ENGLISH FARMS WIND PROJECT

Decommissioning Plan

Tradewind Energy, Inc.

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My license renewal date is December 31, 2018

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Abbreviation	**Meaning**
BOP	Balance of Plant
COD	Commercial Operation Date
DNV GL	DNV KEMA Renewables, Inc.
GRP	Glass Reinforced Plastic
O&M	Operations and Maintenance
OPGW	Optic Ground Wires
WTG	Wind Turbine Generator

EXECUTIVE SUMMARY

At the request of Tradewind Energy, Inc. (“Tradewind” or the “Customer”), DNV KEMA Renewables, Inc. (“DNV GL”) performed a decommissioning analysis of the English Farms Wind Project (the “Project”). The study estimates the costs associated with the dismantling, removal, and salvage or disposal of the equipment; all costs in this study are given in U.S. dollars.

The Project is to be located in Poweshiek County, Iowa approximately 90 km east of Des Moines. The Project consists of up to 68 - 2.5 & 2.3 MW wind turbine generators (WTG) with an aggregate rated output of up to 168.2 MW, and associated infrastructure. The turbines are mounted on 94 & 80 m tubular steel towers. The Project is anticipated to commence commercial operations as early as December 2018.For the purposes of this analysis, it is assumed that decommissioning of the Project will take place 25 years after the start of commercial operations, although guidance is included for operation beyond 25 years.

DNV GL assumes that there are strong parallels between wind power project construction and decommissioning programs and consequently bases the estimates for decommissioning costs on its broad experience of wind power project construction programs and the associated costs of labor, plant, and materials. The complete decommissioning cost is calculated as the sum of the cost of disassembly, removal, and disposal of the turbines and balance of plant, as may be offset by gains from salvage or resale of materials and components. It is noted that crane costs are the most dominant cost item in disassembly while transportation of the large turbine components dominates the costs of removal.

Assessments of salvage opportunities are based on the bill of quantities identified in this report. The average material weights and ratios for turbine components are derived from previous DNV GL studies, Customer documentation, and/or turbine supplier technical specification sheets. Although DNV GL assumes certain commodity prices and disposal service rates based on present day estimates, it does not forecast such future values. The reader is free to make those adjustments. The salvage value is calculated as the difference between the sum of parts resale and scrap revenue, less the landfill cost of the remaining material. Two salvage/disposal scenarios are presented: Scenario 1 considers that all equipment is sold as scrap while Scenario 2 assumes partial resale of some of the Project’s major components.

The net decommissioning value is determined from the difference of 1) the sum of the disassembly and removal cost and 2) the sum of the salvage value and resale. The net decommissioning gain/costs of the Project assuming no resale (Scenario 1) and with partial resale of the Project’s major components (Scenario 2) are presented in the table below.

	Scenario 1 **No Resale**	**Scenario 2** **Partial Resale**
Total per WTG	$34,040	-$23,910
Total Project (68 WTGs)	$2,315,000	-$1,626,000

Note: negative values are positive returns to the Project.

As it is considered to be the more likely option, a breakdown summary of Scenario 2 is shown below.

English Farms Wind Project net decommissioning cost with partial resale

Item	Disassembly (A)	Removal (B)	Disposal (C)	Total Costs (D=A+B+C)	Salvage/Resale (E)	Net (D+E)
WTG	$5,576,000	$4,529,000	$544,000	$10,649,000	-$13,976,000	-$3,327,000
Collection System	$0	$0	$0	$0	$0	$0
High voltage substation	$138,000	$65,000	$9,000	$212,000	-$1,020,000	-$808,000
Transmission Line	$0	$0	$0	$0	$0	$0
Access roads & Crane Pads	$603,000	$873,000	$36,000	$1,512,000	-$397,000	$1,115,000
Met Masts	$0	$0	$0	$0	$0	$0
Mobilization/Soft Costs	$1,394,000	$0	$0	$1,394,000	$0	$1,394,000
Project Totals	*$7,711,000*	*$5,467,000*	*$589,000*	*$13,767,000*	-$15,393,000	-$1,626,000
Total per WTG						**-$23,910**
Total Project (68 WTGs)						**-$1,626,000**

Note: negative values are positive returns to the Project.

It is stressed that this report is based on broad assumptions regarding the Project; the approach to the decommissioning; and the market conditions for contracting costs, scrap value and resale options. It is recommended that the net costs of decommissioning be reviewed closer to the end of the operating period (e.g., at 15-18 years of operation for a 25-year operating life). At that time, it would also be prudent to take into consideration: 1) a scenario in which Project profitability and turbine conditions justify continued operation beyond the initially assumed Project operating life; and 2) a "re-powering" scenario, in which case the existing turbines would be removed in the interest of constructing a more valuable project with larger, more efficient turbines. In the first scenario, decommissioning costs could be paid for by allocations of Project revenues in future Project years, while in the latter scenario, any decommissioning costs could be transferred to the capital budget of the new project.

1 INTRODUCTION

Tradewind Energy, Inc. ("Tradewind" or the "Customer") retained DNV KEMA Renewables, Inc. ("DNV GL") to perform a decommissioning analysis of the English Farms Wind Project (the "Project"). The Project is to be located in Poweshiek County, Iowa; and consist of up to 59 – 2.5 MW & 9 – 2.3 MW MW wind turbine generators (WTG) with an aggregate rated output of up to 168.2MW, and associated infrastructure.

The Customer has advised DNV GL that the required decommissioning includes the removal of all towers, wind turbine generators, substation, underground collection lines, ancillary equipment and other physical material owned by and pertaining exclusively to the Project and restoration of the property, including the Project roads.

Based on local jurisdictions and recommendations provided by the client, the following assumptions have been applied:

- Decommissioning will start soon after the end of Project operating life (for the purpose of this analysis is assumed to be 25 years), and all decommissioning work is performed in generally conducive weather conditions;
- Decommissioning includes removal of wind turbines, cabling, electrical components, roads, and any other associated facilities down to 4 feet (ft) below grade as advised by the Customer:
  - The wind turbine foundations have only the pedestals and concrete transformer pads removed and the remainder of the spread footing is abandoned in place.
  - The Project substation will be completely decommissioned.
  - The collector system will be buried at more than 4 feet below grade and hence will not be required to be decommissioned based on local jurisdiction.
  - All Project roads will be decommissioned. DNV GL considers this a conservative assumption as many land owners may find such roads a benefit to their land and request to keep them.
- Crane pads are assumed to be remediated during decommissioning.
- No decommissioning of the operations and maintenance (O&M) building has been estimated, as the Customer has indicated that this building will remain intact at the end of the Project life.
- No resale of the gearboxes and generators was assumed in the last two years of the Project's life.

This report does not consider the time value of money; the results should therefore be adjusted to represent the inflated costs at the time of decommissioning (e.g., annual escalation). It should also be noted that commodity values are volatile and difficult to predict over the study horizon.

This report also does not consider the assessed scenarios from legal, regulatory, or commercial perspectives, which should be assessed by the Customer.

2 STUDY ASSUMPTIONS

DNV GL's decommissioning study methodology assumes there are strong parallels between wind power project construction and decommissioning programs. DNV GL has used an internal bottom-up decommissioning model it developed from its experience in the wind industry to formulate these study results.

All costs are quoted in 2017 dollars, and it should be noted that no specific quotes were obtained in relation to this study, although the Project's location has been included in the modeling. The study is broken down into three sections: disassembly, removal, and salvage/disposal. Due to the high uncertainty associated with the majority of cost categories assumed and modeled, DNV GL has rounded costs to the nearest $1,000, unless otherwise noted.

2.1 General assumptions

DNV GL has assumed that, on average, one topping crane will dismantle one turbine every day (including time for crane movements from turbine to turbine, crane teardowns where necessary, and some minor weather delays). The number of cranes used determines the approximate time to complete the job. The Project layout was also analyzed for crane walking impediments to estimate crane teardown requirements. While a detailed analysis in this regard was not performed, the Project was assumed to require the number of cranes and teardowns presented in Table 2-1.

2.2 Initiation and mobilization

Before executing any decommissioning works, it is necessary to plan the work carefully, secure the appropriate permits and insurance, and manage the program of work and associated health and safety risks, in order to ensure a successful project. It is assumed that mobilization and soft costs are overhead. Soft costs, for the purposes of this study, include costs not specifically accounted for in the derivations presented later in this Report, including environmental studies, obtaining permits, environmental protection plans, hazardous material disposal, onsite administrative infrastructure and staff, utilities, off-site project management and insurance/legal services. This study assumed an additional 5% of the totals from the hard costs contemplated herein for the soft costs needed.

The study also assumed that an additional 1% of the total hard costs contemplated herein would be needed for contractor mobilization. Table 2-1 summarizes the crane, mobilization, and soft cost assumptions used in this report.

Table 2-1 Mobilization and soft costs assumptions

Item	Quantity
Number of main cranes needed	2
Number of main crane tear-downs needed	6
Number of base cranes needed	4
Number of base crane tear-downs needed	0
Decommissioning contractor's lay-down yard size [m^2]	63,400
Additional mobilization as percent of total hard costs (1)	1%
Decommissioning soft costs as percent of total hard costs (2)	5%
Total Mobilization	**$1,394,000**

(1) Represents the costs of contractor's mob./demob.
(2) For soft costs, it is assumed that the decommissioning would be done for the entire project at once.

2.3 Schedule

It is assumed that the decommissioning program would be 6 to 10 weeks. This time line is based on the assumption that the dismantling rate of the wind turbines is approximately one turbine per workday per crane pair and that 7 to 10 workdays of mobilization and demobilization are allowed before and after turbine dismantling. During construction of wind power projects, it is typical that the time for erection across the entire project schedule averages about one turbine per day per topping crane on a simple site. While disassembly could in theory be done with slightly less care than during assembly (damage to turbines not as much of a concern), safety and resale considerations will likely dictate that disassembly be accomplished in much the same fashion as erection, although in reverse order.

It is also assumed that other works across the site such as foundation removal, substation disassembly and reclaiming of roads, crane pads, and other excavations will be done simultaneously and/or in concert with the turbine dismantling and crane progress.

3 DISASSEMBLY

The disassembly of the Project pertains to all work just prior to physical transportation of the infrastructure from the site. In the case of the wind turbines, it includes the dismantling and loading of the tower sections, nacelles, and blades scraps onto trucks for transport. In the case of concrete foundations or roads and crane pads, it pertains to the tear down, aggregate stripping, excavation and backfilling, and all reclaiming as necessary. Reseeding of removed roads and turbine areas, including crane pads, is included in these costs.

Although certain activities must be sequenced appropriately, based on DNV GL's knowledge of wind project construction considerations, it is assumed that many activities (e.g., turbine, collection system, and substation disassembly) may be undertaken in parallel, facilitating an efficient decommissioning process.

3.1 Turbines

Once the site is mobilized, it is assumed that the decommissioning of turbines would start immediately and sequentially. This typically entails the individual removal of the rotor assembly followed by the nacelle enclosure. The tower internals are stripped of lifts, cables, cabinets, lighting and other miscellanea and are then dismantled, section by section, down to the foundation surface.

For the Project, 68 turbines are to be removed, consisting of59 – 2.5 MW and 9 – 2.3 MW nacelles, with four and three steel tower sections respectively, at 94 and 80 meter hub heights respectively, and 58 meter blade length. It is assumed that the scope of the disassembly works includes the cost of labor, machinery, and tools required to perform the tasks and the loading of the dismantled material onto transport vehicles for removal from site. The topping crane would be required on site for approximately six weeks during the turbine dismantlement activities. The small cranes may be required a slightly longer period in order to assist with the transport loading activities and substation dismantling.

It is also assumed that aside from the possible removal of the drive train to aid lifting, the nacelle and its contents will remain fully intact for purposes of transport. All cooling, heating, and lubrication fluids will be drained, stored, and appropriately disposed of before the nacelle is removed from site. Blades, however, will be cut into sections for easier transport to a recycling or incineration plant.

The costs presented below include the cost of a topping crane to handle the hub/rotor, nacelle and top tower section (or top sections, depending on base crane hired). They also include the cost of a lower crane for lower tower sections as well as aid in loading the components onto transport trucks. The costs take into consideration the rental of special tools needed from the manufacturer as well as the fact that the GE turbines have an external pad mounted transformer.

To comply with Customer/regulatory requirement that the site be remediated to 4 ft below grade, it is assumed that the concrete structures are to be cut and crushed down to 4.5 ft below grade (to allow some margin). It was calculated that about 25 m^3 of crushed concrete will result from removing each turbine's foundation pedestal and pad-mount transformer foundation essentially in their entirety, thus achieving these criteria. Table 3-1 summarizes the turbine disassembly costs for the Project.

Table 3-1 Summary of turbine disassembly costs

Cost item	Costs per WTG
Dismantle hub and blades (3 blades per turbine)	$22,000
Dismantle nacelle (drive train and generator included)	$22,000
Dismantle tower sections, internals included	$28,000
Dismantle pad-mounted transformer	$4,000
Remove turbine foundation	$6,000
Total per WTG **Total Project (68 WTGs)**	**$82,000** **$5,576,000**

DNV GL notes that the disassembly costs of WTGs are highly dependent on crane costs (which include crane plus crane crew): typically, over 60% of the total per-WTG cost is associated with crane-related costs. DNV GL estimated this cost based on experience from various projects in North America. It is noted that crane availability may greatly influence crane costs, and that it is not possible to accurately predict crane costs given the long study horizon.

3.2 High-voltage substation

The Customer has advised that the Project will be equipped with one 161/34.5 kV, 178.5 MVA transformer. The remaining portion of the Project high-voltage (HV) substation is assumed to include typical equipment seen in North American wind power project substations for projects of this size, including grounding transformers, bus bars, relay switches, circuit breakers, air disconnect switches, capacitor banks, reactor banks and a control building. It is assumed that a dead-end structure will also present.

The interconnection switchyard for the Project has not been considered in the decommissioning analysis based on the Client's recommendation.

It is assumed that the scope of the disassembly work includes the cost of labor and machinery required to perform the disassembly tasks, including disconnection work at the terminals, and the loading of the dismantled material onto transport vehicles for removal from site. The following table summarizes the costs to disassemble the Project's high voltage substation and interconnection switchyard.

Table 3-2 Costs to disassemble Project substation

Item	Cost
Preparation	$8,000
Dismantle HV equipment	$25,000
Dismantle and prep. main transformer for shipment (each)	$17,000
Remove control building	$4,000
Remove foundations	$40,000
Large machinery hire	$15,000
Small machinery hire	$13,000
Reclaim and reseed	$16,000
Total	**$138,000**

3.3 Site access roads and crane pads

In practice, it is possible that most of the roads will be kept after the completion of the Project, with the exception of the dead-end access roads that lead to the turbines. However, for purposes of the study, DNV GL has assumed that the entirety of the approximately 29 km of roads will be remediated. Based on Customer information, DNV GL has additionally assumed that 68 crane pads will be remediated during decommissioning. The lay-down yard reclamation is accounted for in the mobilization/demobilization costs. Decommissioning of the site access roads will typically include stripping back the surfaces of project roads connecting the turbines and the crane pads and replacing them with topsoil in keeping with the surrounding environment. In the case of the Project, this phase also includes stripping and piling geotextile material used in the road base. The costs additionally include reseeding with native grasses. A secondary reseeding may be required if the initial work proves inadequate. DNV GL has therefore maintained a baseline assumption of one seeding evolution.

The results are reported in Table 3-3 below. Note the cost of aggregate transport off site is captured in removal costs.

3.4 Disassembly conclusion

The cost of the disassembly of the Project is summarized in Table 3-3.

Table 3-3 Summary of Project disassembly costs

Cost item	Cost
WTG	$5,576,000
Collection system	$0
High-voltage substation (incl. O&M bldg)	$138,000
Transmission line	$0
Access roads & crane pads	$603,000
Met Masts	$0
Mobilization & soft costs	$1,394,000
Total Project Disassembly Cost	**$7,711,000**

4 REMOVAL FROM SITE

Removal of the Project in this study refers strictly to the transporting of the equipment from the site to the appropriate landfill, aggregate rework facility, or scrap yard. Various distances and truck sizes are applied in the DNV GL decommissioning model, depending on which Project component is being calculated. Removal costs also include the costs of unloading the material once it reaches its destination. DNV GL notes that appropriate landfills and scrap yards appear to be located in the general region of the Project.

4.1 Turbines

It is assumed that the scope of the removal of the wind turbines includes the cost of labor and vehicles required to transport the dismantled material to an appropriate disposal, salvage or rework facility. It is assumed that the transport distances for general waste would be within a radius of 125 km whereas the more complex and valuable material is assumed to be transported within a radius of 500 to 750 km—500 km for the tower internals, and 750 km for the main turbine and substation components. These assumptions may be somewhat conservative considering there are a number of recycling or salvage facilities near the Project site. DNV GL additionally notes the presence of rail transport in the relative vicinity could decrease costs for removal of turbine components. While most of the main turbine components are modeled to be removed much as they were initially transported to the site during construction, the turbine blades will be sectioned to limit oversize transport.

Table 4-1 summarizes the costs for the removal of each of the turbine components from the site.

Table 4-1 Turbine removal costs

Turbine component	Cost per WTG
Blades (cut up prior to loading)	$5,000
Hub (one on one truck)	$10,000
Nacelle	$10,000
Tower sections	$39,000
Internals	$1,000
Transformer	$1,000
Crushed foundation (25 m3)	$600
Total per WTG	**$66,600**
Total for Project (68 WTGs)	**$4,529,000**

4.2 High-voltage substations

It is assumed that the transport distances for foundation rubble and general waste would be within a radius of 125 km, whereas the more complex and valuable material is assumed to be transported within a radius of 500 to 750 km. It is assumed that local dump truck loads are 10 yd^3 in capacity.

The following table summarizes removal costs for the Project substation. As previously mentioned, the interconnection switchyards have not been considered in the present study.

Table 4-2 Project substation removal costs

Substation component	Cost
HV equipment	$10,000
Main transformer(s)	$10,000
Control/O&M building(s)	$4,000
Dead-end structures	$10,000
Crushed foundations (local transport)	$24,000
Yard gravel (local transport)	$7,000
Total removal costs for HV substation(s)	**$65,000**

4.3 Site access roads and crane pads

For the purpose of removal calculations and at the Customer's request, the Project's 29 km of roads to be removed were assumed to be 16ft wide and about 1 ft deep and underlain by geotextile in line with Project drawings. While this width attempts to capture any shoulder material as well, the assumption that all roads to be removed are 16' wide is likely conservative with respect to the Project design and is expected to therefore cover the cost of decompaction and reclamation of any additional width required due to crane walking. Dump truck capacity is assumed to be 10 yd^3 and all load trips are assumed to be local. The results are reported in Table 4-3.

4.4 Project removal conclusions

Table 4-3 summarizes the total anticipated costs for removing the turbines, collection system, substations, roadways, and met mast from the Project.

Table 4-3 Project removal conclusions

Item	Cost
WTG	$4,529,000
Collection system	$0
HV substation (incl. O&M bldg)	$65,000
Transmission line	$0
Access roads & crane pads	$873,000
Met Masts	$0
Total Project removal cost	**$5,467,000**

5 SALVAGE – DISPOSAL

While it is impossible to predict the exact evolution of an industry 25 years into the future, it is not unreasonable to assume that there may exist by that time consolidated centers that will fully recycle a wind turbine given that many project "decommissionings" or "repowerings" will have been undertaken prior to that time. For example, DNV GL notes that significant attention is being placed by industry and academia alike into possible uses or methods for recycling the wind turbine blades. **DNV GL notes that in this section only, gains are shown as positive and costs to the Project are shown as negative in parenthesis.**

While it may become easier to recycle wind turbines in the future, DNV GL performed this study assuming only the application of present day means. Following the disassembly and removal of all materials from the Project site, four potential destinations for the remediated material are typically envisaged by DNV GL when performing decommissioning studies. These scenarios may add extra cost to the decommissioning budget or offer an opportunity to reclaim some value from the wind power project components to offset against the cost of decommissioning.

1. Low-grade material such as contaminated aggregate, concrete rubble, wood, non-recyclable materials and other mixed general waste will in all likelihood be sent to landfill or incineration at cost to the Project. DNV GL notes that there is a relatively large volume of waste associated with the glass reinforced plastic (GRP) which composes most turbine blades today. It is possible that in 25 years recycling blade GRP into cement fill, roofing shingles or other useful industrial raw materials may be a net positive for the Project, or at least an offset to the cost, but no such projections have been made in the present study: blade GRP has been considered waste.
2. Medium-grade materials such as small- and medium-gauge cabling, small motors, cabinets of mixed electronics, and lighting may be sent to salvage centers to be stripped for parts and sold for re-use or re-processing. This may be done at a nominal, neutral, or negative cost (positive return) to the Project. However, this material may also be sent to landfill if an appropriate third party cannot be found. DNV GL notes that it is difficult to predict future returns of salvage due to the unpredictability of commodity prices.
3. High-grade materials such as large steel components (tower sections, bedplates, hub castings, gearboxes, and steel cables), large-gauge copper and aluminum cabling, aluminum flooring and ladders will be sent to reprocessing centers at a net neutral cost or positive return to the Project. DNV GL notes that it is difficult to predict future returns of reprocessing due to the unpredictability of commodity prices.
4. Reusable components that are deemed to be undamaged, functional and have not fulfilled their design life could be sold back to the manufacturer or its supply chain for a modest second-hand price for refurbishment. Some electrical infrastructure equipment as well as recently replaced turbine components could fall into this category.

Applying a conservative approach, DNV GL only considered items 1, 3, and 4. No resale gains were assumed for item 2—only scrap/disposal value. Furthermore, item 4 was limited only to certain main components within a conservative age range.

5.1 Pricing assumptions

The following assessment is based on DNV GL's decommissioning model which estimates bill of quantities, typical material weights, and ratios for turbine components acquired from the manufacturer's technical specifications or from DNV GL experience when such is not available. The model uses commodity prices and disposal service rates as inputs.

For the Project decommissioning, the following scrap commodity prices are assumed based on the U.S. Geological Survey (USGS)[2]:

- Steel and cast iron: $300/ton
- Copper: $5,000/ton
- Aluminum: $1,400/ton

Weights are in metric tons. It should be noted that the commodity price of metals is volatile and 25-year values are impossible to predict with any degree of certainty.

Because landfill costs are expected to keep rising, DNV GL used a different cost variable for the incineration, recycling or disposal of GRP. Although it is possible that in 25 years technology will be available to extract the fibers from the epoxy laminate for high-grade industrial reuse at a net benefit, DNV GL assumed a net cost to incinerate or low-grade recycle the GRP as a separate cost to landfill. The following landfill costs are assumed:

- GRP disposal (incineration or recycling): $100/$m^3$
- Class 2 landfill, Industrial/toxic waste : $75/$m^3$
- Class 3 landfill, General waste: $35/$m^3$

5.2 Turbines

5.2.1 Salvage and disposal

There should be considerable opportunity to reclaim scrap value from the turbines from the copper in the low voltage cabling, transformer and generator; steel from the tower, hub, drive train and bedplate; and aluminum from the tower internals. The blades and nacelle housing are made from GRP and would have to be disposed.

The following table summarizes the salvage and disposal costs per each turbine. Component weights have been estimated by DNV GL, and/or obtained directly from manufacturer's documentation.

Table 5-1 Turbine salvage values

Component	Net Scrap Value
Blades	$ (6,000)
Hub + blade steel	$ 7,500
Nacelle/hub GRP	$ (500)
Nacelle bedplate	$ 17,000
Main shaft	$ 2,000
Gearbox	$ 7,000
Generator	$ 21,000

Tower steel sections	$	72,000
Internals	$	11,000
Transformer	$	19,500
Crushed foundation	$	(1,000)
Total per WTG	**$**	**150,000**
Total for Project (68 WTGs)	**$**	**10,200,000**

5.2.2 Partial resale of major components

DNV GL considers that at the end of the Project's operating life, which for the purposes of this analysis is assumed to be 25 years, many of the components of the turbines will still be serviceable and have positive value in the secondary parts market. DNV GL considers that the towers and nacelle shells would still be sold as scrap as well as the rest of the major components that were not resold.

During the Project's operations, DNV GL expects a significant number of failures during the Project operating life involving the major components such as the blades, gearboxes, and generators. These components that fail will typically be replaced or refurbished throughout the operating life. DNV GL continually tracks and models the various failure rates for each of the main components across all major wind turbine model types, and has, for purposes of this study, modeled failure rate assumptions for the Project for an assumed25-year life. Operation beyond 25 years is discussed in Section 6.3.

It is assumed that other North American wind power projects with similar wind turbines (either owned by the Customer or not) will be arriving or will have arrived at their design life at the time of decommissioning of the Project, and some will have chosen to operate beyond it. Therefore, a secondary parts market may be assumed to exist that would demand some of the major components being decommissioned from the Project. Using a conservative approach and with the exception of the transformer, only the major components that are five years or younger (i.e., replaced or refurbished during Project years 21 through 25) are considered candidates for resale. Only the gearbox, generator, blades, pitch system, main yaw system, hydraulic unit, power converter, main bearing, and transformer are considered. The transformer is assumed to have a higher design life and so half are considered candidates for resale. It was also assumed that the gearbox and generators would not be replaced in years 24 and 25 of the Project's life.

Table 5-2 summarizes the turbine partial resale valuations performed by DNV GL for the Project's decommissioning scenario. The calculations account for the lost scrap opportunities that will be subtracted from Table 5-2 and presented in Section 6.

Table 5-2 WTG component resale valuations

Component	New Part Cost [$]	Estimated qty. Aged ≤ 5 years (1)	Qty. to Resale (2)	Value at 25% of New	Scrap Loss [$] (3)
Gearbox	$ 275,000	26	26	$ 1,788,000	$ 182,000
Generator	$ 150,000	19	19	$ 713,000	$ 399,000
Blades	$ 250,000	8	8	$ 500,000	$ (48,000)
Pitch system	$ 12,000	23	23	$ 69,000	$ -
Main Yaw	$ 4,500	3	3	$ 3,000	$ -
Hydraulic unit	$ 10,000	22	22	$ 55,000	$ -
Power converter	$ 80,000	25	25	$ 500,000	$ -
Main Bearing	$ 60,000	8	8	$ 120,000	$ -
Transformer	$ 80,000	3	34	$ 680,000	$ 663,000
Gross Resale Total				**$ 4,428,000**	
Minus Loss of Scrap					**$ (1,196,000)**
Net Resale Total					**$ 3,232,000**

(1) Component replaced within the last 5 years of operation according to DNV GL model.
(2) Component assumed effectively resold based on DNV GL engineering judgment.
(3) Partial resale of turbine components means scrap opportunities need to be subtracted from previous calculations; this is taken into account in this column, and therefore the net resale value of turbine components includes this loss of scrap.

5.3 High-voltage substation

There should be opportunity to reclaim metal scrap value from electrical equipment. Yard equipment such as bus work, circuit breakers, grounding transformers, and main transformers contain a significant amount of conductive material such as copper and aluminum. Dead-end and other steel structures contain a significant amount of steel. The substation yard also contains aggregate fill that would be sold. Rubble from the foundation demolition and all other materials would be sent to landfill at cost. The scrap value of the substation is presented in Table 5-3 below.

DNV GL considers that there is a resale market for substation transformers. Therefore, the transformer could be sold as operational second-hand equipment instead of being scrapped. This scenario has been taken into account in Section 6.

5.4 Site access roads and crane pads

For the purpose of removal calculations and at the Customer's request, the Project's 29 km of roads to be removed were assumed to be 16' wide and 0.3 m (~1') deep and underlain by geotextile.

The results of this valuation are presented in Table 5-3 below.

5.5 Salvage – disposal conclusions

The following table summarizes the opportunities from the salvage / disposal analysis. Please note that this table does not incorporate the resale scenarios of Table 5-2. These will be included in Section 6.

Table 5-3 Gross salvage value (without resale of turbine components)

Item	Disposal	Salvage
WTG	$ (544,000)	$ 10,744,000
Collection System	$ -	$ -
HV Substation	$ (9,000)	$ 311,000
Transmission Line	$ -	$ -
Access Roads & Crane Pads	$ (36,000)	$ 397,000
Met Masts	$ -	$ -
Total Project Salvage Return	**$ (589,000)**	**$ 11,452,000**

Note: The value presented does not include the resale returns of turbine components.

6 NET DECOMMISSIONING COST

The net decommissioning cost for the Project is calculated by subtracting the salvage value from the total of the disassembly and removal costs. This report presents two net decommissioning cost breakdowns: Scenario 1 assumes no resale of Project components, and Scenario 2 takes the more likely scenario for the possibility of partial resale of some of the components mentioned in Section 5.2.2.

6.1 Net decommissioning cost – no resale

Table 6-1 summarizes the Project's net decommissioning costs assuming no resale of any Project components other than for scrap value (Scenario 1).

Table 6-1 Project Net decommissioning cost – no resale

Item	Disassembly (A)	Removal (B)	Disposal (C)	Total Costs (D=A+B+C)	Salvage (E)	Net (D+E)
WTG	$5,576,000	$4,529,000	$544,000	$10,649,000	-$10,744,000	-$95,000
Collection System	$0	$0	$0	$0	$0	$0
HV Substation	$138,000	$65,000	$9,000	$212,000	-$311,000	-$99,000
Transmission Line	$0	$0	$0	$0	$0	$0
Access Roads & Crane Pads	$603,000	$873,000	$36,000	$1,512,000	-$397,000	$1,115,000
Met Masts	$0	$0	$0	$0	$0	$0
Mobilization/Soft Costs	$1,394,000	$0	$0	$1,394,000	$0	$1,394,000
Project Totals	*$7,711,000*	*$5,467,000*	*$589,000*	*$13,767,000*	*-$11,452,000*	*$2,315,000*
Total per WTG						**$34,040**
Total Project (68 WTGs)						**$ 2,315,000**

Note: negative values are positive returns to the Project.

6.2 Net Decommissioning Cost – Partial Resale of Selected Components

Table 6-2 summarizes the Project's net decommissioning costs for Scenario 2 which includes some plausible and conservative resale assumptions.

Table 6-2 Project Net decommissioning cost – partial resale of selected components

Item	Disassembly (A)	Removal (B)	Disposal (C)	Total Costs (D=A+B+C)	Salvage/Resale (E)	Net (D+E)
WTG	$5,576,000	$4,529,000	$544,000	$10,649,000	-$13,976,000	-$3,327,000
Collection System	$0	$0	$0	$0	$0	$0
High voltage substation	$138,000	$65,000	$9,000	$212,000	-$1,020,000	-$808,000
Transmission Line	$0	$0	$0	$0	$0	$0
Access roads & Crane Pads	$603,000	$873,000	$36,000	$1,512,000	-$397,000	$1,115,000
Met Masts	$0	$0	$0	$0	$0	$0
Mobilization/Soft Costs	$1,394,000	$0	$0	$1,394,000	$0	$1,394,000
Project Totals	*$7,711,000*	*$5,467,000*	*$589,000*	*$13,767,000*	-$15,393,000	-$1,626,000
Total per WTG						**-$23,910**
Total Project (68 WTGs)						**-$1,626,000**

Note: negative values are positive returns to the Project.

6.3 Operation and subsequent decommissioning beyond year 25

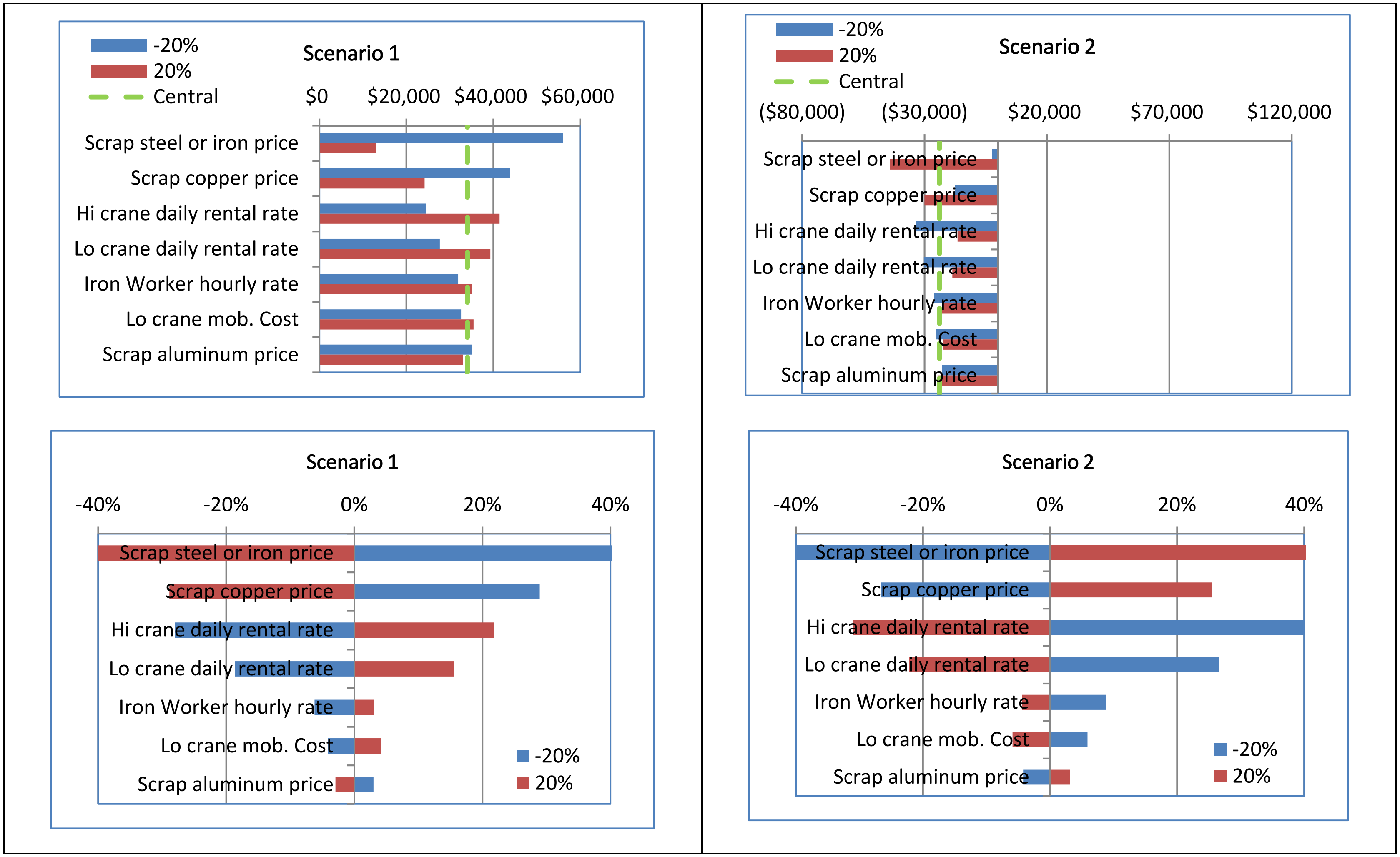
While the estimates presented throughout this report are based on an assumption of decommissioning in operational year 25, DNV GL acknowledges that operation beyond year 25 is a possibility. Presuming the foundations, towers, and electrical plant have been designed for the assumed operational timeframe, DNV GL would estimate the same disassembly, removal, and salvage costs for decommissioning in a year beyond 25 as compared to those presented in this report; however, the estimated revenue from the resale of major WTG components could be impacted. Also, the uncertainty in estimated values associated with longer operational timeframes is increased due to increased uncertainty in analysis inputs such as metal prices.

It is common practice to assume decommissioning will occur when Project structural elements reach a point where the benefit of repair or replacement does not exceed their cost. In the event that site wind conditions (and associated fatigue loading) facilitates normal operational beyond year 25, it can be expected that major WTG component failure rates will also be extended. Thus, DNV GL considers the revenue estimates presented in Table 5-2 would remain the same for decommissioning in a year beyond 25. However, depending on the assumed decommissioning timeframe, DNV GL may not assume any resale value for the WTG transformers as their design life may be exhausted. The lack of transformer resale equates to approximately $1,000,000 of value.

6.4 High-level sensitivity analysis

DNV GL notes that net decommissioning cost estimates are highly dependent on the price of metal, equipment and labor. Figure 6-1 presents a high-level sensitivity analysis of net decommissioning costs per wind turbine where the main input costs/price assumptions were varied by +20% (red bars) and -20% (blue bars). Top graphs show costs in $/WTG while bottom bars present relative changes as percentage points. It is noted that this simple sensitivity analysis does not take into account combined variations of costs/prices.

Figure 6-1 Sensitivity Analysis – Variation of decommissioning costs per WTG.



6.5 Other scenarios

It is stressed that this report is based on broad assumptions regarding the Project; the approach to the decommissioning; the market conditions for contracting costs; and scrap value and resale options. DNV GL recommends that the net costs of decommissioning be reviewed closer to the end of the operating period (e.g., 2 to 4 years prior to the end of operations) when better visibility on these factors would be possible. The value of decommissioning could be reviewed at this time, taking into consideration potential extended operational revenue; if, design and safety conditions warrant, continued operation could be a viable alternative as long as future revenues outpace future expenditures.

Finally, it would be prudent also to take into consideration a “re-powering” scenario, in which case the existing turbines would be removed in the interest of constructing a more valuable project with larger, more efficient turbines. Any cost to remove the old turbines would be incurred as construction costs of the new wind power project.

7 REFERENCES

[1] Email sent by Customer on 14 March 2017

[2] USGS web site: http://minerals.usgs.gov/minerals/pubs/commodity/

APPENDIX A – MAIN ASSUMPTIONS

1100	**Project Basics**	
1101	Wind Power Plant Name	English Farms Wind Project
1102	Construction Status	Starting late 2017
1103	Location	Iowa, USA
1104	No. Wind Turbines	68
1106	Hub Height [m]	94 & 80
1107	Project Capacity [MW]	168.2
1108	Project Design Life (civil, turbine, electrical and financial) [yr]	25
1109	Decommissioning to Occur After Which Project Year	25
1110	No. of Substations to Remove	1
1111	No. of main project transformers	1
1112	No. of O&M buildings to Remove	0
1113	Length of Underground Collection System to Remove [km]	0
1114	Length of Overhead Collection System to Remove [km]	0
1115	Length of Transmission Line to Remove [km]	0
1116	Length of Project Access Roads to Reclaim [km]	29
1117	No. of Meteorological Towers to Remove	0
1118	Average Height of Met Towers [m]	n/a
1119	Met tower type	n/a
1200	**Additional Information**	
1201	COD date	12/31/2018
1202	Warranty term [yr]	n/a
1203	Estimated Annual P50 Production Capacity Factor	n/a
1204	Main step-up transformer voltage [kV/kV]	161/34.5
1205	Main step-up transformer rating [MVA]	178.5
1206	No. of Transmission Line Steel Poles	0
1207	No. of Transmission Line Wood Poles	0
1208	Project Layout	Provided
1209	Breakdown of the number of tower sections per Wind Turbine	4 & 3
1210	Site plan (incl. Electrical layout)	n/a
1211	Construction schedule	n/a
1212	As built or issued for construction (IFC) drawings (civil & electrical)	n/a
1213	Contracts in place or existing quotes/price	n/a

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