

**Decommissioning Plan  
Wareham Solar Project  
Plymouth County,  
Massachusetts**



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**DECOMMISSIONING PLAN**

**WAREHAM SOLAR ENERGY PROJECT, PLYMOUTH COUNTY, MASSACHUSETTS**

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## 1.0 INTRODUCTION

Wareham PV I, LLC (Wareham PV I), a subsidiary of Longroad Energy Holdings, LLC (Longroad), is proposing to construct the Wareham Solar Energy Project in Plymouth County, Massachusetts. The proposed Wareham Solar Energy Project (the Project) is to be located within the Township of Wareham, Massachusetts. The Project will occupy approximately 18 acres of land (within perimeter fencing) and will have a maximum nameplate generating capacity of up to 3.5 megawatts (MW) alternating current (AC) and four (4) megawatt-hours (MWh) of battery storage capacity. Major components of the Project include solar modules, racking/tracking system, inverters, transformers, battery energy storage system (BESS) and a Project substation. Solar modules being considered include the First Solar Series 6 panels (475 watt) or other similar models.

This Decommissioning Plan (Plan) provides a description of the decommissioning and restoration phase of the Project. The decommissioning phase is assumed to include the removal of Project facilities, including the items listed in Section 1.1 and shown in Figure 1.

This Plan includes an overview of the primary decommissioning Project activities: dismantling and removal of facilities, and restoration of land. A summary of estimated costs and revenues associated with decommissioning the Project are included in Section 4.0. The summary statistics and estimates provided are based on an approximately 3.5-MW Project array design. Wareham PV I acknowledges that the revenue to be realized from resale or salvage of Project facilities will not be considered in calculation of the financial security, described in Sections 4.2 and 4.3.

### 1.1 SOLAR FARM AND BESS COMPONENTS

The main components of the Project include:

- Solar panels and racking system
- Foundations and steel piles
- Transformers and inverters
- Electrical cabling and conduits (underground)
- Perimeter fencing
- Site access and internal roads
- BESS units – batteries and enclosures
- Transmission generation tie-in line (overhead)

### 1.2 TRIGGERING EVENTS AND EXPECTED LIFETIME OF PROJECT

Project decommissioning may be triggered by events such as the end of a power purchase agreement or when the Project reaches the end of its operational life. The Project will be considered to be abandoned if the Project is non-operational for a period of twelve (12) consecutive months. If properly maintained, the expected lifetime of a

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solar project is approximately 40 years with an opportunity for a project lifetime of 50 years or more with equipment replacement and repowering. Depending on market conditions and Project viability, the solar arrays may be retrofitted with updated components (e.g., panels, frame, racking system, etc.) to extend the life of the Project. In the event that the modules are not retrofitted, or at the end of the Project's useful life, the panels and associated components will be decommissioned and removed from the Project site (Site).

Components of the Project facility that have resale value may be sold in the wholesale market. Components with no resale value will be salvaged and sold as scrap for recycling or disposed of at an approved offsite licensed solid waste disposal facility (landfill). The resale value of components has not been considered in this Plan; however, the salvage value of the material scrap value has been estimated in Section 4. Decommissioning activities will include removal of the arrays and associated components as listed in Section 1.1 and described in Section 2.

### 1.3 DECOMMISSIONING SEQUENCE

Per Section 595 of the Town of Wareham Zoning By-Laws, Project facilities and components will be removed within 150 days of a Project which has reached the end of its useful life or has been abandoned. Monitoring and site restoration may extend beyond this period to ensure successful revegetation and rehabilitation. The anticipated sequence of decommissioning and removal is described below; however, overlap of activities is expected.

- Reinforce access roads, if needed, and prepare site for component removal
- Install temporary fencing and best management practices (BMPs) to protect sensitive resources
- De-energize solar arrays
- Dismantle panels and racking
- Remove frame and internal components
- Remove inverters and transformers
- Remove electrical cables and conduits
- Remove BESS components
- Remove structural foundations and backfill sites
- Remove above ground transmission line unless retained for future use
- Remove access and internal roads and grade site
- De-compact subsoils (if required), restore and revegetate disturbed land to pre-construction conditions to the extent practicable

## 2.0 PROJECT COMPONENTS AND DECOMMISSIONING ACTIVITIES

The Project components and decommissioning activities necessary to restore the Project area, as near as practicable, to pre-construction conditions are described within this section.

### 2.1 OVERVIEW OF PROJECT EQUIPMENT

Wareham PV I anticipates utilizing approximately 7,356 solar modules, with a total nameplate generating capacity of up to approximately 3.5 MW<sub>[AC]</sub>. On the approximately 18-acre Site. Statistics and cost estimates provided in this Plan are based on a First Solar Series 6, 475-watt or similar, module.

Electrical cabling will be removed, regardless of depth. Access roads may be left in place if requested and/or agreed to by the landowner. Public roads damaged or modified during the decommissioning and reclamation process will be repaired upon completion of the decommissioning phase.

Estimated quantities of materials to be removed and salvaged or disposed of are included in this section. Most of the materials described have salvage value; although, there are some components that will likely have none at the time of decommissioning. All recyclable materials, salvaged and non-salvage, will be recycled to the furthest extent possible. All other non-recyclable waste materials will be disposed of in accordance with state and federal law in an approved licensed solid waste facility.

Table 1 presents a summary of the primary components of the Project included in this decommissioning plan.

**Table 1 Primary Components of Project to be Decommissioned**

Component	Quantity	Unit of Measure
Solar Modules (approximate)	7,332	Each
Racking System (full equivalent racks)	153	Each
Steel Piles (racking)	1,377	Each
Inverters and Transformers	32	Each
Perimeter Fencing (approximate)	7,300	Lineal Foot (estimated)
Internal Access Roads (approximate)	3,865	Lineal Foot (estimated)
Battery Energy Storage Units	2	Each
Above Ground Transmission Line	1,500	Lineal Foot (estimated)

## 2.2 SOLAR MODULES

Wareham PV I is considering the First Solar Series 6 (475-watt) module or similar model for the Project. Each module assembly (with frame) has a total weight of approximately 76.1 pounds. The modules are approximately 79 inches long and 49 inches in width and are mainly comprised of non-metallic materials such as silicon, glass, composite film, plastic, and epoxies, with an anodized aluminum frame.

At the time of decommissioning, module components in working condition may be refurbished and sold in a secondary market, yielding greater revenue than selling as salvage material. **The potential revenue associated with the sale of modules has not been used in the calculation of net decommissioning cost. Wareham PV I is committed to the responsible handling and recycling of Project facilities.** A cost of transportation and recycling of the solar panels has been included in the decommissioning costs (Table 3), although a net profit from resale would be expected during the first ten years of Project life.

## 2.3 RACKING SYSTEM AND SUPPORT

The solar modules will be mounted on a fixed tilt racking system, such as the Titan racking manufactured by APA Solar Racking. For purposes of cost estimating, equivalent racking approximately 32 meters (105 feet) in length, supporting 48 solar modules in two-in-portrait format, were assumed. Smaller racks will be employed at the edges of the layout, to efficiently utilize available space. The racking system is mainly comprised of galvanized and stainless steel; steel piles that support the system are comprised of structural steel.

The solar arrays will be deactivated from the surrounding electrical system and made safe for disassembly. Electronic components, and internal electrical wiring will be removed and salvaged. The steel piles will also be removed and salvaged.

## 2.4 INVERTERS

Wareham PV I proposes to use the transformerless Sungrow inverters to be located within the arrays. The inverters will be deactivated, disassembled, and removed. Depending on condition, the equipment may be sold for refurbishment and re-use. If not re-used, they will be salvaged or disposed of at an approved solid waste management facility. All oils, lubricants, and hazardous materials will be collected and disposed of at a licensed facility.

## 2.5 ELECTRICAL CABLING AND CONDUITS

The Project's underground electrical collection system will be placed at a depth of three feet (36 inches) or greater below the ground surface. In compliance with Section 595 of the Town of Wareham Zoning By-Laws, all above and below-surface Project components will be removed from the site.

## **2.6 BATTERY ENERGY STORAGE SYSTEM**

The Wareham PV I Energy Project will include a BESS with total energy storage capacity of approximately 2 MW/4 MWh. The BESS equipment will be located adjacent to the proposed Project array within the site perimeter fence. Statistics and estimates provided in this Plan are based on a battery energy storage platform that houses lithium-ion batteries placed on a concrete foundation approximately 8.5 feet wide by 65 feet long. Inverters and transformers will be located on an adjacent concrete foundation (approximately 8.5 feet wide by 20 feet long). The BESS and associated equipment will be deactivated, disassembled, and removed at decommissioning.

The battery units are mainly comprised of non-metallic materials such as lithium-ion, nickel, cobalt, steel, plastic, and epoxies. The enclosures are equipped with heating, ventilation, and air conditioning units, as needed.

Collection cabling will be installed below the surface at a depth of 36 inches (three feet). All above ground and subsurface facilities will be removed and salvaged or disposed of in accordance with state and federal law at a licensed solid waste facility.

If properly maintained, the expected lifetime of a utility-scale BESS is approximately 20 years. At the time of decommissioning, the BESS and container units will be completely removed from the Project site. Based on manufacturer information and projected market conditions, the battery units will likely have substantial resale value for the first 10 years or longer.

The BESS, associated electrical equipment, concrete foundations, and gravel pad will be removed and recycled or properly disposed of. The BESS site will be graded and restored to pre-construction condition, to the extent practicable.

The cost summary in Table 3 includes the estimated costs of removal, packing, shipping, and recycling of the BESS units. Although the resale value of the batteries is expected to be greater than the cost of removal and transportation to the reseller, for the first 10 years of the Project, no resale value has been considered in the estimates provided.

## **2.7 PERIMETER FENCING, SITE ACCESS AND INTERNAL ROADS**

The Wareham PV I facility will include a security fence around the perimeter of the site. An access road will allow access to the substation, BESS, and solar equipment. Internal access roads will be located within the array to allow access to the equipment. The access roads will be approximately 20 feet wide and total approximately 3,800 linear feet (0.72 miles). To be conservative, the decommissioning estimate assumes that all access roads will be completely removed.

During installation of the Project facilities, site access road subgrade conditions will be stabilized by placement of geogrid reinforced granular fills over soft ground. This Plan assumes that eight inches of compacted gravel will be placed over geotextile fabric. The estimated quantities of these materials are provided in Table 2.



**Table 2 Typical Access Road Construction Materials**

Item	Quantity	Unit
Geotextile	8,589	Square Yards
Gravel or granular fill; 8-inch deep	1,909	Cubic Yards

Decommissioning activities include the removal and stockpiling of aggregate materials onsite for salvage preparation. It is conservatively assumed that all Geogrid and aggregate materials will be removed from the Project site and hauled up to five miles from the Project area. Following removal of aggregate and Geogrid, the access road areas will be graded, de-compacted with deep ripper or chisel plow (ripped to 18 inches), backfilled with native subsoil and topsoil, as needed, and land contours restored as near as practicable to preconstruction conditions.

### **3.0 LAND USE AND ENVIRONMENT**

#### **3.1 CURRENT LAND USE**

The proposed solar and BESS facilities are predominantly located on vacant land, bounded by Route 25 to the south, woodlands, wetland resource areas and cranberry bogs to the east, municipal buildings to the west and woodlands to the north. The southern end of the Site is wooded. The northern portion of the Site is previously disturbed as a result of historic sand extraction activities and consists primarily of exposed dirt/sand.

The areas of the Site that are disturbed by Project facilities and activities will be restored and revegetated in consultation with the owner(s) of the Property at the time of decommissioning and in compliance with regulations in place at that time.

#### **3.2 RESTORATION, REVEGETATION AND SURFACE WATER DRAINAGE**

Project sites that have been excavated and backfilled will be graded as needed to provide proper site drainage. Topsoil, if held in reserve from project construction, will be placed on disturbed areas and seeded with appropriate vegetation to reintegrate it with the surrounding environment. Soils compacted during de-construction activities will be de-compacted, as necessary, to restore the land to pre-construction land use.

Surface water conditions at the Project site will be reassessed prior to the decommissioning phase. Wareham PV I will obtain the required water quality permits from the Massachusetts Department of the Environmental Protection (MASSDEP) and the U.S. Army Corps of Engineers (USACE), if needed, before decommissioning of the Project. Storm water permits required at the time of decommissioning will be obtained. Work will be completed to comply with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act (WPA) Regulations (310 CMR 10.00), as well as conditions agreed upon by Wareham PV I and Plymouth County, or as directed by regulations in effect at the time of decommissioning.

#### **3.3 MAJOR EQUIPMENT REQUIRED FOR DECOMMISSIONING**

The activities involved in decommissioning the Project include removal of the Project components: solar modules, racking, battery units, foundations and piles, inverters, transformers, access roads, and electrical cabling and conduits. Restoration activities include back-filling of pile and foundation sites; de-compaction of subsoils; grading of surfaces to pre-construction land contours and revegetation of the disturbed areas.

Equipment required for the decommissioning activities is similar to what is needed to construct the solar facility and may include, but is not limited to: small cranes, low ground pressure (LGP) track mounted excavators, backhoes, LGP track bulldozers, LGP off-road end-dump trucks, front-end loaders, deep rippers, water trucks, disc plows and tractors to restore subgrade conditions, and ancillary equipment. Standard dump trucks may be required to transport material removed from the site to disposal facilities.

## 4.0 DECOMMISSIONING COST ESTIMATE SUMMARY

Expenses associated with decommissioning the Project will be dependent on labor and equipment costs at the time of decommissioning. For the purposes of this report 2022 average market values were used to estimate labor and equipment expenses.

### 4.1 DECOMMISSIONING EXPENSES

Project decommissioning includes costs associated with removal of equipment, transfer of components to facilities for reuse or salvage and recycling or disposal of other solid waste. Materials designated as waste will be disposed of at a licensed facility, as required by local and state solid or hazardous waste regulations. Decommissioning costs also include backfilling, grading and restoration of the proposed Project site as described in Section 2.

Labor and equipment rates used to estimate the decommissioning costs are based on average 2022 rates acquired through RSMeans, an industry accepted construction cost estimating tool, that provides labor and equipment rates. Rates are updated annually. Major categories of labor include electricians, equipment operators and unskilled laborers. Rates include overhead and profit. Major equipment is described in Section 3.3. Table 3 summarizes the estimates for activities associated with the major components of the Project.

In addition to removal and restoration costs, Wareham PV I is committed to the responsible re-use and/or recycling of the decommissioned equipment. Solar modules and lithium-ion batteries will have substantial resale value within the first 10 years of the Project. The cost of solar module recycling ranges widely, and is dependent on variables such as the quantity, location, and the technology and processes in place at the time of recycling. No recycling cost is anticipated for the first 10 years of the Project, due to the value of the equipment. However, a conservative cost estimate of recycling fees, with transportation, for solar panels and batteries anticipated after the first 10 years from commencement of power generation is included in Table 3.

**Table 3 Estimated Decommissioning Expenses**

Activity	Unit	Number	Cost per Unit	Total
Overhead and management (includes estimated permitting required)	Lump Sum	1	\$42,000	\$42,000
Solar modules; disassembly and removal (increased handling of modules for resale)	Each	7,332	\$9.20	\$67,454
Racking system disassembly and removal	Each	153	\$275	\$42,075
Steel pile/post removal	Each	1,441	\$12.50	\$18,013

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Activity	Unit	Number	Cost per Unit	Total
Inverters	Each	32	\$425	\$13,600
Access road excavation and removal	Lump Sum	1	\$9,560	\$9,560
Remove below surface electrical cabling	Linear Feet	4,650	\$0.83	\$3,860
Remove above ground transmission line	Linear Mile	0.28	\$64,000	\$17,920
Perimeter fence removal	Linear Feet	7,300	\$2.80	\$20,440
BESS Removal	Lump Sum	1	\$57,940	\$57,940
Topsoil replacement and rehabilitation of site	Lump Sum	1	\$66,900	\$66,900
Public road repairs	Lump Sum	1	\$7,000	\$7,000
<b>Total Estimated Decommissioning Cost (Facility Removal and Site Restoration)</b>				<b>\$366,762</b>
Estimated Recycling Cost of Solar Panels (with Transportation)				\$161,304
Estimated Recycling Cost of Battery System (with Transportation)				\$115,700
<b>Total Estimated Decommissioning Cost with Recycling of Solar Modules and Batteries</b>				<b>\$643,766</b>

**4.2 DECOMMISSIONING REVENUES**

Revenue from decommissioning the Project will be realized through the sale of the solar facility components and construction materials. As previously described, the value of the decommissioned components will be higher in the early stages of the Project and decline over time. Resale of components such as solar panels is expected to be greater than salvage (i.e., scrap) value for most of the life of the Project, as described below. **Wareham PV I acknowledges that the revenue to be realized from resale or salvage of Project facilities will not be considered in calculation of the financial security.**

Modules and other Project components can be sold within a secondary market for re-use. A current sampling of reused solar panels indicates a wide range of pricing depending on age and condition (\$0.10 to \$0.30 per watt). Future pricing of solar panels is difficult to predict at this time, due to the relatively young age of the market, changes to solar panel technology, and the ever-increasing product demand. A conservative estimation of the value of solar panels at \$0.10 per watt, based on guaranteed purchase prices received on similar projects, would yield \$349,400. Increased costs of removal, for resale versus salvage, are expected in order to preserve the integrity of the panels. These increased handling costs are reflected in the estimated costs provided in Table 3.

The main material of the racking system and piles is assumed to be salvageable steel. The resale value of components such as racking, may decline more quickly; however,

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the salvage value of the steel that makes up a large portion of the racking is expected to stay at or above a value that will provide revenue at the time of decommissioning.

Solar modules are expected to be resold if decommissioned during the first 10 years of the Project. At the end of Project life, the panels would be recycled or salvaged for the components such as glass, silicon with aluminum framing. Alternative and more efficient methods of recycling solar panels are anticipated before this Project is decommissioned, given the large number of solar facilities that are currently being developed.

#### 4.3 DECOMMISSIONING COST SUMMARY

Table 4 provides a summary of the estimated cost to decommission the Project, using the information detailed in Sections 4.1 and 4.2. Estimates are based on average 2022 prices, with no market fluctuations or inflation considered.

**Table 4 Decommissioning Cost Summary**

Item	Cost/Revenue
Decommissioning Expenses (Facility Removal and Site Restoration)	\$366,762
Estimated Recycling Cost of Solar Panels (with Transportation)	\$161,304
Estimated Recycling Cost of Battery System (with Transportation)	\$115,700
<b>Total Estimated Decommissioning Cost with Recycling of Solar Modules and Batteries</b>	<b>\$643,766</b>
<b>Gross Decommissioning with 25 Percent Contingency Added (i.e., 125% of Gross Estimated Decommissioning)</b>	<b>\$804,708<sup>1</sup></b>
Stantec does not concur with the example per megawatt decommissioning costs provided in the National Renewable Energy Laboratory (NREL) table referenced in the December 12, 2022, Wareham Planning Board Meeting. We understand, however, that Wareham PV I (in consideration of the referenced NREL table) has agreed to use the following stipulated costs as initial estimated decommissioning costs, provided that the Planning Board (1) adopts the permit conditions proposed in the December 30, 2022 letter from applicant's counsel to the Board, (2) the applicant is permitted to provide financial assurance in the form of a surety bond, and (3) there is no prohibition on reduction of the financial assurance amount if a future review indicates a reduced estimated decommissioning cost. Total decommissioning costs are based on a 3.5 MW <sub>[AC]</sub> system.	
– \$458,000/MW for the solar equipment decommissioning	<b>\$1,603,000</b>
– \$50,000/MW for the BESS equipment decommissioning	<b>\$175,000</b>
<b>Gross Decommissioning with 25 Percent Contingency Added (i.e., 125% of Gross Estimated Decommissioning)</b>	<b>\$2,222,500<sup>1</sup></b>

<sup>1</sup> Stantec understands that Wareham PV I has agreed to increase the financial assurance amount (or updated financial assurance amount, as applicable) by three (3) percent annually on the anniversary of the Project's commercial operation date.

#### 4.4 FINANCIAL MECHANISM/ASSURANCE

Wareham PV I has indicated that it will comply with Section 595.3 of the Town of Wareham Zoning By-Laws (By-Laws):

*Proponents of ground-mounted solar energy facilities shall provide a form of surety, either through escrow account, bond or otherwise, to cover the cost of removal in the event the town must remove the installation and remediate the landscape, in an amount and form determined to be reasonable by the Town, equivalent to 125 percent of the cost of removal and compliance with the additional requirements set forth herein. Such surety will not be required for municipal- or state-owned facilities. The project proponent shall submit a fully inclusive estimate of the costs associated with removal, prepared by a qualified engineer. The submission shall include a mechanism for calculating and adjusting the increased value of the surety removal costs due to inflation.*

Wareham PV I will post financial security as described in the By-Laws, in the amount of **\$2,222,500**, which represents 125 percent of the total gross estimated removal and recycling costs, with no resale or salvage value considered. Wareham PV I also agrees that the surety amount will be increased by three (3) percent each year, on the annual anniversary of Project commissioning.

## FIGURES

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**Figure 1 Project Layout**



