Seven Years after Paris

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"Think globally, act locally" has long been a popular environmental mantra. This article follows the path of someone who for years acted globally (in 2015 he co-chaired the UN negotiations that led to the Paris Agreement and previously helped negotiate the UN Framework Convention on Climate Change and the Kyoto Protocol) but has since tried to implement Paris locally in the Shenandoah Valley.

In a recent article, David Wallace-Wells presents a Dickensian *Tale of Two Cities* view of the current state of efforts to tackle climate change.[1] On the one hand, he says: "Thanks to astonishing declines in the price of renewables, a truly global political mobilization, a clearer picture of the energy future, and serious policy focus from world leaders, we have cut expected warming almost in half in just five years." On the other hand, he acknowledges: "…[T]he likeliest futures still lie beyond thresholds long thought disastrous, marking a failure of global efforts to limit warming to 'safe' levels." And he adds: "Perhaps even more concerning, the more we are learning about even relatively moderate levels of warming, the harsher and harder to navigate they seem." Not exactly "the best of times and the worst of times"—but you get the idea.

In the seven-year interval since co-chairing the final year of negotiations that led to the Paris Agreement in December 2015, I have thought much about what it means to have spent over thirty years on the climate issue—through the early days of the Intergovernmental Panel on Climate Change, to the UN Framework Convention, to the Kyoto Protocol, and finally to the Paris Agreement. For starters, I left federal service in September 2015, retiring from the Department of State soon after President Trump's misguided June 1 Rose Garden speech. Since then, I have been doing what I can, on a personal level, to address the climate emergency.

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Why try to do anything on a personal level? The Paris Agreement does not contemplate individual action, nor does the Kyoto Protocol before it, nor the UN Framework Convention on Climate Change before that. The many multiples of global efforts do not even try to quantify the results of individual actions or take them into account. On an individual level, many people feel powerless to effect change, no matter how Herculean their personal efforts. How should individuals be thinking about individual action when the vast majority of emissions are outside their control?

[Note: What follows is a description of a journey. The actions are not (yet) quantified, and the journey is not yet finished. It is still a "work in progress" and this story is not meant to be a guide or prescription for others, particularly for those who do not have the means to undertake the kinds of actions described. Already, moving forward on the path has taken much time and study, and it is frustrating to realize that all the greenhouse gas emissions avoided or reduced by the actions described can be undone quickly by a single flight to almost anywhere because of the enormous emissions involved in air travel. Still, even unfinished, the story may be worth telling.]

In thinking about these questions, I recall a time after George W. Bush's election in 1998 when a friend from law school who had just been elected to the Illinois State legislature invited me to accompany her to a briefing on climate change in Washington for newly elected conservatives. One of the speakers joked about people trying to ban chlorofluorocarbons (CFCs) from the cooling systems of inter-continental ballistic missiles, implying that there were few things more pyrrhic and stupid. When my friend asked me about this later, I said it was not at all pyrrhic and stupid because, hopefully, those missiles would remain in their silos forever. But no system we have yet designed can prevent slow leaks of those chemicals into the atmosphere. While you may think that a tiny quantity of CFCs leaking from a missile's cooling system is *de minimus,* the same argument could be made for other uses of CFCs. Unfortunately, all those *de minimus* uses eventually add up. But most importantly, I noted, we have substitutes for those chemicals that will not harm the stratospheric ozone layer. So why not use them?

I think about individual climate action in a similar way. My individual actions may be puny and *de minimus*, but when linked to the individual actions of countless others around the world, they ultimately do add up. And David Wallace-Wells gave me hope that even if we are not "there" we may already have reduced the likelihood of the most apocalyptic futures that seemed unavoidable only a few years ago.

FIRST STEPS

In June 2017, my spouse and I bought a split-log home on the side of a mountain in the Shenandoah Valley. It was beautiful but it was twenty years old, and things needed work. First, we re-stained and re-caulked the logs. We used a dark gray color instead of the traditional brown because it looked better (in our view) and it is more resistant to ultraviolet radiation.

Then we replaced the roof. Instead of shingles, we opted for a standing seam metal roof because we could get it in a bright red color that worked well with the dark gray logs and because we will never have to replace it again (metal roofs typically last fifty years). I learned from Fletcher Professor Bill Moomaw, my Ph.D. dissertation adviser, that replacing the roof is the best time to install a solar array. Solar panels work well with standing seam metal roofs because the panels clip onto the seams.

Bill was excited about our project—but he and Margot Moomaw were partly our inspiration. In the early years of this millennium—when finding energy-efficient products was nearly impossible—they retrofit their 1928 house in Williamstown, Massachusetts. Through an intensely studied approach to energy efficiency and an enormous effort to favor energy efficient choices, they made their home one of the first in the Northeast with zero net energy consumption and zero net carbon emissions annually. They and their efforts have been widely cited.[2]

BEGINNING DOWN THE PATH—GEOTHERMAL

Not long afterward, we learned that our air conditioner also needed replacing. Contractors urged us to replace the furnace at the same time. Previously, we burned propane for heat in winter and year-round for hot water. We also used propane for a cooktop in the kitchen and a small fireplace in the master bedroom.

A new propane furnace and electric heat pump promised significant energy efficiency savings, and the price—about USD 15,000 installed—seemed reasonable. But I had heard about geothermal ground source heat pumps for some time, and my spouse, a physicist, thought it would be great to have one. I began to investigate. Installing a geothermal system involved drilling three wells about 150 feet down and about 30 feet apart. Geothermal works by pumping a mixture of water and anti-freeze down the wells and back up again. In winter, the wells carry cool liquid down and bring warmer liquid (warmed by the heat of the Earth below) back up. Similarly, in summer, the wells carry warm liquid down and bring cooler liquid (cooled by the cooler Earth below) back up.

A geothermal system can be installed by drilling vertically, by drilling horizontally, or by running the pipes through a nearby body of water. Initially, we thought that a horizontal system would be cheaper but vertical wells made more sense because they provide a greater differential between the below-ground and surface temperature and involve less excavation. Apart from this, a geothermal unit itself looks pretty much like a propane furnace, if slightly larger, and it uses a much larger filter.

Regarding cost, the best estimate I got was for about USD 37,000 installed—and most of this was for the drilling. Fortunately, Congress provided a 26 percent tax credit, reducing the cost to USD 27,380. The unit itself will last over twenty years while the underground piping structure will last between twenty-five and fifty years. Not only that, the cost of operating and maintaining a geothermal system is significantly less. We would save about USD 3,500 per year (about USD 2,500 in lower heating costs and about USD 1,000 in lower cooling costs). We could recoup the cost in 7.8 years—but we could recoup the added cost of the geothermal system (the USD 17,000 difference between propane and geothermal) in 3.6 years. The Department of Energy estimates that a geothermal system will pay for itself in five to ten years.

We decided to move forward with geothermal. It took six weeks to get the wells drilled, to trench between them and the house, to install the pumps and the unit, and to get everything working. Happily, the system worked flawlessly once installed and the grass grew back.

NO GOOD DEED GOES UNPUNISHED

Suddenly, a major problem occurred. After installing the geothermal heat pump in October 2019, our electric bill in January 2020 jumped from about 300 kWh the year before to over 3,000 kWh. This was a shock—and expensive. I talked to everyone I could about the problem. I installed a shut-off switch on the furnace itself so that the emergency electric heat would not kick in. In fact, my installer said he had done this and never needed that heat in ten years of owning his unit. I installed a Sense monitor in my electric panel to "see" every appliance in the house and how much electricity it consumed. I spoke with an engineer at my local electric cooperative, who found no problem on its end.

Ultimately, the problem came down to two things. I had set the thermostat to a constant 72 degrees in winter whether or not there was anyone at home because people said that with a geothermal system you should set the temperature and leave it. That was a big mistake. If away for any

extended period, it makes sense to turn it down, as with any other furnace. We now set it to 50 degrees whenever we are away, which is warm enough to keep the pipes from freezing.

The second problem was the meter. As we learned later, replacing the electric meter with one that reads backward and forward to measure both "production" and "consumption" of electricity seemed to solve the problem and our usage dropped back to normal levels.

GOING SOLAR

Having installed the metal roof, I got in touch with an outstanding solar installer in West Virginia and installed an 11.7 kW array in early 2021. The job took two days. We have a line running down the side of the house through the foundation to the basement where our inverter is located. Solar panels produce direct current, so an inverter is needed to convert it to alternating current both to use in the house and to sell back to the electric cooperative.

We are fortunate in Virginia to have "net metering." This requires electric utilities to purchase electricity from small producers like me. Powered by sunlight, our solar array generates more electricity than we consume, which allows us to "sell" the surplus to the local electric cooperative. At night we "buy" electricity from the cooperative. In effect, the local electric cooperative serves as a "battery" for our system. The cost of this is about USD 34 monthly or USD 400 annually—simply the cost of being hooked up to the grid.

We could get off the grid entirely by installing an array of batteries, but three of the Tesla Powerwalls, for example, would cost about USD 27,000. Of course, we could take advantage of the 26 percent federal tax credit for this as well, bringing the cost down to just under USD 20,000 if our batteries were only used to store our own electricity as we could no longer "buy" electricity from the grid. Nevertheless, most experts say that battery technology is developing so fast, and prices are falling so quickly, that waiting likely will mean getting significantly more for less in the near future.

While the contract price for the solar array was USD 32,175, the 26 percent congressional tax credit lowered the cost to about USD 23,810. Interestingly, our solar installer offered several financing options at intervals of 10, 15, 20 and 25 years and interest rates (in December 2020) ranging from 0.99 to 5.49 percent. Under the cheapest of these options, we could have paid an average of about USD 128.50 monthly for 25 years,

for both the system and the electricity, with nothing down. Essentially, one could pay a higher cost for the system overall but low monthly payments over 10 to 25 years.

Ultimately, we decided to pay cash to get the best price for the system and claim the 26 percent federal tax credit.

Best of all, we now have a substantial "credit" with the cooperative and have not had to pay an electric bill since the system was installed, apart from the standard cost of grid connection mentioned above. Now we no longer use propane for heating, and we are producing more electricity than we use.

The electric cooperative will buy our "surplus" electricity for cash, but the rate it offers is so low that it makes more sense to keep those kilowatt hours in the "bank" with the electric cooperative. We could also "sell" the emissions reduction certificates we received for the solar array on a regional exchange—but that would enable someone somewhere else to increase emissions. We ultimately decided to keep them.

WHAT ELSE?—THE ELECTRICAL VEHICLE (EV) TRANSITION

Installing a solar array proved an important step, but others remain. For example, (1) we drive internal combustion automobiles that burn gasoline; (2) our cooktop still uses propane; (3) we use propane to heat our water, and (4) we use propane for the fireplace in the master bedroom. How can we tackle these remaining challenges?

In June 2022, I read about a new electric vehicle being produced by Kia: the EV6. All accounts indicate that the EV6 is a wonder. I learned that I could order one at no cost from a dealer in Winchester, VA. The problem is that these vehicles are made in Korea and are back ordered. So, I wait—but not really.

We have already installed a Level 2 charging station at our home in Alexandria. It cost about USD 750 for the unit and about USD 2,300 for the new 60-amp circuit. We are on track to install another station in the Shenandoah Valley. The distance between them is 96 miles. My other regular drive is to Charlottesville, where I teach a course on Global Climate Change at the University of Virginia's Batten School of Leadership and Public Policy—120 miles from Alexandria and 80 miles from the Shenandoah Valley. The EV6 (AWD) Wind's range is about 214 miles in combined highway and city driving in cold weather—enough to get me there and mostly back.

There is a USD 1,000 federal tax credit for installing a Level 2

charging station at a principal residence (not at a vacation home). While the Inflation Reduction Act provisions for EVs are beneficial, it is not clear that they are going to help many people in the near term because: (1) the qualifying vehicles must be made in the United States or with a substantial percentage of domestic content and labor; (2) they will not qualify if they exceed a price cap (many EVs do); and (3) income limits apply to taking the tax credit. I hope that Congress will return to this in the future and relax some of the restrictions to encourage more people to take advantage of these provisions.

Not only that, but EVs are hugely expensive. If it is true that an EV engine contains about twenty moving parts, while the average internal combustion engine contains about 2,000 parts, why is it that EVs are so much more expensive now? The answer is complicated: partly it is the battery cost and the research and development cost, but largely it is supply and demand. Demand today exceeds supply and buying an EV can be an exceedingly slow process. And annual auto insurance will cost more—about USD 1,600 more for Kia's EV6 than our current policy. Still, where we can and when we can we want to move forward. We will soon have the infrastructure installed. Buying an EV now might make sense, or it might make sense to wait a bit. Still, the future is clearly on the side of EVs.

COOKING WITH GAS

There is an easy replacement for our propane cook top—induction. Induction is widely used in Europe, less so it seems in the United States, but it is coming. Induction relies on magnets for heating, and it does so very fast. Induction heating is also very targeted, which prevents wasteful energy use. Induction heating systems also cool down quickly. Best of all, induction cooktops are sleek and clean; each only contains a polished glass surface to wipe down. However, there is one complication: we have a downdraft cooktop (not an overhead hood) and there are few manufacturers that make induction cook tops with the downdraft feature. Still, we hope to find one. In addition, installing an induction heating system will require running a 240-volt electric line to the kitchen.

ALTERNATIVES FOR HOT WATER

The last major item to consider is heating water. Of course, we could substitute an electric water heater for our existing propane heater. But electric heat is significantly less efficient and it can be costly, even if we are

producing our own electricity from the sun. A better alternative may be something called a "de-super" water heater that is linked to the geothermal furnace and uses waste heat to heat water to a certain temperature. At that point, water is transferred to an electric water heater to be warmed to the final (higher) desired temperature. A "de-super" water heater costs about USD 3,500 and does not include the cost of replacing the propane water heater. But this need not be done for a while; perhaps we can wait until the current water heater gives out—at over twenty years, it will not last forever.

PROPANE FIREPLACE

One item we have not yet considered is replacing our propane fireplace. But because, after five years, we have yet to use it—it is not a short-term priority.

CONTINUING ON THE ROAD FROM PARIS

We are fortunate as a couple to agree on these changes. We are also fortunate to have the incentive and the means to make them. We have not yet sought to quantify them, but no doubt they are shrinking our carbon footprint. Will we "solve" the climate emergency? Not even remotely—at least not by ourselves—but neither do we feel powerless. After years of negotiating about the problem internationally, it feels good to be taking concrete steps to address it.

Lastly, we are fortunate too to live in a time of enormous, exciting technological change. Good, economical, "green" options are being developed so fast that it is hard to keep up with them. Why not embrace them? ***f***

ENDNOTES

1 David Wallace-Wells, "Beyond Catastrophe: A New Climate Reality Is Coming Into View," *The New York Times Magazine*, October 26, 2022, https://www.nytimes.com/interactive/2022/10/26/magazine/climate-change-warming-world.html.

2 Tumin, Remy. "Battling the Winds of Climate Change" *Vineyard Gazette*, July 5, 2012, https://vineyardgazette.com/news/2012/07/05/battling-winds-climate-change.