Appendix K

DRAFT Decommissioning & Restoration Plan

DECOMMISSIONING COST ESTIMATE

PREPARED FOR:
THREE WATERS WIND FARM, LLC

Ref. No.: 19-09-028463

THREE WATERS WIND FARM
Jackson County,
Minnesota

29 September 2019

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AWS Truepower, LLC
12396 World Trade Dr., Suite 212 | San Diego, CA 92128 | USA
www.ul.com/renewables

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DOCUMENT CONTRIBUTORS

AUTHOR(S)	REVIEWER(S)	APPROVED BY
J. Tchou	K. Kallevig	J. Tchou

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1. INTRODUCTION

AWS Truepower, LLC, a UL Company ("UL"), was retained by Three Waters Wind Farm, LLC ("Client") to conduct a decommissioning cost evaluation for the Three Waters Wind Farm ("Three Waters" or "Project") located in Jackson County, Minnesota.

The decommissioning cost evaluation was completed to estimate costs the Project will incur for removal and disposal of the turbine blades, foundations, and other Project facilities, and for the restoration of the site following the removal of equipment.

The report includes costs and a high-level plan for turbine component removal (disassembly, using cranes, loading on trailers, etc.) as well as foundation removal work (concrete demolition, loading on trucks, turbine pad reclamation, etc.).

For the roads, it has been assumed that all of the access roads will be removed at the end of the useful life of the wind farm. The cost to remove the crushed rock, load it onto dump trucks, and haul it off-site is included in the cost estimate.

The report describes assumptions and cost estimates for the following major decommissioning activities:

- Decommissioning Planning and Permitting;
- Component Disassembly;
- Demolition and Removal; and
- Site Restoration.

The estimated decommissioning costs (including contingency provisions) are separated into wind turbine decommissioning costs (i.e. nacelle, tower, blades, and foundations) and balance of plant ("BOP") decommissioning costs (i.e. substation and transmission line removal, meteorological tower removal, and crushed rock road surface removal).

The report summarizes the assumptions used as well as the limitations of the cost estimate. For the decommissioning cost estimate, UL has not considered inflation, so all costs are assumed to be in 2020 US Dollars ("USD").

As part of the calculations, an estimate of scrap value has been used and it is assumed that all recyclable materials will be recycled to the extent possible to offset decommissioning costs.

2. EXECUTIVE SUMMARY

A decommissioning cost estimate has been prepared for the Three Waters Wind Farm located in Jackson County, Minnesota. The Project is expected to be comprised of 71 of the GE 2.82 MW wind turbine generators ("WTGs") with a 127m rotor diameter and hub height of 89m. The Project includes a short, <1,500 ft generation tie ("gen-tie") line from the Project substation to the point of interconnection ("POI").

This report describes the process for restoring the Project location to its pre-Project state by removing all Project infrastructure, completing site restoration, and properly disposing of materials and waste.

The decommissioning process includes the following activities: pre-dismantling planning activities, road and crane platform reclamation, WTG dismantling and removal, foundation demolition and removal, and removal of the Project substation and gen-tie line.

The basis of the cost estimate assumes the Project will incur costs for removal and disposal of the blades, foundations, and other Project facilities, and for the restoration of the site following the removal of equipment.

The final estimated costs for the decommissioning of the wind farm are as follows:

Table 2.1: Decommissioning Costs, Including 10% for Contingencies and Salvage Value

	Costs (USD)	Costs (USD/WTG)	Salvage (USD)	Salvage (USD/WTG)	Net Cost (USD)	Net Cost (USD/WTG)
Wind Turbine Decommissioning	11,200,820	157,769	-8,590,000	-121,000	2,610,820	36,772
BOP Decommissioning	5,150,955	72,549	-770,800	-10,856	4,380,155	61,692
TOTAL	**11,200,820**	**157,769**	**-9,361,800**	**-131,856**	**2,610,820**	**36,772**

3. DECOMMISSIONING PLAN

3.1 Project Description

The Project is an approximately 201 MW wind project expected to be comprised of 71 of the GE 2.82 MW WTGs with a 127m rotor diameter and hub height of 89m located in Jackson County, Minnesota.

The <1,500 ft generation tie ("gen-tie") line (345 kV) will connect the Project's substation to the point of interconnection.

3.2 Decommissioning Requirements and Assumptions

According to the Client, under Minnesota Rules Chapter 7854.0500, subd. 13, and in accordance with Minnesota Department of Commerce guidance, a decommissioning estimate for the proposed wind farm in Jackson County, Minnesota.

Additionally, the Client has indicated that the following decommissioning considerations are included in Project leases with landowners:

- Below-grade facilities will be removed to not less than 4 feet below grade;
- Below-grade tower foundation areas will be buried with topsoil;
- Tower pad locations will be reseeded with grasses and/or natural vegetation acceptable to the owner; and
- There is no obligation to remove cables, lines, or conduits buried more than 4 feet below grade.

In accordance with the above, UL has assumed removal of below-grade facilities to 4 feet below grade, below-grade foundation areas to be buried with topsoil, and reseeding and reclamation of tower pad locations will be completed. It has been assumed that the underground collection system will be removed as a conservative assumption, but may be left in place if installed below 4 feet.

The landowner leases states that Project-constructed roads may remain unless removal is requested. As such, UL has assumed the removal of all access roads as a conservative assumption.

Costs associated with the decommissioning O&M building have not been included because these facilities are assumed to be requested to be left in place by the landowner for repurposing.

3.3 Decommissioning Tasks

The anticipated life of the Project is estimated to be 35 years. At the end of Project life, depending on market conditions and Project viability, the wind turbines may be "repowered" with new nacelles, towers, and/or blades, thus extending the useful life of the Project and delaying any decommissioning activities. Alternatively, the Project may be decommissioned, which is the option considered for this cost estimate. The purpose of decommissioning activities is to return the Project and surrounding area to its pre-Project state based on the requirements previously discussed.

After the turbines and other secondary facilities are removed, the decommissioning work will include the necessary tasks to restore the area to its original condition. UL has assumed that all of access roads and all the crane platforms will be restored to the previous condition using appropriate material.

All the wind turbines, including towers, generators, and any other equipment, will be removed as part of the decommissioning process. The concrete foundations of all the wind turbines will be removed to a depth of 4 feet below grade and backfilled with surrounding subsoil and topsoil. The parts of the foundations that are deeper than 4 feet will be abandoned in place.

The decommissioning process includes the following actions: pre-dismantling activities, reconditioning of roads, construction of the crane platforms, WTG dismantling, foundation demolition, road and crane

platform dismantling and reclamation, and removal of the collection system, substation, aboveground gen-tie line and two meteorological towers.

- **Pre-dismantling activities:** This activity includes de-energization and isolation from all external electrical lines. Staging areas should be delineated at each turbine site. All decommissioning activities should be conducted within designated areas, including ensuring that vehicles and personnel stay within the demarcated areas.

- **Reconditioning/improvement of roads:** This activity is to complete any widening or resurfacing necessary to allow cranes and machines to access the wind turbines for the purpose of decommissioning activities. All roads and tracks must have enough weight-carrying capacity for each truck axle with a minimum pre-determined road width in straight stretches and a proper layer of graded aggregate. Once turbines are dismantled, these road improvements will be reclaimed.

- **Construction of the crane platforms:** This activity includes clearing the surface vegetation and reconditioning the ground according to the technical specifications of the Project for crane platforms (as they were originally built in the construction phase of the wind farm) in order to provide sufficient area for the laydown of the disassembled wind turbine components and loading them onto trucks. The topsoil at the crane pad will be removed and compacted crushed gravel will be added. The raised area and the foundation of the platforms must be equivalent to the specifications set for tracks that ensure carrying capacity. Once the turbine disassembly is complete, the gravel area around each turbine will be removed, and the area will be restored to prior use using stockpiled topsoil.

- **Dismantling and removal of the wind turbine generators:** This activity includes the process in which the WTGs are dismantled, which will follow an approach similar to the following.
  - Disconnect the tower from the collection system and disconnect the wiring between turbine sections.
  - Disengage rotor from nacelle.
  - Lower rotor to the ground, (either together as a single unit, or removed separately, blade by blade).
  - Separate the blades from the hub and prepare them for transport (this may include chopping of the blades to reduce length for transportation).
  - Remove nacelle from the yaw ring and power cables from generator and control.
  - Lower nacelle to the ground (either together as a single unit or by separation of major components) and prepare for transport.
  - Drain the lubricating oil from the gearbox once it has been placed on the ground, and dispose of the oil in accordance with applicable regulations.
  - Unscrew every tower section progressively from top to the ground and prepare for transport.
  - Collect every power cable, control cabinet, and other components in the tower and prepare for transport.

- **Demolition and removal of the foundations:** This activity will reclaim foundations to 4 feet below the surface and include a process similar to the following.
  - Clear any vegetation.
  - Dig (mechanically) 4 feet deep around foundations.

- Demolish the upper section of the foundations (above ground foundation slab and 4 feet below surface). The resulting concrete and rebar will be hauled off-site and disposed of at a licensed facility.
- Fill the foundation hole with material previously extracted which is typically from the surrounding soils.
- Fill the foundation upper part with topsoil and seed with native vegetation or regrade for farming use.

- **Dismantling and reclamation of the roads and crane platforms:** This activity will include removing the upper aggregate layer of the roads and then covering the area with topsoil and reseeding with native species or regrading for farming. Some additional restoration work may be necessary for sloping terrain.

- **Electrical infrastructure:** This activity will include removal of all necessary electrical infrastructure and includes a process similar to as follows:
  - The above-ground gen-tie line and substation will be removed.
  - The substation's 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 and the fence will be removed.
  - As with the turbine foundation, the substation foundation will be excavated, and the top 3 feet of concrete will be demolished and hauled off-site to be disposed of at a licensed facility.
  - The excavated area will then be filled in with soil, regraded, and seeded with native vegetation or regraded for farming.
  - All materials will be recycled, where possible, or disposed off-site at an approved and appropriate facility.

- **Auxiliary installations:** This activity includes removal of all other auxiliary items and includes removal of potential items similar to those listed below.
  - Road signs along with the necessary restoration of affected land.
  - Meteorological masts, including foundations, along with the necessary restoration of affected land.

3.4 Estimated Decommissioning Cost

The basis of the decommissioning cost evaluation assumes that the Project will incur costs for removal and disposal of the blades, foundations, and other project facilities and for the restoration of the site following the removal of equipment. The cost to remove the Project components and crushed rock, load it into trucks, and haul it off-site will be at the expense of the Project.

The decommissioning estimated costs include the costs to return the site to a condition compatible with the surrounding land and similar to the conditions that existed before development of the Project and as specified by the relevant regulations. Included are the costs to dispose of or recycle the Project's wind turbines as well as the Project's BOP facilities.

The decommissioning costs for the Project have been divided into the following categories.

- **Wind Turbine Decommissioning:**
  - Setup of the crane pad and work area to be used for dismantling of each wind turbine;
  - Dismantling of the wind turbine and removal of all of its components, proceeding in reverse order to assembly operations, including the demolition and removal of the visible part of the foundation and 4 feet below the surface; and
  - Dismantling of the crane pad and work area and reclamation of the surrounding terrain, which reclamation is comprised of gravel removal, flattening of the ground to the original level, and subsequent seeding with native species or regrading for farming.

- **Balance of Plant:**
  - Collection system removal;
  - Project substation removal;
  - Gen-tie line removal;
  - Crushed Rock Road Surface Removal
    - Reconditioning of the site roads for use by the cranes and necessary transportation vehicles used for the dismantling and removal of the wind turbines. This includes flattening the roads, placement of additional gravel, and road compaction according to the Project's specifications;
    - Dismantling of roads and reclamation of the terrain, which reclamation is comprised of gravel removal, flattening the ground to the original level, and seeding of native species or regrading for farming;
    - Dismantling of trenches and reclamation of terrain as well as subsequent sowing of native species or regrading for farming; and
    - Reclamation of terrain in any other areas that were impacted by the Project, but not included in the previous points, including ground improvement; removing and refilling of trenches, piping, road, and platforms with topsoil and reseeding with native species or regrading for farming.
  - Removal of auxiliary equipment such as road signs or metrological towers.

3.4.1 Disassembly Assumptions

For the calculation of the disassembly costs of the Project WTGs, UL has estimated 1.25 days of a wheeled crane and a support crane per wind turbine. UL estimates a price of approximately $61,200 per day for the wheeled and support cranes. The quantity of material of the wind turbine foundations that is less than 4 feet below the surface has been estimated to be approximately 42 cubic meters with a cost to decommission of approximately $192 per cubic meter.

According to the layout of the wind farm, the length of the access roads will be approximately 23 miles. It is assumed that all of the access roads will be decommissioned, as a conservative assumption. The width of the roads is assumed to be approximately 16 feet and they will be remediated to a depth of 4 feet.

For the calculation of the costs it has been assumed that all the crane pads will be reclaimed and an approximate surface area of 600 square meters has been considered for each crane pad. UL estimates a cost of approximately $10 per cubic meter for road decommissioning and preparation for removal.

Based on information provided by the Client, UL has assumed all of 101 miles of underground 34.5kV collection system will be pulled up, the Project substation will be dismantled down to a depth of 4 feet, and the <1,500 ft above ground Project 345kV transmission line will be removed.

3.4.2 Removal Assumptions

After the wind turbines have been disassembled, the costs to transport the dismantled wind turbines have been estimated. These costs depend on the size and weight of the main components (blades, hub and tower) and the transport distance. In the case of the GE 2.82-127, each blade has a length of approximately 62.2m and a weight of 14.6 tons. The nacelle weighs 92 tons and the hub 34.5 tons. Finally, the steel tower has a length of 84m (weight of 240 tons) and is composed of 4 sections. It has been assumed that the transportation distance for wind turbine component disposal is approximately 200 miles.

It is assumed that 66,500 cubic meters of crushed rock will be removed. The estimated dump truck capacity is assumed to be 11.5 cubic meters and the transportation distance is estimated to be 50 miles, for crushed rock, resulting in a removal cost of approximately $18 per cubic meter.

3.4.3 Cost Summary

3.4.3.1 Wind Farm Total Decommissioning Costs

The following tables show the estimated decommissioning costs for wind turbine and balance of plant components, including disassembly and removal.

Table 3.1: Wind Farm Total Decommissioning Costs

	Total (USD)	Per WTG (USD)
Wind Turbine Decommissioning	10,182,563	143,416
Balance of Plant Decommissioning	4,652,687	65,953
TOTAL	**14,865,250**	**209,370**

If a 10% extra is included for contingency, the final estimated costs for decommissioning of wind turbines and balance of plant is as follows:

Table 3.2: Wind Farm Total Decommissioning Costs, Including 10% for Contingencies

	Total (USD)	Per WTG (USD)
Wind Turbine Decommissioning	11,200,820	157,769
Balance of Plant Decommissioning	5,150,955	72,549
TOTAL	**16,351,775**	**230,307**

3.4.3.1.1 Breakdown of Wind Turbine Disassembly Costs

The following table breaks out the wind turbine disassembly costs, including a 10% contingency.

Table 3.3: Wind Turbine Disassembly Costs, Including 10% for Contingencies

	Total (USD)	Per WTG (USD)
Hub and Blades Dismantling	2,091,128	29,453
Nacelle Dismantling	1,792,395	25,245
Tower Dismantling	2,091,128	29,453
Foundation Demolition	632,610	8,910
TOTAL	**6,607,260**	**93,060**

3.4.3.1.2 Project Removal Costs

Removal costs are presented in the following tables, including a 10% contingency.

Table 3.4: Removal Costs, Including 10% for Contingencies

	Total (USD)	Per WTG (USD)
Wind Turbine Removal	4,593,560	64,712
Collection & Substation Removal	694,364	9,780
Transmission Line Removal	2,845	40
Crushed Rock Road Surface Removal	1,302,030	18,338
TOTAL	**6,592,798**	**92,856**

3.4.3.1.2.1 Breakdown of Wind Turbine Removal Costs

The breakdown of the costs related to wind turbine removal are presented, including a 10% contingency.

Table 3.5: Wind Turbine Removal Costs, Including 10% for Contingencies

	Total (USD)	Per WTG (USD)
Blades Removal	606,002	8,535
Hub Removal	637,296	8,976
Nacelle Removal	714,982	10,070
Tower Removal	2,549,184	35,904
Foundation Removal	86,095	1,213
TOTAL	**4,593,560**	**64,698**

UL's estimates and projections of decommissioning costs are based on UL's experience, qualifications, and judgment and from review of the Project's design as well as information from similar projects in the region. These assumptions are based on reasonable expectations of costs from current economic conditions and the assumed requirements of the decommissioning and remediation process. These cost estimates could deviate in the actuality due to weather, cost and availability of labor, material and equipment, labor productivity, construction contractors' procedures and methods, and other factors, and as such UL cannot guarantee the accuracy of its estimates and projections.

The cost estimates were prepared based on current knowledge of site conditions, current regulations, and current hazardous material classifications. UL's estimates do not include allowances for unforeseen environmental liabilities associated with unexpected environmental contamination due to events not considered as part of normal operations, such as fuel tank ruptures, oil spills, etc. Estimates also do not include allowances for environmental remediation associated with changes in classification of hazardous materials. Given these uncertainties, UL has included a contingency margin in all estimates (10% extra).

3.4.4 Salvage Values

The major components of the wind turbines (tower, nacelle, and blades) are modular items that allow for ease of construction and disassembly of the wind turbines during replacement or decommissioning. The salvage potential of decommissioned turbines and balance of plant infrastructure will help the Project's owners to save on decommissioning costs [1]. Many of these components are easily recyclable and there is a mature market for scrap metals. Additionally, transformers and collection lines are designed for upwards of a 50-year lifespan, so these items could potentially be refurbished and sold for reuse.

It is assumed that the nacelle will yield approximately 80% salvageable materials. Since the tower, hub assembly and bedplate is manufactured steel, it is anticipated that they will yield close to 100% salvageable metallic materials. Copper salvage estimates were derived by assuming that 5% of the nacelle weight consists of salvageable copper bearing materials. At the time of writing this report, the composites used in blade manufacturing cannot be recycled. In the absence of a recycling solution at the time of decommissioning, blades will be chipped before disposal at the nearest landfill that accepts them.

Concrete from turbine foundations and unit transformers will be separated from the reinforcing steel and can be crushed and recycled as granular fill material. The steel will then be sold as scrap metal.

It is assumed that most of the aggregate material from the decommissioning of the crane pads, the road aggregate, and the gravel can be salvaged for future use as aggregate base. The remaining materials would be viable for general fill in non-structural fill areas. Any topsoil that cannot be used in site remediation will be given to the landowner, removed and reused, or disposed of.

Based on the Project details, UL has considered the following salvageable quantities of steel, copper, and aluminum.

- **GE 2.82MW 89m HH**
  - Steel: 350 tons/WTG
  - Copper: 5 tons/WTG
- **Collection System**
  - Aluminum: 120 tons
  - Copper: 90 Tons
- **Substation**
  - Steel: 100 tons
  - Copper: 2 Tons
- **Transmission Line**
  - Aluminum: 0.5 tons

Based on a review of U.S. government data [2] and rates published by scrap metal recyclers, UL has assumed the following scrap commodity prices:

- Steel: $260/ton
- Copper: $6,000/ton
- Aluminum: $1,600/ton

Based on the weight of turbine components, and the scrap commodity prices, the following tables estimate the potential salvage value for the above-referenced weights and components.

Table 3.6: Salvage Values

Component	Total (USD)	Per WTG (USD)
Turbine Steel Salvage Value	6,461,000	91,000
Turbine Copper Salvage Value	2,130,000	30,000
Total Turbine Salvage Value	**8,591,000**	**121,000**
BOP Salvage Value	770,800	10,856
TOTAL	**9,361,800**	**131,856**

UL notes that commodity prices are volatile and therefore, UL is not able to comment on the potential pricing of such materials 35 years in the future.

3.5 Waste Management

As discussed above, the waste generated by the decommissioning of the Project is minimal, and toxic waste is not anticipated. Any waste generated, such as gearbox oil, will be disposed of according to the applicable standards with the emphasis on recycling materials whenever possible. Materials will be broken down into manageable sizes for transport to suitable disposal and salvage facilities. The main sources of salvage material are steel, copper, and aluminum, which may be sold to recycling facilities. All non-salvageable components will be processed and safely transported to an approved disposal facility.

3.6 Assumptions and Limitations

This decommissioning cost estimate has been completed to assist the Project owner in fulfilling requirements for review by applicable authorities.

The Project owner will ensure that the decommissioning of the Project is carried out in accordance with safety requirements and the measures/practices as described in this report as well as any conditions imposed by the laws in the US and/or local authorities.

Prior to decommissioning, consultation with the landowners will be conducted to determine the level and type of decommissioning work to be performed on their land. Some infrastructure may be useful beyond the lifespan of the wind farm, such as roads. Although the cost estimate herein assumes removal of all access roads, the owner will confirm with landowners whether certain access roads should remain in-place.

4. REFERENCES

[1] D. Raimi, "Decommissioning US Power Plants - Decisions, Costs, and Key Issues," 2017.

[2] "USGS Commodity Statistics and Information, https://minerals.usgs.gov/minerals/pubs/commodity/," 2019.

[3] Oak Ridge National Laboratory, "Solid Waste From The Operation and Decommissioning of Power Plants," 2017.

[4] S. Ellis, "Before the Committee of Natural Resources Subcommittee on Oversight and Ivestigations Ovesight hearing "GAO Report Documents BLM's Chronic mismanagement of Wind and Solar Reclamation Bonds"," 2014.