Project:	*Heartwood*	Engineer:	*N van Almelo*
Client:	*Ranger Power*	Issue Date:	*6/14/22*
Location:	*Hillsdale County, MI*	Revision:	*Rev 3*

OPINION OF PROBABLE COST - PV PLANT DECOMISSIONING - SAT

The Heartwood Solar Project is a proposed 150 MW solar electric generating facility using ground mounted photovoltaic panels, located on approximately 700-900 acres of land. The vast majority of the site is currently in agricultural use, most of it farmed in row crops. The land will be reclaimed to reengage farming activities to the extent practicable and acceptable to the landowner.

This opinion of probable costs is based on the engineer's experience in the design and construction of energy facilities and are subject to final engineering. This opinion is also based on our experience supervising the construction of PV plants and supervising the demolition of other non-PV facilities. Costs are estimated with best practices at today's values.

This opinion assumes a third-party contractor, experienced in the construction and decommissioning of PV facilities will lead the effort. The reported costs include union labor, permitting, materials, taxes, insurance, transport costs, equipment rental, contractor's overhead, and contractor's profit. Labor costs have been estimated using regional labor rates and labor efficiencies from the Bureau of Labor Statistics.

This opinion of cost has been split between plant disassembly, site restoration, and salvage which reflects the overall decommissioning process. The PV plant will first be disassembled, with all above and below grade components removed. This includes all buried cables, conduits, and foundations. Costs for disassembly are overall less than those for original assembly of the facility. While PV modules will need to be removed by hand to retain their salvage value, the racks, buried cables, and concrete can be removed by machine to increase efficiency. It is assumed that concrete, gravel, and fiber optic cable do not have salvage value and will be disposed off site. Other materials are assumed to have salvage value and can be sold at market prices.

It is expected that the entire site will be re-seeded with native grasses and vegetation. Planting of trees, shrubs, and other woody vegetation (re-forestation) or other beautification is not included in the costs. It is assumed that mulching and stabilization of seeded areas will only be required where gravel roads or concrete foundations were removed. The remainder of site will already be vegetated and disassembly activities will not significantly disturb the vegetation. Seeding in those areas is included as a precautionary measure.

Any permits required will be included as part of the decommissioning effort. Erosion and sediment control best practices will be installed during decommissioning.

Salvage values have been estimated using publicly available data from http://www.scrapmonster.com. Inverters were priced at the rate for Complete Computers, which is lower than what could be attained if they were disassembled on site. Transformers were priced at 80% of the market rate for Sealed Unit Transformers. PV modules were assumed to have residual value as functioning units. They are priced assuming the power output degrades at 0.4% per year for 25 years, and 5% are broken during disassembly. The modules were assumed to have a market price of $0.05/W, which is less than half of the price projection for new modules made by the Department of Energy in year 25. It is assumed that module recycling will be $50/module plus transportation cost to the nearest recycling facility. Due to uncertainty of the salvage market in 25 years, the reported salvage value in the decommissioning summary have been reduced to 1/3 their original value.

Inflation, if included in this estimate has been projected based on the Producer Price Indices (PPI) for Final Demand Construction, Iron Steel Scrap, and Copper Base Scrap. PPI is a more appropriate measure than the Consumer Price Index (CPI) as it is targeted to the specific commodity. Detailed assumptions and the total opinion of cost for decommissioning is provided on the next sheets.[1]

This opinion of probable costs is based on the engineer's experience in the design and construction of energy facilities and are subject to final engineering. The engineer accepts no liability for errors, omissions, or the accuracy and adequacy of this opinion. It is a violation of state law for any person, unless they are acting under direction of a licensed professional engineer to alter this document in any way.

[1]The Project shall revise and update the decommissioning cost estimate every five years from the date of approval to account for inflation, cost and value changes, and advances in decommissioning technologies over the life of the Project.

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PV PLANT ANTICIPATED DISASSEMBLY METHODS	
ITEM	DISASSEMBLY METHOD
PV Modules	Hand Removal. Place modules face down on pallets, tape wire ends, tied down and transport via skid-steer to staging location. Assumed 5% breakage, salvage value for crystalline, no salvage for thin-film.
Inverters	Removal by crane and transport via flat-bed to staging location. Assume no disassembly. Assumed salvage value.
Transformers	Removal by crane and transport via flat-bed to staging location. Assume no disassembly. Oil removal performed by scrap facility. Assumed salvage value.
Racking Frame	Stabilize w/ machine. Cut legs and lower to ground level. Cut cross beams to appropriate size and transport via dump truck to staging location. Assumed salvage value.
Racking Posts	Remove via post-puller and transport via dump truck to staging location. Assumed salvage value.
Racking Wiring	Disconnect PV connectors, cut cable ties, and remove wires from cable tray. Transport via dump truck to staging area. Assumed salvage value.
Underground Cable	Excavate to cable depth at one end of trench. Use tractor or backhoe pull out all cables in common trench. Cables are direct buried so complete excavation of trenches is not required. Transport via dump truck to staging area. Assumed salvage value.
Fence	Machine roll fence fabric. Remove posts via post-puller and transport via dump truck to staging location. Assumed salvage value.
Concrete	Remove with excavator and jack hammer. Backfill and compact as needed. Transport via dump truck to staging area. Assumed offsite disposal.
Gravel	Remove with skid steer with sweeper. Transport via dump truck to staging area. Assumed offsite disposal.
Offsite Disposal	Assumed disposal at $95/ton or $45/CY including tipping fee.
Re-Seeding	Re-seed using an ATV-pulled drill seeder, at 5lbs bulk seed per acre of native grasses. Stabilize and mulch on areas where concrete or gravel was removed only.
Re-Grading	Minor re-grading will be done to restore the site to pre-construction condition.
Erosion & Sediment Control	Install silt fence around project perimeter. Install tracking control at site entrance and replace once during disassembly. Remove at end of disassembly.

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GENERATION SUBSTATION ANTICIPATED DISASSEMBLY METHODS	
ITEM	DISASSEMBLY METHOD
Steel Structures	Disassembled, lowered by crane, and transported via flat-bed to staging location. Assumed salvage value.
Circuit Breakers	Removed from pads and transported via flat-bed to staging location. Assumed no salvage value, and no difference in recycling vs. disposal cost.
Power & Instrument Transformers	Removal by crane and transport via flat-bed to staging location. Assume no disassembly or oil removal of small units, oil drained from main power transformer prior to transport. Assumed salvage value.
Disconnect Switches	Removal by crane, disassemble, and transport via flat-bed to staging location. Assumed salvage value for metal components. Insulators assumed no value.
Insulators and Arresters	Removal from supports. Assumed no salvage value.
Primary Conductor	Cut cable and bus pipe at ends and transport to staging location. Assumed salvage value.
Underground Cable	Excavate to cable depth at one end of trench. Use tractor or backhoe remove all cables and conduits in common trench. Transport via dump truck to staging area. Assumed salvage value.
Pre-Fab Steel Buildings	Rough disassembly on site. Assumed salvage value.
Control Panels	Removal of electronic components. Rough disassembly. Assumed salvage value for electronic and metal components.
Fence	Machine roll fence fabric. Remove posts via post-puller and transport via dump truck to staging location. Assumed salvage value.
Concrete	Remove with excavator and jack hammer. Transport via dump truck to staging area. Assumed offsite disposal.
Gravel	Remove with skid steer with sweeper. Transport via dump truck to staging area. Assumed offsite disposal.
Offsite Disposal	Assumed disposal at $95/ton or $45/CY including tipping fee.
Re-Seeding & Re-Grading	Re-seed using an ATV-pulled drill seeder, at 3.2lbs per acre of native grasses. Use rough grading machine to lower substation pad to native elevation.

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OPINION OF PROBABLE COST - PV PLANT DECOMISSIONING - ANNUAL INFLATION=0% - END OF LIFE: YEAR 30

DISASSEMBLY & DISPOSAL

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
1.0	PV Modules (500 W)	430,860	$ 2.61	$ 1,124,544.60
1.1	PV Modules Recycling	21,543	$ 52.00	$ 1,120,236.00
2.0	PV Inverter(s) (4.2 MVA)	36	$ 839	$ 30,204.00
3.0	PV Transformer(s) (4.2 MVA)	36	$ 419	$ 15,084.00
4.0	ESS Inverter(s) (2MVA)	0	-	-
5.0	ESS Container(s)	0	-	-
6.0	ESS Transformer(s) (2MVA)	0	-	-
7.0	Racking Frame (Single Axis)	3,715	$ 129	$ 479,235.00
8.0	Racking Posts	63,155	$ 12	$ 757,860.00
9.0	Tracker Motors	3,715	$ 14	$ 52,010.00
10.0	Racking Wiring	6,314,212 LF	$ 0.06	$ 378,852.72
11.0	Underground Cable (LV, MV, Comm)	589,290 LF	$ 1.18	$ 695,362.20
12.0	PV Plant Fence	56,629 LF	$ 1.78	$ 100,799.62
13.0	Interconnection Facilities	1 LS	$ 304,070.59	$ 304,070.59
14.0	Concrete	112 CY	$ 129	$ 14,448.00
15.0	Gravel	25,813 CY	$ 24	$ 619,512.00
16.0	Offsite Disposal by Volume	25,927 CY	$ 45	$ 1,166,715.00
17.0	General Conditions Buffer (Per MW Est)	150 MW	$ 2,849	$ 427,350.00
			SUBTOTAL	$ 7,286,283.73

SITE RESTORATION

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
18.0	Seeding	660 ACRES	$ 500	$ 330,000.00
19.0	Grading	1 LS	$ 500,000	$ 500,000.00
20.0	Erosion and Sediment Control	1 LS	$ 148,251	$ 148,251.00
			SUBTOTAL	$ 978,251.00

SALVAGE

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
21.0	PV Modules (500 W)	409,317	$ 22	$ 9,004,974.00
22.0	PV Inverter(s) (4.2 MVA)	36	$ 2,998	$ 107,928.00
23.0	PV Transformer(s) (4.2 MVA)	36	$ 4,032	$ 145,152.00
24.0	ESS Inverter(s)	0	$ 2,998	$ -
25.0	ESS Container(s)	0 LBS	$ 0.18	$ -
26.0	ESS Transformer(s)	0	$ 4,032	$ -
27.0	Racking Frame (Single Axis)	15,425,856 LBS	$ 0.18	$ 2,776,654.08
28.0	Racking Posts	10,420,575 LBS	$ 0.18	$ 1,875,703.50
29.0	Tracker Motors	200,610 LBS	$ 0.39	$ 78,237.90
30.0	Interconnection Steel Structures	48,082 LBS	$ 0.18	$ 8,654.76
31.0	Interconnection Power & Instrument Transformers	355,421 LBS	$ 0.18	$ 63,975.78
32.0	Interconnection Disconnect Switches (1 & 3-Phase)	7,532 LBS	$ 0.81	$ 6,100.92
33.0	Interconnection Primary Conductor	10,447 LBS	$ 0.81	$ 8,462.07
34.0	Interconnection Pre-Fab Steel Buildings	34,500 LBS	$ 0.18	$ 6,210.00
35.0	Control Panels	1,000 LBS	$ 0.18	$ 180.00
36.0	Electronic Controls	383 LBS	$ 0.25	$ 95.75
37.0	LV Wiring (PV Plant & Interconnection)	796,114 LBS	$ 1.86	$ 1,480,772.04
38.0	MV Wiring	438,228 LBS	$ 1.48	$ 648,577.44
			SUBTOTAL	$ 16,211,678.24

	TOTAL DISASSEMBLY, DISPOSAL, & SITE RESTORATION COST	*$ 8,264,534.73*
Atwell, LLC	*TOTAL SALVAGE VALUE [1/3 subtotal due to uncertainty]*	*$ 5,403,892.75*
	NET DECOMISSIONING COST	*$ 3,003,674.08**

6/14/2022

Jared Hicks, PE — Date

Director - Power & Energy

(248) 310-8107

*A five percent increase has been added to the Net Decommissioning Cost of $2,860,641.98 to account for potential additional costs to Fayette Township for legal fees, potential title work, permitting, and/or environmental consulting.