A Multifamily PV Project at Ecovillage at Ithaca

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If you live in one of the 5 million housing units that are in multifamily condominiums or cooperatives, you may have dreamed about installing a PV system, but couldn't figure out how to make it work. My co-op neighborhood in Ithaca, New York, was recently able to make this dream a reality.

Challenges

There are many benefits to living cooperatively or in a condominium, but the ease of installing a solar-electric system is not one of them. The first problem is that you don't own the roof and walls—so a PV installation requires permission from your neighbors and the homeowners' board. In addition, there are wiring, metering, utility connections, and aesthetic considerations that come into play. For example, your electrical service connection may be located some distance away from your unit, you may need access to a neighbor's roof or attic for attaching modules or routing wiring , or you may find that some of your neighbors don't share your delight in seeing solar collectors gleaming on the roof.

An alternative is to expand the PV project into a neighborhood effort. In this scenario, the condo association or co-op owns the system, and the system benefits all of the residents. That solves a few problems, but brings up several more.

One of the thorny problems is the way most utilities implement net metering. Usually a utility will allow you to hook up a PV system only to your own utility connection. Under an annualized net-metering agreement, the utility credits your household only for PV production *up to* your total usage for that year. Usually, any surplus generation is given to the utility for free or at a low wholesale rate. Since the homes in most multifamily neighborhoods are individually metered, this necessitates having many small PV systems (one per unit), rather than one large, more efficient, cost-effective system.

If this can be overcome, the remaining challenges are how to pay for the system; how to meter and divide the output; and getting approval from utilities, planning departments, rebate providers, and other agencies. Oh yeah, and you have to get everyone in your neighborhood to agree to all of this.

Daunting? Yes. Achievable? Definitely! My community, Ecovillage at Ithaca (EVI) in Ithaca, New York, successfully navigated these obstacles and constructed a 50 kW grid-tied PV system that was financed with local capital and is expected to meet more than half of our community's electricity needs.

Background

EVI is a community of 60 energy-efficient homes in two distinct neighborhoods (soon to be three) clustered in the center of a 176-acre parcel on the outskirts of town. My neighborhood, built in 1997, has 30 compact townhouses and was designed according to cohousing principles: Homes face onto a meandering, car-free central corridor and share access to a large common house that provides space for community gatherings and meals, playrooms, laundry facilities, and offices. The average townhouse is 1,225 square feet, and up to 40% more energy efficient than typical homes in the area due to extensive insulation and sealing, triple-pane windows, a shared hydronic heating system, and passive solar design.

In tune with ecological design, residents were very interested in adding PV systems to the townhouses when they were originally built. At that time, though, it was prohibitively expensive and there were few incentive programs to help out. For many years after, residents discussed adding solar-electric systems, but couldn't find an approach that addressed all the challenges in a cost-effective way. In 2010, that changed, partly because we devised a new approach.

Revisiting our desire for solar electricity began with a bit of friendly conflict among neighbors. My wife Kristen and I, feeling frustrated by the lack of progress implementing renewable energy in our community, wanted to install a small solar heating system on the roof of our unit. When we asked for permission, several neighbors objected, citing the long-standing desire to use our shared roofs to implement a comprehensive PV strategy.

Feeling grumpy about the roadblock, I set out to demonstrate why such a PV system was impractical on our difficult roofs. As I was trying to prove this, it occurred to me that we didn't need to use the roofs—we could ground-mount the PV system.

I quickly switched gears and roughed out a possible design for a 50 kW array located a few hundred feet from the neighborhood. Some initial calculations of costs and available rebates and tax credits, as well as some ideas about financing, made it seem feasible. So I started meeting with other residents to get their feedback. Enthusiasm for the idea ran high, and the group quickly agreed on some core goals:

- All residents should benefit equally from the system;
- Monthly electricity costs should remain similar to existing utility charges;
- Residents are not required to contribute up-front capital;
- The system should be big enough to be worth doing, but small enough to manage.

We assembled a small project team, requested a small amount of seed money from the co-op board, and got busy.

Figuring Out the Financing

We needed to get an accurate cost estimate, so I contacted my neighbor Tony Henderson, who has spent the last few years managing large PV projects around the Northeast. Tony was able to quickly validate and improve my design, and gave us an estimate of about $6 per watt, or $300,000, for the system. The DSIRE website (see Access) provided information on available rebates and tax credits, and we determined a final out-of-pocket cost of about $100,000.

With that estimate in hand, we started working out how to pay for it. We decided that it made sense for the co-op to own the system and that it should borrow the money. We doubted we would find a bank that would lend the co-op money for such a project, so we proposed borrowing it directly from individuals in the community.

With banks paying interest rates of 2% or less, some neighbors were open to lending if the co-op could pay a higher rate. We ran the numbers at an interest rate of 5% and a loan period of 20 years to calculate the monthly payment— the amount we would need to raise each month. To meet the goal of keeping monthly electricity costs similar to what residents were currently paying, that meant that the PV system would need to generate savings equal to the loan payment.

We used PVWatts to estimate the system's annual output and gathered up a year's worth of utility bills to estimate our neighborhood electricity usage in dollars and kWh. The PV system would generate about 55% of all the electricity used. By examining the average residential electricity rate, we determined the approximate dollar value of the PV-generated electricity. If residents continued to pay the same amount as their current monthly electricity bills, the PV system would generate enough income to pay the loans. In fact, the loan period was adjusted to 15 years, instead of 20.

Metering

With a financing plan in hand, the next challenge was net metering. The co-op would only receive credit for PV electricity that offset the annual usage of one utility meter, and we had 30 separate meters. We needed to find a way to combine the meters into fewer separate utility connections.

New York State has well-established procedures to allow the conversion of individual meters to master meters in multifamily dwellings. By following the procedures, we were able within a few months to get our local utility to agree to the conversion. We reduced from 30 separate meters to four—one for each quadrant of the neighborhood.

Moving to master metering meant that the co-op would be responsible for metering and billing of residents, which required installing new submetering equipment. Our initial equipment survey was disappointing—most products we found were expensive and lacked key features. We wanted “smart meters” that would interface with our internal Internet-connected network that allows either wide or local-only access as we see fit. So far, we have chosen to make display data available only internally, but we could make it accessible to the outside world if residents feel comfortable about making their usage info public.

Most products with these capabilities work only with proprietary software and required significant monthly fees. Other smart meters are more suited to individual homeowners and not designed to be centrally installed and managed. Luckily, we found EKM Metering of Santa Cruz, California, which approached smart meters more like a computer startup company and less like a utility, creating inexpensive products that act as flexible building blocks to be “mashed-up” in various ways, rather than creating rigid systems that lock a customer into using only the capabilities provided by one vendor.

We were able to create a cost-effective smart-metering system with no monthly fees. Besides the basic meter reading, we developed software for graphical display of real-time power usage for individual homes as well as aggregate displays of use, PV generation, and purchased energy for each group of townhouses and the whole neighborhood. We are considering making this available for free as open-source software.

With the overall plan in place, we now had to get official approval from our 30 households to commit to the project. In our neighborhood, this happens through monthly meetings open to all residents, with decisions made by consensus after lots of discussion. Our group was challenged to explain the details of a complex project and answer many probing questions.

By the end, it was clear that some aspects of the project, such as exact design requirements and pricing from the utility for master meter installations, utility tariffs, and extraneous permits, could only be confirmed as the project moved through the process. We were frank with residents about these uncertainties. The project was approved unanimously in April 2011.

Implementation

With approval in hand, the focus switched to Tony Henderson and his crew at Hayes Electric to get things rolling. Tony worked with us to obtain approvals for a zoning variance, building and electrical permits, and our application for PV rebates from NYSERDA (New York’s state agency that manages RE rebates). By the end of June, we were ready to break ground.

The system consists of four subarrays of 56 Trina 230-watt modules. Each subarray is connected to a pair of Sunny Boy SB6000US grid-tied inverters. The array, about 200 feet from the nearest building, required trenching across backyards of the residences for more than 500 feet. We located the inverters at the residence-end of the trenches rather than near the array, sending the higher-voltage DC over the long conductors to reduce voltage drop.

We experienced a few big delays, particularly related to the foundation holes, rocks, and a couple of passing hurricanes, but were still able to meet our end-of-year deadline. The system came online on December 29, 2011.

After Construction

With the array complete and our new metering system in place, we set up the billing system. Previously, our residents all were billed at a residential rate, but by combining meters, our only option was to convert our account to commercial. We negotiated the service rate classification for the new master meters with the utility and we got the state public service commission involved as well. We contended that since the load was still all residential usage that we should be able to retain a residential (nondemand charge) tariff. However, New York’s PSC regulations do not include a multifamiliy residential tariff (nor any time-of-use classes, except for large industrial customers), so we ended up on “SC2,” a basic commercial tariff with demand charges.

This was not a big price difference, but it did require paying an additional monthly fee known as a demand charge, which reflects how *quickly* you draw power from the grid, in addition to *how much* you draw. It's as if you were charged for how hard you stomped on your car's gas pedal in addition to having to pay for the gas you use. In our case, demand charge is measured as the highest-drawing 15-minute period during the billing period on each of the four master meters. For example, in January and February 2012, the highest demand was 61 kW across all four quadrants, and at a fee of $8.13 per kW the total charge was about $495. The overall bill for that period (including demand) was $1,327. Despite that big demand charge, it turned out that because some other charges (such as the delivery fee) are cheaper on the SC2 tariff, it only cost about 4% more. And we could have dropped that even lower had we done a better job managing our demand.

That gave us an economic incentive to minimize avoidable energy use during times of peak simultaneous usage, such as during normal meal times. Our smart-metering system gives residents the tools to examine their use and consider rescheduling things like dishwasher loads to be outside of the peak periods. Residents have been changing their energy habits, and even initiated discussion groups to share energy-saving strategies, such as using pressure cookers and slow cookers to decrease electric stove use.

Calculating monthly bills turned out to be more complex than we originally anticipated. Utility bills contain a bewildering number of separate charges, and we wanted to ensure that costs were being passed on fairly for both light and heavy electricity users. Our solution was to classify each of the various charges on the utility bill into categories of fixed, per-kWh, and demand charges, and apportion them to residents. Once these ratios/percentages were figured, we built a spreadsheet to automatically calculate charges for individual households.

The electricity generated by the PV system is divided evenly among the 30 households, giving each a kWh credit. This provides a target to see how close each household can get to "net zero" electricity usage. For the energy-thriftiest households, that sometimes results in having no monthly charge for electricity.

Lessons Learned

The most important thing we learned from this project is the value of steadiness—to neither rush nor allow ourselves to be deterred. At every point, there were obstacles, surprises, and things we didn't know how to do. Cultivating an attitude of relaxed determination kept us on track, and made the project satisfying.

We also became acutely aware of the ways public policy can impact the development of renewable energy. While our project was helped immensely by the generous incentives from state and federal agencies, we also had a lot of complications that would be unnecessary with some common-sense changes to law and regulatory policy.

For example, our array was actually situated only 50 feet from our site's main utility feed. It would have been convenient and cost-effective to connect the array there, if we could have gotten a fair price for the power produced. Instead, since the only way to get a good price for PV power is to do net metering against a load served by a single utility meter, we had to trench more than 500 feet and rework our entire metering system. That added complexity to our project and up to 30% of its cost. A few simple policy changes could greatly facilitate the expansion of PV deployment (see "Changes to Public PV Policy" sidebar).

Benefits

This project has many benefits for our community. The system has been paying for itself from day one. For the 15-year life of the loan, our neighborhood gets more than 50% of our electricity from a local, carbon-free source at utility rates. After the loan is paid, our utility bills will drop by more than half for the system's lifetime. At no point will we pay extra for having a PV system. In addition, the interest from the loans remains among neighbors, helping community families rather than disappearing into the corporate financial system.

Our residents also have new tools to monitor electricity use, which numerous studies have shown can lead to energy savings approaching 10%. We can also track changes over time, allowing us to evaluate the effects of investments in more-efficient appliances and lighting, or behavioral changes.

There are also less tangible benefits. We learned that everyday people can come together to respond in an active way to the problems of living on a finite planet. We don't have to wait for others to provide solutions.

Now, when the sun shines, we feel something more than its warmth on our faces. We're also aware that it's powering our homes, cooking our food, running our computers, and even spreading over the grid to feed clean energy to others, while putting a little change in our pockets. By tapping the sun's ongoing daily flow, rather than further drawing down nonrenewable stores, it feels like we're on a more robust path than before. And that may be the biggest benefit of all.

Access

Jeff Gilmore is a former computer engineer with a long-time interest in renewable energy and community projects. He currently helps manage a variety of technology projects at Ecovillage at Ithaca, where he lives with his wife and three sons.

Database of State Incentives for Renewables & Efficiency (DSIRE) • dsireusa.org

Ecovillage at Ithaca • ecovillageithaca.org

Hayes Electric • 607-279-6964

PVWatts • nrel.gov/rredc/pvwatts

PV System Components:

EKM Metering • ekmmetering.com • Smart metering

RBI Solar • rbisolar.com • Racking

SMA America • sma-america.com • Inverters

Trina Solar • trinasolar.com • PV modules