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Energy Sma

Efficiency Gains + Solar Electricity

Left: Debra and Doug meet all their electrical energy needs annually with a 1,050-watt PV array.

arts

by Doug Horn

Courtesy Doug Horn

The PV array finds a window of sun through the lush foliage of the Pacific Northwest.

A whole-house efficiency upgrade and a net metering agreement with the local utility allowed homeowners Doug Horn and Debra Galandzy to invest in a solar-electric system that meets all their electricity needs, even in the cloudy Pacific Northwest.

Even though winters in our town of Vancouver, British Columbia, can be wet and dark, that didn't dampen our enthusiasm for solar energy. We had read that there are a number of locations that have solar-electric (photovoltaic; PV) systems producing ample electricity with even less of a solar resource than we have here in BC. With a grid-tied system, our sunny months, from May through September, could compensate for our cloudy ones, lending to good overall annual performance.

But the dream of producing our household electricity with the sun came to a screeching halt when Debra and I found out that the local electrical company did not offer net metering—a program that allows homes or businesses to offset grid electricity use with on-site, RE-generated electricity at the same rate per kilowatt-hour (KWH). We had toyed with the idea of installing an off-grid battery-based system, liberating ourselves completely from the electrical utility, but we knew that batteries would be the weak link in such a system. Most batteries require regular maintenance and all types eventually need replacement. Living in a city that very seldom experiences power outages made a battery-based system seem especially unnecessary. With no financial incentives from the provincial or federal governments, except a sales tax rebate of 6 percent, we needed to minimize system costs as much as possible, and a battery bank would have added significantly to the project's overall expense.

Although not having net metering meant relegating our grid-tied project to the sidelines, our interest continued. At the same time we were making our PV plans, we purchased a 1,300-square-foot cottage originally built in 1911 in Vancouver's North Shore area, and found ourselves expanding the project to include a whole-house efficiency upgrade. We knew that decreasing a home's energy consumption was a smart first step before purchasing a PV system. Reducing your need for electricity translates into a smaller—and less expensive—PV system. In fact, every dollar you invest in efficiency roughly shaves $3 to $5 off system costs.

Courtesy Glyn Evans

Doug enlisted help from the Vancouver Renewable Energy Coop during the design and installation of his PV system.

VREC members Rob (white hat) and Mike (orange shirt) provided design support, labor, and oversight for the project.

Courtesy Darren Anderson (2)

Energy Wise Upgrades

The cottage's location made commuting to work or play energy efficient. It is a convenient walk or bike ride to work and essential stores, and the mountains and hiking or biking trails are accessible by foot or pedal. The home had a south-facing roof that looked like it would be well suited for photovoltaic modules. But we had our work cut out for us. The almost-century-old house came with antiquated appliances—a refrigerator, range, and clothes washer and dryer that were all about twenty years old. And the forced-air, natural gas furnace was even older—circa 1960.

Our daily electrical usage was about 14 KWH per day—already about a quarter of what the average Canadian household consumes, and half that of a typical American household. But our goal was to use less than 10 KWH per day, a load which even a relatively small PV system could mostly offset.

Energy efficiency upgrades, like this new washer and dryer set, help whittle down household energy use.

Courtesy Doug Horn

During the first year, we replaced all the old, inefficient appliances with new, efficient ones. The simple act of replacing the 15-year-old refrigerator dropped our electricity consumption an average of 3 KWH per day. We bought a new water heater, and gas range and oven, purchased a new clothes dryer, and got a horizontal-axis washing machine that uses less energy and less water. The final big appliance upgrade was replacing the old natural gas furnace with

Household Energy Consumption

Energy Source	KWH Per Day (Equivalent) Before Upgrades	After Upgrades	Reduction (%)
Electricity	13.7	3.0	78%
Natural gas	63.9	41.7	35%
Totals	77.6	44.7	42%

a 98 percent efficient model. A programmable thermostat for the furnace helps keep home heating bills in check by automatically resetting the temperature setpoints according to planned occupancy times.

We also replaced energy-wasting incandescent lightbulbs with compact fluorescent bulbs, and put the stereo and computer on plug strips to eliminate any phantom loads when they were turned "off." For the washer and dryer, which had digital displays that were phantom loads, we needed to find a slightly better way to shut off the electricity to them after their cycles were finished. We found that the washing and drying times never went beyond an hour, so I installed a 60-minute timer switch. Before using the washer or dryer, we simply give the timer a turn.

Although the efficiency upgrades had a big impact on our energy use, combining them with conservation practices—using a clothesline to dry clothes whenever possible, shutting off lights when we leave a room—improved the savings too. The result? We reduced our average electrical usage by 78 percent—to about 3 KWH per day—and cut our natural gas consumption by one-third. At present electricity and natural gas prices, the energy savings translates into an annual dollar savings of more than Cdn$750, and about 11 years to recoup our investments in appliance upgrades. Of course, as electricity and natural gas rates continue to climb, the savings will grow and the payback time will shrink.

Sizing Up the System

While the efficiency project was in full swing, we kept an eye on the electric utility company, BC Hydro, to see what was

Tech Specs

Overview

System type: Batteryless, grid-tie solar-electric

Location: North Vancouver, BC, Canada

Solar resource: 3.7 average daily peak sun-hours

Production: 88 AC KWH per month average

Utility electricity offset (annually): 100 percent

Photovoltaics

Modules: 6, Sharp NT-175U1, 175 W STC, 35.4 Vmp

Array: One 6-module series string, 1,050 W STC total, 212.4 Vmp

Array AC disconnect: Hubbell, HBL13R90, 30 A breaker

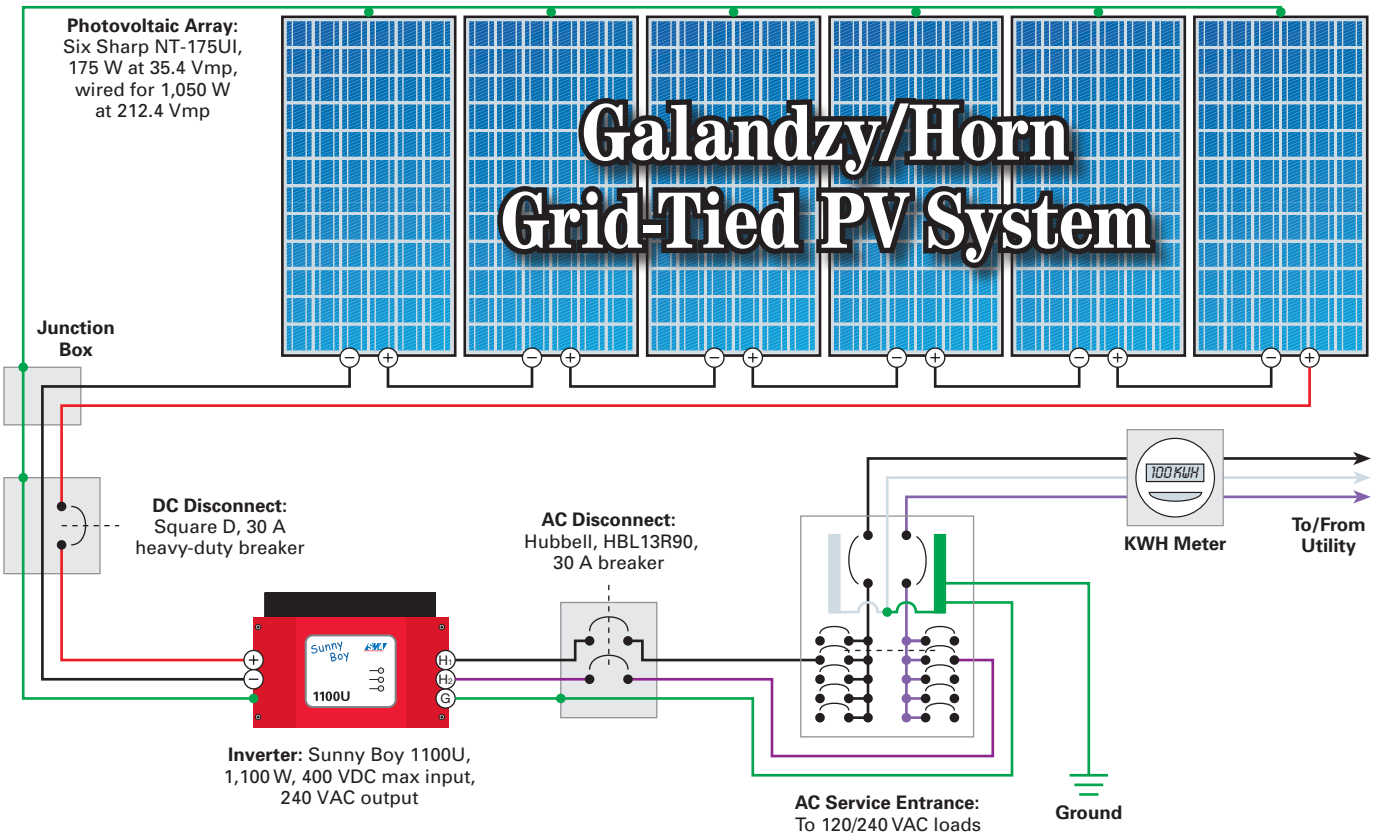
Array DC disconnect: Square D, 30 A, heavy-duty switch/breaker

Array installation: Custom aluminum rack with 6-inch standoffs; installed on south-facing roof, 30-degree tilt

Balance of System

Inverter: Sunny Boy 1100U, 400 VDC maximum input, 145–400 VDC peak power tracking range, 240 VAC output

System performance metering: Sunny Boy LCD display



Courtesy Rob Baxter

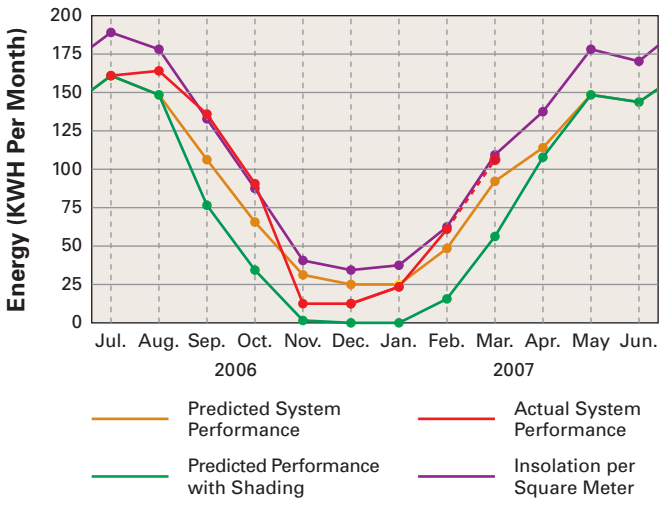
VREC member and certified electrician Darren Anderson works with Doug to finalize the grid-tie inverter wiring.

happening with net metering. Much to our astonishment, a proposal had been presented—and approved—by the utilities commission. In a hurry, that put our PV plans back on track.

Our initial system-sizing goal was to meet 100 percent of our electricity needs. I didn't think this was possible until I started researching the physical size of the system and its cost. The criteria was what we could afford and the available south-facing roof space on the house.

We'd been saving for this project for almost three years, and had initially set aside Cdn$10,000 for the project. Even when the total costs came in at about Cdn$15,000, we decided it was still something we wanted to do. I was pleasantly surprised to find that we could afford a 1 KW system that theoretically could produce all the electricity we would typically consume in a year, with the 3.7 average daily peak sun-hours we get here in Vancouver.

PV System Performance



I designed the system based on information from *Home Power* articles, selected components available from a local PV dealer, and then contacted the utility to sign the interconnection agreement. They were surprised at what we wanted to do—no other private residence had applied for their net billing program, and inexpensive utility electricity (Cdn$0.06 per KWH) made for a lengthy "payback" on a PV investment. They were only expecting small microhydro-electricity systems to become IPPs (independent power producers). But after reviewing the system schematic, they gave me the go-ahead.

Although I felt confident that I could accomplish the installation myself, I decided to enlist the services of the Vancouver Renewable Energy Coop (VERC), a local nonprofit organization that helps install affordable renewable energy systems. They provide solar shading assessments to determine any potential shortcomings at the site, and arrange the ordering and shipping of the system components. VERC also provides a certified electrician who completes all the electrical work on their projects, helping smooth the way for an electrical inspector's approval.

Overcoming Obstacles

The existing shingles on the roof were quite old, so I reshingled the roof in preparation for the PV mounts. Although the house is old and prior renovations seemed like they were done without much forethought, I breathed a sigh of relief when the roof framing appeared to be solid, reasonably straight, and had a predictable 24-inches-on-center layout.

The wiring in the house had been touched by many hands and needed to be replaced. I pulled new wire for most of the electrical runs, and upgraded and installed a few more circuits. The old breaker panel had only 16 circuits and a separate 60-amp breaker box, so the electrician and I replaced it with a larger, 24-circuit box. He felt the inspector would not approve of maxing out the small existing panel and that it would make the PV system's AC connections very difficult.

On a sunny summer day, three VREC staff members and a handful of volunteers showed up to assist with the installation. A few hands made fast work of installing the roof mounts. Robert Baxter and Chris Bouris from VREC, along with one of the volunteers, unpacked the PV modules. While the PV modules were being installed, VERC staff electrician Darren Anderson and I replaced the old main breaker panel.

The installation was completed in about two days. Once all the electrical connections were tested, the system was brought online on a beautiful sunny afternoon. When the inverter kicked on, the analog utility meter ground to a halt and then started turning backwards at a fairly fast pace. The electrical inspector came a few days later to inspect the installation with the VERC electrician, and the system passed with flying colors.

Satisfying Savings

The PV system, installed in June 2006, has worked without a hitch. I have been keeping track of its electrical production and our consumption, and estimates to date indicate that we should be able to achieve the goal of our home being

System Costs

Item	Equiv. Cost (US$)*	Cost (Cdn$)
6 Sharp NT-175U1 PV modules, 175 W	$7,030	$8,100
Sunny Boy 1100U inverter	2,118	2,440
Labor	868	1,000
Goods & services tax	792	912
Provincial sales tax	792	912
Electrical hardware	781	900
Permits & licensing	641	739
Custom PV roof mounts & hardware	590	680
Shipping	226	260
Total	$13,838	$15,943
Less Sales Tax Rebate	-792	-$912
Grand Total	$13,046	$15,031

*Based on a conversion rate of US$0.87 = Cdn$1

a net-zero electrical user. With its annual net metering program, the utility will credit us for excess energy the system feeds into the grid—at the same price per KWH that we pay for utility electricity. We still pay a small monthly fee—Cdn$6—just to be connected to the grid, but are billed biannually.

For us, the PV system was icing on the cake. At present prices for electricity, we couldn't justify the system solely on its economic payback, but it offers some indirect benefits. Besides insulating us from future electricity rate hikes, preparing for the system with efficiency projects reduced our energy consumption, whittling down our utility bills. Second, by using solar energy for our electricity, we're decreasing our ecological footprint and greenhouse gas emissions. We also wanted to show people in our community that using solar energy is feasible, even in our notoriously rainy climate.

But perhaps most importantly, we wanted to point out that you don't have to generate electricity by "alternative" means to have a positive environmental impact—you can do a world of good just by reducing your needs.

Access

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Vancouver Renewable Energy Coop • 778-869-8333 • www.vanrenewable.org

System Components:

Sharp Electronics Corp. • 800-765-2706 or 714-903-4600 • www.solar.sharpusa.com • PV modules

SMA America Inc. • 530-273-4895 • www.sma-america.com • Inverter