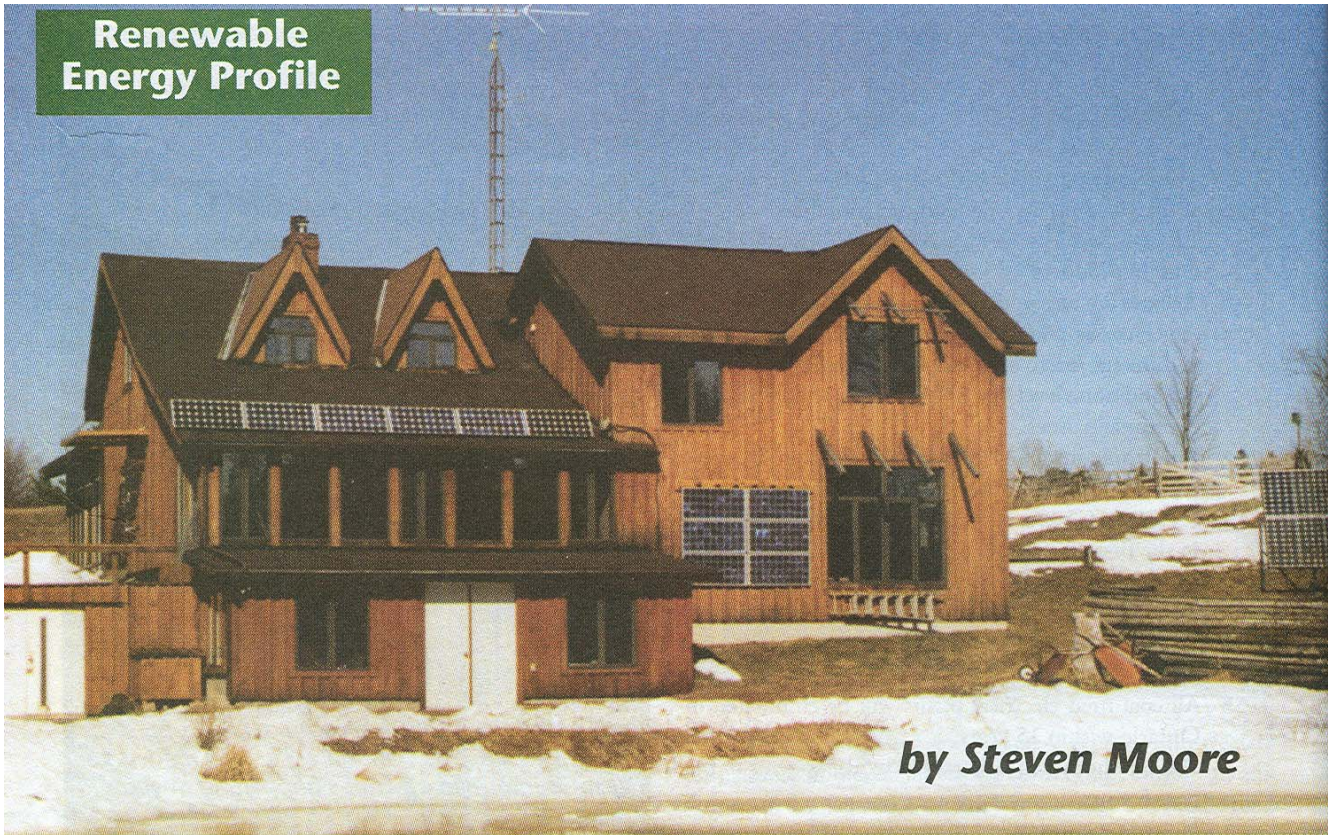


Renewable Energy Profile



by Steven Moore

Our house showing, left to right, the partially underground generator house, rooftop solar array, house solar array and adjustable rack solar array.

Private Power in the Country – A Chronology 7 Years Off-The-Grid

We knew we wanted to live in a solar-powered house in the country. Books like *Limits to Growth* and *Beyond the Limits* by Meadows had alerted us to the advantages of producing our own food and power rather than relying on others for the basics of life.

In the suburbs, we lived in a five-bedroom house on half an acre in a quiet neighborhood. We grew most of our own food, built a small barn, cared for seventeen fruit trees and harvested our own grapes, blueberries, and strawberries. But we hated the traffic and the lawn pesticide signs and road salt and air pollution, plus our children were nearly teenagers. If we didn't move soon, we might never get out.

We looked for three years for land somewhere between Belleville, Bancroft, Ottawa, and Kingston and, after visiting several properties in that large area, thought we found one just north of Tamworth. It was an undeveloped 150 acres including a 30-acre lake.

We drove out to look at it, and I was excited. Blacktopped road, big lake, house and garage, fish camp by a sandy beach. We took pictures and scouted around for a flat building site. But it required permission from the County (road setbacks), the Township (building permit), Environment Canada, the local Conservation Authority, The Ministry of Natural Resources, the Health Department, and several other agencies we probably didn't even know about.

The road and lake setbacks squeezed us into one building area within 75 feet of the road. We ran levels, and staked out a possible site. I kept plunging ahead and my wife, Susan, was carried along with my enthusiasm.

Before we could build, the Township required us to either demolish the existing house (that could have fallen down by itself in the first stiff wind) or sever

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the property (only one house allowed per lot). They didn't care that the lot was 150 acres. The Conservation authority required a 100-foot setback from the lake, although it would have to rise 30 feet and flood most of Southern Ontario before it got our footings wet.

The phone company was eager to charge us \$40,000 to run in lines so they could start sending us a monthly bill. I asked at the post office for names of other people living on up the road, and we wrote to them care of General Delivery to see if anyone wanted to share the cost of a line.

After all that, our offer for the property was not accepted by the owners. But then we received a reply to one of our letters sent up the road.

May, 1996

"Dear Mr. and Mrs. Moore,

"...While I would definitely have been interested in obtaining cheaper phone service, my future plans are now uncertain. We have put our property up for sale this spring, so committing myself to this is not practical for me now."

Another property for sale? We wrote back and asked for details.

June, 1996

"Dear Mr. and Mrs. Moore,

"Our property is still for sale. It is approximately 80 acres with about 15 acres cleared and the balance bush & beaver ponds. The house is situated on a man-made pond and household water comes from a never-failing spring (via a piston pump). We do not have hydro service but produce our own with solar modules charging industrial-type NiCad batteries and a 6.5 KW propane powered demand-start generator for backup power. A small inverter produces 120VAC from the 12VDC batteries and the house is wired for both voltages.

There is a good small barn (24 X 36) with 2 smaller log barns. In addition, there is a small T hanger for an ultralight airplane beside an 800 ft. runway.

I would be happy to show you around or answer any further questions you may have."

Bingo. Susan and I agreed to look at it the next weekend. When we first arrived, we parked in the long circular driveway at the top of the hill next to the house. An overgrown backhouse was on our left. On our right, we tried to look past the 10-foot sumac thicket, then a bed of exposed rock, then two huge popular trees to the small-looking house, part log cabin and part wood frame sided with rough-sawn boards and battens.

Inside we found 2-foot thick exposed logs on the walls and ceiling, topped by the wood of the floors above. A large pine harvest table sat in the eating area next to the stairs. Wooden floors throughout and 40 NiCad batteries in the basement. Susan and I loved it but tried not to seem too interested. We asked a million questions. The kids were wonderful, spending most of the time sitting on alcove cushions while Susan and I talked to the owner. In the workshop we went through some of the intricacies of the batteries, inverter, and generator.

Hours later we left. The field across the road was covered in fireflies - darting and glowing as if a sky full of shooting stars had come down to earth.

After researching the timber and mineral rights, we made an offer conditional on soil and water tests that showed the property was free of any toxic chemicals. The offer was accepted, the tests all came back to our satisfaction, and we bought our farm.

Since we've been here, we've replaced every major system: fences, septic tank and drain field, well, well pump, furnace, batteries, solar modules, inverter, windows, generator, telephone, fridge and washing machine, but our current solar power system should be sufficient for years to come.

November 1996

Of course, the house needed modifications to graduate from supporting one person to containing our family of two adults and two almost teenagers. And, of course, renovations took twice as long and cost twice as much as we planned. After several weekends driving four hours each way to supervise the work and write cheques, we moved in with eight inches of snow on the ground and a six-foot hole in the south wall covered by plastic. November. The start of the worst three months of the year for solar power. We ordered a radio telephone after seeing one in operation on the other side of Tamworth and a truckload of logs we could cut up for firewood.

We all slept in one room for the first two months. The four 75-watt solar modules and 600-watt inverter proved to be woefully inadequate. We spent all the equity from selling our suburban house, our computer would only work when the generator was on, and our high-tech radio phone system hardly ever worked. Welcome to the country.

Despite running all day to support the renovator's power tools, the battery charger in the inverter never pumped up the batteries enough to take us through the night. We shared bathwater, went to bed by lantern light, then were up again at 3:00 am to stoke the basement wood furnace again.

That first Christmas, we froze around the tree huddled in blankets under dim lights unable to call anyone and told each other what fun we were having.

January, 1997

The main bedroom was finally finished. Charlotte raised her hands in the air and cried, "Hooray, my parents are moving out of my room."

A few days later, the wood furnace couldn't keep the house warm, neither the radio telephone nor the computer would work, the generator had just shredded its fan belt, bills were still piling up and I had a cold. I said to Susan, "Maybe it was a mistake moving out here."

Susan replied, "Maybe it was. No one should have to deal with so much."

My dream was in ruins. The scariest part was that Susan thought so, too. We had to do something. That evening, we both took deep breaths and talked about the day. That helped. The kids and I read stories to each other in bed while I struggled with my cold. That helped. We planned how to rescue our dream. That helped a lot.

We started by upgrading the inverter/charger to a 2500-watt model with a charger that filled the batteries to capacity. Now, 25-amp service may not seem like a lot, but it was more than a four-fold improvement over what we had. Actually, conservation and common sense can go a long way toward reducing power needs. So can energy-efficient compact fluorescents and no power hogs such as air-conditioning.

Now we could run the washer, table saw, toaster, or various other power-gulpers without turning on the generator. The new inverter was pure sine wave, which meant no hum on radios and smoother computer compatibility. It had an LCD readout for measuring all states of the power system, seventeen menus (one just for error messages) and a 141-page owner's manual.

Next was more solar production. We added two more 75-watt solar modules to our array and suddenly increased our power production by 50% to 450 watts peak power on the days we had full sun. That made life a lot easier, too. We saved our lanterns for the barn and gleefully snapped on a light when going upstairs. We added a second, larger water tank to cut down on how often the water pump ran.

March, 1997

Four months now without central heating, traffic jams, or pollution.

What we had were skies full of stars, helpful neighbours, home-made haircuts, and sunrise through our bedroom window. After some pretty low times and frustrations over construction, computers, telephones, and electricity (accompanied with occasional second thoughts about the move here), we concluded that the move was a good idea.

We frost-seeded pastures and began to think about fences and how to divide the land into paddocks for the sheep. We built a pig yard so our future porkers could run in about 5,000 square feet (as much as pigs run). I snorted and whuffed myself about high feeding areas, low latrine areas, and providing water from roof run-off, but Susan didn't pay me a lot of attention unless I started to squeal.

We bought a battered '81 pick-up with a brand-new Lincoln V-8 engine from our neighbor and I asked him about welding me up a frame with wheels I could use for a chicken coop and move from paddock to paddock behind the sheep.

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He said, “I can do better than that. I’ve got an old van out in back I was going to cut the engine out of and make into a chicken coop, why don’t you take it?”

It was perfect. Off the ground, critter tight, with lots of doors and windows.

Of course, our temptation was to try to do everything all at once. Animals, garden, orchard, building, repairing, maintaining, hunting, and fishing competed for hours and days. We had to remind ourselves that this was a long process, with no finish line, and that the pleasure was supposed to come with the doing, not the done. Still, I had a three-page single-spaced list of projects and found myself judging the value of the day by the amount completed.

July, 1997

The birds were chirping, the flies were biting--It felt like home.

Our third round of construction was finished and, although we were on the ropes for a minute there, we survived intact.

The carpenters came back for two weeks and the whole house was sided in inch-thick, 10-inch wide rough-planed white pine board and batten. “The Shrine to Pine”, one of the carpenters called it. 2,200 board feet of it. The sawdust from ripping the battens and cutting the boards to length could have filled five bathtubs. Probably another 50 board feet right there. The cut ends supplie us with kindling for five years.

That week we broke our record — 12 vehicles in the yard. Four were ours: the pick-up, two Toyotas, and the chicken van. Also the pickup and the cube van of the builders putting up our garage; the pick-up of the man installing the garage doors; the van of the plumber replacing the well pump and installing the new propane boiler for our hot water heating system; and a backhoe, bulldozer, dump truck, and trailer to re-grade the land around the garage and upgrade the driveway. Too bad we didn’t have some of those coloured, plastic pennants to string around--maybe we could have made a sale or two.

We now had hot water running through radiators in most of the house and a wood-burning cookstove in the kitchen – enough to make the house cozy in the coldest weather and eliminate early morning trips to feed the basement wood furnace. Our new well pump was a soft-start model, which meant there was no beginning power surge to get it started — much easier on our inverter and our batteries.

There was less progress on the phone system. We finally filed a lawsuit for breach of contract against the radio phone manufacturer, distributor, and local installer. We originally ordered a new two-line system but it never worked properly and, after six months of tuning and tinkering, we ended up with a used, one-line system that mostly worked and they wanted to charge us the same price.

January, 1998

We survived the ice storm. Trees and power lines down everywhere and the military was called in but our private power didn’t skip a beat. Our radio phone was out for two days because the ice was so thick on the antennas that it prevented any transmissions. And the kids were delighted to have four days off school .

I worked happily in my office for my corporate clients. As I looked out the window, it was bright sunshine and we were making power. What weather. It sure was nice to be snuggled up with our cookstove and solar modules. At least we never had to worry about running out of power or heat.

The grid was fragile. There were people in Eastern Ontario who didn’t have power for weeks in the midst of the following cold snap. Livestock fell and froze in the feedlots without food or water, it was really something. I guess we all remember the ice storm of ‘98.

June 1998

Time flies like an arrow and, as Groucho Marx would say, “Fruit flies like a banana.”

Our second spring arrived with the redwing blackbirds and blew in a fresh breeze of plans and projects revolving around livestock.

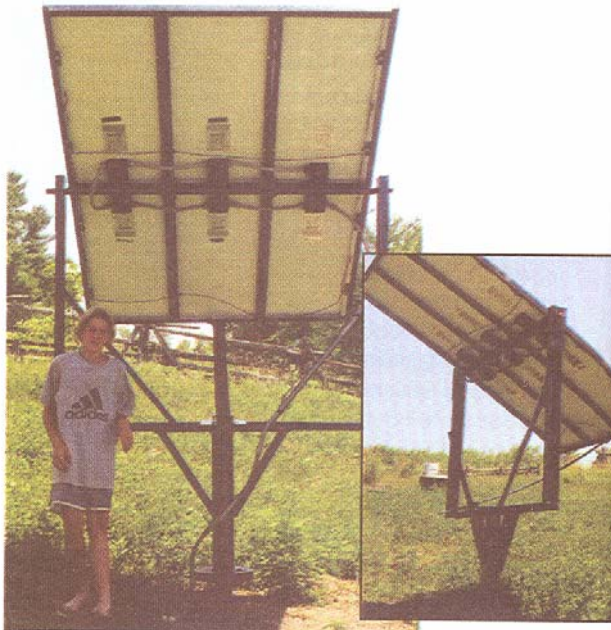
We cleaned under the electric fence of the pig yard, a job that got easier every year as we gradually gained mastery over the weeds and brush. We bought eight purebred Yorkshires and they ate like pigs. They enjoyed the sun the first two days and got sunburned so Susan penned them up during the brightest part of the day. We were thinking of bathing them in olive oil to get a head start on the marinating. Then we installed a 270-gallon water tank in the second story of the barn and pumped it full from the pond with a gasoline pump so we wouldn’t have to carry water to them so often.

Our 20 laying hens (Barred Plymouth Rock), our 50 meat birds (White Rock) and our Scottish Blackface

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sheep arrived. The sheep's owner ran a small magazine and I wrote an article for her on mad cow disease in exchange for the sheep. However, sheep meant that we had to build over a thousand feet of split-rail fence. We started looking for rails.

We set up an anemometer to check the feasibility of a wind turbine, but calculated that solar modules would produce as much power at a lower cost. More modules it is! My neighbor and I welded together a rack to hold six more. It swiveled 360° and tilted so that the modules would always directly face the sun. The kids and I dug a hole six feet square and five feet deep, then we set the base of the rack in the hole and covered it with rocks and 50 bags of mixed cement. Once the modules were bolted to the rack and wired together, we doubled our power production again, now up to 900 watts peak power.



A younger Conor Moore leans against the solar tracker Steven fabricated with the help of his neighbour Jeff.

The neighbor (who sold me the truck), his stepson, and a friend and I all went to Ottawa to pick up 5,000 pounds of NiCad batteries for our system. A fellow there was upgrading his batteries and offered to give me his old ones if I would haul them out of his basement. They were four to a crate, and each crate weighed 175 pounds. What a slug. I gave my friend 20 for helping and we now had 100 more batteries for the cost of the rental truck.

We spent the next day hooking those batteries up to the ones we already had, plus we installed 20 of them in the barn so we would have lights, power for the pig

fence, and the block heater on the tractor. We built cabinets fronted with old windows for the new bank.

Then we cut a hole in the side of the house and built an insulated cabinet vented to the outside for our new electric fridge that had been sitting on the porch in its box for the last month. We could finally get rid of our old propane fridge and have ice cubes, ice cream, and a freezer door that opened without falling off. An electric fridge may seem like a trivial luxury, but it typically uses half the power in a house. It was a great improvement that we couldn't hope to have without the additional modules and batteries.

December 1998

After a full day discussion in fancy Ottawa law offices about our telephone woes with all the parties, we arrived at a mediated settlement that was agreeable. Finally we could close that chapter.

September 2000

The three-cylinder, water-cooled generator was 25 years old and tired. It sat in a cement block enclosure in front of the house and during the cold days of last winter, the only way I could warm it up was by moving the governor rod gently back and forth by hand while coaxing it, then yelling at it, to keep going.

We had already dragged it out of its house and into the pick-up with a come-along then hauled it to Kingston for an overhaul last fall. We replaced the battery with a 20-kilo industrial monster. Now it needed new points. I called the manufacturer and was told they would be \$350.

"No," I said, "I don't need new pistons, rings, and bearings. All I need is points."

"That's right," said the parts supervisor cheerfully, "New Points. \$350."

I wasn't nearly as cheerful as he was. It was a good brand, the best. That meant they could charge whatever they wanted for parts. It also meant a week's worth of phoning around for less expensive points that would fit. No luck. I did find someone in Toronto who built generators, though. After several conversations, we ordered a custom-built one-cylinder propane/gasoline 5.5 kw generator from him.

In the meantime, we set about building a properly-heated generator house into the side of a steep hill

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next to our main house. We dug into the hill and smoothed out a nine by nine footprint, then poured a cement floor and a two-foot high cement pad that had hot water pipes from the house running through it. We sided it with pine boards and battens to match the “The Shrine to Pine”. With insulated walls and roof, the new generator sat snugly underground on its heated pad, enjoying its new home that never got below 15° C, no matter how cold it was outside.

March 2001

Ever since we moved in, solar friends and colleagues had urged us to buy an amp-hour meter to measure the state of charge of our batteries, like the fuel gauge on your car. I always resisted, preferring to judge the batteries by their voltage and saving the cost of the meter, but that was inaccurate because of the many variables that affect voltage. Plus, we were tired of running down to the basement and looking at the inverter readout every time we wanted information about the state of our power system.

The meter has several names, depending on who manufactures it, but it provides digital readouts of battery voltage, instantaneous amperage gain or draw, amp-hours left in the batteries, and hours the batteries will last at the average usage over the last 30 minutes.

It was very convenient to push four buttons in the kitchen and accurately read the state of our system. It was also much easier to yell at the kids, “Come here, look at how much power you’re using.”

By this time, our batteries were growing weaker. Some bad cells were drawing the others down, so we jumped out the worst in each string to bring our system down to 10.8V. It didn’t seem to affect the operation, but the batteries held their charge longer without having to compensate for the bad apples in the strings.

September 2001

This fall, I read an article on the Mr. Solar website (www.mrsolar.com) about a nifty box called a Maximum Power Point Tracking (MPPT) Photovoltaic Charge Controller that claimed to increase the power from our solar array by 30% (www.rvpowerproducts.com).

When solar modules charge a battery, they typically charge at the existing battery voltage, say 12V. But solar modules can produce 17V, and that means you aren’t using the module to its full capacity. The Solar Boost draws current from the module at 17V, then

feeds it to the battery at just above the existing battery voltage. Going from 17V on the input side to 12V on the output side increases the current that charges the batteries if the watts remain the same.

I called a few people and they said the technology was sound, so I ordered one and had it installed. It worked beautifully. It did increase the power production from our 12 modules by 30% — for the cost of one module. It also acted as a charge controller, and was an outstanding addition to our system.

Dec 2002

Despite all our improvements, we still weren’t getting the performance out of our system that I thought we could. The NiCads were tough, but they were 40 years old and even jumping out the weak one in each string didn’t improve them as much as I had hoped. Plus, 100 batteries took up a lot of room and I was getting tired of recording the voltage on each one every month or so and adding water every three months. So, an unexpected, very lucrative writing contract started me thinking about batteries.

After much research we decided on Surrette lead-acid batteries; a Canadian company with a good track record (www.surrette.com). They had several different models, but the distributor I called recommended one that was not on their website: 2V, 2770 amp-hours. That sounded pretty good to me since we were operating on about 400 amp hours at the time.

They were 31 inches high with an eight inch-square footprint. That would require some modification of our battery cabinets, but they would take up one-fifth the room of our NiCads. Six batteries to replace 100. Sold.

We installed them with Hydrocaps that capture the hydrogen normally given off during charging and return it to the battery, cutting down greatly on the need for adding additional water. Six times the capacity, a 10-year guarantee, less maintenance, and less space. Ain’t technology grand?

I was a bit sad to leave the land of NiCads for lead-acids — it was the same feeling as replacing the kid’s aging Macintosh with a DOS machine, but I saved the best 20 NiCads for the barn, just like I refuse to give up my own Mac.

March 2003

A hard winter was broken with some good news. Queen’s University had purchased too many 75-



The basement power centre, left to right, AC breaker panel, DC breaker panel, inverter and solar array disconnects. Above, the Solar Boost charge controller.

watt solar modules and were selling them for half price. We couldn't turn it down.

We bought and installed six more modules, bringing us up to three arrays of six modules each, 18 in total, theoretically providing 1350 watts of peak power every sunny hour. The actual production is more like 1000 w, but this should be more than enough in the summer and not quite enough in the winter, close enough for us.

Since we've been here, we've replaced every major system: fences, septic tank and drain field, well, well pump, furnace, batteries, solar modules, inverter, windows, generator, telephone, fridge and washing machine, but our current solar power system should be sufficient for years to come.

It's been a long slug with a steep learning curve and some mistakes along the way but it's worth it. We have power without monthly bills and don't contribute to the pollution caused by huge grid generating plants.

We started with:

Solar modules: $4 \times 75\text{w} = 300\text{ w}$

Batteries: 225 Ah NiCad

Inverter: 600 w

3-cylinder, 6.5 Kw water-cooled propane generator

Now we have:

Solar modules: $18 \times 75\text{w} = 1350\text{ w}$

Batteries: 2770 Ah lead-acid

Inverter: 2500 w S/W

1-cylinder, 5.5 kw propane-gasoline generator

Heated, underground generator house

Amp-hour Meter

MPPT charge controller

We use about four or five thousand watts a day, while the average Ontario house uses 20 thousand, and we do it all on solar without feeling the least bit deprived. Visitors never guess we produce all our own power unless they happen to see the modules on the roof and in the back yard. You probably want to do it differently but, if we did it, so can you.

When we moved to the country we didn't know the difference between AC current and DC current, but we gradually learned enough to get by. Just remember, you don't have to do it all at once, all you have to do is start. Let me tell you, it's worth it.