Community-Scale Retrofit and Electrification: Results and Lessons Learned From a 3-Year Pilot Project

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ABSTRACT

Community-scale electrification is a vital yet under-researched strategy for scaling an equitable and sustainable energy transition. This study describes one of the first projects in the U.S. to electrify a manufactured home community in Colorado, involving more than three years of fieldwork and continuous community engagement. In total, this project included weatherization, electrification, batteries for flexibility and resilience, and subscription to an off-site solar program. This study also describes the coordination efforts, retrofits applied, the electrification package, roadblocks faced, strategies to address them, reasons for off-site solar, community feedback, and lessons learned, so that other potential projects can leverage the knowledge generated in this project. We also present the instrumentation used and analysis completed to enable the quantification of changes in indoor air quality, energy consumption, costs, and potential impact on local electrical transformers. Weatherization and electrification were implemented at different times due to utility transformer load concerns, allowing for additional analysis of each strategy. Results show that 1) many homes cannot get heat pump water heaters due to space constraints, 2) retrofits improve thermal comfort by increasing the number of hours within the ASHRAE 55 comfort range by 55% but also increase Radon concentration in some of the homes, 3) the solar subscription reduces annual electric bills and 4) mini-split heat pumps increase annual utility costs. With approximately 22 million people living in manufactured homes (representing up to 30% of rural housing units in some states), it is crucial to find solutions to rapidly make our communities more sustainable.

Introduction

Electrifying residential buildings is a critical approach to reducing on-site emissions and improving indoor air quality and comfort when combined with energy retrofits such as attic and basement insulation, air sealing and use of Energy Star appliances and LED lighting (Earle et al., 2023). To increase market participation in electrification, a neighborhood approach could accelerate this process and enhance participants' benefits. However, these changes require careful analysis of various metrics before and after electrification and retrofit, such as prediction of carbon emissions, energy costs, and electrical distribution impacts. Unfortunately, most electrification/retrofit simulation projects are focused on the building level (instead of community-scale) and the few done at community-scale are numerical simulations being done on middle-to-high income areas and/or new construction projects (Wang et al., 2022; White et al., 2019). Previous numerical studies on electrification of full communities have yielded promising results in terms of emissions reductions.

A modeling study conducted on a mixed-use community in Denver, Colorado showed reduced carbon emissions for all building types (Wang et al., 2022). However, the case study mostly focused on commercial buildings.

Of particular interest are manufactured home communities or home parks, as national average energy costs per square foot in manufactured homes are nearly twice ($1.38/ft^2) that of site-built homes ($0.74/ft^2) (Talbot 2012). Although manufactured homes provide significant initial cost savings, they fall outside state and local building codes and do not meet the same energy-efficiency standards as site-built homes, resulting in higher average energy costs over the home's lifetime (Tucker et al 2021). This is significant, as in the United States, approximately 8.4 million manufactured homes (MHs) house around 22 million people across more than 43,000 parks. This accounts for about 5% of households nationwide and can represent up to 30% of rural housing in certain states (Van Dam 2017, MHI 2022). In Colorado’s low-income manufactured communities, energy burdens can reach 16% (DOE, 2023).

Sustainable and resilient communities are central to the nation’s transition to a carbon-neutral energy future. In Colorado, Weatherization Assistance Program (WAP) efforts are typically implemented at the individual household level, and in many rural communities, only a small number of homes are served each year. To address this gap, partnering Colorado entities leveraged funding from two Department of Energy (DOE) grants, Community Scale Pilot Project (CSPP) and Sustainable Energy Resources for Consumers (SERC), to pilot a community-scale approach to weatherization and decarbonization in a mobile home community in rural Colorado.

There is a gap in field demonstrations that show neighborhood-scale retrofits are possible and quantify the benefits of electrification. This study describes one of the first pilot projects in the U.S. to retrofit and partially electrify a manufactured home community in Colorado, involving more than three years of fieldwork and continuous community engagement. Our study also describes coordination efforts, applied retrofits, the electrification package, roadblocks faced, strategies to address them, reasons for off-site solar, community feedback, and lessons learned, so that other potential projects can leverage the knowledge generated in this project.

Methodology

Community Description

The analyzed community is in Lake County, Colorado, within climate zone 7 (very cold) of the IECC. The community comprises approximately 30 manufactured homes, as shown in Figure 1, which depicts the community's overall layout with slight modifications. Homes shaded blue represent the participating homes in this study. In a home park, manufactured homes are very close together.

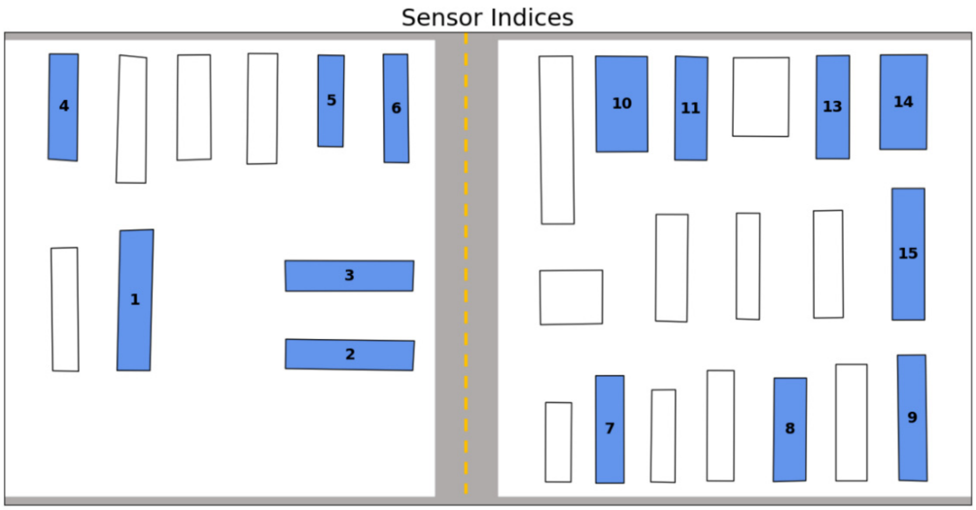


Figure 1. Aerial view of test case community with around 30 buildings and 14 participating homes shaded in green (two additional participating homes are nearby the community and not shown here).

Figure 2 shows the distribution of year built for all homes in the community: from the 1960s to the 2000s. About 1/3 were built before 1975 U.S. Department of Housing and Urban Development (HUD) code (pre-HUD), between 1976 and 1994, and after 1995, respectively, of which nearly all are heated with natural gas.

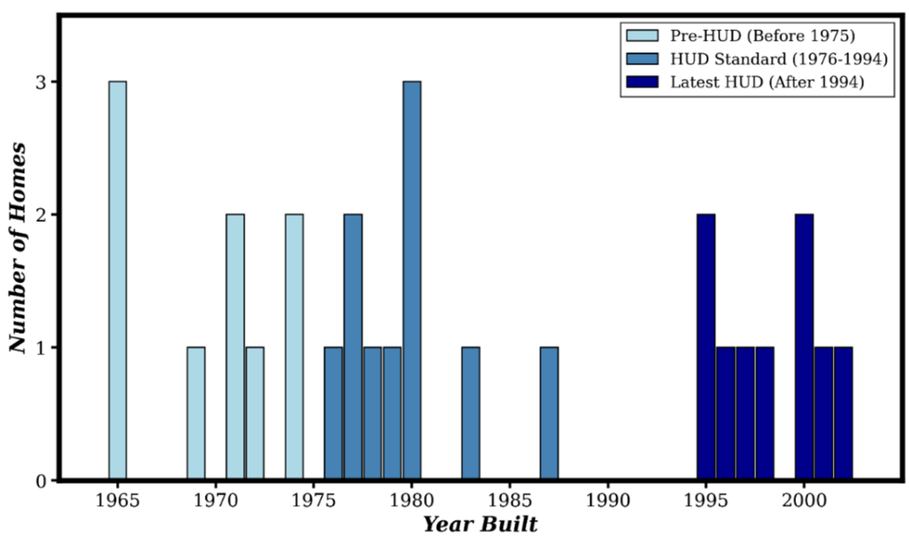


Figure 2. The distribution of the year homes were built for the analyzed communities. Light blue represents homes built before 1975 (pre-HUD), moderate blue represents those built between the HUD standard (1976-1994), and dark blue represents those built after the latest HUD code (after 1994).

Figure 3 shows the conditioned floor area of all homes in this community, ranging from 550 ft^2 to 1,300 ft^2. Pre-HUD houses are the smaller homes in this community. Piloting community-scale electrification in a manufacturing home community provided an opportunity to both deliver at that scale and address an underserved sector.

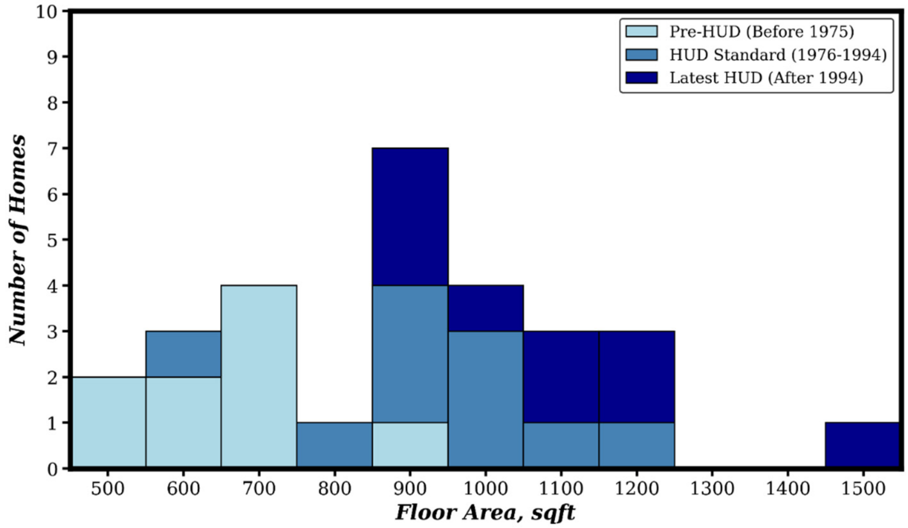


Figure 3. Conditioned Floor area distribution of all homes following the same color scheme as Figure 2.

Retrofit and electrification

All electrification and retrofits were funded by the Colorado Energy Office Weatherization Assistance Program (CEO WAP) and completed through its subgrantee, Energy Outreach Colorado. Therefore, residents had to submit all WAP-related paperwork, including proof of income, agree to release their energy bills, and sign a consent form (approved by Colorado School of Mines Human Subject Research Committee) to allow their homes to be instrumented.

Figure 4 shows both the project implementation timeline and the data analysis periods. This process began with community engagement in late summer 2022 and took about 8 months, with multiple community meetings and visits from Mines, CEO WAP, and EOC. All meetings were held at a local community-based organization during times that most residents were available to attend (weekdays, early evenings). The project team explained the project, requirements, and timeline. Residents also had the opportunity to ask questions and share their concerns, which were incorporated into the project. A focus group was used to gather community feedback on the informative dashboard developed during this project, which provides simplified data for each home.

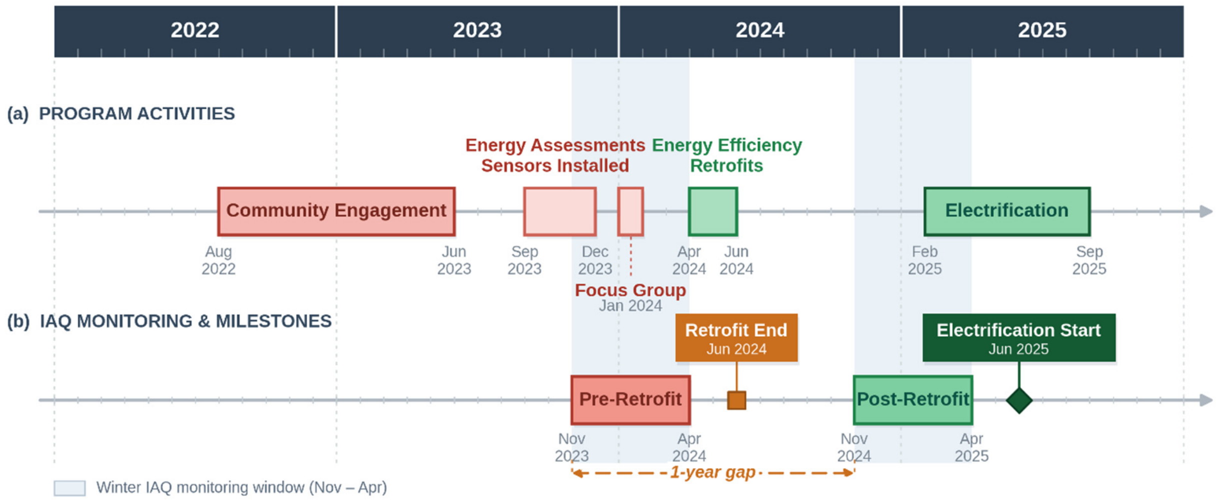


Figure 4. a) Overall timeline to implement the Community-scale electrification, b) Period of time analyzed in this study

In total, 15 residents of the community submitted all paperwork, with three additional residents close to the community. However, two did not meet CEO WAP income eligibility requirements and therefore, could not participate in the program. An energy assessment was done by a general contractor hired by EOC, with reports and analyses prepared using WAP MHEAA software which also included blower door tests and any hazardous actions. Most homes lacked carbon monoxide (CO) detectors, which were later installed. Figure 4 shows there is almost a year gap between energy retrofits and electrification due to three reasons: 1) the approval from the local utility took about 8 months as the utility company was concerned about overloading the local transformer with the new loads; 2) all new electrical wiring (service lines) must be underground; and 3) the local city government has an ordinance that prohibits digging in winter months Oct 1 - May 1 due to frozen ground. This provides an unplanned scenario that resulted in having monitored data before retrofits, after retrofits, and after electrification. In addition, the team found that some of the weatherization work on the skirt insulation was removed and/or not properly installed again after electrification. Thus, future work should first electrify and, right after, weatherize to ensure that the weatherization measures (skirting, insulation) are not damaged during the electrification installations.

Table 1 summarizes the most common weatherization and electrification measures performed in the community. Weatherization measures followed MHEAA and WAP financial requirements to have a Savings-to-Investment Ratio (SIR) of 1.0 or greater[1]. An SIR of 1.0 or greater indicates

[1] These requirements are set by 10 CFR 440.21 WAP guidelines, particularly WPN 24-8, outline that procurement and financial management must align with these regulations, ensuring energy savings justify costs

that the projected energy savings (over the measure's lifetime) must equal or exceed the installation costs.

Table 1. Implemented weatherization, electrification, and distributed energy resources measures in the community. Values in parentheses show the number of houses with a particular measure done.

Retrofits	Electrification (all houses got these measures)	Distributed Energy Resources (DERs) (all houses got batteries and PV subscription)
Most common retrofits (most or all homes) 1. Low-flow showerhead (15/15) 2. LED lighting (15/15) 3. Air sealing (14/15) 4. Floor & pipe insulation (15/15) 5. High-efficiency Furnace (backup heating) (15/15) 6. Bathroom exhaust fans (15/15)	1. Cold-climate mini-splits[*] (with gas furnace backup[**]) 2. Electric-resistant water heater[***] 3. Induction Stove[****] 4. New 100A panel[+]	1. 9.6 kW AC Inverter 2. 16.4 kWh Battery 3. PV subscription
Less common (fewer than 5 houses) 1. Window replaced due to moisture or broken window (5/15) 2. Roof insulation (2/15) 3. New refrigerator (2/15)		

[*]The final system was a combination of mini-splits in every living zone (bedrooms and living rooms) with a ceramic heater in bathrooms. Both the mini-splits and the gas furnace were coordinated with a Flair Puck thermostat and an Ecobee thermostat.

[**]While the original goal was to fully electrify the community, the decision to select a dual-source heating system was due to two reasons: 1) utility company concerns to meet new loads with a backup electrical resistant heating, and 2) community hesitation to solely rely on electrical backup during a power outage

[***]While the project's intention was to install heat pump water heaters, we discarded this idea early in the project as many homes could not fit a heat pump water heater in their water heater closets.

[****]Installed an induction stove and also provided a new set of stainless-steel cookware to all residents.

[+]The final design uses a new 100A panel to supply the new loads (water heater, mini-splits, and stove) and leaves the existing panel as a subpanel to supply the remaining loads (plug loads).

From all the implemented measures shown in Table 1, the following lessons are worth sharing due to their implications for large-scale implementation:

Water heater. Replacing a gas water heater with an electrical one not only increases monthly energy bills (compared to a gas or heat pump water heater) but also substantially increases the electric load (30A). This had implications not only for costs but also for electrical load calculations.

100A electrical panel: The Colorado Energy Office requires a new 200A panel for most weatherization projects.[2] However, this raised concerns with the utility company about the additional loads. The final compromise (with a waiver of state requirements) was to use a new 100A panel to supply the new loads (water heater, mini-splits, and stove) and leave the existing panel as a subpanel to supply the remaining loads (plug loads). This required laying out new (100A) service lines to every participating home (most homes had a 50 or 75A service line) and had implications for community-scale implementation: while a larger panel might provide room for future vehicle electrification, it might also require electrical distribution upgrades, which can slow progress and substantially increase costs.

Batteries. Our initial plan was to use a central battery system, but this was not feasible due to local utility policies; therefore, we pivoted to installing batteries in each home. Due to the inverter's size (40A), the battery system only backs up the subpanel.

PV. The initial plan called for local ground-mounted or rooftop PV. However, most manufactured home roofs cannot support rooftop PV, and the community had limited space for ground-mounted PV. To reduce costs and project complexity, this project subscribed each member to a community solar garden, with the target of reducing their utility bills by 50% savings off their annual electricity costs. Thus, all residents started benefiting from the solar garden credits once retrofits were completed, and the timing of the solar subscription increased the energy cost savings from the retrofits. While not enough time has passed to fully quantify energy cost savings (we need another full year), early utility bills indicate that most residents have not seen cost savings from electrification. This might be due to higher heating setpoints, and higher electric rates compared to gas rates. Starting 2026, residents were given higher credits from the community solar garden

Instrumentation

This study monitored every home to understand how participants use energy before and after retrofits and electrification, focusing on electrical energy consumption, comfort, and air quality. Figure 5 shows the CT meters deployed inside an electrical panel.

Figure 5. Energy meter installed on an electrical panel

Table 2 summarizes the specifications of all sensors used in this study.

[2] CEO WAP Policy 809 Beneficial Electrification, section 7.1.

Table 2. Specification of energy and air quality sensors

Sensor Name	Sensor Location	Measured Quantities	Sampling Frequency	Accuracy
Emporia Vue 2	Circuit Breaker Panel	Electric Power	1 minute	±0.2%
Emporia Smart Plugs	Electrical Outlets	Electric power at selected indoor outlets	1 minute	±5%
Air Things View Plus	Main Living Area	$PM_{2.5}$, CO_2, Temperature, RH, Pressure	5 minutes	$PM_{2.5}$: ±5$\mu g/m^3$ CO_2 : ±50 ppm Temperature: ±1°F RH: ±3.0% Pressure: ±0.6 mBar/hPa
Air Things Wave Plus	Main Living Area	Radon, Temperature, RH, Pressure	5 minutes	Radon : ±10% Temperature: ±0.9°F RH: ±3.0% Pressure: ±0.6 mBar/hPa
PurpleAir	Outside of two homes	Outdoor $PM_{2.5}$	10 seconds	RH: ±3.0% PM2.5: ±10%

- **Electricity Current Transformer (CT) Sensors:** With support from a local electrician company, we installed Vue 2 CT sensors from Emporia Energy in every circuit breaker inside each home's circuit breaker panel. These meters record electric power draw on a minute-by-minute basis.
- **Smart outlets:** About 8 Emporia Energy plug-load meters were installed in each home, each uploading data to the cloud via WiFi. Plug load meters covered most appliances up to 12A, such as TVs, refrigerators, and microwaves. However, 1-2 months after installation, many residents complained that the sensors were turning off at random times. We replaced many of the sensors and worked with the manufacturer; however, the problem persisted, prompting the removal of about 50% of the sensors.
- **Air Quality Sensors**: We measured indoor air temperature, relative humidity, radon, CO_2, $PM_{2.5}$, noise, and occupancy using battery-powered AirThings ViewPlus and WavePlus sensors in each home's living room, in addition to outdoor PM2.5 with PurpleAir sensors. However, halfway through the project, we had to replace the PurpleAir sensors. The AirThings sensors were placed in the room where occupants reported spending the most time, often the main living area. In homes with wood-burning stoves, the team avoided placing sensors directly next to this equipment. Most of the time, sensors were placed on top of furniture such as cabinets or tables. Figure 6 shows an example of a home with air quality sensors and additional sensors for comparison in future studies.

We installed the sensors and began collecting data in the fall of 2023. This provided us with several months to troubleshoot data reliability issues and gather a full year of data from January

2024 to December 2024, which we used for this study. During this period, we experienced intermittent sensor outages due to WiFi connectivity issues.

Figure 6. Example of indoor air quality sensors inside living room

Data analysis

As illustrated in Figure 4(b), most of the data analysis in this study is limited to the pre-retrofit period (November 1, 2023 – April 1, 2024) and the post-retrofit period (November 1, 2024 – April 1, 2025), as not enough time has passed to collect data after electrification (Figure *4*). Pre-processing of the data addressed outliers, scaling variations, missing data, and irregular sampling rates. After resampling ten-minute measurements into hourly averages for all subsequent analyses, we synchronized the time series to a single reference. Longer data gaps were eliminated, and short gaps were filled with linear interpolation. After using a robust z-score based on the Median Absolute Deviation (MAD) to identify outliers, we applied robust scaling to normalize the variables. Equation (1) shows the robust z-score used for outlier detection:

$$z_r = \frac{(x - \tilde{x})}{(1.4826 \times MAD)} \quad (1)$$

where $\tilde{x}$ i s the sample median and MAD is median ($|x - \tilde{x}|$). Observations with $|z_r|>3$ were discarded as outliers; the remaining data were then robust scaled (centered on the median and divided by the MAD).

In addition, using community feedback, the team developed a simplified dashboard that aggregated most of the collected data, allowing residents to view their real-time and historical energy data and compare their energy consumption with peers.

Results

Figure 7 shows the measured infiltration rates (ACH@50Pa) from the blower door tests before any electrification. Light blue represents homes built before 1975 (pre-HUD), moderate blue represents those built between the HUD standard (1976-1994), and dark blue represents those built after the latest HUD code (after 1994). Post-1994 homes had an average ACH_{50} of 13.8, compared to 18.3 in pre-1976 homes, a 32.6% difference. In general, the newest homes have the lowest ACH, and pre-1995 homes can have ACH@50Pa as large as 30.

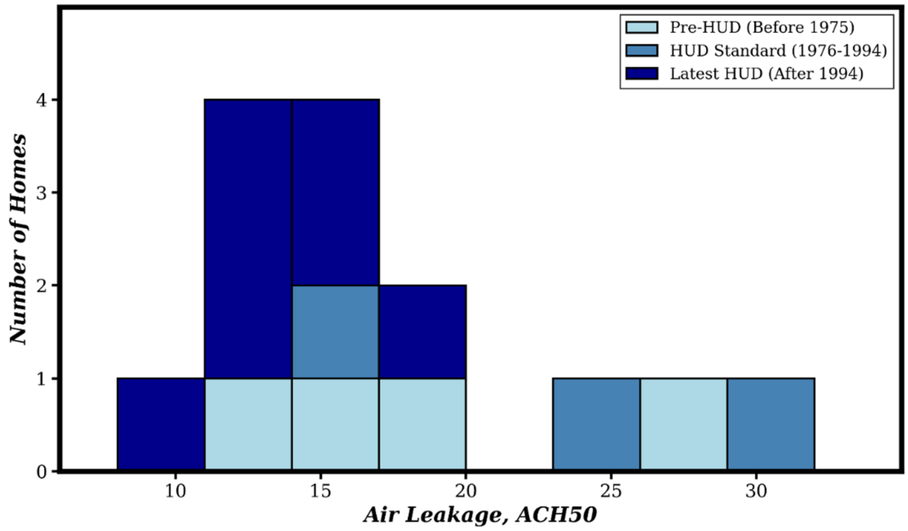


Figure 7. Measured infiltration rates for all analyzed homes, colors are based on the period of year built, following the same color scheme as Figure 2.

Indoor air quality and comfort

Figure 8 shows the average hourly indoor CO_2 before (red) and after (blue) weatherization for all analyzed homes. CO_2 concentrations are higher at night, when most people are at home, and lowest in the morning until midday. Despite air sealing during weatherization, the average CO_2 level is reduced by about 14%, primarily due to improved ventilation from the bathroom exhaust fans.

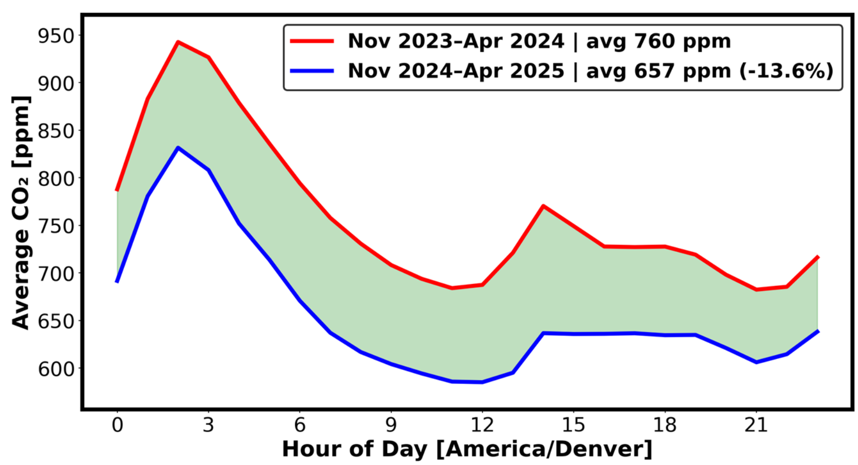
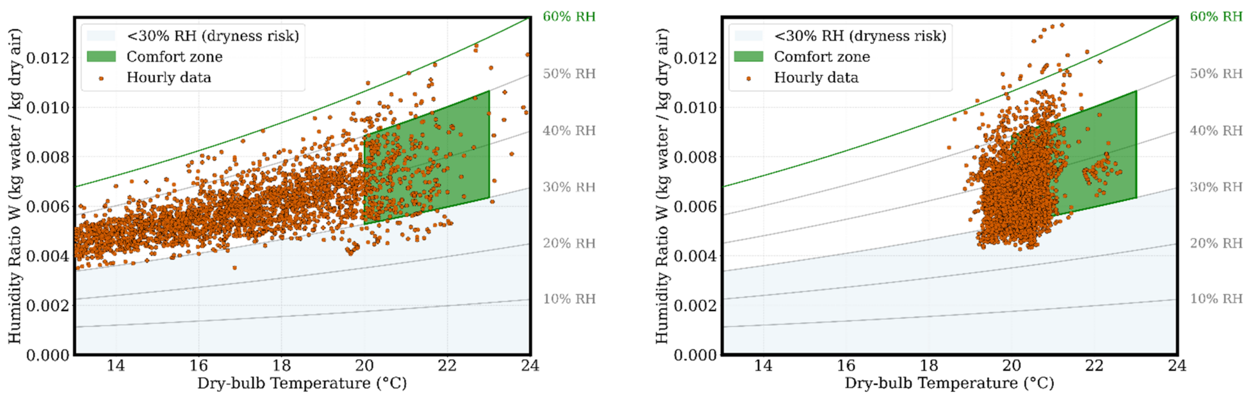


Figure 8. Average hourly indoor CO_2 before (red) and after (blue) weatherization

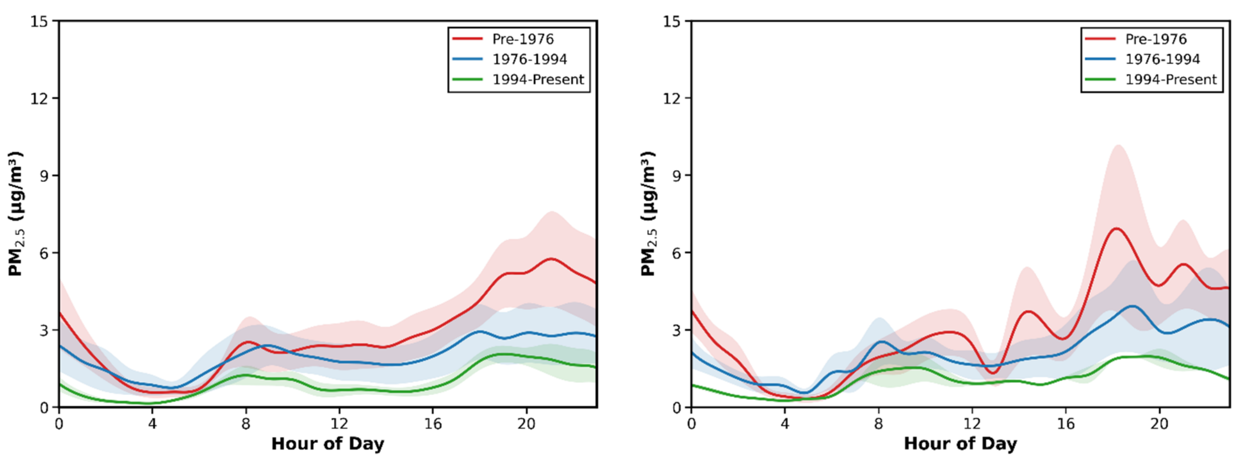
Figure 9 shows psychrometric charts of hourly indoor conditions during the heating season: (a) pre-retrofit and (b) post-retrofit. Red dots represent hourly measurements in homes during these periods. The green-shaded region shows the thermal comfort zone (20–23°C, 30–50% RH), whereas the light blue area below 30% RH indicates dryness risk. Pre-retrofit conditions show that about 91% of hours are outside the comfort zone, with cooler and drier indoor air. In contrast, in Figure 9b (post-retrofit), the data cluster shifts significantly into the comfort zone, with 58% of hours meeting thermal comfort criteria, and it is likely near 100% as most of the lower settings of 19 °C are likely due to the air temperature difference between the thermostat and the actual sensor.



a) b)

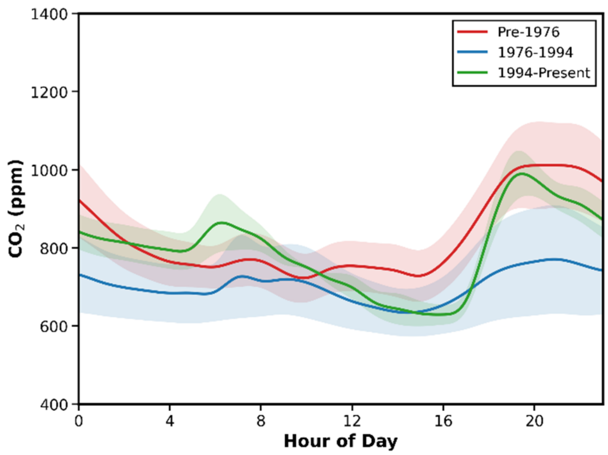
Figure 9. Psychrometric charts of hourly indoor conditions (a) pre-retrofit and (b) post-retrofit.

Figures 10 and 11 illustrate 24-hour indoor levels of $PM_{2.5}$ and CO_2, respectively, a) before and b) after retrofits. Regions show one standard deviation. We again cluster the data into three HUD-defined periods: pre-1976, 1976–1994, and post-1994. Newer homes generally have lower $PM_{2.5}$ and CO_2 levels throughout the day: post-1994 homes have 14% lower $PM_{2.5}$ concentrations and 10.4% lower CO_2 values overall compared to pre-1976 homes. While not shown here, the differences were more pronounced in summer, with post-1994 buildings showing 20% lower $PM_{2.5}$ levels and 17% lower CO_2 levels than pre-1976 homes. While newer homes have lower infiltration values, post-1994 homes (900-1500 ft²) tend to be larger than pre-1976 homes (500-700 ft²) and have similar occupancy, with working bathroom exhaust fans or range hoods. In addition, both measurements show two peaks: one around 7-8am and one around 6-9pm.



a) b)

Figure 10. 24-hour indoor levels of a) $PM_{2.5}$ pre-retrofit, b) $PM_{2.5}$ post-retrofit, respectively, for homes built before 1976, between 1976-1994, and after. Regions show one standard deviation



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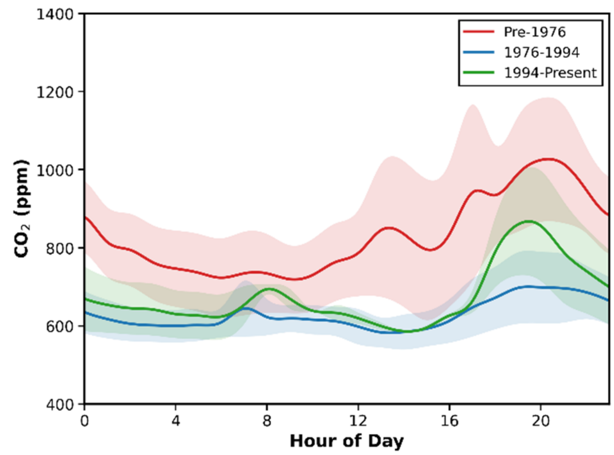


b)

Figure 11. 24-hour indoor levels of a) CO_2 pre-retrofit, and b) CO_2 post-retrofit, respectively, for homes built before 1976, between 1976-1994, and after. Regions show one standard deviation

Figure 12 shows the average radon levels pre- and post-retrofit for all subscribed homes using the home numbers shown in Figure 1. Houses are again clustered by year built. Most houses observe Radon concentration below 2. However, two houses show higher values after retrofit work, approaching or exceeding the EPA guideline of 4 pCi/L, and require further testing and monitoring.

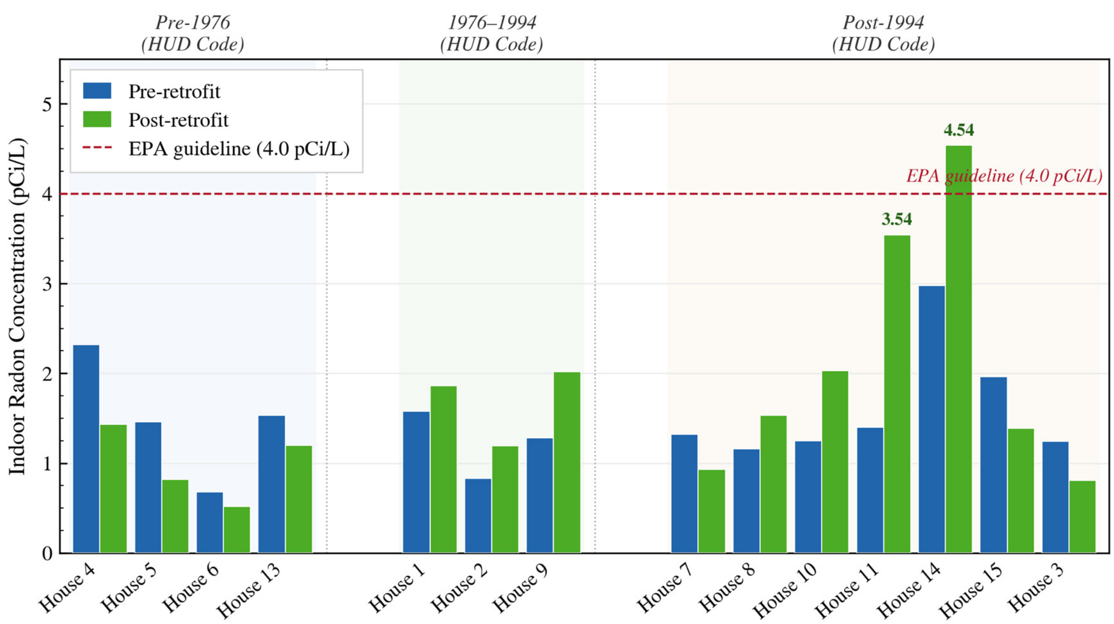


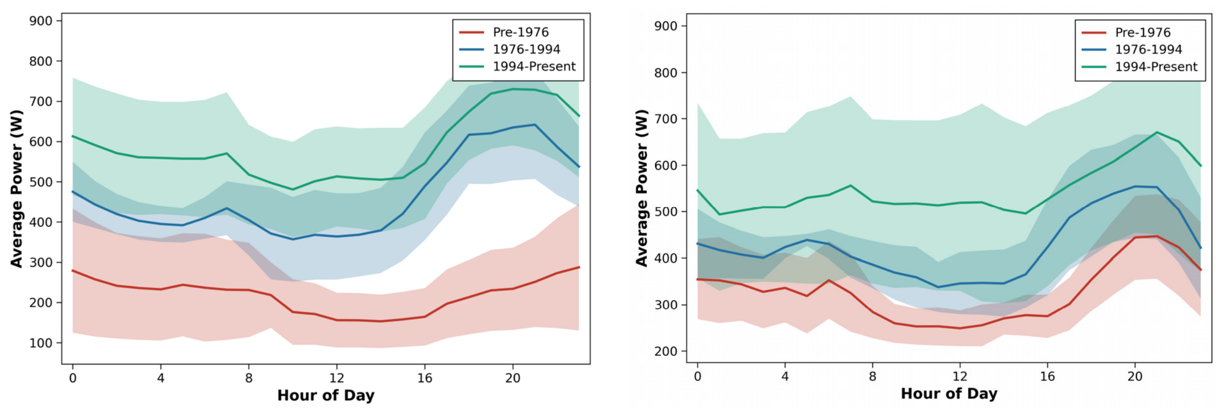
Figure 12. Measured pre (blue) and post-retrofit season average Radon concentrations in each retrofitted home. The red dashed line represents the EPA limit that recommends doing radon mitigation

Energy usage and costs

Figure 13 illustrates the average hourly 24-hour electric consumption profile over the analyzed period pre (a) and after retrofit (b). Regions show ±½ standard deviation for the three analyzed

HUD-defined periods. The highest variation is among homes built after 1994, which might be related to differences in occupancy, ranging from 2 to 6 people. Newer homes use twice as much electricity as pre-HUD homes because they are twice as large (See Figure 3). Peaks occur around 7am and around 6-9pm.

Following retrofit and electrification, both the 1976–1994 and post-1994 HUD clusters follow similar consumption trends, with electricity consumption reduced by 9.9% and evening peak demand falling 9.3% in the 1976–1994 cluster, while the post-1994 HUD cluster showed the greatest reductions, with average consumption decreasing 11.0% and peak demand dropping 12.3%. For pre-1976 homes, however, average consumption increases slightly following retrofit and electrification.



a) b)

Figure 13. a) pre-retrofit b) post-retrofit, respectively, average hourly electricity consumption (W) by building era during the heating season. Lines represent the mean across houses within each HUD code era; shaded bands indicate ±0.5 standard deviations.

Solar credits were applied after weatherization. Given the 1-year lag between weatherization and electrification, residents did not notice significant savings after electrification; in fact, many saw their bills go up because solar credits had been applied a year earlier. Thus, EOC increased its solar garden allocation to accommodate the additional electrical loads.

Community feedback

Gaining residents' trust was essential and required several months of community engagement, as well as establishing clear expectations and boundaries regarding the scope of work. Our initial introduction to the community was facilitated by two local organizations that had prior relationships with residents. Concerns raised by residents included the risk of pipes freezing—which is common in extreme cold weather, as pipes are often located beneath the home—and the possibility of receiving unexpected bills. Additionally, some residents showed interest in having their homes renovated to improve durability.

Following the retrofit, community feedback was overwhelmingly positive. Many residents reported feeling warmer during winter, as illustrated in Figure 10. By adding skirt insulation and insulating pipes under the houses, we have significantly reduced, and in many cases eliminated, freezing. Managing both the central furnace and mini-split systems has proven more complex than operating a single central unit. Furthermore, numerous residents have noted that the bathroom remains colder than other areas of their homes, and the largest increase in energy use was due to mini-splits. Thus, we recommend using a central heat pump system or a ducted mini-split when possible, when planning to electrify low-income communities.

Most notably, residents who initially did not apply to participate in the project have recently expressed interest in joining, highlighting the importance of phased community engagement when expanding such initiatives.

Conclusion and Lessons Learned

This study describes one of the first projects in the U.S. to partially electrify a manufactured home community, involving more than three years of fieldwork and continuous community engagement. In total, our project included weatherization, electrification, batteries for flexibility and resilience, and subscription to an off-site solar program.

Retrofit and electrification were implemented at different times, allowing for additional analysis of each strategy. Results show that 1) many homes cannot get heat pump water heaters due to space constraints, 2) participants welcome the changes in their home, 3) retrofits improve thermal comfort by increasing the number of comfort hours; comfort hours increased by 6x, and reduced indoor CO_2 concentration by 100ppm or 14%. Finally, all residents who initially did not participate in the program now want to join the pilot project, indicating the success of a community-scale approach in maximizing acceptance.

Finally, after 3 years of community retrofit implementation, this study identifies the following recommended policy changes and lessons learned regarding the implementation of community-scale retrofits and manufactured homes:

- Recommended policy changes:
  - New WAP community eligibility. For multi-family properties, an entire building may be eligible for WAP if the property is on HUD's list and 67% of the residents qualify. It would be ideal to have a similar rule for manufactured home communities.
  - Colorado Energy Office WAP flexible panel policy. CEO WAP policies require a 200A panel for most jobs done. While this future-proofs a house for new electrical loads, it might trigger a distribution electrical load review at the community level. Therefore, we recommend keeping electrical panel sizes at 100-125A with smart controls and appliances to manage loads.
- Implementation:
  - Relationships take time; do not expect a full house the first day. It is important to find a local community-based organization that has historically served as a first point of entry for communities. A key consideration is identifying and engaging a community leader who can rally most community members to sign up for the program. This also requires listening to and considering community concerns and needs.
  - Electrical infrastructure. Electrical infrastructure could significantly increase project costs or extend the project timeline. Therefore, before the final selection of

the community, it is important to tour the community with a professional electrical engineer or electrical contractor and a general contractor to ensure the project scope, goals, and budget can be achieved.

- Sign up for flexibility. Many residents might be more risk-prone than others. So, it is important to have a flexible signing-up option so residents can join later. In our case, virtually all residents who did not originally sign now want to join the project.
- Manufactured homes' specific electrification challenges

- Due to limited space, manufactured homes might not be able to accommodate heat pump water heaters, which would greatly increase electrical loads from electric water heaters or higher capital expenses if a split system is selected.
- Our team could not find a dual-fuel cold-climate heat pump option for manufactured housing. In this case, we selected a central furnace with mini-splits, which made controlling both assets more challenging than having a central unit. Residents have complained about the bathroom being colder than the rest of the home and that mini-splits heat their homes unevenly. We now recommend using ducted mini-splits or central heat pumps.
- While it is common practice to first weatherize and then electrify a home, our study recommends completing electrification first and then weatherization to ensure that the weatherization measures (skirting, insulation) are not damaged while the electrification installs occur.
- In addition, electrification and weatherization should be done right after each other. Our case required a time lapse due to electrical infrastructure issues. This time lapse skewed the utility bill impacts – specifically, the electric bill. Any solar credits should also be applied after electrification, with the possibility of increasing them once the actual electrical loads are measured.

Acknowledgments

The authors would like to acknowledge the Alfred P. Sloan Foundation (Grant No. G-2022-19476) and the Colorado Energy Office (Interagency Agreement GAE 23-247) for their financial support of this study. The community-scale weatherization and electrification projects analyzed herein were funded through the U.S. Department of Energy (DOE) Sustainable Energy Resources for Consumers (SERC) program and Community Scale Pilot Project (CSPP) under Federal Award No. DE-EE0009891, administered by the Colorado Energy Office and sub-awarded to Energy Outreach Colorado. The views expressed are those of the authors and do not necessarily reflect the policies and views of the funding agencies. The authors also thank the members of the test case community for their participation.

AI-assisted Tools: Disclosures and Responsibility

AI-assisted tools used: Grammarly
Used for: Editing and grammar review

Extent: light editing.
Human review: The authors reviewed and verified all content, calculations, and citations.

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