# Chapter 19 – Residential Energy

Julie Smith, www.whatwouldjuliedo.blog

***Crank On It!, The Magic Switch, Less is Better, Resistance is Futile!, References***

## Crank On It!

The next largest consumer of energy in the U.S., after food and construction, is residential energy use. This category, similar to food, is driven by direct decisions of residents where they live, which means that each and every one of us can have an immediate impact on our carbon footprint by finding ways to reduce our home energy consumption. Table 1 shows the same general breakdown for residential buildings from Table 5 in Chapter 16. At just under 20% of our carbon emissions, residential energy use is an excellent opportunity for reduction.

Like food and construction, Table 1 includes all the underlying bits and pieces of residential energy, in addition to the obvious electricity and combustion of gas for heat. The non-combustion emissions include the manufacturing of refrigerants used in cooling systems, miscellaneous leaks in the natural gas distribution networks that deliver gas to our homes and the flares and leaks at the production facilities. The transportation includes the energy lost in the electrical transmission lines and natural gas compressors that move the gas in the distribution systems, and the land includes the land the homes occupy, as well as the oil fields, refineries, mines and power plants that provide the gas and electricity.

*Table 1 - Breakdown of U.S. Residential Energy - 2020*

| Priority | Description | $CO_2e$, million metric tonnes/year (mmt/year) | | | | | | | Percent of Gross |
|---|---|---|---|---|---|---|---|---|---|
| | | Non-Combustion Emissions | Electricity | Stationary Combustion | Transportation, Non-Freight | Land | Transportation to Point of Use or Sale | Total | |
| 3 | Residential Buildings | 61 | 578 | 453 | 12 | 9.1 | 0.01 | 1,127 | 15.5 |

A breakdown in residential emissions is shown in Table 2, with carbon footprint per capita followed by percent of gross emissions in parentheses. While the direct uses of electricity and gas are the largest direct components, reducing those will also reduce the leaks and land. While the leaks are obvious, since less distribution proportionally leads to less leaks, the land will reduce over time, as mines, petroleum production facilities and refineries shut down. Also, by reducing electricity, we can eliminate the need for yet more power plants, and shut down existing ones over time.

*Table 2 – Residential Buildings - Carbon Footprint per Capita, mt/person-year*, (% of Gross**)*

| Category | Non-Combustion Emissions | Electricity | Combustion | Transp. On-Site | Land | Transp. Off Site | Total |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Electricity | 0.06 (0.3%) | 1.74 (7.9%) | 0.04 (0.2%) | 0.04 (0.2%) | 0.03 (0.1%) | $3x10^{-5}$ ($1.4x10^{-4}$%) | 1.9 (8.7%) |
| Natural Gas, Propane, etc. | 0 | 0 | 1.33 (6.0%) | 0 | $2.9x10^{-4}$ ($1.3x10^{-3}$%) | 0 | 1.33 (6.0%) |
| Leaks, Non-Combustible Emissions | 0.13 (0.6%) | 0 | 0 | 0 | 0 | 0 | 0.13 (0.6%) |
| Land | 0 | 0 | 0 | 0 | 0.05 (0.2%) | 0 | 0.05 (0.2%) |
| Total | 0.18 (0.8%) | 1.74 (7.9%) | 1.37 (6.2%) | 0.04 (0.2%) | 0.07 (0.3%) | $3x10^{-5}$ ($1.4x10^{-4}$%) | 3.42 (15.5%) |

**U.S. Population in 2020 was 331.5 million; **Gross Emissions in U.S. in 2020 was 7286 mmt of $CO_2$e*

## The Magic Switch

So, where does our electricity come from, anyway? I'm going to assume that most of us realize that power plants are involved, though some might answer that it comes from that light switch on the wall. Like water and wastewater, we tend to take it for granted and don't really notice it unless it doesn't work, as when there's a power outage.

Figure 1 shows the mix of sources used to provide electricity in the U.S.[1] Basically, all the fuels are burned to raise steam that drives turbines at the power plants to generate the electricity. At this point, natural gas is the largest source, at 40%, followed by coal, nuclear and renewables, each at 20%. This mix is from 2020, and natural gas and renewables are gradually replacing coal.

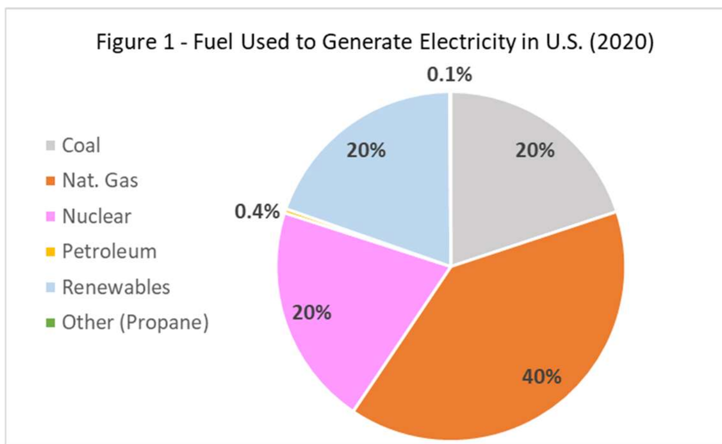


Figure 1 - Fuel Used to Generate Electricity in U.S. (2020)

Figure 2 shows the mix of utility scale renewables in the U.S. as of 2020. Other than the geothermal, and some of the wood and other biomass, all of these are renewable sources of electricity. Most of it is coming from wind farms, followed closely by hydroelectric. Solar makes up a surprisingly small portion, just 11% of the total, and then there are small amounts of energy from geothermal, wood and other biomass, like wastewater biogas and agricultural byproducts.

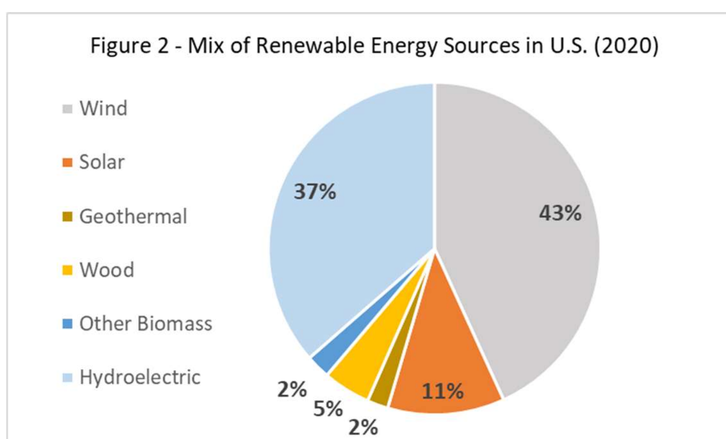


Figure 2 - Mix of Renewable Energy Sources in U.S. (2020)

While renewables aren't entirely free of their own carbon footprints and impact on our planet, they at least don't emit $CO_2$e as they provide energy, making them generally far better for the planet than continued fossil fuel combustion. I used to think that hydroelectric was the cleanest and best source of electricity, but it's not. Especially after considering the environmental cost of dam construction and turbines, and the horrendous impact on freshwater wildlife, particularly salmonids that can't reach their spawning streams and are being driven to extinction, as discussed in Chapter 10. When wood is used, logging underlies that, which removes needed carbon sinks, and geothermal requires drilling of wells, which consumes energy.

Wind turbines and solar panels obviously have an industrial carbon footprint of manufacturing, which is included in the total $CO_2$e of electricity in Table 1, and the renewables in Figures 1 and 2. The total $CO_2$e for wind turbine manufacturing was 6.41 mmt $CO_2$e in 2020, equivalent to 0.1% of U.S. carbon emissions, although most wind turbines are made overseas, so their manufacturing doesn't hit U.S. metrics. However, they certainly hit global metrics, yet another example of how U.S. carbon emissions as presented in this book, based on EPA data, is lower than our actual emissions. The same is true for solar panels, which had a $CO_2$e of 1.88 mmt in 2020, or 0.03% of U.S. emissions, but are mainly made overseas. At the end of the day there is construction and manufacturing for everything we do to get our electricity, whether it be a gas well, dam, power plant or windmills. The important difference is that renewables, once they're built, don't require fossil fuel combustion to operate, and their manufacturing emissions is trivial compared to the fossil fuels they offset once they're in service.

It turns out that different states have different levels of renewable energy in the mix, so it's possible that you already have renewable electricity, depending on how it's distributed. For example, in Colorado we have Xcel Energy[2] supplying the front range, and they're currently at 42% renewables, from wind and solar, which is 22% higher than the national average of 20%. By default, you can reduce your CFP of electricity by 22%, or 4.45% of gross emissions, a nice move in the right direction if you live in Colorado. For other states, you'll have to do your own math, since every state, and actually every power grid within each state, has a different portion of renewables.

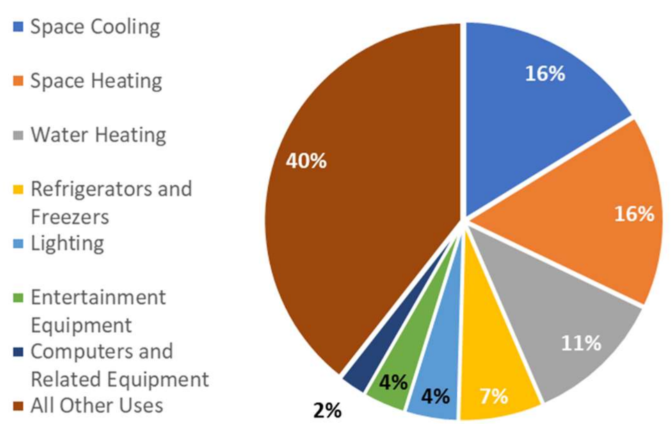
> When I worked at Coors, our 40 MW co-gen power plant ran on a mix of coal and natural gas. Coal made up by far the greatest fuel source, and it was getting more and more expensive to get, because the rail companies had a monopoly on the transportation. I got sick of it, and investigated the potential of running the power plant on straight natural gas. It turned out to be a cost savings, so we stopped the coal. It was also a win for employee safety, as handling the coal was extremely hazardous. And it reduced our carbon emissions. A new employee in malting told me he had worked previously in a coal mine that shut down, and that he liked working at Coors much better.

Xcel also offers opportunities to consume 100% renewables from the grid, with their "Renewable Connect" program, which is a great way to cut your carbon footprint of electricity by 80% without putting up the capital to install solar panels on your home. It's also a great option if you happen to live in a home or apartment that's shaded or doesn't have space for solar panels. If you choose 100% renewable electricity, then you reduce your gross emissions by the 80% of the electrical category, or 8.48%. Any of these options are a significant step towards the overall goal of an 80% reduction in carbon emissions to save our planet. Yet another option for homes that can't install solar panels directly would be solar gardens, which are local arrays of panels installed by cities or coops for residents.

**<u>Less is Better</u>**

Of course, there are plenty of ways to reduce energy at home, and save money on utility bills at the same time. Figure 3 shows the general categories of residential electricity usage in the U.S.[3] The biggest piece of the pie is for "all other uses", which represents the biggest prize when it comes to electricity. This piece includes stuff like clothes washers and dryers, dishwashers, microwaves, miscellaneous electric and electronic devices, heating elements and motors not included in other uses, cooking, cleaning, fish tanks, EV charging, etc.. Space cooling and heating come in next, followed closely by water heating. Most space heating and water heating in the U.S. continues to be with natural gas, but is beginning to move towards more electric. This is an important trend because in order to go to zero-energy, or to reduce our energy emissions by the needed 80%, we'll need to replace natural gas with electricity that can be powered with renewable energy. The combined usages of refrigerators and freezers, lighting, entertainment equipment and computers make up the rest of our consumption, at 17%.

Figure 3 - Residential Electricity in U.S. (2020)




The gas consumption in the U.S. is simpler than electricity, because we mainly use it for heating our homes and for heating water. Specifically, residential natural gas makes up just under 8% of our total carbon emissions, 73% for space heating and the remaining 27% for hot water.

Table 3 shows the breakdowns of electricity and natural gas per capita in units that are more recognizable to the consumer, kWh and therms, respectively. In the table, the average usage per capita is compared with the average usage for Hilary and I. While the average usage per capita is for the entire U.S., including every man, woman and child living in everything from a tiny home to an apartment to a mega-mansion, the Smith household usages are simply divided by 2, since there are 2 of us living in the house. I bring this up to illustrate that living conditions can have a major impact on usage per capita, and can create a bit of confusion, so it's important to consider that when thinking about all this. For example, a home that has 4 people living in it will likely have a lower carbon footprint per capita for space heating than the average per capita, because the same space is heated for all 4 people. For a single person in a home, the space heating per capita would probably be higher. Also, gigantic megahomes are obviously going to use more power for heating and cooling than smaller homes or apartments.

*Table 3 - Electricity and Natural Gas Consumption per Capita, U.S.*

| Usage | Average U.S. Electricity kWh/Year | Average U.S. Natural Gas Therms/Year | Smith House Electricity kWh/Year | Smith House Natural Gas Therms/Year |
|---|---|---|---|---|
| Space Cooling | 760 | 0 | 0 | 0 |
| Space Heating | 743 | 196 | 1,075 | 205 |
| Water Heating | 534 | 72 | 76 | 3 |
| Refrigerators, Freezers | 325 | 0 | 18 | 0 |
| Lighting | 204 | 0 | 20 | 0 |
| Entertainment Equipment | 165 | 0 | 41 | 0 |
| Computers and Related Equipment | 107 | 0 | 37 | 0 |
| All Other Uses | 1,845 | 0 | 2,482 | 48 |
| Total | 4,683 | 268 | 3,749 | 256 |

Compared to the average U.S. resident, in our house (Smith House), the electricity usage for space cooling is zero, and the space heating is higher. This is because we never use air conditioning, preferring to rely on shade from trees, insulation in the walls and roof of our home, control of curtains on windows to minimize solar gain, and optimize cross-flow of cooler air in evening with windows open, and fans during really hot days. It's incredible how much difference a simple fan can make, simply by moving the air, even on a really hot day with outdoor temperatures higher than 100 ºF, while using a fraction of the energy consumed by air conditioners. Our house stays fairly comfortable, and rarely exceeds 80 ºF inside, even on really hot days.

Smith home electricity for space heating is higher than the average because we use a heat pump to heat the house, which is far more efficient than the natural gas we used to use, by at least a factor of three. Heat pumps are relatively new technology, that are basically air conditioners running backwards, using the refrigerant to heat by compression, rather than cool by expansion, like air conditioners. Heat pumps are beginning to take hold in the U.S., but most electrical heating continues to be with baseboard electric radiant heaters, space heaters or tower heaters. I think of these as the old-fashioned brute force way of heating, where electricity heats wires directly, and the heat is blown into the room via fans in the units. It's extremely inefficient, and has historically been more of a desperation back-up plan to heat in cases where natural gas or propane aren't available. In our house, we use the heat pump in the main living area, with the living room and kitchen, and then we have space heaters to take up the slack in the bathroom and bedrooms, which are occupied less often. This allowed us to size the main heat pump smaller and save money as well as energy, and the space heaters fill in the gaps when the temperatures reach winter lows, and we can just plug them in and turn them on as needed.

The rest of the itemized electricity uses per capita at the Smith house in Table 3 are also significantly lower than the national average. This is basically because we either don't demand much, or because we have very efficient appliances. The hot water, like the space heating, is all-electric, and the only thing in the house that we demand hot water for is the shower. Everything else, including hand washing, dishes, laundry and general cleaning are done with cold water, which works just fine. And, we generally only shower a couple times a week unless we're particularly grungy from yard work or hiking. I became convinced long ago that daily showers aren't a good idea. Not only do they waste energy, it's not great for our skin or hair to be washed daily, because the natural oils and biome that reside on our skin, which is our largest organ, shouldn't be constantly compromised by soaps and surfactants that are designed to remove those oils. And, I have better things to do than stand in the shower while wasting energy and water. Anyway.

We have an extremely efficient refrigerator/freezer, and efficient lights that are only on when we're actually in the room. Our outdoor lights are on motion sensors, so they're not on all night long. We use mainly small LED spotlights, and in the bathroom, where the fixture holds 3 bulbs, we only have one bulb in it, which provides more than enough light. Our computers, printers and entertainment systems are off and disconnected from power when they're not in use. We use power strips for multiple plugs for the entertainment center. Easy peasy.

Our "All Other Uses" category of electricity is significantly higher than the national average, and that's mainly because we charge our Electric Vehicle (EV) at home. We don't own a clothes dryer, and our laundry machine is an ultra-efficient model that runs on minimal cold water. We hang our clothes to dry, typically outside, but we hang them inside if it's really cold out in winter. We own a dishwasher, but we use it mainly as a drying rack. We hand-wash our dishes with cold water, then place them in there to dry, to keep our countertops clear, which is important in our tiny kitchen. We try to run the dishwasher about once a month, just to keep the water supply tubes flushed, and tend to do that after a large event when there are a lot of dishes to wash and we can fill it completely. We have a full-sized oven, but we only use it for big events, mainly relying on a much smaller and more efficient air fryer for daily cooking, since there are only two of us in the house. We have an induction stove, which is extremely efficient, imparting heat directly to the cooking pot, without spewing heat everywhere, like a gas stove. Of course, the extra gas is actually fine in winter, but the last thing we want in summer. Any extra heat inside the house in summer is unwelcome, as it increases AC usage, for homes that rely on AC to keep cool. In our house, it helps us avoid AC entirely and stay comfortable on hot days.

The column for average U.S. natural gas usage per capita in the U.S. is actual, but for the Smith house it's shown for reference. The Smith house electricity is current, because we've gone to all-electric, and we charge our EV off the same system, but in 2020 we used natural gas for heating, and that historical usage is in Table 3. Our natural gas for space heating was actually similar to the national average per capita, but our water heating was insignificant, because of the reasons above, using cold water for everything except showers, and limiting the showers. The natural gas under "all other uses" for the

So, what is ***Phantom Energy*** anyway, besides a waste of electricity? Basically, it's all those little things we leave plugged in all day, even though we're not using them. Mainly anything with pilot lights, like microwaves, entertainment systems, computers, printers, stuff like that. Entertainment systems, for example, use more energy when they're "off" but plugged in than they do when they're actually being used. All the bits and pieces can be plugged into a power strip, and then turn off the entire strip when it's not in use. That may seem like a no-brainer, but in the U.S. this wasted energy, known as "phantom energy", consumes about 8% of our electricity. Think about that.

Smith house was the pilot light that constantly runs in all residences, whether gas is actually being used or not. In our house, that made up 20% of our natural gas, which is even worse than the phantom energy from electrical gadgets in U.S. homes that comprise 8% of electricity.

At our home, we've been on a path of reducing energy and carbon footprint for the past three decades. Our journey began with reductions like lights, phantom energy and general waste. We improved our insulation, installed storm windows and doors as budget allowed, and installed good insulating window covers to reduce heat loss in winter and solar gain in summer. We also stopped using fume hoods and fans that draw air out of the house, especially in winter. After all, if we pay bank to heat all that air, why in hell would we want to suck it out of our bathroom, just because it stinks for the first five minutes after number 2? Or if it's humid after a shower? While using a humidifier in the living room to keep the air from getting too dry? Think about that. I mean, is that just ridiculous? We just open the bathroom door and it disperses in no time.

*Table 4 - Comparison of Smith $CO_2e$ Emissions Per Capita With National Average*

| Usage | U.S. Average Per Capita | Smith House Per Capita | Smith House Percent of Average |
|---|---|---|---|
| Residential Electricity | 1.90 | 1.44 | 75.8 |
| Residential Natural Gas | 1.33 | 0 | 0 |
| Transmission Leaks and Land | 0.17 | 0.02 | 11.8 |
| Total Residential | 3.40 | 1.46 | 42.9 |
| Personal Transportation | 3.14 | 1.20 | 38.2 |
| Total With Transportation | 6.54 | 2.66 | 40.7 |
| Solar Panels | - | -1.10 | - |
| Net Carbon Footprint Before Xcel Renewables | - | 1.56 | 23.9 |
| Xcel Renewables on Grid (22%) | - | -0.34 | - |
| Net Carbon Footprint After Xcel Renewables | - | 1.22 | 18.7 |

In Table 4, the electricity, natural gas and transportation are shown in terms of $CO_2e$ per capita, to get all those apples and oranges of electric power, natural gas and gasoline into units of $CO_2e$ that can be compared legitimately, as apples to apples. At this point in our journey, our home electricity is 75.8% of the national average residential electricity emissions per capita. However, at the same time our natural gas is zero because we've replaced natural gas with electricity by going all-electric in our home. Also, by converting to an EV that we charge at home, we've reduced our carbon footprint for personal transportation by 62%, down to 38.2%, even though we also still own and drive a Jeep. That puts our total $CO_2e$ per capita at 40.7% of the national average for the combined categories of direct personal energy consumption, residential energy and personal transportation, which will be discussed in Chapter 20.

Accounting for our solar panels that offset a portion of our electricity, we're at about 23.9% of the carbon emissions for these two sectors, compared to the national average. Finally, we can reduce our net grid electricity by another 22% since the Xcel grid in Colorado that supplies our electricity is 42% renewable at this time, which is 22% more than the national average. Residential energy and personal transportation make up 29.7% of gross U.S. emissions, so a reduction of 81.3% (100 – 18.7) of these two categories combined, works out to a reduction of 24.1% of gross emissions, in addition to our reductions for food (14.8%) and construction (13.3%), putting us at a total of 52.2% reduction towards the needed 80% reduction in emissions to save our planet. Wow! Just 27.8% left to go! At some point, we may install a few additional solar panels on our south-facing roof on the house to offset our electricity even more, although Xcel will continue to increase renewables on their grid, further reducing our carbon footprint.

Luckily, many of us have plenty of opportunities at home to reduce electricity and natural gas before spending money on solar panels and heat pumps. It's best to reduce your usage before sizing those systems anyway, because that allows for smaller, less expensive solar panel arrays and smaller heat pumps, which reduces the cost. Also, you save money in reduced power bills at the same time. Here's a short list of tips:

- The first and most obvious thing is to not leave things on that you're not even using. Entertainment systems are the worst, followed closely by microwaves and computers and printers and such. Basically, anything with a pilot light.
- Don't leave lights on when nobody is in the room, or the house.
- Your lights should all be LED's at this point. And you don't need to spend bank on these, get them from thrift stores that carry dry goods, like Habitat for Humanity, Goodwill or Salvation Army. Of course, they don't always have them, but if you stop in every month or so, eventually they'll be there and you can snap them up!
- Outdoor lights should never be on all night. Put them on motion sensors. If you have outdoor lights on all night, that could be your biggest electricity hog.
- Lose the clothes dryer and hang clothes to dry. In winter, hang them inside. The humidity added to the air from the drying will do you good.
- Don't run the dishwasher unless it's completely full. If you only have a few people in the house, hand wash the dishes with cold water and use the dishwasher as a drying rack. Only run the dishwasher if you have a lot of dishes to wash.
- In summer, if you have AC, keep the temperature to 78 ºF. Please don't crank it to some low temperature where you need to wear a sweater in the house in summer. In many parts of the U.S., a fan does just as well to cool, and uses about 15 times less electricity.
- In summer, cover your windows with shades or curtains on south, east and west-facing windows to keep out the solar gain if your house is too hot.
- If your fridge isn't completely packed with food, fill in the spaces in the fridge and freezer with bottles and jugs of water. The fridge only comes on in response mainly to heat lost when the door is opened, and by replacing air inside with filled jugs, less air escapes. Also, minimize the time the door is open. Don't just stand there and gape at the open fridge. Know what you want and where it is when you open it. Be organized.

- Don't heat-load the fridge with hot food. Leave it on the counter until it cools off, then put it in there. In cold climates, you can set it outside the house and it will cool off in no time. But don't leave it out there, lest it be snatched by some enterprising racoon or other critter, depending on where you live. We find that setting it under a chair with a weight on the lid works for the coons, and in winter bears hibernate, so aren't an issue.
- When we installed the solar panels, we learned that the solar panels take in all the solar gain and convert it to electricity, but what we hadn't thought of was that it also took a lot of heat out of our house, because the panels were actually shading the roof, reducing solar gain, so the house was cooler.
- If strictly solar is installed, the customer still loses power if there's a power outage in the grid, because the utility doesn't want power returning to the grid from solar panels, which could electrocute the workers who are working to repair the system. Who can argue with that? However, when a battery is installed in addition to the panels, the customer continues to receive power off the battery until the grid is replaced, an added measure of energy security during outages.

Saving on natural gas or propane should be easy too. Are you one of those greenie anti-fraccers? If so, try reducing or eliminating natural gas consumption. They're only fraccing because you're demanding the gas. Don't be a hypocrite.

- Wash with cold water, including hands, dishes and general cleaning. Using hot water for this stuff is a completely unnecessary waste. Are you running the faucet full-blast until it gets hot, then washing your hands? Do you know that 10% or less of water from a full-running faucet even contacts your skin? And that your body heat is enough to keep a small flow of water warm enough to wash your hands, even in winter? And that by running full-blast until you have the hot water you don't even need wastes a gallon or more of water before it even reaches the tap? Get over yourself. Knock it off.
- Never set your thermostat above 70 ºF in winter. That's just silly. You don't need to be running around the house in short sleeves at 78 ºF. It's winter. Put on a sweater. And a hat. That will warm you up faster than wasting natural gas will anyway. Challenge yourself to see how low you can go at night, when you're sleeping under the covers. We turn our thermostat down to 50 ºF at night, though the temperature rarely dips below 60 ºF.
- Never run hoods or fans in the kitchen and bathroom unless it's absolutely necessary when you are heating or cooling the air inside the house. Doing that wastes all the energy you just put into that air faster than the draftiest house on the planet. You can run the bathroom fan for just one minute and more than clear out the stench from Number 2 if it's that big of a deal to you. And the moisture from a shower will humidify your home nicely if you simply open the bathroom door after the shower. How hard can it be?
- Insulation is hugely important to reduce heating and cooling requirements, so make sure yours is good. Buildings built in about the past 20 years should be decent, since building code requirements took hold, forcing builders to do the right thing, whether they wanted to or not.

R Factors of 10 to 15, means that the heat flow through the outside walls and roof (building envelope) is reduced by 10 to 15 times what it would be if there were no insulation. The current International Building Code[4] requires new buildings to be at least R20 in the walls and R60 in ceilings in climate zone 5, where we live. When we moved to Golden, we found that the walls in our 1948 home were pretty much devoid of insulation, so as soon as we could pull together the money, we had insulation blown into the walls. Insulation projects pay out fairly quickly in heating costs, within a few years, typically.

- Windows and Doors should be properly sealed, and preferably double paned. Again, double pane is a minimum requirement for new construction, but old homes may need an upgrade. Also, in cold climates storm windows and doors should always be installed. There will be costs to do this, but it will reduce heating requirements. This is a potential DIY project in which you replace your windows gradually as you can afford it, starting with the worst ones.
- Window Coverings are not only for privacy, they make a huge difference in energy. In winter, open them on windows with sunshine to take advantage of solar gain, and close them at night to keep heat inside. In summer, do the opposite to keep heat out of the house. Solar gain is a powerful contributor through windows that face the sun,[5] and in many cases can completely offset daytime heating requirements on sunny days in winter, even when it's really cold.
- Heat Pumps are electrically powered heat sources, that are far more efficient than electric radiant heaters, using about a fourth as much energy. They also use about half as much energy as natural gas forced-air systems. We installed a mini split heat pump in our house, and saw our electricity carbon footprint drop to less than half of what it was for the combined carbon footprint of electricity and natural gas prior to the heat pump, as shown in Table 4. This action, along with installing an electric on-demand hot water heater allowed us to cut and cap our natural gas supply, eliminating the constant demand of the pilot light in the attic, and the heat loss through air ducts in the attic.
- The one thing we still use hot water for is showers. I have been known to take "sailor showers" when hot water isn't available, but I really love a good hot shower. Just saying. We replaced our natural gas hot water heater with an on-demand electric hot water heater, and we put it in the bathroom, where the shower is, to eliminate any losses through pipes under the house. The other hot water taps are tied to the same hot water pipe, but we do have to run the water longer at the more remote taps before it gets hot, which isn't a problem because we don't use hot water anywhere except the shower. We keep our showers to 5 minutes or less, only shower a few times a week, although we may do a quick rinse in between, and we collect the water in buckets in the shower, then use that "greywater" for bucket flushing the toilet, to get two uses out of it. In winter, this is also a way of keeping the heat used to heat the water in the house until it dissipates into the air. After all, hot water contains about a thousand times the heat of an equivalent volume of air at the same temperature, so it seems silly to waste that heat it by letting it go down the drain.
- We switched to an electric induction stove to reduce our natural gas before we did the bigger hot water and heat pump projects. The cost was pretty cheap, we just bought a single counter top plug-in unit to hold us over. Induction stoves are really efficient, but also really picky as far

as what you can use for cooking, so they might not work for everyone. They need the cooking pots to be iron or a steel with iron, so they don't work for Calphalon or other aluminum based cookware, like my canning kettle. Also, if the bottom of the pot is dented from use, they don't work, even if it's stainless steel. A plain old electric stove can be used to reduce natural gas as a first step.

We installed solar panels on the east-facing roof on our home several years ago, then followed that a with panels on the south-facing garage roof and a battery a few years later. Our final project a couple years ago was to install a heat pump and on-demand hot water heater. We had to upgrade the electrical wiring in our 1948 house to handle the on-demand, but we didn't want any hot water tanks sitting in our house wasting energy in the long-term when we weren't calling for hot water, so we took the high road. More cost in the short-term, but better for the planet in the long term. We finally purchased an EV a few years ago, the last part of our journey to this point, which makes us nearly self-efficient with respect to energy, including for transportation. We do continue to own a Jeep, which is used for back-country camping and as a second vehicle when needed, but we don't put very many miles on it. Last year, for example, we drove it 1,000 miles, compared to 21,000 miles on the Tesla. We got rebates for pretty much everything we did, though under our new backwards fascist planet-hating administration these will be iffy at best. Still, in the long-term, remember we're going to run out of fossil fuels anyway, so it's going to be better to avoid the last-minute rush and start taking steps to get ourselves off the big corp fossil fuel tit sooner than later.

**<u>Resistance is Futile!</u>**

It's not always been easy to overcome obstacles to efforts to get off the grid and the natural gas lines. After all, our utilities have built massive power plants and distribution systems to provide us with extremely convenient energy sources for the past hundred years, and it's their bread and butter to continue to do so. However, the realities of the global warming crisis and the fact that we're past peak oil and will run out in the next two generations if we keep cranking on it are hard to argue with. Many utilities and even some big oil companies are realizing that they're going to need to change to remain relevant and keep up with the times.

In Colorado, Xcel Energy[6] has stepped up big time, with a goal of 100% renewables by 2050. They have worked hard to learn how to deal with electricity returns back to the grid from home solar systems, which can be a problem for them, and they pay or credit customers for solar returned to the grid. More recently, they're working with home batteries that store roof-top generated solar to draw off the batteries to help offset extremely high usage periods, such as hot summer afternoons when AC demand is high. They also routinely send out communications about how to reduce energy use in general, and they provide rebates for energy-saving projects like heat pumps, on-demand hot water and even electrical upgrades. A recent e-mail from Xcel offered to pick up an old and inefficient refrigerator free of charge for customers who upgraded to an Energy Star Refrigerator.[7] When I worked at Coors Brewery as the energy engineer, they were amazing partners, offering all sorts of rebates for lighting efficiency, motor efficiency improvements and the like.

The next challenge with Xcel is cutting and capping the natural gas supply after converting to all-electric, but they'll get there. When we were ready to cut it off, I filled out their normal discontinuation form for lack of an alternative, then wrote in the notes that we still live there and want to continue electricity supply, we just want to stop gas. That got ignored, probably because they don't really have a protocol for it yet, so I had to call back a couple times, but it eventually got done. And the tie-in charge was gone on the next bill. I have to hand it to big utilities like Xcel that are setting an example for what is needed to save our planet. Yes, they were forced to do the right thing by Colorado voters, but still. They'll continue to be a very important utility provider, but it will be mainly electricity from renewables rather than power plants and natural gas.

Obviously, it hasn't always been this way. 20 years ago, Xcel was just like any utility company, preferring to provide conventional electricity the old-fashioned brute force way, with coal-fired power plants. However, in 2004, after years of grass-roots efforts by local organizations like SWEEP,[8] CRES,[9] New Energy Colorado[10] and Colorado Renewable Energy COOP,[11] the issue finally went to a vote in the state of Colorado,[12] and the citizens voted in favor of Amendment 37, requiring state utilities to generate a portion of their electricity with renewable energy. Now, the Public Utility Council of Colorado, the state board that represents the citizens of Colorado, oversees the utilities' efforts and ensures that their work aligns with the will of the people. And in the state of Colorado the will of the people appears to lean towards reducing our greenhouse gas emissions to help save our planet. As recently as 2007, HOAs (Homeowner's Associations), could ban solar panels on community homes, but that was made illegal at the state level in 2008 with House Bill 1270, again through pressure and advocacy from local organizations.[13] It's likely to take years or decades, but local advocacy does work. Eventually. You just have to keep pushing.

These days, with the climate emergency looming, more and more local and state governments are changing the rules in favor of the planet, and our diminishing fossil fuels. Crested Butte, Colorado, the state of New York, Seattle, Washington and at least 70 communities in California are examples of the many U.S. cities that have banned natural gas in favor of all-electric to take advantage of renewable electricity.[14] They have fought, mostly successfully, against big utilities that want to continue selling us natural gas whether we want it or not, just so they can keep making money for heating our planet.

In Berkeley, California, the city was actually sued for making natural gas pipes and equipment in new construction illegal per building code, and the ban was blocked in court. Other cities are choosing not to make all-electric mandatory, but through education most citizens are finding that it's a whole lot less expensive to go with all-electric, rather than install natural gas equipment that will be obsolete in just a few years. The building code for the entire state of New Hampshire now requires that all building envelopes meet Passive House standards, which are 90% efficient for heating and cooling loss. It almost feels as though common sense is beginning to wiggle its way in there through grass-roots educational efforts. And it's a relief to see, given that we're unlikely to see any level of leadership from the Federal government for years to come.

The simple truth is that we're past peak oil with more people than ever on the planet, and we need to wean ourselves off fossil fuels sooner than later. How dumb would it be to wait until the last minute, while ensuring planetary disaster at the same time? If we begin changing now, it will be more gradual and less painful in the long run, and we'll minimize additional global warming. Solar energy is now less expensive than fossil fuel, so now is the time. More people are employed in renewables these days than in fossil fuels, by a long shot. Switching to fossil fuels reduces air pollution, in addition to the reductions in greenhouse gas emissions, and over time will reduce the smoke most of us experience these days from wildfires. Also, fossil fuel power plants require enormous amounts of water for cooling, while renewables don't.

Please do the planet a favor and don't let big corp cram into your malleable little brain the idea that nuclear power is the clean, green solution. While it's true that it doesn't release $CO_2$ on burning, everything else about it is as nasty as it gets. It needs to be mined, refined, concentrated, and then transported great distances to plants, just like any other fuel, all of which add to our carbon footprint. Then, once it's used up, the material that's left, concentrated radioactive waste, must be disposed of, and there's no good way to do that, as recent history from the past half-century has proven.

In Utah, the White Mountain uranium mill has contaminated the surrounding area so badly that it's unlivable, with contaminated water and land, and high cancer rates. You gotta wonder when non-smokers are getting lung cancer.[15] And then there's the Fukushima Daichi nuclear power plant in Japan, that's been releasing radioactive wastewater into the Pacific ocean for the past 30 years. And don't forget Chernobyl. It's all just fine and dandy until there's a leak or explosion, which there always is, eventually. Then the damage is devastating and will never go away completely, at least not for centuries. And, obviously, this is yet another way we're killing wildlife. Have you heard the wildlife cancer statistics? Me neither. That's because there are none. We don't track that. We just know the wildlife is decreasing. They get cancer and die, then other wildlife consumes the remains and dies of contamination and so on, spreading the radiation far and wide. Nuclear fuel is nasty and should be left in the ground, just like the remaining fossil fuels.

Renewable energy is a capital expenditure that should be part of building any home, while the cost of fossil fuels is going to skyrocket as we run out. We can get more than 30% of our energy from rooftop solar panels, while eliminating the need for power transmission lines, which have their own problems that are exacerbated by increased heat and drought. They are less efficient in high heat, because they sag and break, causing shorts and sparks that can and do set off wildfires. Power plants also consume billions of gallons of water annually for cooling and steam generation, obviously making water scarcity worse than ever.[16]

It's already getting harder and more expensive to produce fossil fuels, as oil and natural gas wells get deeper, scarcer and more remote, costing more to extract and refine. This is not going to improve on our planet for millions of years, so we'd better get over it. The party's over. Time to wake up and get to work.