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Farm Energy Fact Sheet Series

On-Farm Solar Site Assessment

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Introduction

The number of solar renewable energy facilities certified by the Public Utilities Commission of Ohio (PUCO) has grown from 13 in 2009 to more than 1,226 in 2013. As solar electric systems have entered the on-site distributed energy market in the last decade, agriculture is no longer limited to small off-grid applications. Many agricultural businesses are now taking advantage of policy incentives to substitute part of their energy needs with fixed cost solar energy (Xiarchos, et al., 2011). To maximize the economic and energy production potential of an on-farm solar electric system it is essential to identify a site with clear and unobstructed access to the sun for most or all of the day.

Many farms have access to open rooftops and open spaces that appear to be compatible with solar power generation. However, a number of factors must be analyzed to confirm that open spaces are actually usable space able to support a project. You can conduct an initial site assessment yourself to determine if your property is a good candidate for solar electric. This fact sheet is designed to provide some basic information to help you conduct a site assessment and qualify whether or not your farm is a good match for solar electricity. If you feel your farm is a good fit for a solar electric system, we recommend you contact your utility provider and a qualified solar developer/installer to discuss your plans.

Solar Planning and Zoning

One of the first steps in a site assessment is to understand the local planning and zoning regulations that apply to your property. According to the American Planning Association, seven municipalities and one township in Ohio have adopted zoning ordinances to specifically address the development of on-site solar electric systems (American Planning Association, 2014). An example of issues addressed in solar zoning ordinances may include, but is not limited to:

- Solar panels shall not be placed and arranged in a manner that reflects glare onto adjacent buildings, properties or roadways.
- Solar systems shall be permitted in the rear yard only.
- Solar systems shall be set back ten (10) feet from the side and rear lot line.
- Ground mount solar systems shall not exceed a height of four (4) feet.
- Surface area of a ground mount solar system shall not exceed two percent (2%) of the lot or three hundred sixty (360) square feet, whichever is less.

You can contact your local planning commission and/or zoning board to identify specific rules and regulations that apply to your proposed project site.

Orientation and Tilt

The orientation and tilt of your solar electric system will dramatically influence its performance.

Because Ohio is located in the northern hemisphere, the sun is always in the southern half of the sky. To maximize the output of a solar electric system, the system should have a clear view to the southern sky, oriented due south at an 1800 azimuth. If you cannot lay out your site plan to face due south, southeast- and southwest-facing systems may also be acceptable, but will produce roughly 5 to 10 percent less energy. Increasing the azimuth angle will favor afternoon energy production, and decreasing the azimuth angle will favor morning energy production (PVwatts, 2014). Many online solar electric estimator tools will require the user to input the azimuth angle of a proposed system in order to generate an accurate estimate of solar energy production. Figure 1 outlines the compass directional headings with the corresponding azimuth angle.

In addition to the orientation or direction of your system, it is also important to understand how the module's tilt will affect the overall system performance. As a general guide in Ohio, the optimum angle for a fixed

Figure 1	
Compass Heading	**Azimuth Angle**
N	0 or 360
NE	45
E	90
SE	135
S	**180 (recommended)**
SW	225
W	270
NW	315

system is to tilt your panels on an angle similar to your site's latitude, minus 10 degrees. Some systems allow you to adjust the tilt to take full advantage of the sun's sky path and maximize system production. To accomplish this in the summer, you should decrease the tilt of your modules or arrays an additional 10 to 15 degrees and in the winter, increase the tilt of your modules or arrays an additional 10 to 15 degrees. On rooftop applications installers typically mount panels directly (flush) on an existing south-facing roof. This is done for aesthetic reasons and to minimize wind load and shear.

Shading

Because photovoltaic (PV) solar technology converts sunlight directly into electricity, solar electric systems are more dependent on the amount of sunlight or photons received, not the temperature. Shading can have adverse effects on a solar electric system and possibly represent the largest impact on a site's suitability for development. Therefore, identifying a location where there is no shading can optimize a system's performance. A solar site assessment will ensure that permanent and seasonal shading impacts are accounted for before investing in a system. To measure shading impacts of a proposed site it is recommended that you conduct a physical site inspection and use a solar pathfinder device. As the property owner, you may be best suited to conduct a physical site inspection and track the shade impacts on a proposed site throughout the year. You can contact a solar developer to request an analysis with a solar pathfinder. This device allows the shading potential for the entire year to be determined with a single measurement.

Shadows cast by structures such as trees, chimneys, cables and buildings vary in length and direction throughout the day, and from season to season. As a rule of thumb, vegetation with a mature species height should adhere to a minimum distance-to-height ratio of 2.6 to the nearest point of the proposed array location (U.S. EPA, 2011). For example, in figure 2, a shading obstruction that is 50' high should adhere to a 130' setback to minimize loss of production due to shade. As illustrated in figure 3, the shadowing effect intensifies during the winter season when the sun has a lower sky path. Therefore, it is recommended to analyze the shadow impacts on a proposed site during the winter season, because it will represent a worst-case scenario for the potential loss of sunlight. To protect your investment from future shading impacts, Ohio Revised Code 5301.63 allows you to establish solar easements. A solar easement allows the owner of a solar-energy system to secure rights to continued access to sunlight from a neighboring party whose property could be developed in such a way (e.g. building, landscaping) as to restrict the system's access to sunlight (Database of State Incentives for Renewables and Efficiency, 2014).

Figure 2: Distance-to-Height Setback

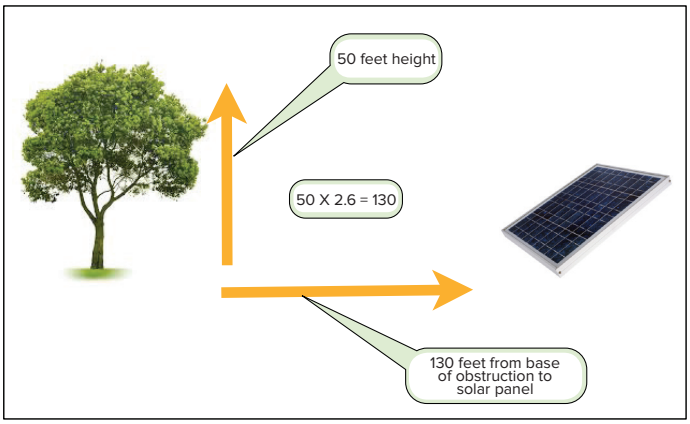
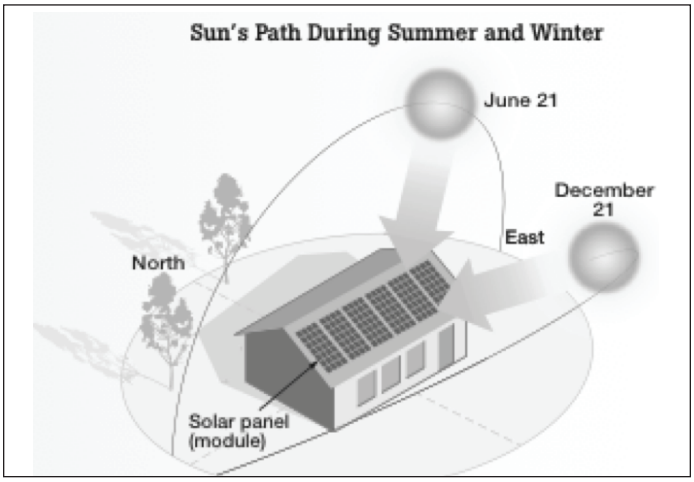


Figure 3: Sun's Path & Shading



Considerations for Rooftop Systems

Rooftop solar electric systems take advantage of unused space, preserving open ground area on the property for other uses of the farming operation. Many farms have access to large rooftops on shops, equipment barns, and animal barns that can be used to locate a solar electric system. The amount of space required

will depend on the size of the system you intend to purchase. A solar electric system will generally require 100 square feet of rooftop (or yard space) for every kilowatt of electricity produced. Thin-film systems are typically less efficient and may require 175 square feet of space per kilowatt (National Renewable Energy Laboratory, 2009).

When considering a rooftop system, you will want to identify a rooftop that is south-facing with little or no equipment on the roof. Panels can be installed on flat roofs often found on commercial, industrial and institutional buildings if they are angled, but should not be placed flat (horizontal) because of snow build-up that will block the sun (University of Wyoming and Montana State University, 2011). It is important to note the type, condition and age of the roof. If your roof is older and likely to require maintenance in the near future, a rooftop system may not be the best option to locate your system. You do not want to incur future costs removing and reinstalling your solar system to perform maintenance on your roof.

A solar developer or a certified third party professional should investigate and document the structural capacity of the roof and the current dead loads on the roof. A conventional solar electric system that includes racking materials will add approximately 6 pounds per square foot of dead load to the roof or structure, though actual weights can vary for different types of systems (U.S. EPA, 2011). Depending on the structure of your building, some roofs may need to be reinforced before the installation of a solar electric system. In this case a ground mounted system may be more economical (see below). If you plan to construct a new facility, simple considerations such as roof space limitations, shading and obstruction, building orientation, roof loading capacity, and electric system designs can make your new building "solar ready" or capable of the eventual installation of a roof top system.

Considerations for Ground Mount Systems

If you cannot place a solar electric system on your roof, you may consider a ground mount system. Ground mount systems are often located in rural areas with access to large open spaces. While ground mount systems can utilize a farm's open spaces to accommodate a larger system, several factors could limit the actual usable or developable space on your farm.

Setbacks—Depending on the project design and local regulations, some planning commissions and/or zoning boards will classify a solar electric system as a permanent structure treated similarly to a building. Even if your township does not have zoning ordinances specific to solar development, county planning commissions are authorized under chapter 711 of the Ohio Revised Code to facilitate rural property subdivisions and the location of buildings and structures. For example, if a planning commission requires a building setback of 30' from the front property line right-of-way and 10' on the side and rear property lines, it is recommended to design your solar electric system to comply with these setback requirements. If your property has not yet been subdivided, you should consider how the location of your solar system could influence future property subdivisions from the parent parcel.

Septic Systems—Identify existing septic systems, areas for replacement septic systems, and water wells to ensure your proposed solar electric system is not located in these areas. Contact your County Health Department to review specific septic system setbacks and regulations.

Emergency Response—Ensure your proposed site does not block fire and rescue access to buildings located on the property. The installation of solar electric systems may be subject to additional requirements implemented by the local fire and emergency departments. Visibly label essential components of the solar electric system and discuss pre-emergency plans with your local officials and check for additional safety requirements.

Easements—As more and more governmental units and utilities seek private land for development, it is essential to investigate whether portions of your property are restricted for development. If a proposed site is laden with existing land restrictions such as leases, easements, road rights-of-ways, mineral rights, or other drainage and title allowances, the agreements may prevent construction on a portion of your property. For example, gas pipeline easements can provide the gas company with permanent access to your property to operate, test, inspect, maintain and protect utility pipelines. Although agreements may vary, rights-of-way can extend up to 25 feet on each side from the center of the pipeline (Columbia Gas of Ohio, 2014).

Many rural properties also have open ditches and subsurface tiles that drain water across or under a proposed site. Check with your local Soil and Water Conservation District (SWCD) to locate existing easements that provide site access to conduct maintenance on the waterways. Most agreements will not allow property owners to build structures or dig within the right-of-way of an easement. It is essential to research the title information in the early planning stages to ensure that all recorded agreements are revealed and examined judiciously. This fact sheet is intended for educational purposes only. Landowners seeking details on legal agreements and property rights should consult with an attorney familiar with such agreements.

Site Layout Plan

Although each site (rooftop or ground) is unique, it is possible to forecast some impacts of a proposed project based on an analysis of the site layout plan. As outlined in this fact sheet, a site layout plan should outline the property lines, location, orientation, easements, setbacks, obstructions, and the square footage of the proposed solar array area. Another consideration in locating a system is access to existing electrical lines. It is usually best to install a system as close as possible to electricity infrastructure already in place. This is especially true of ground mounted systems. Transferring the electricity from a remote location to a location with access to the grid can be expensive. It is useful to print off an overhead map of the site and mark these potential land and roof areas on the map to guide you through the site assessment process. As an online resource, the National Renewable Energy Laboratory (NREL) has developed an electronic design tool called the PV Watts Calculator (**pvwatts.nrel.gov**). The PV Watts Calculator allows you to easily develop a site layout for your specific address that estimates the size and performance of a potential solar electric system.

Summary

Working through the site assessment process will help you to better understand the potential benefits and challenges of a proposed solar electric system. If you conduct a general site assessment and feel your site is a good candidate for solar electric, your utility provider and a solar project developer can provide you with additional information and conduct a more detailed analysis. Combining your site assessment research with input from utility and industry professionals will provide information from multiple sources to determine whether your farm can efficiently integrate an on-farm solar electric system to offset a percentage of your electricity needs.

Additional Resources

American Planning Association—**planning.org/pas/infopackets/open/eip30.htm**

E3A Exploring Energy Efficiency and Alternatives Educators Toolkit—**e3a4u.info**

Energize Ohio: On-Farm Renewable Energy Tools—**energizeohio.osu.edu/farm-renewable-energy-development**

NREL PV Watts Calculator—**pvwatts.nrel.gov**

NREL Cost of Renewable Energy Spreadsheet Tool (CREST)—**financere.nrel.gov/finance/content/crest-cost-energy-models**

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