Innovative

Solar Clovers: Using Solar to Engage 4-H Members in Hands-On STEM Activities

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Introduction

Research suggests 4-H member participation in hands-on activities can have a positive affect on student interest in STEM subjects (Dillivan & Dillivan, 2014; Ridgeway & Brown, 2018). The American Association for Agricultural Education (AAEE) National Research Priority Area #2 addresses adoption of new technologies, practices, and products (Roberts, Harder &, Brashears, 2016). Examples of these new technologies include renewable energy systems used in providing reliable energy for powering lights, water pumping systems, and electricity to rural areas.

Solar photovoltaic (PV) systems are appearing in many locations in our communities. Largest number of systems are in grid-connected residential and light-commercial applications. Roof-mounted solar PV arrays provide the user with energy from the sun during daylight hours while energy from the utility company is used at night. More and more stand-alone solar PV systems are visible in our communities in traffic monitoring systems (solar-powered radar signs), railroad crossing gates, and solar-powered streetlamps.

A charter school in northern Arizona, just outside of the Navajo Nation, holds the title as the first off-grid school in the nation. The K-8 school of 150 students gets its energy from a variety of solar PV arrays and wind turbines. Multiple banks of 48-volt batteries provide the stored energy for The STAR School (www.starschool.org).

How it Works

Funding for the project was secured from an institutional Student Engagement grant from the College of Agriculture and Life Sciences. Projects were identified and decided upon by both project co-principle investigators. Dates for projects meeting were selected and shared with interested 4-H members and parents. 4-H members and parents attended monthly project meetings conducted at the University of Arizona Agricultural Technology Education Center (ATEC). Solar activities were taken from the Classroom Solar textbook (Atchison, 2009) and included pizza box solar cooker, solar whirly gigs, solar racers, and solar fountains. Activity meeting length varied from 90 minutes to two hours. Members were encouraged to enter the projects into division and class at the local county fair in April.

We involved University of Arizona students enrolled AGTM 200 Solar PV Energy Sources lab course. Working in groups, college students engaged in numerous solar-related activities including construction of eight family-sized solar ovens, solar fountains, pizza-box solar cookers, solar racers, and our students served as judges of solar projects at the Pima County Fair. While our students engaged in evaluating 4-H member solar projects, parents of 4-H members utilized the newly constructed family-sized solar ovens to heat up food for 4-H members and our judges to share including hotdogs, beans, and desserts.

Results to Date

Approximately 35 4-H members participated in the project along with 16 college students. Six projects meeting were conducted over the course of the project. Eight family-sized solar ovens were constructed, tested, and donated to the (COUNTY) Cooperative Extension Center. Twenty-five 20-watt solar modules were purchased and added to the 4-H teaching inventory. Materials for constructing approximately 25 five-gallon pump in a bucket solar fountain system, and 25 solar racers. 4-H members learned how to interpret a datasheet for a solr PV module to gain an understanding of how solar PV modules are sized and rated. These variables include watts max power (Wmp), DC voltage max power (Vmp) DC amperage max power (Imp) open-circuit voltage (Voc) and short-circuit current (Isc). Members and parents learned of different solar hand tools and how to use a digital clamp-on multi meter to measure module voltage and current. 4-H members assembled solar fountains using the materials provided, then were challenged to design, construct, and test their own solar-powered water fountains for the solar activity at the county fair.

Future Plans/Advice to Others

In spring 2020, the [UNIVERSITY] Green Fund Committee awarded a $52,000.00 grant to our department to fund our efforts to expand this project focusing on three three tribal community 4-H programs. Federally recognized tribal extension program (FRTEP) agents working with 4-H will be trained in the use of solar PV modules, solar hand tools, and constructing and testing solar projects. A portion of the grant will support a graduate student who will assist with teaching our solar PV energy sources lab course and create a survey instrument to evaluate participant perceptions of our solar 4-H outreach efforts.

Our goal is to expand the project to encompass more tribal 4-H groups in our state and work to create a competitive skill activity focusing solar PV energy systems. Based on feedback we receive from county extension agents, volunteer 4-H leaders, and responses from 4-H members, we hope to create a useable 4-H solar activity curriculum suitable for our state.

Costs/Resources Needed

Funding for Solar Clover Project was approximately $10,000.00. The majority of funds were used to purchase approximately 25 20-watt solar PV modules ($75.00 apiece), five-gallon buckets, 12-volt 2.5-amp bilge pumps ($18.00) , PVC material, hand measuring and cutting tools, solar racer kits ($55.00), pizza box solar oven materials ($10.00), solar whirligig project materials ($100.00) , classroom solar demonstration sets ($500.00), portable solar generator boxes (stand-alone battery storage systems constructed from plastic ammo boxes) ($125.00), and materials for construction of the family-sized solar ovens ($125.00).

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