



LESSONS IN RESIDENTIAL ELECTRIFICATION

AUGUST 2021

A PROJECT AND REPORT BY LEAP AND THE
COMMUNITY CLIMATE COLLABORATIVE

SUPPORTED BY AN ANONYMOUS FOUNDATION



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REPORT OVERVIEW

During 2019 - 2021, the Community Climate Collaborative (C3) and Local Energy Alliance Program (LEAP) conducted a residential electrification project and analysis to understand the potential benefits and challenges of fuel-switching in low-income households. In late 2019 early 2020, LEAP switched HVAC systems, hot water heaters, cooking ranges, and other appliances from fossil fuel-based to electric in eight households in Charlottesville and Albemarle County. C3 then followed the homeowners and their energy usage over the course of two winters.

In this report, you will find the analysis of the climate, energy consumption, and monetary impacts of the project, as well as, individual profiles of project participants and the scope of work for each household.

KEY FINDINGS

- Electrification combined with insulation improvements serves as an important strategy for reducing the overall energy consumption and average greenhouse gas emission of households in our community; especially for those relying on heating oil as a fuel source.
- The yearly GHG emissions of the eight participating households will reduce nearly 95.0% with respect to their baseline emissions by the year 2040 (as a result of expected grid decarbonization efforts), possibly avoiding a total of up to 2,094,281 pounds of CO₂e over the next 20 years.
- Greenhouse gas emissions decreased significantly (between -56.3% and -68.0%) for households that formerly used heating oil. Emissions of those that formerly used natural gas followed a less clear trend.
- The net present value (NPV) of projected yearly monetary savings adds up to ~\$ 32,000 over the next 20 years. The average NPV of \$4,000 per household should be kept in mind when assessing the best technology for replacing HVAC systems. Monetary results, although largely positive and based on a brief evaluation period of three months, varied widely on a case-by-case basis, with no clear reason as to why some households performed better than others.
- As a result of our fuel-switching pilot, the combined performance of the eight pilot participants between Q1 2020 and Q1 2021 resulted in a -56.0% decrease in energy consumption (or 202,567 MBTUs), a -26.6% reduction in energy expenditures (or \$1,946) and a -38.7% drop in GHG emissions (or 22,707 pounds of CO₂e).
- Upgrades will provide combined year-round reductions for the eight pilot participants of about -37.2% in energy consumption (or 340,711 MBTUs/year), -17.7% in energy bills' expenditures (or \$2,926/year), and -25.7% reduction in the GHG emissions (or 40,551 pounds of CO₂e/year).
- When considering monthly energy bill savings — maybe the most important metric for low-income households — further evaluation is necessary due to many unique and relevant variables present in each household. Future analysis of a full year's worth of energy bills for each household will give the most comprehensive insight into the financial impacts of electrification.

REPORT ANALYSIS

Background

Reducing the use of fossil fuels for heating spaces and water in homes (and other appliances to a lesser extent) in the greater Charlottesville area is a challenge that we must overcome together. As identified in [C3's Uncovering Energy Inequity report](#), every winter, many low-income households in greater Charlottesville are overly burdened by energy bills exacerbated especially by high propane and heating oil costs. From a climate perspective, the residential sector is the #1 source of emissions for the [City of Charlottesville](#) and #2 for [Albemarle County](#), with the majority of home-heating emissions estimated to be linked to the use of natural gas.

Electrification of home space and water heating, combined with the [expected decarbonization of Virginia's electrical grid](#), would assist the City of Charlottesville and Albemarle County in their endeavor to meet their new and ambitious climate change mitigation goals. Technological advancements continue to improve the performance and affordability of heat pumps, which has increased the feasibility of using them to reduce energy bills and meet comfort expectations (ACEEE, 2020).

To explore to what extent electrification efforts in the greater Charlottesville area can reduce net GHG emissions and energy costs, LEAP and C3 implemented a fuel-switching pilot, which included fuel switching of different fuels (i.e., fuel oil and natural gas) and functions (space and water heating, and cooking) in eight households in greater Charlottesville. The pilot aimed to provide important information to policymakers (locally and statewide), while also delivering meaningful energy savings, climate impacts, and health benefits to homeowners.¹

Baseline

Our fuel-switching pilot included eight households, three in the City of Charlottesville and five in Albemarle County. Between September of 2020 and January of 2021, participants received energy efficiency upgrades and fully electrified their homes; switching a mix of HVAC, water heating equipment, and other appliances from heating oil or natural gas sources to electricity. In order to compare the performance of the upgrades, this case study compares their energy consumption and expenditures of the first quarter (Q1) of 2020 and of 2021 (recognizing that households' former fossil fuel consumptions were mostly utilized for heating purposes).

Methodology

Our case study did not select participants (nor a control group, for that matter) with the goal of conducting a study with statistically significant results. Moreover, partially due to [Virginia's](#)

¹ Fuel switching refers to the practice of replacing a heating or cooling technology or appliance with one driven by a different energy source, e.g., displacing heating oil and/or propane through the installation of an electric air source heat pump. This is also referred to as "electrification" or "beneficial electrification."

[coldest winter in the last 6 years](#) and the unforeseen COVID-19 pandemic, baseline conditions of our case study were not uniform; which might have further reduced the accuracy of our results.

For instance, according to [NOAA's National Centers for Environmental Information \(NCEI\)](#), average monthly temperatures in Q1 2020 were about 4.3°F higher than in Q1 2021; which is likely to have increased electricity usage for space heating.² Additionally, as observed on Table 1, the household size of some participants increased as children formerly in college moved back home during the COVID-pandemic, while some households are now finally able to meet the heating and cooling needs of areas in their homes that were formerly uncovered by their HVAC systems.³

Table 1. Participants Baseline and Changes

| Participants Baseline | | | |
|-----------------------|----------------------|---------------------------|-------------------------|
| Households | Original Fuel Source | Household Size Change (%) | Covered Area Change (%) |
| Sammy | Natural Gas | 50.0% | N/A |
| B. Household | Heating Oil | 0.0% | N/A |
| Bolden | Heating Oil | 0.0% | 50.0% |
| Grady | Natural Gas | 0.0% | N/A |
| Hicks | Heating Oil | 50.0% | 50.0% |
| J. Household | Heating Oil | 0.0% | 25.0% |
| M. Household | Natural Gas | 0.0% | N/A |
| Terrell | Natural Gas | 0.0% | 25.0% |

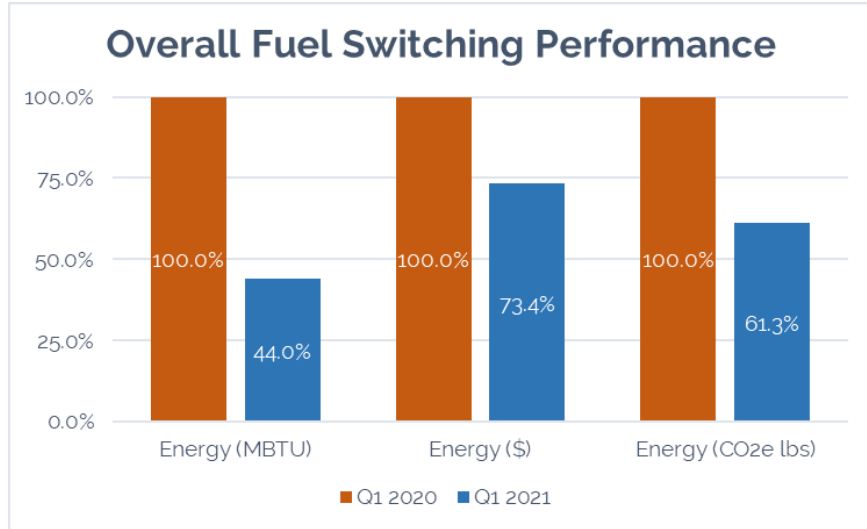
Group Performance

When electrification saves energy (in total MBTUs), saves money, and reduces emissions, it can be viewed as a form of energy efficiency (ACEEE, 2020). According to the combined performance of the eight fuel-switching pilot participants, it is possible to see that our pilot meets all these three criteria and actually served as an energy efficiency upgrade. In the comparison between Q1 2020 and Q1 2021 (Figure 1), energy consumption fell by -56.0% (or 202,567 MBTUs), while energy expenditures reduced by -26.6% (or \$1,946) and GHG emissions dropped -38.7% (or 22,707 pounds of CO₂e).

Figure 1. Overall Fuel Switching Performance

² Using [EnergyHub's estimation](#) of 3% increase in heating energy use as a result of each extra °F in indoors-outdoors temperature differentials.

³ Formerly, Bolden's and Hicks' households were not able to meet their full home heating needs both in terms of area covered and in terms of year-round needs. Therefore, for simplicity, it is assumed that their baseline energy expenditures and consumption only met 50% of their actual heating needs.

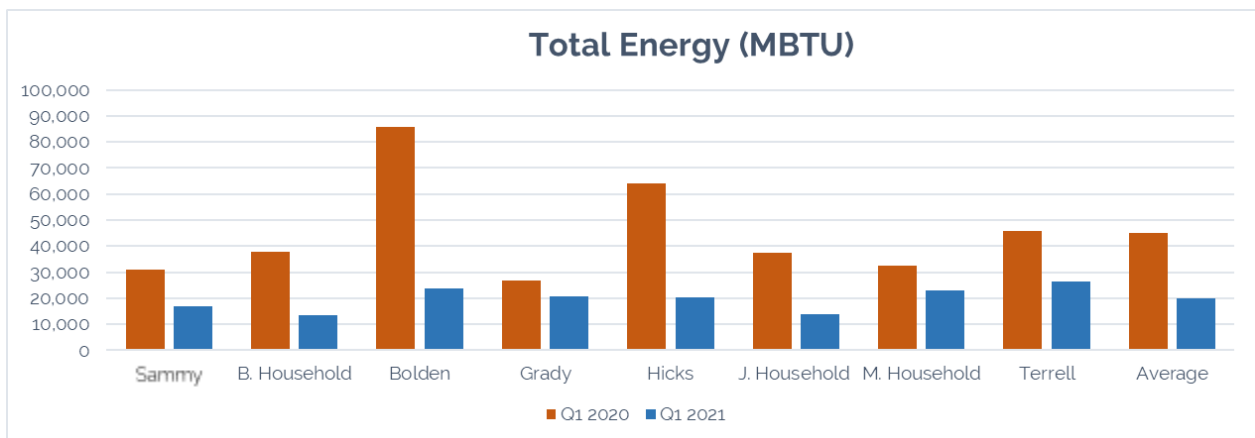


Individual Performance

Energy Consumption

Important energy consumptions decrease, between -62.6% and -72.5%, were observed for households that previously relied on heating oil (B. Household, Bolden, Hicks, and J. Household).⁴ Households that formerly used natural gas (Sammy, Grady, M. Household, and Terrell) also saw their energy consumption levels decrease, but at a lower rate; between -22.7% and -45.4%.

Figure 1. Total Energy (MBTU)

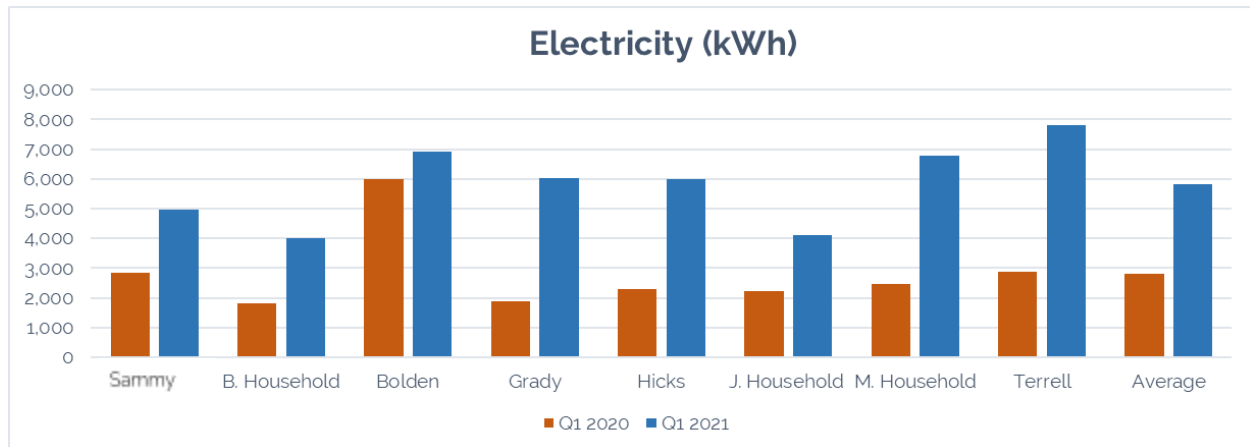


However, as expected, fully electrifying all the eight housing units led to increased electricity consumption for all households (Figure 2) and subsequent growths in electricity

⁴ Baseline consumption of heating oil (in gallons) was estimated by LEAP's team using a theoretical methodology.

expenses. Increases in electricity expenses varied widely (from 15.2% to 222.0%) and with no particular relationship with the original type of fossil fuel consumption; however, it is important to remember the participants' baseline changes (Table 1) and the limitations faced by our case study when comparing pre-post results with all the changes of the COVID-pandemic.⁵

Figure 2. Electricity (kWh)



In terms of overall energy consumption (in MBTUs), the fuel-switching and insulation investments of our pilot lead to reductions for every household between Q1 2020 and Q1 2021, suggesting that all of them benefited from higher energy efficiency levels after improvements were completed.

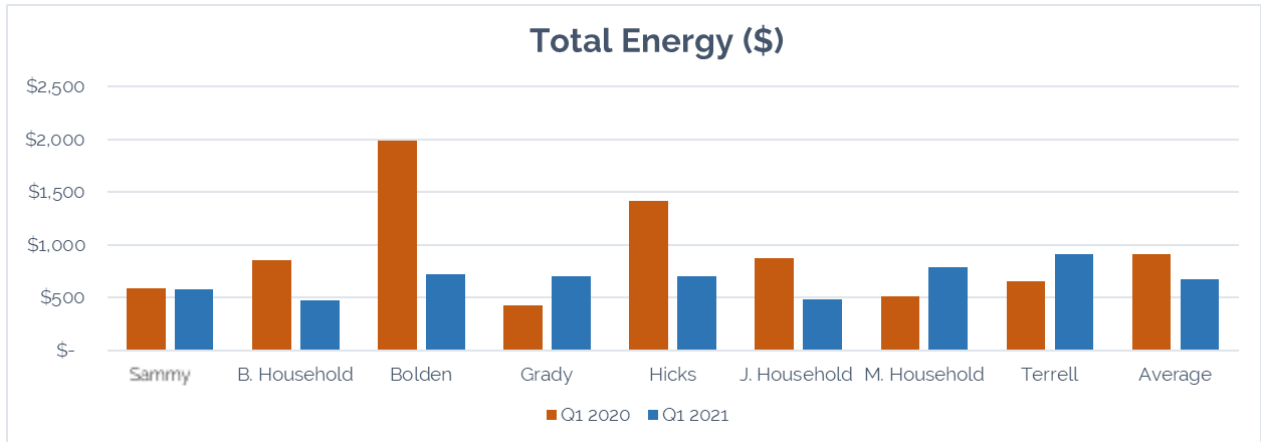
Energy Expenditure

On average, energy costs of pilot participants in Q1 2021 were \$243 lower than in Q1 2020. However, reductions in overall energy expenditure (in dollars) were less universal than reductions in energy consumption (in MBTUs). Five out of the eight participating households experienced reductions in their energy expenditures, ranging from -0.4% to -63.6%. Households that incurred a Q1 2020 over Q1 2021 comparative increase in energy expense for that period (not over the entire year) were impacted by specific reasons that likely included: (i) Colder temperatures in 2021 vs 2020; (ii) increased heating usage caused by more hours indoors because of COVID; (iii) increased heating coverage in the home (whole home versus only the bedroom previously); and (iv) Additional inhabitants in the home. Each case is unique and is discussed in the profile section of the report.⁶

Figure 3. Total Energy (\$)

⁵ Potential differences in the baseline energy efficiency levels of each housing unit, pre insulations works, further limit the capacity of comparing individual results between households.

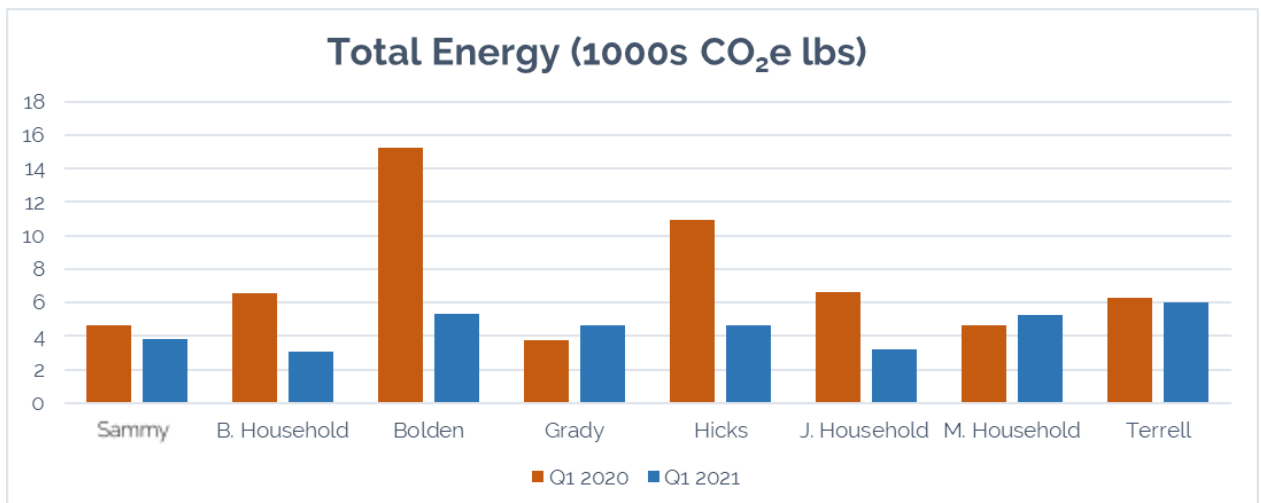
⁶ Changes in households' home usage during the COVID-19 pandemic and the expected rebound effect could also help explain the different performances among households.



GHG Emissions

When it comes to the climate benefits of our pilot, results were overwhelmingly positive and widespread (Figure 4), following a similar trend to that of overall reductions in energy consumption (in MBTUs). GHG emissions decreased more importantly (between -56.3% and -68.0%) for households that formerly used heating oil. Emissions of those that formerly used natural gas changed in a less homogeneous manner.

Figure 4. Total Energy (1000s CO₂e lbs)



Discussion

As onsite residential fossil fuel consumption is mostly used for heating purposes (and, therefore, very seasonal), these results would probably not hold at a similar rate for every quarter of the year. However, Q1 residential fossil fuel consumption is estimated to represent 46.9% of the total year-round consumption (based on information from Charlottesville Gas)

and, therefore, it is reasonable to expect that the fuel-switching upgrades would provide year-round reductions of about -37.2% in energy consumption (or 340,711 MBTUs), -17.7% in energy bills' expenditures (or \$2,926), and -25.7% reduction in the GHG emissions (or 40,551 pounds of CO₂e).

The overall benefits of the pilot, both monetarily or environmentally (or even from a health or comfort levels perspective, as observed in "Section (....)"), are even more impressive when considering the full lifespan of the newly acquired electric systems.

Assuming that the upgrades will last for a period of 20 years, the yearly GHG emissions of the eight participating households would reduce to about 5.0% of their baseline emissions by the year 2040 (as a result of expected grid decarbonization efforts); possibly avoiding a total of up to 2,094,281 pounds of CO₂e over the next 20 years.

From the financial perspective, the net present value (NPV) of the projected yearly monetary savings of the project would add up to around \$ 32,000 over the next 20 years (assuming an annual discount rate of 3%). The average NPV of \$ 4,000 per household should be kept in mind when assessing what's the best technology for replacing old heat pumps.

Although not quantified in our analysis, interviews conducted with the households in the month of June 2021 indicate that the fuel-switching and insulation upgrades are also helping households use their cooling systems in a more efficient way during warmer seasons. Temperature holds for a longer period of time and households feel more comfortable setting their thermostats at temperatures closer to those [recommended by the US DOE](#).⁷

Conclusion

The results of our fuel-switching pilot suggest that electrification combined with insulation improvements serves as a good strategy for reducing the overall energy consumption and average GHG emissions of households in our community; especially for those that used to rely on heating oil as a fuel source.

Monetary results, although positive on average, varied widely on a case-by-case basis, with no clear reason as to why some households performed better than others. For that reason, especially when working with lower-income households, we recommend combining fuel-switching investments with energy efficiency upgrades to ensure that bill reductions are indeed achieved.

Additionally, as households' energy consumption patterns and behavior might impact utility bills and/or undermine energy efficiency work, it is important to empower households with sufficient knowledge about best practices for a more efficient use of their new HVAC systems. This way, potential adverse behavior changes that might lead to [rebound effects](#) in their energy consumption levels would be prevented and the benefits of fuel-switching would be fully realized.

⁷ However, there are still opportunities for increasing households' awareness of [best practices](#) for efficiently setting temperature levels, saving energy and, therefore, further reducing their bills and GHG emissions levels.

FAMILY PROFILES

THE SAMMY HOUSEHOLD

THE GRADY HOUSEHOLD

THE BOLDEN HOUSEHOLD

THE "M" HOUSEHOLD

THE "B" HOUSEHOLD

THE DRUZBA HICKS HOUSEHOLD

THE "J" HOUSEHOLD

THE TERRELL HOUSEHOLD

THE SAMMY HOUSEHOLD

FRY'S SPRING NEIGHBORHOOD
CHARLOTTESVILLE, VA



Just down the road from the Fry's Spring beach club, Sammy and his family are building their own gathering spot for themselves and extended family living nearby. His wife and three daughters moved to the United States 11 years ago on a Special Immigration Visa, due to Sammy's work with U.S. troops as a translator. His two younger daughters are in high school and his eldest is in college.

His sister moved to Charlottesville as a refugee several years prior and enjoyed it so much that Sammy decided to do the same and bring his family here. Since that time, several other family members have immigrated to Central Virginia and they plan to make Charlottesville their forever home.

This plan includes making their home, purchased in 2015, as comfortable, inviting, and efficient as possible. They called on LEAP for a home energy assessment in July of 2020. Their bills to heat and cool their home would exceed \$400 in both the summer and winter months. Additionally, with five people living in the house, hot water for showers was becoming difficult.

Homeowners:
Sammy

Number of Residents in Home:
5

Year Built:
1972

Square Footage:
2,214

Years in the Home:
5

Former Fuel Usage:
Natural Gas

Upgrades:
Replaced natural gas furnace, gas water heater, and removed gas line

Projected Net Energy Savings (Btu):
27,448

Observed GHG Savings (lbs. CO₂):
775

As part of LEAP's weatherization program, they were able to make small energy efficiency improvements right away, including insulation of the water heater (also past its life expectancy), pipes, and attic. To achieve greater efficiency, however, they would need to make a larger investment to replace the 25-year-old furnace, the heat pump, and the water heater. It seemed out of reach.

So when they found out about the fuel-switching opportunity, they gratefully jumped on it. The project kicked off in September of 2020 when A&J Heating & Cooling delivered a new energy-efficient electric heat pump (18 SEER rating) and water heater to their home. Installation went smoothly. The central ductwork in the house was all in good condition and did not require any improvements.

In just a month, the family saw a huge difference in their utility bills, with a decrease from approximately \$600 dollars in February of 2020 (electric only) to \$200 in February of 2021! They are also enjoying consistently hot showers.

We checked in with Sammy in April to see how the family was enjoying their home and dramatically reduced utility bills. Sammy said they absolutely love it! He has a vision for his home to create an inviting place for family and friends to gather: a covered patio, glass-enclosed sunroom, outdoor kitchen, and pergolas covered in grapevine. This project along with the front covered porch that he, his brother, and nephew built is making that vision a reality.



Disclaimer: Our project included a small sample size of eight households. Results for households were based on the comparison of three months of data from Q1 2020 and Q1 2021. Temperature variations between 2020 and 2021 were significant, and the Covid-19 pandemic likely had a significant impact on behavior and energy usage of all participants.

DELOIS GRADY

FOUR SEASONS NEIGHBORHOOD
ALBEMARLE COUNTY, VA



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Delois Grady has been working in daycare for the past 40 years. YES, 40 years! At 66 years old, it's hard to know where she can find the energy to keep up with the 11 children in her care for sometimes 10 hours a day.

"I've seen kids get married, go to college, get jobs, have kids. I've seen it all. And I love it! It's what keeps me going!" Ms. Dee, as the children call her, lives in a 1400 square foot attached home in the Four Seasons neighborhood in the County. She lives there with her differently-abled, 40-year-old son who works at Kroger and also helps with the daycare service when he can. Delois has 9 siblings, 6 of whom reside here in Virginia.

She says one thing that her daycare families really appreciate about her service is that she is basically always open. **"I never close,"** she tells us. **"It's hard for my families. If I close then I am impacting 11 families, and I don't like to do that."** But when we ask her how she keeps up with managing a daycare, she laughs and says, **"The kids give me energy."**

Homeowners:
Delois Grady

Number of Residents in Home:
2

Year Built:
1973

Square Footage:
1,428

Years in the Home:
21

Former Fuel Usage:
Natural Gas

Upgrades*:
Replaced water heater and furnace

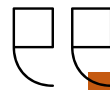
Projected Net Energy Savings (Btu):
15,291

Observed GHG Savings (lbs. CO2):
-924

COVID-19 has impacted her business, but she was grateful to receive the first round of COVID relief funding and hopes that she will be eligible for the second round in early 2021. She would like to use those funds to transform her small outdoor patio into a larger space for the kids: **“It’s important for the kids to get outside every day.”**

Delois was extremely excited about participating in C3 and LEAP’s electrification project for financial and comfort reasons. The cost of a brand new system was unnerving for her to think about, especially as she looks to retirement. Her out-of-date natural gas system would make the upstairs **“feel like a sauna”** while the downstairs was still cold. The unit was also 25 years old and on its last legs.

In time for the colder winter weather, Air Flow Systems came in to take out the aging HVAC and replaced it with a highly efficient 16 SEER A/C system. They also installed a brand new electric water heater. She is so excited to have a more reliable system for her and her son, but also for the kids at daycare.



“The timing of this has been so wonderful. We are very grateful! This is a blessing!”



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Additional Information: A daycare service is operated out of the Grady household creating the potential that water use is high enough that it’s forcing the heat-pump water heater out of heat pump mode in order to recover in time.

ALVER BOLDEN

PORTERS ROAD
ESMONT, VA



COMMUNITY CLIMATE
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Homeowners:
Alver Bolden

**Number of
Residents in Home**
1

Year Built:
1962

Square Footage:
1,354

Years in the Home:
58

Former Fuel Usage:
Oil

Upgrades:
Removed oil tank.
Installed new HVAC
system and
ductwork

**Projected Net
Energy Savings
(Btu):**
93,457

**Observed GHG
Savings (lbs. CO₂):**
9,934



When we pull up to Alver Bolden's home on Porters Road in the heart of Esmont, her son Karl is outside working. His home, built in 1922, is only a stone's throw away from his mother's, and he comes to greet us with a smile. After we exchange pleasantries, Karl tells us about the land upon which his mother's house was built, and how it has been in his family for as long as he can remember. We leave feeling enriched by his stories and even more excited to get this fuel-switching job completed for his 85-year-old mother. Ms. Alver Bolden had been unable to return home after suffering from a stroke in March of 2020; the home that she has lived in for her entire life. This past April, she was finally able to return home.

Karl tells us that the kitchen was always cold, and you could feel air moving through the house. Additionally, the furnace was old and the fuel oil tank under the home was a growing concern for Ms. Bolden. Karl and his sister, Tammy, are delighted that this work will make the house safer, comfortable, affordable, and overall more livable for their aging mom.

In addition to LEAP and C3, many community partners came together to work on the Bolden home, including Building Goodness Foundation and their volunteer contractor partners, and A&J Heating and Air.

The work scope included switching out a 25+-year-old furnace, which was inefficient and ultimately unsafe, with a high-efficient system and new ductwork; building a wheelchair ramp; replacing the roof and adding 15" of insulation; and, completing bathroom upgrades to make everything wheelchair accessible. Best of all, "It's **going to be a surprise,**" Karl tells us with a twinkle in his eye. His mother doesn't know that she will be coming home to a completely upgraded home.

"Mom is most looking forward to being around family, her two dogs, her flowers and being able to look out the window. She loves doing that."

We are happy to report that this spring Ms. Alver returned to her childhood home to be among family and the land once again. This time in a more efficient, more economical, and safer home.



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THE "M" HOUSEHOLD

BELMONT NEIGHBORHOOD
CHARLOTTESVILLE, VA



This Belmont homeowner takes a lot of pride in her Charlottesville home that she has lived in since 1986. Having worked as a chef, florist, and even owned her own shop at one point, she is now retired and living on a small fixed income.

She loves her porch and back deck. Over the years she's added to the home bit by bit, painting the rooms in bold colors. **"I'm not one to be afraid of color,"** she tells us. And when we talked in her living room, I couldn't help but notice the beautiful plant next to her lounge chair that reached the ceiling and spanned at least 4' across. She definitely has a green thumb!

She told us that she was **"tickled"** to find out there was still funding for the fuel switch program. Initially, she was worried about any increase in utility costs, but after speaking with friends and family (who said **"Go for it!"**), she is looking forward to the upgrade. As luck would have it, two days before the project, her clothes dryer stopped working. As unfortunate as it may be for some, it was especially good timing for this homeowner.

Homeowners:
"M" Family

Number of Residents in Home:
2 (including downstairs tenant)

Year Built:
1952

Square Footage:
1,025

Years in the Home:
35

Former Fuel Usage:
Natural Gas

Upgrades*:
Upgraded electrical.
Replaced gas furnace with electric heat pump. Replaced water heater and gas dryer

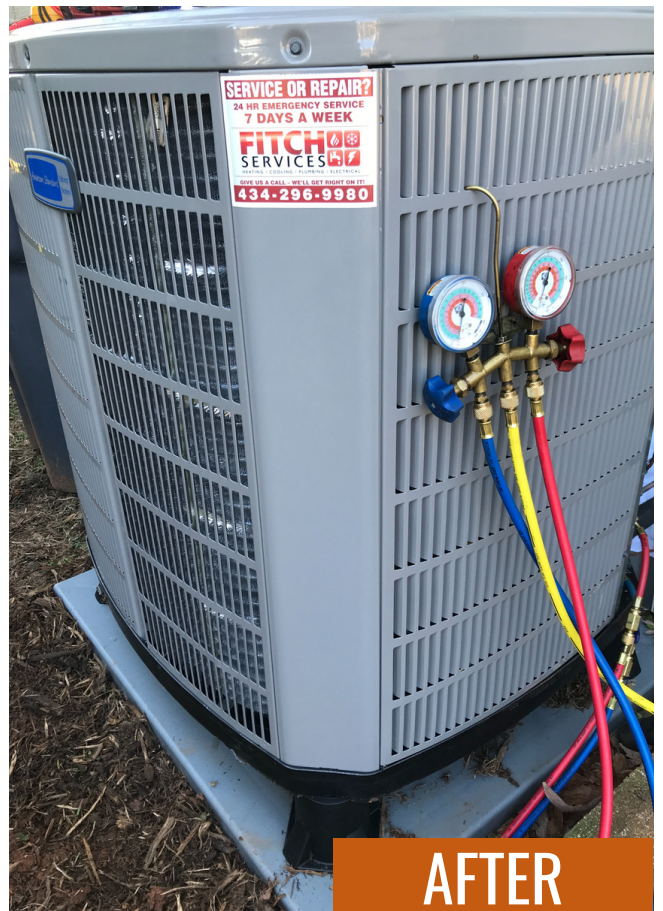
Projected Net Energy Savings (Btu):
20,432

Observed GHG Savings (lbs. CO₂):
-597



“I’m on a fixed income
so this is great.”

She noticed the benefits from the upgrades right away! They increased the home's insulation from 2" to 15" (to achieve an R 49) and installed a super-efficient 16 SEER HVAC system, as well as a new water heater and electric dryer.



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Additional Information: The clothes dryer for the "M" household was a natural-gas dryer and was exhausting CO into the crawl space, making it a significant health and safety concern. The household received a new, efficient electric dryer through the project.

THE "B" HOUSEHOLD

BELMONT NEIGHBORHOOD
CHARLOTTESVILLE, VA



COMMUNITY CLIMATE
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Homeowner:
"B" Family

**Number of
Residents in Home:**
2

Home Built:
1985

Square Footage:
No Data

Years in Home:
24

Former Fuel Usage:
Kerosene

Upgrades:
Removed furnace,
ductwork, and
window unit. Installed
2 mini-split systems

**Projected Net
Energy Savings
(Btu):**
36,342

**Observed GHG
Savings (lbs. CO₂):**
3,470



This Belmont homeowner and her mother were both born and raised in Charlottesville. The pair has lived in their 1980's mobile home in Belmont for 21 and 24 years, respectively. The homeowner is the sole caregiver for her 75-year-old mother, who is bed-ridden and suffers from numerous health issues including asthma, diabetes, high blood pressure, and COPD.

She told us that the kerosene space heater they've been using can cost as much as \$400 in a month, which is difficult for them. Her mother doesn't like electric heaters, so during the cold winter months, the women would use a kerosene heater to stay warm. They did have a propane furnace that was ducted underneath the mobile home, but that was expensive to fill.

Thankfully, she found out about the program through our community partners at AHIP. She is really looking forward to the new mini-split system.

“I don’t like the kerosene heat at all, but it’s the only thing my mother says makes her warm. It will be a relief to have this new system for her.”



Once A&J Heating and Cooling took on the project, they discovered that the installation of the mini-split in the rear of the home would require an electrical upgrade. This needed to be approved by Dominion energy.

Nevertheless, the crew moved forward with the front of the home, where the mother's bedroom resides, and by springtime the rest of the project was complete.

When we checked back in with the homeowner this spring, she said she was liking the system!



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KATHLEEN DRUZBA HICKS

IVY, VA



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Kathleen Druzba Hicks was thrilled to hear about the opportunity to switch her Albemarle home from propane to electricity with the C3 and LEAP electrification project. This mom of two daughters, and a sweet boxer puppy named Phoebe, recently moved back to Charlottesville from South Carolina to be closer to family. After living at the Lakeside apartments, she bought a 1972 home in Ivy and is remodeling it herself. As a single-mom, Charlottesville High School P.E. Teacher, and head coach for the CHS varsity field hockey team, Kathleen didn't want to get blindsided by high utility bills in the winter months.

"The heating system was original to the home, super inefficient, and felt unsafe."

She told us. **"And they warned us of the utility bills. Our first winter we were really cold,"** she said before the new system was installed. The furnace really wasn't doing its job and it had an unpleasant smell.

Homeowners:
Kathleen Druzba
Hicks

**Number of
Residents in Home:**
3

Year Built:
1972

Square Footage:
1,888

Years in the Home:
Less than 1

Former Fuel Usage:
Natural Gas

Upgrades:
Removed propane
tank and installed
heat pump

**Projected Net
Energy Savings
(Btu):**
65,713

**Observed GHG
Savings (lbs. CO₂):**
6,326

"It's rustic, but not in the good sense," she explained. **"It literally smelled rusty."** They had to run space heaters just to keep up.

That's why she jumped at the chance to be a part of the fuel-switching initiative. Immediately after the equipment installation and the insulation upgrades, they could tell a difference. The new heating/cooling system has a SEER rating of 18, and the additional 10" of insulation raised the R-value to 49 (R-value is a measure of how well a two-dimensional barrier, such as a layer of insulation, a window or a complete wall or ceiling, resists the conductive flow of heat. The

higher the R-value the more efficient your home).

"It's been great and we are super grateful."

Her two daughters now live in the house with her, one is a sophomore in college that moved back home once COVID-19 hit. Her aging parents retired here. **"We have 6 out of 7 family members living here in Charlottesville, so it's nice to be close to them now."**

They couldn't be happier with the new system. **"Right girls?"** and her two daughters vehemently nod. She offered to share her story with anyone else who is interested in going electric.

BEFORE



AFTER



Disclaimer: Our project included a small sample size of eight households. Results for households were based on the comparison of three months of data from Q1 2020 and Q1 2021. Temperature variations between 2020 and 2021 were significant, and the Covid-19 pandemic likely had a significant impact on behavior and energy usage of all participants.

THE "J" HOUSEHOLD

COVESVILLE, VA



COMMUNITY CLIMATE
COLLABORATIVE

Homeowner:
"J" Family

**Number of
Residents in Home:**
2

Home Built:
1960

Square Footage:
704

Years in Home:
65

Former Fuel Usage:
Oil

Upgrades:

Removed oil tank and window units. Replaced ductwork and added floor vents. Installed new HVAC system, attic insulation, new roof, weatherization, and air sealing

**Projected Net
Energy Savings
(Btu):**
35,402

**Observed GHG
Savings (lbs. CO₂):**
3,433



This Coveseville homeowner has lived in her 1960's one-story, 704 square foot home for her entire life. She is 91 years old and lives with her 65-year-old son. Before the fuel switch, they were using kerosene heat. This was likely due to the fact that they would go through 500 gallons of fuel oil per winter which by today's standards would cost \$1,400!

We reconnected with the homeowner in the Spring of 2021 to obtain her electricity data. She is very happy with the new system and ductwork. She says this is a huge improvement from the one heating duct for the winter and the two window units that provided cool air in the summer.



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CHARLOTTE AND RALPH TERRELL

10TH AND PAGE NEIGHBORHOOD
CHARLOTTESVILLE, VA



Charlotte Terrell welcomes us into her home with a big smile. We chat in her living room where Christmas stockings of all her family members are hung on the mantel. It's December and we're here visiting after the installation of a new heating/cooling system and water heater for the home as a part of our fuel-switching project. Charlotte's smile, positive attitude, and sprightly gait belie her 66 years as we sit down to discuss their upgrade to an all-electric home.

Charlotte and Ralph Terrell's modest home on Anderson Street, in the 10th and Page neighborhood, has been in the family for nearly 100 years. Ralph, now 70, has lived in the home **"since he was in diapers."** The home was passed onto his Aunt, and then owned jointly between his brothers, until Charlotte and Ralph bought the home. They both worked at the UVA Hospital (in separate departments) for 34 and 43 years, respectively, until retirement.

Her daughter, who suffers from epilepsy, lives at home, as well as her adopted 13-year-old granddaughter who attends Buford Middle School. Even though she's retired, Charlotte stays quite busy!

Homeowners:
Charlotte and
Ralph Terrell

**Number of
Residents in
Home:**
4

Year Built:
1951

Square Footage:
1,082

Years in the Home:
16

**Former Fuel
Usage:**
Natural Gas

Upgrades*:
Removed floor
furnace. Replaced
oven, water heater,
and installed 2
mini-split systems

**Projected Net
Energy Savings
(Btu):**
35,389

**Observed GHG
Savings (lbs. CO2):**
290

This family of four was an excellent candidate for the fuel-switching program as the floor furnace residing in the basement was original to the 1950's home, and the appliances were also outdated. She tells us that the furnace going out was a concern every storm throughout the winter months.



“We had no idea how we were going to pay for a new system since we are both retired, living on a fixed income, with four people to care for.”

The crew at A&J Heating and Cooling was able to take the new unit and water heater up through the floor - a small l-shaped staircase down the basement renders that pathway inaccessible.

She could not be more excited about the switch out. **“I love my new water heater,”** she tells us. **“I really love it!”** She says the mini-split system will take some getting used to for Ralph, though, now that they have remote control heating and cooling in two separate areas of the home. She likes it cooler than Ralph - revealing a married couple conundrum that even the best energy efficiency upgrade might not be able to fix!



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Additional Information: The square footage of conditioned space increased for the Terrell household and likely impacted heating consumption. Their gas range, which was broken and out of use for 4 years, was also replaced with an electric range, which is now in use.