Clearview Solar I, LLC

Clearview Solar

Exhibit G

Summary of Public Outreach

Case No. 20-1362-EL-BGN

December 2020

Clearview Solar Project
Summary of Public Outreach

The following is a summary of the local public outreach by Applicant during the development of the Project and in particular leading up to the filing of the Application:

Social Media

Applicant created a website for the Project in June 2020: https://www.clearviewsolarproject.com/ Applicant regularly updates the website.

Applicant created a Facebook Page for the Project in June 2020: https://www.facebook.com/pages/category/Solar-Energy-Company/Clearview-Solar-Project-101347974960171/ Applicant regularly updates the Facebook page.

Briefing for Township Officials

In March 2020, Applicant met in person with the Trustees of Adams Township and the Township's Zoning Officer to brief them about the Project. The slides used for the briefing are attached as **Appendix A**.

Outreach to Local Officials

In the late spring and summer of 2020, in addition to the officials with Adams Township, Applicant briefed (primarily by telephone and Zoom) the following local officials and organizations about the Project:

- Champaign County Commissioners
- Champaign County Engineer
- Graham Local Schools Board Members and Staff
- Director, Champaign Economic Partnership
- Champaign County Ag Extension Office
- Champaign County Farm Bureau
- Urbana Rotary Club

Meetings with Project Neighbors

In early August 2020, Applicant held a series of four, in-person meetings about the Project with 10 or fewer neighbors at the Firehouse in Rosewood. Each meeting consisted of a 30-minute presentation followed by a 30-minute discussion period. The slides used for the presentation portion of the meetings are attached as **Appendix B**. The written materials about the Project and solar energy that were made available to meeting participants are attached as **Appendix C**.

Local Organizations

Applicant joined the following local organizations or participated in the following local community events:

- Member, Champaign County Chamber of Commerce
- Member, Champaign Economic Partnership
- Sponsor, 2020 Champaign County Fair

Public Information Meetings

Pursuant to the Board's entry issued on August 19, 2020, Applicant held two advertised Public Information Meetings about the Project, as follows:

- Webinar – October 6, 2020 – 6:00 pm. to 8:00 p.m.
- Telephone Meeting – October 8, 2020 – 6:00 pm. to 8:00 p.m.

The same presentation was made at both the meetings, which is attached as **Appendix D**. A summary of the questions asked by the participants and feedback provided by Applicant or Staff is attached as **Appendix E**.

Follow-up Meetings with Project Neighbors

In late October 2020, Applicant held two, in-person meetings with 10 or fewer neighbors at the Firehouse in Rosewood. These were follow-up meetings to the initial meetings held in August. Each meeting consisted of a 30-minute presentation updating the neighbors about the Project followed by a 30-minute discussion period. The slides used for the presentation portion of the meetings are attached as **Appendix F**.

"Virtual" Office Hours

Beginning in mid-October, Applicant started hosting a "virtual" office hour on Zoom on Thursdays. Notices about the office hours were posted on the Project's website and Facebook page. Copies of the initial posts are attached as **Appendix G**.

Letters to and Discussions with Individual Neighbors

Applicant has been reaching out by letter and telephone to many of the landowners in the area of the Project since 2018 as part of its due diligence and acquisition of land rights. Following its briefing of local officials, however, Applicant has sent a number of letters to all of the landowners whose property is adjacent to the area in which the Project is being developed. Each of these letters provided contact information for Applicant. The primary mailings have been as follows:

Time Period	Subject	Enclosure(s)
Early June	Introduction to Applicant and Project	FAQs about solar energy
Late June	Inquiry about Drain Tile	Map for marking drain tile locations USDA drain tile information release form
July	Invitation to Neighbor Meetings	Map showing Project and Neighbor's parcel
Mid-Sept.	Notice of Public Information Meeting	N/A
Early Oct.	Project Update and Landscaping	Map showing revised Project design and landscaping

Applicant has had many individual meetings and telephone calls with a number of different neighbors of the area in which the Project is being developed. Most of the individual discussions have been held as follow-ups to the meetings with neighbors or the Public Information Meetings. Many of these discussions have focused on setbacks, landscaping, drain tile and the relationship of the Project to local water wells.

***

December 2020

Appendix A

OPEN ROAD RENEWABLES

Clearview Solar Project

March 2020

- Overview
- Solar Power & Components
- Economic Benefits
- Community Engagement
- Project Schedule

Separate groups of solar panels in solar farms are connected by buried electrical lines.

Overview

- Adams Township
- 8-10 participating families
- ~900 acres w/solar panels
- Power delivered to DP&L
- Power used locally and in Dayton & Columbus

Solar Components

Piles – steel h-frames driven (no foundations) 5–10 feet deep

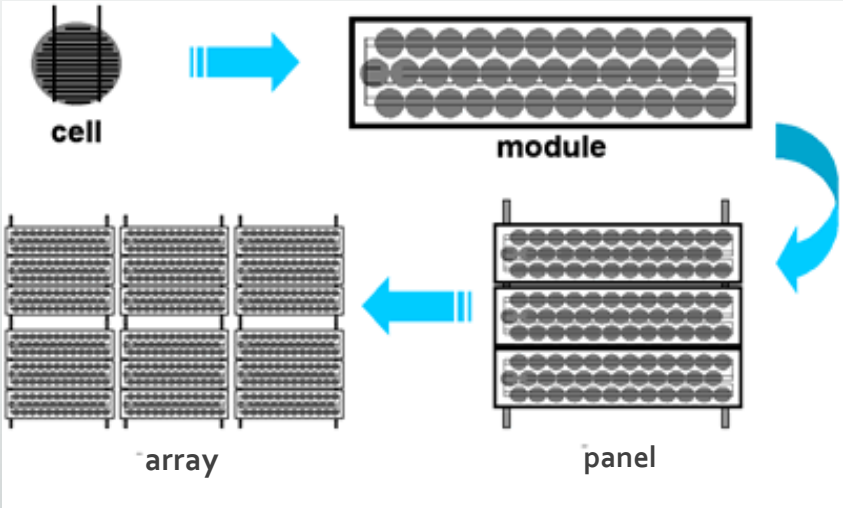
Racking – metal frames mounted on piles

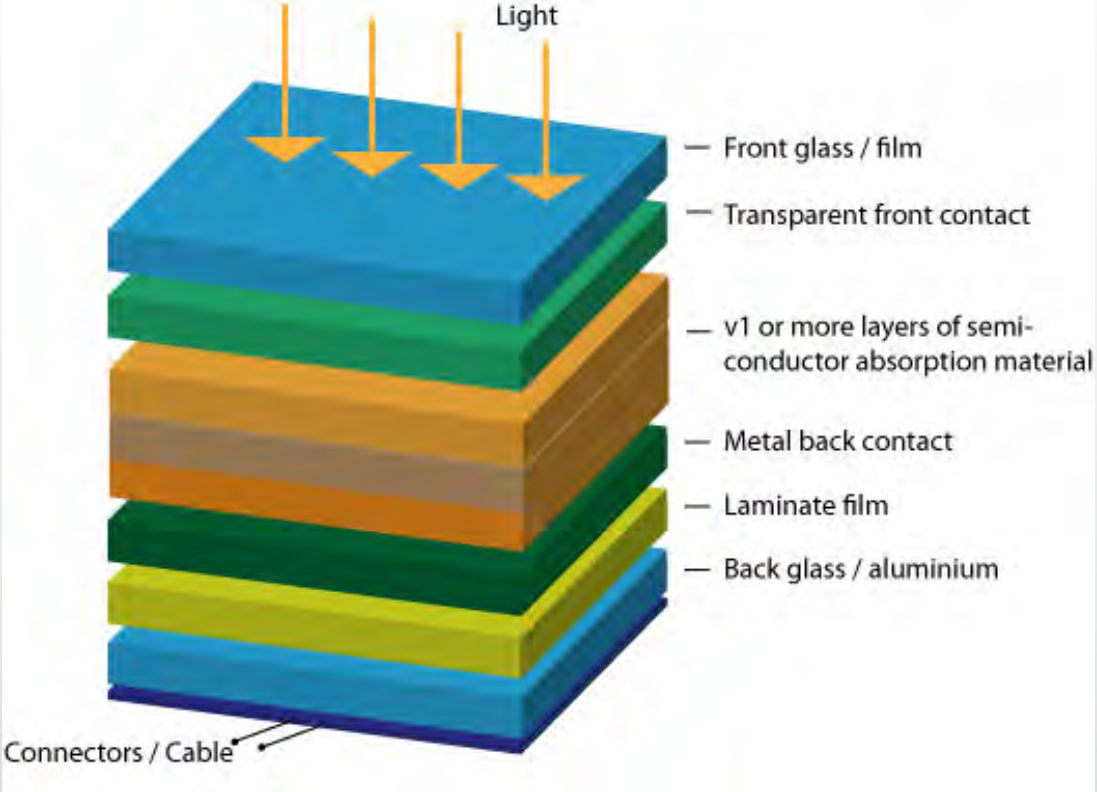
Solar Panels – bolted to racking

How Solar Panels Work

Clearview will use Solar Photovoltaic (PV) technology

Photons from sunlight strike semiconducting material & excite electrons to generate current





Electrical System

- **Inverters** – converts DC to AC; increases voltage; foundation is gravel, skid or pre-fab concrete
- **Collection Lines** – on racking or buried within the solar field (avoid, repair or re-route tile)

Land Use

- 2/3 of land is uncovered
- Few foundations
- Existing drainage is maintained or rerouted
- Minimal grading and compaction
- Topsoil stays on site
- Native turf grass or pollinator cover
- Minimal herbicide use

Operation Impacts

- No odor or emissions
- No dust
- No discernable movement
- Quiet
- Not operated at night
- Minor traffic
- Minimal light

Setbacks & Natural Screening

- Panels have low profile and Project Area is very flat
- Setbacks from external property lines & roads
- Will retain almost all existing trees
- Added vegetation will be needed near homes to improve the view
- Screening will be a green “row” of hedges, short trees and/or native plantings
- Cost is significant, and so not automatically applied to entire perimeter

Removal & Return to Farming

Project is expected to operate for 40 years

Decommissioning Plan will be developed as part of permitting

- Remove equipment
- Return land to substantially original condition
- Ensure tile is functioning for farming

Reclamation Bonding

- Net decommissioning costs estimated by independent engineer
- Conservative estimate method
  - Gross decommissioning costs plus 10% contingency; minus
  - Salvage value minus 10% contingency
- Re-calculated every 5 years

"Modern solar facilities may be considered a temporary, albeit long-term, use of the land, in the sense that the systems can be readily removed from the site at the end of their productive life."

N.C. Clean Energy Technology Center, N.C. State University "Balancing Agricultural Productivity with Ground-Based Solar Photovoltaic (PV) Development" (August 2017), p. 4.

Economic Benefits

Tax Revenue

- $1,008,000/year for life of project
- Revenue is split based on location of the project
- Predictable and long-term
- Low or zero need for taxpayer-supported services

Construction Jobs

- ~200 jobs
- 80% of jobs will be in-state
- Majority do not require specialized skills

Operation Jobs

- 5–9 jobs

Local and Regional Benefits

- Supplier + Contractor Opportunities
- Support for regional manufacturing and fabrication
- Educational Opportunities
- Less reliance on out-of-state generation
- Less coal generation improves air quality, which has health benefits and increases crop yields

Roads, EMS & Education

Qualification for PILOT places other requirements on Clearview

Road Use & Maintenance

Clearview must negotiate a Road Use and Maintenance Agreement with County and Township

- Clearview is responsible for strengthening/upgrading roads
- Clearview will post a bond to ensure repairs during/after construction
- Clearview will restore roads after construction to current condition or better

Emergency Services

Clearview must work with Township and County to provide training and any needed equipment

Higher Education

Clearview must partner with a vocational school or nearby university, for example:

- Curriculum development
- Internship/apprenticeship opportunities
- Funding for training programs or scholarships

Community Engagement

Working with elected officials, county offices, farm bureau, and neighbors is our priority

Meetings

- Public Information Meetings and Presentations
- Updates at meets of Township and County Commissioners
- One-on-one meetings with interested or concerned residents

Information

- Mailings containing information about the project, contact information, and project updates
- Newspaper notices of important meetings and dates
- Informative and frequently updated website

Collaboration

- Local input regarding Drain Tile, Landscaping, and other aspects of project design
- Project personnel will solicit comments and questions, incorporating concerns into project design
- Close collaboration with County and Township offices related to community questions and concerns

Upcoming Briefings

- Soil and Water District – introduce project and discuss drain tile/drainage and ecological surveys
- County Engineer – introduce project and discuss traffic and road survey design, road setbacks, and Road Use and Maintenance Agreement
- School Treasurer/Superintendent – introduce project and discuss PILOT
- County Commissioners – introduce project and discuss project process
- EMS/Fire/Police – introduce project and discuss Emergency Response Plan

Project Schedule

- **Land Rights Acquisition**: In Process through May 2020
- **Grid Interconnection**: In Process through July 2021
- **Local Engagement**: Beginning Spring 2020
- **Site Surveys**: Beginning Spring 2020
- **OPSB Permit**: Fall 2020 through Summer 2021
- **PILOT Application**: Late 2020/Early 2021

OPEN ROAD
RENEWABLES

December 2020

Appendix B

OPEN ROAD RENEWABLES

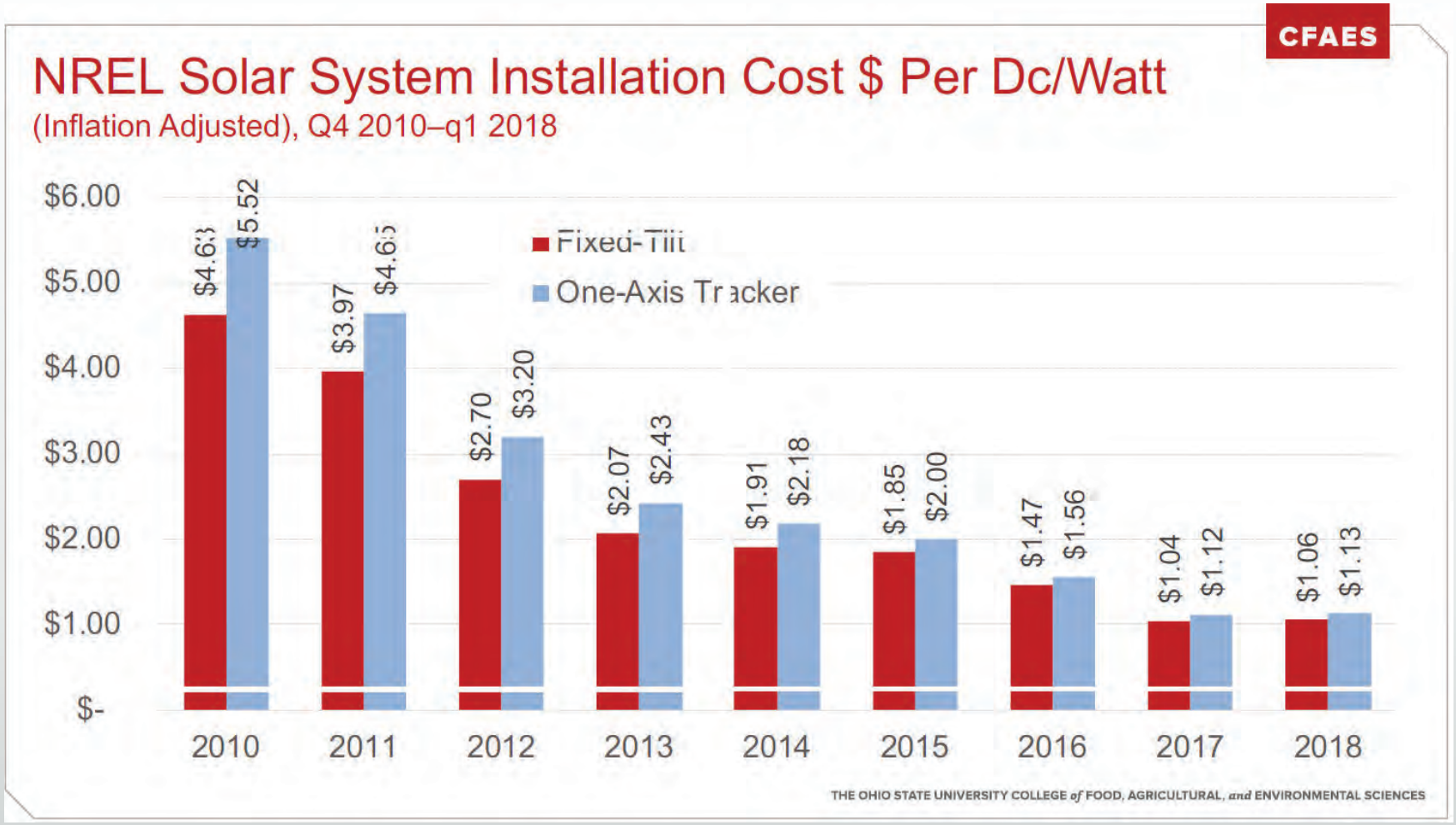
Clearview Solar

August 2020

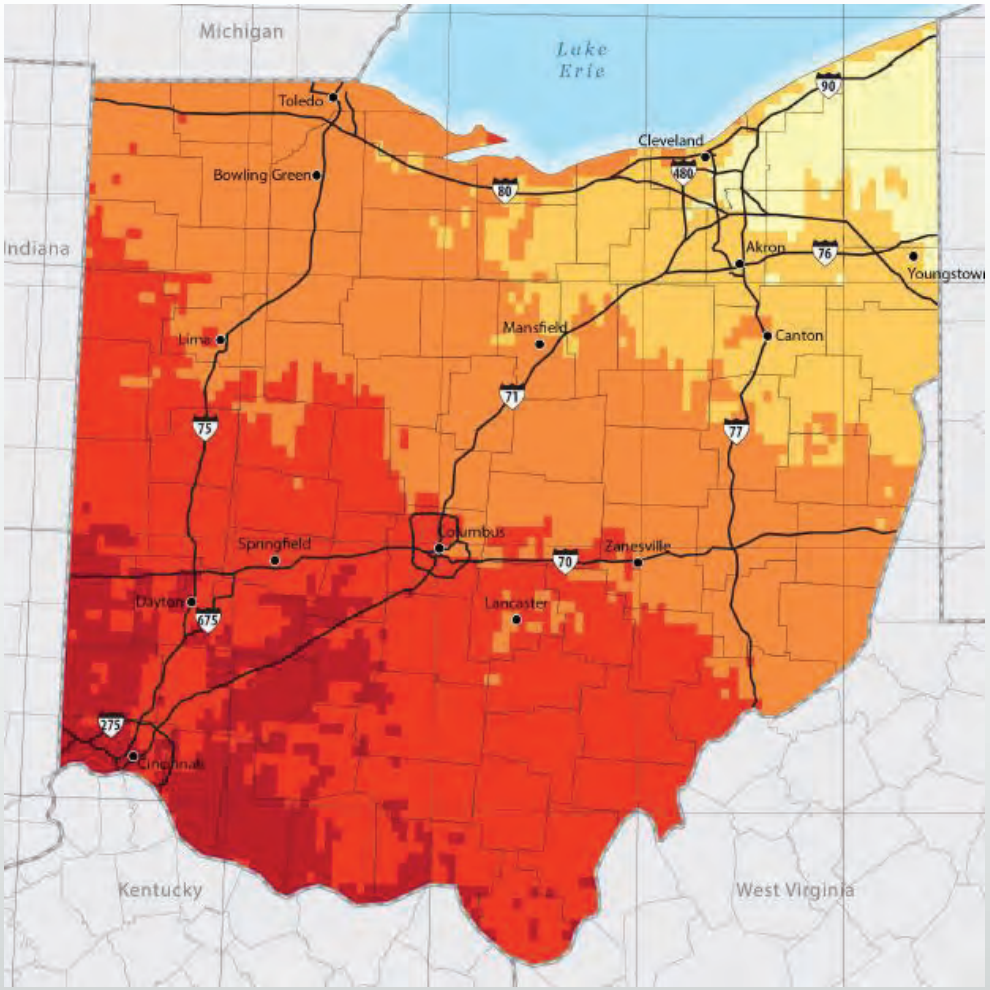
Topics

- Solar Energy
- Land Use
- Operations
- Return to Farming
- Taxes & Jobs
- Location & Appearance
- Permit Process
- Public Input

Reduced Solar Costs



Solar Resource



Transmission System

Solar Projects in Ohio

- **Yellow** = in construction
- **Orange** = approved
- **Red** = being considered

OPEN ROAD RENEWABLES

DP&L Transmission Line

Solar Panels

- 90% of project
- North-south rows
- Rotate to track sun
- Connected with cables
- High edge <15 feet

Secondary Components

- Buried lines
  - Similar to drain tile
  - At least 3 feet depth
- Roads
  - Gravel or grass
- Substation - typical
- Pyranometers
  - Measure solar energy
- Fence
  - Typical is 6 feet
  - Everything above ground

- "Inverters"
  - Convert DC to AC
  - About 1 every 15 acres
  - <15 feet high
  - Gravel, pre-cast block or metal skid

Piles

- No foundations
- 5-10 feet deep
- Drive through topsoil

Land Use

- 2/3 land is open
- Very little grading
- Limited compaction
- Drainage is avoided or redesigned

Land Use

- Topsoil remains
- Native turf grass throughout
- Little herbicide use

Operations

- No air pollution
- No odor
- No dust
- Cannot see panels move
- Quiet
- Not operated at night
- Minor traffic
- Little light

Return to Farming

- Project will operate 40 years
- Required to be removed
- Bonded decommissioning plan

"Modern solar facilities . . . can be readily removed from the site at the end of their productive life."

N.C. Clean Energy Technology Center, N.C. State University "Balancing Agricultural Productivity with Ground-Based Solar Photovoltaic (PV) Development" (August 2017), p. 4.

Taxes & Jobs

- Ohio has a “Payment in Lieu of Taxes” (PILOT) program
- Run by Ohio Development Services Agency
- Steady, annual payment of taxes for life of project – 40 years
- Project receives tax certainty; community receives 15-20x increase in taxes
- Clearview’s PILOT would be >$1.0 million/year
- 80% of jobs must be Ohioans

OHIO JOBS COMMITMENT

Clearview's 200+ construction jobs will be filled by

80% In-State workers

Location & Appearance

Setbacks

- Everything above ground is fenced
- Equipment < 15 feet high
- Minimum setbacks from fence:
  - 25 feet to road ROW (35-40 feet from road edge)
  - 25 feet to property line
  - 150 feet to homes
- Fence to houses mostly far > 150 ft

Trees & Landscaping

- Almost all trees will remain
- Fences near homes will be landscaped
- Landscaping plan being developed
- Committed to working with home owners to design
- Example – next slide


© 2020 Google
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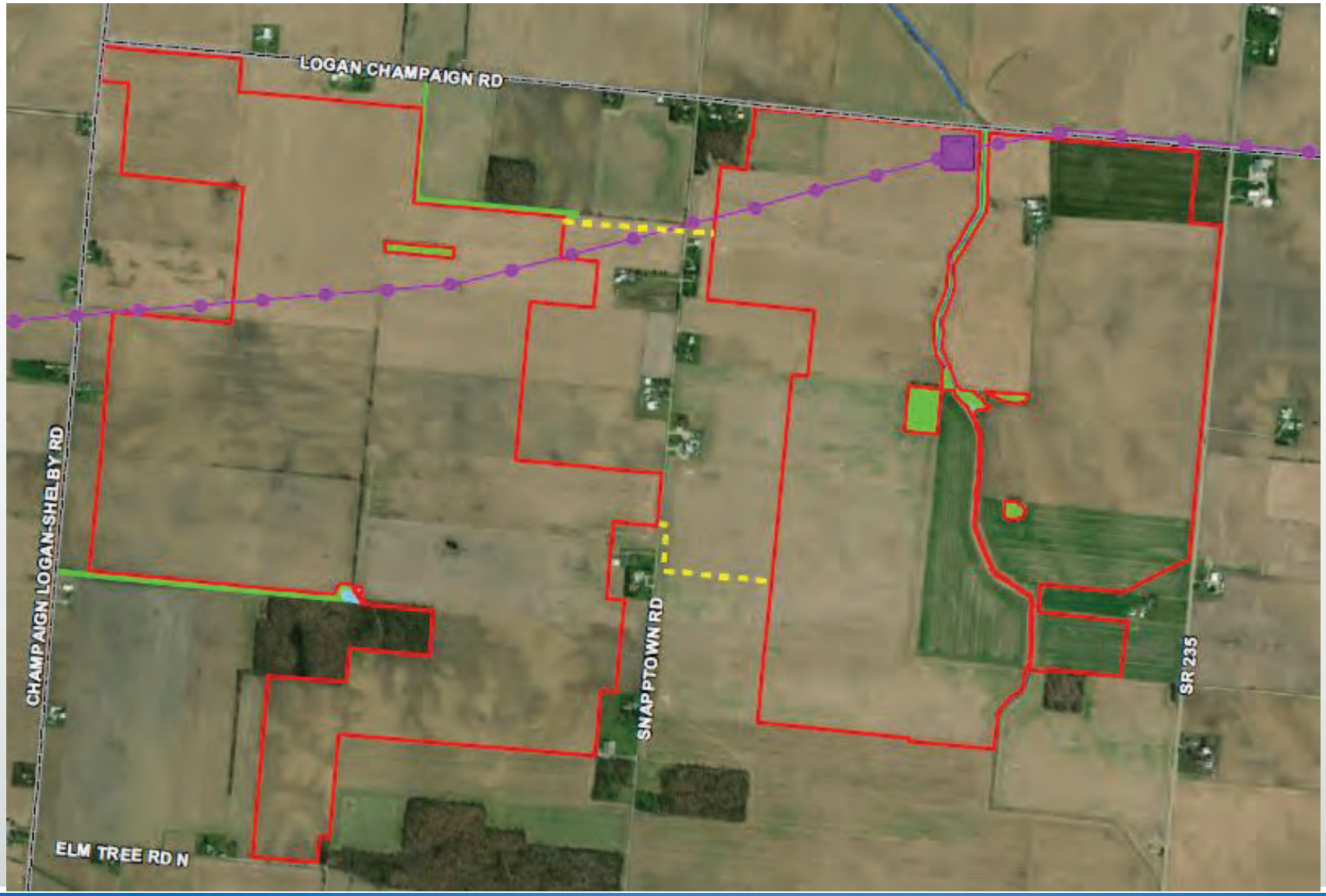
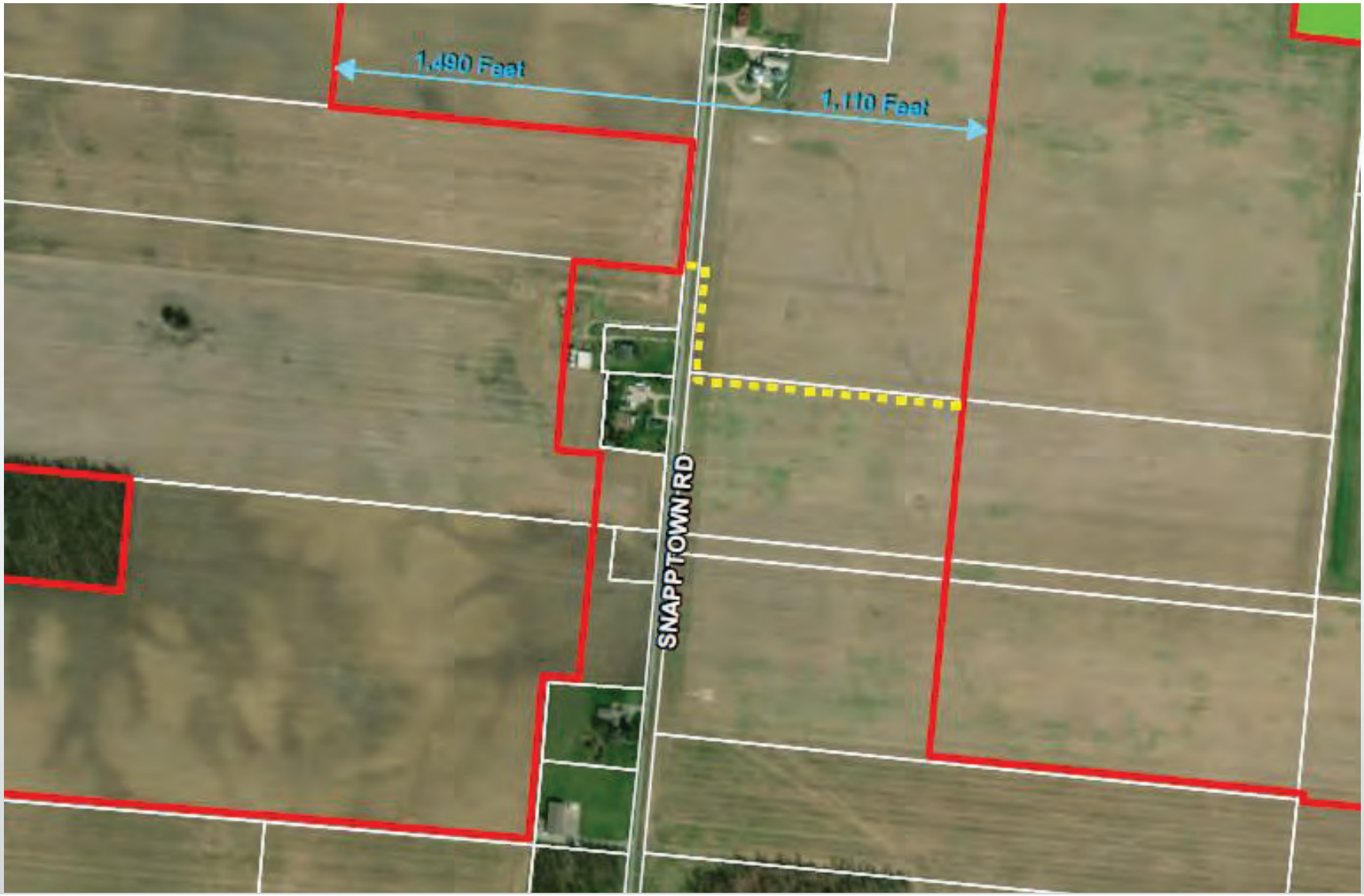
Google earth



Project Boundary

NE Corner

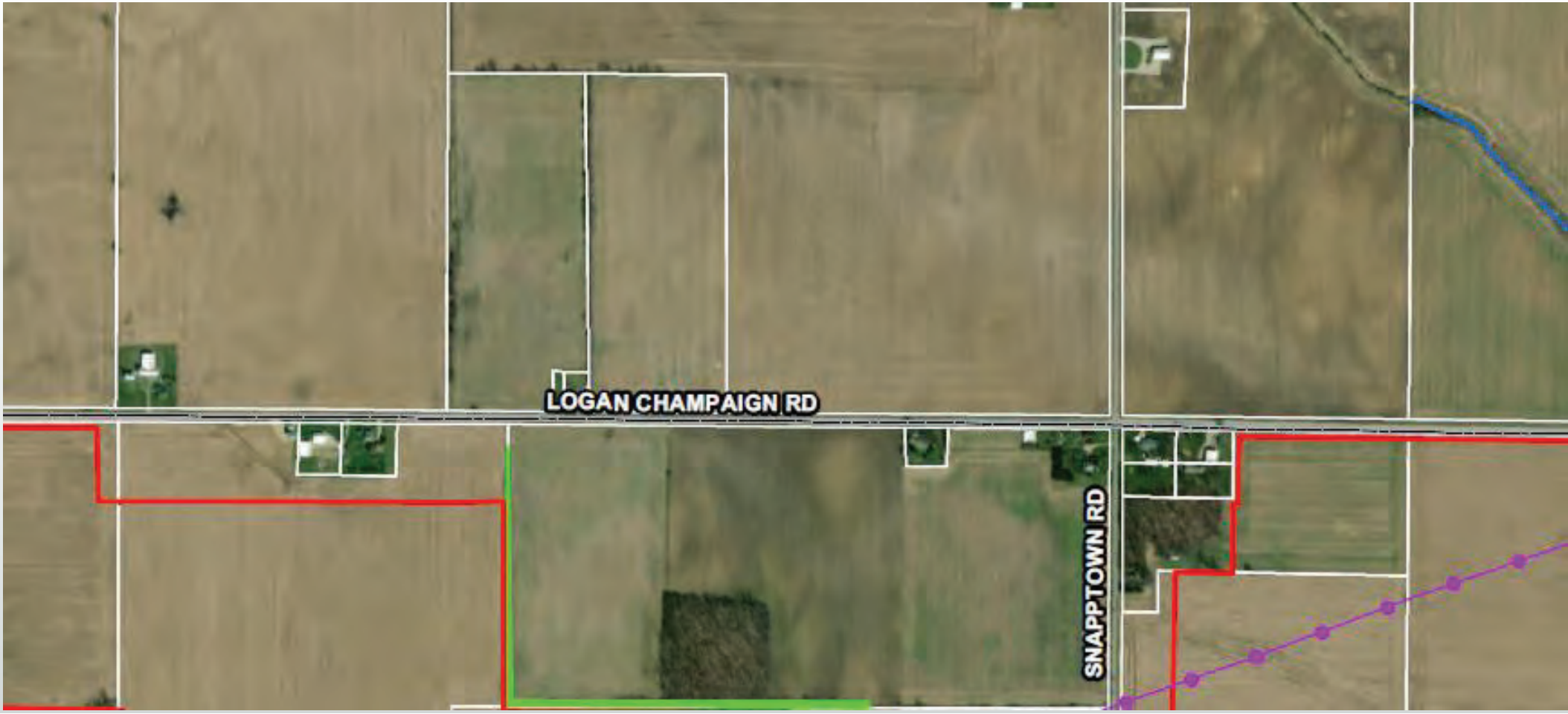
SE Corner



Snapptown South

Snapptown Center

North

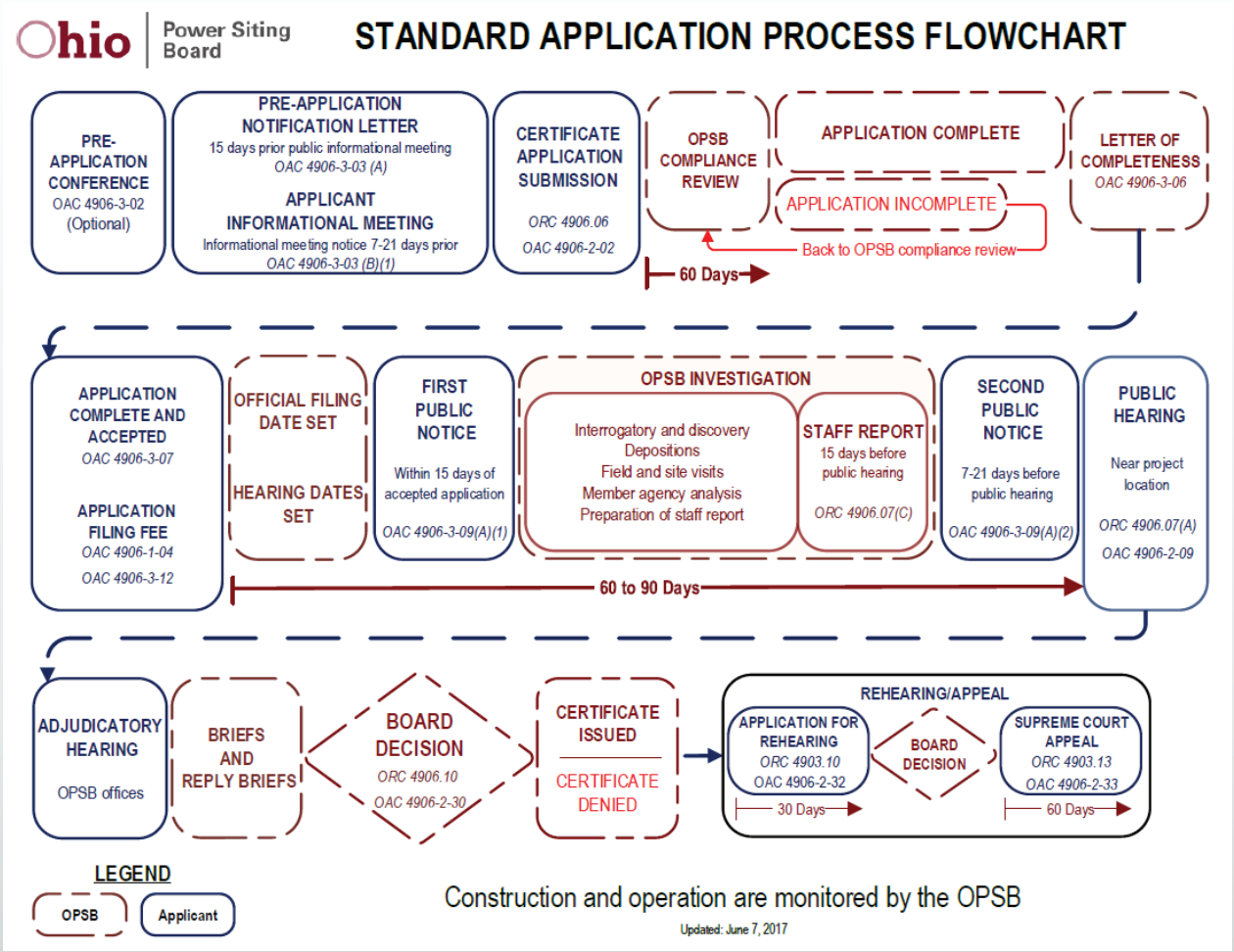


NW Corner

SW Corner

Permit Process

- Ohio Power Siting Board ("OPSB")
- 9-to-12 month process
- Several opportunities for public input



Studies and Surveys

- Wetlands
- Historic
- Archeology
- Sound
- Hydrogeology
- Geotechnical
- Socioeconomic
- Wildlife
- Stormwater Management
- Drain Tile
- Transportation
- Visual
- Vegetation Management
- Decommissioning

Opportunities to Provide Feedback

Clearview Solar

- Contact us (call, text, write, e-mail)
- Website: www.clearviewsolarproject.com
- Facebook: https://www.facebook.com/Clearview-Solar-Project-101347974960171
- We may reach out to you again

OPSB

- OPSB "docket" for project (website)
- May submit written comments at any time
- Will send formal letter notices to neighbors
- "Public Information Meeting"
- "Local Public Hearing"

OPEN ROAD
RENEWABLES

December 2020

Appendix C

SOLAR FARMS
ANSWERS TO FREQUENTLY ASKED QUESTIONS

OPEN ROAD RENEWABLES

Technology

Q. What kind of technology do solar farms use?

A. Solar farms use conventional solar panels just like those installed on the roofs of homes and businesses. This well-established technology has been around for decades.

Q. How do solar panels make electricity?

A. When sunlight hits a solar panel, the electrons in the solar panel's semi-conducting material become energized and create an electric current.

Q. Who uses the electricity from solar farms?

A. The electricity from solar farms goes onto the high-voltage electrical grid that supplies power to everyone. This is different from rooftop solar panels, which mostly deliver power only to the building they are installed on.

Local Economy

Q. Do solar farms require any community services?

A. No. Solar farms require no water service, no sewer service, and no other taxpayer-supported services.

Q. Do solar farms pay taxes?

A. Yes. A solar farm in Ohio pays local taxes of at least $7,000 per "megawatt" each year. So, a 75-megawatt solar farm will contribute over $500,000 new tax dollars each year to the local community.

Q. How many jobs do solar farms create?

A. Depending on its size, a solar farm will create 100-300 jobs during construction. After construction, a solar farm creates a handful of well-paying, long-term jobs for running the facility.

Q. Are there other economic benefits?

A. Yes. Construction of solar farms increases local spending at hotels, restaurants, and gas stations. Land rent payments to participating landowners also provides them a stable long-term source of income.

Cost

Q. Isn't solar too expensive?

A. No. Innovation and competition have dramatically reduced the cost of solar in recent years. In many areas, solar now costs about the same or less than traditional sources.

Q. Will a solar farm near me increase my power prices?

A. No. Not only are solar farms cost-effective, but they supply wholesale power, which does not directly affect your retail rates.

Q. Doesn't solar receive federal subsidies?

A. All types of power generation (including coal, gas, hydro and nuclear power) receive economic benefits from certain federal policy incentives, and solar is no exception.

Pollution & Natural Resources

Q. Do solar farms produce any pollution?

A. No. Solar farms cause no air pollution, no water pollution, and generate no hazardous waste.

Q. Do solar farms require any pipelines?

A. No. The fuel for solar farms is sunlight. It is infinite, free and, over long periods of time, highly predictable.

Q. Do solar farms use water?

A. Very little. Usually rain and other precipitation is enough to clean the panels of accumulated dirt and dust, but occasionally they may be manually cleaned with water.

Risks

Q. Are there any risks or dangers living near a solar farm?

A. No. Solar panels are one of the least intrusive and cleanest forms of power generation available. Access to solar farm equipment will be restricted to maintenance personnel.

Q. What are solar panels made of?

A. Solar panels are made of glass, aluminum, silicon (refined sand), and semi-conducting material. The glass is designed to withstand hail and is tempered, like the windshields of cars, and therefore resists breakage.

Q. What about chemicals?

A. Solar panels contain very small amounts of some chemicals, but they are encased within the panel. There are no liquids in the panels. Most solar panels can be disposed of in regular landfills just like household garbage, but most will be recycled in the appropriate regional facilities.

Q. Do solar farms create electromagnetic fields or EMF?

A. All electric lines and equipment, including the lines to homes and businesses and home appliances, create EMF. Research to date has not found any link between EMF and health problems.

Land Use & Farming

Q. What impact do solar farms have on the land?

A. Very little. In flat areas, little earthmoving is needed for solar farms because the steel piles for the panels are installed directly through the topsoil.

Q. Do solar farms have foundations?

A. Almost none. The steel piles for panels generally have no foundations and most other equipment is installed on gravel pads, prefabricated concrete, or metal skids. Fence posts usually have small foundations.

Q. How much of the land in a solar farm is occupied by equipment?

A. Much less than half. Solar panels are spaced apart to prevent shading and allow room for inspections and maintenance of equipment and maintenance of the grounds.

Q. How is storm run-off controlled?

A. Solar farms are required to implement erosion and sediment controls during construction, and, prior to operation, they must obtain a stormwater management permit that implements an approved Stormwater Pollution Prevention Plan to protect the environment and neighbors.

Q. Can fields used for a solar farm be returned to farming?

A. Absolutely. A study by N.C. State University found that solar has only short-term impacts on productivity and is a "viable way to preserve land for potential future farming."

Q. What happens to drain tile on farm fields?

A. Drain tile would be located and preserved during construction to the extent possible. When a solar farm is decommissioned, any affected drain tile systems would be restored.

Appearance

Q. What does a solar farm look like?

A. Solar farms have very low profiles, follow the natural contour of the land, and can be effectively screened with rows of trees and large shrubs, especially in flat areas.

Q. How tall are solar panels?

A. The "high ends" of solar panels usually are 8-12 feet from the ground and are surrounded by a fence at least 6 feet tall.

Q. Can trees and shrubs outside of the fence enhance the appearance?

A. Yes. In flat areas, preserving any existing vegetation and planting a row of evergreen trees and large shrubs can greatly enhance the views near neighbors' homes and along busy roads.

Impacts to Neighbors

Q. Do solar farms makes any noise?

A. Because they have very few moving parts, solar farms come close to operating silently. Some of the equipment makes small sounds but cannot be heard by neighbors.

Q. Do solar farms have any permanent lighting?

A. Virtually none. Motion-activated and downward facing lights are located only at gates and at some equipment.

Q. Do solar panels reflect sunlight?

A. Solar panels are designed to absorb, not reflect, sunlight. In fact, they reflect much less light than glass or water. All but about 2% of the sunlight is absorbed and converted to electricity.

Q. Do solar farms create any traffic?

A. Virtually none. After construction is complete, a few workers in pick-up trucks will inspect and maintain the equipment, maintain vegetation, and occasionally may clean the panels with water.

Q. Do solar farms create any odor or dust?

A. No.

Construction & Decommissioning

Q. How long does it take to build a solar farm?

A. Construction of most solar farms takes from 6 to 12 months, which is much faster than traditional power sources.

Q. What happens at the end of the useful life of the solar panels?

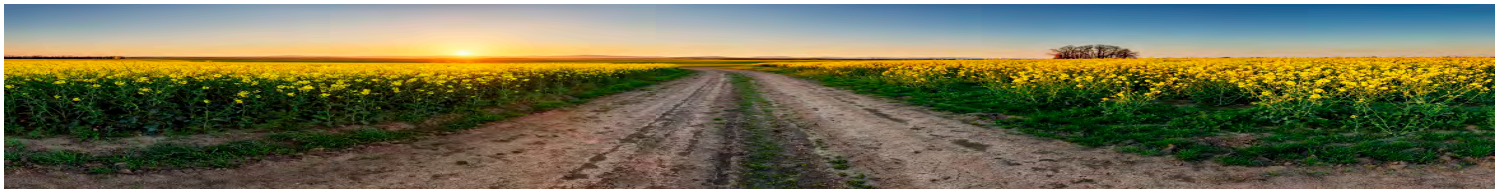
A. After the productive life of the panels, which is 35-40 years, the solar farm will be "decommissioned" and the land returned to its current condition.

Q. What if the owner of a solar farm goes bankrupt?

A. If an owner went bankrupt, it is very likely that a new owner would take over. Solar farms are expensive to build, but reliable and inexpensive to operate. So, there are strong incentives to continue a solar farm's operations.

Q. What assurance is there that the owner will carry out the decommissioning?

A. A financial security, such as a bond, is required to ensure funds are always available for decommissioning and restoration of the land.



WHITE PAPER

Balancing Agricultural Productivity with Ground-Based Solar Photovoltaic (PV) Development

Tommy Cleveland and David Sarkisian
May 2019

NC CLEAN ENERGY TECHNOLOGY CENTER

NC STATE UNIVERSITY

Contents

Balancing Agricultural Productivity with Ground-Based Solar Photovoltaic (PV) Development

Introduction

For centuries North Carolina farmers have made a major contribution to the state's economy by working the land and providing billions of pounds of agricultural and forestry products to meet demands for food and fiber. This resource serves as a foundational economic building block for the state. North Carolina's farming and forestry community provides North Carolinians and people across the world with food and fiber. That said, the demands of our growing, modern society require renewable forms of energy to begin to replace finite non-renewable energy resources that have traditionally provided the means for transportation, electricity, and much more.

Given that land and climatic conditions suitable for agriculture are finite, solar development may compete with agricultural land use. One use converts sunlight and fertilizer into food and fiber, while the other converts sunlight into electricity. The purpose of this paper is to explore the extent to which solar photovoltaic facilities and agricultural production compete for land use, as well as the extent to which agricultural production is affected by solar development. The paper is divided into two sections:

(1) Understanding the Context of Solar Development and Agriculture in North Carolina.
- (1.1) Developing Renewable Energy,
- (1.2) Landowner Land Use Choice,
- (1.3) Solar Facility Construction,
- (1.4) Duration of Solar Use,

(2) Weighing the Impact of PV Development on Agriculture
- (2.1) Solar PV Land Use
- (2.2) Impact on Agricultural Productivity

1. Understanding the Context of Solar Development and Agriculture in NC

This section provides some background on solar development in North Carolina. By illustrating the existing demand for renewable energy (1.1), touching on the state's political climate towards private land use (1.2), and highlighting two important considerations of PV development (1.3 and 1.4), the context surrounding the two competing land uses of solar development and agriculture can be better understood. As agriculture is and has been a dominant, established land use in this state for generations, discussion in this section will primarily focus on the increasing demands of land to be used for solar development.

1.1 Developing Renewable Energy

Currently, almost all of North Carolina's electricity is generated from fuels, such as coal, natural gas, and uranium, which are produced outside the state. Some coal plants in North Carolina are reaching the end of their useful lives and being retired.[1,2] Alternative sources of energy, such as solar and wind, have become much more

economically attractive in the last several years, making it possible to economically replace some nuclear, coal, and gas electricity generation with these sources.[3]

More than three hundred privately financed utility-scale solar facilities operate in North Carolina under current electricity prices, regulations, and policies, with more planned for the future. As with any new technology, price drops and performance improvements may be expected over time as production volumes increase and experience is gained. Since 2009, the total cost to develop and build a utility-scale solar facility in North Carolina has dropped from over $5 per watt to about $1 per watt. This rapid cost reduction in utility-scale solar facilities has greatly improved the financial viability of solar projects; many solar projects are now being planned even without the North Carolina renewable energy tax credit that expired at the end of 2015.[4,5]

In addition to the increasingly attractive economics, some of the shift towards solar energy has been driven by policy choices. Solar and other types of renewable energy have many benefits that have motivated support from policymakers. For instance, they do not use imported fuel, reducing our exposure to fuel price volatility. Solar energy also does not produce the air pollution and greenhouse gases emitted by fossil fuel-powered electricity generation, and it avoids some other environmental risks associated with fossil and nuclear fuels such as coal ash and radioactive waste disposal. Reduction of air pollution has been part of state and national policy for decades, and the U.S. has seen steadily improving air quality as a result[6] Solar and other clean energy sources assist in this ongoing reduction in air pollution.

Solar energy offers many benefits to North Carolina. However, while solar development provides a source of clean in-state energy, it requires land to do so. This means that solar energy projects will sometimes compete with other potential land uses.

1.2 Landowner Land Use Choice

North Carolina policy generally leaves land use decisions in the hands of landowners. That said, the state, local, and federal governments can encourage or discourage specific landowner choices through the incentives or disincentives that they provide for particular uses, as well as through various forms of regulation, such as zoning rules and environmental restrictions. The balance of state-provided incentives for agricultural or solar energy production can, in some cases, be the determining factor in the decision to invest in solar or agriculture development. Also, the current grid infrastructure limits the sites feasible for solar development; it is only feasible to connect solar to certain locations in the grid and only to a limited density.

North Carolina has granted local governments the power to regulate land use in their jurisdictions, although state and federal rules apply in many circumstances. This means that local governments can manage land development with the needs of the community in mind, while also safeguarding natural resources. These land-use regulations can put limits on the allowed uses for some land and thus limit landowners' options, in some cases affecting the viability of solar development. Some agricultural land has been exempted from certain regulations due to "grandfathering," and changing the land use to solar may remove these exemptions, which can affect the ability to return the land to agricultural use in the future.[7]

Land use regulations that may be relevant to solar development, depending on the location, can include (but are not limited to):[8]

- Local zoning and land use rules (fencing, buffer zones between buildings and roads, border shrubs/trees, etc.)
- Floodplain development rules

- Erosion and sedimentation rules
- Permitting regarding military and air traffic impact
- Water quality rules (i.e. Neuse nutrient strategy rules, Coastal Area Management Act rules)
- USDA wetlands impact rules

To determine whether these and other rules are relevant for a potential solar development, landowners and solar developers should consult their local government planning departments, the Soil and Water Conservation Division of the N.C. Department of Agriculture and Consumer Services, the USDA Natural Resources Conservation Service office, and the USDA Farm Services Agency.

1.3 Solar Facility Construction

Solar panels are supported by steel or aluminum racks. The racks are attached to galvanized steel posts driven 6-8 feet into the ground without concrete, although very occasionally, site conditions require the use of cement grout in the pile hole. The only concrete is generally at the inverter/transformer pads which are typically about 10' by 20' each. There is usually no more than one such pad per MW of AC capacity. At some sites these pads are precast concrete or steel skids that sit above grade on helical steel piers. Much of the wiring at the site is above-ground attached to the racking under the rows of panels. The rest of the wiring is 2 to 3 feet underground either as direct-bury cables or in 2"-6" PVC conduit. Most sites involve minimal grading of the land.

Every site provides access for vehicles, which requires roads, or "access aisles," to be constructed. These roads are sometimes improved with gravel, but they do not require application of concrete or asphalt. Many sites only use gravel close to the entry to the public Right of Way, as required by NCDOT regulation, with the rest of the access aisles as simply compacted native soil. Some developers use reusable wooden logging mats to provide temporary stabilization during construction to avoid the need for the addition of gravel. A best practice when building a gravel access aisle is to strip the organic topsoil, place a geotextile fabric under the aggregate and redistribute the topsoil on site to assist in soil stabilization. This will provide stability for the aggregate, allow for more efficient removal of the gravel at the end of the project's life cycle by providing separation between aggregate and subgrade, while preserving the valuable topsoil on site for future agricultural use. Well-drafted leases will specify allowable construction techniques and locations of roads and other infrastructure. The NC Department of Environmental Quality (DEQ) requires soil erosion and sedimentation control plans and permits and inspects implemented measures on the site until vegetative groundcover is established.

1.4 Duration of Solar Use

Currently in North Carolina most utility-scale solar projects have a 15-year Power Purchase Agreement (PPA) with the local electric utility. Some developers prefer to purchase the land, while others prefer to lease, depending on the project's business model and financing arrangements. Typical land leases have a term of 15 to 30 years, often with several optional 5-year extensions.[10] While specific lease rates are generally undisclosed, in our understanding lease rates often range between $500 and $1,000 per acre per year. Most solar PV panel manufacturers include a 25-year power warranty on their panels, which cover the panels to produce at least 80% of their original power output at the expiration of the warranty period.

Modern solar facilities may be considered a temporary, albeit long-term, use of the land, in the sense that the systems can be readily removed

from the site at the end of their productive life. At this point, the site can be returned to agricultural use, albeit with a potential for some short-term reduction in productivity due to loss of topsoil, compaction, change in pH, and change in available nutrients. Leasing farmland for solar PV use, particularly land that is not actively being farmed today, is a viable way to preserve land for potential future agricultural use. PV use is particularly valuable in this regard when compared to commercial or residential development, which require changes to the land that are very difficult to reverse. For landowners struggling to retain ownership of their land due to financial strains, solar leasing may provide a vital, stable income solution. It may also serve as a more appealing alternative to selling their land to buyers intending to use the land for other, more permanent non-agricultural uses.

While it is very difficult to predict the state of electricity, agriculture, and real estate markets 25 or more years into the future, existing circumstances can provide some insight into the likelihood of today's solar facilities continuing as solar facilities at the end of the initial PV modules' useful lifetime. The he economics of existing solar facilities are such that many of the projects built today are likely to update some of their equipment after 20 or more years and continue to operate as a solar electricity facility for many more years. The ability to facilitate interconnection to the electric grid provides great value to a landowner. A parcel of land featuring this capability in today's market will likely also appeal to solar developers in the future due to the infrastructure cost savings.

2. Weighing the Impact of PV Development on Agriculture

The purpose of this section is to explore how the competing land uses of solar development and agriculture interact and can coexist with each other. Subsection 2.1 provides analysis of data and metrics that quantify the current and potential amount of solar development on agricultural land in North Carolina. Subsection 2.2 explores the impacts that solar development could have on future agricultural production on the developed site and neighboring properties. Taken together, Section 2 of this factsheet provides several factors to consider when weighing the impact of PV development on agriculture.

2.1 Solar PV Land-Use

The NC Sustainable Energy Association (NCSEA) with the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) used GIS software to quantify the amount of solar land use. As of December 2016, solar installations occupied 0.2 percent (9,074 acres) of North Carolina's 4.75 million acres of cropland.[11] NCDA&CS has provided an updated estimate; they estimate that 14,864 acres of cropland, or 0.31 percent of the total, were occupied by solar development at the end of the first quarter of 2017.[12] NCSEA and NCDA&CS were able to locate and quantify solar use for 318 of 341 currently-installed utility-scale facilities in North Carolina. A map of the solar installations in the state prepared by NCSEA is available at: http://energyncmaps.org/gis/solar/index.html.[13] The researchers extrapolated the per-MW findings of the 318 sites found in aerial photos to generate an estimate for the remaining 23 projects not yet visible in the latest aerial photography. Across all projects, 79% of solar project area was formerly farmland, defined as land identified from aerial photography to have been used for crops, hay, or pasture before solar development. On average, the solar projects occupied 5.78 acres per MW_{AC}.

N.C. has been losing farmland to various forms of development for many years. Over the last decade, North Carolina has lost about one million acres of cropland to development and housing.

Since 1940, total cropland in N.C. has fallen from 8.42 million acres to 4.75 million acres (as of 2012). The North Carolina Department of Agriculture has identified farmland preservation as one of its top priorities since 2005.

As of the end of 2016, solar PV installations added 2,300 MWAC of solar generating capacity to North Carolina's electricity grid, making NC second in the nation for installed solar PV capacity. These installations generate enough electricity to power approximately 256,000 average N.C. homes, equaling 6.2% of all households in the state.[14] NCSEA and NCDA&CS published the summary of their land-use analysis in February of 2017 and NCSEA released a report on this research in April of this year.[15]

If the current siting and production trends were to continue until ground-mounted solar produced, on average, an amount of electricity equal to *100%* of N.C.'s current electricity use, solar facilities would cover about 8% of current N.C. cropland.[16] This is an unrealistic extreme to illustrate the limited possible magnitude of land usage for solar even at very high solar generation levels, yet even this scenario would occupy only about half of the N.C. cropland acreage lost to development in the last 10 years. Even if solar were to provide all of our electricity, ground-mounted utility-scale solar will almost certainly not be the only source of electricity. As PV prices continue to decline it is likely that North Carolina will see more and more rooftop and parking lot canopies, reducing the need for green field development. A recent Department of Energy study found that rooftop systems have the technical capability to meet 23.5% of North Carolina's electricity demand.[17]

A more likely scenario, even assuming that fossil fuel and nuclear based electricity is entirely phased out, is that other sources of renewable electricity and technologies will meet a large portion of our electricity needs. A Stanford University study of the optimal mix of renewable energy sources for each state to achieve 100% renewable energy found that North Carolina would get only 26.5% of its electricity from utility-scale solar plants.[18] At this still highly expanded level of solar development, based off of the 8.3% land use for 100% solar figure calculated earlier, the amount of NC cropland used for solar would be around 2.2%.

More realistically, in the next decade or two, solar electricity may grow to provide around 5 – 20% of North Carolina's electricity, which would allow solar to meet, or nearly meet, the full requirements of the North Carolina Renewable Energy and Energy Efficiency Portfolio Standard. At the 12.5% REPS requirement, this is about 13 GW_{AC} of PV, which will require about 75,000 acres of land at the average historic density found in the NCCETC/NCDA study. This is not an insignificant amount of land, but if split between agricultural and non-agricultural land at the same ratio as the first 2.3 GW installed in NC this represents about 1.1% of cropland in the state. NCSEA projects that by 2030, utility-scale solar will provide 5.03% of North Carolina's electricity and use 0.57% of available cropland.[19]

Solar energy's land use requirements are comparable to those of existing energy sources. According to an MIT study, supplying 100% of U.S. electricity demand in 2050 with solar would require us of about 0.4% of the country's land area; this is only half the amount of land currently used to grow corn for ethanol fuel production, and about the same amount of land as has been disturbed by surface coal mining.[20]

For landowners interested in solar development, it is important to understand the agricultural value of the land before entering into a solar lease agreement. Careful due diligence in the siting phase can help mitigate the use of the most valuable farmland. Landowners can contact their county tax office for property value information. The following online resources can assist landowners and developers in assessing the agricultural value of land

before selecting the final footprint for solar development:

- www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/dma/ The USDA Natural Resources Conservation Service provides several tools in this link to identify soil types on property.
- www.ncmhtd.com/rye/ The North Carolina Realistic Yields Database provides landowners with a useful mapping and soil analysis tool that produces realistic productivity yields for expected crops given the landowner's property location and soil type.

2.2 Impact on Agricultural Productivity

This subsection provides an overview of impacts that solar development may have on agricultural land. The discussion of these impacts is divided into the following subtopics: construction grading and soil preservation, compaction, erosion, weed control, toxicity, and pollinators, followed by a brief discussion of decommissioning. The subtopic discussions illustrate that solar development, with proper planning and implementation, results in a small but manageable impact on the future agricultural productivity of the land on which it is sited. Further, these discussions also illustrate that solar development is unlikely to significantly affect the agricultural productivity of neighboring properties now or in the future.

Construction Grading and Soil Preservation

The amount of grading necessary to prepare a parcel for a utility-scale solar facility is dependent on the slope of land and the type of solar mounting used. In much of N.C., fixed-tilt mounting of PV requires little to no grading for installation of the PV system. Single-axis tracking systems that slowly rotate each row of panels to track the sun's path across the sky generally require flatter land (typically less than 8% grading) and thus more often require grading of the site, particularly for projects in the Piedmont region or farther west.[21] Typical construction practices require that topsoil be stripped and stockpiled prior to cut/fill operations. The stockpiled topsoil will be redistributed across graded areas, to assist in growing adequate ground cover as quickly as possible to provide ground stabilization. The stripping, stockpiling and redistribution of topsoil in this manner will have some impact on the amount of organics and nutrients that remain in the soil immediately after placement. However, proper ground stabilization practices include soil testing to determine the appropriate levels of lime, fertilizer and seed to be applied to establish ground cover. Proper installation practices require these additives to be tilled into the soil, which effectively reduces the compaction of the upper soil stratum, typically to a depth of 8"-12". Typical solar projects will not remove any topsoil from the project site, partly due to financial implications, but more importantly due to its value in establishing ground cover as quickly as possible[22] (removing soil also requires a mining permit).[23] Most landowners steer solar projects to their least productive soils on a given piece of property to the extent practical.[24]

Soil Quality

Modern agriculture relies on regular additions of lime and fertilizer to maintain soil pH and fertility. Solar facilities maintain vegetative ground covers that can help build soil quality over time, which may require lime and fertilizer to be applied. When the vegetation is cut, the organic matter is left in place to decompose which adds valuable organic matter to the soil. A facility operation and maintenance schedule should include a plan for maintenance of sufficient plant groundcover to protect soil from erosion. Maintaining healthy plant cover will require monitoring of soil fertility and may call for the addition of fertilizer or lime to ensure sufficient

nutrients are available for plant growth and that soil pH is adequate. Vegetation mixes may help balance soil nutrient needs, but will need to be managed. Species composition will change over time.[25] NREL and others are researching and using vegetation mixes that include many native grasses with deep root systems; many include some nitrogen fixing plants as well. According to a study published in July 2016 that measured soil and air microclimate, vegetation and greenhouse gas emissions for twelve months under photovoltaic (PV) arrays, in gaps between PV arrays and in control areas at a UK solar sited on species-rich grassland, UK scientists found no change in soil properties among the three locations. After a solar project is removed, a routine soil test (available from the North Carolina Department of Agriculture) should be obtained to determine fertility requirements, including lime, for optimum crop production.

Compaction

Soil compaction can negatively impact soil productivity and will occur to some degree on every solar site. Soil compaction can also limit water infiltration into the soil environment, and lead to greater surface water runoff during rain events.[27] In addition to the roads built in and around solar project sites, the construction of the facility itself as well as regular use of lawn mowers compacts the soil, decreasing the ability of plant roots to grow. However, use of land as a solar site will avoid agriculture-related activities that can induce compaction, such as tillage. There are no data available on the degree of compaction common at solar facilities, but it is possible that some sites could experience heavy compaction in frequently used areas. In cases of heavy compaction, hard pans in the soil will form that can take decades to naturally free up; however, tractor implements such as chisels and vibrators designed to break up hard pan can often remove enough compaction to restore productivity. To prevent damage to soil due to compaction, landowners can negotiate for practices that will result in the least amount of compaction and for roads to be constructed on less productive land. Additionally, maintaining healthy groundcover, especially varieties with deep root systems, can serve to keep the soil arable for potential future agricultural use. The appropriate use of alternative vegetative maintenance strategies, such as grazing with sheep, can reduce the use of mowing equipment onsite and therefore the compaction that may result from using this equipment.[28] Furthermore, livestock grazing works to cycle nutrients in the pasture ecosystem onsite and improve the soil.

Erosion

According to its current Stormwater Design Manual, the N.C. Department of Environmental Quality allows solar panels associated with ground-mounted solar farms to be considered pervious if configured such that they promote sheet flow of stormwater from the panels and allow natural infiltration of stormwater into the ground beneath the panels.[29] For solar development, an erosion control and sedimentation permit is required, which involves on-site inspections and approval by the North Carolina Department of Environmental Quality. The permit requires establishment of permanent vegetative ground cover sufficient to restrain erosion; according to DEQ staff, the site must be "completely stabilized," although this does not require a specific percentage of ground cover.[30] In-depth information on erosion control and sedimentation laws, rules, principles, and practices is available at the NC DEQ's website, at http://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/erosion-sediment-control-planning-design-manual. Once permanent vegetation is established it will be necessary to maintain soil pH and fertility as mentioned above in order to ensure sufficient, healthy, and continuous ground cover for erosion control.

Weed and Vegetation Control

Maintenance of vegetation on site can be accom-

-plished using several options, including but not limited to the following: mowing, weed eaters, herbicides, and sheep. Reductions in fertilizer use on the site will slow growth of vegetation and weeds. Mowing allows the landowner to have the option of laying cut grass or vegetation on grounds of site to decompose and improve long-term soil fertility. In some cases, landowners have used grazing animals, normally sheep, to frequent the solar site grounds and control the vegetation and weeds, which also returns organic matter to the soil on site.

Like most lawns and parks, many utility-scale solar facilities in N.C. use a combination of mowing and herbicides to maintain the vegetation. When using herbicides, applicators are advised to be mindful of label instructions and local conditions. Herbicide persistence is affected by the organic matter content and moisture level of the soil. The importance of complying with legal responsibilities in using the treatments cannot be stressed enough, especially for land located near surface water, land where the surface is near the water table, or where application might carry over to other neighboring lands.

Herbicide use at solar facilities is typically similar to that in agriculture, and the types of herbicides used are similar between the two uses. As such, the impact of herbicides used at solar facilities on neighboring land and the environment is likely to be no more than that of conventional agriculture. Herbicide use differs widely among different crops and farming techniques, so the change in herbicide appliance between agricultural and solar use will vary in individual cases, but in the aggregate, there is no reason to believe that solar facilities will result in more herbicide impacts on neighboring lands than do current agricultural uses.[31] Herbicide use can be discontinued 1-2 years before decommissioning of a site, minimizing any residual impact on crop production at former solar sites.[32]

A number of sites use sheep at low densities to maintain vegetation during the growing season, although the sheep do not fully replace the need for mowing and/or herbicide use. The sheep are leased from sheep farmers, and the demand for sheep at solar facilities has been beneficial for North Carolina's sheep industry.[33] The grazing of sheep at solar facilities incorporates local farmers into the management of the sites, engaging the local community with solar development. The growth of solar farms represents a huge opportunity for the North Carolina sheep industry, with thousands of acres that are fenced well for sheep, and allow North Carolina farmers to diversify into new agricultural products for which there is increasing demand.[34]

Toxicity

There is no significant cause for concern about leaking and leaching of toxic materials from solar site infrastructure.[35] Naturally occurring rain is adequate to generally keep the panels clean enough for good electricity production. If panels do need to be washed, the washing process requires nothing more than soap and water. Additionally, the materials used to build each panel provide negligible risk of toxic exposure to the soil, environment, or people in the community. Details about toxicity for aluminum and zinc are described below, and more information on the potential for human toxicity can be found in the NCSU Health and Safety Impacts of Solar Photovoltaics white paper.

Aluminum

Aluminum is very common in soils around the world, including those common in North Carolina. In fact, the earth's crust is about 7% aluminum, and most soils are over 1% aluminum![36] The aluminum is generally unavailable to plants as long as the soil pH is above about 5.5. In acidic soils many forms of aluminum become more bio-available to plants; this can be toxic to many plant species.[37] This effect is one of the major reason many plants

do not tolerate very acidic soils. The use of aluminum building materials releases negligible amounts of aluminum during their useful life because the material is so corrosion resistant.[38] The aluminum frames of PV modules are anodized which adds a very thin hard coating of aluminum oxide to the exterior of the aluminum that greatly improves aluminum's already-high resistance to corrosion. Therefore, any minute amount of aluminum that could be released by corrosion from aluminum construction materials during the life of a solar project will not materially add to the thousands or millions of pounds of aluminum naturally present in the soil of a typical N.C. solar facility. The common practice of liming soils to maintain appropriate soil pH for crop systems alleviates most, if not all, concerns about aluminum impacting crop growth in the future.

Zinc

Zinc from galvanized components, including support posts for solar panels, can move into the soil.[39] Zinc from building material stockpiles has been previously noted as a localized problem for peanut production in some North Carolina fields.[40] While it is difficult to predict in advance the degree to which this will occur, it is relatively simple to collect soil samples and monitor this situation in existing installations. Analysis of zinc is included in routine soil testing procedures used by the NC Department of Agriculture & Consumer Services Agronomic Services Division Laboratory. Awareness of zinc concentrations in the soil, and any spatial patterns noted with depth and distance from structures, should allow producers to determine if the field is adequate for desired crops as is. If zinc limitations exist, awareness of concentrations and spatial distribution patterns may indicate the potential for deep tillage, liming, or crop selection alternatives required for successful agricultural use. Of the agronomic crops grown in NC, peanuts are the most sensitive crop to zinc toxicity. Based on information from the N.C. Department of Agriculture and Consumer Services, there is risk of toxicity to peanuts when the zinc availability index (Zn-AI) is 250 or higher, particularly in low-pH situations. Risk increases with increasing soil test levels, especially if pH management through a liming program is not followed. For most other crops, zinc toxicity does not become problematic until the Zn-AI index reaches 2,000-3,000.[41]

Pollinators

Solar projects with appropriate vegetation can provide habitat for pollinators, as well as other wildlife.[42] Rather than planting common turf grasses, some solar facilities are starting to use seed mixes of native grasses and pollinator-friendly flowering plants as ground cover in solar facilities.[43,44] This provides habitat for pollinators, which can be beneficial to neighboring farms. Minnesota passed the country's first statewide standards for "pollinator friendly solar" in 2016. According to Fresh Energy, a clean energy nonprofit in St. Paul, more than 2,300 acres of these plants took root near solar panels last year, according to Fresh Energy.[45] Solar facilities can also cooperate with commercial beekeepers to facilitate honey production, although this may conflict with providing habitat for wild pollinators.[46,47] Pollinators provide benefits for agricultural production at nearby farms where insect-pollinated crops are grown.[48]

Temperature Effects

Solar PV facilities can cause changes in the air and surface temperature of the space in which they are located. The effect of solar PV facilities on surface and air temperatures is different. Solar panels shade the ground on which they are located, reducing the surface (ground) temperature from what it would be without solar panels present.[49] However, solar panels absorb solar radiation more effectively than do typical

agricultural land surfaces due to their darker color, leading to an increase in air temperature directly above the solar panels as the absorbed radiation is released as heat. The decrease or increase for surface and air temperatures, respectively, is around 2-4 degrees Celsius (3.6-7.2 degrees Fahrenheit), depending on the type of land cover in the area.[50, 51]

Temperature effects on land outside the solar facility are much smaller. One study found that an air temperature increase of 1.9 degrees Celsius directly over a solar farm dissipated to 0.5 degrees Celsius at 100 meters in horizontal distance from the solar farm, and less than a 0.3 degree increase at 300 meters.[52] Another study found that a temperature difference of 3-4 degrees Celsius directly above a solar farm was dissipated to the point that it could not be measured at a distance of 100 feet from the solar farm's edge.[53] Meteorological factors can affect the range and size of any temperature effect on land nearby a solar facility, but even under very conducive circumstances the possible temperature increase for nearby land would be on the order of tenths of degrees. Studies have varied on the time at which temperature differences are most pronounced; one study noted as taking place in a desert landscape found that temperature differences were larger at night,[54] while another study found larger temperature differences during midday;[55] differences in weather and landscape between the study locations may be responsible for the different results.

Decommissioning

If land used for a solar facility is to be returned to agricultural use in the future, it will be necessary to remove the solar equipment from the land. This process is known as decommissioning. Decommissioning is basically the construction process in reverse; it involves removal of the solar panels, breakup of support pads, removal of access roads, replacement of any displaced soil, and revegetation.

Solar development often takes place on leased land, although it also occurs on land owned by solar companies. When leased land is involved, it must be determined whether the landowner or the solar developer bears responsibility for decommissioning. Responsibilities for decommissioning are lease-specific in North Carolina. It is important for landowners to consider decommissioning when setting lease terms, although landowners may choose in some cases to accept decommissioning responsibility themselves. Although state rules on solar decommissioning do not currently exist in North Carolina, local jurisdictions can choose to adopt regulations pertaining to decommissioning.

The materials recovered in the decommissioning process have significant economic value, which can help pay for the costs of decommissioning. Some engineering analyses have indicated that the salvage value of recovered materials is more than enough to pay for the removal of all the materials and to return the site to its pre-construction state.[56,57,58,59]

NCSU has produced several resources that provide more information on decommissioning. They include:

- Health and Safety Impacts of Solar Photovoltaics[60]
- Template Ordinance for Solar Energy Development in North Carolina[61]
- Working Paper: State Regulation of Solar Decommissioning[62]
- Landowner Solar Leasing: Contract Terms Explained[63]

Summary

The purpose of this paper is to explore the extent to which competition exists between solar development and agriculture and the extent to which

the agricultural productivity of land is affected by solar development. Discussion on this topic was divided into two sections: (1) Understanding the Context of Solar Development and Agriculture in North Carolina and (2) Weighing the Impact of PV Development on Agriculture. In these sections, information and tools were provided to aid in understanding the impact of solar development on agricultural land. Equipped with the information and tools provided by this paper, landowners may be able to better evaluate the viability of solar development on their land.

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WHITE PAPER

Health and Safety Impacts of Solar Photovoltaics

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NC CLEAN ENERGY TECHNOLOGY CENTER

NC STATE UNIVERSITY

Contents

Health and Safety Impacts of Solar Photovoltaics

The increasing presence of utility-scale solar photovoltaic (PV) systems (sometimes referred to as solar farms) is a rather new development in North Carolina's landscape. Due to the new and unknown nature of this technology, it is natural for communities near such developments to be concerned about health and safety impacts. Unfortunately, the quick emergence of utility-scale solar has cultivated fertile grounds for myths and half-truths about the health impacts of this technology, which can lead to unnecessary fear and conflict.

Photovoltaic (PV) technologies and solar inverters are not known to pose any significant health dangers to their neighbors. The most important dangers posed are increased highway traffic during the relative short construction period and dangers posed to trespassers of contact with high voltage equipment. This latter risk is mitigated by signage and the security measures that industry uses to deter trespassing. As will be discussed in more detail below, risks of site contamination are much less than for most other industrial uses because PV technologies employ few toxic chemicals and those used are used in very small quantities. Due to the reduction in the pollution from fossil-fuel-fired electric generators, the overall impact of solar development on human health is overwhelmingly positive. This pollution reduction results from a partial replacement of fossil-fuel fired generation by emission-free PV-generated electricity, which reduces harmful sulfur dioxide (SO2), nitrogen oxides (NOx), and fine particulate matter (PM2.5). Analysis from the National Renewable Energy Laboratory and the Lawrence Berkeley National Laboratory, both affiliates of the U.S. Department of Energy, estimates the health-related air quality benefits to the southeast region from solar PV generators to be worth 8.0 ¢ per kilowatt-hour of solar generation.[1] This is in addition to the value of the electricity and suggests that the air quality benefits of solar are worth more than the electricity itself.

Even though we have only recently seen large-scale installation of PV technologies, the technology and its potential impacts have been studied since the 1950s. A combination of this solar-specific research and general scientific research has led to the scientific community having a good understanding of the science behind potential health and safety impacts of solar energy. This paper utilizes the latest scientific literature and knowledge of solar practices in N.C. to address the health and safety risks associated with solar PV technology. These risks are extremely small, far less than those associated with common activities such as driving a car, and vastly outweighed by health benefits of the generation of clean electricity.

This paper addresses the potential health and safety impacts of solar PV development in North Carolina, organized into the following four categories:
(1) Hazardous Materials
(2) Electromagnetic Fields (EMF)
(3) Electric Shock and Arc Flash
(4) Fire Safety

1 • Hazardous Materials

One of the more common concerns towards solar is that the panels (referred to as "modules" in the solar industry) consist of toxic materials that endanger public health. However, as shown in this section, solar energy systems may contain small amounts of toxic materials, but these materials do not endanger public health. To understand potential toxic hazards coming from a solar project, one

must understand system installation, materials used, the panel end-of-life protocols, and system operation. This section will examine these aspects of a solar farm and the potential for toxicity impacts in the following subsections:

(1.2) Project Installation/Construction
(1.2) System Components
  1.2.1 Solar Panels: Construction and Durability
  1.2.2 Photovoltaic technologies
    (a) Crystalline Silicon
    (b) Cadmium Telluride (CdTe)
    (c) CIS/CIGS
  1.2.3 Panel End of Life Management
  1.2.4 Non-panel System Components
(1.3) Operations and Maintenance

1.1 Project Installation/ Construction

The system installation, or construction, process does not require toxic chemicals or processes. The site is mechanically cleared of large vegetation, fences are constructed, and the land is surveyed to layout exact installation locations. Trenches for underground wiring are dug and support posts are driven into the ground. The solar panels are bolted to steel and aluminum support structures and wired together. Inverter pads are installed, and an inverter and transformer are installed on each pad. Once everything is connected, the system is tested, and only then turned on.

Figure 1: Utility-scale solar facility (5 MWAC) located in Catawba County. *Source: Strata Solar*

1.2 • System Components

1.2.1 Solar Panels: Construction and Durability

Solar PV panels typically consist of glass, polymer, aluminum, copper, and semiconductor materials that can be recovered and recycled at the end of their useful life.[2] Today there are two PV technologies used in PV panels at utility-scale solar facilities, silicon, and thin film. As of 2016, all thin film used in North Carolina solar facilities are cadmium telluride (CdTe) panels from the US manufacturer First Solar, but there are other thin film PV panels available on the market, such as Solar Frontier's CIGS panels. Crystalline silicon technology consists of silicon wafers which are made into cells and assembled into panels, thin film technologies consist of thin layers of semiconductor material deposited onto glass, polymer or metal substrates. While there are differences in the components and manufacturing processes of these two types of solar technologies, many aspects of their PV panel construction are very similar. Specifics about each type of PV chemistry as it relates to toxicity are covered in subsections a, b, and c in section 1.2.2; on crystalline silicon, cadmium telluride, and CIS/CIGS respectively. The rest of this section applies equally to both silicon and thin film panels.

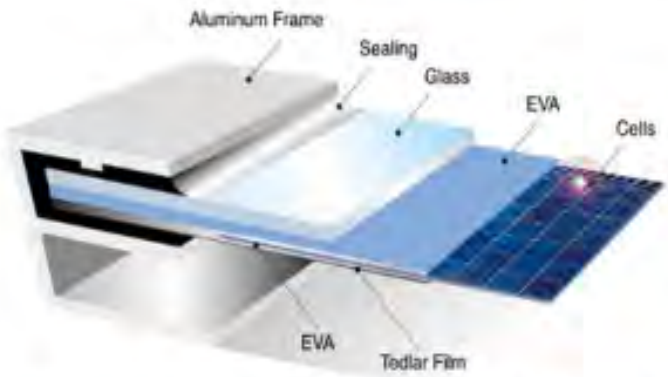

Figure 2: Components of crystalline silicon panels. The vast majority of silicon panels consist of a glass sheet on the topside with an aluminum frame providing structural support. Image Source: www.riteksolar.com.tw

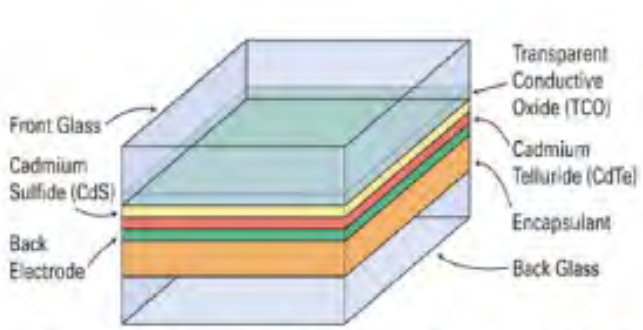

Figure 3: Layers of a common frameless thin-film panel (CdTe). Many thin film panels are frameless, including the most common thin-film panels, First Solar's CdTe. Frameless panels have protective glass on both the front and back of the panel. Layer thicknesses not to scale. Image Source: www.homepower.com

To provide decades of corrosion-free operation, PV cells in PV panels are encapsulated from air and moisture between two layers of plastic. The encapsulation layers are protected on the top with a layer of tempered glass and on the backside with a polymer sheet. Frameless modules include a protective layer of glass on the rear of the panel, which may also be tempered. The plastic ethylene-vinyl acetate (EVA) commonly provides the cell encapsulation. For decades, this same material has been used between layers of tempered glass to give car windshields and hurricane windows their great strength. In the same way that a car windshield cracks but stays intact, the EVA layers in PV panels keep broken panels intact (see Figure 4). Thus, a damaged module does not generally create small pieces of debris; instead, it largely remains together as one piece.

Figure 4: The mangled PV panels in this picture illustrate the nature of broken solar panels; the glass cracks but the panel is still in one piece. Image Source: http://img.alibaba.com/photo/115259576/broken_solar_panel.jpg

PV panels constructed with the same basic components as modern panels have been installed across the globe for well over thirty years.[3] The long-term durability and performance demonstrated over these decades, as well as the results of accelerated lifetime testing, helped lead to an industrystandard 25-year power production warranty for PV panels. These power warranties warrant a PV panel to produce at least 80% of their original nameplate production after 25 years of use. A recent SolarCity and DNV GL study reported that today's quality PV panels should be expected to reliably and efficiently produce power for thirty-five years.[4]

Local building codes require all structures, including ground mounted solar arrays, to be engineered to withstand anticipated wind speeds, as defined by the local wind speed requirements. Many racking products are available in versions engineered for wind speeds of up to 150 miles per hour, which is significantly higher than the wind speed requirement anywhere in North Carolina. The strength of PV mounting structures were demonstrated during Hurricane Sandy in 2012 and again during Hurricane Matthew in 2016. During Hurricane Sandy, the many large-scale solar facilities in New Jersey and New York at that time suffered only minor damage.[5] In the fall of 2016, the US and Caribbean experienced destructive winds and torrential rains from Hurricane Matthew, yet one leading solar tracker manufacturer reported that their numerous systems in the impacted area received zero damage from wind or flooding.[6]

In the event of a catastrophic event capable of damaging solar equipment, such as a tornado, the system will almost certainly have property insurance

that will cover the cost to cleanup and repair the project. It is in the best interest of the system owner to protect their investment against such risks. It is also in their interest to get the project repaired and producing full power as soon as possible. Therefore, the investment in adequate insurance is a wise business practice for the system owner. For the same reasons, adequate insurance coverage is also generally a requirement of the bank or firm providing financing for the project.

1.2.2 Photovoltaic (PV) Technologies

a. Crystalline Silicon

This subsection explores the toxicity of silicon-based PV panels and concludes that they do not pose a material risk of toxicity to public health and safety. Modern crystalline silicon PV panels, which account for over 90% of solar PV panels installed today, are, more or less, a commodity product. The overwhelming majority of panels installed in North Carolina are crystalline silicon panels that are informally classified as Tier I panels. Tier I panels are from well-respected manufacturers that have a good chance of being able to honor warranty claims. Tier I panels are understood to be of high quality, with predictable performance, durability, and content. Well over 80% (by weight) of the content of a PV panel is the tempered glass front and the aluminum frame, both of which are common building materials. Most of the remaining portion are common plastics, including polyethylene terephthalate in the backsheet, EVA encapsulation of the PV cells, polyphenyl ether in the junction box, and polyethylene insulation on the wire leads. The active, working components of the system are the silicon photovoltaic cells, the small electrical leads connecting them together, and to the wires coming out of the back of the panel. The electricity generating and conducting components makeup less than 5% of the weight of most panels. The PV cell itself is nearly 100% silicon, and silicon is the second most common element in the Earth's crust. The silicon for PV cells is obtained by high-temperature processing of quartz sand (SiO2) that removes its oxygen molecules. The refined silicon is converted to a PV cell by adding extremely small amounts of boron and phosphorus, both of which are common and of very low toxicity.

The other minor components of the PV cell are also generally benign; however, some contain lead, which is a human toxicant that is particularly harmful to young children. The minor components include an extremely thin antireflective coating (silicon nitride or titanium dioxide), a thin layer of aluminum on the rear, and thin strips of silver alloy that are screen-printed on the front and rear of cell.[7] In order for the front and rear electrodes to make effective electrical contact with the proper layer of the PV cell, other materials (called glass frit) are mixed with the silver alloy and then heated to etch the metals into the cell. This glass frit historically contains a small amount of lead (Pb) in the form of lead oxide. The 60 or 72 PV cells in a PV panel are connected by soldering thin solder-covered copper tabs from the back of one cell to the front of the next cell. Traditionally a tin-based solder containing some lead (Pb) is used, but some manufacturers have switched to lead-free solder. The glass frit and/or the solder may contain trace amounts of other metals, potentially including some with human toxicity such as cadmium. However, testing to simulate the potential for leaching from broken panels, which is discussed in more detail below, did not find a potential toxicity threat from these trace elements. Therefore, the tiny amount of lead in the grass frit and the solder is the only part of silicon PV panels with a potential to create a negative health impact. However, as described below, the very limited amount of lead involved and its strong physical and chemical attachment to other components of the PV panel means that even in worst-case scenarios the health hazard it poses is insignificant.

As with many electronic industries, the solder in silicon PV panels has historically been a leadbased solder, often 36% lead, due to the superior properties of such solder. However, recent advances in lead-free solders have spurred a trend among PV panel manufacturers to reduce or remove the lead in their panels. According to the 2015 Solar Scorecard from the Silicon Valley Toxics Coalition, a group that tracks environmental responsibility of photovoltaic panel manufacturers, fourteen companies (increased from twelve companies in 2014) manufacture PV panels certified to meet the European Restriction of Hazardous Substances (RoHS) standard. This means that the amount of cadmium and lead in the panels they manufacture fall below the RoHS thresholds, which are set by the European Union and serve as the world's de facto standard for hazardous substances in manufactured goods.[8] The Restriction of Hazardous Substances (RoHS) standard requires that the maximum concentration found in any homogenous material in a produce is less than 0.01% cadmium and less than 0.10% lead, therefore, any solder can be no more than 0.10% lead.[9]

While some manufacturers are producing PV panels that meet the RoHS standard, there is no requirement that they do so because the RoHS Directive explicitly states that the directive does not apply to photovoltaic panels.[10] The justification for this is provided in item 17 of the current RoHS Directive: "The development of renewable forms of energy is one of the Union's key objectives, and the contribution made by renewable energy sources to environmental and climate objectives is crucial. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (4) recalls that there should be coherence between those objectives and other Union environmental legislation. Consequently, this Directive should not prevent the development of renewable energy technologies that have no negative impact on health and the environment and that are sustainable and economically viable."

The use of lead is common in our modern economy. However, only about 0.5% of the annual lead consumption in the U.S. is for electronic solder for all uses; PV solder makes up only a tiny portion of this 0.5%. Close to 90% of lead consumption in the US is in batteries, which do not encapsulate the pounds of lead contained in each typical automotive battery. This puts the lead in batteries at great risk of leaching into the environment. Estimates for the lead in a single PV panel with lead-based solder range from 1.6 to 24 grams of lead, with 13g (less than half of an ounce) per panel seen most often in the literature.[11] At 13 g/panel[12], each panel contains one-half of the lead in a typical 12-gauge shotgun shell. This amount equates to roughly 1/750th of the lead in a single car battery. In a panel, it is all durably encapsulated from air or water for the full life of the panel.[14]

As indicated by their 20 to 30-year power warranty, PV modules are designed for a long service life, generally over 25 years. For a panel to comply with its 25-year power warranty, its internal components, including lead, must be sealed from any moisture. Otherwise, they would corrode and the panel's output would fall below power warranty levels. Thus, the lead in operating PV modules is not at risk of release to the environment during their service lifetime. In extreme experiments, researchers have shown that lead can leach from crushed or pulverized panels.[15, 16] However, more real-world tests designed to represent typical trash compaction that are used to classify waste as hazardous or non-hazardous show no danger from leaching.[17,18] For more information about PV panel end-of-life, see the Panel Disposal section.

As illustrated throughout this section, silicon-based PV panels do not pose a material threat to public health and safety. The only aspect of the panels with potential toxicity concerns is the very small amount of lead in some panels. However, any lead in a panel is well sealed from environmental exposure for the operating lifetime of the solar panel and thus not at risk of release into the environment.

b. Cadmium Telluride (CdTe) PV Panels

This subsection examines the components of a cadmium telluride (CdTe) PV panel. Research demonstrates that they pose negligible toxicity risk to public health and safety while significantly reducing the public's exposure to cadmium by reducing coal emissions. As of mid-2016, a few hundred MWs of cadmium telluride (CdTe) panels, all manufactured by the U.S. company First Solar, have been installed in North Carolina.

Questions about the potential health and environmental impacts from the use of this PV technology are related to the concern that these panels contain cadmium, a toxic heavy metal. However, scientific studies have shown that cadmium telluride differs from cadmium due to its high chemical and thermal stability.[19] Research has shown that the tiny amount of cadmium in these panels does not pose a health or safety risk.[20] Further, there are very compelling reasons to welcome its adoption due to reductions in unhealthy pollution associated with burning coal. Every GWh of electricity generated by burning coal produces about 4 grams of cadmium air emissions.[21] Even though North Carolina produces a significant fraction of our electricity from coal, electricity from solar offsets much more natural gas than coal due to natural gas plants being able to adjust their rate of production more easily and quickly. If solar electricity offsets 90% natural gas and 10% coal, each 5-megawatt (5 MWAC, which is generally 7 MWDC) CdTe solar facility in North Carolina keeps about 157 grams, or about a third of a pound, of cadmium *out* of our environment.[22, 23]

Cadmium is toxic, but all the approximately 7 grams of cadmium in one CdTe panel is in the form of a chemical compound cadmium telluride,[24] which has 1/100th the toxicity of free cadmium.[25] Cadmium telluride is a very stable compound that is non-volatile and non-soluble in water. Even in the case of a fire, research shows that less than 0.1% of the cadmium is released when a CdTe panel is exposed to fire. The fire melts the glass and encapsulates over 99.9% of the cadmium in the molten glass.[27]

It is important to understand the source of the cadmium used to manufacture CdTe PV panels. The cadmium is a byproduct of zinc and lead refining. The element is collected from emissions and waste streams during the production of these metals and combined with tellurium to create the CdTe used in PV panels. If the cadmium were not collected for use in the PV panels or other products, it would otherwise either be stockpiled for future use, cemented and buried, or disposed of.[28] Nearly all the cadmium in old or broken panels can be recycled which can eventually serve as the primary source of cadmium for new PV panels.[29]

Similar to silicon-based PV panels, CdTe panels are constructed of a tempered glass front, one instead of two clear plastic encapsulation layers, and a rear heat strengthened glass backing (together >98% by weight). The final product is built to withstand exposure to the elements without significant damage for over 25 years. While not representative of damage that may occur in the field or even at a landfill, laboratory evidence has illustrated that when panels are ground into a fine powder, very acidic water is able to leach portions of the cadmium and tellurium,[30] similar to the process used to recycle CdTe panels. Like many silicon-based panels, CdTe panels are reported (as far back ask 1998[31] to pass the EPA's Toxic Characteristic Leaching Procedure (TCLP) test, which tests the potential for crushed panels in a landfill to leach hazardous substances into groundwater.[32] Passing this test means that they are classified as non-hazardous waste and can be deposited in landfills.[33,34] For more information about PV panel end-of-life, see the Panel Disposal section.

There is also concern of environmental impact resulting from potential catastrophic events involving CdTe PV panels. An analysis of worst-case scenarios for environmental impact from CdTe PV

panels, including earthquakes, fires, and floods, was conducted by the University of Tokyo in 2013. After reviewing the extensive international body of research on CdTe PV technology, their report concluded, "Even in the worst-case scenarios, it is unlikely that the Cd concentrations in air and sea water will exceed the environmental regulation values."[35] In a worst-case scenario of damaged panels abandoned on the ground, insignificant amounts of cadmium will leach from the panels. This is because this scenario is much less conducive (larger module pieces, less acidity) to leaching than the conditions of the EPA's TCLP test used to simulate landfill conditions, which CdTe panels pass.[36]

First Solar, a U.S. company, and the only significant supplier of CdTe panels, has a robust panel take-back and recycling program that has been operating commercially since 2005.[37] The company states that it is "committed to providing a commercially attractive recycling solution for photovoltaic (PV) power plant and module owners to help them meet their module (end of life) EOL obligation simply, costeffectively and responsibly." First Solar global recycling services to their customers to collect and recycle panels once they reach the end of productive life whether due to age or damage. These recycling service agreements are structured to be financially attractive to both First Solar and the solar panel owner. For First Solar, the contract provides the company with an affordable source of raw materials needed for new panels and presumably a diminished risk of undesired release of Cd. The contract also benefits the solar panel owner by allowing them to avoid tipping fees at a waste disposal site. The legal contract helps provide peace of mind by ensuring compliance by both parties when considering the continuing trend of rising disposal costs and increasing regulatory requirements.

c. CIS/CIGS and other PV technologies

Copper indium gallium selenide PV technology, often referred to as CIGS, is the second most common type of thin-film PV panel but a distant second behind CdTe. CIGS cells are composed of a thin layer of copper, indium, gallium, and selenium on a glass or plastic backing. None of these elements are very toxic, although selenium is a regulated metal under the Federal Resource Conservation and Recovery Act (RCRA).[38] The cells often also have an extremely thin layer of cadmium sulfide that contains a tiny amount of cadmium, which is toxic. The promise of high efficiency CIGS panels drove heavy investment in this technology in the past. However, researchers have struggled to transfer high efficiency success in the lab to low-cost full-scale panels in the field.[39] Recently, a CIGS manufacturer based in Japan, Solar Frontier, has achieved some market success with a rigid, glass-faced CIGS module that competes with silicon panels. Solar Frontier produces the majority of CIS panels on the market today.[40] Notably, these panels are RoHS compliant,[41] thus meeting the rigorous toxicity standard adopted by the European Union even thought this directive exempts PV panels. The authors are unaware of any completed or proposed utility-scale system in North Carolina using CIS/CIGS panels.

1.2.3 Panel End-of-Life Management

Concerns about the volume, disposal, toxicity, and recycling of PV panels are addressed in this subsection. To put the volume of PV waste into perspective, consider that by 2050, when PV systems installed in 2020 will reach the end of their lives, it is estimated that the global annual PV panel waste tonnage will be 10% of the 2014 global e-waste tonnage.[42] In the U.S., end-of-life disposal of solar products is governed by the Federal Resource Conservation and Recovery Act (RCRA), as well as state policies in some situations. RCRA separates waste into hazardous (not accepted at ordinary landfill) and solid waste (generally accepted

at ordinary landfill) based on a series of rules. According to RCRA, the way to determine if a PV panel is classified as hazardous waste is the Toxic Characteristic Leaching Procedure (TCLP) test. This EPA test is designed to simulate landfill disposal and determine the risk of hazardous substances leaching out of the landfill.[43,44,45] Multiple sources report that most modern PV panels (both crystalline silicon and cadmium telluride) pass the TCLP test.[46,47] Some studies found that some older (1990s) crystalline silicon panels, and perhaps some newer crystalline silicon panels (specifics are not given about vintage of panels tested), do not pass the lead (Pb) leachate limits in the TCLP test.[48,49]

The test begins with the crushing of a panel into centimeter-sized pieces. The pieces are then mixed in an acid bath. After tumbling for eighteen hours, the fluid is tested for forty hazardous substances that all must be below specific threshold levels to pass the test. Research comparing TCLP conditions to conditions of damaged panels in the field found that simulated landfill conditions provide overly conservative estimates of leaching for field-damaged panels.[50] Additionally, research in Japan has found no detectable Cd leaching from cracked CdTe panels when exposed to simulated acid rain.[51]

Although modern panels can generally be landfilled, they can also be recycled. Even though recent waste volume has not been adequate to support significant PV-specific recycling infrastructure, the existing recycling industry in North Carolina reports that it recycles much of the current small volume of broken PV panels. In an informal survey conducted by the NC Clean Energy Technology Center survey in early 2016, seven of the eight large active North Carolina utility-scale solar developers surveyed reported that they send damaged panels back to the manufacturer and/or to a local recycler. Only one developer reported sending damaged panels to the landfill.

The developers reported at that time that they are usually paid a small amount per panel by local recycling firms. In early 2017, a PV developer reported that a local recycler was charging a small fee per panel to recycle damaged PV panels. The local recycling firm known to authors to accept PV panels described their current PV panel recycling practice as of early 2016 as removing the aluminum frame for local recycling and removing the wire leads for local copper recycling. The remainder of the panel is sent to a facility for processing the non-metallic portions of crushed vehicles, referred to as “fluff” in the recycling industry.[52] This processing within existing general recycling plants allows for significant material recovery of major components, including glass which is 80% of the module weight, but at lower yields than PV-specific recycling plants. Notably almost half of the material value in a PV panel is in the few grams of silver contained in almost every PV panel produced today. In the long-term, dedicated PV panel recycling plants can increase treatment capacities and maximize revenues resulting in better output quality and the ability to recover a greater fraction of the useful materials.[53] PV-specific panel recycling technologies have been researched and implemented to some extent for the past decade, and have been shown to be able to recover over 95% of PV material (semiconductor) and over 90% of the glass in a PV panel.[54]

A look at global PV recycling trends hints at the future possibilities of the practice in our country. Europe installed MW-scale volumes of PV years before the U.S. In 2007, a public-private partnership between the European Union and the solar industry set up a voluntary collection and recycling system called PV CYCLE. This arrangement was later made mandatory under the EU’s WEEE directive, a program for waste electrical and electronic equipment.[55] Its member companies (PV panel producers) fully finance the association. This makes it possible for end-users to return the member companies’ defective panels for recycling at any of the over 300 collection points around

Europe without added costs. Additionally, PV CYCLE will pick up batches of 40 or more used panels at no cost to the user. This arrangement has been very successful, collecting and recycling over 13,000 tons by the end of 2015.[56]

In 2012, the WEEE Directive added the end-of-life collection and recycling of PV panels to its scope.[57] This directive is based on the principle of extended-producer-responsibility. It has a global impact because producers that want to sell into the EU market are legally responsible for end-of-life management. Starting in 2018, this directive targets that 85% of PV products "put in the market" in Europe are recovered and 80% is prepared for reuse and recycling.

The success of the PV panel collection and recycling practices in Europe provides promise for the future of recycling in the U.S. In mid-2016, the US Solar Energy Industry Association (SEIA) announced that they are starting a national solar panel recycling program with the guidance and support of many leading PV panel producers.[58] The program will aggregate the services offered by recycling vendors and PV manufacturers, which will make it easier for consumers to select a cost-effective and environmentally responsible end-of-life management solution for their PV products. According to SEIA, they are planning the program in an effort to make the entire industry landfill-free. In addition to the national recycling network program, the program will provide a portal for system owners and consumers with information on how to responsibly recycle their PV systems.

While a cautious approach toward the potential for negative environmental and/or health impacts from retired PV panels is fully warranted, this section has shown that the positive health impacts of reduced emissions from fossil fuel combustion from PV systems more than outweighs any potential risk. Testing shows that silicon and CdTe panels are both safe to dispose of in landfills, and are also safe in worst case conditions of abandonment or damage in a disaster. Additionally, analysis by local engineers has found that the current salvage value of the equipment in a utility scale PV facility generally exceeds general contractor estimates for the cost to remove the entire PV system.[59,60,61]

1.2.4 Non-Panel System Components

(racking, wiring, inverter, transformer)

While previous toxicity subsections discussed PV panels, this subsection describes the non-panel components of utility-scale PV systems and investigates any potential public health and safety concerns. The most significant non-panel component of a ground-mounted PV system is the mounting structure of the rows of panels, commonly referred to as "racking". The vertical post portion of the racking is galvanized steel and the remaining above-ground racking components are either galvanized steel or aluminum, which are both extremely common and benign building materials. The inverters that make the solar generated electricity ready to send to the grid have weather-proof steel enclosures that protect the working components from the elements. The only fluids that they might contain are associated with their cooling systems, which are not unlike the cooling system in a computer. Many inverters today are RoHS compliant.

The electrical transformers (to boost the inverter output voltage to the voltage of the utility connection point) do contain a liquid cooling oil. However, the fluid used for that function is either a nontoxic mineral oil or a biodegradable non-toxic vegetable oil, such as BIOTEMP from ABB. These vegetable transformer oils have the additional advantage of being much less flammable than traditional mineral oils. Significant health hazards are associated with old transformers containing cooling oil with toxic PCBs. Transfers with PCB-containing oil were common before PCBs were outlawed in the U.S. in 1979. PCBs still exist in older transformers in the field across the country.

Other than a few utility research sites, there are no batteries on- or off-site associated with utility-scale solar energy facilities in North Carolina, avoiding any potential health or safety concerns related to battery technologies. However, as battery technologies continue to improve and prices continue to decline we are likely to start seeing some batteries at solar facilities. Lithium ion batteries currently dominate the world utility-scale battery market, which are not very toxic. No non-panel system components were found to pose any health or environmental dangers.

1.4 Operations and Maintenance – Panel Washing and Vegetation Control

Throughout the eastern U.S., the climate provides frequent and heavy enough rain to keep panels adequately clean. This dependable weather pattern eliminates the need to wash the panels on a regular basis. Some system owners may choose to wash panels as often as once a year to increase production, but most in N.C. do not regularly wash any PV panels. Dirt build up over time may justify panel washing a few times over the panels' lifetime; however, nothing more than soap and water are required for this activity.

The maintenance of ground-mounted PV facilities requires that vegetation be kept low, both for aesthetics and to avoid shading of the PV panels. Several approaches are used to maintain vegetation at NC solar facilities, including planting of limited-height species, mowing, weed-eating, herbicides, and grazing livestock (sheep). The following descriptions of vegetation maintenance practices are based on interviews with several solar developers as well as with three maintenance firms that together are contracted to maintain well over 100 of the solar facilities in N.C. The majority of solar facilities in North Carolina maintain vegetation primarily by mowing. Each row of panels has a single row of supports, allowing sickle mowers to mow under the panels. The sites usually require mowing about once a month during the growing season. Some sites employ sheep to graze the site, which greatly reduces the human effort required to maintain the vegetation and produces high quality lamb meat.[62]

In addition to mowing and weed eating, solar facilities often use some herbicides. Solar facilities generally do not spray herbicides over the entire acreage; rather they apply them only in strategic locations such as at the base of the perimeter fence, around exterior vegetative buffer, on interior dirt roads, and near the panel support posts. Also unlike many row crop operations, solar facilities generally use only general use herbicides, which are available over the counter, as opposed to restricted use herbicides commonly used in commercial agriculture that require a special restricted use license. The herbicides used at solar facilities are primarily 2-4-D and glyphosate (Round-up®), which are two of the most common herbicides used in lawns, parks, and agriculture across the country. One maintenance firm that was interviewed sprays the grass with a class of herbicide known as a growth regulator in order to slow the growth of grass so that mowing is only required twice a year. Growth regulators are commonly used on highway roadsides and golf courses for the same purpose. A commercial pesticide applicator license is required for anyone other than the landowner to apply herbicides, which helps ensure that all applicators are adequately educated about proper herbicide use and application. The license must be renewed annually and requires passing of a certification exam appropriate to the area in which the applicator wishes to work. Based on the limited data available, it appears that solar facilities in N.C. generally use significantly less herbicides per acre than most commercial agriculture or lawn maintenance services.

2. Electromagnetic Fields (EMF)

PV systems do not emit any material during their operation; however, they do generate electromagnetic fields (EMF), sometimes referred to as radiation. EMF produced by electricity is non-ionizing radiation, meaning the radiation has enough energy to move atoms in a molecule around (experienced as heat), but not enough energy to remove electrons from an atom or molecule (ionize) or to damage DNA. As shown below, modern humans are all exposed to EMF throughout our daily lives without negative health impact. Someone outside of the fenced perimeter of a solar facility is not exposed to significant EMF from the solar facility. Therefore, there is no negative health impact from the EMF produced in a solar farm. The following paragraphs provide some additional background and detail to support this conclusion.

Since the 1970s, some have expressed concern over potential health consequences of EMF from electricity, but no studies have ever shown this EMF to cause health problems.[63] These concerns are based on some epidemiological studies that found a slight increase in childhood leukemia associated with average exposure to residential power-frequency magnetic fields above 0.3 to 0.4 µT (microteslas) (equal to 3.0 to 4.0 mG (milligauss)). µT and mG are both units used to measure magnetic field strength. For comparison, the average exposure for people in the U.S. is one mG or 0.1 µT, with about 1% of the population with an average exposure in excess of 0.4 µT (or 4 mG).[64] These epidemiological studies, which found an association but not a causal relationship, led the World Health Organization's International Agency for Research on Cancer (IARC) to classify ELF magnetic fields as "possibly carcinogenic to humans". Coffee also has this classification. This classification means there is limited evidence but not enough evidence to designate as either a "probable carcinogen" or "human carcinogen". Overall, there is very little concern that ELF EMF damages public health. The only concern that does exist is for long-term exposure above 0.4 µT (4 mG) that may have some connection to increased cases of childhood leukemia. In 1997, the National Academies of Science were directed by Congress to examine this concern and concluded:

"Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects."[65]

There are two aspects to electromagnetic fields, an electric field and a magnetic field. The electric field is generated by voltage and the magnetic field is generated by electric current, i.e., moving electrons. A task group of scientific experts convened by the World Health Organization (WHO) in 2005 concluded that there were no substantive health issues related to electric fields (0 to 100,000 Hz) at levels generally encountered by members of the public.[66] The relatively low voltages in a solar facility and the fact that electric fields are easily shielded (i.e., blocked) by common materials, such as plastic, metal, or soil means that there is no concern of negative health impacts from the electric fields generated by a solar facility. Thus, the remainder of this section addresses magnetic fields. Magnetic fields are not shielded by most common materials and thus can easily pass through them. Both types of fields are strongest close to the source of electric generation and weaken quickly with distance from the source.

The direct current (DC) electricity produced by PV panels produce stationary (0 Hz) electric and magnetic fields. Because of minimal concern about potential risks of stationary fields, little scientific research has examined stationary fields' impact on human health.[67] In even the largest PV facilities, the DC voltages and currents are not very high. One can illustrate the weakness of the EMF generated by a PV panel by placing a compass on an operating solar panel and observing that the needle still points north.

While the electricity throughout the majority of a solar site is DC electricity, the inverters convert this DC electricity to alternating current (AC) electricity matching the 60 Hz frequency of the grid. Therefore, the inverters and the wires delivering this power to the grid are producing non-stationary EMF, known as extremely low frequency (ELF) EMF, normally oscillating with a frequency of 60 Hz. This frequency is at the low-energy end of the electromagnetic spectrum. Therefore, it has less energy than other commonly encountered types of non-ionizing radiation like radio waves, infrared radiation, and visible light.

The wide use of electricity results in background levels of ELF EMFs in nearly all locations where people spend time – homes, workplaces, schools, cars, the supermarket, etc. A person's average exposure depends upon the sources they encounter, how close they are to them, and the amount of time they spend there.[68] As stated above, the average exposure to magnetic fields in the U.S. is estimated to be around one mG or 0.1 μT, but can vary considerably depending on a person's exposure to EMF from electrical devices and wiring.[69] At times we are often exposed to much higher ELF magnetic fields, for example when standing three feet from a refrigerator the ELF magnetic field is 6 mG and when standing three feet from a microwave oven the field is about 50 mG.[70] The strength of these fields diminish quickly with distance from the source, but when surrounded by electricity in our homes and other buildings moving away from one source moves you closer to another. However, unless you are inside of the fence at a utility-scale solar facility or electrical substation it is impossible to get very close to the EMF sources. Because of this, EMF levels at the fence of electrical substations containing high voltages and currents are considered "generally negligible".[71,72]

The strength of ELF-EMF present at the perimeter of a solar facility or near a PV system in a commercial or residential building is significantly lower than the typical American's average EMF exposure.[73,74] Researchers in Massachusetts measured magnetic fields at PV projects and found the magnetic fields dropped to very low levels of 0.5 mG or less, and in many cases to less than background levels (0.2 mG), at distances of no more than nine feet from the residential inverters and 150 feet from the utility-scale inverters.[75] Even when measured within a few feet of the utility-scale inverter, the ELF magnetic fields were well below the International Commission on Non-Ionizing Radiation Protection's recommended magnetic field level exposure limit for the general public of 2,000 mG.[76] It is typical that utility scale designs locate large inverters central to the PV panels that feed them because this minimizes the length of wire required and shields neighbors from the sound of the inverter's cooling fans. Thus, it is rare for a large PV inverter to be within 150 feet of the project's security fence.

Anyone relying on a medical device such as pacemaker or other implanted device to maintain proper heart rhythm may have concern about the potential for a solar project to interfere with the operation of his or her device. However, there is no reason for concern because the EMF outside of the solar facility's fence is less than 1/1000 of the level at which manufacturers test for ELF EMF interference, which is 1,000 mG.[77] Manufacturers of potentially affected implanted devices often provide advice on electromagnetic interference that includes avoiding letting the implanted device get too close to certain sources of fields such as some

household appliances, some walkie-talkies, and similar transmitting devices. Some manufacturers' literature does not mention high-voltage power lines, some say that exposure in public areas should not give interference, and some advise not spending extended periods of time close to power lines.[78]

3. Electric Shock and Arc Flash Hazards

There is a real danger of electric shock to anyone entering any of the electrical cabinets such as combiner boxes, disconnect switches, inverters, or transformers; or otherwise coming in contact with voltages over 50 Volts.[79] Another electrical hazard is an arc flash, which is an explosion of energy that can occur in a short circuit situation. This explosive release of energy causes a flash of heat and a shockwave, both of which can cause serious injury or death. Properly trained and equipped technicians and electricians know how to safely install, test, and repair PV systems, but there is always some risk of injury when hazardous voltages and/or currents are present. Untrained individuals should not attempt to inspect, test, or repair any aspect of a PV system due to the potential for injury or death due to electric shock and arc flash, The National Electric Code (NEC) requires appropriate levels of warning signs on all electrical components based on the level of danger determined by the voltages and current potentials. The national electric code also requires the site to be secured from unauthorized visitors with either a six-foot chain link fence with three strands of barbed wire or an eight-foot fence, both with adequate hazard warning signs.

4. Fire Safety

The possibility of fires resulting from or intensified by PV systems may trigger concern among the general public as well as among firefighters. However, concern over solar fire hazards should be limited because only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer backsheets (framed panels only), plastic junction boxes on rear of panel, and insulation on wiring. The rest of the panel is composed of non-flammable components, notably including one or two layers of protective glass that make up over three quarters of the panel's weight.

Heat from a small flame is not adequate to ignite a PV panel, but heat from a more intense fire or energy from an electrical fault can ignite a PV panel.[80] One real-world example of this occurred during July 2015 in an arid area of California. Three acres of grass under a thin film PV facility burned without igniting the panels mounted on fixed-tilt racks just above the grass.[81] While it is possible for electrical faults in PV systems on homes or commercial buildings to start a fire, this is extremely rare.[82] Improving understanding of the PV-specific risks, safer system designs, and updated fire-related codes and standards will continue to reduce the risk of fire caused by PV systems.

PV systems on buildings can affect firefighters in two primary ways, 1) impact their methods of fighting the fire, and 2) pose safety hazard to the firefighters. One of the most important techniques that firefighters use to suppress fire is ventilation of a building's roof. This technique allows superheated toxic gases to quickly exit the building. By doing so, the firefighters gain easier and safer access to the building, Ventilation of the roof also makes the challenge of putting out the fire easier. However, the placement of rooftop PV panels may interfere with ventilating the roof by limiting access to desired venting locations.

New solar-specific building code requirements are working to minimize these concerns. Also, the

latest National Electric Code has added requirements that make it easier for first responders to safely and effectively turn off a PV system. Concern for firefighting a building with PV can be reduced with proper fire fighter training, system design, and installation. Numerous organizations have studied fire fighter safety related to PV. Many organizations have published valuable guides and training programs. Some notable examples are listed below.

- The International Association of Fire Fighters (IAFF) and International Renewable Energy Council (IREC) partnered to create an online training course that is far beyond the PowerPoint click-andview model. The self-paced online course, "Solar PV Safety for Fire Fighters," features rich video content and simulated environments so fire fighters can practice the knowledge they've learned. www.iaff.org/pvsafetytraining
- Photovoltaic Systems and the Fire Code: Office of NC Fire Marshal
- Fire Service Training, Underwriter's Laboratory
- Firefighter Safety and Response for Solar Power Systems, National Fire Protection Research Foundation
- Bridging the Gap: Fire Safety & Green Buildings, National Association of State Fire Marshalls
- Guidelines for Fire Safety Elements of Solar Photovoltaic Systems, Orange County Fire Chiefs Association
- Solar Photovoltaic Installation Guidelines, California Department of Forestry & Fire Protection, Office of the State Fire Marshall
- PV Safety & Firefighting, Matthew Paiss, Homepower Magazine
- PV Safety and Code Development: Matthew Paiss, Cooperative Research Network

Summary

The purpose of this paper is to address and alleviate concerns of public health and safety for utility-scale solar PV projects. Concerns of public health and safety were divided and discussed in the four following sections: (1) Toxicity, (2) Electromagnetic Fields, (3) Electric Shock and Arc Flash, and (4) Fire. In each of these sections, the negative health and safety impacts of utility-scale PV development were shown to be negligible, while the public health and safety benefits of installing these facilities are significant and far outweigh any negative impacts.

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December 2020

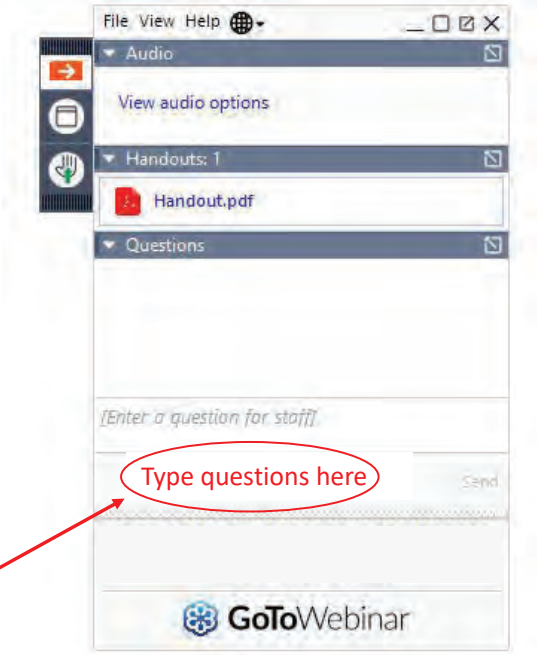
Appendix D

Clearview Solar

Public Information Meeting

Webinar Guide

- Webinar will be held on Tuesday, Oct. 6th from 6-8pm.
- Register at any time by visiting: https://attendee.gotowebinar.com/register/1572161299594049036. The webinar ID, if needed, is 468-308-187. Upon registration, you will be sent a confirmation email with an individual link to join the meeting using your computer, tablet, or smart phone/handheld device.
  - Check your spam folder if you do not receive an email confirmation shortly after registration.
  - Click the "Join Webinar" link from the meeting confirmation email, calendar event, or the GoToWebinar website at the time of event.
- Presentation will be approximately two hours and will be recorded.
- We will break to address questions at the end of the presentation.
  - To post a question during the Q&A session, utilize the "Questions" section in your GoToWebinar panel.
  - If you have questions following the Q&A session, please submit them via our website at: www.clearviewsolarproject.com

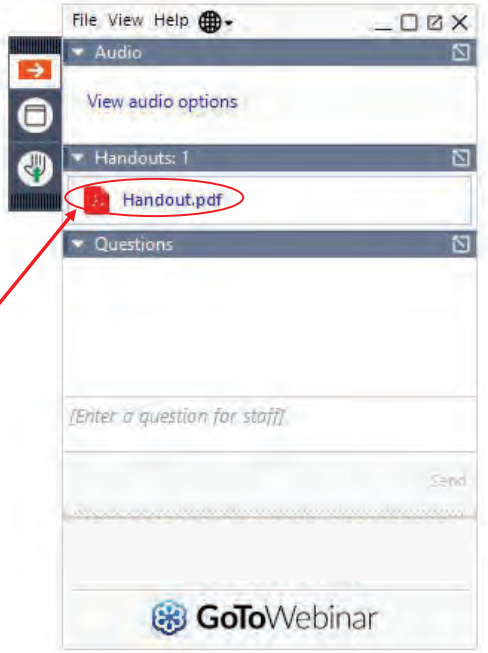


Teleconference Guide

- The telephone version of the meeting will be held Thursday, Oct 8th from 6-8pm.
- Presentation will be approximately two hours and will be recorded.
- We will break to address questions at the end of the presentation.
- Questions can also be submitted after the presentation via website or to clearview@openroadrenewables.com

Technical Assistance

- If at any time you require IT support, please contact GoToWebinar:
  - URL: https://support.goto.com/webinar?labelid=4a17cd95
  - Chat Support: https://support.goto.com/webinar#856-299
  - Toll Free Phone: +1(833) 851-8340



- Technical assistance handout available in GoToWebinar access panel.
- You can also watch a video recording of the virtual presentation on the project website and let us know of any additional questions. www.clearviewsolarproject.com

Agenda

- Introductions
- Organization Structure and History
- Description of the Project
- Siting Criteria
- Need for the Project
- Activity in Champaign County
- Local Project Impacts
- Project Schedule
- Project Studies
- Preliminary Design
- Solar Components
- Preliminary Landscaping
- Operational Impacts
- Decommissioning and Restoration
- In Summary
- Contact information - Clearview Solar
- OPSB's review and certification process
- Contact information - OPSB

Introductions

Doug Herling
VP - Development, Open Road Renewables

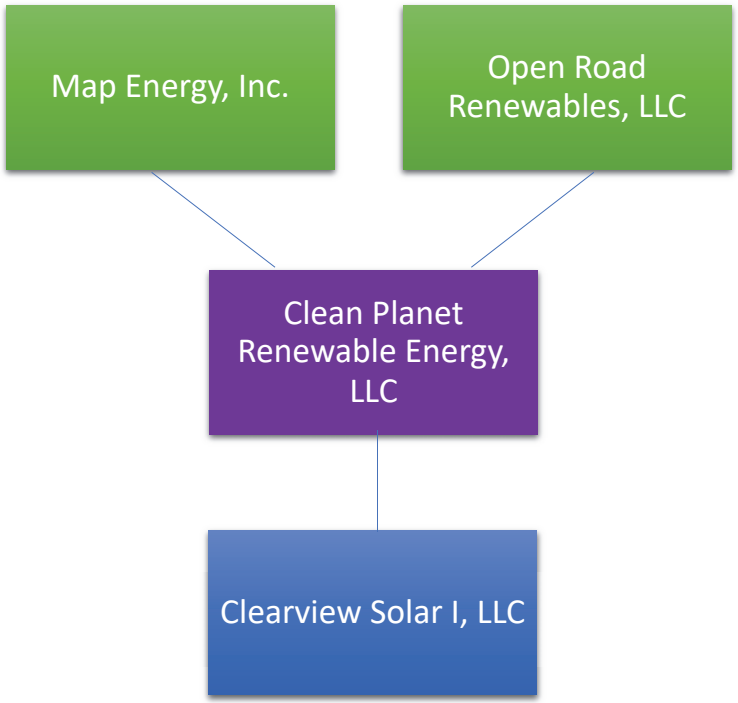
David Savage
Founder & VP, Open Road Renewables

Erica Tauzer
Project Manager, EDR

Matt Butler
Public Affairs, Ohio Power Siting Board

Organization Structure and History

- Open Road develops utility-scale solar energy projects in the Eastern US
- Open Road focuses on larger solar projects, such as the 200-Megawatt ("MW") Hillcrest Solar Project now under construction in Brown County, OH
- Open Road's partner is MAP Energy, one of the most experienced energy investors in the U.S. with successful investments in over 12,000 MW of operating energy projects
- MAP and Open Road co-own Clean Planet Renewable Energy, of which Clearview Solar is a wholly owned subsidiary
- Clearview Solar will be the "Applicant" in the Ohio Power Siting Board permitting process

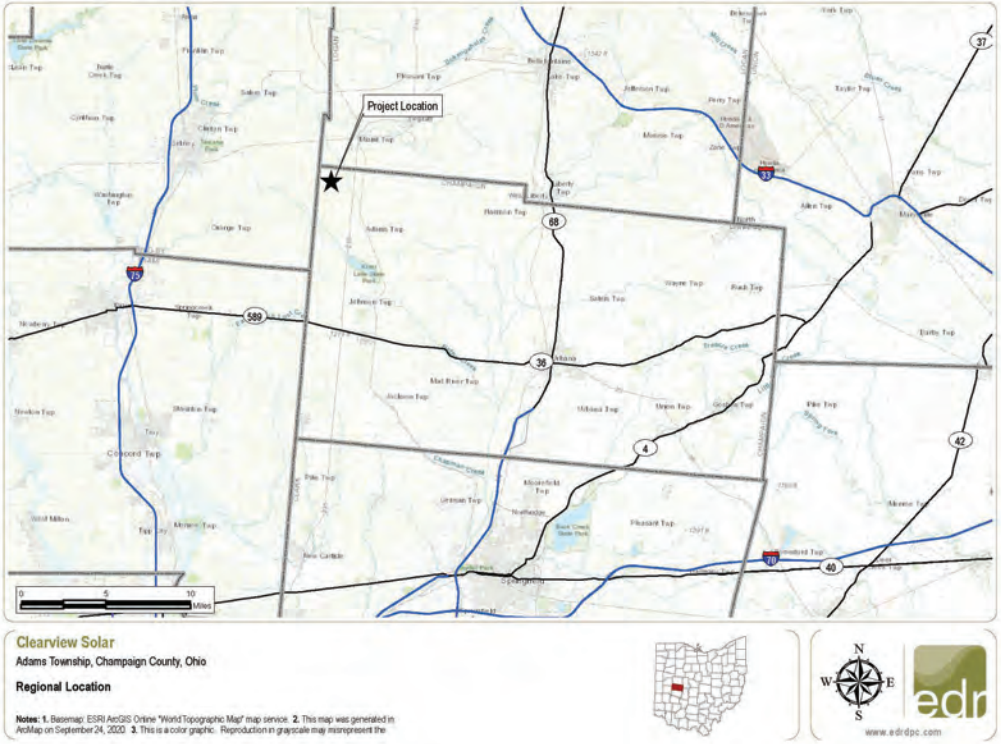


Description of Project

Clearview will be a photovoltaic (“PV”) electric generation facility located north of Rosewood in Adams Township, Champaign County. The Project will have a maximum nameplate capacity of 144 MW. The Project will occupy about 1,000 acres of agricultural land, which can be returned to farming after 40 years. Construction of the facility is expected to begin in late 2021 and take about 12 months.

Project Data:

- Technology: Solar PV
- Racking: Single-Axis Tracker
- Foundation: Driven steel pilings
- Interconnection Voltage: 138kV
- Interconnecting Utility: Dayton
- Maximum Capacity: 144 MW



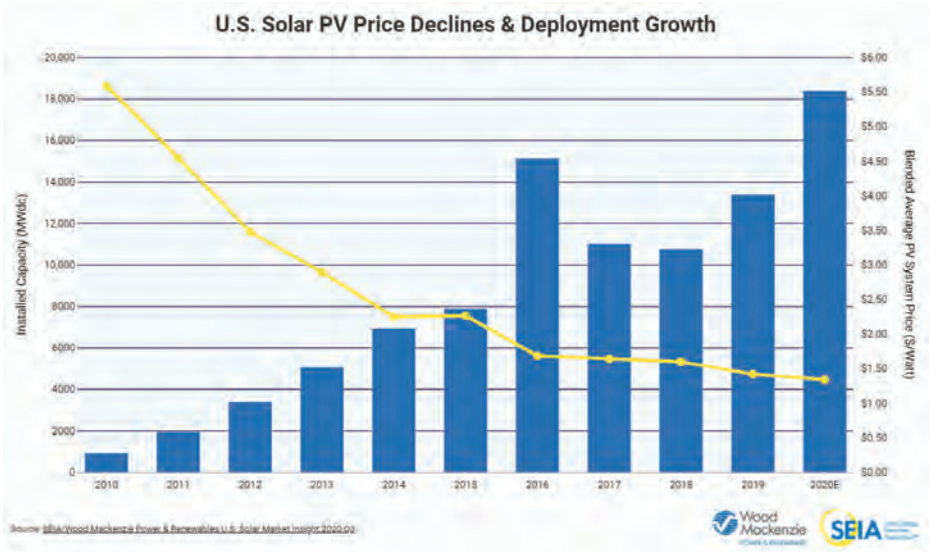
Siting Criteria

Solar PV is a mature technology utilized worldwide to safely and economically produce electricity.

Due to dramatic reductions in the cost of solar and increase in module efficiency, solar is competitive throughout the US, including Ohio.

Clearview was sited in Champaign County for several key reasons:

- Access to robust transmission capacity on Dayton Power & Light system
- Availability of cleared, well-drained, relatively flat land
- Proximity to transportation and delivery infrastructure
- Limited sensitive ecological and cultural resources
- Willingness of area landowners to participate



Need for Clearview Solar

The Project will respond to several important needs in Ohio and Champaign County:

1. Solar is a cost-effective in-state power generation option for replacing a portion of the retiring fossil fuel generation fleet
2. Demand for in-state renewable energy options from large-scale energy users in Ohio or considering relocating to Ohio
3. Diversification of and increase in revenue for local taxing jurisdictions
4. Opportunity for landowners to diversify farm income and preserve agricultural land for use by future generations
5. Workforce development and support in an emerging, vibrant sector

Activity in Champaign County

- Clearview has been actively negotiating land agreements in Champaign County, OH since mid-2019
- Clearview has begun providing information to the greater Adams Township and Champaign County communities about utility-scale solar and the OPSB process
- Clearview is communicating with Champaign County, Adams Township, the Graham Local School District, Ohio Farm Bureau, and other local officials and organizations
- Clearview will work with Champaign County officials to evaluate and implement an agreement under Ohio's Payment in Lieu of Taxes ("PILOT") program
- Under the PILOT program, the Project will pay more than $1 million each year for decades to local taxing jurisdictions

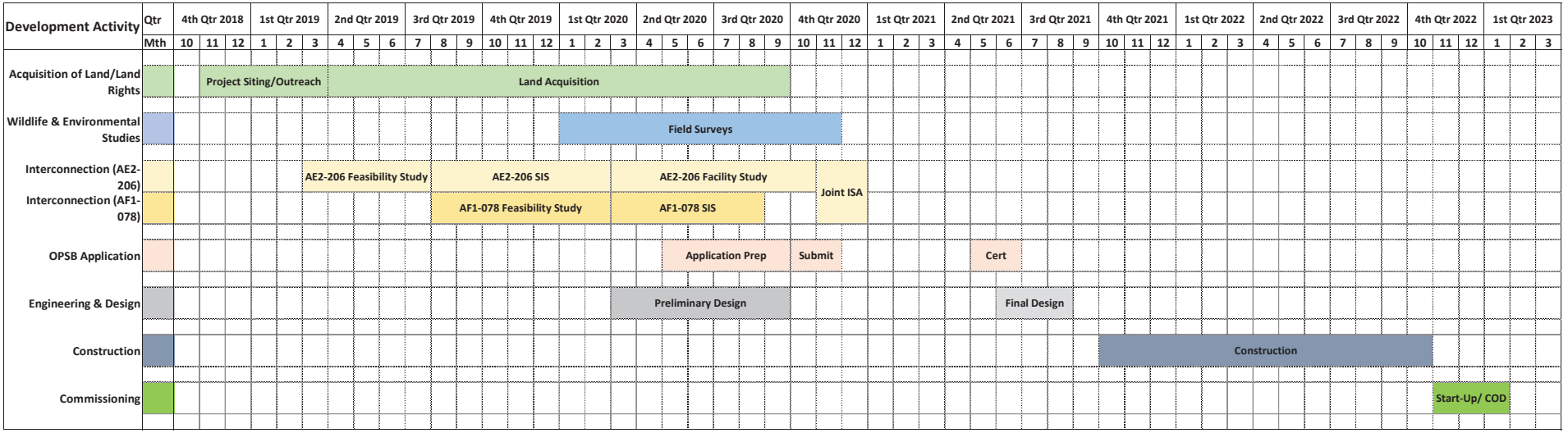
Local Project Impacts

- **Workforce Development**
  - The PILOT program requires that 80% of construction employees must live in Ohio—a potential impact of hundreds of local jobs
  - Construction roles include: laborers, electricians, truck drivers, heavy equipment operators, and surveyors
  - The Project will provide a small number of permanent jobs for the operation and maintenance of the site and equipment
- **Regional Purchasing**
  - Ohio is home to many companies in the solar manufacturing supply chain—and many will be strongly considered for use on this project (Ohio-made panels are being installed at Hillcrest Solar)
  - Solar construction and operation provides opportunities for equipment rental, fencing, civil work, landscape supply, seed, tiling, roadwork, and more
- **Economic and Educational Benefits**
  - Over $1 million in revenue per year (10x–15x current) for local taxing jurisdictions including: Graham LSD, Adams Township, Champaign County, Fire and EMS, Developmental Disabilities, Roads, etc.
  - Partnership with local vocational school or higher education institution

Project Schedule

Permitting Timeline

- October 8 – Telephone Public Information Meeting
- November 2020 – Application Submission
- 1st Quarter 2021 – Public Hearing
- 3rd Quarter 2021 – Target Certificate Issuance



Project Studies

The Project has completed or started a variety of studies that are required for permitting or are necessary for the design and construction of the Project.

Civil	Cultural	Socioeconomic / Transportation	Environmental / Ecological	Interconnection
Drainage Assessment	Cultural + Historical Desktop Study	Economic Impact Study	Wildlife Report	Feasibility Study
Culvert Inventory	Visual Resources Assessment	Transportation / Route Study	Wetland Delineation	System Impact Study
Decommissioning Plan	Phase I Workplans		Vegetation Management Plan	Facilities Study
Well Survey & Groundwater	Phase I Architecture Survey		Glint & Glare Analysis	Interconnection Services Agmt
Prelim Geotech Investigation	Phase I Archeaology Survey		Sound Level Assessment	
Preliminary Design			Landscaping Plan	
			USACE Jurisdictional Determination	

Preliminary Design

Preliminary Plant Design

Maximum capacity: 144 MW

Total fenced area: 1,061 acres (+/-)

Inverter Type: Central

Racking type: Single-Axis Tracker

Foundation: Driven Pilings

Maximum height: 15 feet

Ground Coverage Ratio: 31% (+/-)

Minimum Setbacks from Non-Participating Residences

Fence: >150 feet

Inverters: >500 feet

Minimum Setbacks from Property Lines and Road ROWs

Fence: >25 feet

Minimum Setbacks from Streams and Wetlands

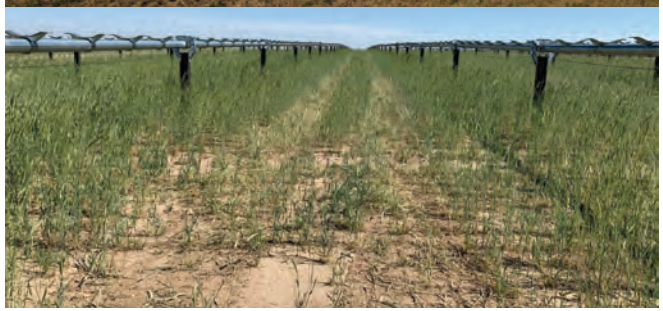
Fence: >25 feet

Solar Components

Steel Pilings

Construction of a solar facility requires minimal ground disturbance and results in the creation of very few impermeable surfaces

- Steel pilings are the foundation for solar arrays.
- Pilings are driven 5 – 10’ into the ground for stability.



Solar Components

Racking

Solar projects use racking that is either fixed tilt or single-axis trackers (SAT)

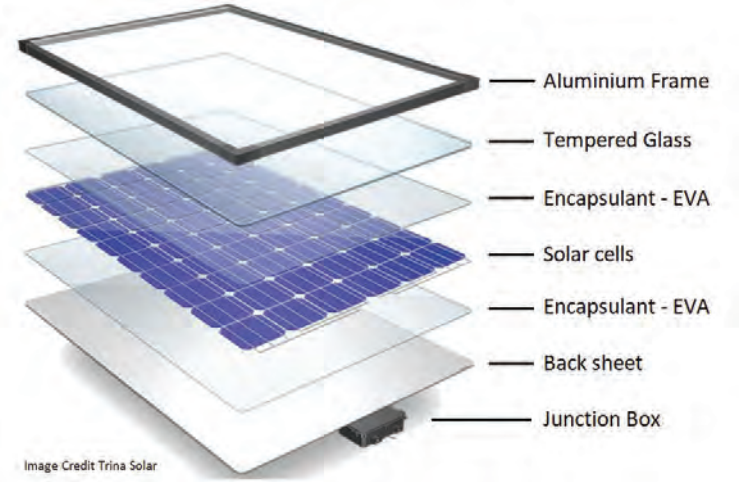
- Metal racking is mounted on the rows installed pilings
- Rows are spaced to avoid shading each other and for maintenance access
- Racking is configured to withstand high wind speeds and, in the case of SAT, stows for maximum array stability

Solar Components

Solar Panels or Modules

Solar PV is a mature, safe technology used to produce energy in many settings such as at homes, schools, farms, or businesses

- Solar projects use several industry standard solar panel varieties: Crystalline, Crystalline Bi-facial, or Thin Film
- Solar panels are composed of layers of tempered glass, encapsulant, solar cells, and a back sheet
- In the event of cracking or breakage, solar panels maintain their integrity (similar to a car windshield) and contain nothing that can leak



Solar Components

Inverters, Collection Lines, & SCADA

Direct current (“DC”) electricity generated by the solar panels is converted to alternating current (“AC”) at an inverter and is transported Clearview’s substation through a network of collection lines

- Inverters are located throughout the solar array and are installed on concrete pad or metal skid along with a medium voltage transformer
- The collection line network is buried 2 – 4’ below ground and transport AC electricity between the inverter/transformer and substation
- Supervisory Control and Data Acquisition (SCADA) is a system that allows for control and monitoring of the array trackers, inverters and other project components. SCADA networks are connected via fiber optic cables

Preliminary Landscaping

Clearview is working with a Columbus-based firm to design perimeter landscaping for the facility. The goal of this effort is to address aesthetic concerns by blending the facility into the existing landscape. These goals are accomplished by:

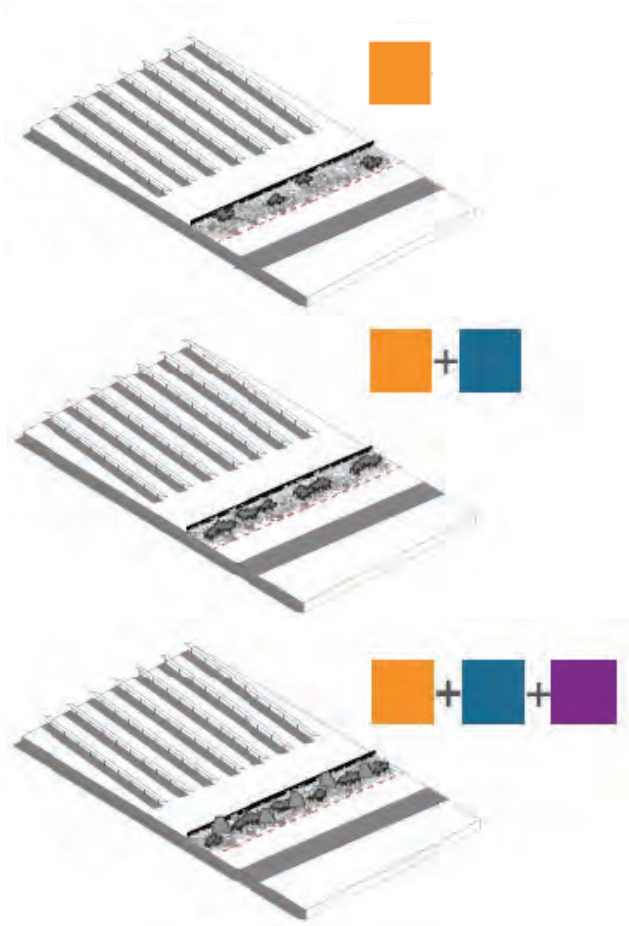
1. Maintaining existing vegetative buffers
2. Incorporating setbacks from residences that will continue to be actively farmed or utilized as pollinator habitat
3. Developing landscaping modules using native pollinator, grass, shrub, and tree species that are regionally appropriate and non-invasive
4. Ensuring that modules fit in the landscape, softening and blending views of the facility

Overview Map

Proposed Modules

Clearview proposes to design its perimeter landscaping utilizing three modules:

- **Low Density**
  - Pollinator mix and small shrubs
  - Installed along road frontages and in areas away from homes
- **Medium Density**
  - Pollinator mix, large shrubs, and small trees
  - Installed in areas near clusters of residences or along road frontage near homes
- **High Density**
  - Pollinator mix, large shrubs, small trees, and large trees
  - Installed where homes are in closer proximity to the Project fence

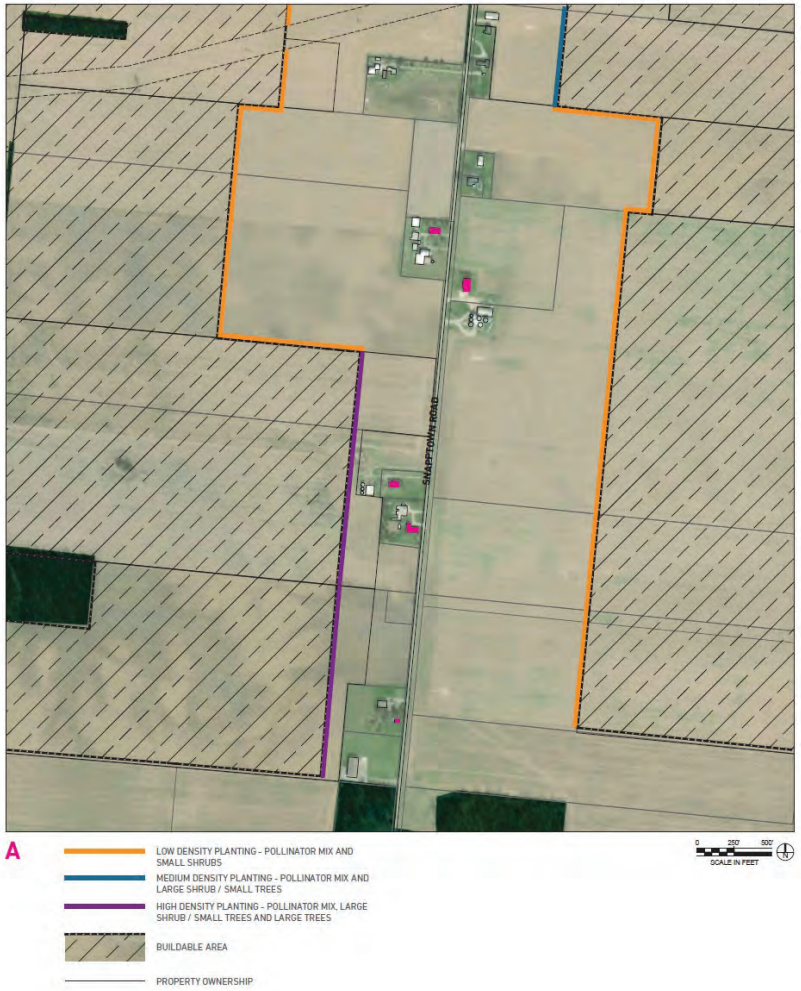


Preliminary Landscaping

Snapptown Road

Clearview proposes installing the following modules in the central portion of the project area. For reference, the Project proposes setting back at least 500’ from the road.

- High Density Plantings and Medium Density Plantings in the vicinity of homes along Snapptown Road
- Low Density Plantings are proposed where fence is in the distance and will be seasonally obscured by row crops.



Preliminary Landscaping

OH-235 and Eastern Champaign Logan Road

Clearview proposes installing the following modules in the eastern portion of the project area:

- High Density Plantings in the vicinity of residences and the Project Substation
- Medium Density Plantings along OH-235
- Low Density Plantings along Champaign Logan Road

Preliminary Landscaping

Champaign Logan Shelby Road and Elm Tree Road North

Clearview proposes to setback 300’ from Champaign Logan Shelby Road.

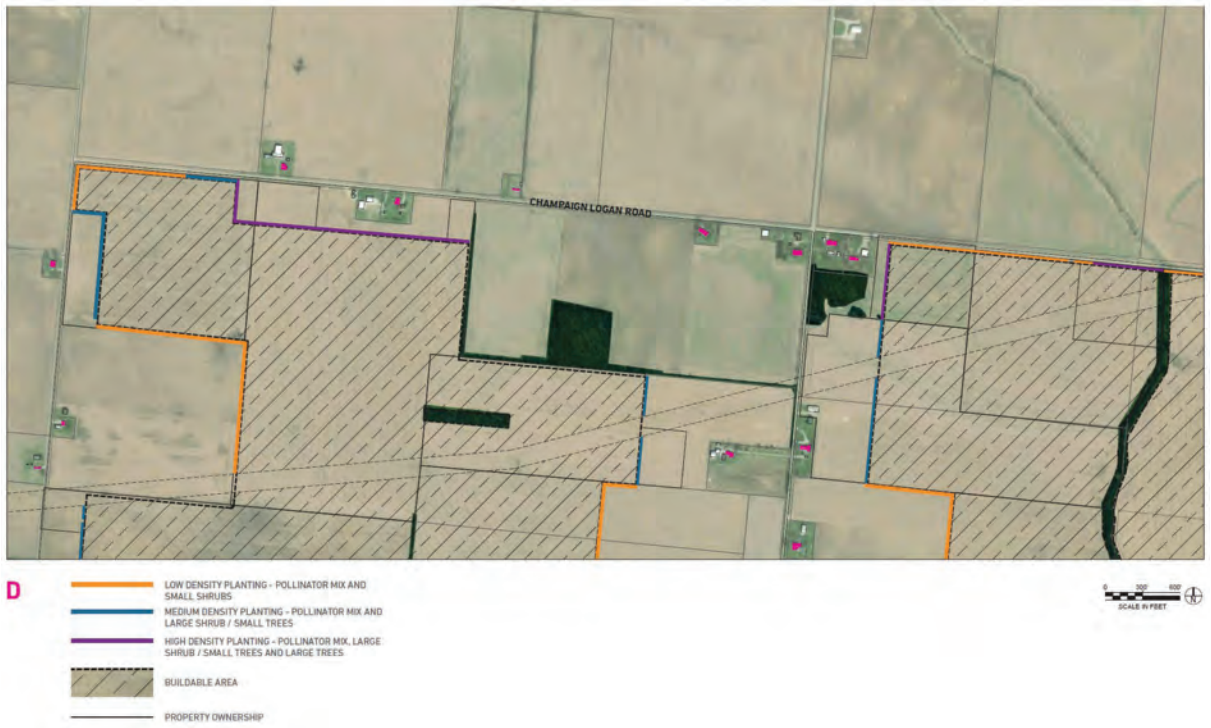
- High Density Plantings are proposed along the fence line in the vicinity of residences along Elm Tree Road North
- Medium Density Plantings are proposed along the N/S fence along Champaign Logan Shelby Road
- Low Density Plantings are proposed for portions of the fence away from homes

Preliminary Landscaping

North Champaign Logan Shelby Road and Champaign Logan Road

Clearview proposes installing the following modules in the northern portion of the project area:

- High Density Plantings are proposed along fence lines in the vicinity of homes
- Medium Density Plantings are proposed along roads in the vicinity of homes
- Low Density Plantings are proposed for areas away from homes



Operational Impacts

- No pollution
- No odor
- No dust
- No discernable movement
- Quiet
- Not operated at night
- Minor traffic
- Minimal light

Removal & Return to Farming

At the end of the Project's 40-year life, the solar project will be decommissioned, and land restored to its current agricultural condition.

As part of its OPSB submission, Clearview will submit a preliminary Decommissioning Plan that describes:

- Bonding to ensure funds are available for decommissioning and restoration
- Removal of equipment from the site
- Removal and decompaction of roads
- Restoration of agricultural land to substantially its pre-solar condition

In Summary

- Clearview is in the early stages of permitting a 144 MW solar project
- Solar is a mature, safe, and cost-effective means of generating in-state electricity
- Clearview is undertaking a comprehensive study process to ensure minimal adverse impacts to sensitive area resources
- Clearview is using thoughtful setbacks, landscaping, and careful equipment siting to mitigate and minimize impacts to visual, environmental, and cultural resources
- Once constructed, Clearview will benefit local schools, the Township, and the broader Champaign County community

Applicant's Contact Information

- Website: www.clearviewsolarproject.com
- Facebook: https://www.facebook.com/Clearview-Solar-Project-101347974960171
- Email: clearview@openroadrenewables.com

Ohio | Power Siting Board

Ohio | Public Utilities Commission

OhioEPA

Ohio Department of Agriculture

Ohio | Development Services Agency

Ohio Department of Health

Phone: (512) 524-1195 Email: Clearview@openroadrenewables.com Web: clearviewsolarproject.com

Ohio | Power Siting Board

OPSB role

- Before any company can build a "major utility facility," the OPSB assures that it benefits Ohio's citizens, promotes the state's economic interests, and protects the environment and land use.
- Public and local government participation are strongly encouraged, but decision making authority rests with the OPSB.
- If approved, the OPSB issues a certificate for the construction, operation, and maintenance of the facility.

Ohio Power Siting Board

OPSB jurisdiction

Electric Generation

Solar farms
50 MW and greater

Wind farms
5 MW and greater

Fossil fuel plants
50 MW and greater

Electric Transmission

Lines and associated facilities 100 kV and greater

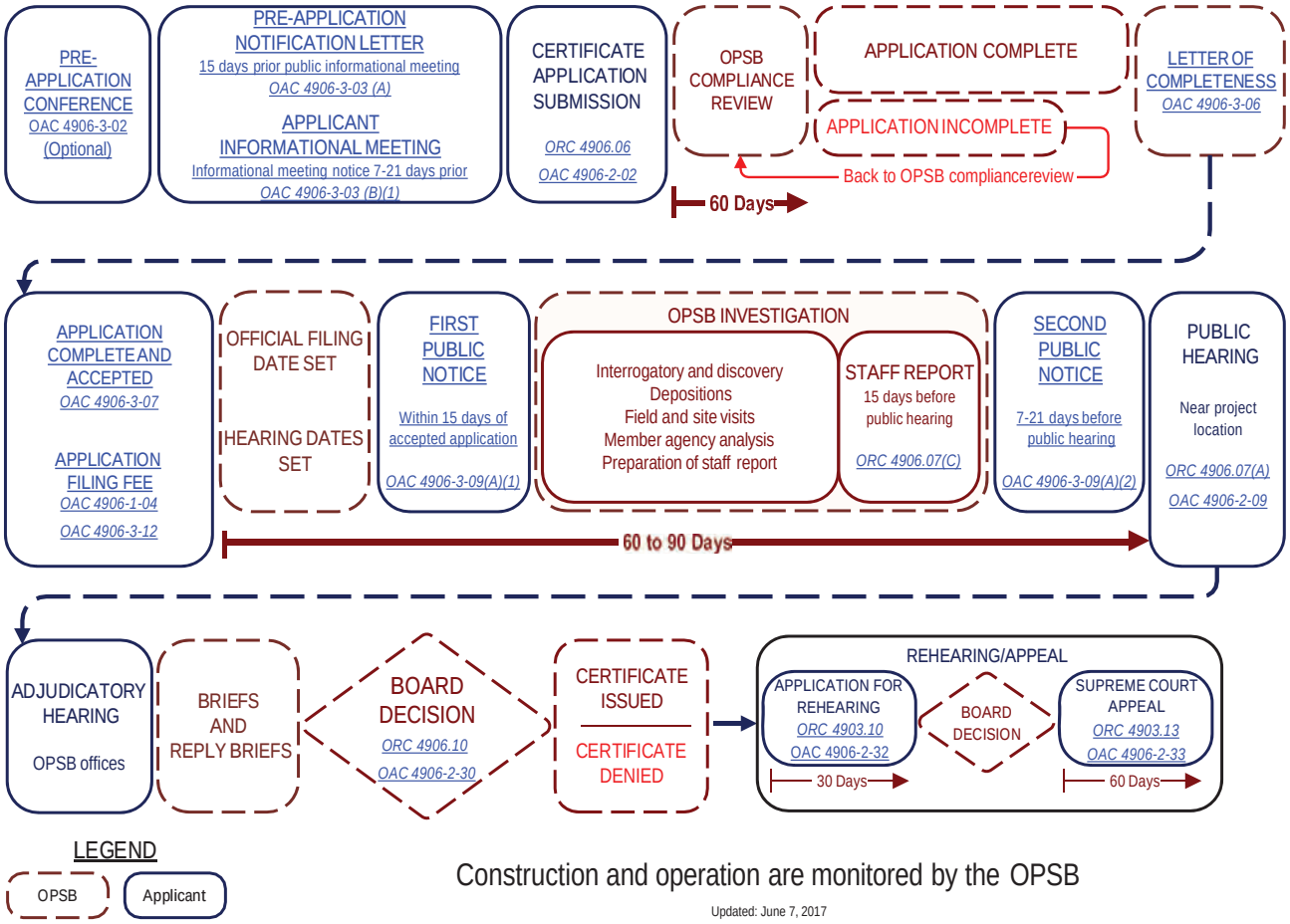
Natural Gas Transmission

Pipelines greater than 500 feet in length and 9 inches in diameter

Maximum operating pressure greater than 125 psi

Ohio Power Siting Board

Standard Application Process



Construction and operation are monitored by the OPSB

Updated: June 7, 2017

Ohio | Power Siting Board

How to participate

Public informational meeting

Developer educates community about project and gathers input to consider while developing its application. OPSB representatives provide information about siting process and public participation.

Public comments

Written comments are filed in the case to inform the Board members and staff. Comments are accepted at any time after a case number is established.

Online:
https://opsb.ohio.gov/wps/portal/gov/opsb/help-center/file-a-comment

Email: contactOPSB@puco.ohio.gov

Mail:

Ohio Power Siting Board
180 E. Broad Street
Columbus, Ohio 43215

Local public hearing

Board obtains sworn statements from members of the public who wish to testify. The statements are transcribed and become part of the official record that the Board considers before making its decision.

Held at least 15 days after staff publishes its report of investigation. Notification letters sent to property owners and local officials. Newspaper notice published 7-21 days before the hearing.

Adjudicatory hearing

The developer, OPSB staff, and parties to the case present testimony and evidence regarding the facility and cross examine each other. Intervention grants individuals and local governments the right to participate as a party in the adjudicatory hearing, file for rehearing, or appeal the result to the Supreme Court of Ohio.

Held approximately 2 weeks after the local public hearing. Property owners and local officials receive letters advising them of right to intervene.

Ohio | Power Siting Board

Construction & operation

- **If a project is approved**, the OPSB monitors construction and operation to ensure compliance with the certificate and any conditions.
- The developer must notify landowners prior to start of construction.
- The developer must establish a **complaint resolution process** to address concerns resulting from project construction and operation.
- OPSB can assist individuals who feel they are not obtaining a resolution from the developer.

Ohio | Power Siting Board

Resources

OPSB Website

www.OPSB.ohio.gov

- Case summary page
- Process information
- Calendar of events
- www.facebook.com/OhioPSB

Docketing information system (DIS)

https://dis.puc.state.oh.us/

- View case documents and public comments
- Case number 20-1362-EL-BGN
- Subscribe for case notifications

Call us at 866-270-6772

Ways to get in touch with us

Phone: (512) 524-1195

Email: Clearview@openroadrenewables.com

Web: clearviewsolarproject.com

December 2020

Appendix E

Environmental Design & Research,
Landscape Architecture, Engineering & Environmental Services, D.P.C.
217 Montgomery Street, Suite 1000, Syracuse, New York 13202
P. 315.471.0688 • F. 315.471.1061 • www.edrdpc.com

memorandum

To:	Doug Herling, Open Road Renewables	EDR Project No:	192008
From:	Erica Tauzer, Kalyna Paraszczak, EDR		
Date:	October 06, 2020		
Reference:	Clearview Solar PIM Live Q&A Report		

Clearview Solar Virtual PIM Live Q&A Session
October 06, 2020
4:00 PM – 6:00 PM
Moderator: Erica Tauzer; EDR
Panelists: (Partner Team) Doug Herling, Open Road Renewables; David Savage, Open Road Renewables; Erica Tauzer, EDR; Matt Butler, Public Affairs at Ohio Power Siting Board; Ray Strom, EDR; Samantha Sawmiller, Open Road Renewables.

This Q&A Session was part of a series of public engagement events related to the Clearview Solar Virtual PIM. During this virtual session the project team, including the panelists listed above, delivered a presentation containing information about the Clearview Solar Project. Following the presentation, virtual attendees were able to ask questions, which were answered by the panelists. The questions and responses are listed below. Frequently Asked Questions were also discussed and are listed below.

Question 1 Part 1
Received From: Thomas C.
Do the solar panels rotate to follow the sunlight during the day?
Answer: (David Savage, Open Road Renewables) The answer to that is that it depends on the tracker technology being used. If you go down to the Graham Elementary School and Middle School, you may have seen, there are new solar panels down there. They have what's called a fixed array. Those panels are just facing south, which is where the sun is. We're here in the Northern Hemisphere and they're at a fixed position, they don't move during the day. The other common kind of solar panels is called an tracker, and those do track the sun from the beginning of the day. They face East and they have various small electric motors on them, and they move as a unit and track the sun as it goes from East to West during the day. And the project, here at Clearview, will utilize the tracking technology, and the reason we do that is even though they're more expensive, the additional energy we can generate from the trackers makes it worth it at a larger scale. So, in general, there are two kinds, but we'll be using the tracking variety that does follow the sunlight during the day.

Question 1 Part 2
Received From: Thomas C.
So, do the solar panels rotate to follow the sunlight throughout the year?
Answer: (David Savage, Open Road Renewables) The panels will rotate all year, in the sense they'll operate all year during all daylight hours, you know, winter, or summer they'll produce power. What they will not do is rotate or adjust themselves, so that they're tracking the sun specific path as it changes during the year. There is a technology that does that. It's called a double tracker. And it moves the panels not only during the day, but also adjusts the path of the panels

differently depending on what season. They're expensive and they're not really deployed at scale yet because they're just not worth it for the additional energy that they produce.

Question 2
Received From: Doreen R.
Who is the end user of the electricity generated?
Answer: (David Savage, Open Road Renewables) So, for our project there will be an immediate user, and then there'll be end users. The project will supply power to the high voltage transmission system that operates at the wholesale level. We get all of our power in Ohio, in homes, businesses and schools at the retail level, with the smaller voltage lines, but all of that power comes from some point from the wholesale system. We'll be supplying the power to the wholesale system and the immediate purchaser is still to be identified. But the ultimate end user will be just people in their homes and businesses and schools throughout southwest Ohio that will at least use part of the power. The way the electricity moves on the transmission system is such that it's not something that's tracked. You can't follow electricity from a particular generator to a particular end user, but a good bit of a power will be purchased by consumers in the southwest Ohio area including in Champaign County.

Question 3
Received From: **Sean O.**
How is the facility going to be connected into the DPL transmission system? Will it be above ground or buried? What path will it take?
Answer: (David Savage, Open Road Renewables) The project will deliver its power to an existing power transmission line at a high voltage line that runs right through the middle of the Project Area. The way that the project will deliver the power is that it will collect the energy from the individual solar panels, mostly through buried cables. Then, once that power is collected into one place, it will then deliver it to that line, up through a very short, above ground line, around 100 feet long. So, for practical purposes, because the Project Area sits on top of the Dayton Power and Light transmission system, the delivery will be underground, for all practical purposes.

Question 4
Received From: Christopher W.
Does the project have an off taker?
Answer: (David Savage, Open Road Renewables) We are discussing this with parties about that. That's an important commercial aspect of the project: at some point in its early life, a wholesale buyer leads to large portion of the power. So, we have ongoing discussions along those lines. They are confidential of course because of the sensitive nature of those discussions, so at this point, we haven't announced an off taker.

Question 5
Received From: Doreen R.
What scientific data can you provide about heat generated from the panels that may create a mini climate, affecting rainfall amounts on surrounding crops?
Answer: (David Savage, Founder and VP at Open Road Renewables) Yeah, it is a good question, and it is an interesting question. There has been some research about whether solar panels large groups of solar panels may create some heat around the panels. Not a lot, but some studies. And what they found, just as a practical matter, anyone who goes inside the secure fence of a solar facility on a hot day, if they touch the solar panels, it'll be hot to the touch, no question. Most of the energy is being converted from sunlight to electricity, but there is aluminum. The panels are framed with aluminum. There's other metal and they are covered in glass, so they are fairly hot to the touch. Most of that energy is going into creating electricity, not into creating the heat. Nonetheless, there is a little bit of heat created right near the panels. What the studies that have been done show is that it dissipates fairly quickly. Once you walk away from the panels, and particularly in a large solar facility, such as Clearview will be, there won't be any heat generated. We will

be vegetating the entire project area, including under the panels themselves with a robust grass and other vegetation. And the studies to date indicate that if anything, that kind of vegetation tends to dampen the temperature. There is a last bit of the question that I think that you said something about rainfall. And I am not aware of any studies one way or the other looking at whether solar panels somehow encourage or discourage rainfall. We do not think they would, both because we are not aware of any mechanism by which that would occur but also, we just have not heard of that being researched.

Question 6
Received From: Julie M.
So how do we know this will function for 40 years? What similar projects were started in 1960 to confirm a 40-year projected lifespan?
Answer: (Doug Herling, Open Road Renewables) 40 years is the maximum life of the project. We anticipated it should function for that length of time and the basis for that number comes from how manufacturers of this equipment, stress tests it. Just like your car has a warranty that is for a certain amount of time. It is because they have tested those components to know how long they will last, and solar is the exact same way. Are projects going back 10, 20 years? I do not know of any projects that are from 1960 that aren't floating around the Earth on a satellite right now, but there's a lot of science testing that goes into making sure these panels will last.

Question 7
Received From: Julie M.
Who are the members of the Ohio legislature that serve on OPSB and how do people find that out?
Answer: (Matt Butler, Public Affairs at Ohio Power Siting Board) The members, as I said, there are two from the House, and two from the senate, one from each party. Let me pull up the current list. I don't want to give you any wrong information here. Hang on one second.

(Erica Tauzer, EDR) And let me know if you want me to switch to a slide, Matt. The whole PowerPoint is up here.

(Matt Butler, Public Affairs at Ohio Power Siting Board) That's fine. For some reason, our site is not wanting to pull that up for me. Hang on one second here…. I'm sorry if you want to move on to the next question, maybe that's what we should do.

(Matt Butler, Public Affairs at Ohio Power Siting Board) (Revisited) Currently the non-voting legislative members from the house are Representative Nino Vitaly and Representative Jeffery Crossman, then the two senators from the Ohio Senate, Senator Kendra Williams, and Senator Steve Wilson. If you go to our website, OPSB.ohio.gov, you will be able to get to that. I think there is something going on with my access to it right now, here internally, but I did go to it through my phone, and you can get to that list just fine.

Question 8
Received From: **Sean O.**
This area is on the very fringe of the NOAA weather alert radio coverage area, meaning that reception is very poor. Considering how often we get severe weather in this area, what is the EMI and other are RF effects of the **inverter's** substation and transmission line. Meaning on the site and connecting the site to the transmission lines, what is the effects of those components on the NOAA radiofrequency? And what about AM, FM, 5G, etc.?
Answer: (David Savage, Open Road Renewables) We don't think there would be any effects is the short answer. In our experience, we've not seen any studies or literature or even heard of any significant situations where solar facility has caused any sort of interference with any kind of communications, whether it's cellular, microwave or just good old-fashioned radio or TV's. I do believe the OPSB rules that govern generation facilities do have a couple of questions

related to communications. To date, the information we have provided, and I believe that other solar companies that provided, is what I just said. There is no information to indicate any kind of communication problem, primarily because of the low, lying nature of the facilities. They are low to the ground and the low frequency electromagnetic fields that would be associated with the project are weak. They dissipate significantly with distance, and they really do not add much to what's already in the area, with all the transmission lines, appliances and everyone's homes. So, I do not think that would have any effect.

Question 9
Received From: Mike P.
Why is the PILOT better for local community members than the regular utility tax structure?
Answer: (Doug Herling, VP of Development at Open Road Renewables) The PILOT is the kind of tax agreement that we frequently pursue with counties in lieu of being taxed traditionally on the value of equipment out there, as it depreciates over time. The PILOT is superior for several reasons. One, it is predictable, long-term revenue. As you saw in the presentation, that's over one million dollars per year for the life of the project, which is, depending on the current millages in the area, typically 15 to 20 times what folks are currently are paying and what those taxing jurisdictions are currently getting off that same acreage. There are additional components such as the 80% in-state workforce requirement and workforce development with local college and vocational school. And then partnering with EMS for equipment necessary for training with ensuring that there is an agreement in place to keep the roads in good condition during the construction and operation of projects. So, there are many, many components outside of just the predictable revenue that makes it a win-win for the county in the community.

Question 10
Received From: Meredith T.
When does the final layout of the project need to be completed and submitted by? Can adjustments still be made to the current layout?
Answer: (David Savage, Open Road Renewables) I think you said layout, but many use the word footprint, because that's where there are a lot of details for the project within the fence. That may be many months away from being finalized through engineering and final design. We will be looking to finalize that when we submit a formal application to OPSB, and I believe there is a deadline for that; maybe 90 days after today's public information meeting. I know that it's our goal to submit it sooner than that. We would be planning on finalizing the footprint when we submit that application, so, yes, between the maps that are shown in the presentation and the footprint that appear in the application, there could be changes between now and then.

Question 11
Received From: Thomas C.
Can you apply for a license extension as you approach the 40-year life? What are the possibilities for applying for a license extension after the duration of the facility's lifespan guarantee of 40 years?
Answer: (David Savage, Open Road Renewables) I believe maybe someone else has a different answer to this, because this is kind of getting into the OPSB rules themselves…. Mr. Butler may disagree with me on this, and I would be happy to be corrected…. but I believe that there is no such thing as just a license extension. In other words, we would hope that the OPSB would issue a certificate for the project. We plan to request that it operate for 40 years, and we expect to be required to remove it after 40 years. I believe that, in order to have the project continue its life, past that, 40 years would require going back and getting another certificate. Just to be clear, even if there was an extension or something easier than going back and starting over and getting a whole new certificate, our project is commercially arranged as a 40 year project, apart from the licensing from the state. So, for instance, we'd have to go back to all our landowners and see if they want to extend the life of the project as well. We have independent obligations to remove the solar panels after the end of their useful life, to decommission a project, and to return the land in a condition that it can be cultivated. So, along with an answer to, I do not believe so, and the projects not set up to do that.

(Matt Butler, Public Affairs at Ohio Power Siting Board) I would just say in general, that the certificate is for the life of the facility and that any conditions that are contained in that certificate would apply to it. I cannot really speculate beyond that.

Question 12
Received From: Julia J.
How many holes will be dug for the poles supporting the panels?
Answer: (David Savage, Open Road Renewables) There actually will not be any holes dug for the poles. I guess, technically speaking, the answer is zero. The devices that raises up the solar panels are called piles and they are called "I" beams. They're actually pretty narrow, usually made out of galvanized steel, and they hold up the panels without any foundations, so there's no concrete poured at the bottom of the hole. They are simply driven into the ground, at a sufficient depth, which is usually on the order of 5 to 10 feet, so that they securely hold the array in place. We require piles for the project, but they will all be simply inserted right through the topsoil, rather than digging a hole and putting a foundation in place or something like that.

Question 13
Received From: **Sean O.**
There are several Native American sites in the area of the proposed solar facility. What studies are you doing to ensure proper cultural resource management? Who will do the studies and where will the results be posted?
Answer: (David Savage, Founder and VP at Open Road Renewables) There'll be OPSB's rules to consider cultural resources in the application. There is an entire section of the application that is designed to address one of the OPSB's rules on this subject. There will be an analysis completed that looks at these sorts of things, not just Native American sites, but also any other cultural resource. OPSB staff will collaborate with the staff at the Ohio Historic Office to send some experts in the field to ensure that these studies are done right and all that information would be posted in the application, and then it would continue as the project moves forward and will be publicly available.

Question 14
Received From: Julia J.
So, how many panels will there be and how many piles will hold them up?
Answer: (David Savage, Open Road Renewables) I don't know the exact number, but we will actually put a number in the application or at least a range of numbers in the application, but it will be tens of thousands of individual solar panels. There'll be a lot fewer piles than that, because the solar panels are mounted on devices called racking and it's basically a long tube. Then you only need a pile, every…I'm not sure exactly but somewhere in the order of 40 or 60 feet you need a pile along the tube. I believe the application will probably include a range of the number of piles. It certainly will include a range of the number of panels, but there are quite a few but I'll have to check the figures.

Question 15
Received From: Anna G.
Is there an e-mail and how to can we expect to have a recording of the meeting posted?
Answer: (Erica Tauzer, EDR) Yes. The answer is yes to both of those things. That e-mail is posted here on the screen. And if you can't see that I'll read it off to you. It's Clearview@openroadrenewables.com and on it is the e-mail address that you can use to get in touch with us. The recording of both the presentation and this Q & A session will be posted on the website. I think it's safe to say within the week. David or Doug, correct me on that, but we'll have that very shortly after this meeting on the website. Anything to add, David or Doug, along those lines?

(Doug Herling, Open Road Renewables) Covers it, Erica, thank you.

(Erica Tauzer, EDR) There's also a phone number here on the bottom of the slide as well if you want to get in touch that way.

Question 16
Received From: **Sean O.**
Is the PILOT now able to increase as local property valuations go up over the decades of the life of the project? If the solar costs keep dropping, is there any chance that this project becomes unviable down the road and the PILOT payments go away?
Answer: (David Savage, Founder and VP at Open Road Renewables) The PILOT payments would not go up over time; it is sort of a contract and they also can't go down. So, one of the features of that for local taxing entities is the ability to plan with certainty over future payments and knowing the exact amounts over the exact period. Generally, in our experience, it's that certainty of payments, and that substantial payment (it would be minimum a million dollars a year for 40 years). It will probably be in the order of 20% or 30% more than that every year for 40 years, so it doesn't change. That's one of the features of a PILOT is that it's certainty for everyone involved, including the local taxing jurisdictions. I didn't really hear the second question, can you? There was a second question in there.

(Erica Tauzer, EDR) Yes, the second question was if solar costs keep dropping is there any chance this there any chance that this project becomes unviable down the road and the PILOT payments go away?

(David Savage, Open Road Renewables) No, future costs of new solar projects wouldn't really affect the ongoing operation of a project. Solar facilities are unique generation sources in that there are quite expensive to build, but once they are built, they're inexpensive to operate. They do not have a lot of moving parts. The fuel, which is the sun is free and abundant, and it is highly predictable over long periods of time, even if it is not predictable over days or weeks. So, once a solar project is built, and up and running, there's extremely little chance that it would stop producing power, because you already paid to build it and it is inexpensive to operate. It represents a significant source of generation that will certainly be there for the entire period. The PILOT payments do not go away once they are contracted.

Question 17
Received From: Meredith T.
How does this power siting board make a decision, and what influences the decision?
Answer: (Matt Butler, Public Affairs at Ohio Power Siting Board) That's a great question. There are eight criteria that are spelled out in Ohio law that the board has defined before it can decide in a case. And those criteria are available, again, on our website, through the link to the revised code. Essentially, in doing that, the Board is making its decision based on the full record in the case so, not only the application submitted by Clearview solar, but also the findings that are made by the staff, all the testimony compiled at the local public hearing, all the testimony in cross-examination back and forth that would be part of the transcript from the adjudicator hearing, and then finally, any briefs and reply briefs and potentially, what we call stipulations, which are agreements that could be arrived at between two or more parties to the case. All of that together forms the case record, and like a court, the Board must make its decision based upon all that information. So, its input is coming from lots of different places, and the Board has to take that all into consideration before making a decision.

Question 18
Received From: Frequently Asked Questions
Who make sure that the roads are taken care of?
Answer: (David Savage, Open Road Renewables) During construction, the project could be responsible for ensuring the roads are in good condition, or return to their pre-construction condition or better once the project's in place and the way that's ensured is during the power setting board application process. We do need to do a transportation study, as you saw in the presentation, that'll be available for folks to see, and we'll be working with the engineer and

commissioners and other folks on the road use and maintenance agreement, and that's part of the PILOT. For us to keep that PILOT agreement in place, we need to live up to that maintenance agreement. That will include elements of financial surety to be sure that there's money to make those improvements or repairs.

Question 19
Received From: Sean O.
What happens if a landowner in the proposed project area wants to sell their land during the 40-year life span of the project?
Answer: (David Savage, Open Road Renewables) If there's a parcel of land that's in the project area participating in the project, they would have a long term lease on the land for whatever portion of it is hosting the solar panels. And then anytime during that period, the landowner can sell the land just like they could if there was no project; the lease would travel with the land, so to speak. So, the new purchaser of that project would also step into the shoes of that former landowner as a landlord on the solar project, and they would then start receiving whatever benefits the former landowner was receiving. You can buy and sell the property without regard to the project.

Question 20
Received From: Julia J.
What percentage of the panels will be in Logan County?
Answer: (David Savage, Open Road Renewables) We're not really planning on having any in Logan County. It would all be Adams Township in Champaign County.

Question 21
Received From: Frequently Asked Questions
Will any of the jobs during construction be local?
Answer: (Doug Herling, Open Road Renewables) As we mentioned regarding the PILOT, there is a requirement for 80% in state jobs for fourth project during construction. Many of those jobs can certainly be filled by local folks, whether it's union skilled or unskilled. There are lots of opportunities on construction of solar projects. Typically, that between 200-300 positions during construction.

Question 22
Received From: Anna G.
Open Road Renewables appear to be the parent company of Clearview Solar. Is this true?
Answer: (David Savage, Open Road Renewables) Yeah, that's a standard approach in the industry where an individual project has a significant enough undertaking and it also facilitates financing if there is a separate company for the project itself.

Question 23
Received From: Rebecca S.
How many landowners are in Adams Township that have signed a contract already? Are the **owner's** names public knowledge?
Answer: (David Savage Open Road Renewables) I'm going to have to give a range, because it depends on how you count owners, as people or single families, but between 5 and 10, depending on how you count it. Typically, land contracts have a memorandum which are a public record, which I believe we did in this case and that are in the regular accounting records. You can look those up.

Question 24
Received From: Frequently Asked Questions
What kind of technologies do solar farms use?

Answer: (Doug Herling, Open Road Renewables) Sure, there is sometimes some confusion about this. In some situations, in the Southwest and in extremely arid parts of the world, there are occasionally concentrating solar rays which are vast arrays of mirrors that of focus the sun at one point to generate steam. But we use a solar PV, which are not non reflective solar panels that convert the sun's rays to electricity. These are the same kind that you'll find on someone's house, or on a business, or at a school.

Question 25
Received From: Frequently Asked Questions
Who uses the electricity from solar farms?
Answer: (Doug Herling, Open Road Renewables) As David mentioned a little bit earlier, this project is connected to the Dayton Power and Light system, which supplies electricity to the local retail distribution level grid in Champaign County and the surrounding counties. That is where a lot of it is used, but the buyers of electricity are typically large energy users: industrial, commercial, and otherwise.

Question 26
Received From: Frequently Asked Questions
Do solar farms pay taxes?
Answer: (Doug Herling, VP of Development at Open Road Renewables) You hear this a little bit during the presentation, and we touched on it somewhat here. Solar farms in Ohio typically pay what's called a payment in lieu of taxes, to really kind of simplify the process and in Ohio that's a state mandated by, $7000 per megawatt each year, and that's how we arrive at the approximately one million dollar number for the 144 megawatt project.

Question 27
Received From: Rebecca S.
Where do I look to get landowner names?
Answer: (David Savage, Open Road Renewables) Sure, thanks for the question, Rebecca. Again, it is not information that we are at liberty to give out, but there are certainly resources in the county government to lookup land by parcel number, etc.

Question 28
Received From: Anna G.
Where can I get the slides from this meeting?
Answer: (Erica Tauzer, EDR) We'll have a recording of this meeting on the website, so the recording will have the slides for the meeting.

(Doug Herling, Open Road Renewables) We will also have the slides themselves in PDF format on the website, which should already be there through a link.
(Erica Tauzer, EDR) The website is Clearview@openroadsrenewables.com.

Question 29
Received From: **Sean O.**
What kind of lighting and how much would be installed in the proposed project area?
Answer: (David Savage, Open Road Renewables) We get this question quite a lot, and we'll be addressing it thoroughly in our application. But generally, there's very little permanent lighting installed. There is typically motion activated lighting near the gates for the entire project area, and then temporary lighting, and maybe some push activated lighting for maintenance purposes only at inverters. Otherwise, temporary lighting will be used for the project.

Question 30

Received From: Doreen R.
How does the project affect surrounding firms as far as underground cabling, etc.? Is farm tiling affected, is field tiling affected?
Answer: (Doug Herling, Open Road Renewables) As for, as far as impacts the surrounding farms, especially field tiling, I've learned a lot about the field tiling in Ohio, these last, 4 or 5 years. It's something that we have to look for and locate. So, we're working with our landowners, local till experts, the county, and Soil and Water to identify them. Especially mains between farms we know that mains cross and drain areas that might be outside of the project to an area inside the project and vice versa. So, we will be identifying that tile and avoiding it or working with any affected landowners to reroute and maintain it. So, that's our plan there and we're more than happy to speak with you individually, or anything else about any concerns you have about tile.

Question 31
Received From: John H.
What frequency is employed to the AC to DC converters?
Answer: (Doug Herling, Open Road Renewables) I want to get back to you about the exact frequency. But those at the transformers and inverters will be obviously going from DC to AC and stepping up to voltage to 34.5 kilo-volts. But we can get more information about that, and especially with utility scale inverters, most of that information will be available on the equipment factsheets that are a part of any solar application.

Question 32
Received From: Sean O.
For those roads shown on the project map, those added roads be dirt, gravel, or something else?
Answer: (David Savage, Open Road Renewables) Sean, the application will go into detail on this. I know I am saying that a lot, but this we are planning on gravel roads temporary width of 25 feet permanent width 16 feet and in some cases, those may be dirt or grass roads. We are anticipating gravel as the default.

Copies To: file

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memorandum

To:	Doug Herling, Open Road Renewables	EDR Project No:	192008
From:	Erica Tauzer, Kalyna Paraszczak, EDR		
Date:	October 08, 2020		
Reference:	Clearview Solar Teleconference Live Q&A Report		

Clearview Solar Teleconference Live Q&A Session
October 08, 2020
6:00 PM – 8:00 PM
Moderator: Erica Tauzer; EDR
Panelists: (Partner Team) Doug Herling, Open Road Renewables; David Savage, Open Road Renewables; Erica Tauzer, EDR; Matt Butler, Public Affairs at Ohio Power Siting Board; Ray Strom, EDR; Samantha Sawmiller, Open Road Renewables.

This Q&A Session was part of a series of public engagement events related to the Clearview Solar Virtual PIM. During this virtual session the project team, including the panelists listed above, delivered a presentation containing information about the Clearview Solar Project. Following the presentation, virtual attendees were able to ask questions, which were answered by the panelists. The questions and responses are listed below. Frequently Asked Questions were also discussed and are listed below.

Question 1
Has a PILOT been secured yet?
Answer: (David Savage, Open Road Renewables): The PILOT has not been secured yet. Over the next several months, Clearview plans to begin working with the Champaign County Commissioners and county staff to evaluate implementing a PILOT.

Question 2
Does the project plan to use a construction manager or EPC? Has that decision been made? If unknown, when will that decision be made?
Answer: (David Savage, Open Road Renewables): Utility-scale solar projects do typically work with an EPC to manage the construction phase. Clearview has not yet chosen an EPC or Construction Manager as that decision typically occurs following the project securing key permits, such as the OPSB Certificate.

Question 3
Will there be MSDSs (Material Safety Data Sheets) available for the public regarding the project materials?
Answer: (David Savage, Open Road Renewables): Clearview plans to submit publicly available technical data and manuals to the Ohio Power Siting Board staff for key project components. Clearview does not plan to finalize its equipment selection until post-Certificate Issuance.

Question 4
Received From: Frequently Asked Questions

Explain the PILOT and where does the money go?
Answer: (Doug Herling, VP of Development at Open Road Renewables) The PILOT is paid out based on where the project is physically located, so to the taxing jurisdictions that folks are currently paying property tax to in the area of the township hosting project. So that would include jurisdictions along with schools, along with the County and Adams Township, EMS, 911, the vocational school, anything that folks are currently paying taxes to are what we would be paying the taxes to it as well. And then approximately a million dollar a year file payment could be up to 30% more than that, as we mentioned in the presentation. There are some pretty significant payments these taxing jurisdictions.

Question 5
Received From: Frequently Asked Questions
Do solar farms require any community services?
Answer: (Doug Herling, VP of Development at Open Road Renewables) Regarding community services, there's very little required by the project. No water service, no sewer service, very minimal tax based supportive services. Because we're paying taxes about 15 times what is currently being paid based on acreage, we're making up for our presence in the area. Some of the local benefits that we mentioned in previously in the presentation is a lot of what we call benefits to the supply chain. Whether that's directly solar related to different companies in Ohio that produce either solar panels, racking, or other equipment used to construct a solar farm. Or other companies that might supply fencing or gravel, seed or other landscape supply, catering, port a johns, really anything, there's a lot of ripple effects that aren't just directly from folks being a part of the project or working on it so it's surely important to know that.

Question 6
Received From: Frequently Asked Questions
How do you (Open Road Renewables as a developer) make sure that the roads are taken care of during construction? What happens when the solar project has run its course after 40 years?
Answer: (Doug Herling, VP of Development at Open Road Renewables) As part of that PILOT arrangement, and like we said in the presentation the project would be working on regardless of the county, is what's called a road use and maintenance agreement. This agreement will put the onus on the project to make any minor upgrades to roads needed to handle legal load. During the 6-12-month construction of the project, the project would be on the hook for making sure that roads are in good shape for area residents and commerce passing through. And to do that we would be required to have financial surety behind that promise to make sure we have money to get it done. So that would be a lot of coordination with the engineer and that office, and the commissioners, and the township. The second part of that question, obviously solar is temporary land use. Once the project has run its course, the area is restored to its previous, agricultural condition. That's pulling out posts driven into the ground, decompacting any grass or gravel roads, or moving fences, fixing drain tile on the landowners' property as per our agreements. Things like that to make sure that land can be as productive as it is now. To ensure that is the case the project will be required to have financial insurity in place that covers the cost of decommissioning the project and there will be a lot more information on that in the project decommissioning plan and its application once that is complete.

Question 7
Received From: Anna G.
You guys talked about some specific sites are that you are already planning to have solar panels placed, but are you doing that for more and more places as you go?
Answer: (Doug Herling, VP of Development at Open Road Renewables) Open Road continues to develop projects in Ohio. Clearview is just the project here and we don't anticipate the project increasing in size. We are permitting for the project this size, any change to it would require us to go back to the siting board redo the process again. Given that it is a long process and given the timeline we plan to construct the project on, we just want to go through the process once.

Question 8
Received From: Anna G.
Who are you talking about when you talk about the landowners? Are you just talking about those specific places you guys talked about tonight?
Answer: (Doug Herling, VP of Development at Open Road Renewables) When David talked about a timeline used when we explored the area, that takes place over a couple of years of talking to potential land owners, and by that, we're referencing the folks that take part of the project or who might have been approached about the project. At this stage when we talk about landowners, we will typically are referring to folks of the project and adjoining or adjacent landowners who are also obviously part of the community and folks that we intend to work with long term through permitting to operation and construction of the project.

Question 9
Received From: Anna G.
Are you working on two sites right now or is it one?
Answer: (Doug Herling, VP of Development at Open Road Renewables) The Clearview Solar Project is one site in Adams Township.

Copies To: file

Attached: 2020-10-06_Live Q&A Participation Analytics Report

December 2020

Appendix F

Clearview Solar

October 28, 2020

Agenda

- Concerns about Clearview Solar
  - What We've Heard from You
- How the Project Addresses Concerns
  - Project Design
  - Application Commitments
- How the Ohio Power Siting Board Addresses Concerns
  - Recommended Certificate Conditions

Concerns We've Heard From You

- Potential damage to Drainage and Drain Tile
- Groundwater or Soil Contamination
- Project Aesthetics
- Distance from homes to Project
- EMF/EMR
- Road Widths and Suitability for Construction
- Property Values
- Long-term farmland viability

Addressing Concerns Through Project Design

Preliminary Design

Preliminary Plant Design

Maximum capacity: 144 MW

Total fenced area: 1,061 acres (+/-)

Inverter Type: Central

Racking type: Single-Axis Tracker

Foundation: Driven Pilings

Maximum height: 15 feet

Ground Coverage Ratio: 31% (+/-)

Minimum Setbacks from Non-Participating Residences

Fence: >150 feet

Inverters: >500 feet

Minimum Setbacks from Property Lines and Road ROWs

Fence: >25 feet

Minimum Setbacks from Streams and Wetlands

Fence: >25 feet

LEGEND:

- PROJECT BOUNDARY
- EX. LOT LINE
- EX. SECTION LINE
- EX. RIGHT OF WAY LINES
- EX. EASEMENT LINES
- EX. STREAM
- EX. TREELINE
- EX. WETLAND
- EX. OVERHEAD POWER
- EX. FENCE
- EX. GRAVEL ROAD
- EX. PAVED ROAD
- EX. CULVERT
- EX. STRUCTURE
- EX. RESIDENCE
- SOLAR ARRAY
- FENCE SETBACK
- EASEMENT LINE
- ELECTRICAL EQUIPMENT
- ACCESS ROAD
- SECURITY FENCE
- UNDERGROUND COLLECTOR
- OVERHEAD POWERLINE
- LAYDOWN YARD
- SUBSTATION
- NO SOLAR BUILD AREA
- SITE ENTRANCE

Westwood

Phone (952) 937-5150 12701 Whitewater Drive, Suite #300
Fax (952) 937-5822 Minnetonka, MN 55343
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

PREPARED FOR:

CLEARVIEW SOLAR, LLC

1105 Navasota St
Austin, TX 78702

REVISIONS:

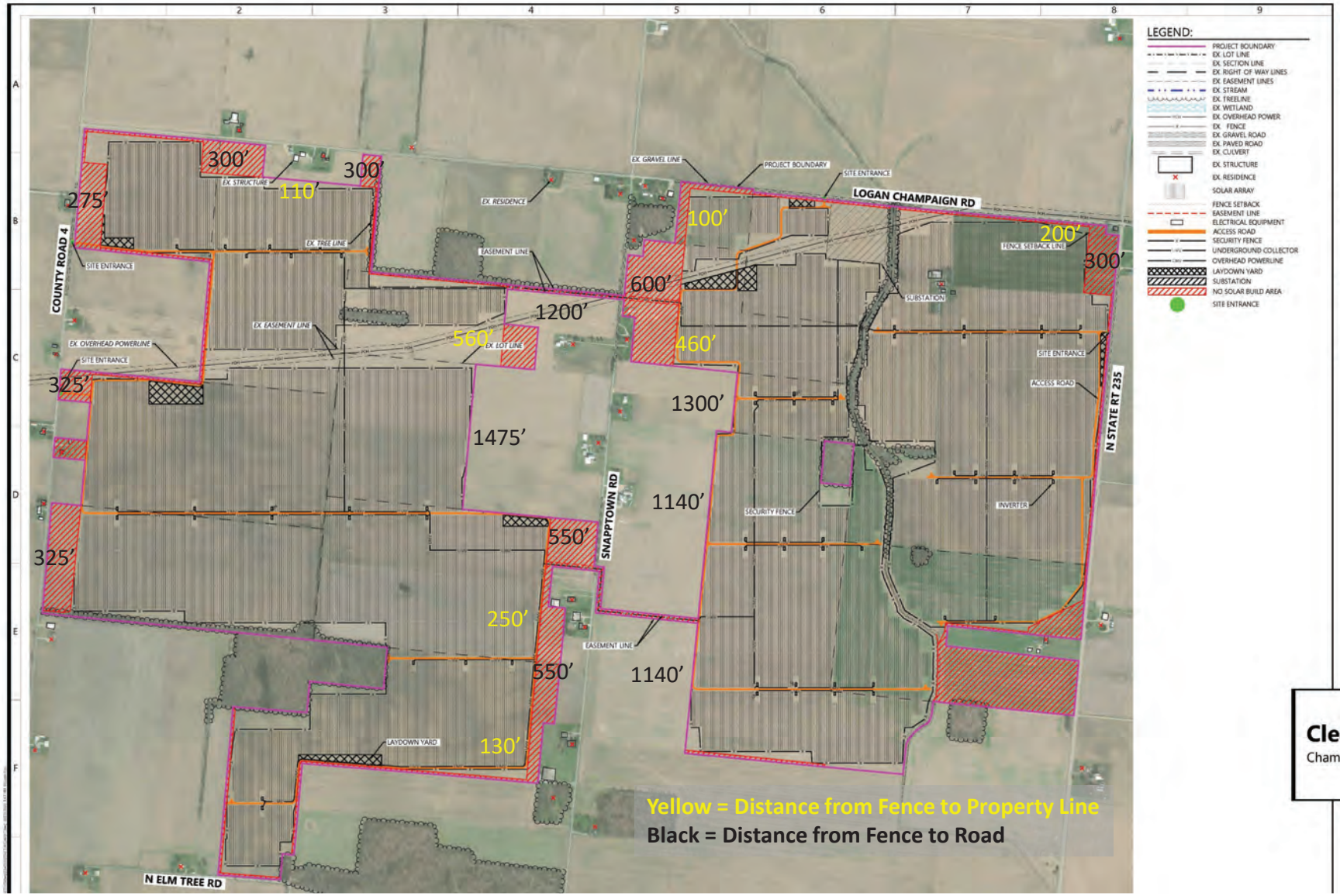
#	DATE	COMMENT

0' 500' 1000' 1500'

Clearview Solar

Champaign County, OH

Overall Site Plan



Westwood

Westwood Professional Services, Inc.

PREPARED FOR:

CLEARVIEW SOLAR, LLC

1105 Navasota St
Austin, TX 78702

REVISIONS:

#	DATE	COMMENT

Clearview Solar
Champaign County, OH

Overall Site Plan

Preliminary Landscaping

Clearview is working with a Columbus-based firm to design perimeter landscaping for the facility. The goal of this effort is to address aesthetic concerns by blending the facility into the existing landscape. These goals are accomplished by:

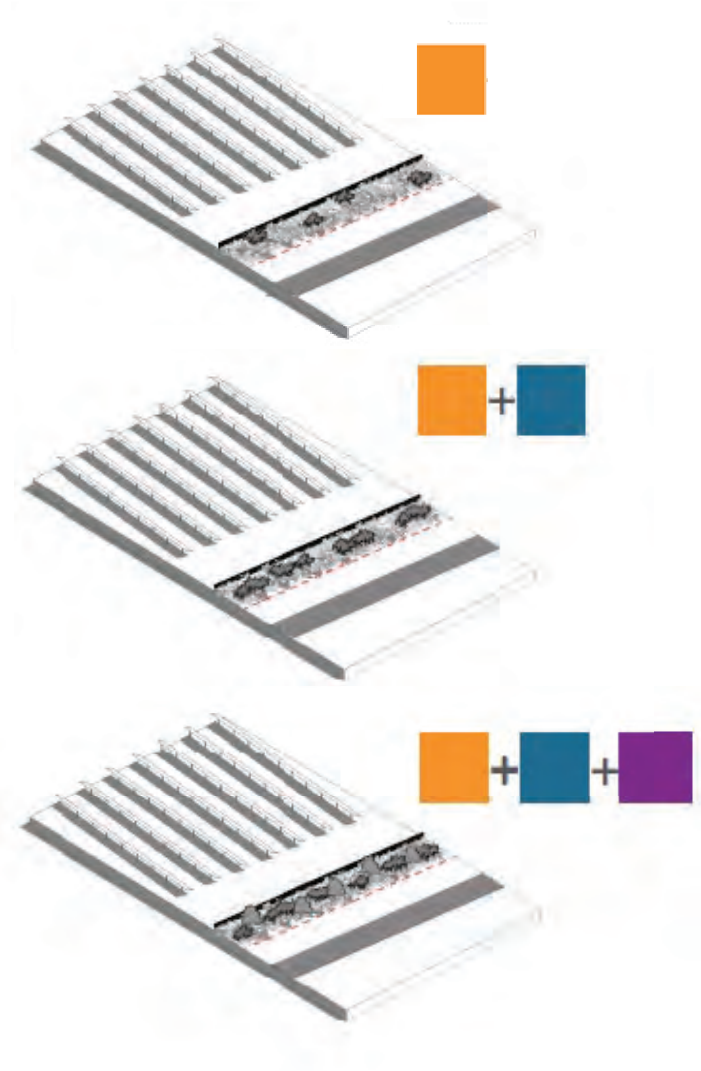
1. Maintaining existing vegetative buffers
2. Incorporating setbacks from residences that will continue to be actively farmed or utilized as pollinator habitat
3. Developing landscaping modules using native pollinator, grass, shrub, and tree species that are regionally appropriate and non-invasive
4. Ensuring that modules fit in the landscape, softening and blending views of the facility

Overview Map

Proposed Modules

Clearview proposes to design its perimeter landscaping utilizing three modules:

- **Low Density**
  - Pollinator mix and small shrubs
  - Installed along road frontages and in areas away from homes
- **Medium Density**
  - Pollinator mix, large shrubs, and small trees
  - Installed in areas near clusters of residences or along road frontage near homes
- **High Density**
  - Pollinator mix, large shrubs, small trees, and large trees
  - Installed where homes are in closer proximity to the Project fence

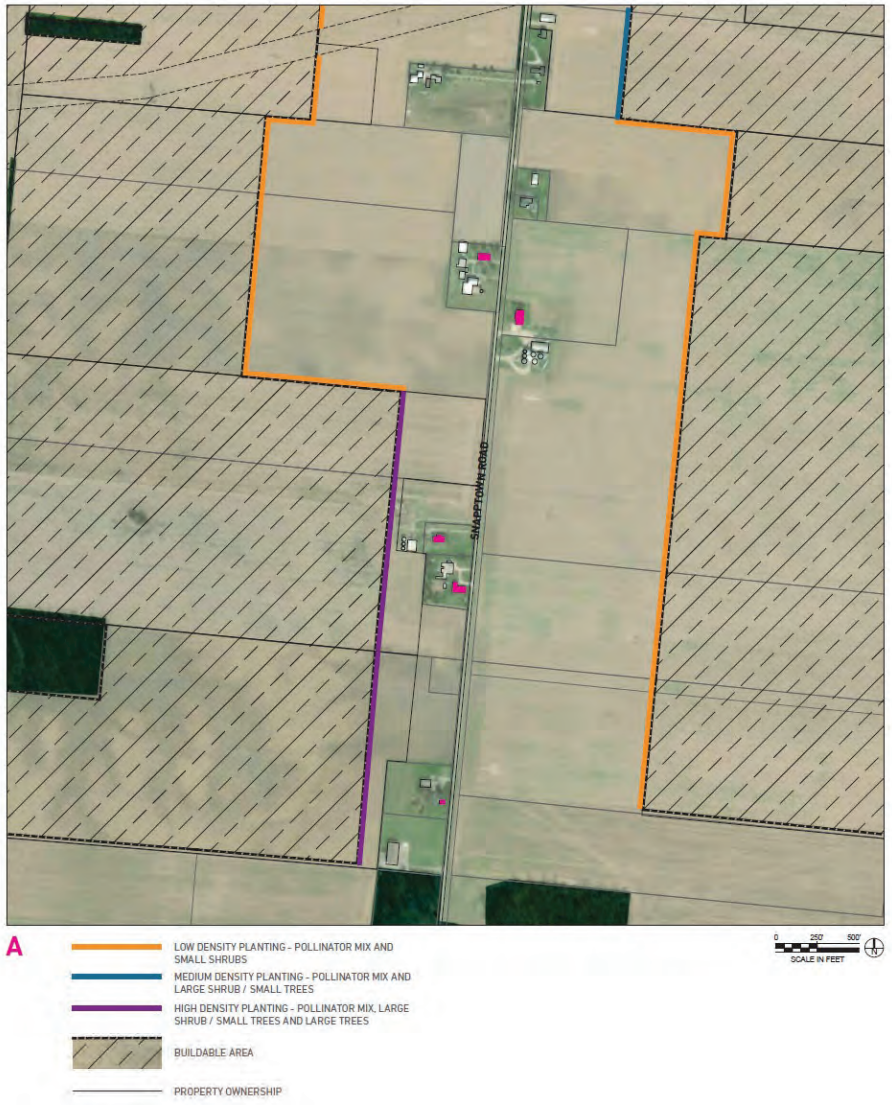


Preliminary Landscaping

Snapptown Road

Clearview proposes installing the following modules in the central portion of the project area. For reference, the Project proposes setting back at least 500’ from the road.

- High Density Plantings and Medium Density Plantings in the vicinity of homes along Snapptown Road
- Low Density Plantings are proposed where fence is in the distance and will be seasonally obscured by row crops.



Preliminary Landscaping

OH-235 and Eastern Champaign Logan Road

Clearview proposes installing the following modules in the eastern portion of the project area:

- High Density Plantings in the vicinity of residences and the Project Substation
- Medium Density Plantings along OH-235
- Low Density Plantings along Champaign Logan Road

Preliminary Landscaping

Champaign Logan Shelby Road and Elm Tree Road North

Clearview proposes to setback 300’ from Champaign Logan Shelby Road.

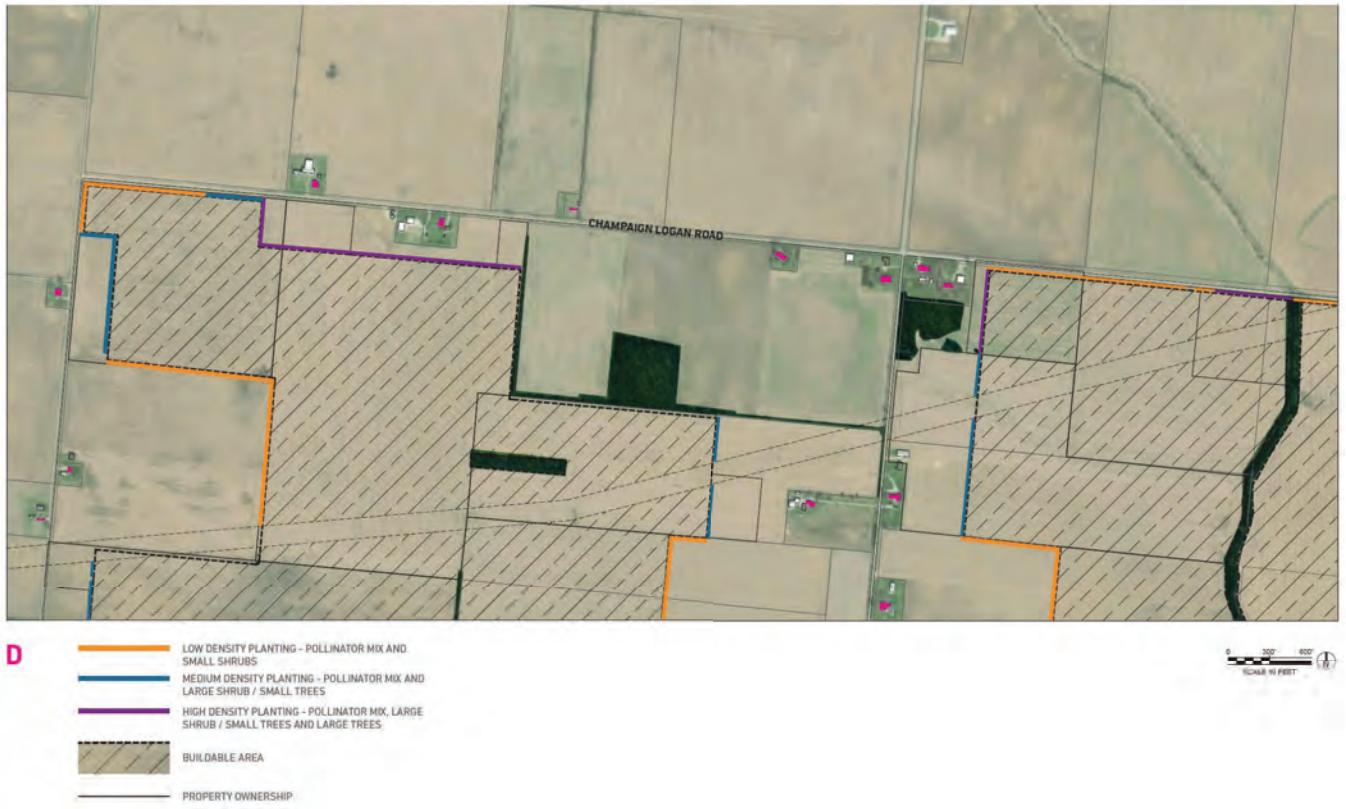
- High Density Plantings are proposed along the fence line in the vicinity of residences along Elm Tree Road North
- Medium Density Plantings are proposed along the N/S fence along Champaign Logan Shelby Road
- Low Density Plantings are proposed for portions of the fence away from homes

Preliminary Landscaping

North Champaign Logan Shelby Road and Champaign Logan Road

Clearview proposes installing the following modules in the northern portion of the project area:

- High Density Plantings are proposed along fence lines in the vicinity of homes
- Medium Density Plantings are proposed along roads in the vicinity of homes
- Low Density Plantings are proposed for areas away from homes

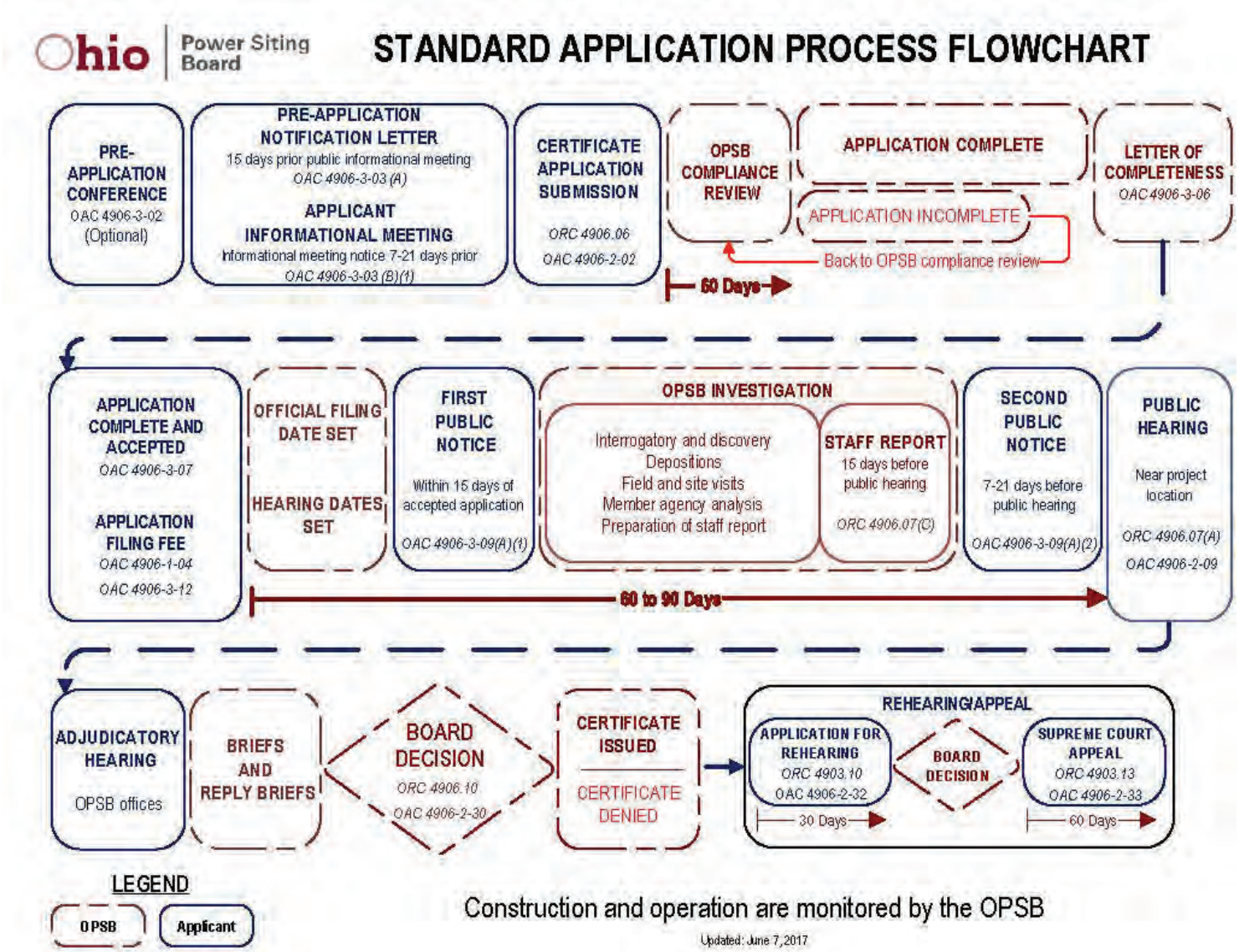


How the Application Addresses Concerns

The application to the OPSB requires certain studies and preliminary plans be completed prior to submission. In the application, the Project also commits to additional agreements and plans that will be made available to the OPSB prior to construction.

Civil	Cultural	Socioeconomic / Transportation	Environmental / Ecological	Misc.
Drainage Assessment EVS, Inc.	Cultural + Historical EDR	Economic Impact Study University of Cincy	Wildlife Report Cardno	Complaint Resolution Plan
Culvert Inventory Hull, Inc.	Visual EDR	Transportation Study Hull, Inc.	Wetland Delineation Cardno	Public Information Plan
Decommissioning Plan Hull, Inc.	Phase 1A Workplan EDR	Traffic and Access Plan	Vegentation Management Hull, Inc.	Road Use and Maintenance Agreement
Hydrogeology/Wells Hull, Inc.	Phase I Architecture EDR		Glint & Glare Analysis Westwood PS	Emergency Services Training Agreement
Geotechnical Investigation Hull, Inc.	Phase I Archeaology EDR		Sound Level Assessment Epsilon	
Preliminary Design Westwood PS			Landscaping Plan MKSK Studios	

How the OPSB Addresses Concerns



Certificate Conditions

- When the OPSB issues its Staff Report, they also provide a recommended set of conditions
- Prior to the Adjudicatory Hearing, the Project and any parties may stipulate to additional conditions to address concerns.
- If the project is approved by the OPSB, it must adhere to these conditions along with any commitments made in the application in order to build and operate the project

Working Together on Conditions

- OPSB Staff will likely issue a set of 20 or so recommended certificate conditions with their Clearview Solar Staff Report
- Are there any concern not addressed in these recommended conditions, our plans/studies, or project design?
- If so, we would like to address these concerns with our own set of recommended conditions to Staff that we design with you

December 2020

Appendix G

Clearview Solar Virtual Office Hours Posts

Clearview Solar Project
Published by [redacted] · October 16 ·

Please join us for virtual office hours Thursday, October 22 at 11:00am!

25
People Reached

0
Engagements

Boost Post

Like Comment Share

Comment as Clearview Solar Project

Press Enter to post.

Clearview Solar Project
Published by [redacted] - October 24 at 10:56 AM -

Please join us for virtual office hours and learn more about the economics of Clearview Solar!

Wednesday, October 28th
11:00am-12:00pm... See More

Clearview Solar Project
Solar Energy Company
Send Message

1,182
People Reached

11
Engagements

Boost Again

Boosted on October 24 at 11:04 AM
By Jennifer Moore Lynch
Completed

People Reached 1.2K

Messaging Conversations... 0

View Results

Like Comment Share

Comment as Clearview Solar Project

Press Enter to post.

Clearview Solar Project
Published by [redacted] · November 1 at 8:43 PM ·

Please join us for virtual office hours!

Wednesday, November 4th
12:30pm-1:30pm... See More

2,066
People Reached

44
Engagements

Boost Again

Boosted on November 3 at 3:43 PM — Completed
By Jennifer Moore Lynch

People Reached	2K	Post Engagements	36

View Results

7 — 1 Share

Like · Comment · Share

Comment as Clearview Solar Project

Press Enter to post.

Clearview Solar Project
Published by [redacted] · November 9 at 7:05 PM ·

Please join us for virtual office hours!
Thursday, November 12
5:00pm-6:00pm
Virtual office hours link:
https://zoom.us/j/92527091465

1,719
People Reached

19
Engagements

Boost Again

Boosted on November 9 at 7:06 PM — Completed
By Jennifer Moore Lynch

People Reached 1.7K

Post Engagements 21

View Results

Like Comment Share

Comment as Clearview Solar Project

Press Enter to post.

Clearview Solar Project
Published by [redacted] · November 15 at 8:02 PM

Please join us for virtual office hours!
Wednesday, November 18th
12:00pm-1:00pm
Virtual office hours link:
https://zoom.us/j/92527091465

1,010 People Reached | 15 Engagements | Boost Again

Boosted on November 15 at 8:03 PM — Completed
By Jennifer Moore Lynch

People Reached	968	Post Engagements	15

View Results

2

Like | Comment | Share

Comment as Clearview Solar Project

Summary: Application -Part 9 of 31 Ex. G Summary of Public Outreach electronically filed by Christine M.T. Pirik on behalf of Clearview Solar I, LLC