Net Zero and Me*

*Or How I learned to Stop Worrying and Love the Grid.

Background

My journey to energy self-sufficiency began where many such journeys begin . . . in college. It was the 1970s and Jimmy Carter and Jerry Brown were the reigning gurus of the day – Carter put a solar hot water system on the White House and Brown was busy here in California talking about environmental causes and energy conservation and that was considered wacky by the rest of the country. He chose to live in a regular apartment instead of the Governor's mansion because it saved energy. His ideas eventually were proven valid, but at the time he was called Governor Moonbeam.

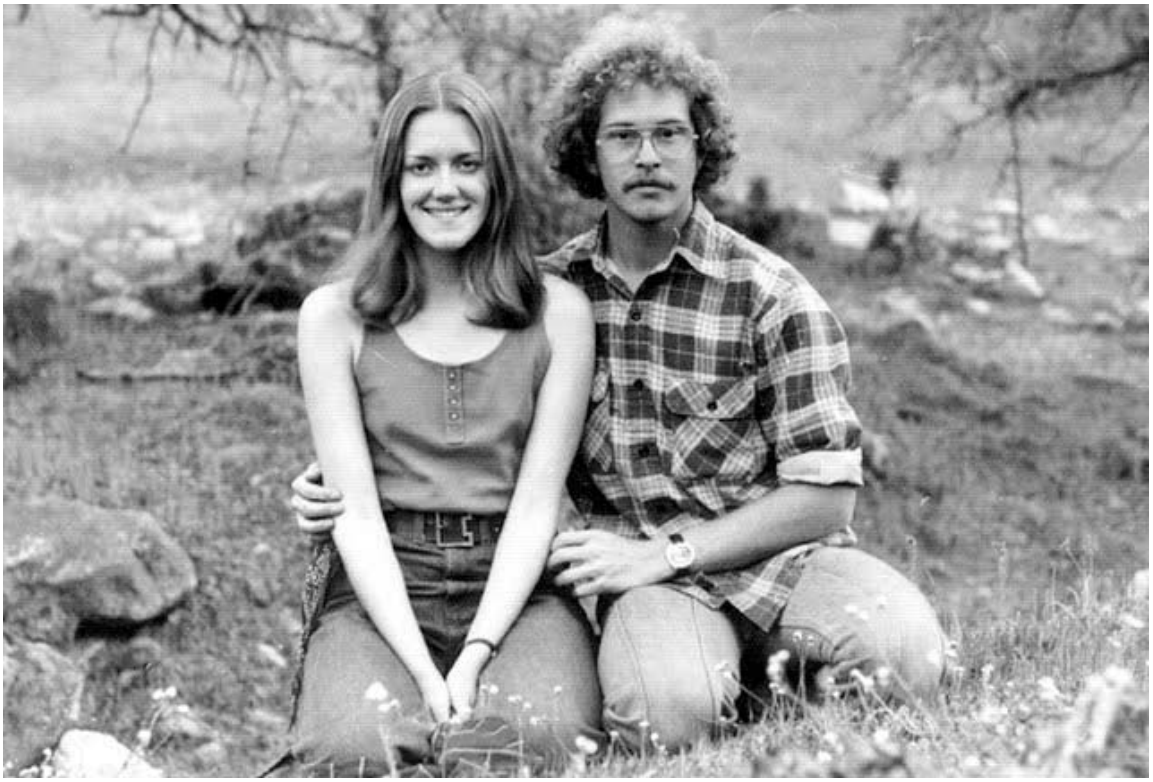
My first exposure to these ecological ways of thinking was as a first-time freshman in a groundbreaking CSU college class called “Man and the Natural Environment” (MNE).

Exploring the natural environment in Owens Valley in 1975

It was an 18 unit inter-disciplinary, team-taught course that brought together Anthropology, Geology and Biology. It blended classroom instruction and field experience in mountain, desert and coastal environments with emphasis on how the environment affects us humans and how we have drastically altered the planet.

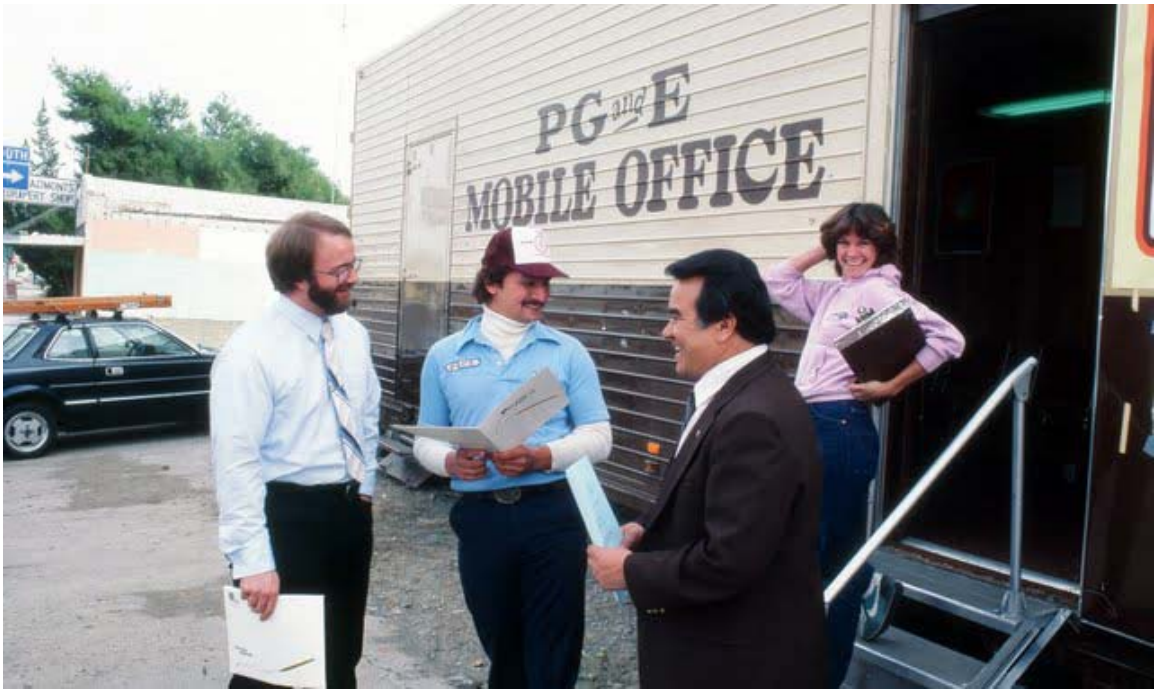
This approach caused a transformation of consciousness for me. Before MNE, I thought about becoming a civil engineer; now I felt that I should be working towards tearing

down dams, rather than building up new ones. I soon found myself working for a solar water heating company, and then was interviewing with our local utility, Pacific Gas and Electric, to investigate energy conservation-related jobs. I was hired in 1979 by PG&E to work in their new Energy Conservation Department.



Virginia and Bob Riding. Hey, it was the '70s.

My new job was doing residential energy audits, which detailed a comprehensive (for then) analysis of conservation and energy efficiency measures and provided the homeowner with a menu of investment-grade options that would save energy, money and increase their comfort. We also offered to finance installation of attic insulation at zero interest!



PG&E reps delivering energy efficiency to homeowners after the 1984 Coalinga quake

In my 30+ year career at PG&E, I have been fortunate to be able to explore a variety of jobs, including commercial, industrial and agricultural energy efficiency, electric and natural gas vehicle advocacy, electrical grid demand reduction programs and in my current position as Community Energy Manager. I try to help them understand the relationship between GHGs and their activities.

A New Path

It was 1980 and I had just graduated from college, gotten married and been hired by PG&E. My wife Virginia and I soon bought a 1,000 sq ft, 1950's tract house in Fresno, which was about as energy inefficient as it was possible to be – basically it was a stuccoed barn – no insulation, single pane windows, wall heaters and no air conditioning, (just a swamp cooler).

Not exactly a model of energy efficiency, 1980.

I thought that this would be the perfect platform for me to put into practice all the latest techniques that I had been urging my customers to do, since we were planning on doing improvements to the home anyway. Thus began my quest to practice what I preach. . .

By the time we sold the property five years later (at a loss, I might add – this was before the days of rampant house-flipping and crazy property value escalation), we had insulated the attic and walls, added a central heat pump, insulated the water heater, added an approved woodstove, and installed a rooftop breadbox solar water heater. I was working in the Solar Water Heater Incentive Program at the time and was able to get a $1,200 rebate from PG&E.

Andy Riding: a chip off the old batt.

Larger, But More Energy Efficient?

By 1985 our family had grown to four with the addition of two little boys, and we felt we needed more space. We ended up moving into a 1,600 sq ft home in a new subdivision nearby. The place was much more energy efficient right from the start - Title 24 State standards required R11 walls, R19 attic insulation, a 4 foot fluorescent kitchen fixture, and a dual pack on the roof with an EER (Energy Efficiency Ratio) of about 6, which we thought was pretty swell. I installed ceiling fans in most rooms and a whole house fan, which allowed us to cool the house down with cooler night air and reduce A/C use during the day.

New and improved, 1985

Life was good in the burbs, but we had always thought that we might like to be back-to-the-landers and attempt a more self-sufficient and rural lifestyle. My wife wanted to raise chickens and I wanted to build a self sufficient homestead in the country.

Not Quite Self-Sufficient But the Eggs Were Good

We began actively looking for property and in June 1991 found a 5 acre parcel that we could afford about 8 miles east of town that included an existing well, septic system and a 600 sq ft 1960's era mobile home, that was "move-in ready".

How small was it? It was sooo small that you had to go outside to change your mind.

Once we were settled in with the boys and the 2 terriers, we hatched out some chickens and then assessed our energy options. The trailer (it almost qualified as a mobile home) was even worse energy-wise than our first house, in that there was no gas heating - there was an old leaky Franklin wood stove that stayed hot for about as much time as it took you to bring in the next load of wood, and a swamp cooler that didn't work. We decided to not spend money fixing the trailer, but rather to concentrate on planning and designing the new house.

It was 1991 - credit was tight and despite our frugality of lifestyle, extremely good credit scores and winning personalities, we were turned down numerous times by banks and credit unions. The reason typically given was that there were no comps (comparable properties) that "far out" in the country, so we hunkered down and waited and planned for the new place. The chickens, dogs and kids seemed to enjoy the "camping out", trailer living, and Virginia was happy that it only took about 4 minutes to clean the place.

The Final Stop (But So Far To Go)

We agreed that we wanted a home that looked like a 19th century 2-story farmhouse, yet contained the most energy efficient features that we could incorporate. We soon found a builder that was willing to work with us and my friend and colleague, Jeff Adolph, who offered to do the Title 24 calcs for us. Three months of communal trailer living turned into ten. We were finally able to secure a mortgage and start construction in January 1992.

Our strategy was to make the house as energy efficient as possible, which would (we hoped) minimize the use of mechanical systems and take advantage of the site's natural attributes (which, in the central valley of California is basically flat, hot and smoggy).

The first step was to plan the house so that natural ventilation was enhanced. We designed each room to have at least two windows, and oriented the house to take advantage of the site's prevailing winds, which turned out to be 45 degrees off due north. We maximized the insulation in the building envelope by increasing the wall thickness to 6", which allowed an R19 to be added. We installed an R38 to the attic, and wrapped the walls with Tyvek to help eliminate infiltration. We went with vinyl siding which included an additional R2 foam board on top of the building wrap.

Title 24 required dual-glazed windows but high-performance, spectrally selective, low-e, or argon-filled windows were just becoming common, (and were beyond our budget,) so we opted for standard vinyl windows that we could add solar screens to in the summer, (which cut summer heat gain by two-thirds).

No air leaks, vinyl windows, vinyl siding, and fiberglass doors: Virginia named it the "Tupperware House", because it was so tight she said you had to burp it. 1992

We used compact fluorescent recessed cans, which were difficult to find in 1992.
We installed a powered attic fan to help reduce attic heat buildup. The water heater chosen was 20% more efficient than code. We received a new construction incentive from PG&E that required that you plant a shade tree to the west (which we did – a Raywood Ash). We installed 2 split systems – condensing furnaces of 92% efficiency and 11 SEER air conditioners (quite a jump in EER from our prior house). We also installed a single stage evaporative cooler on the roof that was ducted to both floors. The result was a house that was 40% more efficient than Title 24 standards.

“High” efficiency in 1992 – 11 SEER

The in-laws enjoying free cooling – shade!

Energy was still relatively cheap in the early 1990’s and the existing well was providing all the water we needed for domestic use and irrigation, so we felt confident in planting 700 eucalyptus trees around the perimeter of the property and adding 12,000 sq ft of lawn.

Keeping up with the landscaping. 1996

We left the center of the property as open meadow habitat and planted some native oaks. We also planted our favorite landscape trees such as redwoods, willows, alders and mulberries, which all are, as it turned out, very thirsty trees.

Water Water Everywhere (Except At Our House)

By 1998 we had water problems. The original well was not keeping up with our demand for water, so we made the decision to drill a new well. Also Y2K was just around the corner, so we felt that we could still utilize the original well by installing an old-style wind –powered water pump (windmill). It was more of a backup in case of power outages and Y2K eventualities.

1999 brought a new barn and significantly higher utility bills from the additional square footage and the fact that we now had two teenagers living at home.

Y2K insurance, and a place to send teenagers. 1999

It turned out that the new well was not a good producer so after going through a few summers where the water would stop flowing for hours at a time with no warning, (quite exciting during showers), we decided to assess our water demand vs our supply.

We decided that we had created an unsustainable situation with lots of lawn and non-native thirsty plants and trees. The energy costs to pump the water had increased with

the new well due to the extreme depth that we had to drill and the total amount of water that we were now using. Summer bills were regularly over $300/month.

Our two main concerns were:
1) Make it through the summer with a continuous supply of water and
2) Lower our energy costs to a more reasonable level.

An Offer We Couldn't Refuse

By 2001, California had begun to offer incentives to install photovoltaics that paid almost half the installed cost of a system. There was also a state tax credit. Coincidentally a friend, who was a local green builder (Alvis Projects), was installing PV systems. We did some calculations that showed that we could install a large enough system to reduce our electric bill to zero and give us a 7-8 year payback. We also discovered that if we refinanced our mortgage and included the solar system, our actual monthly out-of-pocket costs (mortgage + utility bill) were *less with* the new system than doing nothing. Needless to say, this was not a difficult decision to make!

To Tree, or Not To Tree

Next we assessed which vegetation would stay and which would go. On the "out" list were any trees or shrubs which couldn't get by on once or twice a week of drip irrigation. This included 90% of our existing vegetation and our beautiful Bermuda grass lawn. We decided to stop watering the 700 eucalyptus trees, since in Australia, they make it alright with just rainfall. And we had no Koalas to harass them.

We let the lawn die, cut down many trees and with the advice of a friend, Joseph Oldham, (who was extremely knowledgeable about native and drought tolerant plants), planted many local and California natives.

100 holes drilled for native plants. 2001 Looking and smelling good. 2005

We added other plants that provided habitat for native insects and birds, had pleasing smells, and provided food (including figs and kitchen herbs). Everything (except a small patch of lawn), went on drip irrigation.

We decided that it was silly not to utilize our working antique windmill, so we installed a 2,500 gallon water storage tank, piped the windmill to pump into it and reduce the work need by the main well pump.

Off peak water storage to keep the showers (and everything else) flowing. 2005

<u>To Grid, or Not To Grid</u>

After much calculation (mostly how long it would be before the boys were back living with us, as they had just moved into local college dorms), we had Alvis Projects install a 6.5 kW, ground-mounted, single-axis tracking PV system that we estimated would allow us to get to net zero, which means that you have no bill (on a yearly basis).

The state incentives were very good – at $4.50/Watt, they paid for about half the cost of the system.

We can change the tilt-angle of the panels manually – this saved money and ensured no future technical issues, which can happen with automated trackers.

At the time you didn't get any additional benefit from over-sizing the system: any production below zero wouldn't be credited against your bill, so it was critical to try to get as close to zero as possible without going over (unless you just wanted to donate extra power to California's grid reserves).

We thought about going off the grid with batteries and 12 volt appliances, propane refrigerator, etc, but decided against it since all of the incentives were offered only if you stayed grid-tied, and Virginia didn't really believe that a 12 volt vacuum cleaner could handle terrier hair and keep on tickin'.

Next we replaced our existing older appliances with the most energy efficient appliances that we could afford, using Consumer Reports as a guide. This included a new front-loading washing machine, ceiling fans, refrigerator, compact fluorescents,

Front loaders spin so fast- clothes get dizzy – and very dry. Recessed 13 Watt fluorescents – still working 20 years later. Lamps replaced at 10,000 hours.

and the main energy-saving strategy for the summer – a highly efficient 2 stage evaporative cooler that allows us to remain very comfortable for a fraction of the cost of the most efficient air conditioning unit. Summer nighttime operation means we sleep with heavy blankets!

MasterCool Direct-Indirect evap cooler

Hottest day of the year – never hit 80 º.

The PV system doesn't provide us with 100% of our energy, but because of the time-of-use rates, we bank energy in the fall-winter-spring, that offsets the high-use summer months so that we zero out the energy costs at the end of the year.

Riding Ranch, 2010

Does Net Zero Mean Zero Fun?

As to lifestyle changes, there really haven't been many; mostly just being aware of the time of day that we do things. We do laundry on weekends, water more at night, and don't turn on the cooler until after 6PM, which, after cooling the house down the night before to the low 60's, isn't an imposition.

The first year our bill was $0. The next year it was about $425.00 mainly because our two sons moved back in with us after being away at college so we had double the washing, cooking, water use, etc. Year three it was about $110. Remember, we sized the system to provide ALL of the electricity for my wife and myself, so I was not surprised by the higher second and third year bills.

Conclusions for Musing in 2011

It is now 20 years since we bought the property and 10 years since we installed the PV system. The Raywood Ash is huge and provides incredible shade in the hottest part of the summer, the native plants are all thriving on little water, no addition fertilizer or fuss, the PV has already paid for itself, and there are still 10 more years left on the panel warranty. We have had no problems with the system, except for a stray golf ball from a cowardly neighbor with a bad slice who never came forward. The panel still worked fine, but we replaced it anyway.

Old and new technologies working in harmony.

What is our advice for the average person looking to get control of their energy costs?

1) ENERGY EFFICIENCY FIRST! Solar PV is great and can dramatically lower your bill, but it costs 5-7 times what energy efficiency costs, and once you tighten up your house, the system needed will be smaller and less costly. I usually tell people that you don't need to put in as many panels as we did - in fact a more cost-effective approach is to put in enough panels to "peak shave" to stay under your Baseline quantities. 2.0-2.5 kW would be a good choice for the average homeowner.
2) Watch your water use and reduce where possible. Whether you pump your own water or rely on public infrastructure, water is our most critical resource, and energy is embedded in its pumping, treatment and delivery. Also native plants can be way more fun and far less work that what most people are accustomed to, and their benefits are great.
3) Take advantage of incentive and tax breaks. Most of the improvements that we made cost more than their baseline equivalents, but there are billions (with a B) in assistance. Start with your local utility and do your homework.

Happy - with no electric bill.

The Future is Electric

Our annual true-up bill for 2010 is now due and it is $175 for the year. It's my fault it's so high, though. I just couldn't pass up that 2009 ARRA tax credit money. I went and bought an NEV (Neighborhood Electric Vehicle) The federal tax credit almost paid for the entire vehicle cost. Now it's solar-powered from Riding Ranch.

Clean, quiet, costs pennies a mile to operate and makes you slow down a bit - not bad.

But I'm not worried, I'm thinking that if I put in a wind-power generator on the barn (the CEC has an incentive that will pay for just about all of it), I could get our bill back to pretty close to zero.