



Memorandum

To: Gravel Pit Solar, LLC
Gravel Pit Solar II, LLC
Gravel Pit Solar III, LLC
Gravel Pit Solar IV, LLC

Date: May 15, 2020
Updated: July 18, 2020

Project #: 42569.00

From: Susan Moberg PWS, CFM

Re: Gravel Pit Solar Project, East Windsor CT
Carbon Debt Analysis

VHB performed a Carbon Debt Analysis for the proposed Gravel Pit Solar Project (the Project) in East Windsor, Connecticut. The Project is proposed on eight parcels of land totaling approximately 737 acres adjacent to Apothecaries Hall Road, Wapping Road, and Plantation Road (the Project Site). The Project proposes to develop approximately 485 acres as a solar photovoltaic (PV) system. The purpose of this analysis is to determine when the Project will have a net improvement in greenhouse gas (GHG) emissions compared to the loss of 91.2 acres of forested areas. This analysis also accounts for emissions considerations of 229.0 acres of cropland conversion and the emissions associated with upstream activities of the solar PV system.

Methodology and Assumptions

This analysis primarily relied upon United States (U.S.) Environmental Protection Agency (EPA)-derived conversion factors. These included the amount of carbon sequestered in one year by one acre of average U.S. forest (0.77 metric tons [MT] CO₂), the carbon stock in one acre of average U.S. forest (85 MT CO₂), and the carbon stock in one acre of cropland, plus the soil carbon stock and emissions from drained organic soils (22.76 MT CO₂).¹

To estimate emissions avoided by converting 229.0 acres of land from active agriculture (i.e., primarily shade tobacco, with smaller rotations of corn [feed] and other vegetables) to either gravel/compacted roads or cool-season grasses, this analysis used emissions estimates specific to Hartford County provided by Michigan State University's U.S. Cropland Greenhouse Gas Calculator.² This tool accounts for emissions associated with farming activities such as soil tillage, fuel consumption, and fertilizer use. Soybean crop was used as a proxy for all agricultural production at the Project Site so as not to overestimate the benefits of avoiding such activities. Soybean crop has the lowest overall emissions per acre per year among all available inputs within the tool (i.e., corn, wheat, soybean, switchgrass, silage, and oats). For reference, estimated GHG emissions per year for soybean production is 0.15 MT CO₂eq per acre compared to 0.40 MT CO₂eq per acre for corn production.

1 EPA. (2019). "Greenhouse Gases Equivalencies Calculator - Calculations and References." Retrieved 12 May 2020, from <https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>

2 Michigan State University. (2020). "US Cropland Greenhouse Gas Calculator." Retrieved 12 May 2020, from <http://surf.kbs.msu.edu/county/CT/Hartford>

100 Great Meadow Road
Suite 200
Wethersfield, CT 06109-2377
P 860.807.4300

To calculate GHG emissions associated with upstream activities of the Project's system components, this analysis utilized a study from the National Renewable Energy Laboratory (NREL) that estimated total life cycle emissions of solar PV systems to be approximately 40 g CO₂eq per kilowatt-hour (kWh), with upstream activities accounting for up to 70 percent of these emissions (28 g CO₂eq per kWh).³ Upstream activities of solar PV systems include:

- Raw materials extraction;
- Materials production;
- Module manufacture;
- System/plant component manufacture; and
- Installation/plant construction.

Estimated emissions generated, avoided, or sequestered were extended over a 30-year period, which is the assumed lifetime of the Project. This period is consistent with the NREL study on the life-cycle of solar PV systems.

Findings

The carbon debt of the Project is estimated to be 230,104.8 MT CO₂eq over a period of 30 years. This figure includes:

- Tree removal (30-year sequestration loss): 2,864.4 MT CO₂;
- Tree removal (one-time release of carbon stock): 10,538.1 MT CO₂;
- Cropland conversion (30-year emission avoidance): ((1,030.5) MT CO₂eq;
- Cropland conversion (one-time release of carbon stock): 5,212.7 MT CO₂; and
- Upstream activities of solar PV system: 212,520.0 MT CO₂eq.

The Project is expected to produce 253,000 megawatt hours of electricity in its first year of operation. Using non-baseload output emission rates provided by the EPA specific to the Project's eGrid region (NPCC New England),⁴ the estimated annual emissions avoided by the Project is anticipated to be 107,463.6 MT CO₂eq. **Attachment A** provides GHG emissions equivalencies for this estimate. For example, the Project's estimated annual emissions avoidance is equivalent to GHG emissions from 23,217 passenger vehicles driven for one year and CO₂ emissions from 12,401 homes' energy use for one year.⁵

Anticipating a carbon debt of 230,104.8 MT CO₂eq and annual production benefits of 107,463.6 MT CO₂eq, it would take the Project 2.1 years (or 25.7 months) to have a net improvement in GHG emissions.

³ NREL. (2013). *Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics*. Retrieved 12 May 2020, from <https://www.nrel.gov/docs/fy13osti/56487.pdf>

⁴ EPA. (2018). *eGrid Summary Tables 2018*. Retrieved 12 May 2020, from https://www.epa.gov/sites/production/files/2020-01/documents/egrid2018_summary_tables.pdf

⁵ EPA. (2020). "Greenhouse Gas Equivalencies Calculator." Retrieved 12 May 2020, from <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

Attachment A

The sum of the greenhouse gas emissions you entered above is of Carbon Dioxide Equivalent. This is equivalent to:

107,464 Metric Tons

Greenhouse gas emissions from



CO₂ emissions from



Greenhouse gas emissions avoided by



Carbon sequestered by



Source: EPA, 2020