Reducing our carbon footprint in a Hopkinton, MA household

Introduction

Over the past few years, I have become increasingly aware and concerned about the impacts of climate change, and as a household, this awareness has impacted many of our decisions. I'm writing this document to share some of our experiences in trying to reduce our carbon footprint. I hope that it can be helpful to our neighbors in assessing payoff times based on the local

programs and conditions. In the words of Dr. Katherine Hayhoe, a renowned climate scientist, “The most important thing you can do to fight climate change is talk about it.”

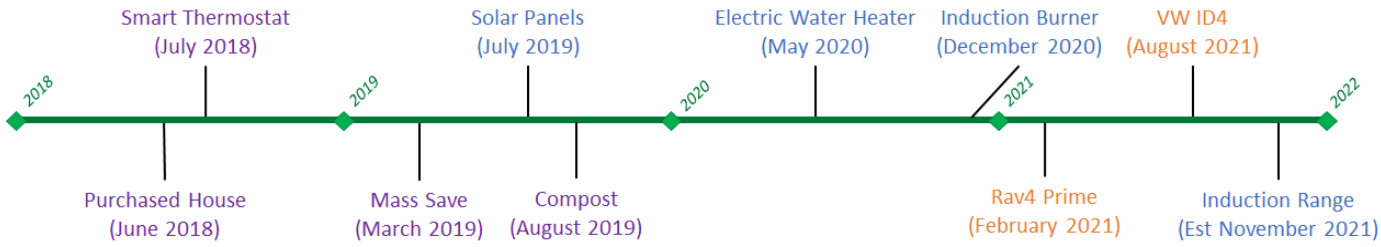
We are a family of three: Nicole, David, and our three year old Hailey. We moved into our house in Hopkinton, MA in 2018. David and I are engineers and tend to think analytically. We like data and problem solving. We are fortunate to have the financial means (like many in Hopkinton) to make some of these investments that have a higher upfront cost. My hope is that future policy decisions and investments will make these options more attainable for everyone.

As individuals, it can be overwhelming and hard to know what to do about climate change. While individual actions can’t solve this crisis–that will take major systemic change–I do believe there are benefits to individual actions:

- It may influence others, compounding the impact.
- When those who can afford it make the more environmentally friendly choices, it lowers the cost for future consumers.
- It is meaningful to feel like you are doing something, and live according to your values.

Of course the most substantial impacts can come from electing climate focused representatives and reaching out to businesses and leaders who have the influence to make larger scale changes. But this problem will take multiple avenues to address.

A quick disclaimer: none of this is to suggest my household is doing this right or perfectly. We’re doing what we can and are trying to factor the environmental impact into decisions we are making anyway. Below is a timeline of relevant actions we have taken over the past four years:



Applied Solutions

Smart Thermostats

July 2018

Updating the thermostats was a relatively easy early project after moving into our house. There were already programmable thermostats in the house, but they weren’t “smart”, so the settings

were static. We had put in the Nest thermostat in our previous home and really liked it, but this time to be able to do some more smart home integration, we went with the Ecobee.

For installing it, you'll want to check the color wire you already have in place to ensure compatibility. The websites for either thermostat have handy guides for making sure it will work for you.

Environmental Benefits:

The primary benefit is that the system learns and adapts to your behaviors and the conditions through sensors, programming, and your location. Therefore, energy is not wasted heating or cooling a house that no one is in.

There might also be the option you can opt into with your energy company for when there is high energy demand like on a hot summer day. It adjusts the temperature of your thermostat a few degrees higher in these conditions to help avoid brownouts or power loss in the community. As a result, you can avoid paying the premium of the energy cost at these peak demand times. If you need to, you can alway override it through your thermostat.

Project Drawdown: Smart Thermostats

Financial Benefits:

The cost is on the order of $100-$300 depending on the model you go with, but it qualifies for a rebate from Mass Save to offset the costs. The thermostats estimate a 10-15% cost savings on heating and cooling, which can pay for itself within a couple years.

Other Benefits:

With a WiFi enabled thermostat, if you want to check or change the status while you aren't home, you can do it from an app.

Ultimately, you may be more comfortable because your house is heated or cooled to the temperature you want by the time you want it, accounting for the external temperature to determine when to start heating or cooling by the time you wake up in the morning.

Mass Save

March 2019

Mass Save is an awesome program available to everyone in Massachusetts. You can schedule a time for an inspector to come and assess lighting, air sealing, fan venting, and insulation in your house from top to bottom. A report is written up with recommended changes, the cost, payoff time, and suggested contractors to complete the work.

The recommendations we received included:

- Front door weather stripping
- Attic stair cover thermal barrier
- Duct sealing
- Bath fan venting
- More attic insulation

We had already switched all of our lights to LEDs. But If you need LED lights, those may be given to you on the spot from their inventory.

Environmental Benefits:

A house with better air sealing and insulation requires less heating and cooling. Since our house is currently heated with natural gas, this reduces the fossil fuel usage to heat our home.

LED lights use far less energy than incandescent bulbs. It is an easy and inexpensive way to cut energy usage.

Project Drawdown: Insulation; LED Lighting

Financial Benefits:

It's free to get the audit, and most of the solutions are fully or mostly covered! The audit provides the estimated payoff time with every proposal. We ended up getting about $2600 of work done for $200. You can choose from the list of proposals exactly what you want done.

Other Benefits:

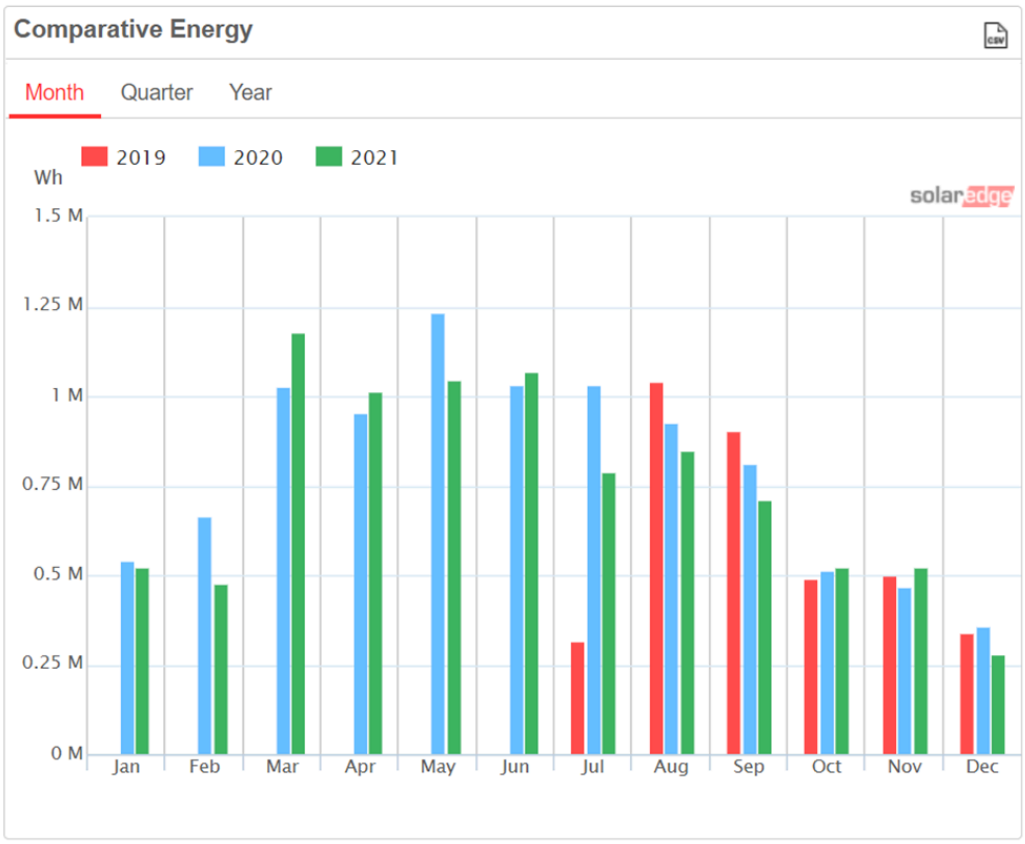
- With the door and window sealing, it will be less drafty in the winter.
- Proper venting of fans avoids a mold problem, which we had in the attic.
- LED lights last longer, turn on instantaneously, and don't let off excess heat.

Solar Panels

July 2019

When we first thought about doing solar, we started with looking up our "sun number" online, which you can find by looking up your house on Zillow. This analyzes your roof direction, pitch, shadows, and local climate to determine how good your house would be for solar. Our house is south facing with minimal shadows, so the score for our front roof was 90 out of 100, pretty good! Our roof was replaced in 2010, so it was about 9 years old at that point. We decided that wasn't too late to take this on, and the sooner we added solar panels, the more worthwhile it would be in the lifetime of the roof.

We got quotes from both Revision Energy and Boston Solar. Both were great, but we liked the layout design by Revision Energy better, so we went with them. Our ~3000 sq ft house has a front roof area that is ~33 ft x 17 ft with no obstructions. The design could perfectly fit 30 panels. We opted for the LG 320W panels. For this type, they are all black and the grid lines aren't visible. Alternatively, for a higher cost, we could have opted for higher efficiency 365W panels which have the grid lines. That choice is really just about personal preference for aesthetics, cost, and space available to generate sufficient power to cover your needs. Overall, it is a 9.6 kW system, meaning our peak production capability is 9.6kW at any one time. The system is expected to generate ~9,500 kWh/yr when considering seasonal variation. Our energy usage was ~6000 kWh/yr, so it fully covered our usage at the time, with some room to grow as we converted to electric appliances and vehicles. The warranty on the panels is for 25 years, though the projected life of the panels is around 40 years.



Monthly production comparisons

2020 was our first full year of solar power generation and was a total of 9,560 kWh, which aligns with the projected capacity of the system. 2021 is on track for a little less production, but still around 9,000 kWh, likely due to the very rainy summer, especially July. The generation varies through the year due to hours of sunlight, angle of the sun, leaves in trees casting shadows, temperature efficiency, and rain and snowy weather. Snow generally slides right off the panels the next day once the sun causes a little melt.

Massachusetts has net metering, which means any energy you produce but don't use in a month can be carried forward in future months as a monetary credit. In MA, these credits never expire. This is helpful because there are some times in the year where the system generates more power, and that credit can help cover the lower power generating months in the winter. Also, if you oversize that system in anticipation of future need, you can bank credits to use later.

As part of the installation, we decided to add a NEMA 6-50 240V outlet in the garage for $800. The electricians were already there, and we knew that long term we'd want to get an EV. By doing it as a part of our solar installation, it qualified for the tax incentives as well.

The federal tax rebate for solar panels at the time was 30% (now it is 26%). The MA state tax rebate is $1000.

Massachusetts also has the SMART program. In this program, utilities pay monthly for the amount of power that you generate for 10 years. This has nothing to do with how much you utilize. Basically, your energy provider is compensating you for helping them to reach their renewable energy targets. We were able to get into the first block of the program for Eversource, meaning it had the highest payout rate at the time: $0.14 / kWh, or an average of $105 deposited in our bank account every month for 10 years. Sweet!

The project took a few months from the time we signed the papers to when it was turned on. There was a waitlist for installation, then approvals for permits in town, inspections, etc. In general we were very happy with Revision Energy, as most of the delays were outside of their control.

Environmental Benefits:

Solar panels are a form of renewable energy and therefore can offset the need to generate electricity from extracting and burning fossil fuels.

Project Drawdown: Distributed Solar

Financial Benefits:

So what's the bottom line?

- The total cost of the project was $31,420.
- With our taxes the following year, we were refunded $9,426 federal, and $1000 state. That puts the net cost at $20,994.
- The SMART program generates about $1,250 per year for 10 years. At our electricity usage at the time, we would spend about ~$1,500 / yr. Between the SMART payment and the savings on what we would have paid for electricity, the payoff time is about 7.5 years.
- Of course our electricity usage didn't stay the same--it went up as we continue to "electrify everything" in the household. So instead using the cost that correlates with our full energy production capacity, the payoff time shifts to less than 6 years.

Beyond the payoff time, we continue to get those SMART payments until 10 years, and free electricity for the life of the panels. High upfront cost, but ultimately a very good investment!

Other Benefits:

- Less wear on the roof because of the panel coverage.
- Installing solar speeds up the payoff time of all household electric appliances or vehicles.
- It's fun to watch the metrics throughout the year. We have an app where we can track the power generation at any time. Fun for data nerds!
- In the future, we could choose to add a battery wall at home (rather than a generator) for power outage resiliency. Without that installed, we lose power along with everyone else, since the system shuts off for power line safety.

Compost Service

August 2019

We were thinking about starting to compost our food waste when we heard that Black Earth Compost service would be available in Hopkinton. It costs $115 for 6 months of weekly pick up service. The outdoor bin is provided, but we purchased a kitchen countertop bin for everyday use and utilize the green compostable bags for the kitchen bin and outdoor bin. Hopkinton currently (Dec 2021) has 131 households participating. We need to get to 300 for the price to drop to $81 for 6 months. As a town we have diverted 47 tons of waste from a landfill. I think that's pretty cool and I'd love to see us do more by growing the number of participating households!

Since starting with composting, I have definitely become more aware of our waste and make an effort to reduce our single use plastic, as that's the majority of what ends up in the trash. We generally take out one bag of trash every 2 weeks. I take the small compost bags down to the outdoor bin about 3 times a week, full of egg shells, vegetable peels, fruit pits, melon rinds, meat trimmings, bones, paper napkins, compostable takeout containers, greasy paper towels, etc.

Environmental Benefits:

Composting allows organic waste to break down in the presence of oxygen, avoiding the environmentally potent greenhouse gas methane (a molecule that is 34x more harmful to the environment than carbon dioxide). Instead, it generates a nutrient rich soil that traps carbon.

Project Drawdown: Composting

Financial Benefits:

None today. This is a service that costs money to participate in. There is no discount for reduced trash in Hopkinton.

Other Benefits:

- Trash doesn't smell
- Less trash goes to a landfill
- More aware of trash, and focused reduction of single use plastic

And specifically to using the Black Earth Compost service vs. backyard:

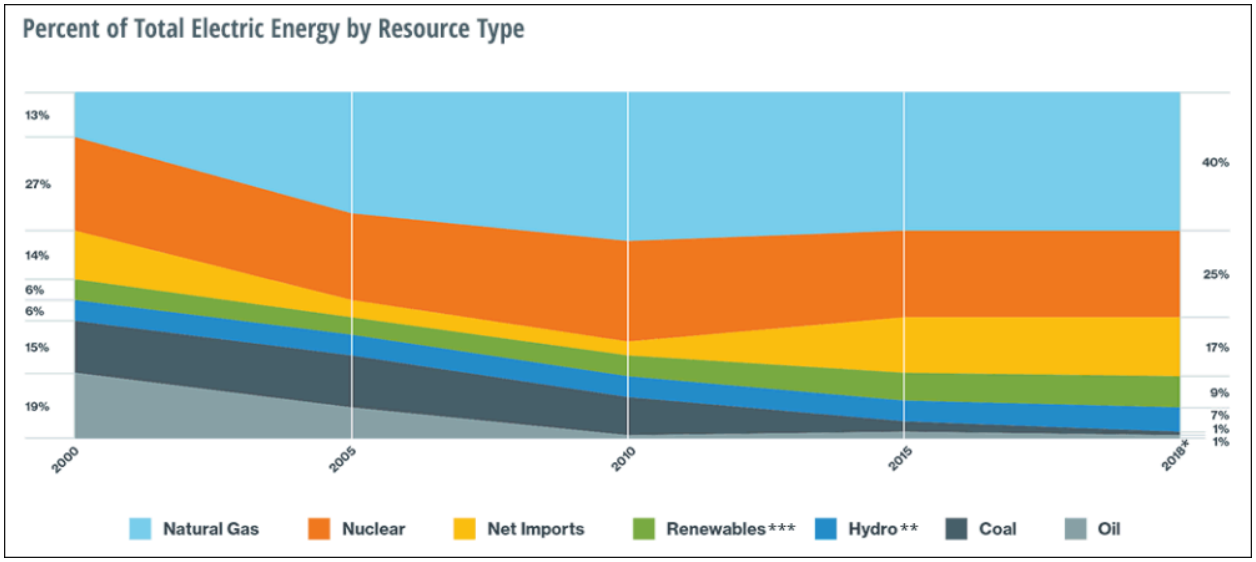
- It's a lower barrier from a time and effort perspective
- You can compost more complex organic material, like raw meat scraps, due to the heated process
- You get a free $10 bag of compost each year

Water Heater

May 2020

When our gas water heater died unexpectedly at 8 yrs, we needed to choose a replacement quickly. The easy choice is to just replace it with a new gas powered model. But with our solar panels, this was an opportunity to consider electrification. We priced out both options. The gas 50 gallon was about the same cost as the electric 80 gallon, $2750. A larger tank was recommended for electrically powered water heater because it is slower to heat. For an electric tank, we needed to have an electrician wire the connection ($850). The cost of the plumber capping the gas line was included in the installation. The cost of operating the water heater would be effectively $0 over the lifetime, as our electricity was now free due to the solar panel capacity we installed. We opted that the switch to electric was worth it. (Note: Knowing what we know now, we should have pushed for a heat pump water heater. This would be significantly more efficient but the contractor talked us out of it)

This is one of those costs of being a homeowner that isn't exciting, because once the bill is paid, you end up with the same outcome, hot water. But since a water heater lasts 8-12 years, we are happy that the new one we installed is not fossil fuel dependent. With every appliance replacement that is electric rather than gas powered, we are one step closer to reaching a household net zero footprint. Even if we did not have solar panels, Massachusetts' electric generation as of 2019 was ~40% renewables, nuclear, and hydro. This proportion will only increase as time goes on with the state energy commitments to 100% net zero by 2050, with intermediate benchmarks of 50% in 2030 and 75% in 2040. A gas powered water heater will always be 100% fossil fuel, while an electric water heater would be about 60% fossil fuel powered through electric generation today and reduce over time. Therefore, it is a choice that gets greener over time.



How New England's energy mix has changed since 2000 -- before Pilgrim's closure (Courtesy of ISO New England)

Environmental Benefits:

When the hot water heater is powered by electricity rather than natural gas, it reduces the carbon footprint to that of the local electricity generation which will become more renewable over time. And this is an investment that lasts for 8-10 years, so it's a decision that has a long term cumulative impact.

Financial Benefits:

The cost of the gas and electric water heaters were comparable, but we had the added cost of the electrician. Over time, that difference will be made up by the free electricity due to our solar panels. We don't have a good baseline for the gas usage of our old water heater vs. the electric usage of our new water heater to do the math on what the cost difference would be to operate.

Other Benefits:

None. Either way we have plenty of hot water for our needs.

PHEV and EV Cars

February and August 2021

Toyota Rav4 Prime

Both of our cars were getting older (2009 Honda CRV and 2010 Mazda3) and we were ready to get a new family car that would be more reliable. So much has changed for safety features in all cars over the past few years, so with a kid we wanted something newer to get the benefits of those features. We started looking in early 2020 and were trying to find an option that would be

big enough for our needs (similar size to a CRV) and would be environmentally friendlier. There were a few hybrid options out there that would meet these criteria, but the EVs of that size available at the time (Tesla Model X and Audi e tron) were financially well beyond what we were interested in paying. That's when we heard that Toyota was coming out with a Rav4 Prime: a plug in hybrid electric vehicle, or PHEV.

Here are some definitions if that's helpful. A hybrid car drives more efficiently than a traditional internal combustion engine (ICE), but is still powered by gas. A battery is recharged during operation to be able to gain more miles per gallon. A PHEV takes it one step closer to an Electric Vehicle (EV), because it has a larger battery that can be plugged in and charged to provide miles of electric range before switching to the hybrid engine. For the Toyota Rav4 Prime, this range is estimated at 42 miles, but in our experience in the summer months we saw up to 50 miles (lithium ion batteries have increased capacity in warm temperatures). Once you run out of electric range, it's a typical hybrid at about 40 miles per gallon. This got us the best of both worlds: for David's daily commute, it is effectively an EV; for long trips, there was no range anxiety because we could gas up as needed when we were beyond the electric range. At the hybrid driving efficiency, even on long trips we gassed up less often then with our previous car.

The total cost of the car for us was ~$47,200 including the weather package, taxes, and high demand for new car surcharges. The price certainly is higher than we would typically look for in a car, but it qualified for the federal $7500 and state $1500 tax rebate. **Note, we realized late that the state is not part of annual taxes and must be submitted within 3 months of purchase! Fortunately, we were able to still get that when we realized at tax season, but you'll want to submit to the state right away.** Once you factor that in, the price looks very similar to the comparable sized ICE vehicles. Cost was not our only motivator, and we were willing to pay a little more to align with our environmental goals. But in talking about this car to friends since then, we've gone back to figure out how the financials stacked up for different models.

Category	2021 XLE Rav4 (ICE)	2021 XLE Rav4 (Hybrid)	2021 Rav4 Prime SE (PHEV)
Engine Type	Gas	Hybrid	Plug-in Hybrid
MSRP	$ 27,645.00	$ 30,195.00	$ 38,350.00
Federal Rebate	$ -	$ -	$ 7,500.00
State Rebate	$ -	$ -	$ 1,500.00
Equivalent Cost	$ 27,645.00	$ 30,195.00	$ 29,350.00

The first thing to look at is upfront costs for a traditional internal combustion engine (ICE), a hybrid (HE), or a plug-in hybrid (PHEV). Taking into account the MSRP and the federal and

state rebates, if you are considering buying a hybrid car and are able to manage the higher upfront costs, the PHEV is actually cheaper.

When you start looking at the longer term cost of owning a car, you need to look at the driving efficiency and planned daily and yearly mileage. Instead of mpg, an EV/PHEV refers to driving efficiency in terms of miles/kWh. The Rav4 Prime has a battery efficiency of ~ 2.8 mile/kWh. Depending on the highway/ back roads driving amounts and the style of driving this will fluctuate.

Below is a table showing the cost of ownership of both the ICE and PHEV models. It assumes a 42 mile electric daily range for the PHEV. The ICE has an estimated MPG of 30 and the PHEV has an estimated MPG of 38 when using the hybrid engine alone.

Usage Information	
Daily Commute (miles per day)	*30*
Long Distance Travel (miles per year)	*3000*
Gas Price ($ / gallon)	*$ 3.38*
Electric Price ($ / kWh)	*$ 0.22*

Using the above assumptions we can estimate a break-even point for when the cost of usage for the PHEV would be lower than the ICE. Due to the higher gas efficiency and the all-electric battery range the break even timeframe is ~ 5 years. These numbers are very dependent on the current price of gas and the price of electricity. As the price of gas increases or the price of electricity decreases, the break even time frame will decrease. Since our solar panels are producing more than our current need, we do not consider the “Annual Commuting Cost” to be a part of our expenses. Considering this, our break even time is less than 2 years.

Category	2021 XLE Rav4 (ICE)	2021 Rav4 Prime SE (PHEV)
Engine Type	Gas	Plug-in Hybrid
Equivalent Cost	$ 27,645.00	$ 29,350.00
MPG	30.0	38.0
Electric Range	-	42.0
Cost Per Day (Gas)	$ 3.38	$ -
Cost Per Day (Electric)	$ -	$ 2.36
Annual Commuting Cost	$ 845.00	$ 589.29
Long Distance Cost	$ 338.00	$ 266.84
Total Annual Cost	$ 1,183.00	$ 856.13
Cost Break Even vs. Base ICE (yrs)	0.0	5.2

We got on the waitlist for the car, but there was limited availability in the US initially. We hoped to get it in 2020 to get the tax rebates sooner, but it ended up getting to us in Feb 2021.

Home Charger

By going with a plug-in car, we also decided it was time to add an at home charging station. The car only came with a level 1 charger, which means we can plug it into a standard 120V outlet. That can fully charge the Toyota Rav4 battery in about 12 hours, which is still a reasonable timeframe for a commuter car if you don't want to invest in a wall charger. Drive to work and back, plug in overnight, and ready to go the next day. And if you need to use the car without reaching that full charge, it's not a big deal as there's the hybrid range to fall back on. We pack this cord with us when we travel so we can plug in at our family's houses to fill the battery before our return trips.

We did want to get the level 2 changer, which lets us charge in about 4 hours. We already had the NEMA 6-50 240V outlet in the garage from when we installed solar panels ($800 electrician, qualified for the 30% rebate by doing it with our panels). The Rav4 Prime has an industry standard SAE J1772 plug, standard for all EV's besides Tesla. Knowing that we would eventually get a second car with a plug, we went with Clipper Creek that has a 2 plug option. The one we selected plugs directly into the NEMA 6-50 outlet, but other options could be wired directly by an electrician if you don't have the 240V outlet. This one retails for $1369, but the comparable one plug model costs less than $600.

This car is not optimized for charging, so on the road it is not compatible with a Level 3 DC quick charge. If you are somewhere for a few hours and have access to a Level 2 charger, then plug in! But I wouldn't plan a trip around plugging in for this car, since it takes about 4 hours to get just the 40-50 miles range. More about on the road charging later...

Volkswagen ID.4

Once we had the Rav4 Prime, we were hooked. Gassing up the car was rare, really only after long trips since daily work commutes were within the electric range. Plugging in at home was routine and worked out great. We felt good about this significant reduction of fossil fuel usage and charging was offset by our solar panels. Due to a variety of factors, during the summer we started to think about replacing my car as well. This time, we wanted to go all in with an EV. Already having a PHEV, we figured there would be flexibility. For trips we would go further than the car's range, if we didn't want to deal with charging, we could take the Rav4 Prime. But trips between 50 miles and 250 miles, we could take the EV.

I'll digress for a moment to mention that it's not lost on me how privileged this discussion is to be a two car household and get a second new car within one calendar year. We are very fortunate to have that option. But as I know we are not unique within Hopkinton, I'm being transparent about our story and expenses in case it is helpful to decisions for folks in a similar position.

We went to check out the newly released Volkswagen ID.4. With about 250 miles of range, it could cover or almost cover many of the trips we take. As a tall family and with a car seat in the back, we cared about leg room and we found it in this car. It's rear wheel drive (all wheel drive coming soon), and that initially had me nervous for winters, but with the low center of gravity from the heavy battery we decided that wasn't a factor we were too concerned about. The car comes with navigation, which is handy for planning in a charge stop along the way. Charging takes about 8 hours on the Level 2 charger like we already had set up at home, but that's only on days when you need a full charge which would not be a typical day. It has the same SAE J1772 plug as the Rav4 Prime, but also the additional DC charge component below it to be compatible with Level 3 CCS quick charging on the road.

We loved the car and how it drove. We lucked out and got one pretty quickly, although I expect usually there would be a waitlist due to the current unavailability of new cars. Because of that, there was a $3,000 markup on all new vehicles when we purchased it. The price was ~$49,000 after markups and taxes and there were good financing options available. Here again, the car qualifies for a $7500 federal tax rebate, and a $2500 state tax rebate (must be submitted within 3 months of purchase!) since it's a full EV, making the price look much more reasonable.

Charging on a Trip

We quickly wanted to try it out for a long drive to figure out on the road charging, and had the opportunity with a trip to visit family in New Jersey. One really nice thing is that the car comes with 3 years of free charging from Electrify America. There are charging stations all over the northeast corridor, and more are being built. With these Level 3 DC fast chargers, the car can go from 20-80% charge in about a half hour. For our family, stopping once on a 4-5 hour drive is pretty typical. So now we are a little more intentional about where we stop for a restroom, food, and stretch spot to also include charging. Many of these chargers are placed in locations with that same experience in mind.

We have now learned more about what to look for when picking a charging station. The Plugshare app is great for showing what's available across providers and compatible with your car. The reviews can be useful for figuring out the condition of the chargers and what's around. To truly achieve that quick charge rate of 80% charge in about a half hour, we look for chargers that are at least 50kW, but ideally 150kW. Chargers with a lower max power take longer to charge. The 350kW doesn't really give any benefit to this car because the battery will be limited to how fast its circuit can charge. With the free Electrify America, it's been great to stop at those for a free charge. But if we did need to pay, the cost would vary as some charge based on time and others on power delivered. Of the five on-the-road charges we have done so far, the average cost would have been $17, and the max $29 (when we did a 9%-90% charge).

I've been asked a few times "what happens if you run out of power on the road?". To me, I'm not that worried. I have never run out of gas in my years of driving, and I don't see this as much different. The car is not going to let you get that low without many many warnings. Chargers are pretty widely available, and if I was desperate I could go to the more common Level 2

charger to get enough charge to get to a Level 3 charger or my destination. And if I was really really desperate, I always keep the Level 1 charger in the car that can plug into any outlet and charge at about 3 miles an hour. There might be a little more planning involved in trips, but to me it's worth it, and really not difficult in the northeast with a large network of chargers. And it's only going to get easier in the next few years as more charging stations pop up.

Since getting the ID.4, we've taken it for all of our longer trips (to NJ, NH, VT, western MA, the Cape). Going to the Cape and back, for example, can be done on one charge. Longer trips, we really haven't minded stopping for a charge because we probably would have made a stop around that time anyway. Therefore, we haven't gassed up the Rav4 once since getting the ID.4. We switch off cars in our household based on who's doing a longer drive that day, and have been fully EV because of it.

These were the two cars that worked best for our family at the time we were ready to purchase them, but the options for PHEV and EVs are growing all the time. It's exciting to see the market moving in that direction, and hopefully soon this will be less notable or scary for the typical car buyer.

Environmental Benefits:

Hybrid and electric cars reduce and eliminate emissions due to operating a car. With renewable energy, charging up an EV is zero carbon. But even without a direct renewable energy source, the power would be comparable to the local grid, which will over time become less dependent on fossil fuels. In contrast, an ICE vehicle will be 100% dependent on fossil fuel power over its lifetime.

Cars without a tailpipe also reduce pollution impacts on highways and the communities that neighbor highways.

Project Drawdown: Electric Cars; Hybrid Cars

Financial Benefits:

- No gassing up required with an EV, and less frequently with a PHEV. Charging a car on the road can be a few dollars more expensive than filling a tank of gas (~$36 / 250 miles vs ~$28 / 250 miles), though gas prices show more fluctuation than electric pricing. Charging a car at home is less expensive than filling the car with a tank of gas (~$18 / 250 miles). When car companies have incentives for free charging (like our VW with ElectrifyAmerica) or discounted membership for charging for a few years, that can save money on trips. And when you have solar panels at home, the cost of home charging is further reduced or eliminated as well.
- No oil changes with an EV, and fewer with a PHEV.
- The overall cost of an EV or PHEV is higher upfront, though many are priced such that with the tax rebates, the cost ends up being close to the same price of a comparable ICE vehicle.

Other Benefits:

- These are fun cars to drive. When you press the accelerator, it just goes! The car rides smoothly and quietly.
- Without an internal combustion engine, there is much less that can fail or need maintenance on the car.
- No more standing out in the New England cold gassing up your car. Just go home and plug in!
- You can warm up your car in the garage with no carbon monoxide risk.
- This is the way of the future, with several car companies announcing that they are moving to an all-electric fleet in the next 10-15 years.

Induction Cooking

December 2020 / est. December 2021

This story has two parts. I was interested in switching us from a gas powered stove and oven to an induction range. My husband, the cook of the family, was skeptical.

I had multiple reasons for wanting the change. Every time we turned on the oven, I could smell the gas. To me, this didn't feel safe or healthy. I would open windows and turn on the fan. As I read more, I learned that gas cooking was associated with a 42% increase in a child developing asthma. Also, the air quality when using gas cooking would be illegal per outdoor standards.

With a toddler in the house who always wants to be in on the action, I'm always nervous with her near the cooking flame. And as the cleaner in the household, cleaning the gas cooktop surface is more time consuming and annoying than a smooth surface.

Our gas range was aging, but didn't yet need replacement. So we decided to do a test run with a single induction burner. Induction works by magnetic field with the pot or pan, therefore only magnetic metal pots and pans work on the cooktop. We tested all of our current pots and pans with a magnet and we already had a dutch oven and pasta pot that passed the test. We supplemented those with a small saucepan and two sizes of frying pans.

From that point on, we have done almost all of our cooking on this surface. Many meals only require one pot to cook at a time. If we want to utilize the fan, we place the burner right on our gas stove. The cook of the family, David, was convinced that it was as good or better for cooking, with as much control as a gas burner. The surface only gets hot immediately under the pot and cools down quickly. It's way easier to clean and creates no indoor pollution. It even came in handy when we had a winter outdoor gathering and could plug it in outside to keep our soup warm.

Our oven of course was still natural gas powered. It has gotten much slower to preheat, and at 16 years old, it's time for a replacement. We went over to Hudson Appliance, as they had induction units on display. Ultimately we landed on the GE Profile Induction Range. It is about $150 more than the comparable gas range. We did not have the 240V outlet in place, so we again needed an electrician to install it for $735. Due to the supply chain issues impacting microchips and therefore all appliances, there is a few months wait time to receive the appliance.

Environmental Benefits:

This continues the "electrify everything" theme. When the appliance is powered by electricity rather than natural gas, it reduces the carbon footprint to that of the local electricity generation which will become more renewable over time. And this is an investment that lasts for 15 years, so it's a decision that has a long term cumulative impact.

Financial Benefits:

For the range replacement, our motivation was more for the other benefits than for the financial reasons. It is about 5% more expensive for the induction range compared to the gas model. There was an added cost of $735 from the electrician because our kitchen didn't have the 240V outlet. Plus some replacement pots and pans for compatibility. With solar panels, the power source is free electricity vs the gas cost over 15 years.

The single induction burner was a good relatively low cost interim solution before we were ready to do a full replacement.

Other Benefits:

- Safer, with no hot surface or open flame
- Water boils faster
- Healthier with no increased asthma risk
- Easier to clean than gas cooktop surface

Other Product Choices

We've started trying some products that are more sustainable. We've used Grove for many of these products and place an order when we need enough things to be worthwhile. Some products are starting to appear in stores as well.

Paper Products

We've tried the toilet paper from Grove, which is made of 100% bamboo and is packaged without plastic. This is really good quality, and we aren't sacrificing any comfort by choosing it. Bamboo is better environmentally because it regenerates within months, vs a tree that takes

many years to reach maturity and carbon sequestration potential. When I consider the use of toilet paper, I hate to think about trees being cut down for a product with such a short use.

We've also tried paper towels made from bamboo or recycled paper. Recycled paper also has benefits because it again doesn't require cutting down mature trees for a new short term purpose, and doesn't require as much energy to produce. While we try to use washcloths as much as possible, when a paper towel is needed, I prefer this option.

Project Drawdown: Bamboo Production; Recycled Paper

Recycled Plastic Trash Bags

We've started using the 100% recycled plastic trash bags from Grove. They work just as well as any other kitchen trash bags, but aren't requiring new fossil fuels to generate them. This is one of those places that we don't feel we can eliminate plastic, so might as well use recycled plastic!

Reusable Shopping and Produce Bags

We keep several bags in the cars. I don't think we've even bought most of these bags, because they are given away so often at different events. We bring them not just into grocery stores but into other types of stores as well. That way we can avoid the plastic bags, and even the paper bags, since reuse is always better than recycle. Every few uses, I throw them in the wash to keep them clean.

We've also started using produce bags at stores rather than the plastic bags in the produce section. These are often sold in sets with multiple sizes. They can also help keep food fresh in the fridge. We have enough of these in rotation to be with the bags in the car, in the fridge with the fruit or veggies, or in the wash.

Laundry Detergent

We've tried out laundry detergent sheets, and have been really happy with them. I don't think I'll ever switch back to traditional detergent. There are two different brands I've ordered: Earth Breeze and Tru Earth. Both have worked great, and clothes come out just as clean. For most loads, I use a half sheet as recommended. Tru Earth is nice because the sheets are perforated to rip in half, but the Earth Breeze are easy enough to rip (just not as evenly). The sheet can either go into the load directly, or get loaded in the detergent drawer. These options are a bit more expensive than typical detergents, but to me the benefits have been worth it. I just wish these were available in stores and didn't require ordering online.

There are several benefits:

- These are plastic free, so there are no giant detergent containers involved. Although I have always recycled the empty bottles, I know a depressingly small amount of plastic actually gets recycled. It is nice to eliminate that entirely.
- Since it comes in small envelopes, it takes up less space in a cluttered laundry room. It is also lighter to carry around or easy to take when traveling.
- It's less messy. No sticky detergent to spill or cups with detergent residue left in them.

Shampoo and Conditioner Bars

I was skeptical about these at first, since my hair is long and thick and I've always been picky about shampoo and conditioner. I tried the shampoo and conditioner bars made by Peach, sold through Grove. I also bought a few mesh bags to put these in and stuck a few metal hooks in the shower to hang them. I've been pleasantly surprised with this product! As long as I get it wet enough to get some suds, it's been just as effective as liquid shampoo, without the plastic bottles. That combined with the classic bars of Dove soap, it cut out the plastic bottles from the shower. The only bar shampoo I've come across in stores so far has been the Love Beauty and Planet Shampoo Bar at Target.

Diapers

Diapers are a challenge because it's necessary but just a constant source of waste for a couple years. We went a combination of two routes with this: bamboo diapers and cloth diapering.

For the disposable diapers, we did a subscription service through Dyper. This sent us a monthly box in our specified size. These are made of bamboo, so unlike the typical diapers, they will decompose and won't stay in a landfill for hundreds of years. These were a quality product that worked as well or better than typical diapers. They still have the blue line, securing tabs, and were just as absorbent. Dyper recently added an additional service where they will send you the compostable bags and box to package your used diapers in to send back to them for composting. Although we use a local compost service, these diapers cannot be disposed of through that process because obviously human waste cannot be part of the compost soil that is generated.

In the last few months of diapering for our daughter, some friends offered to lend us cloth diapers in a size that they weren't utilizing. I was intimidated by the concept but they explained everything we needed to know: how to fold the cloth and secure them with a snappi, the bamboo disposable liners, the waterproof covers, the extra absorbent layer to use at night, and the wet bags to store soiled diapers. We ended up doing this at night and on weekends for the remainder of our diaper usage and while continuing to use Dyper for daycare. This added a load of laundry each week. Because this reduced our disposable diaper usage, we were able to cancel a few of the deliveries from Dyper and saved some money. There's some debate about whether cloth diapering is truly more sustainable. Utilizing the same diapers for multiple children definitely helps the equation. Air drying rather than adding another dryer cycle can also

help. From a cost perspective, getting the diapers second hand definitely made this a cost saving option, though if purchasing these new it could add up.

Ultimately, knowing what I know now I would have tried to potty train a few months earlier to eliminate the need for diapers sooner. But this balance as a whole worked for our family.

Buy Nothing Facebook Page

I love that in Hopkinton we have a “Buy Nothing” facebook page. This site is a great place to post items that you no longer need but still have life to them. I have both given and received many items for this page. I love avoiding a landfill with items that we no longer need but someone else could enjoy, and the community that it forms by sharing with neighbors.

Farmshare

For the past few years, we have been getting a farmshare for June to October. This is great because the food is local and seasonal, so there is a lower footprint from the transport while supporting nearby farmers and businesses. There is much less plastic packaging involved compared to purchasing in a store. It also encourages eating with a plant rich diet. With this farmshare, we are able to get a small vegetable share every other week, which we have found to be just right for our family’s needs while creating minimal food waste. We are able to share our preferences and edit our order so we only get foods we will use. We have added eggs, bread, and fruit in our orders, so there is little we need from the grocery store during farmshare season. And it inspires what to make for the week based on the variety of veggies we have coming. Our farmshare is through Warner Farm and pickup is available in Marlborough or Framingham (location chosen at the beginning of the season), but there are many great options in the area for similar programs. The cost for ours for the season with all of the add ons was $375 so there is an upfront cost to the future groceries.

Project Drawdown: Plant Rich Diet

Future Plans

We aren’t done yet! There are more steps we can take to further reduce our carbon footprint. Here are a couple we’re thinking about.

Heat Pump

We have not yet pursued a heat pump for our house, but we know that is the direction we’ll go when the furnace needs to be replaced, as this is another one of those 15-20 year decisions that could have a big impact. Heat pumps have come a long way in the past few years, so there is no longer reason to avoid them in New England. As has been the theme, this would transition from natural gas powered to electric. A heat pump is fundamentally a two directional air

conditioning system, so one system handles both heating and cooling. The heating has a higher efficiency than a traditional furnace. We have not yet looked into the upfront cost and any tax incentives available.

Project Drawdown: High-Efficiency Heat Pumps

New Windows

Another future project is replacing the windows. While ours are already double paned, they are still drafty. That heat loss leads to an overall increased energy use. A key area for reducing carbon footprint isn't limited to just switching to renewable power, but reducing the overall energy demand, especially as more and more appliances and vehicles go electric.
The payoff time for this isn't as clear, because it can be expensive. But we have aesthetic and functional motivation for the change as well, so it's not exclusively an energy related decision.

Closing

There are many ways to approach reducing a household's carbon footprint, with varying costs and impacts. Some of the choices we made were because something in our house reached the end of its useful life and needed replacement; some were more about small lifestyle or shopping changes. Once we started thinking about sustainability, we have wanted to do more and more, shifting the way we approach our purchasing decisions.

I have learned quite a bit from listening to environmental podcasts such as "A Matter of Degrees" (available anywhere) and "How to Save a Planet" (Spotify), as well as reading books such as "Drawdown" edited by Paul Hawken (more of a reference than a cover to cover novel), "All We Can Save" edited by Dr. Ayana Elizabeth Johnson and Dr. Katherine Wilkinson, and "Saving Us" by Dr. Katherine Hayhoe. All of these podcasts and books are solution oriented, so the overall takeaway is hopeful and empowering, and not the doom and gloom that can come from thinking about something as scary as climate change.

With all of these potential solutions, I think it's important not to get caught up in guilt of not doing enough, since none of us can individually fix the problem. I know that there is always more I can do. But by taking on new steps each year, I feel like I am moving in the right direction individually, while continuing to support, vote, and advocate for changes on a bigger scale.

I hope this reference was helpful, if in nothing else to inspire your own research and ideas about how to make sustainability changes!