Solar Power Comes to Ypsilanti's Historic District

By Dave and Paula Strenski

An idea is born

The Ypsilanti Food Cooperative was founded in 1979 when a buying club incorporated into a member-owned grocery store, to offer healthful, affordable food and educational programs for the local community. Along the way the Co-op has moved several times, but for the past 20 years has been housed in an 1860's building that was originally a foundry for flour milling parts. It is a fairly well preserved brick structure known as the Mill Works Building. The Mill Works Building is located in one of Ypsilanti's zoned historic districts, which offers the Co-op distinction as a community business and, for the building's owners, extra building codes to navigate when improvements are needed.

In the fall of 2004 we learned of small grant monies available through the State of Michigan targeted to non-profit organizations for projects promoting the use of technologies in categories such as solar photovoltaic, green building, and alternative vehicle fuels. With encouragement from Corinne Sikorski, the Co-op Manager, a proposal was submitted to the State, and we were granted $6000 to design and implement a demonstration photovoltaic system.

Designing the System

Before we knew whether our proposal was selected, two Co-op volunteers joined the Great Lakes Renewable Energy Association to learn some basics about photovoltaic technology.

When we learned that we had received funding, our first task was finding a PV contractor to work with. Since John Wakeman of S.U.R Energy Systems was based only ten miles away in Ann Arbor, it was consistent with the local mission of the Co-op to work with him. We had decided to use as much volunteer help as possible to stretch grant dollars and gain hands on experience. Wakeman turned out to be just the person to guide us through this project.

A typical PV system design would start with an assessment of electrical loads. However, with a fixed budget, we had to design the system backward to avoid overspending. We assumed that we could cover most installation parts and costs with about $1000, which left roughly $5000 for the inverter and panels. Guessing at an inverter size and subtracting that cost from the $5000, we then calculated how much money remained for panels, and whether the panels' total wattage would be less than the capacity of the inverter we chose. We initially looked at the Sunny Boy 2500u, but it left too little money for panels.

We then considered and settled on the Sunny Boy 1100u, which left enough money to purchase four Sanyo 190 watt panels. The Sunny Boy 1100u can handle the 760 watts, and leaves us capacity for two additional panels. Mindful of the temporary shortage of panels, we decided to place our order as early as possible.

The intent of the grant program is to generate public awareness regarding the feasibility of solar power in Michigan. Therefore we decided to install digital watt gauges where it would be easy for visitors to see how much electricity we are harvesting from the solar panels, and how much the store is consuming via our local utility, DTE Energy. There is a display on the front of the Sunny Boy inverter, but we wanted to bring all the information to one easily accessible location. To accomplish this we decided to purchase four Upland Technologies "Energy Viewers." For clarity, we will refer to them here as "digital watt gauges," or simply "watt gauges."

Why four watt gauges? The Co-op has three separate electric meters for the store: one for air conditioning, one for the majority of the store, including several commercial refrigerators and freezers, and one for the office and kitchen area. There was not an easy way to integrate these three values into one display, so we attached a watt gauge to each feed, and mounted these three watt gauges side by side on the wall. The fourth watt gauge displays the amount of power coming from the solar panels, supplying the office/kitchen area. This gauge is mounted directly below its corresponding utility watt gauge. As we had hoped, the watt gauges are easy to read. At any time we can determine how much power is being generated by both the PV system, and the utility (see Figure 1).

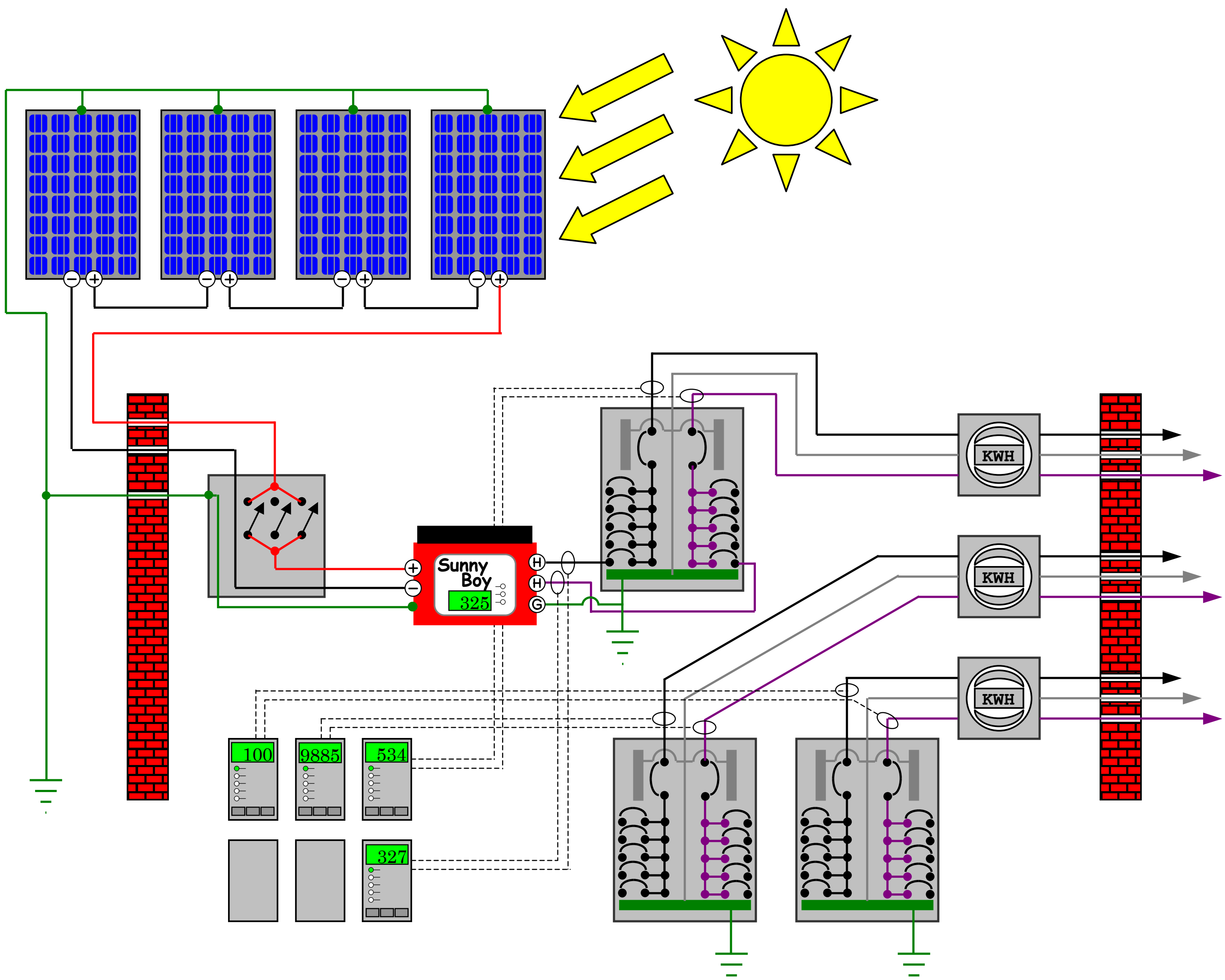
Installing the Digital Watt Gauges

Since January is usually a time of freezing temperatures in Michigan, we decided to begin with the indoor work. The digital watt gauges were ordered, and volunteer Blue Way of Blue Sky Carpentry began construction on a prominent interior wall of the Co-op.

When the watt gauges arrived, we secured the help of Tim Neff, a licensed electrician. The watt gauges each consist of a transducer doughnut that the power line is fed through, a circuit board mounted inside a 4-inch electrical junction box, a 9-volt power supply, and a digital display unit. Neff helped us to momentarily disconnect the power from the utility to our breaker panel. We then disconnected the two hot leads from the breaker panel, slipped the transducer over the wires, and reconnected them. The transducer picks up the small magnetic fields generated by the alternating current running through the wires. This analog signal travels through a couple of small wires to the circuit board, which converts it to a digital signal for the wall displays. A 9-volt supply is used to power the circuit boards and LED displays.

Since we have three different feeds coming into the store we had to repeat this operation for the other two breaker panels. Slipping the transducers for the fourth watt gauge around the wires coming from the Sunny Boy, we could display the power generated from the PV panels. When we secure additional funds to add solar panels to tie in with one or both of the other two breaker panels, we will purchase two more watt gauges. As we mentioned earlier, our goal is for a visitor to see at a glance the total power being supplied to the store from both the utility and our solar panels.

We immediately noticed that at low power levels there was a significant difference between the watt values displayed on the Sunny Boy, compared with the corresponding watt gauge on the wall. When the Sunny Boy said it was generating 40 watts, the wall gauge was showing 120 watts. We were puzzled at first, and then noticed that on a clear day when the Sunny Boy was displaying 300 watts, the wall gauge was showing a value just a watt or two different. At this time we are inclined to trust the accuracy of the Sunny Boy's display. Perhaps the digital watt gauges on the wall are not as accurate at lower levels. In the coming months we plan to borrow a multi-meter to compare and assess the accuracy of these gauges at various power levels.



Costs

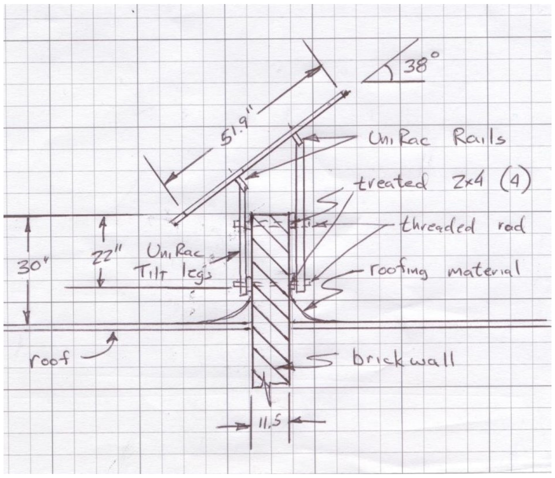
The total cost of the project was $7360, with $6000 received from the State grant, and the balance paid for by the Co-op. The four digital watt gauges were not absolutely necessary to build a successful demonstration solar power project, and these added about $900 to the bottom line. However, since this project was focused on educating the public, we felt it was more important to bring real time information regarding the power received from both the solar panels and the utility to a visible area of the store. We are pleased that we decided to invest the extra money. The watt gauges were immediately a big hit with visitors because they are easy to read and understand.

Sunny Boy 1100u inverter	**$1400**
4 Sanyo 190watt panels	**$4000**
UniRac & UniStrut	**$ 344**
Square-D disconnect	**$ 284**
Cogeneration Application Fee	**$ 100**
Building Permit	**$ 94**
Misc electrical hardware	**$ 86**
Misc mechanical hardware	**$ 65**
Electrical permit	**$ 60**
Historic District permit	**$ 30**
4 Energy Viewers	**$ 896**
Total	**$7359**

There were no labor costs incurred in this project. The Co-op is fortunate to have a generous pool of skilled and willing volunteers to make projects such as this one possible.

Designing and Installing the Solar panel supports

When we first thought about putting solar panels on the building, we assumed we would bolt them down to the flat roof. That is how we initially drew the racking system when we submitted our sketches to the city's Historic District Commission for approval. The HDC was very supportive of the project, although they were curious about how visible the panels would be. They concurred that technology changes with time, and noted that originally the building did not even have electricity. Therefore adding solar panels to the roof would be a natural progression with respect to the building architecture.



A few weeks later, when we were ready to obtain our building permit, we were talking with architect Don MacMullan, whose firm is also housed in the Mill Works Building. It dawned on us that we could use the parapet wall as a mounting structure. As illustrated in the drawing and photo above, the parapet wall is an extension of the interior brick wall that divides the building into separate office spaces. By attaching the panels to the parapet wall, we could avoid making holes in the roofing material and could attach the racking to a very solid 12" wide brick structure. MacMullan quickly made up a new set of drawings, and we applied for the building permit. Although this change did not greatly alter the height or the location of the panels, it did cost us a couple of weeks' time for re-approval by the HDC.

With all the paper work in order, three Co-op volunteers performed the installation. Much to everyone's surprise, the supports were easily bolted to the wall and the panels were installed in less then 3 hours. One useful tool was a hand made custom level. Using a bit of trigonometry, we cut a triangular block of wood with a 38 degree angle, and mounted a small bubble level on the top. This level allowed us to mount the panels at the correct angle.

As the building is two stories high with the front wall extending five feet above the roofline, and with the panels located closer to the back of the building, it turns out that the panels are not visible from the street side. From the alley in back of the building, where the ground elevation is higher, one can get a pretty good view of the panels.

Wiring it all together

One of the most tedious jobs was wiring it all together. Relying on volunteer time, the wiring happened piece meal over several months. Hanging the Sunny Boy and the Disconnect was easy enough, but the conduit was a challenge, trying to keep everything neat in a tight space. With the wiring and conduit starting on the roof, a junction box was bolted to one of the uprights on the solar panel rack. The Sanyo panels have a waterproof connector, so they easily plug together in series. The positive and negative ends of this series loop are then attached to wires in the junction box, brought down the exterior wall and into the Co-op, where the positive side is connected to the disconnect. Another learning aspect of this

project was finding out that direct current (DC) arcs more easily than alternating current (AC). Therefore the Disconnect had to be a special DC disconnect, and the positive wire had to be split across two blades of the switch to prevent arcing.

From the Disconnect, the DC power is connected to the Sunny Boy inverter. The Sunny Boy converts the DC power into AC power and matches the wave amplitude and frequency of the power coming from the utility. The AC power is now connected to a 240 volt, 20-amp breaker in the electrical panel.

We became stumped again as we tried to determine from the schematics whether it was safe to connect the AC ground in the electrical panel to the DC ground used for the solar panels. A quick phone call to Wakeman assured us that since the grounding rods are close to each other, they function as one.

With everything ready for launch, Wakeman gave everything one last check, and walked us through the start up procedure for the Sunny Boy. We have kept the system running ever since, and we were thrilled that we passed our municipal electrical inspection flawlessly.

Cogeneration and net metering in Michigan

With the system up and running there was only one last bit of paper work to finish. We needed to submit an application to the utility for cogeneration. With the small size of our system and the large consumption of the refrigerators and freezers we will be amazed if even one extra electron ever leaves the store. However, since we plan to expand our system, and want to learn as much as possible, we completed the Michigan Electric Utility Generator Interconnection Requirements application.

The application was complicated, since it covers generators up to 30kW and calls for a lot of start up and shut down procedures. Haukur “Hawk” Asqeirsson at DTE Energy was very helpful. He immediately understood the simplicity of our system, and guided us through the application process.

Net metering is new to Michigan and utilities are still figuring out the details of how to implement it. Hawk assured us that submitting the cogeneration application is the first step, and in doing so we have volunteered to be one of the first solar projects to apply for net metering.

Please note that if our PV system expands to the extent that we harvest more solar power than we need, and could sell electricity back to our utility, our digital watt meters are not designed to display the direction of the power flow—only the amount of power flowing. For demonstration purposes, we would need to enhance our watt gauges with some sort of direction-of-flow indicator to show whether our PV panels were overflowing power back out to the utility, or just augmenting our utility power usage.

Educational Aspects

The original goal of this grant project was to educate the public about the potential of solar power. To this end we feel we have succeeded. A core group of Co-op volunteers gained first hand experience in the nuts and bolts of solar power. The community has expressed tremendous interest in the project. Many customers check the watt gauges each time they visit. The Co-op has already received a generous donation for the next set of panels. We are offering a series of public presentations to explain how solar power works. For more information contact the Ypsilanti Food Co-op, 312 River Street, Ypsilanti, Michigan 48198, 734-483-1520 or visit: www.ypsicoop.com.

Future Expansion

With the 760 watt system up and running, we are now thinking about expansion. There remain a few inexpensive tasks we can do immediately to enhance our total solar power harvest. An old, now unused chimney on the building roof casts a shadow from the east side. A volunteer contractor can remove this chimney as soon as weather permits. To maximize power collection in the afternoon, we could trim a few deciduous trees on the west side of the building along the street.

The ultimate goal for the Co-op is to be 100% solar powered, using the utility net-metering as our storage device. The digital watt gauges show that what we need to be self-sufficient is a rather tall order. The biggest issue with self-sufficiency is the cost of the panels and inverters. The Co-op applied for a larger $60,000 state grant for a 10 kw photovoltaic system, but was not selected. We plan to re-apply next year, and to seek additional sources of funding.

Access (Sources)

S.U.R. Energy Systems
(Photovoltaic Contractor)
Attn: John Wakeman
221 Buena Vista Avenue
Ann Arbor, Michigan 48103-4301
734-913-9944

Congdon's ACE Hardware
Attn: Paul or Don
111 Pearl Street
Ypsilanti, Michigan 48198
734-482-2545

Tim Neff
Licensed Electrician
734-320-5528

Blue Sky Carpentry
Attn: Blue Way
River Street
Ypsilanti, Michigan 48198
734-368-3017

Don MacMullan
MacMullan Architects
308 River Street
Ypsilanti, Michigan 48198

734-483-1200

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