

# Incorporating Solar into Agricultural Landscapes: Workshop for Farmers



photo by Chris Anderson

## *Some Considerations, Informational Resources, and Brief Summary of Current Work Related to Solar in Virginia*

Friday, March 4, 2022  
Harrisonburg, VA

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# Highlighting Multidisciplinary Energy-related Extension Programs in Virginia

John Ignosh, Area Extension Specialist, Department of Biological Systems Engineering, Virginia Tech; Jennifer Abel, Senior Extension Agent, Faculty and Consumer Sciences, Virginia Cooperative Extension; Dr. Jonah Fogel, Community Viability Specialist, Virginia Cooperative Extension; Dan Swafford, Project Associate, Virginia 4-H State Office; Dr. Martha Walker, Community Viability Specialist, Agricultural & Applied Economics, Virginia Tech; and Matt Booher, Crop & Soil Extension Agent, Virginia Cooperative Extension

## RESIDENTIAL ENERGY EFFICIENCY

Many low-income apartment renters in Arlington and Alexandria frequently struggle with paying their rent and utilities. The *Energy Masters Program* helps reduce energy bills for tenants or property managers and helps minimize related rent increases. Program objectives: 1) To provide energy- and water-saving retrofits in low-income apartments. 2) To educate tenants about easy actions they can take to conserve energy, thereby saving them money. To date 154 trained Energy Masters volunteers have performed energy- and water-saving retrofits in 710 Arlington and Alexandria apartments. The program has grown to include new elements, including: a student mentorship program for 19 high school students as Energy Masters volunteers; an Energy Bingo program in community and senior centers where attendees learn about energy efficiency, and a series of energy education lessons that volunteers have shared with 1,757 K-12 students.

### Energy and Water Saving Retrofits (2011-2017)

Apartment Units Completed	710
Compact fluorescent light bulbs installed	3,514
LED light bulbs installed	584
Outlets and switch plates sealed	8,800
Vents sealed	248
Baseboards sealed	43
Faucet aerators installed	739
Low-flow showerheads installed	337
Toilet tummies installed	284
Power strips given to residents	321
Water saved (estimated, GPY)	9,320,808
Energy saved (estimated, kWh/yr)	299,683



## ENERGY MASTERS



## Virginia Cooperative Extension conducts a variety of needs-based energy programming

These multidisciplinary efforts are tailored to meet diverse stakeholder needs, including: farmers exploring solar-powered water pumping systems for livestock; low income renters identifying energy-cost saving opportunities via improved energy efficiency practices; county planners evaluating renewable energy project development opportunities, among other areas highlighted here.



### Opportunities Going Forward

- Grow aspects of energy programs from multidisciplinary to interdisciplinary
- Expand upon successes of regional pilots
- Enhance asynchronous educational content to cost-effectively strengthen elements and reach of programming
- Efficiently synthesize evaluation data and report aggregate impacts of programs

### Contact Us For More Information on These Programs

**Residential Energy Efficiency:** Jennifer Abel (jabel@vt.edu); **Farm Energy Efficiency & Renewables:** John Ignosh (jignosh@vt.edu), Dr. Martha Walker (walker53@vt.edu), Matt Booher (mrb260@vt.edu); **Youth Energy:** Dan Swafford (jswaffor@vt.edu); **Community Planning & Development:** Dr. Jonah Fogel (jfogel@vt.edu); **General Questions:** John Ignosh (jignosh@vt.edu)

## FARM ENERGY EFFICIENCY & RENEWABLES

The 2012 *Census of Agriculture* indicates, that across Southside and Southwest Virginia, farmers spent more than \$66M in farm energy-related expenses. In 2010, Virginia Cooperative Extension partnered with agricultural service providers and agencies, to secure funding from the Virginia Tobacco Commission to support the *Agricultural Energy Efficiency Initiative* program to identify farm energy-cost saving opportunities. Retrofits are executed via a cost-share program which also incentivizes participation in extension educational energy events. The program has delivered more than 20 workshops on energy efficiency best practices to renewable energy conversion technologies. During the 2014-2016 phase of the program, 64 farm energy audits identified potential annual savings of:

873,968 kWh in electricity	\$850,734 energy costs
429,847 gallons of propane	3,151 MTCO <sub>2</sub> e GHGs



In other regions of Virginia, on-farm energy project demonstrations are used to evaluate the use of renewables to meet aspects of the Chesapeake Bay TMDL, for instance: the *Farm Manure-to-Energy Initiative* explores thermal conversion of poultry litter to displace propane while also generating a phosphorus rich co-product; and the *Alternative Fencing & Solar-Powered Water Pumping Systems for Livestock* demonstrations explore using solar photovoltaics to power portable water pumping stations with integrated, and semi-permanent, fencing systems to provide water for livestock on rented pastureland.



## YOUTH ENERGY

### Can you teach alternative energy in an area where coal is king?

Since the fall of 2014, the Virginia state 4-H office at Virginia Tech has conducted a program on alternative energy education to Agriculture Education classes in Southwest Virginia. The program includes both a youth and adult component. Youth receive training on alternative energy technologies. Adults, serving as Agricultural Educators or 4-H Agents, also receive training on alternative energy technologies as well as orientations on teaching with hands-on energy laboratory kits.

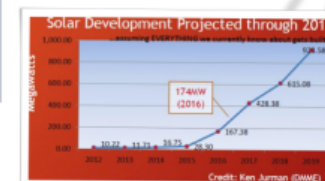


To date this program has:

- Conducted 156 presentations
- Reached 1,631 students
- Engaged 26 schools
- Served 14 southwestern Virginia counties
- Trained 73 teachers & 17 pre-service teachers

## COMMUNITY PLANNING & DEVELOPMENT

The interest in utility-scale solar farm projects has increased dramatically across Virginia over the last few years. More than 40 projects have been proposed as of March 2016, ranging from tens of acres to more than 1200 acres. There are several questions that must be addressed to fully prepare for this emerging land use. Likewise, opportunities and pitfalls exist for landowners. Through this program, planning commissioners, local elected officials, farm-property owners, and staff planners are being educated about the technical, contractual, and policy implications of on-farm and utility scale solar projects. For example, in November 2016 the *Solar Farm Workshop for Local Governments and Landowners* was held in Emporia, Virginia to educate participants on utility-scale solar: siting, permitting, and ordinance design and to also learn from similar project experiences at sites in North Carolina. For more information, please visit [www.planvirginia.com](http://www.planvirginia.com)





# *Workshop theme..*

## **Incorporating Solar into Agricultural Landscapes: Workshop for Farmers**



*photo by Chris Anderson*



~ < 1kW



~ 1 - 10 kW



~ 10 kW – ~ 2 MW



~ > 2MW

Depending on your management objectives, solar can potentially be incorporated across a variety of scales.

For example:

- off-grid solar to power a small water pump
- installed to offset all or a portion of the electrical energy usage through net metering
- While in other cases, landowners may opt to enter a solar land lease to host a utility-scale solar project.
- *Among many other options..*

The variety of "solar" options continues to expand as markets and policies change.

No one application is a fit for everyone or everywhere, and it's important to understand all the details especially when expensive investments or long lease contracts are considered.

These resources are by no means exhaustive, but offered as starting points for exploring solar options that may (or, may not) be a fit for your management objectives.

**\*\*Also posted online for easier access\*\***



# Estimated System Costs



In 2020, the ranges in average U.S. PV system pricing across methods were reported to be:

- \$2.7/W to \$3.7/W for residential
- \$1.4/W to \$2.9/W for nonresidential
- \$0.9/W to \$1.1/W for utility-scale.

System costs can vary  
by project size

In the first half of 2021, the ranges in average U.S. PV system pricing across a *smaller set of* methods were reported to be:

- \$2.7/W to \$3.9/W for residential
- \$1.6/W to \$2.5/W for nonresidential
- \$0.9/W to \$1.9/W for utility-scale.

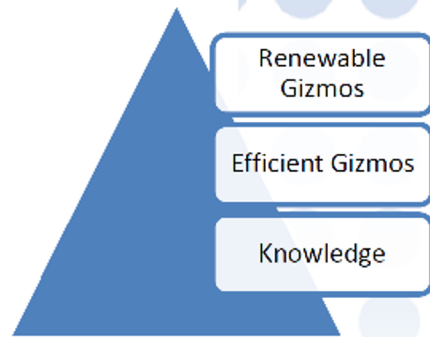
Source: <https://www.nrel.gov/docs/fy22osti/81325.pdf>

# What are your goals?

- Examples:
  - Reduce system energy requirements
  - Reduce energy costs
  - Reduce reliance on grid-tied energy
  - Increase use of renewable energy
  - Offset grid-tied energy where possible
  - Become completely independent of grid
  - Invest a specific amount of money toward a renewable system
  - Generate more than you use?\*
  - Interested in exploring a long-term land lease
  - *Among many others.....*
- System design choices and considerations for each of these could look very different; and viability for some varies too\*
- Understanding your goals is very important



# General Strategy



## ENERGY ACTION PYRAMID

COMPLEXITY  
AND COST

### ALTERNATIVE ENERGY

Choices such as installing solar, wind, geothermal, micro hydro or biofuels systems

### EFFICIENCY: Investment in Longer Term Energy Savings

Choices such as:

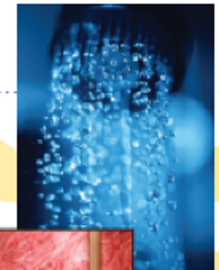
- Installing energy efficient lighting, fixtures, windows, doors, appliances, and equipment
- Installing water-efficient appliances and fixtures
- Investing in items with Energy Star, EnergyGuide or WaterSense labels
- Insulating homes

### CONSERVATION: Simple Everyday Actions

Behaviors such as:

- Turning off lights, equipment, fans, and appliances when not in use
- Adjusting thermostats in heated or cooled spaces
- Using powerstrips to control for phantom electrical loads
- Caulking and weatherstripping around windows and doors
- Landscaping with native and xeric plants, and utilizing rain water

**ASSESSMENT:** Assess your personal objectives and your energy and water use to determine cost-effective strategies for implementing conservation and efficiency measures and integrating renewable energy systems in your home.



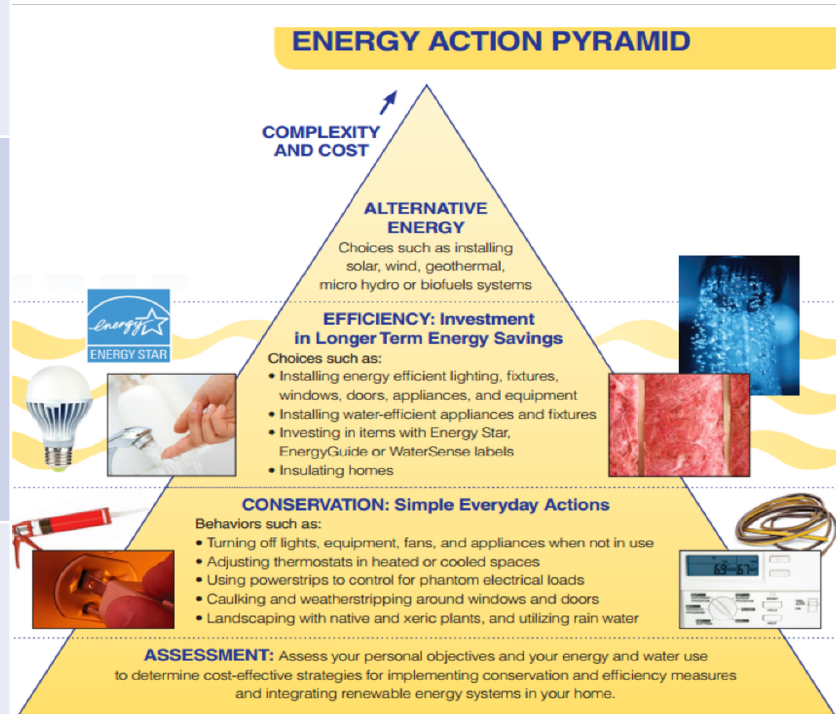
Source:

[http://www.ces.ncsu.edu/wp-content/uploads/2012/05/Con\\_PyramidRev1.pdf](http://www.ces.ncsu.edu/wp-content/uploads/2012/05/Con_PyramidRev1.pdf)

Example	With Efficiency	Without Efficiency
Annual Farm Energy Usage (kWh)	100,000	100,000
Annual Electrical Energy Load After 10% Energy Efficiency Improvements (kWh)	90,000	n/a
10 kW Solar PV Annual Generation (kWh)	14,018	14,018
Energy Purchased (kWh)	75,982	85,982
Percent Electrical Energy Met by Solar PV	16%	14%

Source PV Watts

<https://pvwatts.nrel.gov/pvwatts.php>



**Main Point**  
Often it's good to look for the **LOW COST**, and sometimes, **NO COST**, energy efficiency improvement options **BEFORE** implementing renewables. USDA usually has programs that can help farmers identify & implement these opportunities





USDA Service Centers are designed to be a single location where customers can access the services provided by the Farm Service Agency, Natural Resources Conservation Service, and the Rural Development agencies. This web site will provide the address of a USDA Service Center and other Agency offices serving your area along with information on how to contact them.

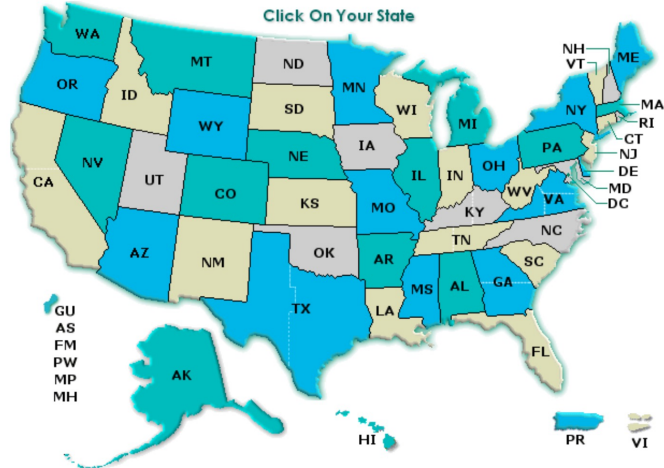


Table 1: Summary of Energy Improvements (Examples of recommended measures shown.)

Recommended Measure	Estimated Annual Reduction in Energy Use				Estimated Costs, Savings, Payback, and Prioritization for Implementation				
	Electric Savings (kWh)	Natural Gas Savings (ccf)	Propane Savings (gal)	Other <sup>1</sup>	Energy Savings (MMBtu)	Installed Cost [a]	Annual Cost Savings [b]	Payback in Years [a/b]	Est. Life in Years
Lighting	25,210				86	\$1,740	\$2,094	0.8	7
Seal Air Leaks			477		44	\$1,500	\$809	1.9	8
Insulate Brood Curtain			98		9	\$450	\$167	2.7	10
Exposed Foundation Wall Insulation			383		35	\$5,621	\$651	8.6	20
Curtain to Solid Insulated Sidewalls			442		41	\$7,168	\$754	9.5	20
<b>Totals:</b>	<b>25,210</b>		<b>1,400</b>		<b>215</b>	<b>\$16,479</b>	<b>\$4,475</b>	<b>3.7</b>	

Sources:

<https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=stelprdb1046252>

[https://www.nrcs.usda.gov/wps/PA\\_NRCSConsumption/download?cid=stelprdb1264606&ext=pdf](https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1264606&ext=pdf)

# Energy Audits USDA - NRCS

## EQIP On-Farm Energy Initiative



## On-farm Energy Initiative

The Environmental Quality Incentives Program (EQIP) On-Farm Energy Initiative helps farmers and ranchers make voluntary improvements that can boost energy efficiency on the farm. This emerging agricultural trend produces benefits, including reduced input costs, increased productivity per unit of energy consumed by equipment and lighting, and reduced air pollutants and greenhouse gas emissions caused when energy is generated for agricultural use.

Financial assistance is available to inventory and analyze farm systems that use energy and identify opportunities to improve efficiency through the development of an Agricultural Energy Management Plan (AgEMP). **The AgEMP, or energy audit, is completed by NRCS-certified Technical Service Providers (TSPs) and provides:**

- > Itemized energy use by individual systems to establish a baseline for electricity and other fuel improvements,
- > Recommendations for equipment improvements and upgrades,
- > Potential energy reductions and financial savings for each recommendation
- > Cost estimates of potential improvements, and
- > Length of expected payback for energy efficiency upgrades

Alliance for Shenandoah Valley's  
March 4 & 11, 2022 Workshops

"Incorporating Solar into Agricultural Landscapes Workshop for Farmers"

Solar Info Resource Page Supplement

Website: <https://tinyurl.com/ShenSolarWorkshops2022>

***Contains  
Resources  
Based on  
Some  
Common  
Questions***





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### Solar Info Resource Page Supplement

Virginia Cooperative Extension  
A History of Applications

The video player displays a collage of images including solar panels, agricultural equipment, and people working in a field. A red box highlights a specific image of solar panels on a farm.

An Introductory Video on the  
Fundamentals of Solar  
Photovoltaics

What is it like to apply for far...  
REAP: Rural Energy for America Program

The video player shows a man in a plaid shirt and a cap speaking. The text 'REAP: Rural Energy for America Program' is overlaid at the bottom.

Hear First Hand Experiences  
from 2 Virginia Farmers on  
Solar Incentives & USDA REAP  
Program

**SOLAR FARMS IN VIRGINIA**  
**Sharing Experiences from Spotsylvania County**  
Thursday, December 19, 2019 from 10AM-11:00AM  
**Internal VCE In-Service Webinar**

**Solar Farms**  
Solar farms, or "utility-scale solar photovoltaic (PV)", projects are increasing across Virginia. Many projects have been developed and many more proposed, often with mixed reactions across the communities. This internal VCE In-service webinar features Mr. Richard Street, Deputy Director of Environmental Codes, Spotsylvania County (VT Alum, Biological Systems Engineering). Mr. Street will share some of his experiences with utility-scale solar PV from project development in Spotsylvania County, Virginia. So, please join us to hear the presentation and ask questions.

**Map of Utility-Scale Solar Projects**  
From: Solar Energy Industries Association  
1/18/19  
<https://www.seia.org/sites/default/files/2019/01/2019-utility-scale-solar-projects-list>

**Rationale for this Internal VCE In-Service Webinar**  
As part of VCE's Natural Resource Management (NRM) Program Team 2019 Internal-VCE Needs Assessment Work several requests for information regarding utility-scale PV Projects were identified. This informational webinar is a step toward responding to these interests while also enabling further discussions to better identify specific informational and training needs regarding the broader topic within VCE.

**REGISTER FOR THE WEBINAR HERE:**  
[https://virginiatech.zoom.us/join/register/WN\\_vleFAQMOQCct34lepTk2w](https://virginiatech.zoom.us/join/register/WN_vleFAQMOQCct34lepTk2w)

If you are a person with a disability and desire any assistive devices, services or other accommodations to participate in this activity, please contact John Igoosh, VCE Northern District Office at 540-432-6029/TDD\* during business hours of 8 a.m. and 5 p.m. to discuss accommodations 5 days prior to the event.  
\*TDD number is (800) 828-1120.

**Virginia Cooperative Extension**  
Virginia Tech • Virginia State University  
[www.ext.vt.edu](http://www.ext.vt.edu)

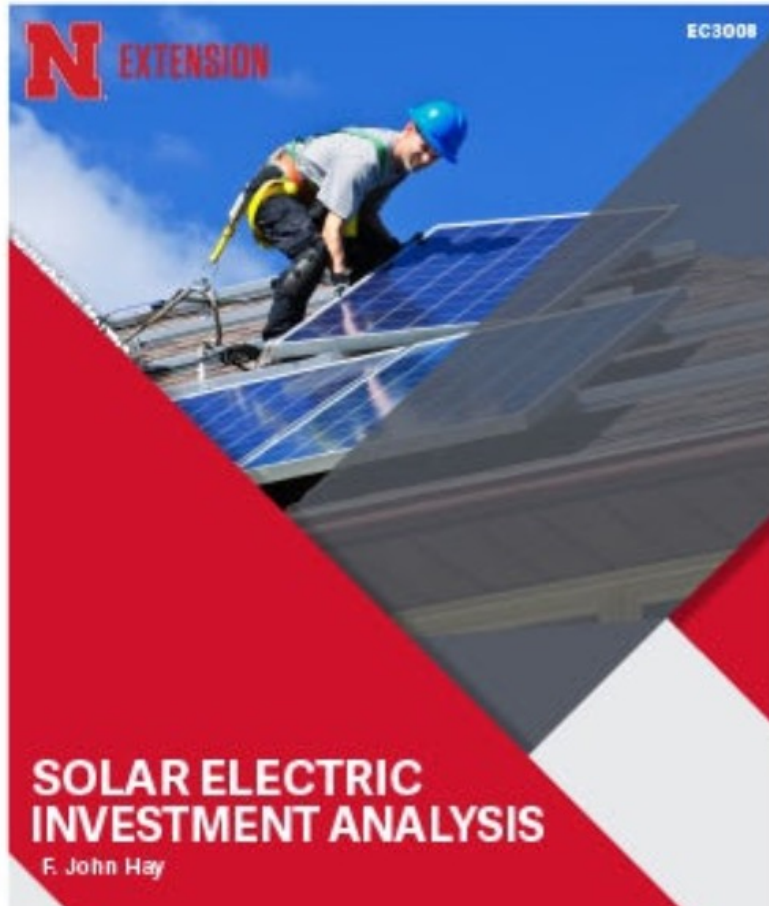
[sites.google.com/vt.edu/vceinservice121919solarfarms](https://sites.google.com/vt.edu/vceinservice121919solarfarms)

Utility-Scale Solar in Virginia  
Informational Webinar Series

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## Publication on Evaluating/Comparing Solar Project Proposals for Net Metered Systems

(University of Nebraska Extension)

More at: [Farm Energy Answers](#)

Related videos below



# Alliance for Shenandoah Valley's March 4 & 11, 2022 Workshops

## "Incorporating Solar into Agricultural Landscapes Workshop for Farmers"

### Solar Info Resource Page Supplement



Virginia

## Net metering in Virginia

### What is net metering?

[Summary of Virginia  
Net Metering  
by Solar United Neighbors](#)

*Note Details Vary by Type of  
Utility*

[Virginia  
Net Metering Code for  
Electric Cooperatives](#)

*Note Details Vary by Type of  
Utility*

[Virginia  
Net Metering Code for  
Investor Owned Utilities](#)

*Note Details Vary by Type of  
Utility*

# Understanding Net Metering in Virginia

Get acquainted with our new Virginia State Law Portal! [Law Help Center](#)

VIRGINIA GENERAL ASSEMBLY / LIVE HELP / US HELP CENTER / US PHONE

**LIS**  
VIRGINIA LAW

Code of Virginia - Search

Code of Virginia  
Table of Contents » Title 56, Public Service Companies » Chapter 22, Virginia Electric Utility Regulation Act » § 56-594.01, Net energy metering provisions for electric cooperative service territories

Popular Names  
2021 Updates

SECTION LOOKUP  
22-4007.01 Go

Administrative Code

§ 56-594.01. Net energy metering provisions for electric cooperative service territories.

A. The Commission shall establish by regulation a program that affords eligible customer-generators the opportunity to participate in net energy metering in the service territory of each electric cooperative, which program shall commence on

Get acquainted with our new Virginia State Law Portal! [Law Help Center](#)

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VIRGINIA LAW

Code of Virginia - Search

Code of Virginia  
Table of Contents » Title 56, Public Service Companies » Chapter 22, Virginia Electric Utility Regulation Act » § 56-594, Net energy metering provisions

Popular Names  
2021 Updates

SECTION LOOKUP  
22-4007.01 Go

Administrative Code

Constitution of Virginia

Charters

§ 56-594. Net energy metering provisions.

A. The Commission shall establish by regulation a program that affords eligible customer-generators the opportunity to participate in net energy metering, and a program, to begin no later than July 1, 2014, for customers of investor-owned utilities and to begin no later than July 1, 2015, and to end July 1, 2019, for customers of electric cooperatives as provided in subsection G, to afford eligible agricultural customer-generators the opportunity to participate in net energy metering. The regulations may include, but need not be limited to, requirements for (i) retail sellers; (ii) owners or operators of distribution or transmission facilities; (iii) providers of default service; (iv) eligible customer-generators; (v)



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Virginia Contacts at the SolSmart  
Program Can Provide  
Informational Resources  
Regarding Certain Solar  
Questions

Additional Resources at: <https://solsmart.org/resources/>

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### Solar Info Resource Page Supplement



## USDA Rural Energy for America Program Resources

Program information on competitive grants and subsidized loans to for project costs associated with energy assessments, efficiency improvements, and renewables for farms and rural small businesses



## SREC Information

Information on Solar Renewable Energy Certificates (SRECs) from [PJM](#) additional SREC information available from [SRECTrade](#) and [Virginia Solar United Neighbors](#)

Home > Program Information > Virginia

### Virginia

#### Overview

The Virginia Clean Economy Act (April 2020) establishes a mandatory Renewable Portfolio Standard (RPS), which sets Virginia on a path to reach 100 percent clean electricity by 2050. The law applies to two large investor-owned utility companies in the state, Dominion Energy and Appalachian Power Company.



#### Geographic Eligibility



COMPARE SOLAR PRICES ONLINE & SAVE

Average cost of solar panels based on system size

SYSTEM SIZE	AVERAGE SOLAR PANEL SYSTEM COST (BEFORE TAX CREDITS)	AVERAGE SOLAR PANEL SYSTEM COST (AFTER TAX CREDITS)
2 kW	\$5,620	\$4,159
3 kW	\$8,430	\$6,238
4 kW	\$11,240	\$8,318
5 kW	\$14,050	\$10,397
6 kW	\$16,860	\$12,476
7 kW	\$19,670	\$14,556
8 kW	\$22,480	\$16,635
9 kW	\$25,290	\$18,715
10 kW	\$28,100	\$20,794
12 kW	\$33,720	\$24,953
15 kW	\$42,150	\$31,191
20 kW	\$56,200	\$41,588
25 kW	\$70,250	\$51,985

These prices reflect the cost of a solar energy system both *before AND after* deducting the federal solar tax credit (known as the ITC), which reduces your solar system cost by 26 percent. Some states, local governments, and utilities also offer rebates and other tax

PAY CASH

Own the system; maximize savings

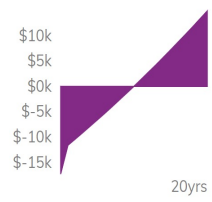
Pay for a turnkey system; Government incentives cover 30% - 65% of the cost.

**\$15,000** 20 Year Net Savings

**\$13,000** Net Cost

**10 Years** Payback

**3% or more** Increase in Property Value



Your Estimated Savings

\$0-DOWN LOAN

Own the system; no up-front cost

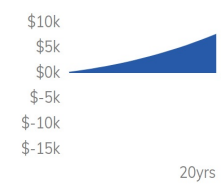
Qualify for government incentives; Interest may be tax deductible.

**\$7,400** 20 Year Net Savings

**\$0** Out-of-Pocket Cost

**Immediate** Payback

**3% or more** Increase in Property Value



Your Estimated Savings



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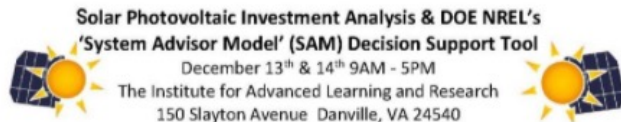
#### Exploring Virginia-based "Solarize" Project Models

These presentations were part of an educational webinar to help raise awareness of the "solarize" project model, highlight some project experiences from Virginia, and provide an overview of the Rural Energy for America Program (REAP) administered by USDA Rural Development. This event was hosted by Virginia Cooperative Extension on Tuesday, December 1, 2015 10-11AM

##### Resources

- [Database of State Incentives for Renewables & Efficiency \(DSIRE\)](#)

#### Solar Project Financial Analysis & System Advisor Model (SAM): Webinar and Workshop



Solar photovoltaic (PV) project development is expanding throughout Southside and Southwestern Virginia. Projects are being developed at a variety of scales and clientele are evaluating variety of project types with each raising a variety of questions confounding efficient project exploration and raising project

#### Information on "Solarize" Solar Purchasing Buying Co-operatives

Solar purchasing co-ops seek to aggregate demand for multiple projects to negotiate more favorable project costs and warranty terms, etc. across multiple participants

#### Information on Solar Project Analysis Tools

[PVWatts](#) is a free online tool to explore solar project. A more detailed tool to explore solar projects and their energy and financial aspects is the [System Advisor Model \(SAM\)](#), a free tool from the US Department of Energy. This resource includes information from a webinar and workshop on using this tool. A similar tool is RETScreen, more information at: <https://youtu.be/lphiDNeGwrg> AND <https://www.nrcan.gc.ca/maps-tools-and-publications/tools/modelling-tools/retscreen/7465>

# Additional Resources



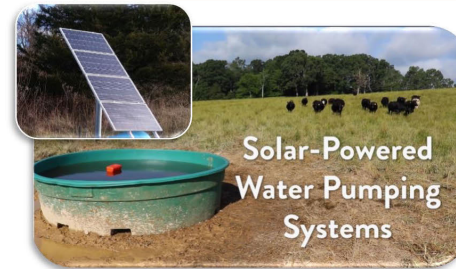
		incentive			
<a href="#">Net Metering</a>	VA	Regulatory Policy	Net Metering	01/01/2000	11/16/2018
<a href="#">Guidelines for Solar and Wind Local Ordinances</a>	VA	Regulatory Policy	Solar/Wind Permitting Standards	06/21/2011	10/12/2018
<a href="#">Qualified Energy Conservation Bonds (QECBs)</a>	US	Financial Incentive	Loan Program	10/23/2008	08/22/2018
<a href="#">USDA - Rural Energy for America Program (REAP) Loan Guarantees</a>	US	Financial Incentive	Loan Program	04/09/2003	08/21/2018
<a href="#">USDA - Rural Energy for America Program (REAP) Grants</a>	US	Financial Incentive	Grant Program	04/09/2003	08/21/2018
<a href="#">USDA - Rural Energy for America Program (REAP) Energy Audit and Renewable Energy Development Assistance (EA/REDA) Program</a>	US	Financial Incentive	Grant Program	02/18/2015	08/21/2018
<a href="#">Modified Accelerated Cost-Recovery System (MACRS)</a>	US	Financial Incentive	Corporate Depreciation	03/15/2002	08/21/2018
<a href="#">Green Power Purchasing Goal for Federal Government</a>	US	Regulatory Policy	Green Power Purchasing	02/19/2004	08/21/2018
<a href="#">Energy Goals and Standards for Federal Government</a>	US	Regulatory Policy	Energy Standards for Public Buildings	06/19/2006	08/21/2018

<https://www.dsireusa.org/>

**IN-PERSON & HANDS-ON WORKSHOP**  
**Solar-Powered Water Pumping Systems for Livestock**

Thursday & Friday, April 7<sup>th</sup>-8<sup>th</sup> 9AM – 4PM

[Shenandoah Valley AREC - McCormick Farm 128 McCormick Farm Circle Raphine, Virginia](#)



Please join us for an in-person and hands-on workshop focused on water pumping systems for livestock. Participants will learn the principles and applications of solar-electric water pumping. The primary focus will be on solar-powered water pumping systems, however, some other alternatives will be discussed too. Please join us to learn more about these systems, some considerations for their use, and hear farmer experiences.

**Topics**

- Management Considerations
- Basics of Photovoltaics (PV)
- Siting Considerations
- System Components, Design & Equipment Specifications
- Farmer Experiences
- And More!

**SPACE LIMITED & PRE-REGISTRATION REQUIRED**

**\$40 REGISTRATION FEE INCLUDES LUNCH EACH DAY**

**Featured Workshop Trainer: Ken Gardner, SEI** Mr. Gardner conducts training sessions for [Solar Energy International \(SEI\)](#) as part of their industry-leading renewable energy technical training program. His company, Gardner Engineering Alternative Energy Services, based in Utah, designs and installs solar-, hydro-, and wind-electric systems.

**Speakers from Virginia Cooperative Extension:** [Matt Booher](#), Rockingham/VCE, [Dr. Gabe Pent](#), Shen Valley AREC/VT & [John Ignosh](#), Biological Systems Eng. Extension/VT



**PLEASE REGISTER FOR THIS WORKSHOP AT:**

<https://tinurl.com/VCEsolarpump>

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Upcoming Workshop at the  
McCormick Farm in Steeles  
Tavern in April

**Solar-Powered Livestock Watering Systems:  
Evaluating System Options for Use in Freeze-free  
Months for Farmers on Rented Ground with Short-  
term Leases (M. Booher, A. Horn, G. Pent, J. Ignosh)**







## UNDERSTANDING SOLAR ENERGY AGREEMENTS

Shannon L. Ferrell  
Professor, Oklahoma State University  
Department of Agricultural Economics



This publication is developed through support provided by the National Agricultural Law Center



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An Agricultural Law Research Publication

### Farmland Owner's Guide to Solar Leasing

**Peggy Kirk Hall**

Associate Professor and Director, Agricultural & Resource Law Program  
Ohio State University Extension

**Evin Bachelor**

Law Fellow, Agricultural & Resource Law Program  
Ohio State University Extension

**Eric Romich**

Associate Professor and Field Specialist, Energy Education  
Ohio State University Extension



This material is based upon work supported by the National Agricultural Library, Agricultural Research Service, U.S. Department of Agriculture.

# Research...



~ < 1kW



~ 1 - 10 kW



~ 10 kW – ~ 2 MW



~ > 2MW

- Most of the solar-related work I'm currently collaborating on relates to: small off-grid applications (solar water pumps); and aspects of larger utility-scale solar in Virginia
- Other colleagues are focused on other solar applications (residential, 4H-STEM, etc.)

### RESIDENTIAL ENERGY EFFICIENCY

Many low-income apartment renters in Arlington and Alexandria frequently struggle with paying their rent and utilities. The Energy Masters Program helps reduce energy bills for tenants so property managers and help minimize related rent increases. Program objectives: 1) to provide energy and water saving retrofits in low-income apartments; 2) to educate tenants about energy saving actions they can take to conserve energy, thereby saving them enough to do one 120-minute Energy Masters volunteer hour; 3) to provide energy and water saving retrofits in 200 Arlington and Alexandria apartments. The program has grown to include new elements, including a student mentorship program for 10 high school students as Energy Masters volunteers; an Energy Bridge program in community and senior centers where attendees learn about energy efficiency; and a series of energy education lessons that volunteers have shared with 1,757 K-12 students.

Energy and Water Saving Retrofits (2011-2017)	
Apartment Units Completed	710
Compact fluorescent light bulbs installed	5,214
LED light bulbs installed	568
Outlets and switch plates sealed	8,800
Watts saved	248
Barboards sealed	42
Faucet aerators installed	739
Low-flow showerheads installed	537
Toilet flushes installed	288
Power strips given to residents	321
Water saved (estimated, GPM)	9,320,808
Energy saved (estimated, kWh/yr)	299,681

### FARM ENERGY EFFICIENCY & RENEWABLES

The 2012 Census of Agriculture indicates that across Southside and Southwestern Virginia, farmers spent more than \$68M on farm energy-related expenses. In 2010, Virginia Cooperative Extension partnered with agricultural service providers and agencies, to secure funding from the Virginia Tobacco Commission to support the Agricultural Energy Efficiency volunteer program to identify farm energy cost saving opportunities. Retrofits are executed via a cost-share program which also incentivizes participation in extension educational events. The program has delivered more than 20 workshops on energy efficiency best practices to renewable energy conversion technologies. During the 2014-2016 phase of the program, 68 farm energy audits identified potential annual savings of:

- 872,068 kWh in electricity
- 2826,734 energy costs
- 429,847 gallons of propane
- 1,153 MFCO2e offset

In other regions of Virginia, on-farm energy project demonstrations are used to evaluate the use of renewables to meet aspects of the Chesapeake Bay TMDL, for instance, 80 Farm Measure-to-Energy Initiative explores thermal conversion of poultry litter to produce propane while also generating a phosphorus rich co-product, and the Alternative Farming & Solar-Powered Water Pumping Systems for Livestock demonstrations explore using solar photovoltaics to power portable water pumping stations with integrated, and semi-permanent, fencing systems to provide water for livestock on rented pasturesland.

Needs Based  
Stakeholder Driven  
Extension Energy Programs

### ENERGY MASTERS

### COMMUNITY PLANNING & DEVELOPMENT

The interest in utility-scale solar farm projects has increased dramatically across Virginia over the last few years. More than 40 projects have been proposed as of March 2017, ranging from tens of acres to more than 1200 acres. There are several questions local governments must address to fully prepare for this emerging land use. However, opportunities and pitfalls exist for stakeholders. Through this program, planning commissioners, local elected officials, farm property owners, and staff planners are being educated about the technical, contractual, and policy implications of on-farm and utility-scale solar projects. For example, in November 2016 the Solar Farm Workshop for local governments and landowners was held in Emporia, Virginia to educate participants on utility-scale solar: siting, permitting, and ordinance design and to also learn from similar project experiences at sites in North Carolina. For more information, please visit: [www.virginiastate.edu/energy](http://www.virginiastate.edu/energy)

### YOUTH ENERGY

Can you teach alternative energy in an area where coal is king?

Since the fall of 2014, the Virginia state 4-H office at Virginia Tech has conducted a program on alternative energy education to Agricultural Education Officers in Southwestern Virginia. The program includes both a youth and adult component. Youth receive training in alternative energy technologies. Adults serving as Agricultural Educators or 4-H Agents, also receive training on alternative energy technologies as well as orientations on teaching with hands-on energy laboratory kits.

To date this program has:

- Conducted 156 presentations
- Reached 1,415 students
- Engaged 26 schools
- Served 14 southwestern Virginia counties
- Trained 73 teachers & 17 pre-service teachers

### Opportunities Going Forward

- Grow aspects of energy programs from multidisciplinary to interdisciplinary
- Expand upon successes of regional pilots
- Enhance experiential educational content to cost-effectively strengthen elements and reach of programming
- Efficiently synthesize evaluation data and report aggregate impacts of programs

Contact Us For More Information on These Programs

Residential Energy Efficiency: Inesha Abel (inab01@vt.edu), Farm Energy Efficiency & Renewables: John Lynch (jlynch@vt.edu), Dr. Martin Weber (mweber@vt.edu), Alan Koster (akoster@vt.edu), Youth Energy: Dan Stafford (dstaff@vt.edu), Community Planning & Development: Dr. Sarah Engel (sengel@vt.edu), General Questions: John Lynch (jlynch@vt.edu)

# *Current Research & Demonstrations...*



~ < 1kW



~ 1 - 10 kW



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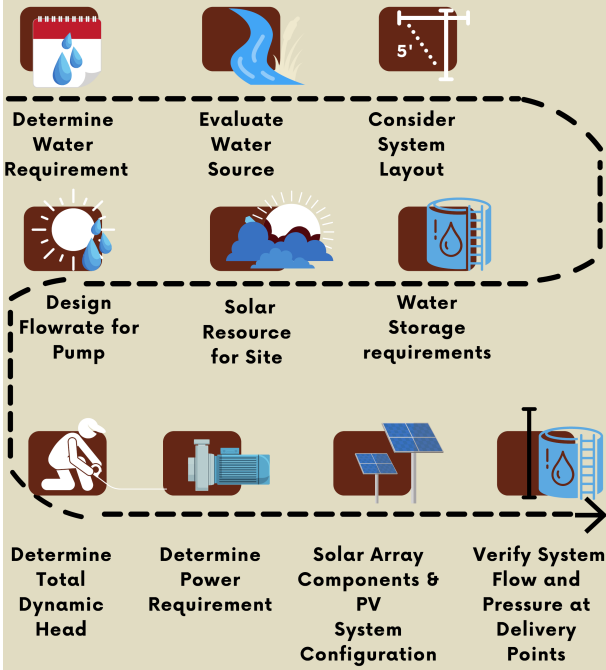
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# Solar-Powered Livestock Watering Systems: Evaluating System Options for Use in Freeze-free Months for Farmers on Rented Ground with Short- term Leases (M. Booher, A. Horn, G. Pent, J. Ignosh)



## 10 Step Overview System Components/Sizing



Solar-Powered Water Pumping Systems

Please join us for an in-person and hands-on workshop focused on water pumping systems for livestock. Participants will learn the principles and applications of solar-electric water pumping. The primary focus will be on solar-powered water pumping systems, however, some other alternatives will be discussed too. Please join us to learn more about these systems, some considerations for their use, and hear farmer experiences.

### Topics

- Management Considerations
- Basics of Photovoltaics (PV)
- Siting Considerations
- System Components, Design & Equipment Specifications
- Farmer Experiences
- And More!

**SPACE LIMITED & PRE-REGISTRATION REQUIRED**  
**\$40 REGISTRATION FEE INCLUDES LUNCH EACH DAY**

**Featured Workshop Trainer: Ken Gardner, SEI** Mr. Gardner conducts training sessions for [Solar Energy International \(SEI\)](#) as part of their industry-leading renewable energy technical training program. His company, Gardner Engineering Alternative Energy Services, based in Utah, designs and installs solar-, hydro-, and wind-electric systems.

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**Upcoming Workshop at the McCormick Farm in Steeles Tavern in April**

# Current Research...



~ < 1kW



~ 1 - 10 kW



~ 10 kW – ~ 2 MW



~ > 2MW



# The Virginia Tech Solar "Panel"

Virginia Tech's College of Agriculture and Life Sciences  
& Virginia Cooperative Extension



## Active Project: Identify Research & Extension/Outreach Priorities Regarding Utility-scale Solar in VA

### Context:

A pilot project to drive a collaborative process for industry-engaged, and stakeholder-relevant, prioritized research/extension work focused on responding to utility-scale solar (USS) issues in Virginia



### Method:

- Transdisciplinary VT-led "panel", with input via collaboration of internal and external stakeholders with experiences, insights, questions & concerns regarding USS in VA. 13 VT faculty involved.
- Iterative process to identify, refine & prioritize research/extension needs via modified DELPHI process, to better target limited resources and best respond with timely information
- Framework for parsing issues best addressed by adapting information from the existing literature from those issues that may warrant further investigation via original research to address knowledge gaps



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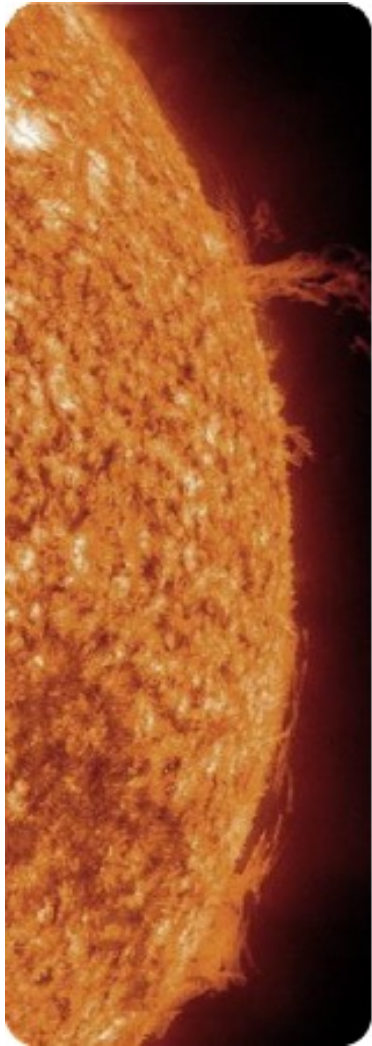
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# The Virginia Tech Solar "Panel"

A New Pilot Project from Virginia Tech's College of Agriculture and Life Sciences & Virginia Cooperative Extension



- [Bovay, John - AgEcon, Asst. Prof. & Extension Specialist](#)
- [Daniels, W. Lee - SPES, Professor](#)
- [Fike, John - SPES, Professor & Extension Specialist](#)
- [Ignosh, John - BSE, Extension Specialist](#)
- [Lane, Robert - BSE, Extension Specialist](#)
- [Meyers, Ron - CNRE, Assoc. Professor](#)
- [Munsell, John - FREC, Professor & Extension Specialist](#)
- [Paulette, Morgan - Pulaski County, Extension](#)
- [Pent, Gabe - SVAREC, Director](#)
- [Prysbj, Michelle - VA Master Naturalist, Director](#)
- [Sample, David - BSE, Assoc. Prof & Extension Specialist](#)
- [Shortridge, Julie - Asst. Prof & Extension Specialist](#)
- [Welbaum, Greg - SPES, Professor](#)



**PRIORITIES**

- 1.
- 2.
- 3.

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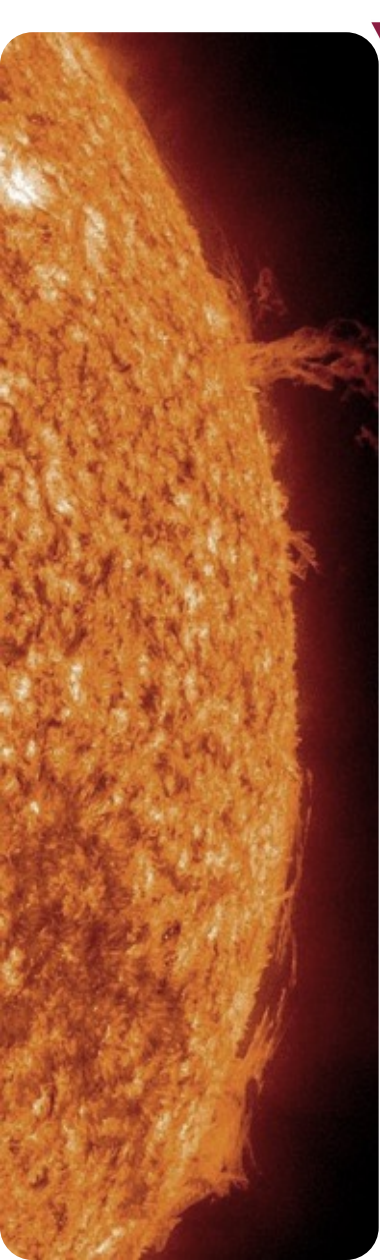
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# The Virginia Tech Solar "Panel"

Virginia Tech's College of Agriculture and Life Sciences  
& Virginia Cooperative Extension



## Active Project:

- Process Helped Identify Priority Areas to Focus Limited Resources on More Urgent Needs, Including:
  - Some of the **Priority Research Areas Identified** include:
    - **Stormwater** and Utility-Scale Solar
      - *Future work planned*
    - Opportunities for **Dual-Use with Utility-Scale Solar**
      - *Future work planned, to explore dual use applications across smaller to larger project types*
  - Some of the **Priority Extension Areas Included:**
    - Development of additional VCE **trainings** on the issue
      - *Efforts underway: e.g., solar land lease considerations, dual use, project tours*
    - Development of related **fact sheets**
      - *Efforts underway: e.g., landowner considerations and solar leases*



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# Upcoming In-person April 2022 Workshops

## Solar Water Pumping

**IN-PERSON & HANDS-ON WORKSHOP**

**Solar-Powered Water Pumping Systems for Livestock**

Thursday & Friday, April 7<sup>th</sup>-8<sup>th</sup> 9AM – 4PM

Shenandoah Valley AREC - McCormick Farm 128 McCormick Farm Circle Raphine, Virginia



Solar-Powered Water Pumping Systems

Please join us for an in-person and hands-on workshop focused on water pumping systems for livestock. Participants will learn the principles and applications of solar-electric water pumping. The primary focus will be on solar-powered water pumping systems, however, some other alternatives will be discussed too. Please join us to learn more about these systems, some considerations for their use, and hear farmer experiences.

**Featured Workshop Trainer: Ken Gardner, SEI** Mr. Gardner conducts training sessions for [Solar Energy International \(SEI\)](#) as part of their industry-leading renewable energy technical training program. His company, Gardner Engineering Alternative Energy Services, based in Utah, designs and installs solar-, hydro-, and wind-electric systems.

**Speakers from Virginia Cooperative Extension:** [Matt Booher](#), Rockingham/VCE, [Dr. Gabe Pent](#), Shen Valley AREC/VT & [John Ignosh](#), Biological Systems Eng. Extension/VT



**PLEASE REGISTER FOR THIS WORKSHOP AT:**

<https://tinyurl.com/VCEsolarpump>

### Topics

- Management Considerations
- Basics of Photovoltaics (PV)
- Siting Considerations
- System Components, Design & Equipment Specifications
- Farmer Experiences
- And More!

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Workshop Made Possible By:



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## Micro Hydro

**INTRODUCTORY WORKSHOP: MICRO-HYDRO POWER SYSTEMS**

SATURDAY, APRIL 9<sup>th</sup> 9AM – 6PM

RINER VOLUNTEER FIRE DEPARTMENT

3595 Riner Road, Riner, VA 24149



Please join us for an introductory workshop exploring micro-hydro systems and applications for energy generation. Participants will learn the principles and applications of hydro-electric water pumping. Learn more about these systems and some key considerations for their use. The session will begin with presentations in the morning through lunch, followed by an optional site visit in the afternoon to a field site approximately 6 miles away for in-person site assessment work. Please note, rugged terrain and difficult access to field site.

**Afternoon Site Visit Requires High Clearance 4WD Vehicle to Ford Stream; Carpooling with Workshop Hosts May Be Needed for Last Leg of Travel for Access to Site**

**Featured Workshop Trainer:**

**Ken Gardner, SEI** Mr. Gardner conducts training sessions for [Solar Energy International \(SEI\)](#) as part of their industry-leading renewable energy technical training program. His company, Gardner Engineering Alternative Energy Services, based in Utah, designs and installs solar-, hydro-, and wind-electric systems.

**Additional Speakers:**

[Thomas Miller](#), Host & Landowner, AP Environmental Science, Blacksburg High School  
[John Ignosh](#), Biological Systems Eng. Extension/VT

### Topics

- Micro-hydro Site Assessment
- Safety Procedures
- Understanding Water Hydraulics
- Hydroelectric System Components
- Reaction & Impulse Hydro Turbines
- Maintenance Considerations
- And More!

**SPACE LIMITED & PRE-REGISTRATION REQUIRED**

**\$40 REGISTRATION FEE INCLUDES BOX LUNCH**

Morning will be classroom session held at engine bay at fire hall. Afternoon consists of optional field visit to potential micro-hydro site, road access requires 4WD and high clearance vehicles, then approximately 1/4 mile of roundtrip hiking, with rough terrain. Final logistics will be confirmed during the morning session.

**Virginia Tech COVID Protocols in effect on workshop date will be followed**

**PLEASE REGISTER FOR THIS WORKSHOP AT: <https://tinyurl.com/VCEmicrohydro>**

Workshop Made Possible By:



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[www.vce.edu](http://www.vce.edu)

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# Incorporating Solar into Agricultural Landscapes: Workshop for Farmers



*photo by Chris Anderson*

*Thank You!*

Friday, March 4, 2022  
Harrisonburg, VA

**John Ignosh**  
Extension Specialist, BSE/VCE-VT  
Harrisonburg, VA  
540-432-6029 x108  
jignosh@vt.edu

