HOW BPA/WSUN SCHOOL PV EFFORT WORKED AT ELMIRA HIGH SCHOOL

Frank Vignola
Physics Department
1274-University of Oregon
Eugene, Oregon 97403
fev@darkwing.uoregon.edu

Joe Savage
Emerald People's Utility District
33733 Seavey Loop Road
Eugene, OR 97405
joe@epud.org

ABSTRACT

This article reports on lessons learned from installing a photovoltaic system at Elmira High School through cooperation between Emerald People's Utility District (a local utility), Bonneville Power Administration, and Western SUN (a utility oriented photovoltaic system wholesaler). Key factors needed for this project were interest from the school, advantages for the local utility in installing a solar electric system in its service territory, and a mechanism to help share the cost of the system.

The school and the students benefit in having a renewable energy system that can be used as an educational aide. The local utility and BPA benefit from experience with the PV system and the positive publicity generated by the project.

Initial reactions of the utility and the school are reported. However, it will take a while to develop and refine lesson plans to make full use of the solar electric system.

1. INTRODUCTION

In early 2001, the Bonneville Power Administration (BPA), in conjunction with Western SUN (WSUN), initiated a pilot photovoltaic project between utilities and schools. The goal was to develop a standardized photovoltaic (PV) system that could be integrated into K-12 curriculums. While cost savings were anticipated by having a standardized system, it would also be much easier to share curricula if the systems were of similar design.

In this pilot project, BPA "bought down" the system costs for fifteen solar electric (PV) systems. In other words, BPA paid the $2,500 for each system and the utility paid the rest of the cost. Participating utilities paid for and coordinated the installations at K-12 schools taking part in the program. Four utilities in Oregon and eleven in Washington were involved in this project. This study looks at the participation of Emerald People's Utility District (PUD) and Elmira High School in this pilot program. Elmira, Oregon is a small town about 15 miles west of Eugene.

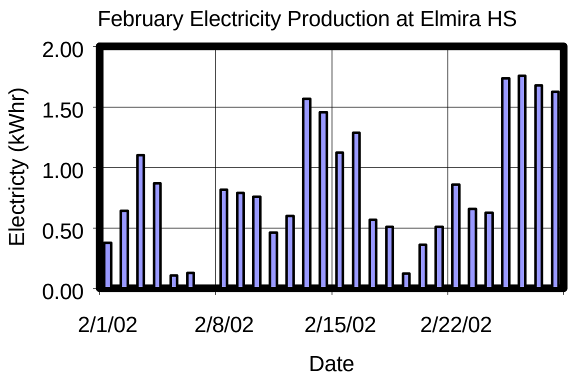
The focus of this study will be:

- Key factors that were necessary to enable this to occur
- The process that brought about the completion of this project
- The initial reactions of the utility and school to the project

2. KEY FACTORS

Emerald PUD is a small public utility with a large service territory surrounding the Eugene-Springfield metropolitan area. It runs an active conservation and solar domestic water-heating program. Emerald had funded a grid-tied photovoltaic system at the Aprovecho Research Center in Cottage Grove, Oregon and was examining ways to fund PV systems for high schools in its service territory. Having a knowledgeable staff with an active interest in renewables, the utility was in an ideal position to take advantage of the BPA offer.

It is also important to have someone at the school with renewable energy experience and an interest in teaching about solar energy. Emerald had begun preliminary discussions about installing a PV system as a teaching tool with Richard Walker at Elmira High School. Walker had installed a solar water heating system on his own house and, as the vocational-technical instructor at the high school, was



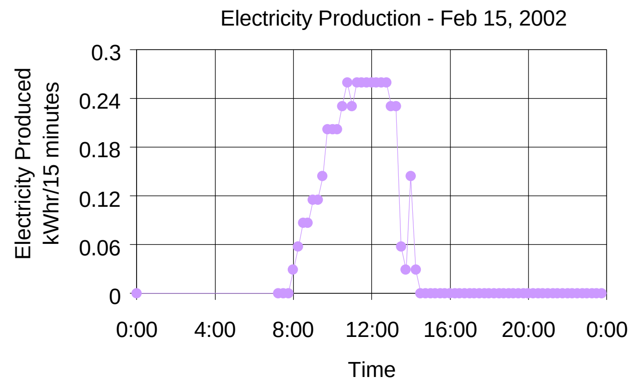


Fig. 1: February 2002 daily data. Output of the PV array is monitored by the Bonneville Power Administration and is made available to the school to use in their lesson plans.

Fig. 2: Electricity produced over the day. Note that the resolution of the reading is approximately 0.03 kWhr per 15-minute interval.

looking for ways to use renewable technologies to enhance the educational experience of students.

When BPA issued its call for proposals, Emerald and Elmira applied for the system and their proposal was one of fifteen that were accepted. The system cost from Western SUN was $4512.99, BPA contributed $2500 and Emerald PUD paid the difference and covered the installation cost. The project really started when BPA offered to pay part of the equipment cost.

The system is a grid-tied 600-watt$_{peak}$ array consisting of eight 75-watt BP275 modules and a Trace Sun Tie inverter. The inverter is located in a hallway between offices and is clearly visible to the students and easily accessible for class examination or to show visitors. The array is located on the roof by the courtyard and is visible from the courtyard, but not easily accessible to students without a ladder. The output of the array is monitored and phoned in nightly to a computer operated by BPA. The output from the array is then made available to the school and can be used as input information for lessons (Fig. 1).

The data logger records data in 15-minute intervals. Fifteen-minute records are far superior to hourly data in showing the variability of the system output over the day. Note the effect of clouds on February 15 in Fig. 2. The morning is fairly clear and clouds come in during the afternoon. There is a brief clearing period about 14:00 when the sun is shining and electricity production sharply increases. With hourly data, the quick response of the solar cells to changes in incident solar radiation would not as clearly visible. Note that the inverter basically shuts down and no electricity is produced when the incident solar radiation falls below a given level.

After examining the performance of this system, it is apparent that adding more panels to array so that the array output more closely matches the inverter input rating of 1.5 kW can increase the efficiency of the inverter.

The one feature that is lacking which could significantly enhance the system's utility as a teaching tool is information on the incident energy. Information on the incident energy can be used to evaluate system efficiency and is an ideal lead-in to many interesting discussions on how solar cells produce electricity.

3. SYSTEM INSTALLATION

The system was installed on October 17, 2001. Newt Loken of Solar Assist and an electrician from KS Electric installed the system. The original plan was to have the school district electrician work on the system, but due to an injury he was unable to participate.

Maintenance of any system is important and training of school district personnel is an important factor in keeping a system running properly. Unfortunately the training was planned, but circumstances prevented the actual training. This shows the value of some flexibility in any project.

The specifications package that came with the PV system gave a very detailed description of the photovoltaic arrays and other components. This information is provided to both the teacher and the maintenance personnel and offers an excellent educational opportunity. The teacher can use the documents can be used for background material and the maintenance personnel can use the material to learn how the system works.

Planning involves cooperation of many participants and a desire by those involved to make it happen. The initial idea was to install the system on the roof of a remodeled and expanded classroom. However, concerns about mounting the system on the new roof led to the location of the system on the roof near the courtyard. Persistence by those interested in having the system as a teaching tool led to the selection of an alternative location. Without the inside support, the project might have been dropped.

Installing the inverter where it was accessible to students had one major drawback. When the inverter cooling-fan turns on, it makes a steady hum. The secretary in a nearby office turned off the system because of the noise. The teacher involved with the project built an insulating box that enclosed the inverter and this reduced the noise to an acceptable level.

4. FACILITATING THE LEARNING PROCESS

Lesson plans developed for the Million Solar Roofs Initiative were given to the teacher to assist in the integration of the PV system into the curriculum. These lesson plans can be found at http://solardata.uoregon.edu/LessonPlans.html. Sample questions and answers are also available for the plans at the following URLs:
http://solardata.uoregon.edu/download/Lessons/PVLessonPlan1SampleQuestionsAndAnswers.doc
http://solardata.uoregon.edu/download/Lessons/PVLessonPlan1SampleQuestionsAndAnswers.pdf
http://solardata.uoregon.edu/download/Lessons/PVLessonPlan2SampleQuestionsAndAnswers.doc
http://solardata.uoregon.edu/download/Lessons/PVLessonPlan2SampleQuestionsAndAnswers.pdf
Note that there are no line breaks or spaces in the URLs.

In the first lesson plan students are introduced to the basic physics and chemistry behind the operation of a solar cell. It is designed to teach how incident solar energy is turned into electricity in a single crystal silicon cell. The second lesson plan discusses the components of a solar electric system and the concept of the photovoltaic IV curve. (An IV curve is a plot of current verse voltage for a photovoltaic system. The IV curve for solar cells is similar to an IV curve for a battery.) Also discussed are how the modules are put together to generate the desired voltage and current and how an inverter helps the system to operate efficiently. The third lesson plan teaches the use of a software tool called PV Watts to calculate the output of PV arrays as a function of local conditions. The lesson plan also challenges students to think about energy usage.

In addition the University of Oregon Solar Radiation Monitoring Laboratory (UO SRML) offered to answer questions and provide initial assistance as required. Most teachers have a busy schedule and don't have time to research new subjects and develop new material. Providing the initial lesson plans and background material is very helpful.

The UO SRML Web site (http://solardata.uoregon.edu) also contains simple solar related software tools as well as the capability to plot solar radiation and meteorological data. These software tools currently include a solar position calculator and a sun path chart generator. Expanded information about the solar resource is being implemented on the Web site. To enhance the usefulness of the Web tools, teachers and students involved in the solar schools program have been invited to participate in a workshop on the use of solar radiation.

The Bonneville Power Administration is monitoring the output of these systems and supplies the information directly to the schools involved. A data logger is connected directly to the power meter and records the power output of the array. A phone line is connected to the data logger and each night the data logger phones in the data collected during the day. There have been discussions about making these data available over the Internet.

5. RESULTS TO DATE

Overall, all parties are pleased with the process. On February 18, 2002, there was a ribbon cutting ceremony to celebrate the complete installation of the project (Fig. 3).

Fig. 3: The high school principle holds the plaque presented to the school from BPA as an Emerald PUD board member and the school instructor who helped initiate the project cut the ribbon. (Photo by Judith Manning – Emerald PUD)

Fig. 4: Local reporters interview students involved in a class that will use the solar electric system as a teaching aide. (Photo by Judith Manning – Emerald PUD)

Fig. 5: Instructor, Richard Walker, receives MSR certificate recognizing the solar electric system on the schools roof. The school principle, on the right, looks on. (Photo by Judith Manning – Emerald PUD)

Representatives from the Emerald PUD, the school, students, the school board and local chamber of commerce, as well as the news media attended.

Local reporters interviewed Elmira students who were already using solar cells to power model racing cars as part of their class assignments (Fig. 4). These interviews appeared on local television and in local newspapers. Teaching renewable energy technology provides important lessons for today's students.

Already, some solar lessons are being taught at Elmira. With an actual PV system, its performance data, and the PV lesson plans provided, the teacher is enthusiastic about increasing the number and quality of the renewable energy lessons being taught to the students.

In order to acknowledge the contribution of Richard Walker, he was presented a Million Solar Roofs (MSR) certificate in recognition of installing a solar system on the school's roof (Fig. 5). The certificate is now proudly displayed in his classroom.

With the success of the first installation, Emerald PUD hopes to duplicate the effort in the other four high schools in its service territory. Ways to fund these future systems are under active study.

6. SUMMARY

Key factors for this project

- Interest within a utility
- Desire of a teacher to use solar energy technologies in lesson plans
- Funds to help buy down the system costs
- Monitoring of the PV system output

Helpful elements

- Lesson plans and other resources available to assist the teacher
- The ability to network and share experience
- The ability to duplicate elements of the project in future installations

Lessons learned

- It is important to have the inverter visible but the noise from the inverter must not interfere with work or teaching
- Measuring incident solar radiation alongside system performance would lead to enhanced lesson plans.
- The size of the solar array should be increased to better match the size of the inverter. The inverter performs more efficiently with a better match.

7. ACKNOWLEDGEMENTS

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