) removal, and 3) salvaging and/or scrapping. The decommissioning cost is calculated as the sum of the cost of disassembly plus the cost of removal (transport). The net salvage value is calculated as the difference between the sum of parts resale and scrap revenue, less the landfill cost of the remaining material. The net decommissioning value is determined from the difference of the decommissioning cost and the net salvaga value.

Project name	Generic	Number of HV substations to remove	1
Number of WTGs	50	Number of main step-up transformers	1
Project design life (years)	20	Length of underground collection system to remove (km)	25
Warranty from substantial completion / COD (years)	2	Length of overhead collection sys to remove (km)	6
Going concern considered after design life	yes	Length of transmission line to remove (km)	[illegible]
Decommissioning to begin after which Project year	20 or 30	Length of Project access roads to reclaim (km)	25
Turbine manufacturer	Generic	Operations & maintenance building¹	1
Turbine capacity (MW)	2.0	Number of meteorological masts to remove	1
p50 net capacity factor	[illegible]	Number of blades per WTG	3
Estimated annual p50 production (MWh)	[illegible]	Number of WTGs with 4 tower sections	0

1. It is assumed that the O&M building, as real estate, has a positive value but for conservatism this value is not used.

Beginning Assumptions

Results

Scenario 1 – Going Concern

Step 1: Determine if it is physically possible for the wind project to continue operations beyond its design life. The structural integrity of the non-replaceable portions of the plant must be determined, and while everything theoretically can be replaced at some cost, for practical and safety purposes such structures as the foundations, tower sections, hub castings, main shafts, and nacelle bed plate are assumed non-replaceable.

Germanischer Lloyd establishes an analytical or a practical method for accomplishing this task[1]. Utilizing both would be recommended to ensure continued operations don't affect the safety of the plant. Analytical methods would include design loads analysis (site specific) to ensure fatigue loading is still within the margins of safety. Practical methods would include thorough inspections of the equipment, with particular attention to those portions identified by the analytical methods as having lower factors of safety or being critical failure modes.

This step must be performed by qualified, independent experts for wind turbines.

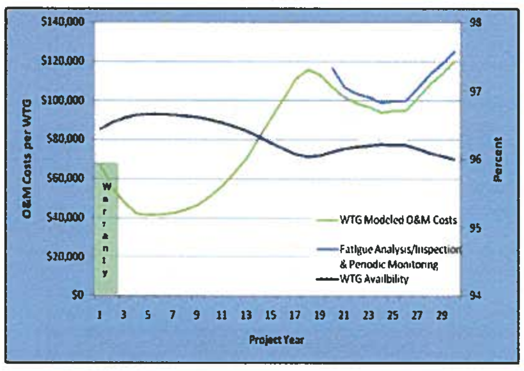
If Step 1 reveals that continued operations is not safe, Scenarios 2 or 3 may have to be implemented.

Step 2: Determine a periodic monitoring program for continued operations which implements recommendations of the certiffying expert which performed Step 1.

Step 3. Determine if continued operations is financial feasible. While the wind resource may be familiar at this point, revenues will be impacted by future power pricing as well as an expected lowering of turbine availabilities. On the expense side, an increase in operational costs for extended life operations can be expected. The periodic monitoring program as well as increases in scheduled and unscheduled maintenance should be modeled. Fortunately, project debt should have already been paid off, so an increase of some O&M costs should be able to be absorbed.

Below are generic examples for O&M costs and availability assumptions which have to be modeled. Actual values will depend on technology type, service contracts in place, and site conditions.

O&M Costs and Availability Modeling



Step 4: If re-powering the site with new technology is an option, this option should be financially weighed against the continued operations with the existing plant. Consideration should be given to existing leases, land-owner relationships, interconnection agreements, and the decommissioning costs given in **Scenario 2** and **Scenario 3** to make an informed financial decision.

Scenario 2 – Decommission to Scrap

If decommissioning is to occur a long time beyond the design life of the project, for example as part of the asset retirement obligations of two back to back twenty year leases, then it should be assumed that all the plant will go to scrap and no components will be resold. For this example, it will be assumed that the option to decommission at 30 years will fall into this category. The following are typical costs that can be expected from our generic wind farm through this decommissioning process.

Step 1: Disassembly Costs

Mobilization and Soft Costs Assumptions

Item	Value
Number of Hi cranes needed	2
Number of Hi crane tear-downs needed	0
Number of Lo cranes needed	2
Number of Lo crane tear-downs needed	0
Decommissioning contractor's laydown yard size (m²)	20,000
Additional mobilization as percent of total hard costs	1%¹
Decommissioning soft costs as percent of total hard costs	5%

1. Mobilization costs were calculated by adding: the crane mobilization/demobilization costs, the laydown yard construction and tear down costs, plus adding a percentage of the total hard costs.

Summary of WTG Disassembly Costs

Cost Item	Total
Dismantle hub and blades (3 blades per turbine)	$12,910
Dismantle nacelle (drive train and generator included)	$13,270
Dismantle tower sections, 3/WTG (internals included)	$13,710
Dismantle external pad mount transformer	$2,410
Dismantle turbine foundation to (-3ft) below grade	$6,080
Total per WTG	$48,380

Summary of Project Disassembly Costs

Cost Item	Total
WTGs DISASSEMBY	$2,419,000
COLLECTION SYSTEM	$247,500
HV SUBSTATION	$136,620
TRANSMISSION LINE	$847,500
ACCESS ROADS & CRANE PADS	$500,000
MET MASTS	$7,564
MOBILIZATION & SOFT COSTS	$424,491
TOTAL PROJECT DISASSEMBLY COST	$4,582,675

Step 2: Removal Costs

Summary of WTG Removal Costs

Turbine Component	Total
Blades (cut up prior to loading)	$14,970
Hub (two on one truck)	$4,995
Nacelle	$9,990
Tower (3 sections)	$29,970
Internals	$623
Transformer	$623
Crushed foundation (25m³)	$100
Total Wind Turbine Removal Cost (per WTG)	$61,270

Summary of Project Removal Costs

Cost Item	Total
WTGs	$3,063,500
COLLECTION SYSTEM	$84,830
HV SUBSTATION	$43,130
TRANSMISSION LINE	$57,340
ACCESS ROADS & CRANE PADS	$165,000
MET MASTS	$10,180
TOTAL PROJECT REMOVAL COST	$3,423,980

Step 3: Salvage and Disposal

Commodity / Disposal Price Assumptions¹

Scrap steel or iron ($/tonne)	$300
Scrap copper ($/tonne)	$5,000
Scrap aluminum ($/tonne)	$1,700
Class 2 landfill ($/m³)	($45)
Class 3 landfill ($/m³)	($15)
GRP end of life cost ($/m³)	($100)²

1. It should be noted that the commodity price of metals is volatile and future values are impossible to predict with any degree of certainty. No predictions are made.
2. More research is needed in this particular subject field.

Turbine Salvage Values

Component	Cu (T)	Value	Fe (T)	Value	Al (T)	Value	GRP (m³)	Cost	Class 2 fill (m³)	Cost	Cl. 3 fill (m³)	Cost	Net Scrap Value
Blades		$0		$0		$0	39	-$3,900		$0		$0	-$3,900
Hub steel		$0	20	$6,000		$0		$0		$0		$0	$6,000
Nacelle/hub GRP		$0		$0		$0	12	-$1,200		$0		$0	-$1,200
Nacelle bedplate		$0	30	$9,000		$0		$0		$0		$0	$9,000
Main shaft		$0	8	$2,400		$0		$0		$0		$0	$2,400
Gearbox		$0	7	$2,100		$0		$0	2	-$90		$0	$2,010
Generator	2	$10,000	1	[illegible]		$0		$0		$0		$0	[illegible]
Tower steel³ sections		$0	122	$36,600		$0		$0		$0		$0	$36,600
Internals	1.5	$7,500		$0	15	$25,500		$0	2	-$90		$0	$32,910
Transformer	1.2	$6,000	2	$600	0.5	$850		$0	1	-$45		$0	$7,405
Crushed fndtn (25m³)		$0		$0		$0		$0		$0	25	-$375	-$375
Total/WTG													$101,750

Gross Salvage Value of the Project

Item	Total
WTGs	$5,087,500
COLLECTION SYSTEM	$312,609
HV SUBSTATION	$167,710
TRANSMISSION LINE	$232,500
ACCESS ROADS & CRANE PADS	$412,500
MET MASTS	$2,038
TOTAL PROJECT SALVAGE	$6,214,857

Step 4: Net Decommissioning Cost – no component resale

Net Project Decommissioning Cost - No Part Resale

	Disassembly	Removal	Disposal/ Salvage	Net Totals
WTG	$2,419,000	$3,063,500	($5,087,500)	$395,000
COLLECTION SYSTEM	$247,500	$84,830	($312,609)	$19,721
HV SUBSTATION	$136,620	$43,130	($167,710)	$12,040
TRANSMISSION LINE	$847,500	$57,340	($232,500)	$672,340
ACCESS ROADS & CRANE PADS	$500,000	$165,000	($412,500)	$252,500
MET MASTS	$7,564	$10,180	($2,038)	$15,706
MOBILIZATION/SOFT COSTS	$424,491			$424,491
PROJECT TOTALS	$4,582,675	$3,423,980	($6,214,857)	$1,791,798
TOTAL PROJECT NET DECOMMISSIONING COST	$1,791,798¹	[or $35,836¹ per WTG]		

1. Positive numbers here are a net cost or negative return to the Project owner.

Note: This Scenario yields a total decommissioning cost to the Project owner. Such a scenario would be more likely for decommissionings beyond the existance of a secondary parts market. However the scrap metal value serves to significantly offset the total cost.

Scenario 3 – Decommission with Partial Resale

If Decommissioning is to occur immediately after the design life of the Project, it can be assumed that some of the turbine components could be resold in a secondary parts market. The validity of this assumption will be based on several project-specific factors. The turbine type and technology employed on the project, the degree to which that particular WTG penetrated the market, the commercial operation date of the project vis a vis other projects employing the same turbine, and the proximity of the other wind farms continuing operations beyond our project's decommissioning date will all be critical in understanding the viability of such a secondary parts market.

For conservatism, it will be assumed that only those parts replaced within the last five years before decommissioning will be considered for resale. The only exception to this assumption is the turbine transformer, which is assumed to have a higher design life and for which half are assumed available for resale. Furthermore, any part which fails during that time and which would not be able to pay for itself within the time left before decommissioning, will not be considered for resale. In order to implement the previous statements, a rigorous failure scheme as well as an understanding of individual turbine annual revenues is prerequisite. 25% of the values of the new parts costs are assumed as proceeds of any resale. For further conservatism, only the gearbox, generator, blades, transformer, and main bearings of a WTG are considered for resale. It is highly probable that many more minor components will be able to be resold.

Step 1: Determine Composition of Components Remaining

Feasibility of Replacements with Pending Decommissioning

Major Component	Repaired, Refurbished or Replaced if Failed in Year 16	Year 17	Year 18	Year 19	Year 20
Gearbox	yes	yes	yes	no	no
Generator	yes	yes	yes	yes	yes
Blade	yes	yes	yes	yes	no
Transformer	yes	yes	yes	yes	yes
Main Bearing	yes	yes	yes	yes	no

Step 2: Determine Resale Impacts on Salvage and Scrap Values

WTG Component Resale Net Valuations

Component	New Part Cost	Qty. Aged ≤5 Years	Qty. to Resale	Value at 25% of New	Scrap Loss
Gearbox	$267,468	17	16	$1,069,872	$32,160
Generator	$92,833	14	14	$324,916	$152,600
Blades	$210,000	11	10	$525,000	-$39,000
Transformer	$35,000	0	25	$218,750	$185,125
Main Bearing	$36,471	2	2	$18,236	
Gross Resale Total				$2,156,775	
Minus Loss of Scrap					-$330,885¹
Net Resale Total					$1,825,890

1. This subtracts the scrap metal gains previously accounted for in Scenario 2

Other BoP Significant Resale Items

Component	Quantity	New Cost	Value at 25% of New
Main Transformers	1	$2,500,000	$625,000
Gross Resale			$625,000
Minus Loss of Scrap			-$139,400¹
Net Resale			$485,600

1. This subtracts the scrap metal gains previously accounted for in Scenario 2

Step 3: Net Decommissioning Cost – partial component resale

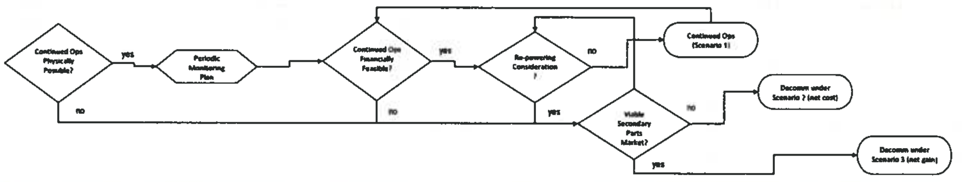
Net Decommissioning Cost – Resale of Selected Components

	Disassembly	Removal	Disposal/ Salvage	Net Parts Resale	Net Totals
WTG	$2,419,000	$3,063,500	($5,087,500)	($1,825,890)	($1,430,890)
COLLECTION SYSTEM	$247,500	$84,830	($312,609)		$19,721
HV SUBSTATION	$136,620	$43,130	($167,710)	($485,600)	($473,560)
TRANSMISSION LINE	$847,500	$57,340	($232,500)		$672,340
ACCESS ROADS & CRANE PADS	$500,000	$165,000	($412,500)		$252,500
MET MASTS	$7,564	$10,180	($2,038)		$15,706
MOBILIZATION/SOFT COSTS	$424,491				$424,491
PROJECT TOTALS	$4,582,675	$3,423,980	($6,214,857)	($2,311,490)	($519,692)
TOTAL PROJECT NET DECOMMISSIONING VALUE	($519,692)¹	[or ($10,394)¹ per WTG]			

1. Negative numbers here are a net gain or positive return to the Project owner.

Note: This Scenario yields a total decommissioning value to the Project owner. Such a scenario would be more likely for decommissionings which occur in the presence of a secondary parts market. However, it would still be the responsibility of the Project owner to coordinate the resales.

Conclusions



Wind farm end of life scenarios are explored, along with the likely decision-making process required. It is found that many project-specific factors will influence the net cost or net gain yielded from such scenarios. The largest influencing factor affecting decommissioning costs, apart from commodity prices which are not predicted in this study, is the existance of a viable secondary parts market for project component resales. Depending on the decommissioning horizon, a project will yield a net gain or net cost to decommission.

References

1. Guideline for the Continued Operation of Wind Turbines, Germanischer Lloyd *Rules and Guidelines, IV Industrial Services, Part 1, 2009 Edition*

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