



On-Farm Solar Energy Development

Teaching Outline



THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

ENERGIZE OHIO

go.osu.edu/farmenergy

Introduction



The agriculture sector was an early adopter of off-grid photovoltaic (PV) solar systems as a remote energy source. Over the last decade, high cost have limited the widespread adoption of on-farm PV solar systems that are connected to the grid. However, energy policy tools combined with significant reductions in the price of PV solar panels has made on-farm solar systems more affordable to install.

According to a U.S. Department of Energy Sun Shot Report, the national average installed price for large scale PV solar systems has dropped significantly from an average installed cost of 21.4 cents per kilowatt hour in 2010 to 11.2 cents per kilowatt hour in 2013.

In general, PV solar systems are very compatible with agriculture operations; as farmers have access to open land and often have high electricity demands. Additionally, many farmers support PV solar because it reduces volatility of future energy costs, has low maintenance costs, positive environmental attributes, and once the initial capital investment is recovered, the fuel is free. In Ohio, many farms are installing systems with a projected breakeven timeframe of 4 to 7 years. According to the 2009 On-Farm Renewable Energy Production Survey, solar projects are the most prominent way to produce on-farm renewable energy, as they are present in 93% of farms with on-farm renewable energy production (U.S. Department of Agriculture, 2011). However, the continued expansion of grid connected on-farm solar electric applications will ultimately depend on the continued decline in the cost of solar systems and the rise in the cost of electricity.

The purpose of this program is to provide farmers additional information regarding on-farm PV solar development to assist them in the decision making process.

This curriculum is intended for use by Extension Educators with who have interest in delivering educational programs to inform clientele about advanced energy solutions on the farm. Using a “train-the-trainer” approach, the initial target audience for this teaching outline is Extension Educators and the intended external audience is agricultural producers, agribusinesses, and community leaders.

Preparation Tips

- Determine appropriate meeting location and time for your audience. Consider locating farms with operating solar electric systems to visit as a tour following your program.
- Review the curriculum materials, fact sheets, videos, and supplemental materials prior to planning your program.
- Determine how you will disseminate materials, hard copy or electronic reference.
- This teaching outline assumes the local Extension Educator will serve as the presenter and facilitator. If contacted in advance, a member of the on-farm energy team may also be available to co-present.
- Consider inviting a guest speaker from a local utility, the PUCO, and/or a developer.
- If you have a invited speaker, make sure that they understand Extension is focused on presenting non-biased educational materials, and not selling an individual product or service.

Program Time

Option 1: Evening Workshop - 75 Minutes (see page 4 for details)

Option 2: Lunch & Learn Series - 4 sessions / 30 minutes (see page 4 for details)

Purpose

Introduce core principles of photovoltaic solar electric and key considerations for applications on the farm.

Learning Objectives

- Understand net metering and renewable energy policy drivers
- Comprehend how photovoltaic solar technology generates electricity
- Assess on-farm solar applications
- Identify key site assessment considerations
- Know how to estimate the size of a solar system
- Better understand economics of developing an on-farm solar system

Program Materials

- Presentation Slides
- Recorded Presentation with Narration
- Fact Sheet (CDFS-4101-14) - An Introduction to On-Farm Solar Electric Systems
- Fact Sheet (CDFS-4102-14) - Estimating the Size of Your Solar System
- Fact Sheet (CDFS-4103-14) - On-Farm Solar Site Assessment
- Fact Sheet (CDFS-4104-14) - Financial Considerations of On- Farm Solar
- Short Video – Swine Facility with Rooftop Solar
- Short Video – Construction of a Rooftop Solar System
- Short Video – Financial Considerations of On-Farm Solar Energy
- Program Evaluation Form

Materials are available for download at go.osu.edu/farmenergy.





Program Timeline

Option 1 – Evening Workshop (75 Minutes)

The first delivery option for the On-Farm Solar Energy Curriculum includes a 75 minute workshop. This page provides a template of how to structure your program learning objectives, suggested discussion points, and supporting materials. You should view the *Recorded Presentation: [On-Farm Solar Generation](#)* prior to developing your program.

Note: Photovoltaic solar systems are still in the early adoption development phase and many farmers are still unfamiliar with the technology and the applications to agriculture. To demonstrate real life applications you may consider locating a solar installer or solar system owner to discuss their expertise, experiences, and lessons learned. If you have a guest speaker, you can provide them 30 minutes to speak by eliminating the case study (15 minutes) and adding an additional 15 minutes to the program. It is also suggested to review the program outline to coordinate topics that will be covered to prevent duplication.



Program Section	Time	Key Discussion Points	Supporting Materials
Introduction	5 minutes	Energy trends and cost of electricity.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4101-14) Presentation Slides 1 - 8
Renewable Energy Policy and Net Metering	10 minutes	Discuss how net metering supports on-farm energy development.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4101-14) Presentation Slides Slides 18-26
Understanding Photovoltaic Solar	5 minutes	Photovoltaic solar panels generate electricity from the sun's light energy, not heat.	<ul style="list-style-type: none"> Short Video - Construction of a Rooftop Solar System Presentation Slides 9-17
Site Assessment Considerations	10 minutes	Outline the directional orientation and tilt to optimize panel efficiency.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4103-14) Presentation Slides 27 - 32
How to Size Your System	5 minutes	Review the 10 steps for estimating a system size and the inputs required for making the calculations.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4102-14) Presentation Slides 33 - 38
Review of Project Economics	15 minutes	Discuss cost of PV solar systems and incentive programs to recover initial capital investment.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4104-14) Presentation Slides 39 - 46 Short Video – Financial
Case Study Example	15 minutes	Examine the economics and net metering of an operating PV solar project.	<ul style="list-style-type: none"> Short Video – Swine Facility with Rooftop Solar Presentation Slides 47 - 52
Review, Questions, & Evaluation	10 minutes	Facilitate discussion with participants and complete evaluation form.	<ul style="list-style-type: none"> Presentation Slides 53 Program Evaluation Form

Program Timeline

Option 2 – Lunch & Learn Series (4 sessions / 30 minutes)

The second delivery option for the On-Farm Solar Energy Curriculum includes a lunch and learn structure with 4 sessions. This page provides a template of how to structure your programs learning objectives, suggested discussion points, and supporting materials. You should view the *Recorded Presentation: On-Farm Solar Generation* prior to developing your program.

Program Section	Time	Key Discussion Points	Supporting Materials
Session 1 – Net Metering			
Introduction	5 minutes	Energy trends and cost of electricity.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4101-14) Presentation Slides 1 - 8
Renewable Energy Policy and Net Metering	20 minutes	Discuss how net metering supports on-farm energy development.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4101-14) Presentation Slides 18 - 26 Presentation Slides 48, 52
Review, Questions, & Evaluation	5 minutes	Facilitate discussion with participants and complete evaluation form.	<ul style="list-style-type: none"> Presentation Slides 53 Program Evaluation Form
Session 2 – Photovoltaic Solar			
Introduction	5 minutes	Energy trends and cost of electricity.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4101-14) Presentation Slides 1 - 8
Understanding Photovoltaic Solar	20 minutes	Photovoltaic solar panels generate electricity from the sun's light energy, not heat.	<ul style="list-style-type: none"> Short Video - Construction of a Rooftop Solar System Presentation Slides 9 - 17
Review, Questions, & Evaluation	5 minutes	Facilitate discussion with participants and complete evaluation form.	<ul style="list-style-type: none"> Presentation Slides 53 Program Evaluation Form
Session 3 – Site Assessment and Sizing a Solar System			
Introduction	5 minutes	Energy trends and cost of electricity.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4101-14) Presentation Slides 1 - 8
Site Assessment Considerations	10 minutes	Outline the directional orientation and tilt to optimize panel efficiency.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4103-14) Presentation Slides 27 - 32
How to Size Your System	10 minutes	Review the 10 steps for estimating a system size and the inputs required for making the calculations.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4102-14) Presentation Slides 33 - 38
Review, Questions, & Evaluation	5 minutes	Facilitate discussion with participants and complete evaluation form.	<ul style="list-style-type: none"> Presentation Slides 53 Program Evaluation Form
Session 4 – Economics of Developing an On-Farm Solar System			
Introduction	5 minutes	Energy trends and cost of electricity.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4101-14) Presentation Slides 1 - 8
Review of Project Economics	20 minutes	Discuss cost of PV solar systems and incentive programs to recover initial capital investment.	<ul style="list-style-type: none"> Fact Sheet (CDFS-4104-14) Short Video – Financial Presentation Slides 39 - 46 Presentation Slides 47 - 52
Review, Questions, & Evaluation	5 minutes	Facilitate discussion with participants and complete evaluation form.	<ul style="list-style-type: none"> Presentation Slides 53 Program Evaluation Form



Additional Resources

ENERGIZE OHIO

Fact Sheets

- [Photovoltaic Systems for Solar Electricity Production](#)
- [Using Solar Energy to Produce Electricity for Ohioans](#)
- [Renewable Energy Policy Series: Ohio SB 221](#)
- [Renewable Energy Policy Series: SB 232–Leveling the Playing Field](#)
- [Producing Your Own Electricity in Ohio](#)
- [A Business Retention & Expansion Strategy](#)
- [A Business Guide for Investing in On-Site Energy Generation](#)

Webpages

- [Search Incentives Database](#)

Videos

- [Solar Energy farm in Wyandot County](#)
- [How Wyandot County Became Ohio's, Midwest's Solar Leader](#)
- [Ohio State Helps Power the Future](#)

USDA & U.S. DOE

Reports

- [Annual Energy Outlook 2014](#)
- [Solar Energy Use in U.S. Agriculture Overview and Policy Issues](#)

Websites

- [U.S. DOE National Center for Photovoltaics](#)
- [U.S. DOE SunShot Initiative](#)
- [USDA Rural Energy for America Program](#)
- [Database of State Incentives for Renewables and Efficiency \(DSIRE\)](#)

Videos

- [Energy 101: Solar PV](#)
- [SunShot Solar PV](#)





Mobile Solar Unit

DEMONSTRATE PHOTOVOLTAIC TECHNOLOGY AND THE POWER OF EXTENSION

In 2014, a team of OSU Extension Educators designed and built a Mobile Solar Unit to compliment renewable energy programming. The Mobile Solar Unit consists of a 140 watt Photovoltaic (PV) solar panel, charge controller, battery back-up system, 2000 watt inverter, and safety disconnects. All of the components are built into a mobilized cart that can be transported to events throughout Ohio in the back of a pickup truck.

The Mobile Solar Unit is as a teaching tool used to demonstrate the major components of how PV solar technology works, assist in disseminating renewable energy curricular materials and videos, as well as promote Extension impacts via short videos at the many Extension events throughout Ohio. The Mobile Solar Unit is ideal for remote outdoor events, field days, county fairs, and 4-H camps where it can enable access to power many appliances the presenter might need such as a projector, TV, computer, or microphone. The Mobile Solar Unit also serves as a great teaching

tool at indoor events as well, acting as an attraction by allowing visitors to plug-in cell phones and laptops to get a quick charge.

While the primary motivation was to design a tool to help demonstrate solar technology, it is also a great promotional resource that will attract an audience to stop by and watch short videos of outstanding OSU Extension programs taking place throughout the state. In the absence of sunlight to power the solar panel, the unit has a battery backup system designed to run a 32" TV (provided with Mobile Solar Unit) for a minimum of 8 hours.

To reserve the Mobile Solar Unit for one of your on-farm energy programs, please contact Eric Romich at romich.2@osu.edu or 740-725-6317.



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