NYU Wagner Urban Planning Capstone Report

ADVANCING EQUITABLE BUILDING DECARBONIZATION

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the old spaghetti factory

Preface

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Preface

EXECUTIVE SUMMARY

For many years the negative effects of climate change have disproportionately impacted disenfranchised communities of colors. Recently, there has been a resurgence of calls to address these impacts through a reduction in the use of fossil fuels.

This movement could serve as an opportunity to rectify long-standing historical injustices found throughout many of these disinvested communities. By implementing fair and equitable decarbonization practices it would be possible to alleviate energy burdens, enhance health outcomes, and foster stable economic prospects for low-income communities

Led by the Institute for Sustainable Communities (ISC), the Advancing Equitable Building Decarbonization (AEBD) initiative aims to build the capacity of community leaders to implement fair decarbonization practices. To accomplish this goal, Leadership Alliances have been established to spearhead pilot programs in Oakland, Ca, Philadelphia, PA, and St. Louis, MO. By successfully decarbonizing a local test building in each community, the Leadership Alliance would be able to develop a set of replicable guidelines to share with other building owners of color.

The Project Scope

In September 2023, the ISC enlisted the help of the Environmental Community Outreach (ECO) Group, a capstone team from the Wagner Graduate School of Public Service, to assist in developing a set of best practices for decarbonization initiatives. Given that each Leadership Alliance was in various stages of development, the ECO group decided to do a case study of an external organization that had effectively implemented energy efficiency measures (EEM) and possessed data suitable for determining best practices. Tower Grove Community Development Corporation was then chosen as the case study.

Tower Grove Community Development Corporation (Tower Grove) provided us unfettered access into their process for upgrading the energy systems of three multi-family residential buildings. We conducted an analysis of their EEM retrofit implementation, project financing, pre- and post-tenant energy usage, and the environmental policies influencing the projects. The Tower Grove projects were ideal because they were on a smaller scale, with only three buildings with EEM upgrades. In addition, the scope of the Tower Grove projects were minimally invasive, facilitating the manageable analysis of various EEMs.

Tower Grove Community Development Corporation

- Real estate-related community development organization
- Owns and manages affordable housing units throughout St. Louis
- Renovated three properties with energy efficiency measures (see below)

3732-34 Bamberger Avenue:

- Built: 1916
- Number of Units: 4
- Project Start Date/Duration: July 2019 / 16 months

3606-08 Bamberger Avenue:

- Built: 1913
- Number of Units: 4
- Project Start Date/Duration: February 2021 / 9 months

3169-71 Alfred Avenue:

- Built: 1928
- Number of units: 4
- Project Start Date/Duration: July 2021 / 11 months

Key Findings

The setup of the Tower Grove projects allowed us to divide our analysis into four distinct sections: funding and finance, project implementation, energy usage, and policy and governance.

Funding and Financing

Tower Grove's approach to energy efficiency upgrades and retrofits focused exclusively on Energy Efficiency Measures (EEMs) to maximize impact within a limited budget. The organization meticulously calculated what upgrades they were able to afford and in the end set on specific retrofits that made sense for the building within the budget.

Financing for these projects involved multiple financial channels. First, Tower Grove utilized grant funding through the US Bank Foundation to cover all upfront costs. Supplementary funding, aimed at reducing overall project expenses, was obtained through utility rebates. Tower Grove evaluated project feasibility based on these rebates, although upfront funding from the US Bank Foundation was necessary since rebates were only accessible post-project completion.

Project Implementation

Tower Grove implemented EEM retrofits in three multi-family residential buildings, each constructed between 96 and 111 years ago. These two-story buildings each contain four rental units. The EEM retrofits varied in cost, ranging from LED light bulbs to high-efficiency furnaces. However, implementation faced limitations due to both the layout of the buildings and budget constraints. For instance, exterior walls were unable to be insulated because it involved extensive demolition and would have required replacement of the building's wiring.

We conducted a cost-benefit analysis of the EEMs by comparing their initial cost to the energy savings they generated. Subsequently, we calculated the time required for energy savings to surpass the initial investment. Our analysis revealed that LED light bulbs provided the highest energy savings relative to their cost. Other items, such as high-efficiency furnaces and programmable thermostats showed mixed results and proved beneficial only under specific usage conditions. Other upgrades, like energy-efficient windows failed to positively impact energy usage due to mitigating factors. While cost savings varied greatly, tenants overall reduced energy consumption and expenses.

Energy Usage

Tower Grove provided the ECO Group with four years of energy usage data encompassing electricity and natural gas consumption. We analyzed energy usage before and after the installation of EEM retrofits to assess the impact of each EEM on energy consumption. Utilizing this information our team was able to determine the three projects collectively generated an annual cost savings of $1,591 (8.5%) and an annual energy savings of 69,861 kBtu (7.4%). Savings did vary across the three properties, ranging from a 4% to a 18% savings.

Despite an overall reduction in energy usage across the three properties, the actual savings fell short of the projected savings for each property. The disparity between projected and actual savings reached as high as 88%.

Lastly, according to the US Bureau of Labor Statistics, the average cost of electricity in St. Louis has increased every year since 2019 and has had a significant effect on energy burdened residents who pay a higher than average percent of their income on heating and cooling. Rate increases are regulated by the state's Public Service Commission (PSC) and they have approved rate increases yearly, starting in 2017

Policy and Governance

The energy conservation code, enacted in 2018, was instituted to require higher energy efficiency standards in new construction. One consequence was the ordinance prompted the local utility to begin phasing out other incentives. Specifically, utility rebates used by Tower Grove to offset the renovation costs of EEMs. The rebates were deemed an unnecessary incentive for EEM now that higher efficiency standards were legislated.

Another ordinance that had an effect on energy efficiency efforts was the Building Energy Performance Standards (BEPS) created to set energy performance standards for which the city could identify properties with the highest energy usage. Once identified, those properties would be given financial and logistical support needed to increase the efficiency of the structure. These standards applied to buildings over 50,000 square feet and small residential properties, like Tower Grove's, were not included in the program.

Lastly, energy costs in St. Louis are continuously increasing year after year and have a significant influence on energy burdened residents who pay a higher than average percent of their income on heating and cooling. Rate increases are regulated by the state's Public Service Commission (PSC) and they have approved rate increases yearly, starting in 2017.

Key Recommendations

After analyzing the composition of the Tower Grove projects and reviewing the challenges and strategies employed in implementing EEM retrofits and upgrades at three of Tower Grove's properties, we formulated a set of suggested best practices for building decarbonization in low-income neighborhoods. Consistent with the findings, these recommendations have been categorized into funding and finance, project implementation, energy usage, and policy and governance.

Funding and Finance

1. Employ a dedicated grant writer to maximize potential state, federal, and philanthropic funding sources.
2. Utilize on-billing financing provided by utility providers as an alternative funding source, alongside grants and bank loans.
3. Conduct energy audits to ensure that enhancements are factored into the property's value.

Project Implementation

1. Prioritize retrofits with significant energy savings and shorter payback periods, such as LED light bulbs.
2. Maximize the efficiency of EEMs by combining multiple measures that complement each other and enhance overall effectiveness.
3. Engage with tenants to ensure they understand the EEMs and how to utilize them effectively to reduce energy usage and costs.
4. Evaluate retrofits not only for immediate cost savings but also for their long-term impact on property value and environmental sustainability.
5. Ensure retrofits meet the specific needs of the property and its environment, such as prioritizing upgraded heating in regions with harsh winters and mild summers.
6. Complete a comprehensive evaluation of your building to identify the EEMs that would prove most effective in reducing energy consumption.

Energy Usage:

1. Inform tenants of methods to maximize energy savings, such as unplugging chargers

or washing clothes using cold water.
2. Advocate for solutions to the split-incentives issue by creating incentives for landlords to fund EEMs, even if they do not directly benefit.
3. Promote incentives that modulate utility rates and invest in renewable energy sources to ensure the consumption of fossil fuels is not unjustly advantaged over other greener alternatives.

Policy and Governance:

1. Overall, more advocacy is necessary to make sure the needs of low-income communities of color are considered when making decisions surrounding climate change and energy.
2. The BEPS ordinance should be expanded to apply to properties smaller than 50,000 square feet and properties owned or occupied by low-income residents should not be excluded from the standards. BEPS needs to identify all buildings with high energy usage, like the residences managed by Tower Grove, and target them for intervention with adequate funding support.
3. Advocate for the needs of low-income residents by educating members of the Missouri PCS to make sure they are aware of the needs of the low-income residents and understand the impact utility regulations have on them, specifically. Advocate for lower utility rate increases for these residents in order to mitigate rent burden.

INTRODUCTION

Climate change represents one of the most pressing challenges of our time, with profound implications for people, ecosystems, economies, and society as a whole.

Unfortunately, those impacts are distributed unevenly across societies, with divested communities often bearing the brunt of its effects. Low income communities and communities of color, in particular, are disproportionately affected by the consequences of climate change. Historically, these communities have been disenfranchised and neglected, leaving many people living with polluting industries and excluded from discussions and decision-making processes on how to address the issue.

This recognition highlights the importance of energy justice, which is a human-centered movement to address injustice and inequity within the energy sector. Energy justice acknowledges that the benefits and costs of transitioning to clean energy sources are not equally distributed among all segments of society. There are four dimensions of energy justice:

1. **Distributional Impacts of Energy Production:** Traditional fossil fuel extraction and distribution impose localized costs, such as pollution and health hazards, while the benefits are often enjoyed by a broader population. Oftentimes these extraction, processing, and distribution facilities are co-located with low income and communities of color. One infamous example of this is Cancer Alley in southeast Louisiana. Decarbonization efforts aim to mitigate these disproportionate health impacts by transitioning towards cleaner energy sources and reducing reliance on fossil fuels.

2. **Energy Insecurity and Energy Poverty:** Lower-income households and communities of color face higher energy burdens, spending a larger share of their income on electricity and heating. Additionally, historic and systemic discrimination has led to disparities in housing quality, with divested communities often living in older, less energy-efficient housing stock. Addressing energy insecurity and poverty requires targeted interventions to improve energy efficiency and affordability for vulnerable populations.

3. **Access to Clean Energy Technologies:** Access to clean energy resources is not uniform across society, with certain households and communities facing barriers to adopting renewable energy technologies. Factors such as upfront costs, technological literacy,

and infrastructure constraints can limit the equitable distribution of clean energy benefits. Ensuring equitable access to clean energy requires policies and programs that address these barriers and prioritize the needs of divested communities.

4. **Carbon Policy and Equity Impacts:** Market-based approaches to decarbonization, such as carbon taxes and cap-and-trade systems, can have differential impacts on various segments of society. While these policies are essential for reducing greenhouse gas emissions, there is a risk of additional financial burdens on low-income communities of color, further exacerbating existing inequalities. Therefore, it is crucial to design carbon policies with equity considerations in mind, ensuring that the transition to a low-carbon economy is equitable and inclusive.

Energy justice involves remedying the disproportionate burdens placed on divested communities, particularly in terms of the social, economic, and health impacts resulting from energy production and consumption. Addressing these injustices can include a multitude of different tactics. This report will analyze strategies that have been taken by one St. Louis organization in addition to providing future recommendations that the Institute for Sustainable Communities can implement in their pilot hubs. These include reducing building-related greenhouse gas emissions, decarbonizing the built environment in low-income communities, and providing the necessary financial resources to support these efforts.

Introduction

THE INSTITUTE FOR SUSTAINABLE COMMUNITIES (ISC)

Founded in 1990 by Vermont's then-Governor Madeleine Kunin (D), the Institute for Sustainable Communities (ISC), a global non-profit organization, is dedicated to advancing equitable climate solutions for these frontline communities. Through collaborative partnerships and community-centered approaches, ISC works to uplift Black, brown, and low-income communities and foster resilience in the face of climate change. Central to ISC's mission is the promotion of an inclusive decision-making process and the development of tailored strategies to address the specific needs of vulnerable communities.

In August 2023, the ISC embarked on the Advancing Equitable Building Decarbonization (AEBD) initiative to facilitate building decarbonization within low-income communities of color.

This initiative, funded by CBRE (a global leader in commercial real estate services and investment) marks a significant step towards rectifying historical disparities by prioritizing Black and brown communities. Building decarbonization is about more than improving buildings—it is about ensuring that individuals have a safe, healthy, and affordable environment to thrive in. Additionally, building decarbonization could unlock major benefits such as reduced energy cost, a healthier living environment, and improved productivity.

The initiative involves three pilot hubs across the nation, each having one anchor institution and a Leadership Alliance made up of leaders within those communities:

- Oakland, CA - Imani Community Church
- St. Louis, MO - Community Builder Network of Metro St. Louis
- Philadelphia, PA - Overbrook Environmental Education Center

Each pilot hub is a distinct entity with a unique thematic focus and scope. In Oakland, Imani Community Church hub directs its efforts towards ensuring that their church is accessible for people of all abilities as well as energy efficiency. Meanwhile, Overbrook Environmental Education Center in Philadelphia is prioritizing the installation of a solar powered pavilion that serves as a community center. In St. Louis, Community Builder Network aims to increase energy efficiency and lower energy cost in low-income residential buildings.

Our report spotlights the work of a St. Louis non-profit, Tower Grove Community Development Corporation, as our central focus. With this collaboration, we researched and investigated their innovations and major challenges in affordable housing decarbonization in order to make recommendations for implementing best practices for any organization bringing climate change initiatives to divested communities.

Introduction

TOWER GROVE COMMUNITY DEVELOPMENT CORPERATION (TGCDC)

The Tower Grove Community Development Corporation (Tower Grove) is a real estate-related community development corporation, promoting responsible development, developing market rate/affordable housing and addressing vacant and abandoned property within St. Louis. Founded with a commitment to revitalizing neighborhoods and promoting equitable access to resources, Tower Grove has been instrumental in addressing the challenges faced by residents, particularly in historically divested communities.

Affordable Housing Initiatives: Tower Grove provides affordable housing options for residents across St. Louis City. With over 84 deeply affordable housing units across 25 affordable properties, the organization aims to ensure that individuals and families have access to secure, quality housing options at the lowest price points which represent only 8% of the total housing market. Most of Tower Grove's residents fall within the 80% or lower area median income band.

Community Development Efforts: In addition to affordable housing initiatives, Tower Grove is actively engaged in promoting responsible urban development and neighborhood revitalization through direct improvement of the St. Louis housing stock. Through collaborative partnerships with local stakeholders, including community organizations, elected Alderpeople, and government agencies, Tower Grove works to purchase and renovate vacant and abandoned properties, eliminate nuisance properties, and facilitate infrastructure improvements. By advising on best practices for development and using incentives such as tax abatements and tax credits, Tower Grove is working to stabilize neighborhoods and foster economic growth.

Energy Efficiency and Sustainability: This report concentrates on Tower Grove's initiatives to reduce the energy burden experienced by a significant proportion of its low-income tenants. Aligned with the objectives of the energy justice movement, particularly concerning issues of energy insecurity and poverty, Tower Grove has embarked upon initiatives geared towards increasing energy efficiency. These projects are intended to lower energy usage, diminish utility expenses, and enhance the environmental sustainability of its properties. Acknowledging the significance of environmental sustainability and energy efficiency, Tower Grove integrates these principles into its community development programs.

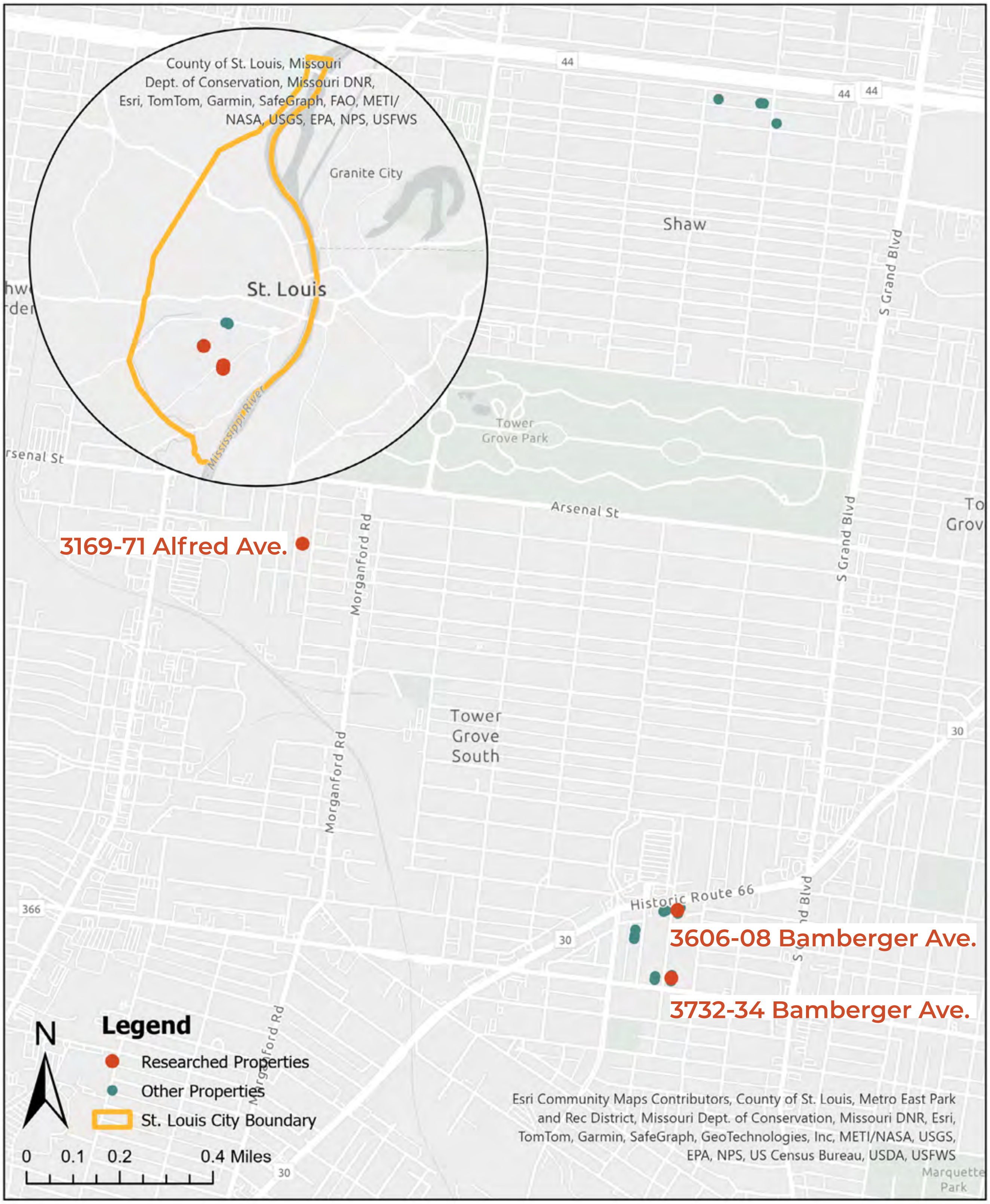
Our work focused on three affordable housing properties that received energy efficiency upgrades between 2019 and 2022:

3606-08 Bamberger Avenue

3732-34 Bamberger Avenue

3169-71 Alfred Avenue

Map of Tower Grove CDC Properties



Methodology

RESEARCH

To frame our research and gain a baseline understanding of ISC's work, we first set out to better understand the equity concerns surrounding building decarbonization.

Literature Review

We completed a literature review using fifteen sources that focus on how national initiatives, crucial for combating global climate change, intersect with social justice concerns, particularly its impact on lower-income and divested groups. Some key takeaways were the prevalence of systemic challenges, notably energy poverty and inefficient housing, that disproportionately impact Black, brown, and low-income communities, further entrenching social disparities. Additionally, we came to understand the implications of decarbonization on health, well-being, and socio-economic factors, especially in the context of low-income communities [see Appendix II]. We concluded from the literature review that potential solutions to address these inequities lie in policy development, governance, and coalition building and that political influence and financial resources are critical to promoting equitable decarbonization.

Existing Conditions

In preparation to support ISCs three pilot hubs, we also conducted research on the pilot hub cities to gain insight into how the social, economic, and political landscapes contributed to both energy justice concerns and the ease of implementation of decarbonization initiatives. Specifically, we reviewed local climate goals and sustainability policies, local clean energy and building codes, and financial incentives available to advance widespread building decarbonization. Looking at the city demographics and industrial landscape, we began to identify opportunities for sustainable development [see Appendix I].

Through examining pilot hub cities, we gained insights into the diversity of each locale, understanding how distinct demographic and economic compositions influence their efforts to enact equitable climate change policies. We also identified numerous shared initiatives at the state, regional, and local levels, highlighting a collective commitment to shared principles. Like the other hub cities, Oakland has developed a comprehensive city plan to combat its effects. However, unlike its counterparts, Oakland benefits from more state-level political support facilitating climate change policies.

On the other hand, St. Louis, with the highest percentage of African-Americans and being the most economically disadvantaged among the hub cities, has also formulated a strategic plan to mitigate climate change effects. Nevertheless, St. Louis contends with relatively less financial and political backing at the state level, such as efforts around state-wide green infrastructure.

Furthermore, the similarities and discrepancies are also apparent in Philadelphia, where a commitment to carbon neutrality is widely endorsed by local officials, including the mayor. However, the influence of the oil and gas industry over the state legislature in Pennsylvania has hindered some carbon-neutral regulations in the city. Overall, these cities, despite their inherent differences, share a common commitment to reducing carbon emissions and implementing strategies to combat the adverse effects of climate change, highlighting their collective dedication to environmental sustainability and resilience.

Identifying Funding Sources

Comprehending the financial landscape of the decarbonization movement was an important part of our research. We first needed to ascertain what the financial obstacles were in order to formulate effective strategies for surmounting them. Part of that process involved creating a list of federal funding opportunities that involved conducting extensive desk research, leveraging resources from ISC's workshops and reports, and attending conferences to learn more about the subject matter while adding more financing sources.

The desk research phase involved reviewing official federal websites and other funding opportunities identified by different nonprofit organizations. ISC's funding and financing workshop offered additional insights. Attending conferences was helpful in identifying financing, particularly through learning from other case studies and making connections that directed us to available tools and resources for identifying more funding opportunities.

Calculating Energy Use Intensity

Our team worked closely with Tower Grove to obtain historical, strategic, and operational insight on the organization's energy efficiency initiative from 2019 to 2024. We completed informal interviews with Dana Gray, Tower Grove's Community Development Outreach Coordinator and obtained several sets of data pertaining to the three properties that underwent upgrades.

The data we received included the type, cost, timeline, and funding of energy efficiency upgrades in each property. We also obtained energy use data (both pre-and post-upgrades), tenant occupancy data, and historic utility rates for both gas (Spire/Laclede) and electricity (Ameren) providers.

The data analysis on the energy efficiency upgrades was supported by Aaron Michaels of Energy Resource Group (ERG), a consultancy that Tower Grove contracted to complete benchmarking for the three properties. For their analysis, ERG used a proprietary program, UtiliTool, which was developed using the International Performance Measurement and Verification Protocol methodology for whole facility calculations. Tower Grove provided ERG with utility data from 2016-2023, which was used to benchmark each property's energy usage pre-and post-implementation of the Energy Efficiency Measures (EEMs). ERG normalized the data where necessary to control for weather variance and tenant vacancies [see Appendix IX for the full ERG report].

After receiving ERG's benchmarking report as well as the raw data used in the calculations, we analyzed the environmental implications of the EEMs. By converting the energy savings for both electricity and gas into carbon equivalencies, we were able to quantify the greenhouse gas emissions savings associated with the upgrades. Below are the emissions factors we used for our calculations:

Input Units	Emissions Factor	Output Units
kWH	0.0006214215[1]	tCO2e / kWH
Therms	0.005311	tCO2e / therm

Researching Policy and Governance

Tower Grove oversees properties in the city of St. Louis, and the operations of these properties are significantly influenced by various local, state, and federal regulatory agencies, as well as political representatives. In order to gain a comprehensive understanding of how laws, policies, agencies, boards, and representatives impact Tower Grove's initiatives to provide energy-efficient housing to low-income residents, we conducted an in-depth analysis of each of these entities.

Our initial focus was directed towards two newly enacted laws: the Missouri Landlord Tenant Law, which came into effect in January 2024, and the Energy Conservation Code (Ordinance 70799), implemented in 2023, which has already affected the types of rebates offered by utilities. We were interested in their intended purpose, what is required from residents, and the community response, specifically from low-income residents. Additionally, we monitored the progress of legislation proposing energy disclosure requirements for renters in St. Louis City.

St. Louis has governmental offices and agencies dedicated to advancing clean energy and sustainability, such as the Office of Sustainability and the Clean Energy Advisory Board. To best understand the role of the government entities, we examined their mandates and activities to assess their influence on city ordinances and their efforts to promote sustainability and clean energy practices.

1 Based on the SRMW egrid subregion's output emission rate of 1,370 lb/MWh in 2022

Lastly, St. Louis is governed by a city council known as the Board of Aldermen. We identified the Aldermen representing the 6th Ward and the neighborhoods of Tower Grove, Daniela Velazquez. We scrutinized her political platform, voting history, and other public appearances to ascertain whether she prioritizes sustainability or endorsed initiatives conducive to decarbonization efforts in the community.

Methodology

PROJECT LIMITATIONS

This project was subject to several external influences that impacted our findings. The COVID-19 pandemic and subsequent disruptions in the supply chain contributed to delays and inflation, resulting in some cost overruns and delays that may not reflect current purchasing costs and completion timelines.

In assessing the energy usage data, we faced several limitations that prevented us from drawing concrete conclusions on building decarbonization in affordable housing developments. All three buildings have a vacancy period from 6 months to more than a year. The vacancy periods impacted ERG's ability to conduct a comprehensive benchmarking analysis. We likewise had limited access to raw unit-level energy usage data across Tower Grove's properties and could only draw conclusions based on ERG's analysis. Since many Tower Grove tenants do not have internet service, programmable thermostats were installed in each unit rather than smart thermostats, so we could not analyze the impact of unit-level temperature setpoints on energy usage, and we were not able to conduct interviews with the tenants to gather insights on their behavior. Without this data, we could not assess the degree to which tenant behavior impacted the efficacy of the EEMs. The small sample size of our analysis—which included twelve housing units—also does not indicate the population at large.

FINDINGS & RECOMMENDATIONS

The report findings are outlined across four focal areas: (1) Funding and Finance, (2) Project Implementation, (3) Energy Use Intensity, and (4) Public Policy and Governance.

KEY FINDINGS

- **Overall, the three Tower Grove projects generate an annual cost savings of $1,591 (8.5%) and an annual energy savings of 69,861 kBtu (7.4%).**
- **The EEMs generated fewer energy/cost savings than predicted in all three properties. Tenant behavior is likely one cause of this discrepancy.**
- **LED lighting renovations are the most inexpensive and most effective measure across all buildings.**
- **Upfront grant money was essential to getting the EEMs implemented.**
- **Missouri's Public Service Commision is approving energy rate increases regularly, increasing electricity costs every year since 2019.**

Attention was first directed towards aggregating the funding sources and financial frameworks that influenced organizations' capacity to enact sustainability initiatives. This encompassed an exploration of Tower Grove's financial structure alongside an examination of public and private funding sources available for decarbonization endeavors. Next, we undertook a comprehensive analysis of the project's sustainability retrofits, encompassing an evaluation of the challenges encountered in upgrading buildings, the executed retrofits, and an assessment of their efficacy.

We then appraised the properties' energy usage to gauge the pre-and post-retrofit energy usage. This analysis allowed us to assess the overall effectiveness of the energy efficiency measures and determine any external factors influencing building efficiency. Finally, we analyzed the political landscape in St. Louis to determine the actions undertaken by municipal authorities and state representatives in advancing clean energy and decarbonization initiatives.

The study's overarching findings revealed abundant funding sources catering to property owners and community groups interested in enhancing property sustainability and energy efficiency. However, the main challenges lie in aligning individual needs with grant and program requirements and identifying initiatives tailored to the specific needs of St. Louis organizations and residents. In addition, the investigation unveiled Tower Grove's implementation of an array of upgrades and retrofits, encompassing heating and cooling systems, windows, lighting, and thermostats. Subsequent cost-benefit analyses ascertained the efficacy of each retrofit, with the collective savings across the three buildings amounting to 8.5%. Notably, the retrofit with the most favorable cost-to-benefit ratio was the transition to LED light bulbs, yielding substantial cost savings beyond the initial investment.

While energy usage did not uniformly decrease across each building, the aggregated energy usage revealed an overall reduction of 7.4%. Each property under-delivered in its energy savings compared to the predicted savings, pointing to a significant impact of human behavior on energy consumption reduction. Lastly, an examination of city and state legislations showed few initiatives aimed at alleviating the energy burden of low-income residents in St. Louis. While there existed prioritization of low-income residents' welfare, particularly concerning eviction reform, actionable steps around legislation addressing energy insecurity and poverty or broader dimensions of energy justice remained limited. Consequently, we recommend solutions that advocate for enhanced community engagement to develop support around these issues, initially at the local level, before advancing to the state level.

FUNDING AND FINANCE

When outlining the project scope to retrofit three aging residential properties within the Tower Grove portfolio, primary considerations are affordability and financing. Tower Grove's revenue model mainly relied on rental income, supplemented by public grants, subsidies, and philanthropic contributions. Conversely, expenses included mortgages on all three properties and basic upkeep and maintenance expenditures.

In strategizing for the upgrades and retrofits, Tower Grove opted to implement the swiftest and least intrusive renovations within their financial means. This entailed enhancements such as upgraded thermal windows, LED light bulbs, shower and faucet aerators, energy-efficient air conditioners, gas furnaces with ECM motors, and programmable thermostats, among others. Given the energy-efficient nature of the upgrades targeting low-income buildings, Tower Grove qualified for substantial utility rebates through Ameren's Income-Eligible Program. In budgeting for the project, Tower Grove factored in utility rebates expected to offset nearly a third of the total upgrade costs. The three renovation projects, completed consecutively, all required Tower Grove to have the financing in place to cover all expenses upfront because the utility rebates would not be dispersed until after the project was completed. The initial expenses were fully covered by US Bank Foundation Community Possible Grants.

Tower Grove received the utility rebates several months after the project implementation and were then applied to Tower Grove's overall operating budget. The overall expenses, including labor but excluding personnel costs, amounted to approximately $88,734 with a total of $31,839 in rebates.

Findings - Funding and Finance

Upon review of the project's budget, two primary insights emerge, highlighting the significance of funding sources and the impact of cost management on renovations. First, the project's external funding sources were essential to its feasibility. Like most affordable housing providers,Tower Grove's financial structure is not structured to make large-scale capital improvements as the low rental income does not support it. Different from market-rate housing, affordable housing providers supplement their revenue with government programs, typically in the form of grants or subsidized loans, as rental income often falls short of making acquisitions and capital improvements financially feasible. Tower Grove, however, did not opt for government funding or subsidized loans, instead opting for a private grant from the US Bank Foundation as the grant met the needs of the project and Tower Grove met the specific requirements of the grant, facilitating the completion of renovations without incurring additional debts.

Cost, Rebate, and Grant Overview for Energy Efficiency Improvements

Figure 1. Chart depicting project cost, cost projections, and funding received through grants and rebates.

Secondly, Tower Grove encountered cost overruns on one of the projects; despite contingency measures in place to mitigate such occurrences, the project suffered from negative impacts of COVID-19 on construction and the supply chain. At 3606-08 Bamberger Avenue exceeded its initial estimated cost by $4,645. The 2020 COVID-19 pandemic had a significant impact on many global industries and construction was no exception. After a pause in all non-essential construction projects, demand for construction and construction materials surged. One consequence was a shortage of available contractors available to complete the project. Estimates for materials were inaccurate because of the constantly changing supply chain disruptions and inflation. Consequently, when estimates proved inadequate and costs of materials and labor surpassed initial projections, Tower Grove had additional contingency funds to bridge the gap.

Recommendations - Funding and Finance

We propose the following recommendations to ISC or other organizations looking to fund decarbonization projects based on our findings.

To complete these projects, Tower Grove leveraged all available financial resources within their reach. This exhaustive research into financial opportunities, meticulous collection and submission of required information, and regular monitoring and follow-up on the grant process demanded considerable time and effort from numerous Tower Grove staff members. It is recommended that Tower Grove prioritize grant writing and fundraising activities to optimize revenue streams. Various approaches can be adopted to achieve this objective, including contracting or hiring a dedicated grant writer tasked with identifying and applying for grants. As many grants may not precisely align with an organization's specific needs it is important that Tower Grove remain adaptable, flexible and open to a variety of financial opportunities. The capacity to research a large number of grants enhances the likelihood of identifying the grants best suited to the organization's needs. These represent some of the benefits of having a full or part-time employee dedicated solely to grant-related activities.

In addition, Tower Grove used a private grant to cover the upfront costs of these projects. However, they also worked with the utility company to secure rebates that brought the project's overall costs down. Therefore, we also recommend looking into other forms of funding through utility companies, such as collaborating with tenants to secure on-bill financing. On-bill financing allows utility companies to cover the upfront costs of energy efficiency projects, with the repayment made through energy bills. This method ensures that the financial burden on the end-user is mitigated, and the utility is reimbursed over time, typically ranging from 2 to 16 years, using the savings generated. This financing mechanism offers several benefits as it is a secure source of funding that covers upfront installation costs and allows the property owner to complete upgrades faster.

However, on-bill financing faces challenges. Ameren in St. Louis offers an on-bill financing program at an interest rate of 8.99% which could prove to be financially unfeasible for many low-income renters. Though this rate in Missouri is relatively high, similar programs in other states have rates as low as 0%[1]. Advocacy for more favorable financing terms is crucial to ensuring programs like on-bill financing are implemented with Energy Justice in mind. By engaging in discussions with utility companies and elected officials, the adoption of more accessible energy efficiency financing options for disadvantaged communities and affordable housing providers is possible. Additionally, challenges arise when the ownership of a building changes before completing their repayment.

1 According to Southern California Edison, program participants are able to access 0% loans.

This change can create ambiguity regarding the responsibility for ongoing payments, underscoring the need for clear policies that address the transfer of obligations to new owners.

Furthermore, incorporating energy audits and planning at the property acquisition phase offers advantages. This approach benefits building owners and loan originators because efficiency upgrades enhance the performance of properties, which improves financial stability, tenant satisfaction, and physical condition. During the underwriting process, accounting for reduced operating costs from energy efficiency upgrades can increase the property's cash flow, leading to larger loans. Also, a more efficient, healthier, and comfortable living environment enhances tenant satisfaction, further bolstering the financial stability of the property and reducing vacancy. Affordable housing providers could reach out to local Community Development Financial Institutions (CDFIs) or apply for Energy Efficiency Mortgages (EEMs) administered by entities like Fannie Mae, Freddie Mac, and various state and local governments to benefit from energy efficiency financing opportunities.

Lastly, understanding the variety of financial opportunities is integral to finding the most appropriate funding for energy efficiency improvements. Recently, with the passage of the Inflation Reduction Act for energy efficiency projects, we have organized funding opportunities into a spreadsheet, in addition to funding sources from CDFIs and philanthropic organizations. This document aims to support affordable housing providers and nonprofit organizations in accessing potential funding sources This spreadsheet is accessible here and further explained in the Tools section.

Findings & Recommendations

PROJECT IMPLEMENTATION

Tower Grove provided access to the financial breakdown of their construction budget and allowed us to complete an in-depth exploration of implementation costs and analysis of the project's financial benefits. This examination delves into the financial considerations of implementation, encompassing both the immediate costs and the financial and energy savings resulting from these retrofits.

Within this framework, we analyze the impact of retrofits at both the unit level and building-wide scale, aiming to determine which types of upgrades yield the most significant reductions in energy expenses for residents. Our investigation entails an examination of individual retrofit components to discern their respective financial and energy-saving implications, culminating in an amalgamation of these findings to present a comprehensive project analysis. Across all three projects, a strategic approach to retrofitting emerges, characterized by a balance between immediate returns and long-term investments.

Findings - Project Implementation

3169-71 Alfred Ave. is a two-story rental building, built in 1928 and has a total of 4 units. 3606-08 and 3732-34 Bamberger St. are both two-story rental buildings with the same floor plan. 3606-08 was built in 1913, and 3732-34 was built in 1916; they both have 4 rental units each. At the start of this initiative, the buildings were heated by natural gas with a thermostat installed and cooled by outdated, energy-intensive window-mounted air conditioners. In addition, lighting relied mainly on using incandescent light bulbs and water through traditional faucets, and the buildings used traditional gas-powered hot water heater

The projects involved three multi-family buildings in different locations in St. Louis. The

Property	Project Start Date	Project End Date	Duration
3169-71 Alfred Ave.	July 2021	May 2022	11 Months
3606-08 Bamberger.	Feb. 2021	Oct. 2021	9 Months
3732-34 Bamberger.	July 2019	Nov. 2022	16 Months

timelines ranged from 9 months to 16 months and were completed concurrently.

Retrofit Items

Upgrades across the three project units included upgraded thermal windows, LED light bulbs, shower and faucet aerators, energy efficient air conditioners, gas furnaces with ECM motors, and programmable thermostats.

Payback

Payback is the calculation used to determine the years it will take before energy savings surpass the initial cost of the improvement. According to Tower Grove's Ameren Missouri Multifamily Programs Enrollment Form, all three projects had an expected payback period ranging from 12.7 to 30.8 years. However, in the case of these projects, the payback amount is forwarded to the tenants rather than the building owners because the tenants are responsible for paying energy bills. Longer-term benefits of interventions (such as an increase in real estate value) are to the benefit of the building owner.

Cost Analysis

Among all three projects, the most costly upgrade overall were the "15.5 SEER Energy Star Rated Air Conditioners" with a maximum unit cost of $4,125. Installing this air conditioner system was a significant investment in high-efficiency cooling solutions [see Appendix VI for detailed upgrade details for each building]. On the other hand, the least expensive upgrades were readily available LED light bulbs and water-saving fixtures. This retrofitting strategy focuses on two main goals: first, to quickly save energy by making affordable upgrades, and second, to cut down on energy use over the long term by investing in advanced, efficient cooling systems. All three projects show a strategic approach to retrofitting that balances immediate gains with long-term investments.

Cost-Benefit Analysis

In order to understand the overall cost-benefit for multi-family housing decarbonization projects, we conducted a comprehensive cost-benefit analysis of decarbonization retrofits across Tower Grove's three multi-family buildings. We examined individual retrofit items to understand their financial and energy saving impacts and aggregated these findings to present an overall project analysis. Following the financial and energy saving analysis, we recommend best practices for implementing similar projects in the future, emphasizing cost efficiency, energy savings, and environmental benefits.

Detailed Retrofit Cost-Benefit Analysis Table		
Retrofit Category	**Cost Details**	**Benefits & Observed Outcomes**
LED Lighting	Cost: Unit Price ($6.5 - $9) + Installation Fee	• Benefit: LED light bulbs use up to 85% less energy than traditional incandescent light bulbs to produce the same amount of light, which contributes significantly to kWh savings. LED light bulbs also have a longer lifespan, compared to traditional light bulbs, reducing long-term costs. • Most effective: LED Light bulbs were the most effective measure across all buildings, significantly reducing electricity usage with a clear positive impact.
Duct Sealing	Cost: Unit Price ($6.25) + Installation Fee	• Benefit: Effective duct sealing minimizes air leakage, improving HVAC system efficiency and leading to energy savings. • Effective: Improved HVAC system efficiency.
High-Efficiency Furnaces with ECM Motors	Cost: Unit Price ($2,300 - $2,663) + Installation Fee	• Benefit: High-efficiency has an Annual Fuel Utilization Efficiency rate above 90%, meaning these furnaces are able to convert a higher percent of gas into usable heat and use less gas overall. This leads to lower heating costs and reduces resident's carbon footprint. • Partially effective: Some instances showed expected improvements, but overall impact was less consistent than anticipated. The results varied across three buildings. Tenant behavior and varying building features are the main reasons for the differing result.
Programmable Thermostats	Cost: Unit Price ($87.5 - $225) + Installation Fee	• Benefit: Programmable Thermostats are designed to optimize heating and cooling because they allow automatic adjustments of temperatures based on daily schedules, reducing energy use when it's not needed, increasing kWh savings, enhancing occupant comfort, and reducing tenant's carbon footprint. • Partly effective: Expected improvements were observed in some units, highlighting the influence of occupant interaction with the technology.

Double Pane Energy Star Rated Window (Multi-Size)	Cost: Unit Price ($138 - $557) + Installation Fee	• Benefit: Double-pane windows improve thermal insulation, reducing energy loss and leading to significant heating and cooling savings. Also increase indoor air quality.
		• Not effective: Did not demonstrate the expected energy use reductions, indicating potential discrepancies between theoretical implementation and real-world application. The unexpected result could have been caused by:
		  ◦ Tower Grove's inability to also insulate the exterior walls, leaving the residences vulnerable to thermal loss and mitigating the savings
		  ◦ Characteristics could also affect the efficiency of the windows such as the effect of window location (for example, if a window is facing a side that has strong wind or sunshine).

Aerator & Shower Head at different GPM level (0.5 - 1.5)	Cost: Unit Price ($8 - $20) + Installation Fee	• Benefit: Aerators can help reduce water usage (at different temperatures) by introducing air into the water stream, creating a flow with less water, which enhances water saving efforts. • Effective: Though not an energy specific retrofit, the aerators proved to have a positive impact on reducing the water usage in the Tower Grove units.

Recommendations - Project Implementation

The three projects achieved a 7% improvement in energy use and an 8% cost savings, with individual EEMs showing varying levels of effectiveness. Some retrofits, like LED lighting, show clear benefits, while others, such as window upgrades and high-efficiency HVAC systems show opportunities for further investigation.

Best Practices and Recommendations:

1. Prioritize High-Impact Retrofits: Focus on retrofits with substantial energy savings and shorter payback periods. For instance, upgrading to high-efficiency HVAC units and LED lighting are both proven to enhance energy efficiency. However, LED bulbs can yield savings in just a few months, while the return on investment for an upgraded HVAC system might take several years. When determining what EEMs you are going to use, start with low cost, high impact items.
2. Maximizing the EEM Impact: When planning EEM, it is important to consider all improvements to ensure the positive impacts of one EEM retrofit are not offset by external factors. For example, adding high-efficiency windows can reduce thermal loss, but if the external walls are not insulated, that space may still see a net loss of thermal energy. We recommend investing in retrofits that can maximize savings in the environment in which they are installed. Also, ensure that when installing a high-efficiency window, wall insulation is evaluated and upgraded if necessary to optimize the building's thermal envelope, the space that tenants will be using energy to heat or cool them.
3. Community Engagement: Engage with tenants about the benefits of EEMs and how their behaviors can have a significant impact on their finances. EEMs are only as effective as their implementation, particularly regarding HVAC unit usage, thermostat settings, and window usage. We recommend leveraging educational initiatives to aid tenants in making informed decisions about their energy usage, using technology to provide timely feedback, motivating tenants to adopt EEMs through incentives, and maintaining consistent dialogue with tenants to ensure long-term implementation. Examples are provided in the Tool - Tenant Engagement section.
4. Consider Long-Term Benefits: Evaluate retrofits not only for immediate cost savings but also for their long-term impact on property value and environmental sustainability. For example, HVAC systems might have a higher upfront cost but can significantly increase property value and provide long-term energy saving if used properly.
5. Tailor Retrofits to Specific Needs: Customize retrofit choices to the unique needs and conditions of each property to ensure optimal energy savings. For example, consider a property located in a region with extremely cold winters and mild summers. The energy retrofit for the building might prioritize an energy efficient heating system rather than investing heavily in cooling systems.
6. Conduct Pre-Assessment of Building: Conduct detailed evaluations of buildings to identify the most beneficial EEMs, considering its unique characteristics, external factors, and tenant needs and behaviors.

ENERGY USE INTENSITY

Over the past four years, Tower Grove has accumulated energy usage data, allowing us to develop quantifiable cost-benefit analysis of the three housing decarbonization projects.

This analysis connects the benefits of reducing energy usage and the cost savings derived from decarbonization efforts in housing. Our analysis draws upon an extensive dataset including unit specifics, retrofit measures, financial metrics including estimated versus actual costs, unit price, payback periods, and funding sources. A detailed examination of energy savings and consumption provides a clear foundation for assessing both anticipated and realized energy savings, as well as the associated financial advantages.

This approach enables us to forecast and validate the actual energy and cost savings achieved, and display a comprehensive overview of the project's economic and ecological footprint. Our methodology encompasses the calculation of greenhouse gas (GHG) emission based on energy use, using the standard metrics of tonnes of CO2 equivalent per square foot (tCO2e/sf).

Additionally, we address the pre-renovation baseline by comparing it to the post-renovation energy bills, allowing for a direct assessment of energy saving achieved. This approach not only quantifies the benefit of housing decarbonization retrofitting, but also highlights housing decarbonization's contribution to environmental sustainability through the reduction of GHG emission.

Findings - Energy Use Intensity

Energy and Cost Savings

Overall, the upgrades generated both energy and cost savings. Because the EEMs include upgrades that impact the building's heating and cooling (such as programmable thermostats and furnace upgrades), ERG calculated direct savings on electricity and natural gas in addition to baseload savings[2]. To aggregate total energy savings, the electricity savings (in kWh) and the natural gas savings (in therms) were both converted to thousand British thermal units (kBtu). **Overall, the three projects generate an annual**

2 Baseload energy refers to energy used by appliances in a home outside of space conditioning, such as refrigerators and lighting.

cost savings of $1,591 (8.5%) and an annual energy savings of 69,861 kBtu (7.4%).

Final Energy and Cost Savings		
Property	**Energy Savings (kBtu)**	**Cost Savings**
3169-71 Alfred Ave.		
Previous Usage	314,686	$5,803
Current Usage	264,520	$4,758
Savings (net)	50,166	$1,045
Savings (%)	15.9%	18.0%
3606-08 Bamberger Ave.		
Previous Usage	277,550	$5,255
Current Usage	263,019	$5,010
Savings (net)	14,531	$245
Savings (%)	5.2%	4.7%
3732-34 Bamberger Ave.		
Previous Usage	355,069	$7,674
Current Usage	349,905	$7,373
Savings (net)	5,164	$301
Savings (%)	1.5%	3.9%
Project Total		
Previous Usage	947,305	$18,732
Current Usage	877,444	$17,141
Savings (net)	69,861	$1,591

In their analysis, ERG found that only LED lighting upgrades made a consistent impact on energy savings. Surprisingly, window and A/C upgrades did not generate the expected energy savings. This can be attributed to tenant behavior or other limitations in the scope of the EEMs. For example, the knob-and-tube wiring in these properties (which is common in older buildings) has exposed wiring that prevents new insulation installation. Without improving the insulation of a space, energy efficiency saving measures can be dwarfed.

Resource Innovations—the implementer of Ameren's Income Eligible program—provided Tower Grove with a projection of savings that the energy efficiency upgrades would bring to each property. However, based on the benchmarking and reporting by ERG, there was a significant gap between the projected and actual savings. For each property, the projected savings was significantly greater than the actual savings (see Figure 2).

ERG's analysis largely attributed this discrepancy to tenant behavior. In some instances, energy usage went up significantly post EEM due to a changeover in tenants within one unit, such as the second floor tenant at 3606 Bamberger Ave [see Appendix IX]. A 33% increase in electricity usage post-EEM implementation (particularly in the warmer months) points to a significant increase in air conditioning usage compared to the previous occupants. This indicates that upgrading air conditioners to 16 SEER units did not generate enough energy savings to offset the increased usage. Because ERG's analysis was solely based on utility usage data, it is unclear which exact behaviors contributed to increased energy consumption. For instance, replacing an A/C unit to a 16 SEER unit will not generate savings if a tenant is leaving doors and windows open while running the units or simply likes a colder apartment. ERG also could not obtain data on thermostat setpoints used by tenants, so it is unclear what role the programmable thermostats played in reducing energy consumption.

Environmental Implications

As expected, a gap between projected and actual energy savings translates to a gap between projected and actual carbon emissions savings (see Figure 4). By converting the expected electricity and natural gas savings to carbon equivalencies, we calculated the projects were projected to generate a carbon savings of 31.31 metric tonnes of carbon dioxide annually. In reality, they only generate approximately 6.84 metric tonnes of carbon dioxide in savings annually (roughly equivalent to 17,494 miles driven by an average gasoline-powered passenger vehicle).[3]

The project scoping did not include full electrification, which yields greater environmental benefits but requires costly and time-consuming retrofits and is challenging to implement in older building stocks. Instead, Tower Grove's proposed EEMs were scoped to reduce both electricity and natural gas consumption through both baseload reductions and reduced heating/cooling. However, looking at the resulting emissions by energy source reveals that roughly half of the properties' actual emissions come from natural gas for 3169-71 Alfred Avenue and 3606-08 Bamberger Avenue. This reveals a significant potential for an increased environmental impact with future electrification. Interestingly, natural gas consumption actually increased post-EEM in 3732-34 Bamberger Avenue, resulting in negative savings. This reiterates the finding that tenant behavior can override the benefits of energy efficiency upgrades.

3 Based on the EPA's Greenhouse Gas Equivalencies calculator

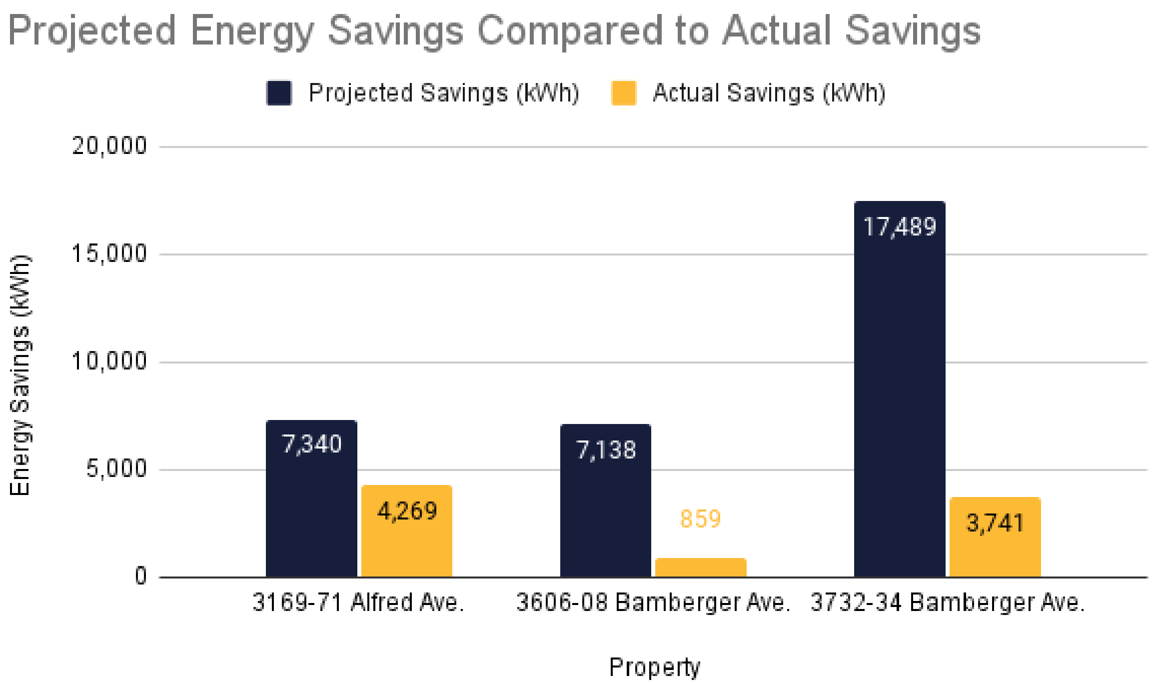


Figure 2. Chart depicting projected energy savings as compared to actual energy savings.

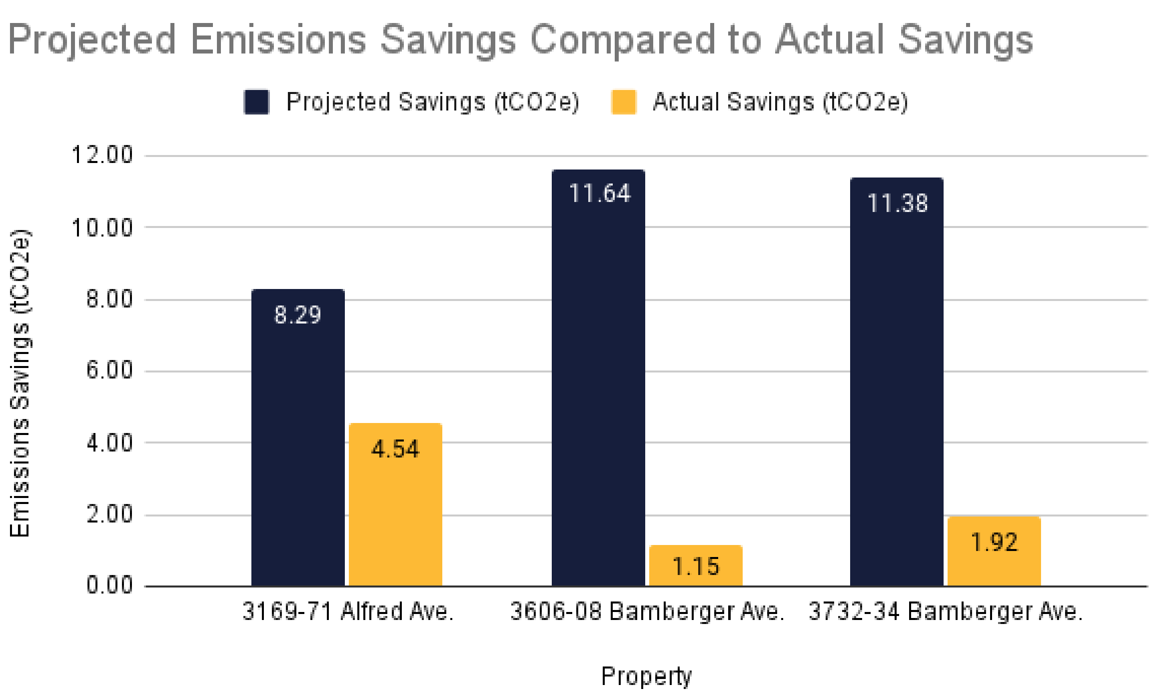


Figure 3. Chart depicting projected emissions savings as compared to actual emissions savings.

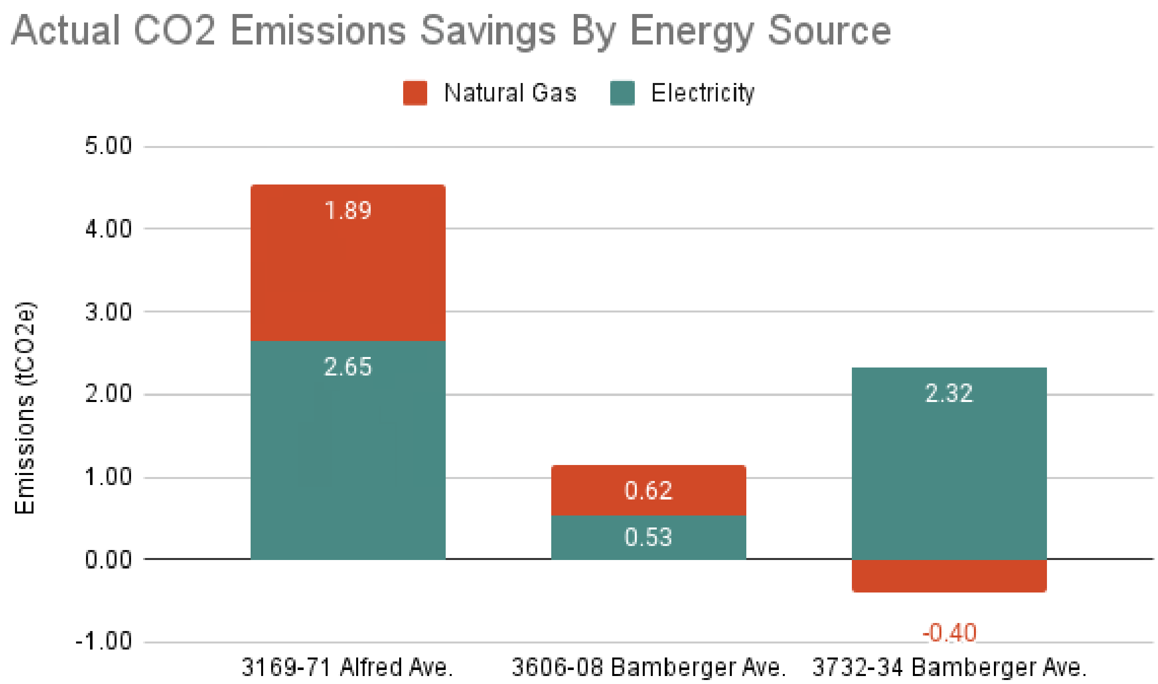


Figure 4. Chart depicting each property's CO2 emissions by energy source after adding EEMs. The chart shows the natural gas consumption increase post-EEM in 3732-34 Bamberger Avenue, resulting in negative savings.

Utility Rate Increases

Another key finding in our analysis is that St. Louis's primary electricity and gas providers (Ameren and Spire, respectively) both increased their customer charges (flat service rate) and utility delivery rates (based on usage) between 2017 and 2022[4]. Increasing utility rates is one contributor to energy insecurity for low-income residents. Despite energy-efficiency upgrades and/or lowered energy usage, consumers can continue to spend a large portion of their incomes on energy if the rates continue to increase.

Electric Rates- Increase Between 2017 and 2022	
Customer Charge	0.00%
Low-Income Program Charge	250.00%*
Summer Energy Charge	3.02%
Winter Energy Charge- First 750 kWh	0.57%
Winter Energy Charge- All kWh	-1.50%

Gas Rates- Increase Between 2017 and 2022	
Winter - All Ccf	56.61%
Summer- First 50 Ccf	56.60%
Summer- In excess of 50 Ccf	56.61%

* Despite the high percent change, the program charge only increased from 4 cents to 14 cents. See Appendix VIII for detailed energy raw data.

4 Historic data was obtained from the ERG analysis. 2013-2016 data is omitted from the gas data because in 2017 Spire's payment structure shifted to its current structure of charging a higher rate for consumption >50 CcF in the summer months. Before 2017, Spire (which operated under its former name of Laclede Group) charged customers a higher rate for consumption >30 therms in the summer months.

Energy Burden

Energy burden refers to an individual's energy costs in comparison to their income. According to the Department of Energy's Low-Income Energy Affordability Data (LEAD) Tool, the national average energy burden for low-income households (defined by those earning 0-80% of the area median income [AMI]) is 6%. This is three times higher than the average energy burden for non-low-income households, which is roughly 2%.

Currently, 11 of the units within the Case Study properties are occupied and one is vacant (3608 Bamberger 1f). All 11 tenants are considered low income (<80% AMI) and have an annual income of <$56,250. We calculated each tenant's energy burden by comparing their monthly electricity and natural gas expenses to the monthly income and found that the average energy burden is 3.50%, which is slightly above the national non-low-income average. While low-income TGCDC tenants within these three properties are less energy-burdened than other low-income households nationally, reducing their energy burden even more can help promote broader energy justice.

Energy Burden of Current Tenants						
Property	**Annual Income**	**Monthly Income**	**Average Monthly Natural Gas Charge (2023)**	**Average Monthly Electricity Charge (2023)**	**Total Average Monthly Utility Charge (2023)**	**Energy Burden**
Tenant 1	$37,752	$3,146	$53.26	$41.14	$94.40	3.00%
Tenant 2	$39,480	$3,290	$43.27	$46.35	$89.62	2.72%
Tenant 3	$36,912	$3,076	$53.09	$127.15	$180.24	5.86%
Tenant 4	$38,400	$3,200	$42.28	$41.45	$83.73	2.62%
Tenant 5	$17,950	$1,496	$33.83	$56.00	$89.83	6.01%
Tenant 6	$39,996	$3,333	$54.22	$68.00	$122.22	3.67%
Tenant 7	$31,200	$2,600	$20.67	$49.00	$69.67	2.68%
Tenant 8	$53,832	$4,486	$26.08	$32.82	$58.90	1.31%
Tenant 9	$33,804	$2,817	$70.70	$42.56	$113.26	4.02%
Tenant 10	$24,850	$2,071	$44.93	$31.29	$76.22	3.68%
Tenant 11	$30,000	$2,500	$58.03	$14.13	$72.16	2.89%

Recommendations- Energy Use Intensity

Based on our findings, we propose the following recommendations to maximize the return on energy efficiency measures while centering energy justice concerns in building decarbonization.

Conduct Tenant Engagement

After analyzing the energy consumption patterns at Tower Grove, it became evident that tenant behavior significantly influenced energy usage. ERG notes that tenant behavior dwarfed the actual energy savings. To fully capitalize on the benefits of implementing energy retrofits, it is important for tenants to adopt behavioral practices that curtail unnecessary or wasteful energy consumption. Fortunately, several actions can be implemented immediately, often at minimal or no cost.

In order to assist tenants in their efforts to reduce energy usage, we propose the creation of informative material in the form of flyers, refrigerator magnets, and workshops containing practical examples of energy-saving practices.

These practices include:

- Turning off lights upon exiting a room.
- Utilizing natural sunlight for lighting and heating when feasible.
- Employing appropriately sized pots on burners and covering them with lids.
- Adjusting the hot water heater temperature to a maximum of 120°F.
- Washing clothes with cold or warm water instead of hot.
- Utilizing the Energy Star qualified sleep feature on computers.
- Switching off electronics and unplugging chargers when not in use.
- Utilizing window blinds or shades to regulate indoor temperature.
- Fully loading dishwashers, clothes washers, and dryers before operation.
- Adjusting the thermostat when leaving home for an extended period.

For more details on best practices for energy-saving tenant engagement, see the “Tools” section.

Address the Split Incentives Problem

The split incentives issue emerges when incentives intended to encourage energy-saving investments accrue not to the property owner, who funds the investment, but to the tenant occupying the property. This problem often arises when landlords finance energy efficiency upgrades but they are not paying the electricity bills. Consequently, landlords do not directly benefit from the resulting savings on the energy bill and are often not incentivized to make these types of capital improvements.

To address this issue, several strategies can be employed.

Green Leases

Green Leases, also known as aligned leases or high-performance leases, add green language and integrate clauses into rental agreements that align the interests of landlords and tenants toward achieving energy efficiency and sustainability goals. This leasing model fosters a collaborative environment where both parties share the costs and benefits of implementing energy-efficient practices, upgrades, and sustainable products. A key feature of green leases is their flexibility to adapt to the specific needs and goals of the property owners and renters. They can include provisions for sharing utility savings, outlining responsibilities for achieving energy efficiency certifications or agreeing on sustainable operations and maintenance. For instance, a green lease might stipulate that landlords invest in an energy-efficient HVAC system or insulation while tenants agree to use energy responsibly and purchase energy-saving appliances. The mutual benefits are clear: landlords can enhance the value of their properties by making them more sustainable and energy-efficient, potentially attracting tenants willing to offset their energy cost savings to the benefit of greener living space. On the other hand, tenants can enjoy lower utility bills, improved indoor environmental quality, and the satisfaction of living or working in a space that aligns with their environmental values. A great example of a green lease is the Energy Aligned Clause [see Appendix VII for Detailed Energy Aligned Clause Information], which requires tenants and landlords to share in the investments and any energy rebates, ensuring both parties contribute to the upfront costs but also share in the benefits.

Agreement on Predicted Savings

After any capital investments, predicted savings are determined by a mutually agreed upon energy specialist who establishes a common ground for savings estimates.

Extended Payback Period

When owners recover the cost of the investment through savings in operating expenses, specifically energy costs, the simple payback period is extended by 25% to account for the shared benefits and risks between owners and tenants. The simple payback period refers to the time it takes for the initial investment in an improvement, like an energy retrofit, to be recovered through the savings it generates. It can be calculated by dividing the costs of the investment by the annual financial savings.[5]

Creating Incentives for Upgrades and Retrofits over Repairs

In some green leases there are clauses that recommend property owners choose energy retrofits over repairing outdated and inefficient systems. This strategy would encourage an upfront investment in retrofits with fewer maintenance and repair costs.

Overall, addressing the split incentives problem through approaches such as green leases, agreements on predicted savings, and strategic investment choices not only aligns the financial incentives of landlords and tenants but also promotes sustainable practices.

5 For example if a retrofit costs $1,000 and saves $200 per year in energy costs, the simple payback period would be $1000/$200 per year = 5 years

These strategies ensure that energy efficiency gains and the associated benefits are shared, thereby incentivizing property owners and tenants to start energy savings retrofits.

Advocate for utility rate regulation

One added hindrance to building electrification is that electricity utility rates are currently greater than gas rates and there is a concern that they will continue to go up as the country transitions away from fossil fuels. In the near future, as fossil fuels are transitioned out, it is anticipated that this relationship will become the inverse where gas rates are much higher than electricity utility rates. This has occurred in the past as society made a transition from burning coal to gas for heating. Using 2022 utility rates, 100 therms in gas would cost around $36 but $195 in electricity during the winter and $380 in the summer. This hinders decarbonization progress. Tenants would bear the increased utility costs if they do not have energy-efficient appliances, which exacerbates energy justice concerns for energy-burdened households. In turn, tenants may be less supportive of electrification despite the environmental and health benefits that come with decarbonization. This is consistent with Tower Grove's experience in which the higher cost for electricity has been a burden on tenants where units were converted to all electric service.

In the United States, utilities are regulated by the state's Public Service Commission (PSC), sometimes also called a Public Utilities Commission (PUC). The composition and structure of these PSCs can significantly differ across states. For instance, in Missouri, the PSC consists of five commissioners, whereas other states may have varying numbers of commissioners. In addition, the appointment process for commissioners in Missouri involves gubernatorial selection, differing from other states where commissioners may be elected or require confirmation by the state legislature.

The Missouri PSC is responsible for ensuring that "Missourians receive safe and reliable utility services at just, reasonable and affordable rates." The PSC regulates not only the extent to which utility companies invest in clean energy and where new energy projects are sited but also the rates consumers pay for their energy. The process of revising or adjusting utility rates is lengthy and complicated. It requires the PSC staff to undertake a thorough and independent review of a utility company's assets and liabilities to determine all alterations' reasonableness and financial viability. Following the assessment, these adjustments require approval by the PSC commissioners through a majority vote. The PSC also oversees the implementation of federal policies such as the Inflation Reduction Act.

PSCs/PUCs have the ability to approve agreements that can facilitate energy justice and equitable decarbonization. In February 2024, the Michigan Public Service Commission approved a settlement agreement with clauses to address energy justice for low-income consumers. This included a $15 million increase in low-income energy efficiency program investments and improvements to the existing Income-Qualified Multifamily Program, which helps affordable housing providers install heat pumps and other energy-efficiency upgrades.[6] In 2021, the Hawaii Public Utilities Commission approved a suite of publicly-reported metrics and performance-based regulation (PBR) scorecards. This PBR approach not only increases transparency on the utility company's performance but also holds them accountable in reaching promised goals for affordability and clean energy transition.

Housing providers and residents can both address systemic energy insecurity and just decarbonization by advocating for clean energy investment, utility rate regulation, and policies that freeze rates for low-income ratepayers to their state PSC/PUC. Ratepayers can sign up to testify at public PUC/PSC proceedings and hearings in support of clean energy and energy justice initiatives. In states where the commissioners are elected, individuals can also advocate and vote for the candidates who prioritize climate issues and energy security in their campaigns.

Consider other sources of renewable energy

Equitable building decarbonization will require strategies that address energy burden, particularly for low-income renters. We recommend exploring avenues of renewable energy that will keep costs affordable for tenants while lowering building-related greenhouse gas emissions. Electricity supplied by Missouri's grid is generated through the combustion of fossil fuels. St. Louis falls within the SMRW EPA eGRID subdivision, which has the fourth highest CO_2 total output emission rate in the country, 66% higher than the national average.[7] As such, investing in renewable energy sources is one way to lessen our dependence on fossil fuels while still providing essential heating and cooling options to homes.

One increasingly common pathway is to utilize renewable energy generation through the installation of localized photovoltaic (PV) systems (solar arrays). The growing community solar movement, which incentivizes multiple customers to subscribe to energy generated by solar panels, has two primary models. The off-site model (the more common of the two) allows customers to pay a monthly subscription fee to access energy generated by solar panels at an off-site array. Energy generated through the array is sold to the utility company. The customer in turn receives a credit for the electricity generated by their share of the community solar system in the form of an electricity bill credit. This allows renters and those who cannot build PV systems on their property to participate in the solar movement. Ameren, which serves Missouri and Illinois, currently operates two community solar centers—Lambert Community Solar Center and Montgomery Community Solar Center—which have been in operation since 2019 and 2022, respectively. Housing Development Corporations, such as Tower Grove, can include community solar options in their tenant education materials (see above).

6 Earthjustice, "Advocates and Consumers Energy Reach Agreement on Critical Energy Efficiency Programs"

7 According to the EPA's eGRID data explorer, the SMRW eGrid subdivision has an output of emission rate of 1,370 lb of CO2 per MWh of electricity. The national average is 823.15 lb/MWh as of 2022.

In the on-site model, building owners build solar arrays on the roof of apartment buildings and multi-family homes (often with the help of statewide incentives) and the residents share the benefits. Usually, the energy generated goes towards powering a building's common areas due to the logistical challenges of diverting the power to numerous individual units. However, one major drawback of the program is its inability to accommodate small multi-family residences similar to the property managed by Tower Grove. As with the Tower Grove properties, these spaces typically have little to no communal areas to which this power can be diverted. This also prevents residents from participating in net metering, the process of a private entity selling the power in excess of their immediate on-site needs back to the utility company. Moreover, net metering is legal across some states, thereby restricting participation in renewable energy generation.

Beyond community solar, building owners and housing providers should consider other forms of renewable energy that are geographically appropriate. Geothermal, wind, and hydropower are all growing sectors of the renewable energy landscape, particularly as the Inflation Reduction Act funds and provides tax credits for renewable energy generation.

Findings & Recommendations

PUBLIC POLICY AND GOVERNANCE

Municipalities and governmental agencies have a significant influence over the urban development process, primarily through the enactment of legislation, formulation of policies, allocation of funds, and establishment of ordinances.

This influence spans various levels of government, including local, state, and federal entities, collectively shaping a city's growth trajectory by either facilitating or inhibiting particular activities. The execution of large-scale initiatives often necessitates financial backing from multiple sources, with federal budgets typically playing a major role. Initiatives oriented towards advancing the public good, rather than serving private interests, heavily rely on governmental intervention to institute change. Given this multifaceted challenge, governance is an integral factor in addressing this issue. In analyzing Tower Grove's efforts to combat climate change, we have analyzed the impact of current and potential local, state, and federal legislation on its progress.

Findings - Policy and Governance

Laws and Ordinances

In examining ordinances and policies that had an impact on Tower Grove's efforts to provide affordable, energy-conscious housing to low-income residents, two regulatory measures were identified: the Energy Conservation Code (Ordinance 70799) implemented in 2018 and the Building Energy Performance Standards (BEPS) ordinance of 2020. In addition, the Missouri Public Service Commission's (PSC) approval of the rate increases in 2023 and 2024 significantly impacted the EEMs initiated by Tower Grove

The Energy Conservation Code has tangible implications for Tower Grove's initiatives. This code updates building regulations to establish minimum energy efficiency standards for new constructions. Although Tower Grove's properties are far from being newly constructed, this law has ramifications on the incentives available for energy efficiency upgrades. Incentive programs such as utility rebates, utilized by Tower Grove, were originally intended to incentivize property owners and developers to construct buildings with higher energy efficiency. However, with energy efficiency now mandated by law, utilities have initiated the phasing out of many incentive programs.

The BEPS ordinance, unanimously approved by the Board of Aldermen in 2020, mandates energy performance standards for all municipal, commercial, institutional, and residential properties exceeding 50,000 square feet. Properties with the highest energy usage are required to implement upgrades to reduce energy consumption. However, Tower Grove's buildings remain unaffected by this ordinance as they fall below the 50,000 square-foot threshold. If the ordinance did affect smaller buildings, Tower Grove, like many other building owners, would face pressure to make changes that would positively impact all residents burdened by inefficient housing energy costs.

Lastly, the escalating cost of energy significantly impacted Tower Grove's residents, with utility rates steadily increasing from 2017 onwards. Missouri, like many other states, has a Public Service Commission (PSC) that serves as a regulatory agency to safeguard public interests against private utility interests. The Missouri PSC has shown to mitigate rate increases but ultimately approves a portion of all rate increase requests made by utilities.

Recommendations - Policy and Governance

Advocacy
Combating the negative effects of climate change is a global imperative that requires all people to commit to advancing a shared vision for how to solve this problem. Unfortunately, this global movement is far from homogenous and is not even uniform nationally. This is clear when analyzing the agencies and structures of Missouri in comparison to other states. For instance, the Missouri power grid is far dirtier than California's. In addition, regulations around political and financial oversight are structured differently than other pilot hubs. That said, the plan being suggested is limited due to the vast disconnect amongst local and state sustainability measures and programs. These recommendations center on the structure of Missouri and St. Louis' utility and may not be applicable to a national audience. However, the foundation of all our recommendations is advocacy.

Low-income communities of color have historically and systematically been disenfranchised and left politically powerless. That is why the advocacy and awareness around the needs of these groups are imperative to legislating the changes critical to bringing all climate change opportunities to them. There are two areas of advocacy that could prove beneficial to this end.

In St. Louis, there are a multitude of initiatives aimed at making buildings more efficient and incentives to upgrade and retrofit buildings with energy consciousness but far too often they are not targeted at low-income properties. The main reason being not to burden low-income residents with additional financial expenditures as energy upgrades and refits can be expensive. That said, implementing initiatives such as the BEPS ordinance to include smaller low-income residential buildings that include equitable supports depending on need would be more supportive to divested communities than excluding them altogether.

In addition, escalating utility costs have posed a significant challenge to the tenants featured in the case study in their efforts to reduce energy expenses, despite the implementation of energy efficiency measures. Consequently, advocates are essential at the state level to educate agencies such as the Missouri PSC, tasked with regulating investor-owned utilities and establishing electricity prices. Currently, the PSC is in support of utility rebates being phased out in lue of the funding from the Inflation Reduction Act (IRA). It is crucial for advocates representing low-income communities to remind these agencies of the adverse impact these policies can have on our most vulnerable populations. Continued work is needed to educate the PSC to allow organizations like Tower Grove to use a combination of utility rebates, funds from the IRA, and other incentive programs to improve housing for low-income residents.

ADAPTATION TO PILOT HUBS

This report aims to outline both the accomplishments and obstacles encountered by three residential units in St. Louis, Missouri.

It is important to acknowledge the inherent limitations of the research conducted, particularly concerning its focus on small, multi-family residential properties, which may not directly translate to the diverse needs and challenges of Leadership Alliance members. Nonetheless, the insights derived from this report have the potential to develop actionable recommendations applicable to any organization striving to bring climate change mitigation initiatives to low-income communities of color. Emphasis should be placed on determining avenues to leverage this information rather than focusing on its lack of direct relevance to individual needs.

While the financial structure employed by Tower Grove aligns with the needs of an affordable housing development corporation, the case study provides insights that can be shared with congregants of a religious institution or members of a community center. We offer tools for identifying programs tailored to multi-family dwellings, single-family residences, and community-based organizations. Tower Grove's reliance on grants and utility rebates to meet its objectives in Missouri highlights the potential for other organizations to leverage alternative incentives offered in their respective states, in addition to federal programs that can be applied nationwide.

Local climate strongly influences the energy needs of a place. Certain regions need extensive heating and cooling measures while others do not, and geography also influences the availability of renewable energy sources. In addition, we acknowledge that laws and regulations also bring a level of specificity to the analysis and affect the capabilities of climate change initiatives at the state and local level. Nevertheless, the insights gained from this analysis transcend geographical boundaries, such as the actionable recommendations aimed at instigating behavioral changes conducive to reducing energy consumption and enhancing efficiency, thereby bolstering the decarbonization movement.

Lastly, energy injustice disproportionately impacts low-income communities of color, and creating a more just and equitable future will require looking beyond financial and greenhouse gas emissions savings [see Appendix II- Literature Review]. As a whole, decarbonization improves air quality, reduces injuries and death resulting from fossil fuel infrastructure, and reduces environmental damage related to fossil fuel resource extraction, particularly in low-income communities and communities of color.

Furthermore, decarbonization not only fosters a healthier living environment but also has tangible non-energy benefits (NEBs) such as improved safety and wellness outcomes. According to the US Department of Health and Human Services, the social determinants of health include economic stability, education access, health care access, neighborhood, and community, which can all be affected by how energy efficient someone's home is.

Replacing outdated, inefficient windows with energy-efficient alternatives mitigates pollutants, enhances security, and reduces indoor sound pollution. Similarly, improved health resulting from cleaner air can mitigate absenteeism among students, thereby potentially leading to improved educational outcomes. These instances highlight the broader societal implications of home upgrades, creating a ripple effect that positively impacts the community and its residents. Thus, when scoping decarbonization projects, these impacts (which are more challenging to quantify than energy savings) must be considered in order to advance broader environmental justice.

AREAS OF FURTHER RESEARCH

Further research in equitable building decarbonization is essential to address several key areas. There is a need for more studies on the effectiveness of current funding mechanisms in reaching and adequately supporting the disinvested communities. This includes evaluating the impact of federal and state programs on actual energy cost savings and improved living conditions. Moreover, research should focus on developing innovative financing models that can overcome the barriers of split incentives, especially in rental housing, and more effectively channel investments into energy-efficient retrofittings.

Also, qualitative research involving community engagement can provide insights into the procedural justice aspect, ensuring that the voices of impacted communities are heard and integrated into policy-making and program design. Lastly, the financial and technical barriers to renewable energy upgrades in neighborhoods that have been historically disinvested, pose additional challenges in which more research is needed around policy development, governance, and coalition building, critical to promoting equitable decarbonization.

CONCLUSION

The analysis of Tower Grove's energy improvements provided valuable insights into the effectiveness and impact of EEMs. We learned that there are numerous financial opportunities to fund these types of projects, but finding them can be difficult. Additionally, we learned that there are many different ways to implement EEMs, but the benefits vary. We also learned that EEM effectively reduces energy, but external factors can diminish these benefits by affecting the overall energy cost. Overall, the implementation of the EEMs in Tower Grove had a positive impact on its residents.

This report aims to equip other organizations working to decarbonize buildings and promote a greener environment within their community with actionable recommendations derived from our findings. Some recommendations are directly applicable to nonprofit organizations or can be shared with constituencies to maximize its impact, while other suggestions can be adapted to fit the needs of the partnering organizations.

We also learned that EEM effectively reduces energy, but external factors can diminish these benefits by affecting the overall energy cost. Overall, the implementation of the EEMs in Tower Grove had a positive impact on its residents. These resources are designed to support organizations in their efforts to initiate similar initiatives and advance their sustainability goals.

Tools

AFFORDABLE HOUSING DECARBONIZATION PIPELINE

The Affordable Housing Building Decarbonization Pipeline is a tool designed by ISC to guide the process of building decarbonization.

The Affordable Housing Building Decarbonization Pipeline is a tool designed by ISC to guide the process of building decarbonization. The pipeline provides a much-needed framework that encompasses all steps from project scoping to completion along with considerations for each step of the process. This framework also recommends the continuous consideration of project funding and financing, which spans all four stages of the pipeline.

ISC developed this tool as a part of their application to the EPA's Environmental and Climate Justice Community Change Grants Program: a $2 billion funding opportunity through the Inflation Reduction Act. Community Builders Network (CBN), along with more than a dozen other partners and with the support of ISC and Elevate are applying for this grant to advance affordable housing building decarbonization across six community development corporations in St. Louis. If the grant is awarded, it will be used to refine, scale, and implement the pipeline across properties owned by these CDCs. The pipeline is also a valuable resource for the pilot hubs as they move beyond the scoping stage of their decarbonization projects.

We recommend building out the pipeline to further reflect equity concerns in order to advance environmental and energy justice, as outlined in Figure 6. By assessing every stage of this pipeline through an equity lens, housing providers can integrate best practices in their decarbonization pipeline that benefit not only the tenants but also suppliers and construction staff.

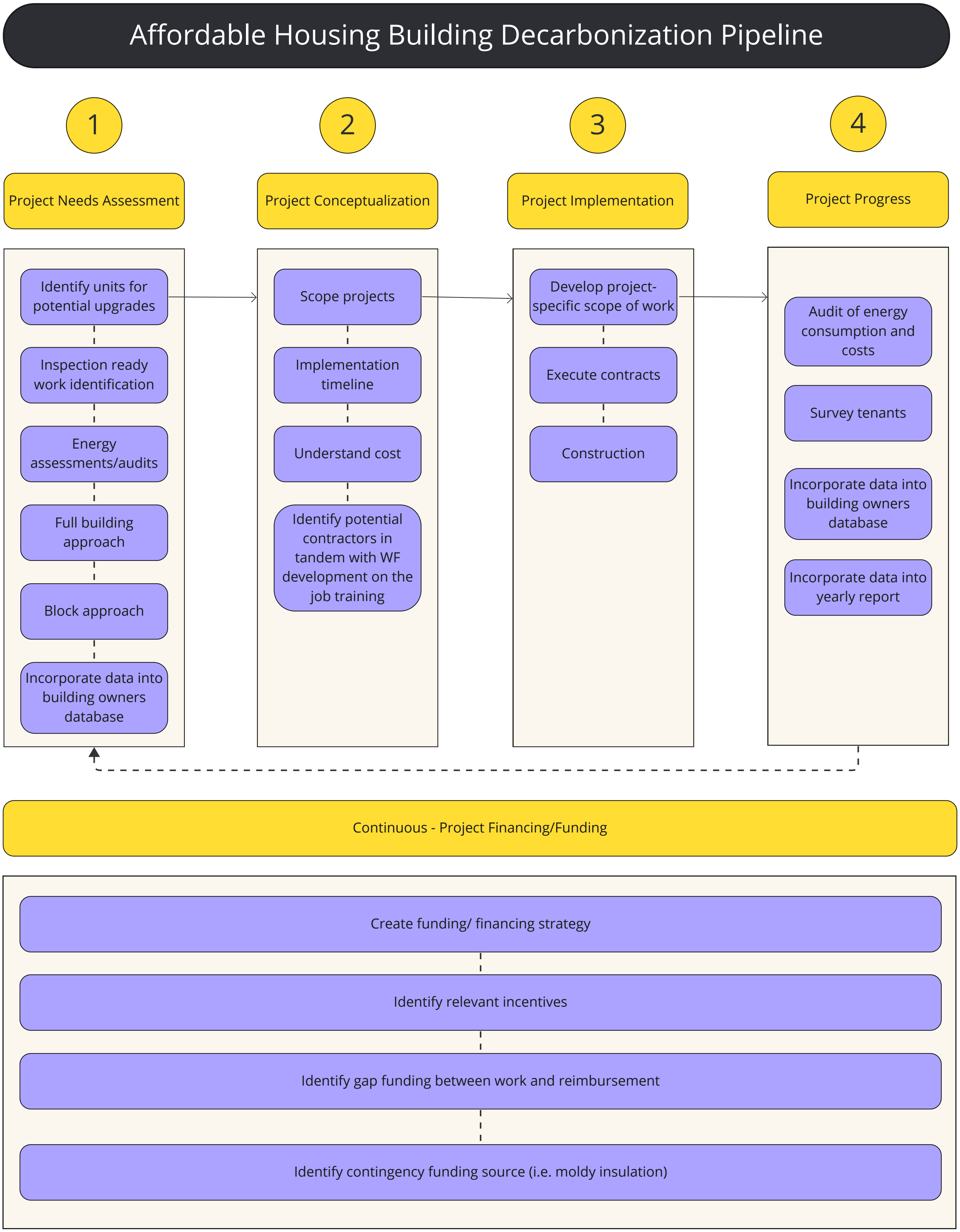


Figure 5. ISC's Affordable Housing Decarbonization Pipeline framework.

Integrating Equity Concerns Into the Affordable Housing Decarbonization Pipeline		
Pipeline Stage	**Action**	**Additional Equity Concerns**
Project Needs Assessment	Identify units for potential upgrades	Outside of infrastructure needs, are there specific tenant needs or vulnerable populations (i.e. children, the elderly, people with disabilities) within particular units that can benefit from upgrades?
Project Conceptualization	Scope projects	In addition to saving energy, what improvements can be made to promote tenant health and comfort (i.e. through air and noise pollution abatement)? For example, replacing gas stoves with electric stoves can significantly improve indoor air quality.
	Identify potential contractors	What standards are being used to vet contractors outside of bid pricing? How can project managers integrate diversity criteria in supplier selection?
Project Implementation	Construction	What can be done to ensure that construction companies have fair labor practices?
Project Progress	Survey tenants	What is the target response rate? What steps will a property owner take to ensure that they hear from a diverse set of voices? Are materials being translated into other languages? Are they being distributed digitally or on paper?
Project Financing/ Funding	Identify relevant incentives	Are there incentives or grant programs that rate payers can participate in to reduce their energy bills? How will housing providers communicate these opportunities to their tenants?

Figure 6. Table depicting the integration of additional equity concerns into the existing framework.

Tools

TENANT ENGAGEMENT

Tenant engagement is at the core of a successful implementation of energy efficiency measures (EEM) in multi-family housing.

Engaging tenants as an equal partner in decarbonization efforts will ensure they understand the connection between EEMs and the actualized benefits. By facilitating a collaborative exchange of ideas, community organizations and the community being served can develop an informed plan of action in which everyone is in alignment.

Goals of Tenant Engagement

- Equip Tenants with knowledge about energy-saving practices, so they have better control over their energy usage. From simple actions like turning off lights when not in use to more complex tasks such as effectively utilizing programmable thermostats, tenants should understand the steps available to them to improve their energy efficiency.
- Supporting tenants in making informed decisions by serving as a thought partner as they determine how to best implement changes in their personal lives.
- Promote the financial benefits of reducing energy usage by connecting EEMs to savings they can see in their personal finances.

Strategies for Effective Tenant Engagement

1. Educational initiatives: Education is crucial to empowering tenants to participate in energy-saving practices. Facilitate interactive and engaging workshops and provide straightforward materials that simplify complex energy concepts. It is important to also share information about similar programs that can help tenants feel more connected to the aims of the project. These initiatives help tenants understand how their actions impact energy consumption and encourage informed decision-making.
   Example: Infographics that visually breakdown energy consumption patterns and effects or interactive elements like quizzes or games during workshops can make learning about energy efficiency more engaging.

2. Technology and real-time feedback: Utilizing technology like smart meters and mobile apps provides tenants with real-time data on their energy usage, enhancing their awareness and empowers them to make timely adjustments to lower their energy bills. Also, equipping tenants with knowledge to help lower their monthly bills. Digital displays in common areas can further motivate tenants by visually presenting energy savings and fostering a sense of community competition.
   Example: An Energy Management Information System (EMIS) that collects and visualizes energy performance data and helps tenants track energy consumption in real-time. In addition, digital displays in common areas to show progress and

promote a community-wide effort to reduce energy use.

3. Use of incentives and rewards: Incentives are powerful motivators for sustaining tenant engagement in energy efficiency. Property managers can offer rewards such as rent discounts. These incentives encourage ongoing participation and highlight the benefits of energy-conscious behaviors [see Appendix V].

4. Continuous communication: Consistent and clear communication keeps tenants informed about the benefits of their energy-saving efforts. Regular updates that show the environmental and personal gains from reduced energy use can motivate tenants to continue participating in energy efficiency programs and align their activities with broader sustainability goals.
   Example: Periodic newsletters with success stories from the tenant community, tips on reducing energy usage, and updates on collective energy savings goals.

5. Visual Tools: Utilize scorecards and dashboards that display energy consumption data using bar charts or pie charts, which can be easily understood. Regular updates on these platforms can keep tenants informed and motivated, with leaderboards to spark friendly competition.

See the next pages for example flyers from Energy Star's Communication Tools: "Plant Energy Awareness Posters: Turn it Off" campaign.


DONE USING THAT?
TURN IT OFF!
I
O
You wouldn't leave a parked car running. So why keep equipment on?
Help us reduce energy waste.
• Turn off lights and equipment when not in use and during periods of nonproduction.
• Use shutdown procedures such as walking the facility before closing to make sure everything is properly shut down and turned off.
LOCK
energy
LEARN MORE AT energystar.gov
SCAN FOR MORE WAYS TO SAVE

DONE USING THAT?
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SCAN FOR MORE WAYS TO SAVE

BLACK AND BROWN BUILDING OWNERS DATABASE (BBBOD)

The Black & Brown Building Owners Database, managed by the ISC, aims to compile information pertaining to commercial properties owned, operated, or leased by people of color.

This encompasses buildings owned or rented by minority-owned businesses, non-profit organizations, and other community-based entities such as houses of worship or independent schools. The primary objective of this database is to serve as a comprehensive resource for commercial building owners of color, serving as a foundation for outreach initiatives and the identification of buildings to target for decarbonization efforts.

To optimize the utility of the database, we suggest implementing the following actions to ensure that ISC constituents perceive the data outputs as reliable, easy to access, and useful:

Data reliability is paramount in database management. Data that is accurate, updated in a timely manner, and aligned with user requirements ensures that the information is actually going to be accessed and used to advance goals of the decarbonization movement. Proposed actions to improve data reliability include:

1. **Appointing a dedicated database manager** responsible for data entry, management, and quality control. A database manager would be able to provide insight into the data, provide regular updates on any changes in the data, and serve a point person for customer service related inquiries. The database manager could facilitate a shift towards making data-driven decisions by presenting trends and takeaways from the data, leading professional development workshops for Alliance members, and help strategically plan initiatives based on the available data.

2. **Establishing a data quality framework** to independently verify data aggregation algorithms, ensuring accuracy, completeness, and consistency. This step is crucial because incorrect data negatively impacts analytic efforts by introducing errors into data models. Validated data is essential as constituents rely on it to assess program

effectiveness or plan for the future. Without trustworthy data, it cannot be effectively utilized. To ensure quality, we recommend:

a. Using statistical sampling to select a representative subset of data that is verified through comparative analysis and calculating an error rate.
b. Leveraging data quality tools, such as SAP Data Services or Informatica Data Quality, to automate regular quality checks.

3. **Creating a system** and schedule for regular updates to ensure constituents receive the most up-to-date and accurate data possible. This practice instills confidence in the data and enhances its reliability as a tool for constituents.

4. **Setting clear expectations** for the information collected in the database. When managing large datasets, understanding both the benefits and limitations is crucial. It is important to communicate to users that no data, database, data management tool, or data analysis software is perfect. However, this acknowledgment does not mitigate the potential benefits that can be gained from utilizing the data effectively.

Making data secure and easy to access will be critical to empowering constituents to regularly make data analysis part of their decision making process. By eliminating barriers to accessing and analyzing data, constituents are more inclined to utilize the data more often and be able to draw actionable insights and conclusions. To achieve this, we suggest:

1. Selecting a database system that is accessible independently by all constituents. Data should be easily accessible in a format that users can easily aggregate, disaggregate, filter, and summarize. Empowering users to securely analyze their own data increases the likelihood of accessing and utilizing the data during routine organizational meetings or strategy sessions. We recommend incorporating a data query engine capable of translating data requests (questions) into data queries (e.g., SQL), streamlining the data retrieval process for users.

Ensuring the data is valuable to an organization is essential to the adoption of the database as a regular part of the constituent's decision making process. To maximize the value of the database, we propose:

1. **Aligning the collected data** to the requirements of grants, loans, and philanthropic donations. The database's potential lies in its ability to assist organizations in identifying properties suitable for decarbonization and other climate mitigation measures. This involves connecting property owners with logistic and financial support critical for implementation. Aligning the database data with the requisites of incentive and other support programs enhances its utility as a tool for matching businesses with financing opportunities.

2. **Promoting widespread usage of the database** by catering to a diverse range of constituents. Highlight the benefits of using the database by showcasing successful utilization by various stakeholders effectively disseminates best practices and encourages broader adoption. By spotlighting how others have used the database to meet their needs, it becomes a more compelling resource for all users. Ensuring ongoing conversations about the benefits of database usage further encourages its regular utilization, resulting in more positive outcomes to showcase.

Tools

FEDERAL FUNDING OPPORTUNITIES SPREADSHEET

The Federal Funding Opportunities spreadsheet serves as a resource for identifying available federal financial support aimed at enhancing building energy efficiency.

This list provides building owners with access to funding opportunities for deploying energy efficiency projects, electrification, or clean energy initiatives. The list extends support to non-profit organizations, enabling them to undertake efficiency initiatives or to improve workforce development in this realm. Users of this spreadsheet can leverage it as a tool to navigate through the various funding options, understanding the scope and eligibility criteria for each.

Link to the spreadsheet (Last Updated on April 19, 2024)

Program	Agency	IRA section	Target Sector	Program Description (Purpose/ Use)
Home Efficiency Rebate	Department of Energy $4.3 Billion	Section 50121	Residential	The rebate programs operated by state energy offices must "provide rebates to homeowners and aggregators for **whole-house energy saving retrofits**" that begin on or after the date of enactment of the IRA and are completed by September 30, 2031.
Home Electrification and Appliance Rebates	Department of Energy $4.5 Billion	Section 50122	Residential	High efficiency electric home rebate programs must provide rebates to eligible entities for **qualified electrification projects**, including appliance upgrades (e.g., for the installation of heat pump water heaters, heat pumps for space heating or cooling, electric stoves and ovens, electric heat pump clothes dryers) and non-appliance upgrades (e.g., for insulation and ventilation and electric wiring upgrades).
State-Based Home Energy Efficiency Contractor Training Grants	Department of Energy $200 Million	Section 50123	Contractor Training	The program provide financial assistance for the development and implementation of state training and education programs to contractors engaged in the installation of home energy and electrification improvements. States may use the funds to reduce costs for training contractor employees, provide testing and certification of contractors trained under state programs, and partner with nonprofit organizations for the development and implementation of state training programs.

Figure 8. Preview of the Federal Funding Opportunities spreadsheet showing opportunities through the Inflation Reduction Act (IRA).

Appendix I

EXISTING CONDITIONS

Introduction

This memo is an overview of the existing conditions in the three pilot cities—Oakland, California, Philadelphia, Pennsylvania, and St. Louis, Missouri. This comprehensive assessment aims to provide an understanding of each city's demographics, economic landscape, environmental regulations, climate threats, political environment, and available financial opportunities for green and sustainability initiatives.

Pilot Hub Site Details

The common trends across these sites in Oakland, Philadelphia, and St. Louis highlight a strong focus on community involvement and revitalization. Oakland's Imani Community Church Church serves as a center for spiritual growth and social services, providing diverse services including both virtual and in-person worship.. Philadelphia's Overbrook Environmental Education Center emphasizes nature appreciation and sustainable practices in an urban setting. In St. Louis, efforts are concentrated on retrofitting buildings in historically diverse neighborhoods, addressing issues like high utility costs and the need for energy-efficient upgrades. Each site reflects a commitment to improving and serving their respective communities.

Oakland
Imani Community Church was established in 1996 in Oakland, California. The Church shows a vibrant faith community dedicated to fostering spiritual growth, community service, and social justice. Known for its dynamic worship that blends spirituals, traditional hymns, and contemporary gospel music, Imani draws its name from the Swahili word for "faith," reflecting its deep roots in both African heritage and the ongoing struggle for African American liberation. The church actively engages in various ministries, aiming to impact both local and global communities positively. With its commitment to faith, community, and service, Imani Community Church serves as a spiritual home where members believe, belong, and become part of a larger purpose.

Philadelphia
The Overbrook Environmental Education Center (OEEC) is a community center dedicated to fostering an appreciation for nature through educational programs that focus on preserving the natural and built environments. OEEC collaborates with local and national partners to support education and involvement in sustainable technology and environmental initiatives. Built on a reclaimed brownfield, the center has transformed into an urban oasis featuring native plantings, outdoor biology labs, and environmentally

friendly architecture.

St. Louis
The scope of work in St. Louis involved retrofitting units within multi-family buildings predominantly owned by the Black and Brown community in the Dutchtown and Penrose neighborhoods. Dutchtown, known for its diverse population and an array of historic architecture, stands as one of the most densely populated neighborhoods in the City of St. Louis. Demographically, Dutchtown's population is composed of approximately 51% Black or African American residents, alongside a 28% White population. Penrose, with a total population of 5,243, has a majority of Black or African American residents, accounting for over 90% of its demographic. Penrose has experienced challenges with vacant or poorly maintained homes, highlighting a need for retrofitting and community support.

The Dutchtown properties at 3224 Meramec Street and 4056 Minnesota Ave are targeted for retrofitting. The key issue is high utility costs for tenants, significantly impacting their overall rent, which averages $463 including utilities, but can rise sharply in winter. Both buildings need audits for energy improvements like tuck pointing, energy-efficient windows, and appliance replacements.

The North Newstead Association's properties at 3918 - 3920 Lexington Avenue and 4465 - 4467 Clarence are targeted for retrofitting. The Lexington Avenue property, built in 1913, consists of four one-bedroom units, with three awaiting rehabilitation, including HVAC maintenance and mold remediation. The Clarence property, a 1911 four-family building, consists of three-bedroom units. Two units here have recently undergone cosmetic updates, including flooring, patching holes, and HVAC maintenance.

Demographics

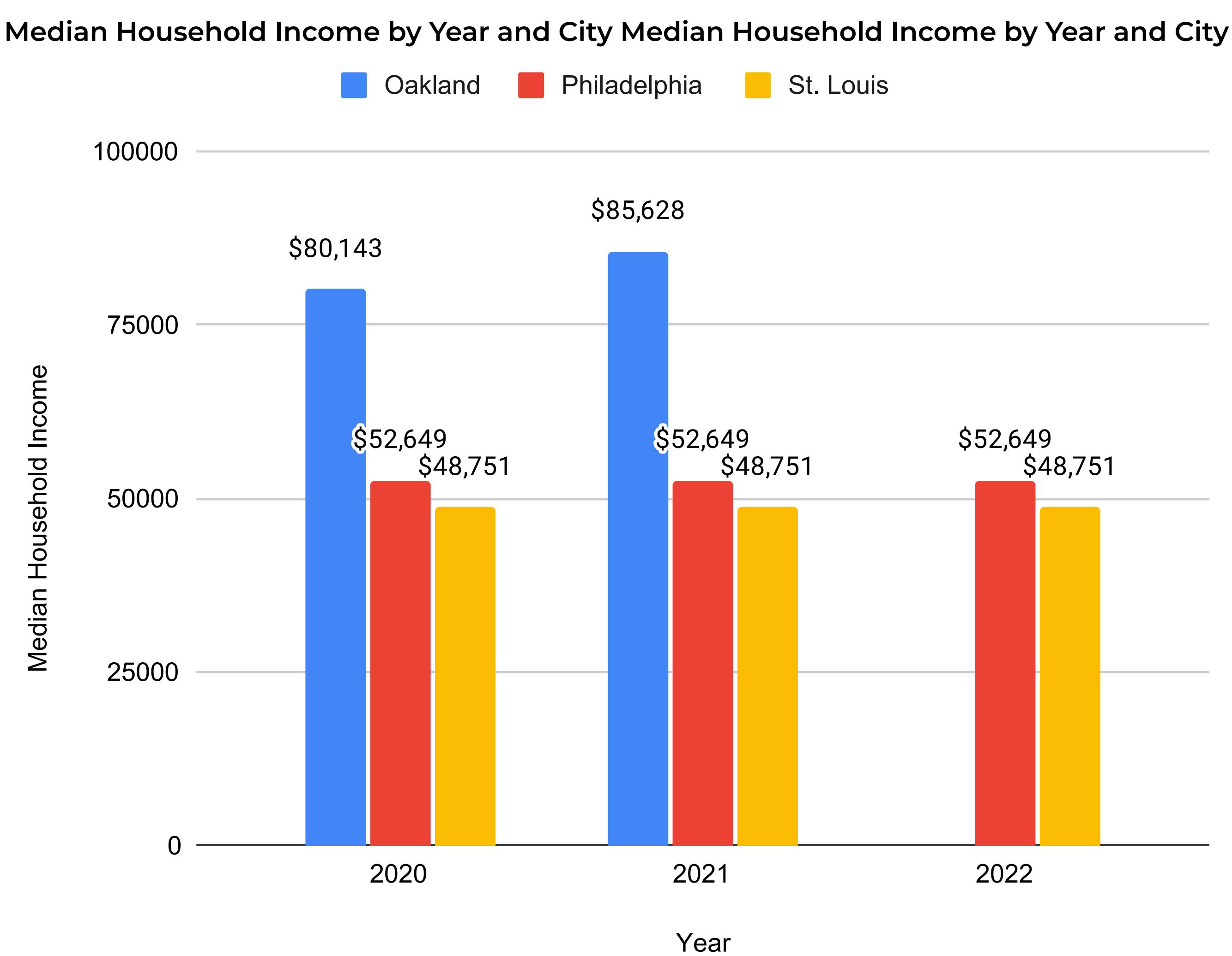
Oakland, Philadelphia, and St. Louis display distinct yet overlapping demographic trends. Oakland's growing population is marked by diversity and a notable portion living below the poverty line. Philadelphia, with its significant Black or African American and White populations, faces higher poverty rates and economic disparities. St. Louis, experiencing a population decline, has a near-equal racial distribution between White and Black residents, coupled with economic challenges highlighted by its poverty rate. These cities, while unique in their demographics, share common issues such as economic disparities and poverty.

Racial Demographics of Three Cities (% of Population)

City	White	Black or African American	Asian	Hispanic or Latino	Two or more races	Other races
Oakland	75.5	3.6	6.3	19.1	3.0	1.6
Philadelphia	38.5	40.8	7.4	15.4	5.3	0.0
St. Louis	46.3	44.8	3.4	4.2	4.0	0.0

Age Distribution of Three Cities (% of Population)

City	Under 5 years	Under 18 years	65 and over
Oakland	5.6	21.7	17.3
Philadelphia	6.4	21.8	13.7
St. Louis	6.1	19.0	13.9



Oakland
As of July 1, 2022, Oakland, California's population was estimated at 430,553. The city has experienced consistent growth, with the number of residents rising from 422,575 in 2020 to 437,548 in 2021, reflecting a 3.54% increase. Concurrently, the median household income in Oakland also grew by 6.84%, from $80,143 in 2020 to $85,628 in 2021. The median age in the city is 36.9 years (Data USA, n.d.).

Demographically, Oakland showcases diversity, with children under 5 years constituting 5.6%, those under 18 years making up 21.7%, and seniors aged 65 and above accounting for 17.3%. Females slightly outnumber males, representing 50.4% of the populace. Racially and ethnically, the population comprises 75.5% White, 3.6% Black or African American, 6.3% Asian, 1.6% other races, and 3.0% belonging to two or more races. The Hispanic or Latino population stands at 19.1%, while 58.9% of the population is White alone, not Hispanic or Latino.
The median household income in Oakland from 2017 to 2021 was $69,021. Despite this, the city faces challenges with poverty, as 13.5% of its population lives below the poverty line, exceeding the national average of 12.6% (US Census Bureau, 2022).

Highland is a neighborhood in South Oakland, California, known for its urban-suburban mix feel. Most of its 4,121 residents rent their homes, and the area is appreciated for its numerous parks. The community is characterized by a diverse population and tends to lean liberal. Highland's public schools are rated average, and the neighborhood has a lively nightlife. Housing is affordable, with a median home value of $413,332 and median rent at $1,649. The area's weather is highly rated, adding to its appeal.

Philadelphia
As of July 1, 2022, Philadelphia, Pennsylvania, boasted a population of 1,567,258. The demographic profile of the city is characterized by both diversity and dynamism. Children under 5 years constitute 6.4% of the population, with those under 18 years accounting for 21.8%. Seniors, aged 65 and over, make up 13.7% of the populace, and female residents slightly outnumber males at 52.4%.

Racial and ethnic diversity is a significant feature of Philadelphia, with Black or African American individuals forming the largest group at 40.8%, closely followed by White individuals at 38.5%. The Asian community represents 7.4% of the population, and those identifying as two or more races make up 5.3%. The Hispanic or Latino population comprises 15.4% of the total population. In terms of ethnicity, 33.8% of the population is White alone, not Hispanic or Latino.
Economically, Philadelphia has a median household income of $52,649, recorded over the period from 2017 to 2021. However, the city faces significant economic challenges, as evidenced by a high poverty rate. Persons living in poverty account for 22.8% of the population, highlighting economic disparities within the city.

The Overbrook neighborhood is located in West Philadelphia and reflects the diversity of Philadelphia's population. Children under 5 years constitute 4.5% of the population, with those under 18 years accounting for 21.5%. Seniors, aged 65 and over, make up 14.2% of the populace. The community is home to a blend of racial and ethnic backgrounds, with African American residents forming a significant portion of the population. African Americans make up 82.6% of the neighborhood. In addition, 24.3% of Overbrook residents who are living below the poverty line.

St. Louis
As of mid-2022, St. Louis, Missouri, recorded a population of 286,578, indicating a decrease from the 2023 figure of 279,390. This decline aligns with a broader pattern of a 2.4% annual decrease and a 7.03% drop since the 2020 census, which reported 300,528 inhabitants. The city's age and gender distribution depicts 6.1% for young children (under 5 years), 19.0% for those under 18, and 13.9% for seniors (65 and over). Women constitute a narrow majority at 51.3%.

In terms of racial and ethnic composition, St. Louis is characterized by nearly equal proportions of White (46.3%) and Black or African American (44.8%) residents. Asians make up 3.4%, while those of mixed race contribute 4.0%. The Hispanic or Latino population is at 4.2%, with the demographic of White individuals, excluding Hispanic or Latino, standing at 44.3% (US Census Bureau, 2022).

From 2017 to 2021, the average household income in St. Louis was $48,751. However, economic challenges persist, with 19.6% of the population living in poverty. This economic snapshot offers insights into the current state of St. Louis and highlights ongoing changes in both population and economic indicators.

Business and Industry

The business landscapes in Oakland, Philadelphia, and St. Louis showcase diversity and specialization. Oakland thrives as a hub for health, transportation, and arts, with significant contributions from major companies in various sectors. Philadelphia's economy is bolstered by life sciences, financial services, and technology, supported by a collaborative ecosystem and a deep talent pool. St. Louis features a mix of industries, with major educational institutions, manufacturing, and financial services playing key roles in its economic framework. Each city presents a unique blend of traditional and emerging industries, contributing to their respective economic strengths.

Oakland
Oakland is recognized as the major health, transportation, and logistics hub in the Bay Area. It has gained prominence in the arts, solar and green energy, food production, and the "maker" movement, including artisans, industrial fabricators, and manufacturers. Major companies in Oakland include Kaiser Permanente, Clorox, Dreyer's Grand Ice Cream, Pandora, Rainin Instruments, Securitas Security Services, Southwest Airlines, and others.

Philadelphia
Philadelphia's major industries include life sciences, financial services, technology, and manufacturing. These sectors, along with their subsectors, offer opportunities for both global firms and local entrepreneurs, creating high-quality job opportunities. The region is renowned for its deep talent pool, collaborative ecosystems, vast consumer markets, and an attractive cost of doing business.

St. Louis
St. Louis hosts a diverse array of businesses, including major employers like Washington University, Boeing, Barnes Jewish Hospital, General Motors, St. Louis University, Anheuser-Busch, Monsanto, Express Scripts, and Enterprise. Noteworthy manufacturing companies and financial services, such as Edward Jones and Wells Fargo, also contribute significantly to the local workforce.

Local Clean Energy and Building Codes

A common trend in the local clean energy and building codes across these cities is the encouragement of integrating renewable energy sources, particularly solar.

Oakland
Oakland adopts the California Green Building Standards Code (CALGreen) and incorporates mandatory measures for sustainability. Provisions include electric vehicle charging in new constructions, resilient flooring systems complying with VOC emission limits, and design standards for heating and air-conditioning systems to improve indoor air quality (City of Oakland Building Bureau, 2019). Solar panel requirements are covered in the California Energy Code and the California Electrical Code (Oakland Municipal Code, 2023, Chapter 15.33).

Philadelphia
The city has adopted the International Energy Conservation Code, setting efficiency standards for various parts of new constructions, such as walls, windows, and ductwork. Additionally, the zoning code incentivizes developers to incorporate green roofs, allowing them to build 25% more units than the code originally permits. Solar installations are permitted in all zones, with rooftop systems exempt from requiring a zoning permit. However, ground-mounted PV installations may require a zoning permit, along with building and electrical permits.
It is important to note that state policy influences construction codes and renewable energy policies at the city level. Pennsylvania tends to adopt a more conservative approach compared to Philadelphia's more progressive stance and can limit green initiatives within the city.

St. Louis
St. Louis has taken steps towards sustainable development, with the adoption of the

Building Energy Performance Standard (BEPS) in 2020. This legislation mandates reductions in building energy use for properties of 50,000 square feet and larger. This legislation also establishes a new Office of Building Performance, which will be responsible for overseeing the Building Energy Awareness ordinance (#70474).

The city also enacted a solar-ready ordinance for both commercial and residential buildings, making it the first city in the Midwest to do so in 2020. The ordinance requires structures to be capable of supporting solar panel installations. The city's zoning requirements and guidance regarding solar are still under review.

Energy

Each of the three cities has sustainability plans that outline the path towards significant reductions in net greenhouse gas emissions in the near future, ranging from an 80% reduction to full carbon neutrality. These plans detail both actions that the city must take in regards to building regulations and timelines for the cities' energy providers to decarbonize.

Oakland
The City of Oakland's decarbonization initiatives, outlined in the 2030 Equitable Climate Action Plan (ECAP) adopted in 2020, aim for a 56% reduction in greenhouse gas emissions by 2030 (compared to a 2005 baseline) and carbon neutrality by 2045 (City of Oakland, 2020). In regard to building decarbonization, the plan includes initiatives to retrofit and electrify existing buildings and to ban fossil fuels in new constructions. Also, the plan commits to enhancing community energy resilience during power-losses due to extreme-weather events by increasing the availability and storage of renewable energy and supporting community-owned solar.

Building-related emissions account for approximately 25% of the city's local emissions. To counter this, the 2030 Plan aims to transition 98% of Oakland customers from Pacific Gas & Electric Company (PG&E), the current primary utility provider, to East Bay Community Energy, supplying 100% renewable energy by 2030. Furthermore, 15% of commercial customers' energy providers will need to provide fully renewable energy by 2045.

Unified Ground's analysis reveals a relatively low average energy burden of 1% of income for Oakland residents, lower than the national median of 3%. Incentive programs for energy efficiency upgrades, promoted in conjunction with local government, are available through PG&E and Bay Area Regional Energy Network (BayREN, n.d.).

Philadelphia
The City of Philadelphia is committed to transitioning to renewable energy and achieving carbon neutrality by 2050, as outlined in the Philadelphia Climate Action Playbook (CAP). The CAP outlines the City's strategies to accomplish carbon neutrality by 2050 by adopting both new policies and carrying out commitments cross-listed in other plans

including the Municipal Energy Master Plan. Key climate actions in the plan include working towards a 100% clean energy grid, increasing accessibility to solar installations, increasing building energy efficiency, and lowering municipal energy consumption.

Philadelphia's primary utility providers are Philadelphia Electric Company (PECO), which is the primary electricity provider, and Philadelphia Gas Works (PGW), which supplies natural gas. The Office of Sustainability details how a fully clean energy grid will require purchasing local renewable energy credits, maintaining existing nuclear power generation, and legalizing community solar installations.

Based on Unified Ground's preliminary analysis of the pilot hubs, the average energy burden—meaning the percentage of income that is spent on energy—for Philadelphia residents is 3%. This is equal to the national median of 3%. Philadelphia residents and businesses have access to various incentive programs to invest in energy efficiency upgrades on their properties. These are available both through PECO and PGW.

St. Louis

St. Louis is committed to reducing greenhouse gas emissions, increasing energy efficiency, and enhancing the city's natural resources, as outlined in the City of St. Louis Sustainability Plan (Stauder, 2013) and the Climate Action & Adaptation Plan (CAAP) (Stauder, 2013). The CAAP aims for an 80% reduction in greenhouse gas emissions by 2050, emphasizing the Triple Bottom Line model, which centers sustainability between social, economic, and environmental benefits.

Building-related emissions account for approximately 77% of the city's local emissions. St. Louis' main energy provider, Ameren Missouri, produces 71% of its energy from coal burning power plants but plans to reach net-zero carbon emission by 2045.

Unified Ground's analysis reveals a relatively low average energy burden of 4% of income for St. Louis residents, slightly higher than the national median of 3%. Incentive programs for energy efficiency upgrades are available through Ameren, including participation in the community solar network (Ameren Missouri, 2023).

Climate Threats

Common climate threats across the three cities include extreme heat, flooding, and increasingly frequent weather-related events.

Oakland

Oakland faces climate risks such as extreme heat, flooding, wildfires, and landslides. The risk of wildfires increases with drought and higher temperatures.

The California Climate Adaptation Strategy emphasizes the danger of heatwaves and urban flooding, while landslides are triggered by weather events and poorly managed development. With more than half of the area consisting of gentle slopes or hills and roughly a quarter of the city characterized by slopes steeper than 15 percent exacerbates the susceptibility to these natural hazards (City of Oakland, n.d.)

Philadelphia

Philadelphia is experiencing the consequences of climate change, including increased occurrences of hot summer weather, heatwaves, and intense rainfall events. There has been a rise in the frequency of heat-event days in urban areas, going from about 4 days in 1980 to nearly 12 days in 2013. Vulnerable communities, such as low-income and elderly populations, are particularly affected, emphasizing the need for equitable climate adaptation strategies.

St. Louis

St. Louis faces risks from a variety of weather-related events, such as extreme heat, heat waves, cold waves, drought, tornadoes, and flooding. St. Louis currently experiences more heat waves each summer compared to the past; 2015 saw nearly 20 days of extreme heat, an increase from the approximate 10 days in 1970. The urban area of St. Louis experiences higher temperatures than the surrounding rural areas, by an average of 17 degrees Fahrenheit during summer.

St. Louis also experiences extreme cold weather, with recent years witnessing record low temperatures and high levels of winter precipitation. Also, being in Tornado Alley, St. Louis is vulnerable to tornadoes, with an increase in recorded tornadoes within city limits in recent years. Additionally, the city is experiencing varying precipitation patterns, such as significantly reduced rainfall in the summer of 2017, leading to drought conditions that adversely affected agriculture and the regional economy (The City of St. Louis, 2018).

Political Climate

All hub cities are committed to addressing the impacts of climate change. Mayors in each city recognize the urgency of tackling climate challenges, evidenced by the presence of dedicated offices within their administrations. At the state level, governors in all hub cities have taken steps to protect the environment, with California leading in more aggressive initiatives compared to Missouri and Pennsylvania. Notably, it is essential to acknowledge that, while recognizing the importance of addressing climate change, none of the mayors prioritize it as their top concern. Crime and post-pandemic recovery consistently take precedence in their identified priorities.

Oakland

Democratic Governor Gavin Newsom leads California in transitioning to clean energy with a goal of net-zero carbon emissions and 100% clean electricity by 2045 (gov.ca.gov/). In Oakland, Mayor Sheng Thao's top priority is reducing crime however the city council of Oakland, in conjunction with her predecessor, did pass the 2030 ECAP in 2020, which aims to reduce GHG emissions by 56% by 2030 and 83% by 2050. Overall, the political willingness to combat the effects of climate change is very strong in both Oakland and across the state (City of Oakland, n.d.).

Philadelphia

The Democratic governor of Pennsylvania, Governor Josh Sapiro, prioritizes environmental initiatives to promote clean air and water, along with expanding charging stations for electric vehicles. The state of Pennsylvania, through the Department of Conservation and Natural Resources, actively oversees the Climate and Sustainability Initiative and works collaboratively with the GreenGov Council to encourage environmentally sustainable practices within state policy, planning, operations, and regulations.
Philadelphia Mayor Jim Kenney is committed to implementing existing climate-friendly policies, aiming for carbon neutrality by 2050, and has strengthened the city's Climate Action Playbook with more stringent regulations and sustainability goals. Under this administration, an Office of Resilience was created to oversee the multitude of efforts and lead collaborations among city agencies to ensure a whole-city response to climate change.

St. Louis

Missouri's Republican Governor, Mike Parson has a mixed record on climate change legislation. In 2021, he signed legislation that would make it easier to close coal burning power plants, but also banned municipalities from prohibiting natural gas hookups in new buildings (governor.mo.gov/). St. Louis' Democratic Mayor, Tishaura Jones has restaffed the head position at the Office of Sustainability to address climate change and environmental concerns in the St. Louis region (stlouis-mo.gov/).

Financial Capital and Investment

Green banks and economic development organizations play crucial roles in advancing climate sustainability efforts. By partnering with green banks, communities can access private financing in addition to public grants. Many green banks have the capacity to provide low-interest loans to organizations focused on sustainability and in need of capital investments.

As mentioned before, the combination of private and public investment will be critical to long-term success of climate initiatives in low-income communities. The Community Development Financial Institutions Fund (CDFI Fund) makes that connection. The CDFI has combined federal funds, administered by the US Department of the Treasury, and private partnerships to implement $1.8 billion in projects that support economically disadvantaged communities, including projects in our pilot hubs.

In addition, the Loan Programs Office of the Department of Energy (DOE) is actively promoting clean energy initiatives by investing in both large scale industrial projects as well as smaller projects targeting individual homeowners. The DOE has programs such as the Solar Energy Technologies Office which funds research and development projects. Lastly, the Office of Energy Efficiency & Renewable Energy has funding through the

Better Building Initiative.

Oakland
California has green bank partners, including the California Infrastructure and Economic Development Bank (IBank), California Alternative Energy and Advanced Transportation Finance Authority, and California Pollution Control Finance Authority, supporting long-term sustainability initiatives like the Advancing Equitable Building Decarbonization (AEBD) initiative. The Coalition for Green Capital reports around 40 green banks nationwide, with institutions such as IBank providing low-interest loans for green projects.

IBank's Infrastructure State Revolving Loan Fund program provides low-interest loans to nonprofits partnering with public bodies for infrastructure projects and has financed over $3 billion in green projects. Also, the Oakland Climate Action Coalition engages residents and encourages city-wide participation in climate solutions, complementing the capital brought in by green banks (Coalition for Green Capital, n.d.).

Philadelphia
The Philadelphia Green Capital Corp., affiliated with the Philadelphia Energy Authority, is Pennsylvania's first and only green bank, currently financing over $250 million in clean energy and energy efficiency projects. In 2022, they successfully invested $89.9 million in clean energy, generating over 750 jobs.

St. Louis
Nationwide, there are approximately 40 green banks, and Missouri hosts institutions like the Missouri Environmental Improvement and Energy Resources Authority (EIERA). EIERA offers subsidized low-interest loans through the sale of highly rated public and private bonds. Additionally, the Missouri Green Banc collaborates with state agencies to promote clean energy investment (Coalition for Green Capital).

Conclusion

In Oakland, Philadelphia, and St. Louis, a common trend is the collaborative approach towards sustainability and resilience. Oakland's progress is marked by joint efforts of government, businesses, and community groups. Philadelphia shows a unified effort toward carbon neutrality, with a focus on inclusive development in the face of climate change and economic disparities. St. Louis emphasizes reducing greenhouse gas emissions and leveraging sustainable practices, indicating a positive trajectory for the city's future. Each city reflects a commitment to environmental responsibility and sustainable development.

Oakland
The overview of existing conditions in Oakland, California, highlights the current landscape of Oakland, reflecting a city not only grappling with challenges but actively

engaging in innovative solutions. The collaboration between government, businesses, and community organizations sets a promising foundation for a sustainable and resilient future for Oakland and its residents.

Philadelphia

The collaboration between the state and city, as well as the instrumental role played by green banks, exemplifies a united approach toward building a sustainable and prosperous future for Philadelphia. As the city navigates its path towards carbon neutrality by 2050, the outlined initiatives, policies, and partnerships underscore a collective dedication to environmental responsibility and the well-being of its residents. However, the presence of economic disparities and the amplified impact of climate change on vulnerable populations necessitate ongoing efforts to ensure inclusive and resilient development.

St. Louis

This comprehensive overview of St. Louis paints a nuanced picture of the city's current landscape. Looking ahead, the commitment to reducing greenhouse gas emissions and the increasing involvement of green banks and economic development organizations signal a positive trajectory for St. Louis. By fostering collaboration, leveraging economic opportunities, and embracing sustainable practices, St. Louis has the potential to navigate its challenges successfully and emerge as a resilient and vibrant city in the years to come.

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Appendix II

LITERATURE REVIEW- EQUITY CHALLENGES IN BUILDING DECARBONIZATION

Introduction

In this literature review, we examine the complex issue of equity in building decarbonization. We focus on how national initiatives, crucial for combating global climate change, intersect with social justice concerns, particularly its impact on lower-income and divested groups.

Our review unravels the intricate relationship between environmental goals and social equity. It examines dimensions such as historical and systemic challenges, funding and finance mechanisms, and the influence of policy-making on equitable outcomes. By analyzing academic literature, we highlight key issues of distributional and procedural justice within environmental initiatives. The review critically explores how systemic challenges, notably energy poverty and inefficient housing, disproportionately impact vulnerable communities, further entrenching social disparities. Additionally, we discuss the implications of decarbonization on health, well-being, and socio-economic factors, especially in the context of low-income communities.

This review also serves as a foundational tool for our capstone project with the Institution for Sustainable Communities. The insights gained will provide a comprehensive understanding of the broader context of building decarbonization. This includes understanding the social equity aspects, especially how decarbonization impacts divested communities. Our review's focus on systemic challenges and policy-making will inform the project's approach in calculating the impact of equitable decarbonization in Oakland, St. Louis, and Philadelphia. By incorporating these insights, the project will not only achieve its technical goals but also ensure that its outcomes are equitable and beneficial for all community segments, particularly those most affected by climate change.

Our Methodology

In the process of determining the literature to be reviewed and cited in this literature review, our primary focus was directed towards our research question. The question guiding our investigation concerns the identification of specific challenges associated with equity in the context of building decarbonization. Using our internal knowledge of the subject matter, we established overarching themes such as funding and financing, historical challenges, education and awareness, coalition building, and competing priorities for local governance. During the review of academic articles, we sought out these themes to acquire a better understanding of their implications for the decarbonization movement.

Our search for relevant academic journal articles encompassed a comprehensive exploration of all literature addressing the topic of decarbonization. We used phrases such as energy justice, environmental justice and equity, decarbonization, green politics, and decarbonization policy in our search to find the relevant academic articles. While prioritizing contemporary research, we refrained from imposing restrictions based on publication date, thereby including older articles that remained applicable to contemporary concerns. In addition, our search went beyond geographical boundaries, encompassing articles from diverse regions globally, but with a particular emphasis on efforts in decarbonization in the United States. Following a thorough examination of academic articles, more specific themes pertaining to equity challenges emerged, encompassing issues related to funding and finance, historical and systemic challenges, impacts on health and well-being, and policy and coalition building.

Takeaways

Historical and Systemic Challenges

Many environmental justice issues can be traced to urban planning decisions that have been informed by and are rooted in systemic racism. In literature around energy justice, author Lavenda (2021) distinguishes these issues by grouping them into two broad classifications: distributional and participatory (sometimes also referred to as procedural) (para. 14). Distributional issues reflect the theory “that all members of society have the right to equal treatment, and that outcomes should be fairly distributed” (Reames, 2016, para. 4). In the context of environmental justice, distributional issues reflect both burdens (such as the siting of renewable energy production and transmission) as well as benefits (such as the access to clean energy technologies). All energy production—both non-renewable and renewable—generates locally undesirable land uses (LULUs) that produce negative externalities, which we detail in Impacts on Health and Well-Being. Historically, LULUs are concentrated in minority and low-income communities due to systemic environmental racism and can be explained by a lack of political power, and racist public policies such as the overt racist stratagem of redlining (Kevin, 1997) which lowered land value and exacerbated the exploration of the residents in affected communities.

Distributional challenges are also reflected in energy insecurity and energy poverty within low-income communities. Decarbonization and electrification, though integral to combating climate change, do lead to an increase in energy prices. In addition, energy costs are regressive; they take up a larger proportion of income for low-income individuals than for higher income individuals. Because energy is an essential good, low-income households often sacrifice other necessities such as food and medicine to cover energy costs (Bennear, 2022). This in turn can snowball into larger health impacts that affect well-being, the ability to work, and ultimately, serve as an impediment to breaking the cycle of energy poverty.

Furthermore, systemic poverty amongst low-income communities of color bleeds into challenges that are specifically faced by renters who have limited accessibility to high-quality housing stock. Low-income households tend to live in inefficient homes and even when controlling for income, studies have found that households of color live in less energy-efficient homes when compared to white households (Drehobl & Ross, 2016). Low-income households who rent also have limited control over energy efficiency improvements in their homes, which further contributes to energy poverty. Even when low-income households do have the authority to renovate, the ability to do so is hampered by the significant amount of capital needed to make meaningful upgrades.

Participatory/procedural issues, on the other hand, reflect the ability of impacted communities (in this case, low-income communities of color) to be prioritized in the decision-making planning processes that determine distributional outcomes. This includes decisions ranging from where energy production facilities are located and land use regulations impact access to renewables to the design of policy packages that make renewables more accessible. Procedural justice concerns the extent to which impacted communities are involved in making the very decisions that directly affect their health and well-being. Stakeholder involvement in town halls, advisory boards, public comment periods, policy design, and citizen juries, for instance, ensure that diverse perspectives are taken into account to drive equitable decisions (Beierle & Konishy, 2001). Participatory justice also facilitates community involvement, which in turn empowers community members to participate in future participatory processes (Rogers et al., 2012). Ultimately, community involvement and widespread participatory justice results in a more equitable distribution of environmental benefits and burdens (Gellers & Jeffords, 2015).

Funding and Financing

Additional barriers that low-income communities of color face are education and awareness around incentives and grants that could ease distributional inequities. Securing funding is crucial to facilitate energy efficiency retrofits and electrification in low-income communities and affordable housing stock. However, several persistent challenges serve as a hindrance to these communities' access to funding. First, finding grants that apply to your specific housing situation can be difficult and confusing. On a related note, having the capacity and bandwidth to complete grant applications correctly and timely can also be a challenge to accessing these funds. Secondly, the issue of split incentives in rental buildings arises when the incentives for tenants and landlords to decarbonize aren't aligned. Affordable housing owners may lack the capacity to conduct energy efficiency retrofits or have no incentive to invest in improvements that benefit renters who pay their own utility costs (York et al., 2022).

The Building Energy, Equity and Power Coalition's brief highlights persistent inequity in federal funding and home upgrade programs (Connolly et al., 2023). For example, the Federal Weatherization Program (WAP) subsidizes up-front costs and serves about 35,000 low income households annually. However, the program falls short of addressing the needs of an additional 35 millions WAP-eligible households. Moreover, Connolly et al. points out that lower income communities have lower access to market-based incentives such as tax credits and rebates, typically utilized by well-funded early adopters for building electrification programs. A notable example is the disproportionate concentration of rooftop solar panels in predominantly White neighborhoods, as opposed to majority Black and Hispanic neighborhoods, primarily due to the differential access to solar tax credits. A report conducted by the Climate Center, the Building Decarbonization Coalition, & AECOM (2023) indicates that the incentives are not sufficient to cover the costs of upgrading the homes and to be electrified ready. The barriers in funding and financing reveal a systemic inequity, hindering the disadvantaged communities' access to energy-efficient upgrades and the broader benefits of building decarbonization.

Impacts on Health and Well-Being

The literature we reviewed also highlights the importance of considering human health and well-being when planning energy-efficiency upgrades in low-income communities of color. Greening buildings is an expensive proposition, and the financial strain can hurt those who are already rent and/or energy burdened. Additionally, retrofitting older buildings is a complex process, making it particularly costly, and potentially dangerous, for those least able to shoulder that burden.

In addition, the adoption of certain renewable energy technologies can inadvertently lead to adverse health outcomes. For instance, technologies like waste incineration, while part of some renewable energy strategies, can increase air pollution, disproportionately impacting the same low-income communities (Lavenda, 2021) the initiative was aiming to help. Environmental justice movements have highlighted these concerns, emphasizing the need for careful evaluation of decarbonization technologies. It is crucial to ensure that the pursuit of green buildings does not increase the gap between different income-level's health status, particularly in communities already burdened by the effects of environmental injustices. This calls for a holistic approach to decarbonization: one that integrates environmental sustainability with social equity and public health considerations.

Furthermore, industry surveys suggest that homeowners consider a variety of factors beyond simple financial analysis and energy use when deciding on home energy upgrades (Walker et al., 2023). Health and safety are crucial in their decision-making, with a focus on indoor air quality, reducing risks like respiratory issues, and kitchen safety. The health impacts of gas cooking, particularly on children, are well-established, prompting a shift towards electrical alternatives like induction cooktops. While the benefits in terms of comfort, utility, and sustainability are acknowledged, quantifying these factors remains a challenge. Electrification also offers safety improvements, such as reducing risks of carbon monoxide poisoning and fire, which are crucial yet difficult to quantify. Addressing these aspects is vital in decarbonization strategies. However, equity concerns, such as the cost of appliances and a lack of awareness about the benefits of electrification, pose significant barriers, especially for lower-income households (Walker et al., 2023). Policies and programs promoting home electrification need to address these equity issues to ensure that health and safety benefits are accessible to all.

Employment

Transitioning from fossil fuels to renewable energy sources also has profound implications on employment. While the shift towards greener energy solutions is expected to result in job losses in traditional energy sectors, it simultaneously heralds a surge in employment opportunities within the green job sector. This transition highlights a dual-edged reality. Communities that have traditionally depended on fossil fuel industries may face immediate economic and employment challenges. However, this shift also opens avenues for substantial job creation in emerging green technologies and industries, presenting opportunities for economic rejuvenation and sustainable employment. The Department of Energy's Energy Efficiency and Renewable Energy initiative aims to lead the US to a net-zero emissions economy by 2050, focusing on fair and equitable methods (Walker et al., 2023). This initiative to combat the climate crisis through the incorporation of clean energy is regarded as a significant opportunity for fostering the creation of numerous high-quality employment opportunities and nurturing a thriving industry. This includes sectors like manufacturing and construction, specifically in developing emission-free technologies for American homes. This transition also poses unique challenges and opportunities for low-income communities of color. They face environmental injustices and need targeted green investments. The green job sector's growth necessitates retraining and redefining job roles, making them more inclusive. Overcoming barriers in education and job access is crucial, as green careers offer stability and improved living conditions, aligning with goals of environmental justice and economic improvement. (Kane & Tomer, 2023)

Policy, Governance, and Coalition Building

Every day, stakeholders from every part of a state or municipality engage in concerted efforts to vie for influence over government policy and/or a share of the finite municipal and state budget. This necessitates a perpetual cycle involving the persuasive presentation of the merit of one's cause to policy makers and subsequent negotiations regarding legislation and the allocation of funds. Frequently, movements aimed at addressing societal issues such as climate change, which benefits the broader community, particularly those who are most underrepresented, have not acquired sufficient influence and funding required for the effective mitigation of the localized and global challenges of climate change.

This is evident when analyzing the governmental structures of building decarbonization initiatives in Denver, Colorado and Salt Lake CIty, Utah. These two municipalities are both similar in size and demographics and both cities had committed to reduce their usage of fossil fuels with the support of local government officials and residents alike. While both cities achieved success in lowering their dependence on fossil fuels, Salt Lake City's impact was less significant. The difference in the effectiveness of the two initiatives was political influence and financial resources (Stein & McKendry, 2023).

The difference in governance played an integral role, as Salt Lake City's building codes were subject to state regulation, constraining the city's ability to update building codes for enhanced sustainability, compared to Denver. Also, Salt Lake City relied solely on its municipal budget for funding and did not have supplemental external financing. Consequently, the decarbonization initiatives in Salt Lake City found themselves in competition with various other departments, programs, and initiatives for resources, resulting in a more scaled down project compared to Denver (Stein & McKendry, 2023).

Another theme pertains to the influence of private enterprises and the implications of climate initiatives on their financial performance. Illustrative of this phenomenon are two instances within the energy sector where climate change initiatives are resisted if they pose a detriment to profitability. The movement to ban fossil fuel infrastructure in new construction gained momentum in 2019, with Berkeley, California pioneering this approach. Subsequently, trade associations representing the fossil fuel industry actively engaged in lobbying state governments to enact legislation outlawing the prohibition of fossil fuel infrastructure. This legislative tactic thwarted the ability of numerous municipalities, including Philadelphia, Pennsylvania, from implementing policies necessary to achieving greenhouse gas (GHG) emission reduction. The lack of political leverage of these climate change initiatives rendered them unable to counteract the influence exerted by the fossil fuel industry (Gibbs et al., 2022).

Conclusion and Further Research

The literature on equity issues surrounding building decarbonization sheds light on how systemic inequities, funding challenges, governance, and policy impact access to renewable energy technologies, health, and wellness for low-income households and communities of color. Environmental justice, when inclusive of both distributional and procedural justice, ensures that communities most deeply impacted by climate change have a say in how environmental benefits and burdens are distributed across race, class, and gender. Beyond historical and systemic inequities, the financial and technical barriers to renewable energy upgrades—particularly for the older affordable housing stock that low-income households have access to—pose additional challenges. The barriers to building decarbonization have further negative implications on health, employment, and overall well-being for environmental justice communities. Potential solutions to address these inequities lie in policy development, governance, and coalition building; political influence and financial resources can be leveraged efficiently to promote more equitable decarbonization.

Further research in equitable building decarbonization is essential to address several key areas. There is a need for more studies on the effectiveness of current funding mechanisms in reaching and adequately supporting the disadvantaged communities. This includes evaluating the impact of federal and state programs on actual energy cost savings and improved living conditions. Although the Inflation Reduction Act and Justice40 Initiative have a positive outlook on promoting equitable decarbonization, it is important to monitor and track these programs to ensure they effectively reach and benefit the intended communities. Moreover, research should focus on developing innovative financing models that can overcome the barriers of split incentives, especially in rental housing, and more effectively channel investments into energy-efficient retrofittings. Also, qualitative research involving community engagement can provide insights into the procedural justice aspect, ensuring that the voices of impacted communities are heard and integrated into policy-making and program design. Lastly, these national initiatives must also be lobbied to State and local governments to ensure an effective top down implementation that ensures decarbonisation targets are met.

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Appendix III

CASE STUDIES

Land Use Policies and Zoning Regulations

Land use regulations and specialized zoning overlays have proven to be an effective tactic for fostering sustainable and energy-efficient development and retrofits. Incentives designed to promote clean energy practices typically disseminate across urban areas; however, through regulation and zoning, cities can concentrate green infrastructure and establish designated green zones wherein services and support systems can be centralized within a compact area. Leveraging the authority of zoning, municipalities such as Oakland, California, and Minneapolis, Minnesota, have successfully implemented this approach.

Oakland EcoBlock (Oakland, California)
Oakland EcoBlock is an example of the neighborhood-scale decarbonization effort. The block comprises 24 properties, sharing similar characteristics: they are all 1-2 story wood-frame constructions, built between 1890s and 1970s. Among these, 18 properties with 24 dwellings are participating in the project. The block aims to reduce its overall energy costs and greenhouse gas emissions through building energy efficiency retrofits at the block scale. These retrofits include floor and attic insulation, heat pumps, and energy-efficient appliances, complemented by microgrids supported by rooftop photovoltaics , a shared battery, and an electric vehicle charging station (Oakland EcoBlock, n.d.).

The pilot EcoBlock's capital costs are covered primarily by the California Energy Commission in addition to grants and other donor funds. The report also explores potential financial mechanisms for future EcoBlock projects. The capital costs are categorized as private assets (in-home retrofits) and shared assets (block-scale improvements). The report suggests that the capital costs for private assets be covered by the property owners and financed through Property Assessed Clean Energy (PACE) programs. Meanwhile, the shared assets - block-scale decarbonization capital costs - could be financed using funds from a Community Facilities Districts (CFD) program. CFD can finance both upfront costs and ongoing operational expenses which include both energy and water infrastructure.

Currently, the project is in the phase of building energy-efficient retrofits. The anticipated result of these energy-efficient retrofits is a reduction in Energy Use Intensity (EUI) from 22 kBtu/sqft-yr to 18. Depending on the initial condition of the buildings, energy usage is expected to decrease by 28% to as much as 71%. With additional funding, the next steps involve developing a microgrid system, which includes solar panels, an EV charging station, and rooftop battery storage.

The community benefits from this block-scale decarbonization initiative in several ways. Firstly, it fosters a strong sense of community and elevates the movement for sustainable practices. The planning process engages residents collectively in improving their shared environment, offering a platform for the exchange of knowledge and skills. Secondly, upgrades to the efficiency of homes enhances thermal comfort and creates healthier living conditions. Thirdly, this approach to decarbonization and electrification achieves cost-effectiveness over time. Lastly, the shared ownership of clean energy resources positions the EcoBlock as a model green community, setting a precedent for others to emulate.

Minneapolis Green Zone (Minneapolis, Minnesota)
In 2013 the City of Minneapolis took similar steps to address climate change by adopting the Minneapolis Climate Action Plan which identified the Green Zone Initiative as a key strategy for promoting equitable approaches to environmental sustainability. In 2017 and 2018, two zones were designated as Green Zones to serve as pilot hubs, Southside Green Zone, which includes the greater Phillips community and Cedar-Riverside neighborhood, and a Northside Green Zone, which includes the neighborhoods of Hawthorne, McKinley, and Near North, and portions of Bottineau, Sheridan, St. Anthony West, and Marshall Terrace (Sam, n.d.).

The Minneapolis Green Zone primarily focuses on neighborhoods that bear a disproportionate share of climate effects, particularly those encountering economic and health disparities, and racial and political marginalization. The Green Zone lists ten goals, which include addressing environmental issues through the redevelopment of brownfields, improving quality of life by preserving vegetation habitats, and promoting the use of clean energy. The ten goals also focus on energizing the economy by increasing green job opportunities and raising environmental awareness and education.

Each Green Zone has a Green Zone Advisory Group composed of members that represent the neighborhood, and is responsible for the implementation and evaluation of the Green Zone Work Plan. Monthly meetings are convened, along with an annual summit to gather Environmental Justice organizations working in and around Minneapolis to facilitate the exchange of ideas and discuss critical issues, trends, and share best practices. The most recent meeting indicates that weatherization retrofits are the 2024 priority.

Sustainable Vacant Property Revitalization

In many cities—particularly in disinvested communities—vacant and abandoned properties (both with and without structures on them) are abundant. St. Louis, for example, saw a 63% decline in population (since its peak in 1950) resulting in one of the highest rates of vacancy in the country, which is quantified in roughly 25,000 vacant properties as of 2018. These vacant properties can sit untouched for years (and even decades), but represent an opportunity, especially in urban areas where real estate is limited. For private developers, vacant properties can be seen as an opportunity for new construction and for cities they are an opportunity to sell the land in order to revitalize the blighted area. However, through the lens of energy and environmental justice, several alternative uses for vacant land should be considered prior to indiscriminate private development.

Even in cities with declining populations, there is a growing demand for affordable housing. Rehabbing historic building stock—which is often made with higher quality building materials—is one solution that can address this demand but could also serve to address the issue of sustainability by way of energy efficiency upgrades. Rather than demolition and reconstruction, prioritizing rehabilitation of existing structures where possible can be an elegant solution for addressing community concerns. Policies and well-designed funding structures can encourage property owners to rehabilitate their buildings, as well as facilitate cities in converting seized properties into affordable housing.

New York City's Vacant Building Program (New York City, New York)
Due to an economic downturn, the 1960s and 1970s saw a number of neighborhoods in the City of New York experience a significant increase in disinvestment and housing abandonment. City foreclosure and housing abandonment resulted in the city owning and managing over 5,400 buildings at its peak (Allred, 2000). New York City's Vacant Building Program, which ran from 1988-1996, permitted the transfer of titles of vacant city-owned buildings and lots to private developers for $1 each. Through a clever funding mechanism, this became an opportunity to build up the city's affordable housing stock. The City offered fixed-rate mortgages and low-interest loans to cover up to two-thirds of the rehabilitation costs under the condition that future rents for tenants would be set in accordance with the City's Housing Preservation and Development (HPD)'s guidelines for affordability for low-, middle-, and moderate-income households. Affordable housing units topped 9,568 as a result of this 8-year program. Yet, the regulatory agreements that govern these projects' affordability are often temporary, with their expiration usually coinciding with the end of the 30-year fixed mortgage period. Thus, additional policies must be developed to ensure permanent affordability for new housing constructed under these programs.

The City of Baltimore's Green Pattern Book (Baltimore, Maryland)
In instances where vacant structures are beyond the point of rehabilitation or where the property is a vacant lot, the land holds strong potential for increasing greenspace and community sustainability and health. The land can be repurposed to become sites for parks, community gardens, and urban farms. The Green Pattern Book published by the City of Baltimore highlights several benefits of these initiatives, including job creation, improved community safety, decreased food insecurity, and improved resident health and belonging. Increasing greenspace in a neighborhood increases shade coverage and in turn can mitigate extreme heat, which disproportionately impacts people of color and low-income communities.

Cleveland City Planning Commission (Cleveland, Ohio)
A similar report developed by Cleveland's City Planning Commission (2008), "Re-Imagining A More Sustainable Cleveland: Citywide Strategies for Reuse of Vacant Land," outlines additional ecological services made possible by greening vacant lots. These include soil remediation, carbon sequestration, habitat creation for local wildlife, and blue and green infrastructure can also bring the added benefit of stormwater management, particularly in flood-prone areas. Given that cities are mostly built on impervious surfaces, blue and green infrastructure helps to mitigate stormwater run-off and combined sewage overflows.

Build-Ready and Re-Powering America (New York State, United States)
Vacant properties also represent an opportunity to localize renewable energy storage and generation to increase accessibility of renewable energy to divested communities. Through its Build-Ready Program, The New York State Energy Research and Development Authority (NYSERDA) partners with local communities to identify and prepare under-utilized land such that it becomes "build-ready" for construction and operation under private renewable energy developers. Similarly, the Environmental Protection Agency's (EPA's) RE-Powering America's Land Initiative encourages the development of renewable energy projects on current and formerly contaminated land, including brownfields. By encouraging site remediation and redevelopment for clean energy, the program intends to bring environmental benefits, affordable renewable energy, and green jobs directly to impacted communities. As of May 2023, the program has supported 502 renewable energy projects that generate over 2.4 gigawatts of installed capacity.

Community Outreach and Environmental Activism

Green the Church (Oakland, California)
Green The Church has emerged as a transformative movement at the intersection of environmental concerns and social justice within the African American community. Historically, divested communities, particularly those of African American descent, have borne a disproportionate burden of environmental pollution and climate change impacts. The GTC initiative, founded in 2010 by Rev. Dr. Ambrose Carroll Sr. and Carroll Ministries International (Green the Church, n.d.), aims to connect the Black Church with the Environmental and Sustainability Movement. Its mission is to harness the influence of the Black Church community to promote environmental and economic resilience. The program is built on three pillars (Green the Church, n.d.):

- Amplifying Green Theology: Focusing on the Christian duty to protect God's creation and integrating environmental teachings in church teachings.
- Promoting Sustainable Practices: Aiding churches in implementing sustainable practices in their buildings and operations, such as energy audits and healthy food programs.

- Building Power for Political & Economic Change: Empowering churches to influence policy decisions related to climate change, green economy, and community resilience.

The bigger picture of GTC is to leverage the influential role of the Black Church in the African American community in order to foster a movement for environmental and economic resilience. By integrating sustainable practices, green theology, and community empowerment, the initiative aims to address climate change, promote environmental justice, and bring economic opportunities to historically divested communities. This approach reflects a holistic vision that combines spiritual stewardship of the environment with practical, sustainable development and political advocacy for systemic change.

Since its inception, the GTC initiative has expanded its reach to encompass over 3,000 congregations across the nation. Through annual summits and climate revivals, the organization has effectively communicated the interconnectedness of religious doctrine and climate justice to thousands of participants. GTC also maintains an active presence on various social media platforms and produces The R.A.C.E. podcast on YouTube (Carrol, 2023). WIth an active role in environmental advocacy, GTC is currently lobbying the California legislature in response to cuts by the California Public Utilities Commission to solar incentives, coinciding with an increase in participation by black homeowners (A. Carroll, personal communication, February 6, 2024).

With its extensive network of climate supporters, GTC is planning to diversify into real estate development and job training endeavors. Operating as a for-profit entity, GTC aims to construct upwards of 100 environmentally friendly churches nationwide. Additionally, GTC recognizes the potential of the green jobs sector to provide high-wage employment opportunities for its community, particularly for individuals who have been formerly incarcerated. As part of its mission, GTC seeks to offer green job training and placement services tailored to the needs of the Black community (A. Carroll, personal communication, February 6, 2024).

Another key initiative of GTC involves fostering community support for sustainable investments. This entails serving as a reliable resource for climate-friendly incentives, grants, tax advice, and guidance for individuals interested in establishing climate-focused ministries or nonprofit organizations (A. Carroll, personal communication, February 6, 2024).

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Appendix IV

TGCDC ENERGY EFFICIENCY PROJECT COSTS AND REBATES

Estimated vs Actual Installation Costs ($) of TGCDC Energy Efficiency Projects

Property	Estimated Cost ($)	Actual Cost ($)	Difference ($)
3169-71 Alfred Ave.	25,227	22,338	-2,889
3606-08 Bamberger Ave.	36,591	41,236	4645
3732-34 Bamberger Ave.	31,002	25,160	-5,842

Rebates for TGCDC Energy Efficiency Project from Ameren Income Eligible Program

Property	Rebate Amount ($)
3169-71 Alfred Ave.	7,744
3606-08 Bamberger Ave.	10,013
3732-34 Bamberger Ave.	14,082

Appendix V

TENANT ENGAGEMENT CASE STUDIES

Case 1: Wells Real Estate Property-Level Scorecards

Background:
Wells Real Estate aimed to improve the energy performance of their properties by engaging tenants directly in their energy efficiency goals.
Strategy: To make energy performance visible and engaging for tenants, Wells Real Estate introduced property level scorecards. These scorecards were posted prominently with the properties and updated monthly to reflect progress towards the buildings' energy efficiency goal.

Implementation:
Property managers took an active role in updating these posters, ensuring that tenants were always aware of the latest energy performance data. This transparency allows tenants to see the direct impact of their actions on the building's energy efficiency.
Outcome: Wells Real Estate was able to win the 2012 Energy Star Award which is given by EPA to companies and groups that contribute to environmental protection through outstanding energy efficiency achievements.

Recommendations:
Be Transparent: Sharing energy efficiency goals and progress transparently with tenants to build trust and foster a collaborative environment.

Case 2: Beacon Capital Partners' Energy Efficiency Race

Background:
Beacon Capital Partners is a private real estate investment firm based in Boston, they sought to encourage energy conservation in tenant spaces.
Strategy: To leverage the spirit of competition among tenants to promote energy efficiency, Beacon Capital Partners organized the Energy "STAR" Cup competition. This competition challenged tenants to reduce their energy usage over a specified period of time.

Implementation:
Participants were provided with Energy Star's "Bring your Green to Work" campaign toolkit. Inside the toolkits there are practices for saving energy such as turning off lights

when not in use and powering down computers at the end of the workday. Progress was visually displayed as a car race on a status board, motivating tenants by showing real-time achievements in energy efficiency.

Outcome:
The winner at the end achieved the most significant energy savings, showing that it is possible to significantly reduce energy consumption through simple behavior changes. Notably, the winner managed to lower the unit's lightning and plug load consumption by 20%, a reduction that was maintained even after the competition ended.

Recommendations:
Create Engaging Activities: Creating healthy and rewardable activities like competition among tenants to encourage participation in energy saving actions. Information about how to change tenant's behavior can be included in the activity as a toolkit to help tenants reach the goal.

Adopt Visual Communication Tools: Using visual tools such as scorecards, dashboards, or digital displays in common areas to share energy performance data and keep tenants informed and engaged.

Case 3: Engaging Renters in Energy Efficiency to Enhance Customer Experience

Background:
Energy efficiency projects often overlook tenant engagement, which can lead to missed opportunities in energy savings and customer satisfaction. Recognizing this gap, innovative approaches are needed to motivate renters to adopt energy-saving behaviors that contribute to the broader goals of energy conservation and enhanced tenant experience.

Strategy:
The strategy involves utilizing data-driven insights to personalize communication and create targeted, engaging content that resonates with renters. The key is to understand the demographics, preferences, and behaviors of tenants through data analysis and to use this information to create messages that are most likely to encourage energy-efficient behaviors.

Implementation lessons learned:
Data Analysis: Utilize customer data to analyze the tenants and build messages that address their specific circumstances and needs.

Personalized Communication: Develop customized communications that speak directly to the concerns and values of different renter segments. For example: younger renters might be more interested in digital messages that highlight the convenience of programmable thermostats.

Engagement Campaigns: Launch campaigns that educate tenants on how to reduce energy usage, featuring tips that are easy to implement. These might include using energy-efficient appliances, optimizing heating and cooling systems, and better managing water usages

Feedback and Incentives: Provide feedback on energy savings and offer incentives for behavior changes. This could be through a mobile app that tracks energy usage and rewards points redeemable for rent discounts or other benefits.

Outcome: The targeted engagement strategy leads to increased tenant participation in energy-saving programs. Tenants not only improve their energy consumption patterns but also express higher satisfaction rates due to improvements in living conditions and cost savings. Additionally, property managers observe a decrease in overall building energy costs and enhanced tenant loyalty, which are critical for long-term business sustainability.

Recommendations:
Use Technology: Use smart meters and apps to provide tenants with real time data about their energy usage and practical ways to reduce it.

Host Engagement Workshops: Hold regular educational sessions and workshops to help tenants understand and implement energy-saving techniques.

Provide Regular Updates: Keep tenants informed about their progress and the environmental impact of their actions to maintain engagement and motivation.

Highlight Benefits: Clearly communicate the personal benefits tenants will gain, such as lower utility bills alongside the environmental advantages.

Appendix VI

UPGRADE DETAILS AND COSTS

3606-08 Bamberger Ave.:

Upgrade Category	Qty	Estimated Total Cost	Unit Price	Project Finish Date
Replacing LED Bulb (9 Watt)	48	$332	$6.91	5/20/2021
Replacing LED Bulb (5 Watt)	12	$78	$6.50	5/20/2021
Honeywell Programmable Home Thermostat	4	$700	$175.00	9/14/2021
Brushless Permanent Magnet (BPM) Blower Motor with 96% Efficient Gas Furnace	4	$1,000	$250.00	No Date
96% Efficient Gas Furnace With ECM Motor	4	$10,652	$2663.00	No Date
15.5 SEER Energy Star Rated Air Conditioner	4	$16,500	$4125.00	No Date
Double Pane Energy Star Rated Window (muti-size)	52	$7,181	$138.09	9/16/2021
1.5 GPM Aerator	4	$37	$9.25	5/20/2021
1.0 GPM Aerator	4	$32	$8.00	5/20/2021
1.5 GPM Showerhead	4	$80	$20.00	5/20/2021

3732-34 Bamberger Ave.:

Upgrade Category	Qty	Estimated Total Cost	Unit Price	Project Finish Date
Replacing LED Bulb (9 Watt)	30	$195.07	$6.50	10/6/2020
Replacing LED Bulb (5.5 Watt)	20	$116.25	$5.81	10/6/2020
Replacing LED Bulb (15 Watt)	6	$54.00	$9.00	10/6/2020
15 SEER Energy Star Rated Air Conditioner	2	$7,368.42	$3,684.21	4/17/2020
ECM Motor in 80% Efficient Gas Furnace	4	$9,201.20	$2,300.30	4/17/2020
Duct Sealing	160	$1,000.00	$6.25	No Date
NEST Thermostat E Self-Programming Model	4	$800.00	$200.00	4/17/2020
1.5 GPM Aerator	4	$35.98	$9.00	No Date
0.5GPM Aerator	4	$32.41	$8.10	No Date
1.25 GPM Showerhead	4	$80.00	$20.00	No Date
Double Pane Energy Star Rated Window (multi-size)	21	$12,118.42	$577.07	10/5/2020

3169-71 Alfred Ave.:

Upgrade Category	Qty	Estimated Total Cost	Unit Price	Project Finish Date
Replacing LED Bulb (9 Watt)	43	$292	6.79	11/20/2021
Replacing LED Bulb (5 Watt)	5	$33	6.6	11/20/2021
EcoBee Light Smart Thermostat	4	$900	225	12/14/2021
Brushless Permanent Magnet (BPM) Blower Motor with 96% Efficient Gas Furnace	2	$500	250	No Date
96% Efficient Gas Furnace With ECM Motor	2	$4,661	2330.5	12/14/2021
Energy Star Rated Gas Water Heater	4	$6,000	1500	5/25/2022
Double Pane Energy Star Rated Window (multi-size)	36	$12,694	352.61	
1.5 GPM Aerator	4	$37	9.25	11/20/2021
0.5 GPM Aerator	4	$32	8	11/20/2021
1.5 GPM Showerhead	4	$80	20	11/20/2021

Appendix VII

DETAILED ENERGY ALIGNED CLAUSE (EAC) INFORMATION

The Energy Aligned Clause is a leasing agreement innovation specifically designed to address the split incentive problem in commercial real estate, particularly in the context of energy retrofits in multi-tenant buildings. The EAC was developed by the Mayor's Office of Long-Term Planning and Sustainability in New York City. The EAC lets owners get back their costs based on expected savings. However, it only allows them to charge tenants for 80% of these expected savings each year. This creates a 20% "Safety Margin" to make sure tenants are not overcharged if the savings are not as high as predicted. For multi-family housing or non-commercial real estate, adapting the EAC concept to address the split incentive problem could involve creating incentives or mechanisms where homeowners and tenants share the costs and benefits of energy efficiency upgrades. This could take the form of shared investment agreements or rebates where both parties contribute to the upfront costs, but also share in the long-term savings.

Mutual Benefits for Property Owners and Tenants:

- The use of the EAC creates opportunities for both parties to benefit financially from base building energy retrofits.

For Property Owners:

- Cost Recovery: Through a Shared Investment Agreement, property owners can recover the costs of energy-efficient upgrades via the energy saving achieved. This arrangement can make investments in energy efficiency more attractive since there's a clear pathway to recouping expenses.
- Increased Property Value: Energy-efficient buildings often command higher market values, potentially resulting in diminished vacancy durations owing to the appeal of lower utility costs and improved comfort.
- Reduced Operating Costs: Over time, energy-efficient retrofits can lead to a significant reduction in operating costs, making the property more profitable.

For Tenants:

- Lower Utility Bills: Even though the cost of retrofits is recovered through the rent, the overall utility savings can result in a net decrease in monthly expenses for tenants.
- Improved Comfort and Health: Energy-efficient retrofits often include improvements

to heating, cooling and ventilation systems, leading to better indoor air quality and comfort in different weather conditions.

- Environmental Impact: Tenants can contribute to environmental sustainability by living in energy-efficient homes.
- Additionally, the risks to tenants from underperforming retrofits are minimized as these costs are relatively small compared to overall rent expenses.

Appendix VIII

ENERGY CALCULATIONS

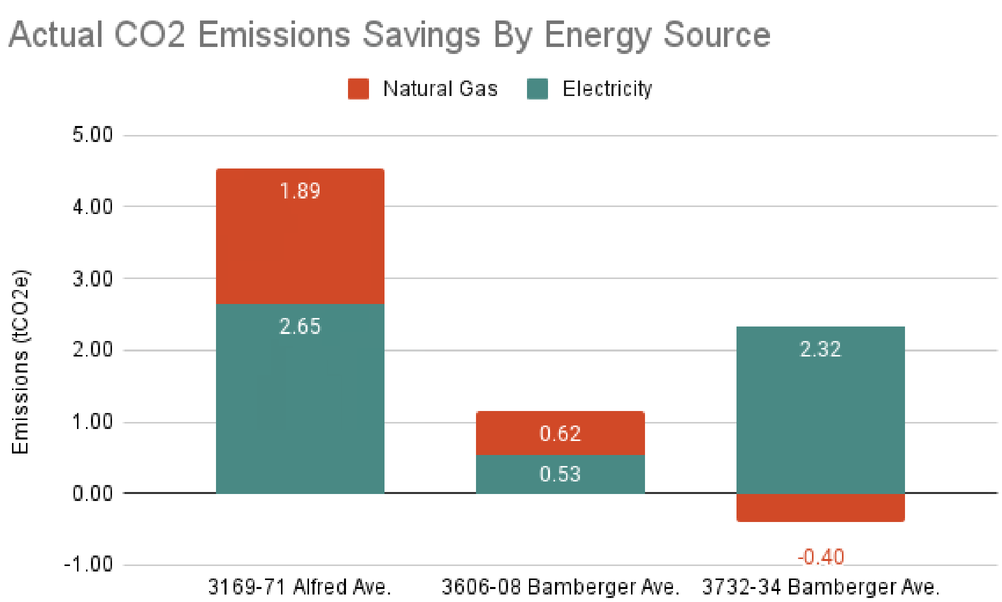
Projected Savings and Emissions					
Property	**Savings**	**Units**	**Emissions Factor**	**Units**	**Emissions, (tCO2e)**
3169-71 Alfred Ave.	5,534	kWh	0.0006214215	tCO2e / kWH	3.44
3169-71 Alfred Ave.	914	therm	0.005311	tCO2e / [therm/gal]	4.85
				Total Emissions	8.29
3606-08 Bamberger Ave.	7,281	kWh	0.0006214215	tCO2e / kWH	4.52
3606-08 Bamberger Ave.	1,340	therm	0.005311	tCO2e / [therm/gal]	7.12
				Total Emissions	11.64
3732-34 Bamberger Ave.	18,309	kWh	0.0006214215	tCO2e / kWH	11.38
3732-34 Bamberger Ave.		therm	0.005311	tCO2e / [therm/gal]	
				Total Emissions	11.38
				Grand Total	31.31

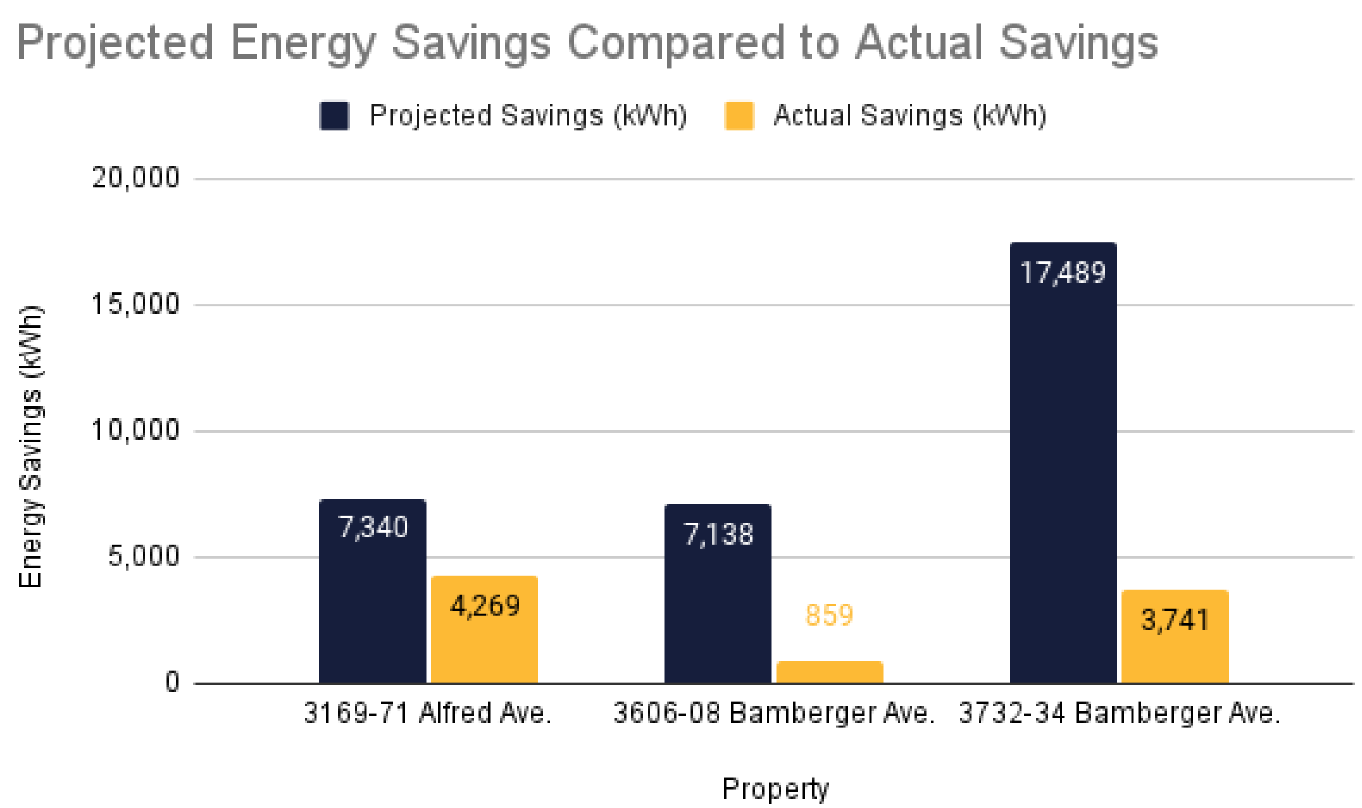
Actual Savings and Emissions					
Property	**Savings**	**Units**	**Emissions Factor**	**Units**	**Emissions, (tCO2e)**
3169-71 Alfred Ave.	4,269	kWh	0.0006214215	tCO2e / kWH	2.65
3169-71 Alfred Ave.	356	therm	0.005311	tCO2e / [therm/gal]	1.89
				Total Emissions	4.54
3606-08 Bamberger Ave.	859	kWh	0.0006214215	tCO2e / kWH	0.53
3606-08 Bamberger Ave.	116	therm	0.005311	tCO2e / [therm/gal]	0.62
				Total Emissions	1.15
3732-34 Bamberger Ave.	3,741	kWh	0.0006214215	tCO2e / kWH	2.32
3732-34 Bamberger Ave.	-76	therm	0.005311	tCO2e / [therm/gal]	-0.40
				Total Emissions	1.92
				Grand Total	7.61

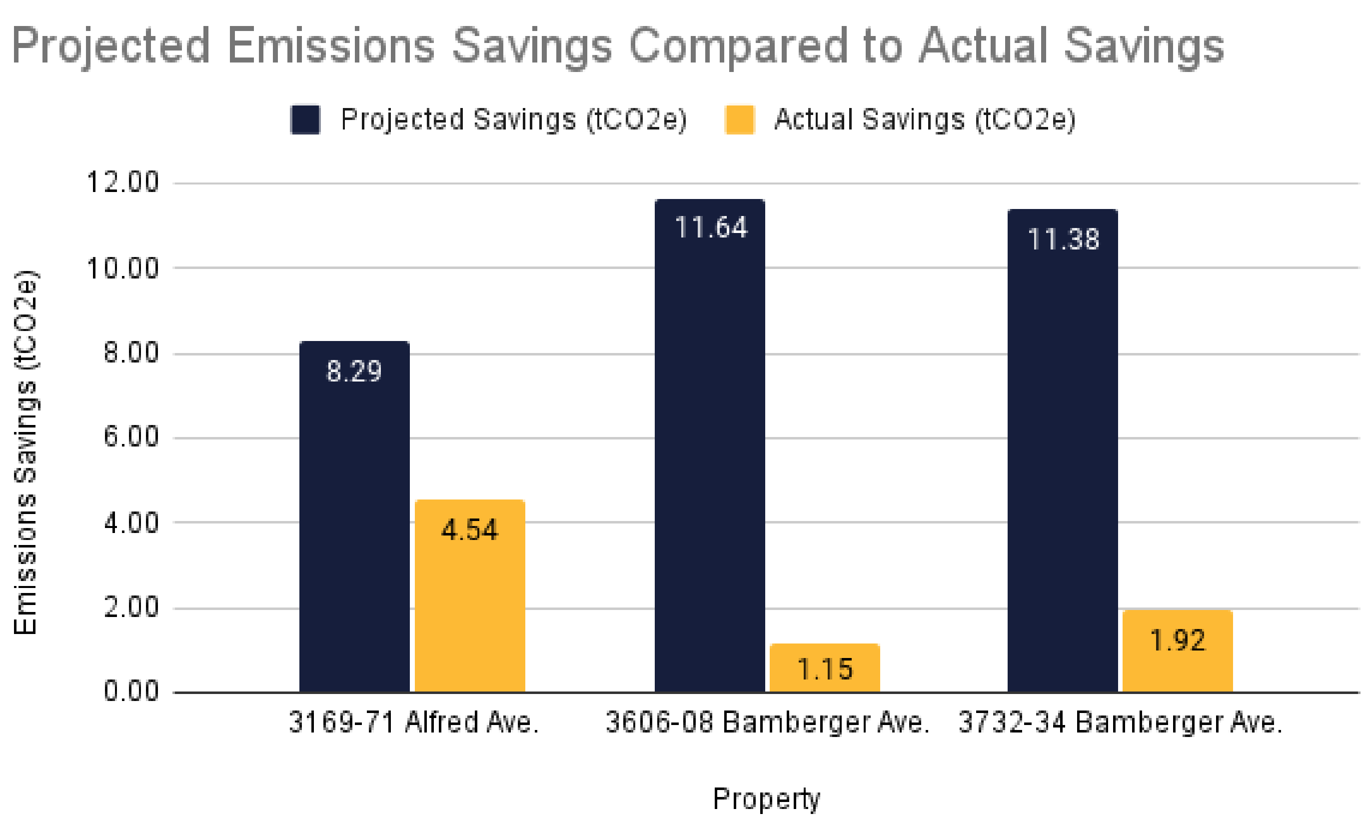
Projected vs Actual Energy Savings (kWh)			
Property	**Projected Savings (kWh)**	**Actual Savings (kWh)**	**% Difference Between Projected and Actual Savings**
3169-71 Alfred Ave.	7,340	4,269	-42%
3606-08 Bamberger Ave.	7,138	859	-88%
3732-34 Bamberger Ave.	17,489	3,741	-79%

Projected vs Actual Emissions Savings (tCO2e)		
Property	**Projected Savings (tCO2e)**	**Actual Savings (tCO2e)**
3169-71 Alfred Ave.	8.29	4.54
3606-08 Bamberger Ave.	11.64	1.15
3732-34 Bamberger Ave.	11.38	1.92

Emissions Resulting from Post-EEM Usage				
Property	**Electricity Emissions (tCO2e)**	**Electricity Emissions (%)**	**Natural Gas Emissions (tCO2e)**	**Natural Gas Emissions (%)**
3169-71 Alfred Ave.	2.65	58.39%	1.89	41.61%
3606-08 Bamberger Ave.	0.53	46.42%	0.62	53.58%
3732-34 Bamberger Ave.	2.32	121.01%	-0.40	-21.01%




Projected Energy Savings Compared to Actual Savings
Projected Savings (kWh)
Actual Savings (kWh)
Energy Savings (kWh)
20,000
15,000
10,000
5,000
0
7,340
4,269
7,138
859
17,489
3,741
3169-71 Alfred Ave.
3606-08 Bamberger Ave.
3732-34 Bamberger Ave.
Property


Projected Emissions Savings Compared to Actual Savings
Projected Savings (tCO2e)
Actual Savings (tCO2e)
Emissions Savings (tCO2e)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
8.29
4.54
11.64
1.15
11.38
1.92
3169-71 Alfred Ave.
3606-08 Bamberger Ave.
3732-34 Bamberger Ave.
Property

Residential electric rates										
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Customer Charge	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 9.00	$ 9.00	$ 9.00	$ 9.00	$ 9.00	$ 9.00
Low - Income Program Charge	$ 0.0300	$ 0.0300	$ 0.0300	$ 0.0300	$ 0.0400	$ 0.0400	$ 0.0400	$ 0.0600	$ 0.0600	$ 0.1400
Summer Energy Charge	$ 0.1136	$ 0.1136	$ 0.1208	$ 0.1208	$ 0.1258	$ 0.1258	$ 0.1258	$ 0.1181	$ 0.1181	$ 0.1296
Winter Energy Charge										
First 750 kWh	$ 0.0808	$ 0.0808	$ 0.0858	$ 0.0858	$ 0.0876	$ 0.0876	$ 0.0876	$ 0.0804	$ 0.0804	$ 0.0881
All kWh	$ 0.0538	$ 0.0538	$ 0.0573	$ 0.0573	$ 0.0600	$ 0.0600	$ 0.0600	$ 0.0538	$ 0.0538	$ 0.0591

Electric Rates- Increase Between 2017 and 2022	
Customer Charge	0.00%
Low - Income Program Charge	250.00%
Summer Energy Charge	3.02%
Winter Energy Charge- First 750 kWh	0.57%
Winter Energy Charge- All kWh	-1.50%

2022 Cost of 100 therms of Electricity	
100 therm = 2930.71 kWh	
Summer	379.820016
Winter	194.954961

Residential gas rates										
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Customer Charge	19.5	19.5	19.5	19.5	22	22	22	22	22	20
Winter - All Ccf					0.2333	0.2333	0.2333	0.2333	0.2763	0.36538
Summer- First 50 CcF					0.20994	0.20994	0.20994	0.20994	0.24863	0.32877
Summer- In excess of 50 CcF					0.25435	0.25435	0.25435	0.25435	0.30123	0.39835
* Winter = Nov-April, Summer = May-Oct										

Gas Rates- Increase Between 2017 and 2022	
Winter - All Ccf	56.61%
Summer- First 50 Ccf	56.60%
Summer- In excess of 50 Ccf	56.61%

2022 Cost of 100 therms of Gas	
100 therm = 98.039 Ccf	
Winter	35.82148982
Summer	36.356

Appendix IX

ENERGY BENCHMARKING REPORT

See following pages for the original report compiled by Aaron Michaels of Energy Resource Group (ERG) for Tower Grove CDC.

ENERGY SAVINGS ANALYSIS REPORT

For Tower Grove CDC

3169-3171 Alfred,
3606-3608 Bamberger, and
3732-3734 Bamberger

February 2024

Energy Resources Group, Inc.
innovation in energy and environmental design

www.EnergyResourcesGroup.com ■ 6744 Olive Blvd. | St. Louis, MO 63130 ■ 314-644-0000

Contents

Executive Summary

Tower Grove CDC implemented energy efficiency improvements in three four-family buildings in St. Louis from 2020 through 2022.

The utility analysis showed high variability in energy use between units in the same building, and also between tenants in the same unit at different times, with usage doubling or dropping precipitously between tenants in some instances. These tenant change-over effects at times dwarfed the energy savings by considerable margins, so ERG took efforts to control for these changes when possible.

The overall project energy use improvement was 7%[1] with an 8% cost savings. The results of the savings analysis are presented below.

Savings Analysis Results

	Site kBtu		$	
3169-71 Alfred				
Previous Usage	314,686		$ 5,803.00	
Current Usage	264,520		$ 4,758.00	
Savings	50,166	16%	$ 1,045.00	18%
3606-08 Bamberger				
Previous Usage	277,550		$ 5,255.02	
Current Usage	263,019		$ 5,010.00	
Savings	14,531	5%	$ 245.02	5%
3732-34 Bamberger				
Previous Usage	355,069		$ 7,674.00	
Current Usage	349,905		$ 7,373.00	
Savings	5,164	1%	$ 301.00	4%
Project Total				
Previous Usage	947,305		$ 18,732	
Current Usage	877,444		$ 17,141	
Savings	69,861	7%	$ 1,591	8%

[1] Weather-normalized site energy use

Investment Results

The efficiency investment results are shown in the table at right. The improvements in the Alfred building are slightly outperforming the estimated returns on the investment, while both of the Bamberger buildings are underperforming.

EEM Results

ERG briefly analyzed the individual improvements, inspecting the energy use profiles of the buildings where each improvement was installed to determine if the movement in the energy use profile was in the direction expected, given the type of improvement made.

Only one improvement consistently made an impact on the building in the expected direction, and that was LED lighting. Other EEMs showed expected improvements in some instances and not in others.

Unexpectedly, window improvements and 16 SEER unit upgrades did not show the expected impacts on energy use in this analysis.

Efficiency Investment Results

3169-71 Alfred		
Implementation	$	22,338
Rebates	$	7,744
Out of Pocket	$	14,594
Annual Savings	$	1,045
Rate of Return		7.2%
Estimated ROR		6.7%
3606-08 Bamberger		
Implementation	$	41,236
Rebates	$	10,013
Out of Pocket	$	31,223
Annual Savings	$	245
Rate of Return		0.8%
Avg. Estimated ROR		4.2%
3732-34 Bamberger		
Implementation	$	25,160
Rebates	$	14,082
Out of Pocket	$	11,078
Annual Savings	$	301
Rate of Return		2.7%
Estimated ROR		7.9%
Project Total		
Implementation	$	88,734
Rebates	$	31,839
Out of Pocket	$	56,895
Annual Savings	$	1,591
Rate of Return		2.8%
Avg. Estimated ROR		6.3%

Utility Savings Analysis

Data summary and rate schedules

All electrical usage data were provided by Tower Grove CDC. Gas usage was partially provided by Tower Grove CDC and partially provided directly by Spire Energy. Water usage is not metered for residential accounts in St. Louis City, so cannot be analyzed.

Utility costs were calculated from current residential rates from Spire and Ameren Missouri, including only costs that increase per unit of energy (i.e., excluding the "customer charge", but including taxes, fuel adjustment charges, and efficiency and renewable investment charges.):

	Summer	Winter	
Ameren	$ 0.152	$ 0.107	per kWh
Spire	$ 1.15	$ 1.19	per CCF

There is no on-site renewable energy generation.

Methodology

When using monthly data, ERG recommends using 2 or more years of utility data from both before and after energy efficiency improvements in order to determine energy savings rates most accurately. During this time period, the operating parameters of the building ideally remain constant.

In the case of the buildings analyzed, some Energy Efficiency Measures (EEMs) were installed through the fall of 2022. Electrical energy data were provided on some meters from January 2016 through May of 2023. Gas usage was collected on most meters from July 2017 through November 2023.

Energy use typically drops when units are vacant, thus ERG omitted energy data from the analysis when units were vacant.

The meter data were inspected on a meter-by-meter basis to determine if there were usage anomalies during billing periods. Tower Grove CDC provided occupancy data back to 2017, however, usage on a particular meter could unexpectedly go to near zero. When this was the case ERG assumed that the unit in question was unoccupied if that was unusual usage for the season, and those data points were also omitted from the analysis.

ERG also omitted some outliers from the analysis (noted in text where this is the case).

If a building did not have at least 15 months of complete occupancy during both the pre- and post-EEM period, ERG performed a meter-level analysis where the energy use was inspected per meter.

Most data were available to ERG on a per-meter basis, but this was not universal. At times, multiple meters in the same building had been summed to a single record, so for the sake of both consistency and efficiency of analysis, the energy usage was summed, they were treated as a single unit.

The utility analyses were carried out with weather data available from the Midwest Regional Climate Center (MRCC)2 for the Lambert Airport NOAA weather station (KSTL). Monthly utility usage data were normalized to average daily usage for each billing period and plotted against average monthly temperature data available from the MRCC. Regression analyses were performed on the data to develop profiles of energy usage for the building. Each building profile can be used to project annual usage in a normal[3] year.

Time-periods of interest were developed from the reported timeline of energy improvements, and building energy use profiles were developed for each time-period of interest. These were largely "Pre-EEM" and "Post-EEM" profiles, but the energy use data were also inspected independently of these timelines and evident usage patterns visible in the data were used to develop additional building-energy-use profiles.

Comparing the "Pre-EEM" and "Post-EEM" profiles for each building and utility enables quantification of energy savings, either between time-periods or – when the data provided enough clarity – to attribute savings to particular energy efficiency measures.

At times, there were energy use changes that did not correspond to the implementation of known energy efficiency measures. These periods are also noted in this report.

[2] http://mrcc.purdue.edu/

[3] Note: the "normal" year is the expected distribution of temperatures in an average year based on twenty years (1996-2016) of hourly weather data from the KSTL weather station at Lambert Airport – available from the MRCC.

3169-3171 Alfred

Improvements

Tower Grove CDC installed the following improvements in the building. We show the date of installation in the chronological energy-use charts below with vertical green lines.

- 11/20/2021: All LED bulbs, faucet & shower aerators, installed by Just One Fix
  (Expected impact on electric use only)
- 12/14/2021: Two 96% efficient ECM gas furnaces installed by Airpro (3169 1st fl & 3171 2nd fl)
  (Expected impact on both utilities)
- 12/14/2021: 4 programmable thermostats installed by Airpro.
  (Expected impact on both utilities)
- 5/25/2022: 4 Water heaters installed by Knesis
  (Expected impact on natural gas use only)

Occupancy and data availability

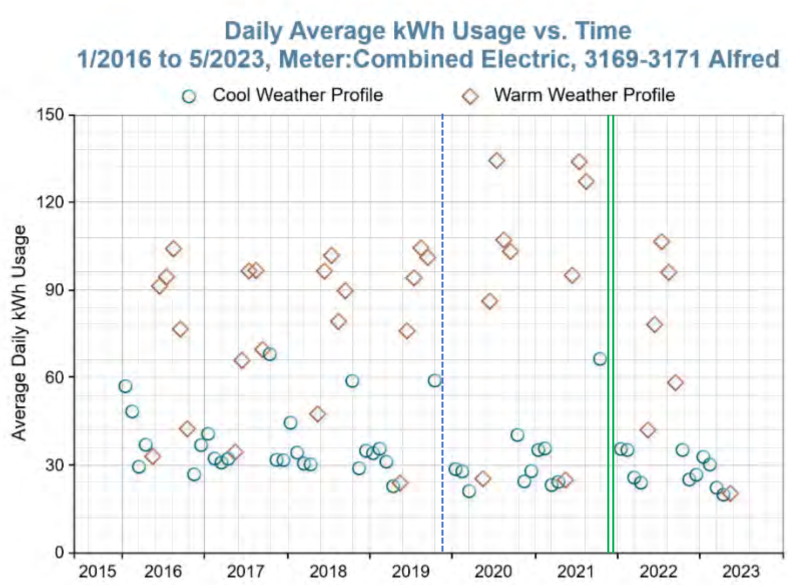
The Alfred building did not have as much vacancy as the other buildings, with vacancies only reported in: Nov 2019, Dec 2019, April 2020, and Sept, Nov, and Dec 2022. These data points were omitted from the analysis.

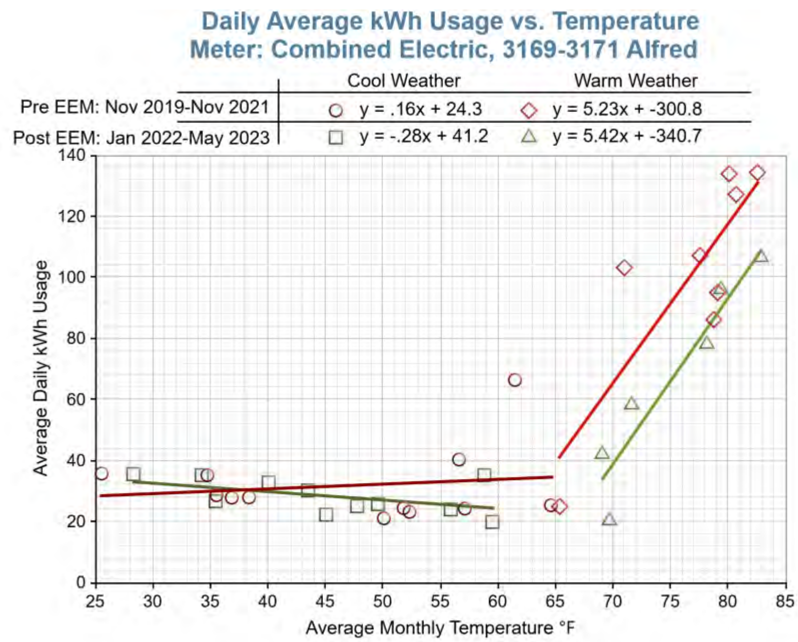
A limitation on this analysis, however, is that the measures were implemented later, reducing the amount of 'Post-EEM" data available for analysis, slightly reducing the confidence in the results.

Energy Usage – Electric (19% savings)

Electrical usage data were available for this building from January 2016 through May 2023. The chart (right) shows energy use over time, with improvements marked with vertical green lines and dashed vertical blue lines marking additional building energy-use profiles.

There has been a gradual decline in winter use over this time period, with variable summer energy consumption.





ERG defined the "Pre-EEM" time period as November 2019-November 2021, and the "Post-EEM" period as January 2021-May 2023.

The chart at right compares these two time periods by creating energy-use profiles as linear regressions of energy use (kWh) vs. outdoor air temperature (°F). The red lines are the regressions of the usage data from before the EEMs were implemented, "Pre EEM", the green lines are from usage data after implementation, "Post-EEM".

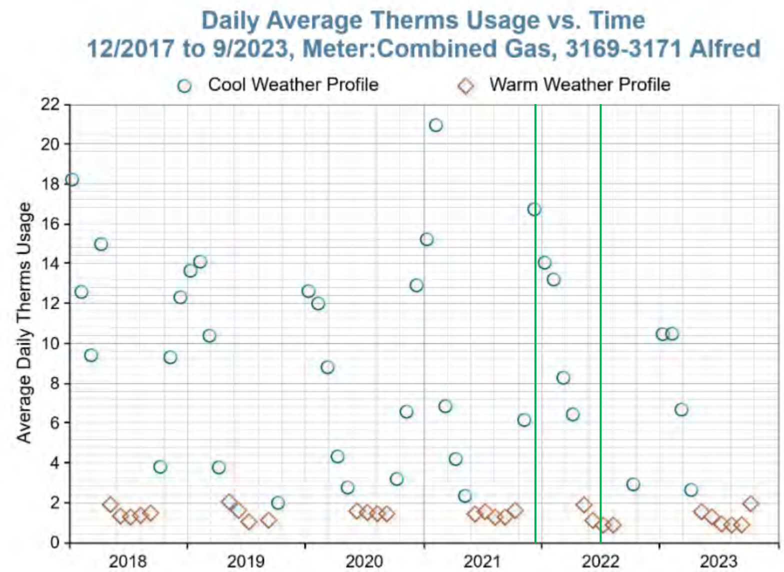
ERG uses the regression analysis of each energy-use profile to calculate energy usage and cost in a typical year. Comparing those annual projections of energy use, ERG can calculate savings. In this case, usage **electrical usage improved by 19% between the two profiles: 4270 kWh, and $585 annual savings.**

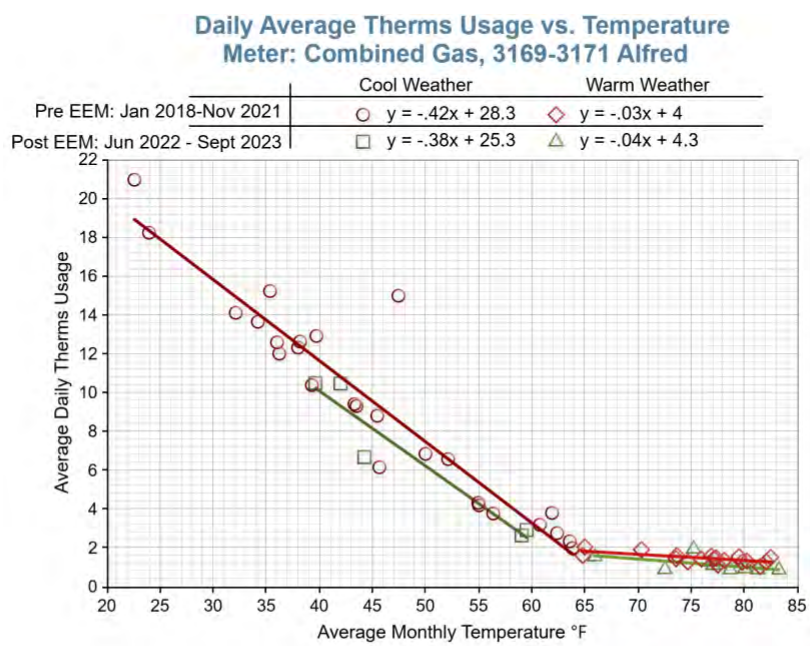
The savings come from both baseload reductions (33%), which are expected from lighting and ECM upgrades, and from cooling savings (20%). The programmable thermostat contributed to the cooling savings, but ERG was not notified of major upgrades to cooling equipment, so the extent of these cooling savings is unexpected.

Energy Usage – Natural Gas (15% savings)

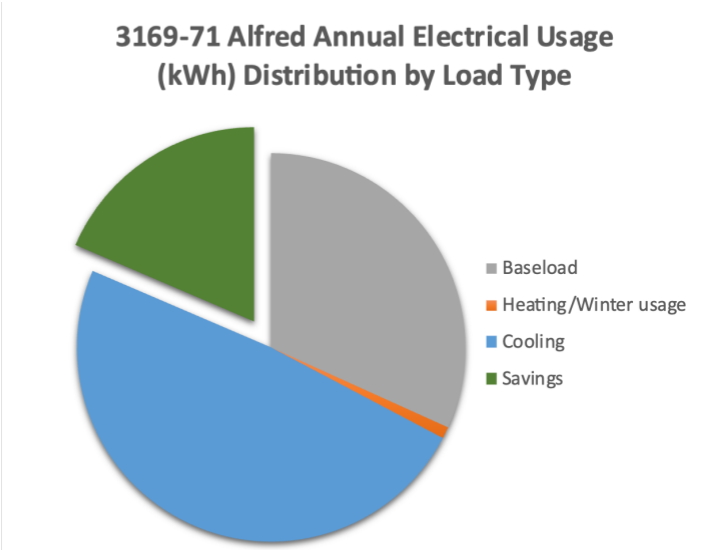
Natural Gas usage data were available for this building from January 2018 through September 2023, shown chronologically at right with EEM timing indicated.

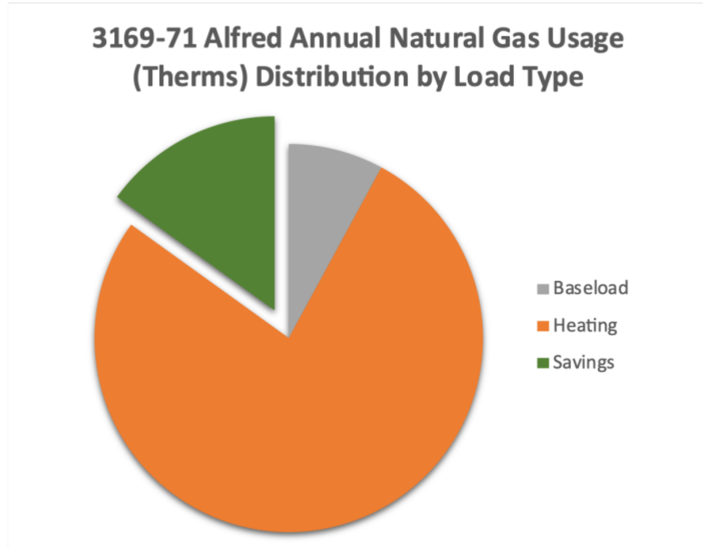
The regression analysis of these two Pre- and Post-EEM profiles indicates a **15% savings in natural gas usage: 356 therms and $460.**

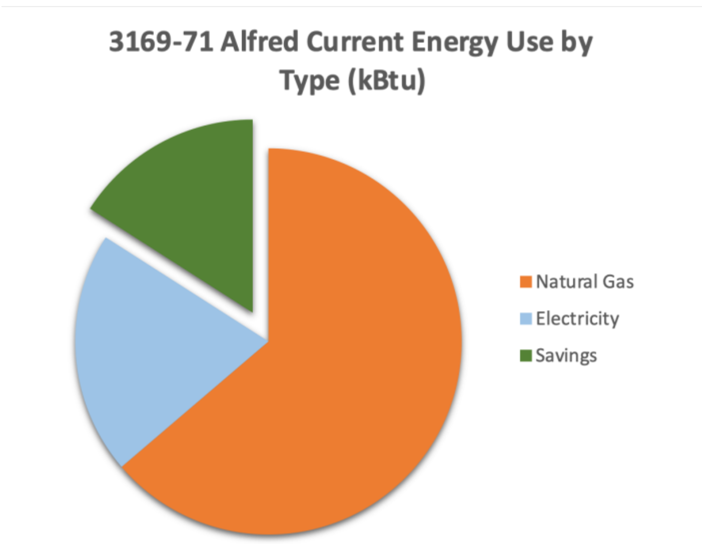


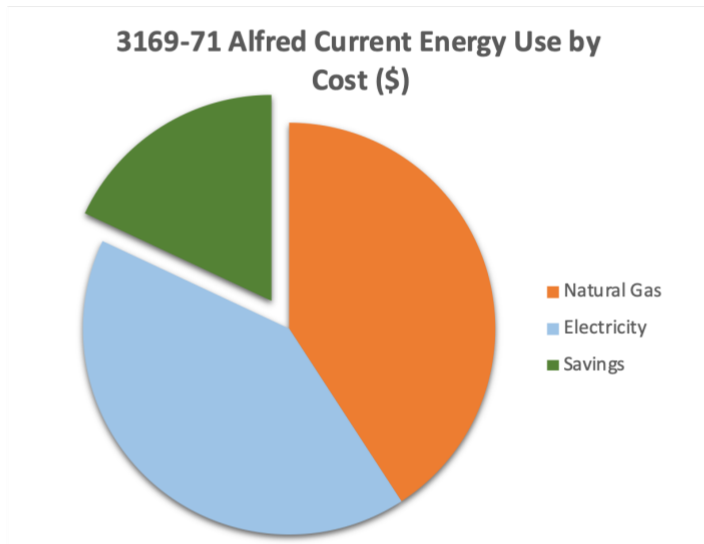


Summary


3169-71 Alfred Annual Electrical Usage (kWh) Distribution by Load Type
Baseload
Heating/Winter usage
Cooling
Savings


3169-71 Alfred Annual Natural Gas Usage (Therms) Distribution by Load Type
Baseload
Heating
Savings


3169-71 Alfred Current Energy Use by Type (kBtu)
Natural Gas
Electricity
Savings


3169-71 Alfred Current Energy Use by Cost ($)
Natural Gas
Electricity
Savings

3169-71 Alfred Energy Usage Summary Table

Weather-normalized Annual Usage

	Electricity kWh		Natural Gas therms	
Pre-EEM use	23,003		2,362	
Post-EEM use	18,734	81%	2,006	85%
Savings	4,269	19%	356	15%

	Site Kbtu		Site Kbtu	
Pre-EEM use	78,486	25%	236,200	75%
Post-EEM use	63,920	20%	200,600	64%
Savings	14,566	5%	35,600	11%
Total Savings	50,166	16%		

	Cost ($)		Cost ($)	
Pre-EEM cost	$ 2,974		$ 2,829	
Post-EEM cost	$ 2,389	80%	$ 2,369	84%
Savings	$ 585	20%	$ 460	16%
Total Savings	$ 1,045	18%		

3606-3608 Bamberger

Improvements

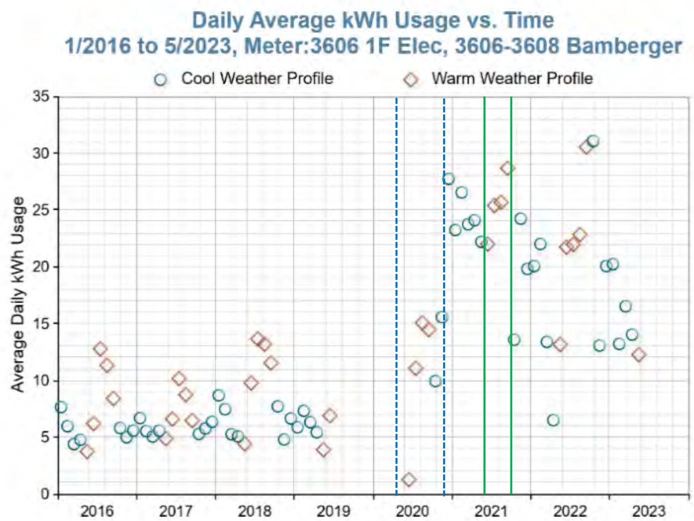
Tower Grove CDC installed the following improvements in the building. We show the date of installation in the chronological energy-use charts below with vertical green lines.

- 5/20/2021: All LED bulbs, faucet & shower aerators installed by Just One Fix
  (Expected impact on electric use only)
- 7/13/2021: Electric Panel upgrade by Collins Electric
  (no expected impact, so not shown)
- 9/14/2021: 4 16 SEER A/C, Four 96% gas furnaces with ECM motor & programmable thermostats installed by Airpro. (Expected impact on both utilities)
- 9/16/2021: Windows installed by NG Services LLC 9/16/2021
  (Expected impact on both utilities)

Occupancy

The periods of vacancy in the units in this building were sufficiently distinct from one another that omitting data when any unit was vacant overly restricted the data set and it was impossible to analyze the building as a whole, so meters were analyzed individually. 3608-1 was also vacant after October 2022, leaving only 12 months of “Post-EEM”. This reduced the accuracy of the confidence in the analysis of the 1st floor of 3608.

3606 1st Floor



Occupancy and data availability

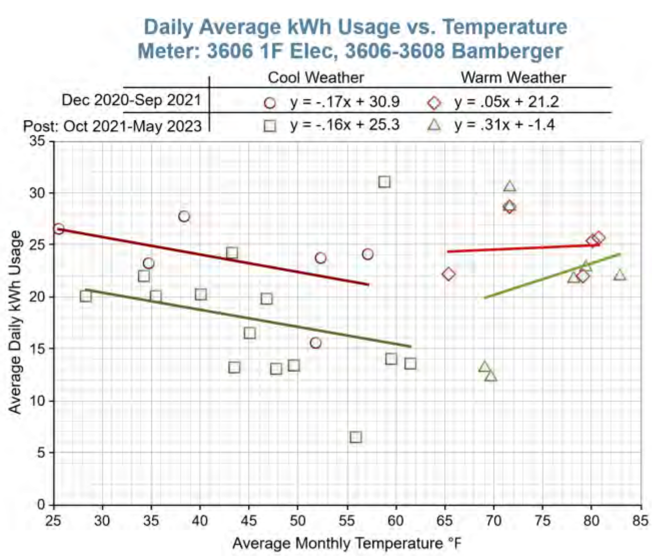
This unit was reported as vacant from July 2019 through May 2020. In addition, there were gas data reporting problems from June 2020 through October 2020 and November and December 2021, reducing the available analysis.

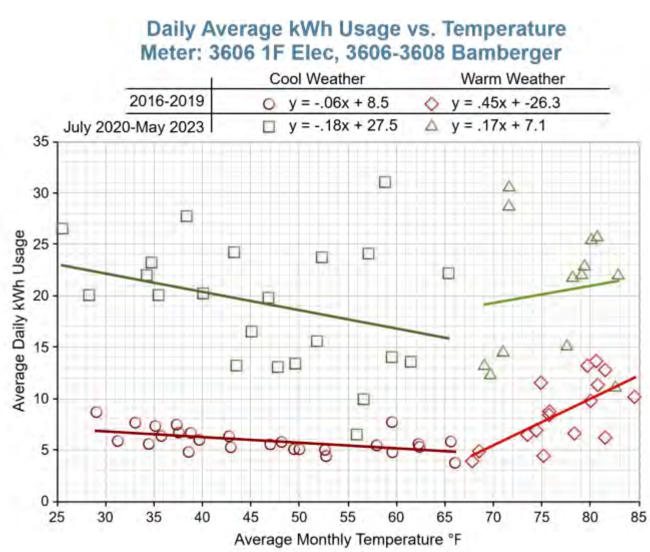
Energy Usage – Electric (18%* savings)

The chart (above, right) shows energy use over time. The major identifiable shift in energy use is seen after a long period of vacancy, after which the usage in the space becomes very irregular and **increases by approximately 100%** (mostly baseload). This shift, pictured bottom right, **occurs prior to the implementation of energy efficiency measures**, and the reason for the shift is unknown, though likely related to occupant behavior. With this shift, this unit became the largest consumer of electricity in the building by a considerable margin, 228% of the unit with the lowest usage.

Since this shift occurred more than a year prior to the implementation of EEMs, it does not impact the calculation of savings from the EEM improvements, but it does decrease the amount of data available for assessing a Pre-EEM profile. In order to assess this very irregular data, ERG defined a Pre-EEM profile with a very narrow time window, **reducing the confidence** in the energy savings figures.

Given those caveats, ERG compared: **Pre EEM: Dec 2020 – Sept 2021, and Post EEM: October 2021 – May 2023**, data, bottom left, which showed: **18% savings: 1590 kWh, and $185.**





Energy Usage – Natural Gas (6% increase)

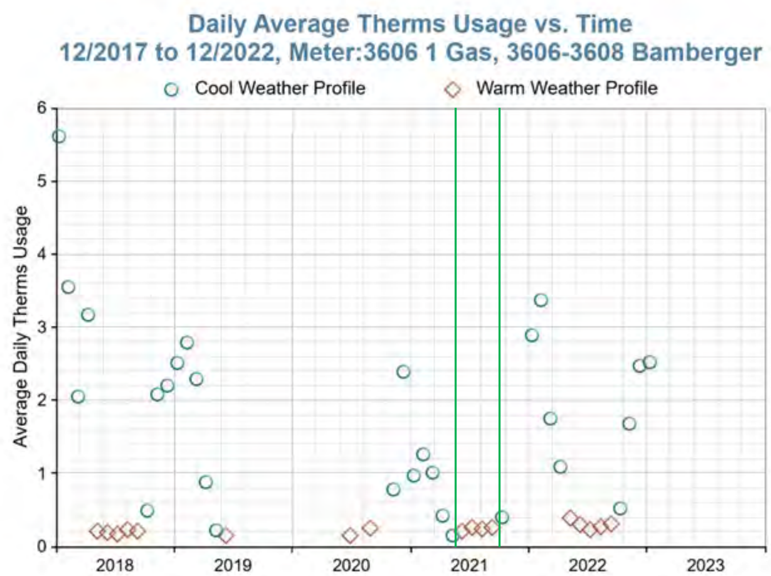
Usage does not improve after the EEM implementation.

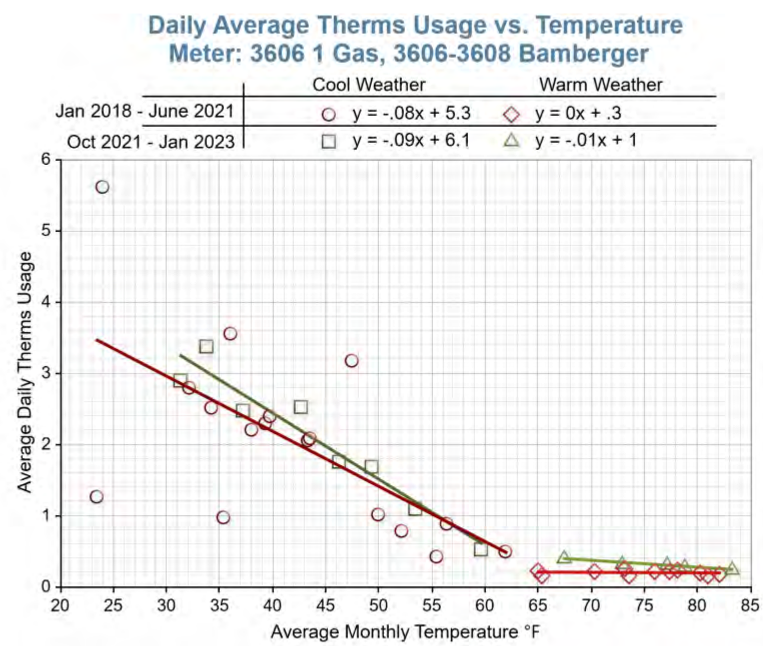
The pre-EEMs data were **extremely variable** with data points both 200% above and below the regression line.

Comparing time-periods:

- Pre EEM: Jan 2018 - June 2021
- Post EEM: Oct 2021 – Dec. 2023

Indicates a **6% increase** in natural gas usage: 25 therms and $70.

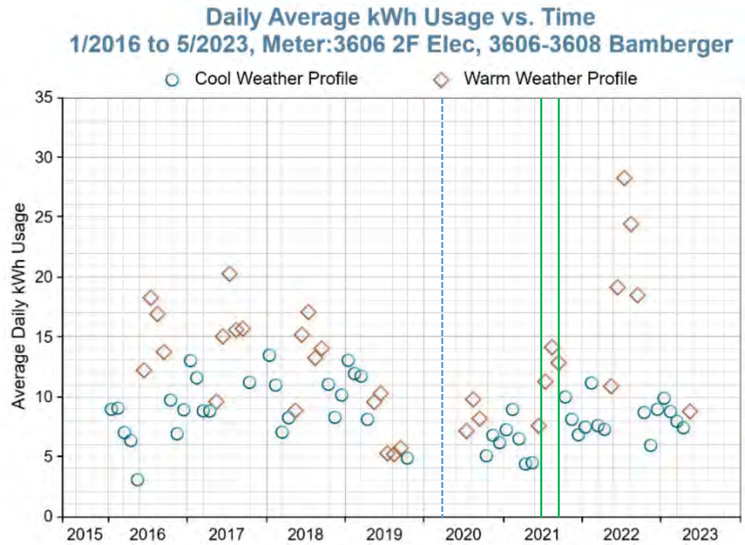




3606 2nd Floor

Occupancy and data availability

This unit was reported as vacant from November 2019 through May 2020. In addition, June 2020 was presumed vacant because of anomalously low utility usage.



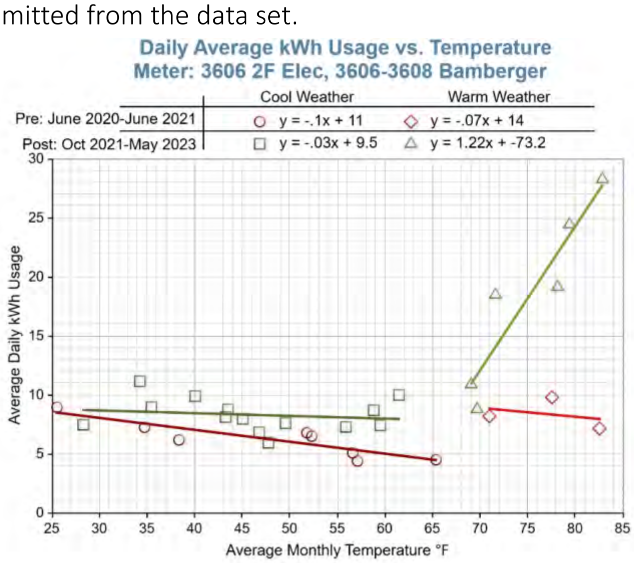
Energy Usage – Electric (33% increase)

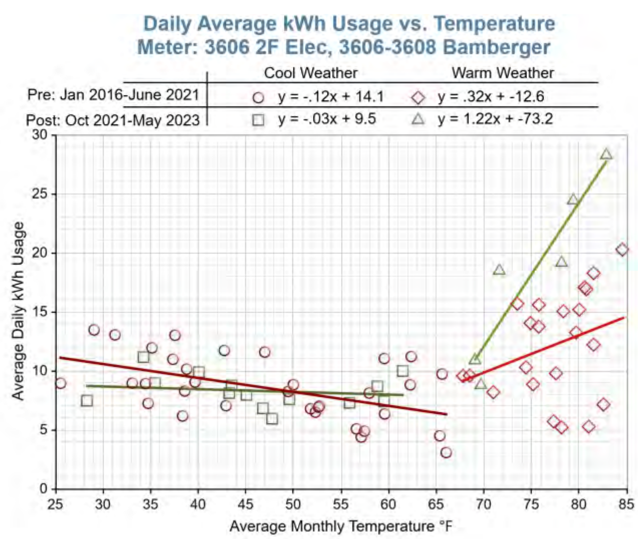
The chart at top right shows energy use over time. There are three distinct periods shown, 2016-2019, June 2020-June 2021, and Oct 2021-May 2023.

ERG would typically choose the June 2020-June 2021 as the “Pre-EEM” period to compare with the “Post-EEM” period, as it immediately precedes the implementation; however, that period shows an annual usage that is essentially flat (chart at bottom left) with no evidence of air-conditioning of any kind. For this reason, ERG has included usage data back to 2016 in the “Pre-EEM” condition (bottom right).

The usage comparisons between these two data sets show a **33% increase in usage: 1233 kWh and $184.** This increase is entirely related to the increase in cooling energy used.

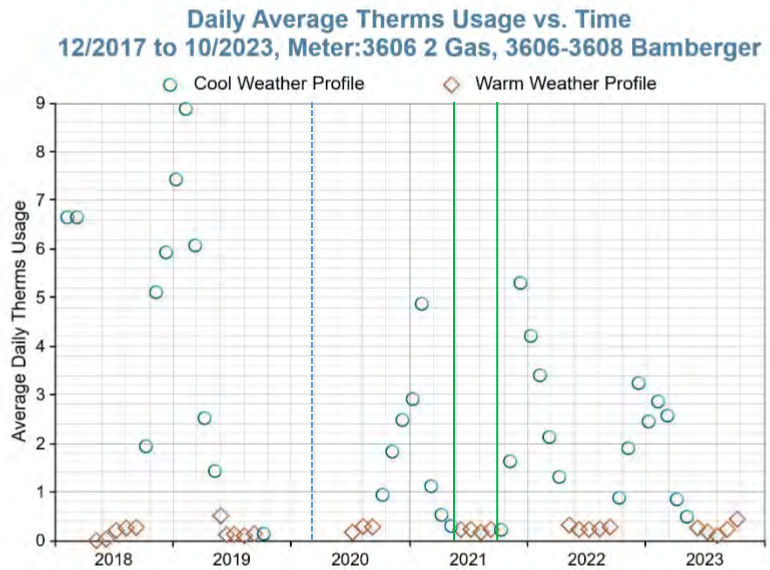
Note: Two outliers that were 400+% higher than typical from November and December of 2017 were omitted from the data set.





Energy Usage – Natural Gas (8% increase)

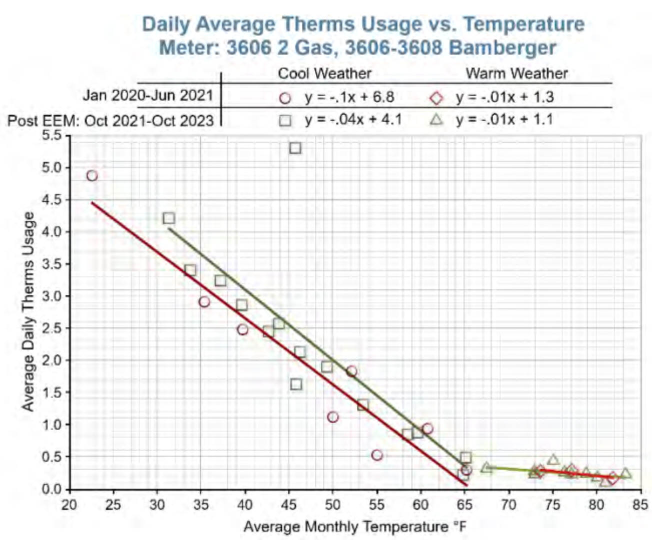
Energy usage patterns in natural gas have the same chronology as the electrical usage with three distinct periods shown, 2018-2019, June 2020-June 2021, and Oct 2021-May 2023 (at right).

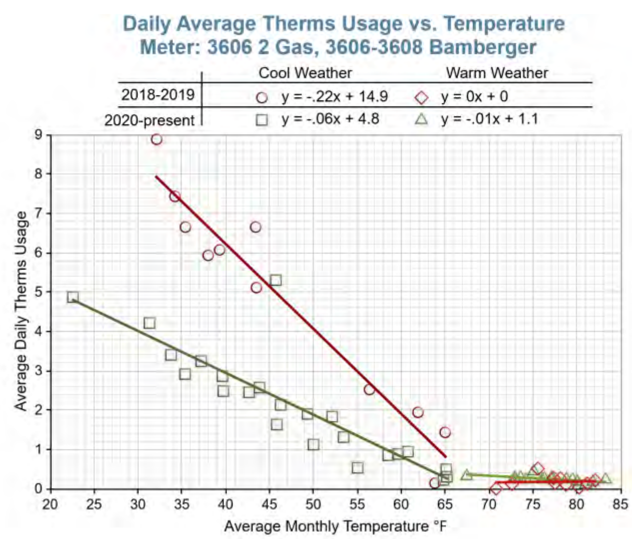


In the case of gas usage, there is a **slight rise in energy use after Oct. 2021: 8% increase, 41 Therms, $110.**

The most significant change is shown between the 2018-2019 data and the 2020-present data (lower right).

The cause for the change at this point in time was not revealed to ERG, but it corresponded with a period of vacancy with a presumable tenant change. The difference between the profiles is a 54% reduction in usage after 2020, corresponding to savings of 654 therms and $930 per year.





3608 1st Floor

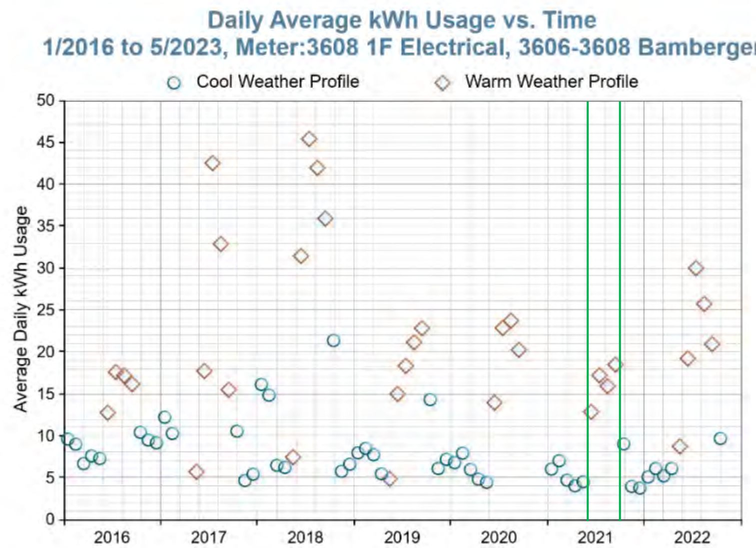
Occupancy and data availability

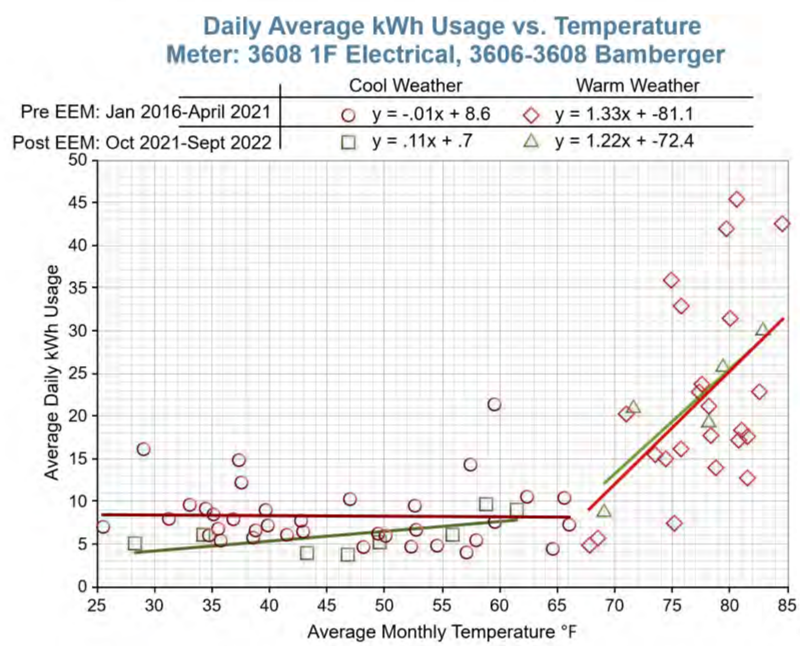
TGCDC reported this unit was vacant from October through December 2020 and from October 2022 until the end of the collected data. Gas data was missing in January 2021.

Energy Usage – Electric (10% savings)

The chart at right shows energy use over time. ERG did not have information about occupancy changes pre-2020. The energy use pattern suggests operational changes during that period, but ERG cannot attach those changes to known events in building use. The only known occupancy change is indicated with the dashed blue line and has too little data prior to the implementation date to create a reference profile. For this reason, ERG considered all use prior to the building improvements to be part of the "Pre-EEM" data set. The Post-EEM data set includes all data available after implantation was complete.

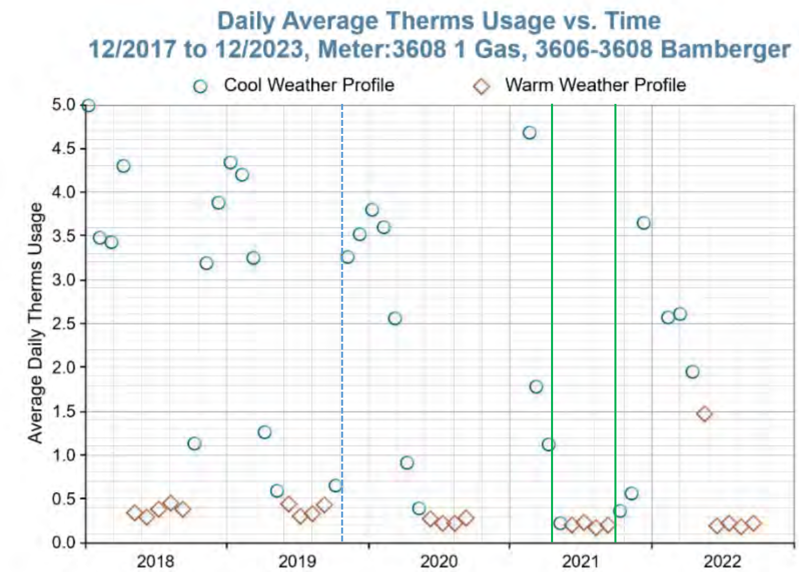
Comparing the two usage profiles shows a 10% reduction in energy use after improvements: 504 kWh and $53. This usage reduction is all related to reduction during the colder temperatures – as would be expected from lighting and ECM upgrades. There are no savings evident related to the upgrade of cooling equipment to higher SEER equipment.





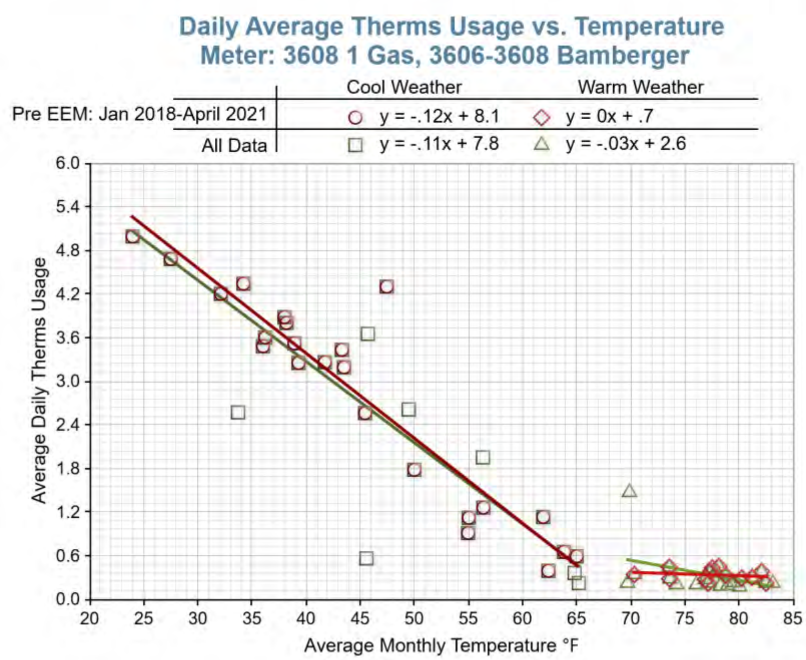
Energy Usage – Natural Gas (4%+* savings)

As with the electrical usage data for this unit, ERG considered all use prior to the building improvements to be part of the "Pre-EEM" data set. The Post-EEM data set includes all data available after implantation was complete.



Note, January 2021 showed zero usage. ERG believes this was a reporting error from Spire, and omitted the point from the analysis.

Unfortunately, this unit had insufficient data to develop a Post-EEM profile, so ERG was not able to do the standard savings analysis on this unit's gas usage; however, comparing Pre-EEM usage to a data set including all usage shows a **4% improvement, or 24 Threms and $28 annual savings**. While the Post EEM data is quite scattered, this methodology reduces estimated savings, so savings are likely higher than 4%.



3608 2nd Floor

Occupancy and data availability

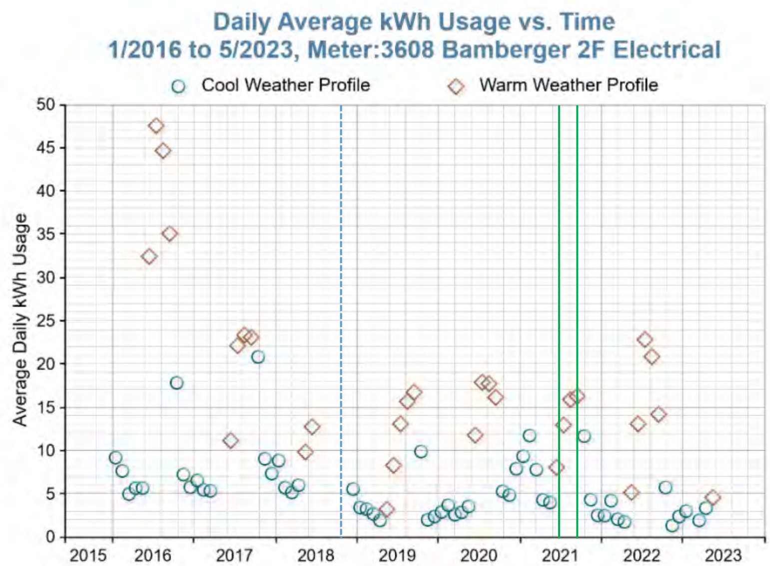
Tower Grove CDC reported this unit was vacant in April and May 2017, from July through November 2018, and in February 2023. ERG also omitted an outlier data point in March 2023.

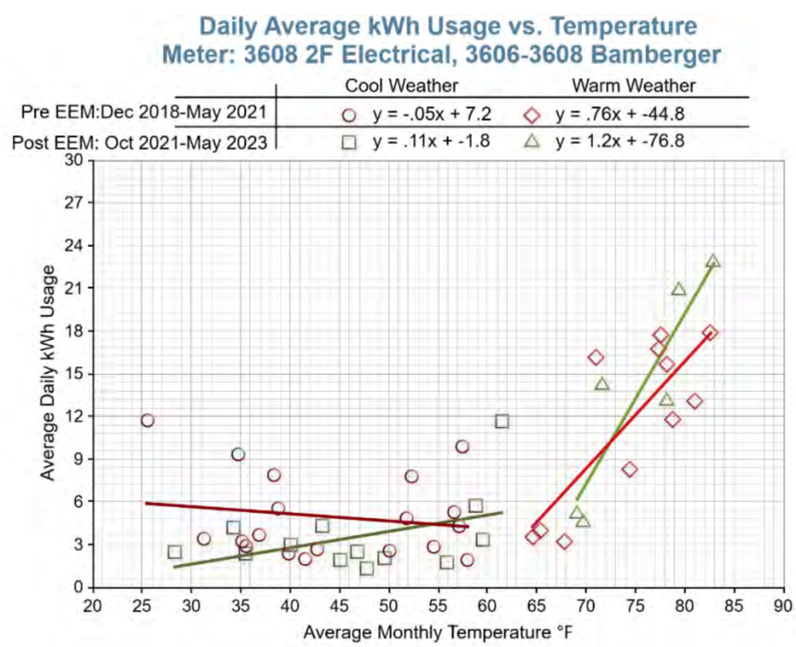
Energy Usage – Electric (1% increase)

ERG selected the time-range of Dec 2018 to May 2021 to form the Pre-EEM profile and included all data from after EEM implementation for the Post EEM profile.

The regression analysis showed a **zero change in annual usage**, with a **shift** of approximately 280 kWh **from winter usage to summer usage, increasing costs 4%:** ~ $16.

ERG considers this change within the margin of error. It is not explained by the changes made to the building.





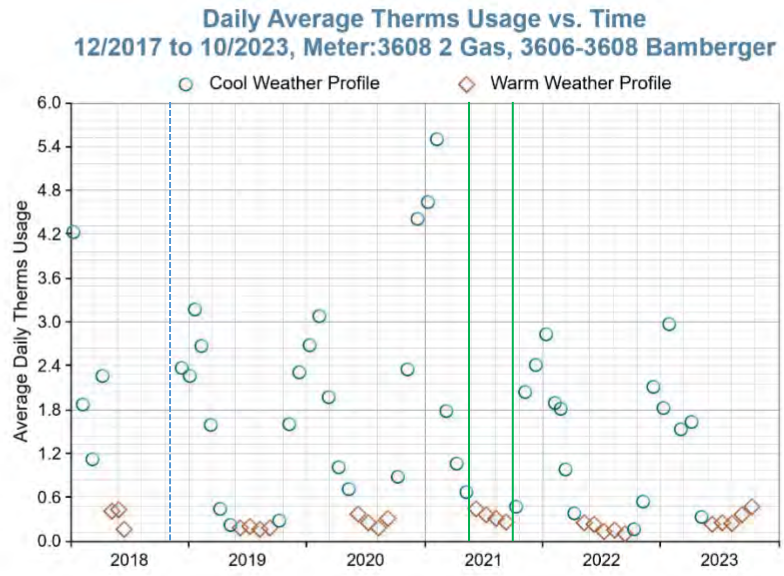
Energy Usage – Natural Gas (30% Savings)

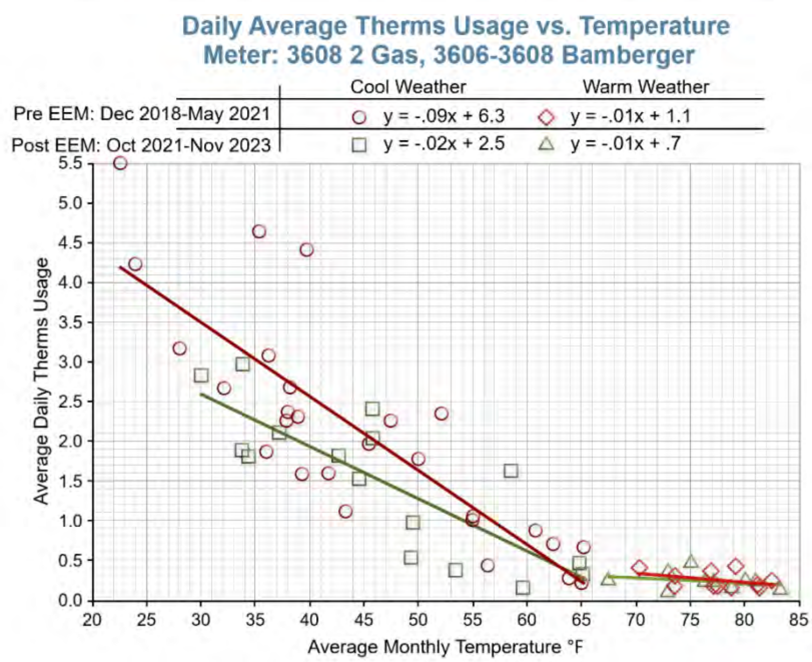
ERG selected the time-range of Dec 2018 to May 2021 to form the Pre-EEM profile, and included all data from after EEM implementation for the Post EEM profile.

The regression analysis showed a **30% decrease** in natural gas usage, an **annual savings of 158 therms and $188.**

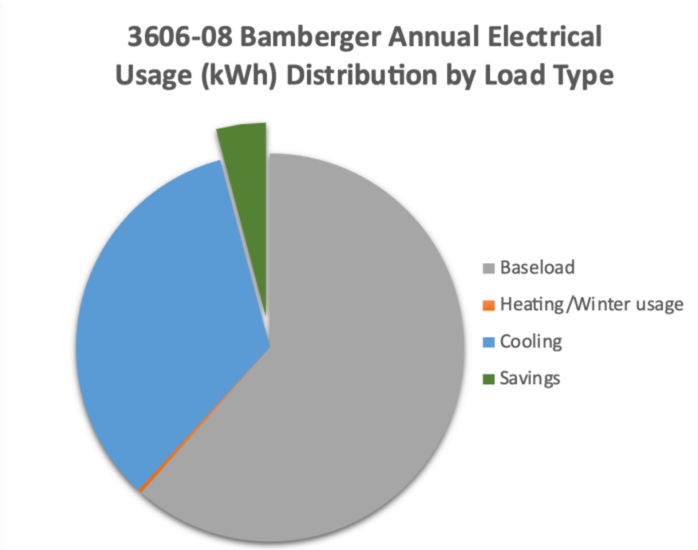
In both time periods, the winter usage data shows high variability, indicating inconsistent operation of the natural gas using equipment in the unit.

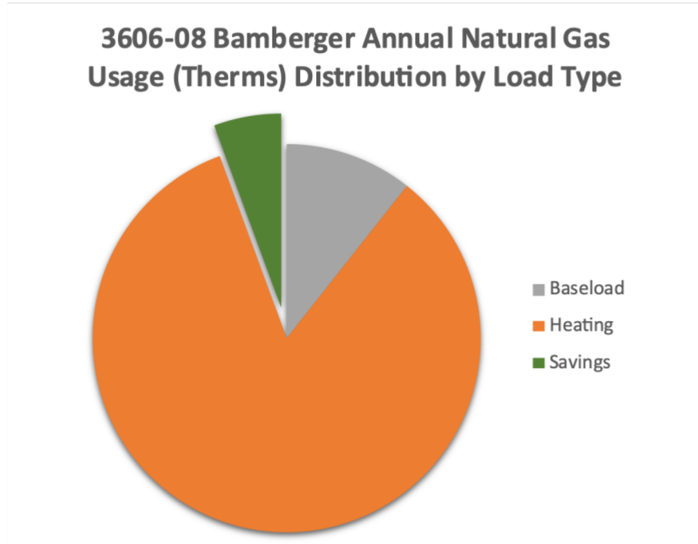
The improvements shown are in the expected direction, given the improvements in furnace efficiency, installation of programmable thermostats, and upgraded windows.

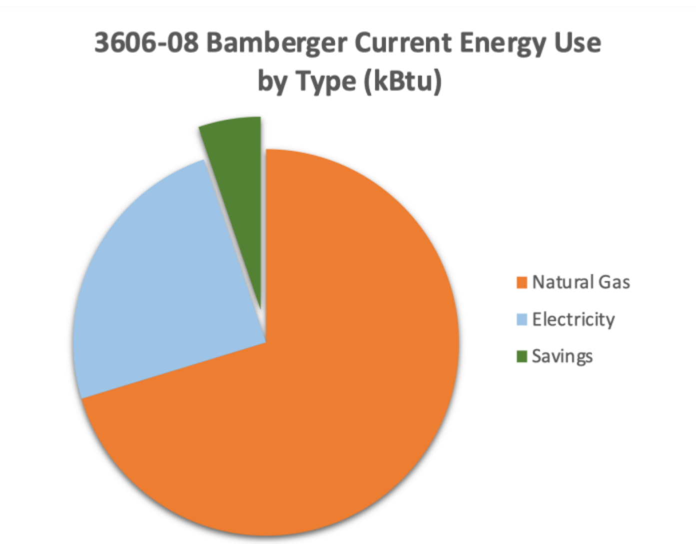


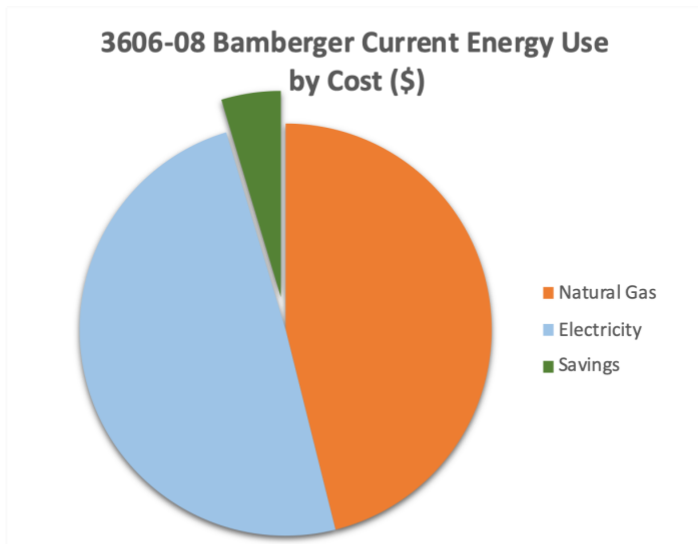


Summary


3606-08 Bamberger Annual Electrical Usage (kWh) Distribution by Load Type
Baseload
Heating/Winter usage
Cooling
Savings


3606-08 Bamberger Annual Natural Gas Usage (Therms) Distribution by Load Type
Baseload
Heating
Savings


3606-08 Bamberger Current Energy Use by Type (kBtu)
Natural Gas
Electricity
Savings


3606-08 Bamberger Current Energy Use by Cost ($)
Natural Gas
Electricity
Savings

3606-08 Bamberger Energy Use Summary Table

Weather-normalized Annual Usage

	Electricity kWh		Natural Gas therms	
Pre-EEM use	20,765		2,067	
Post-EEM use	19,906	96%	1,951	94%
Savings	859	4%	116	6%

	Site Kbtu		Site Kbtu	
Pre-EEM use	70,850	26%	206,700	74%
Post-EEM use	67,919	24%	195,100	70%
Savings	2,931	1%	11,600	4%
Total Savings	14,531	5%		

	Cost ($)		Cost ($)	
Pre-EEM cost	$2,694.02		$2,561.00	
Post-EEM cost	$2,587.00	96%	$2,423.00	95%
Savings	$107.02	4%	$138.00	5%
Total Savings	$245.02	5%		

3732-3734 Bamberger

Improvements

Tower Grove CDC installed the following improvements in the building. We show the date of installation in the chronological energy-use charts below with vertical green lines.

- 4/17/2020: 4 furnaces w/ ECM motors, 2 AC, & flu liner installed by Galmiche & Sons (Expected impact on both utilities)
- 10/5 and 10/6 2020: 30 windows installed by XL Bldg Products, All LED bulbs, faucet & shower aerators, & ducts sealed by Just One Fix
  (Expected impact on both utilities)

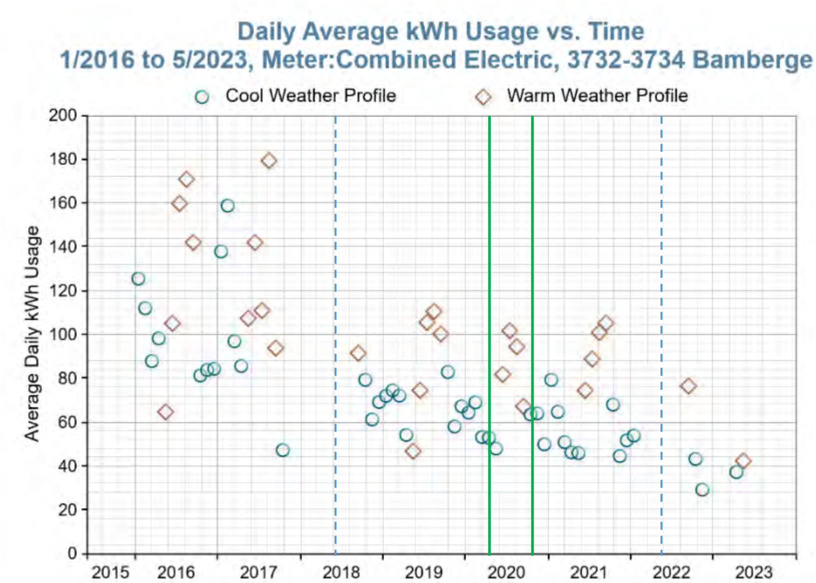
Occupancy

Some units in the building were vacant from May through August 2022 and December-February 2022/2023. These data points were omitted from the analysis. Since Improvements were completed in October 2022 there were sufficient data in both gas and electric data to do a full-building analysis. See the Occupancy Table in the Appendix.

Energy Usage – Electric (8-13% savings)

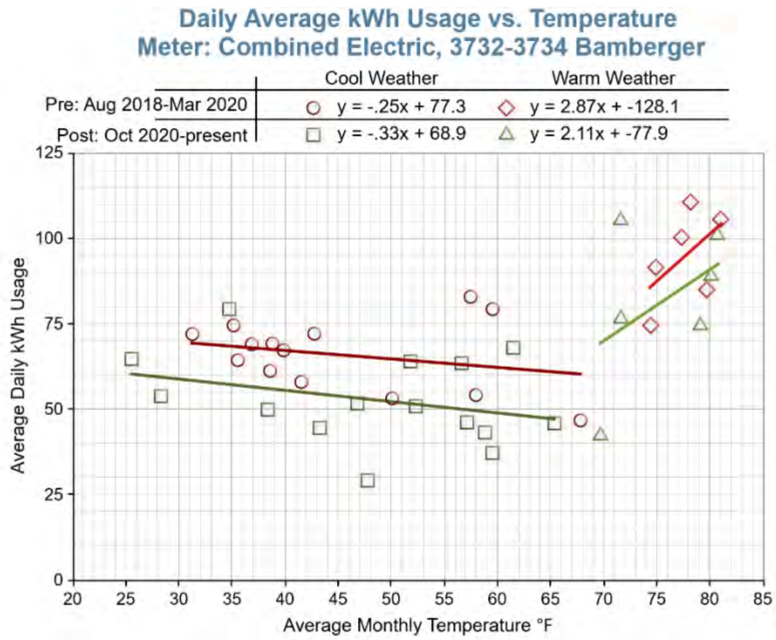
Electric usage data were available for 3732-3734 Bamberger from 1/1/2016 through May 2023, shown chronologically at right.

Electrical use reductions are visible over time, with the decreases clearly evident in the chronological data. Green vertical lines show the installation date of the building improvements. Dashed vertical blue lines represent additional distinct building profiles used in the analysis.



It is notable that the improvements do not produce immediate jumps in building performance, rather, there is a gradual decline in energy use from the initial install date until March 2022. This indicates that other factors in energy conservation may be at play as discussed in the General Interpretations section above. Notably, there were periods of vacancy in 2022 and early 2023 in all of the units, such that we assume that the building had complete occupant turnover.

EEM-based improvements

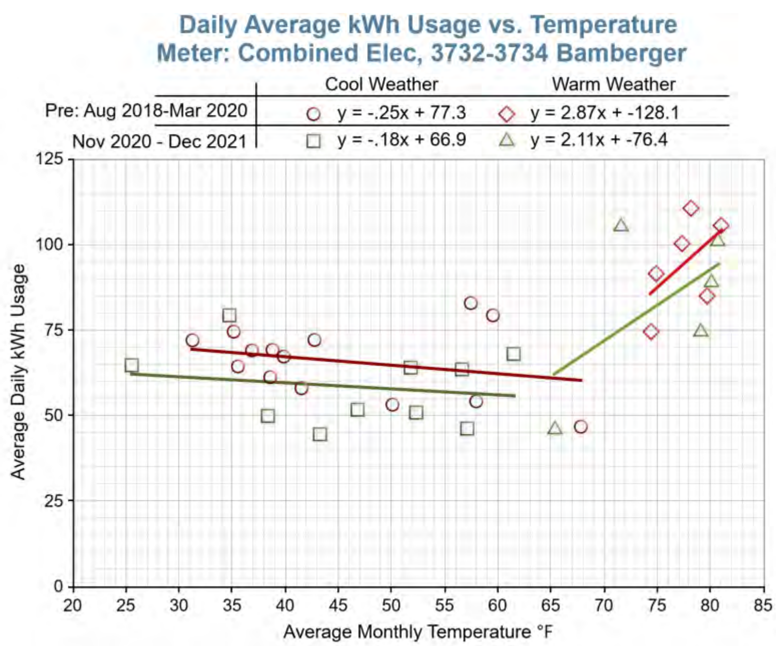


The chart at right compares two different energy-use profiles of 3732-34 Bamberger, one from before the EEMs were implemented, and one from the **complete time-period after the improvements were complete.**

- Pre EEM: August 2018 – March 2020
- Post EEM: October 2020 – May 2023

Comparing the usage profiles pre- and post- improvements reveals the following savings:

- **13% total savings,** 3741 kWh, and $453 per year.



ERG noted that there was a notable shift in usage corresponding with the tenant changeover. **A more conservative estimate** of savings is calculated **omitting the post-vacancy data,** shown at right.

- Pre EEM: August 2018 – March 2020
- Post EEM: October 2020 – Dec 2021
- This comparison shows: **8% total savings,** 2237 kWh, and $274 per year.

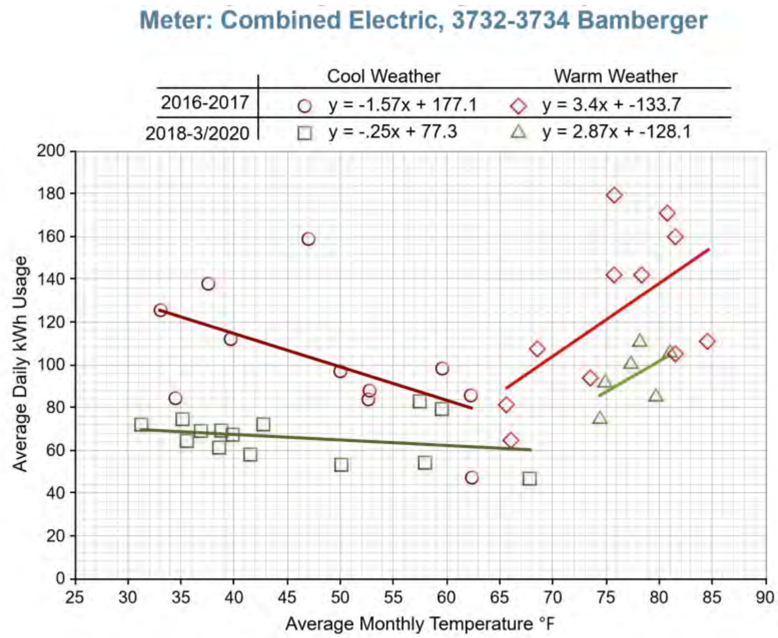
Inspection of the savings profile reveals that these savings can primarily be attributed to baseload reduction, which is consistent with ECM motors and lighting upgrades. Window improvements would be expected to reduce cooling loads, and while energy use is lower in summers than in the prior periods, the summer improvement is better explained as a baseload reduction than as a cooling profile improvement.

Additional Energy Data Features: 2016-2017 vs. 2018-2020

Reviewing the building performance improvements evident in the data, the largest percentage improvement occurred between the 2016-2017 data and the 2018-2020 data. This improvement was largely in baseload and heating.

- 34% total savings, or
- 14,734 kWh, and
- $1779 dollars per year.

While the building operational change was not reported to ERG, it may be that space heaters were taken out of use between these two profiles. It also appears that cooling setpoints were shifted to warmer temperatures during the later period.



Estimated Annual Savings - 2018-3/2020 Compared to 2016-2017

Annual	14,734	34.4%	$1,779	33.6%	
Baseload	7,305	25.0%	$893	25.0%	20
Heating	4,700	77.7%	$504	77.5%	
Cooling	2,730	36.4%	$382	35.5%	

Weather-Normalized Annual Usage Profile: 2016-2017

					Rates
Annual	42,774	kWh	$5,298		$0.000
Baseload	29,220	68.3%	$3,573	67.4%	80
Heating	6,049	14.1%	$650	12.3%	$0.107
Cooling	7,505	17.5%	$1,075	20.3%	$0.152

Weather-Normalized Annual Usage Profile:2018-3/2020

					Rates
Annual	28,040	kWh	$3,519		$0.000
Baseload	21,915	78.2%	$2,680	76.2%	60
Heating	1,350	4.8%	$146	4.1%	$0.107
Cooling	4,775	17.0%	$693	19.7%	$0.152

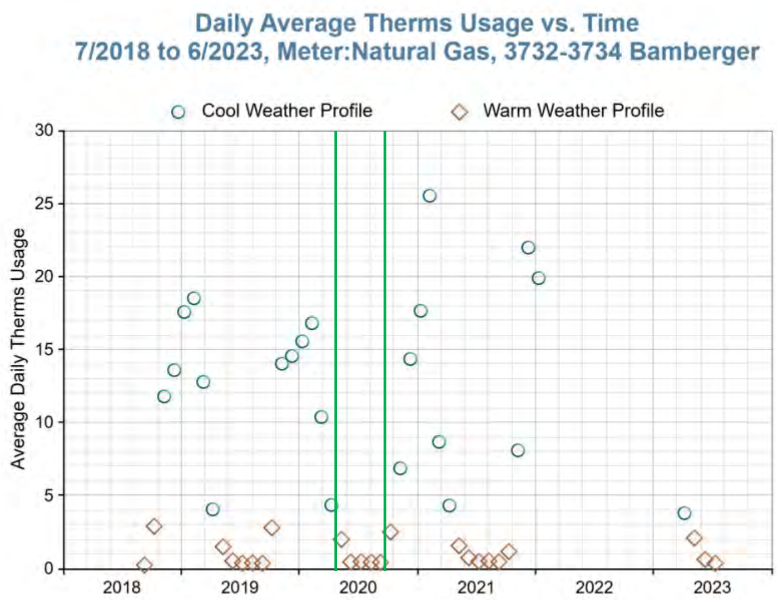
Energy Usage – Natural Gas (3% increase)

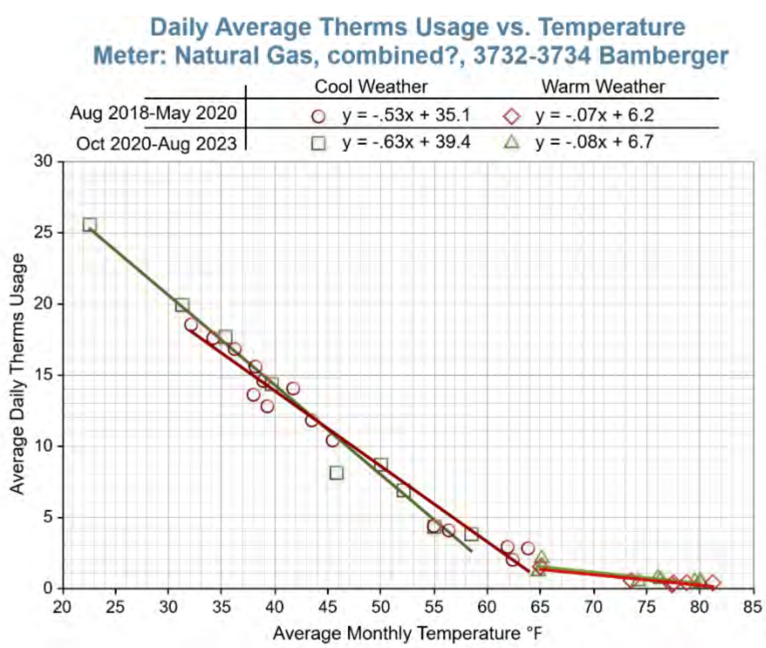
Natural gas usage data were available for 3732-3734 Bamberger from 6/1/2018 through July 2023, shown chronologically at right.

Use reductions are not clearly visible over time. Green vertical lines show when building improvements were made.

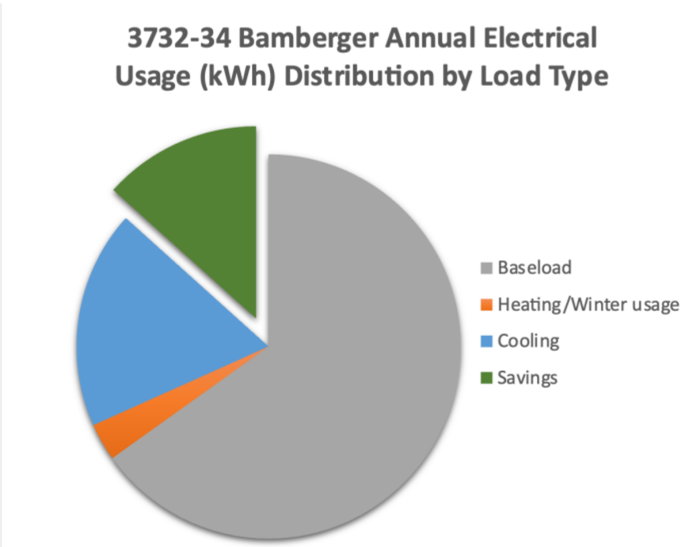
Pre-EEM and Post-EEM gas usage profiles were developed showing a **3% increase** in gas usage Post-EEM, which ERG considers to be **within the margin of error**.

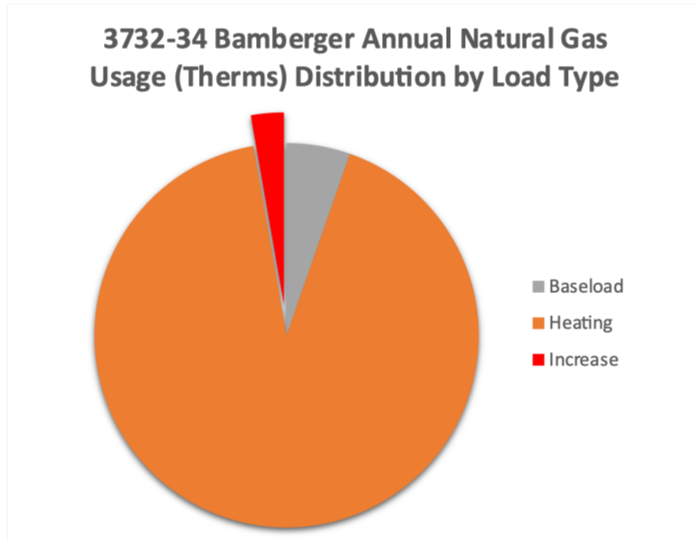
Note: There was one outlier entry in the natural gas data for this building. In December 2021, usage in Apartment 3732 2nd Floor was more than 150% higher than expected usage given outdoor air temperatures that month. There may have been a maintenance issue that caused this anomaly. This point was omitted from the analysis.

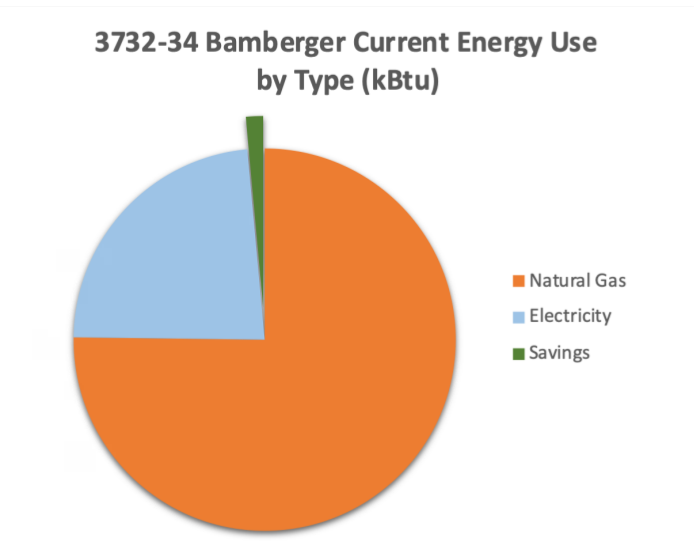


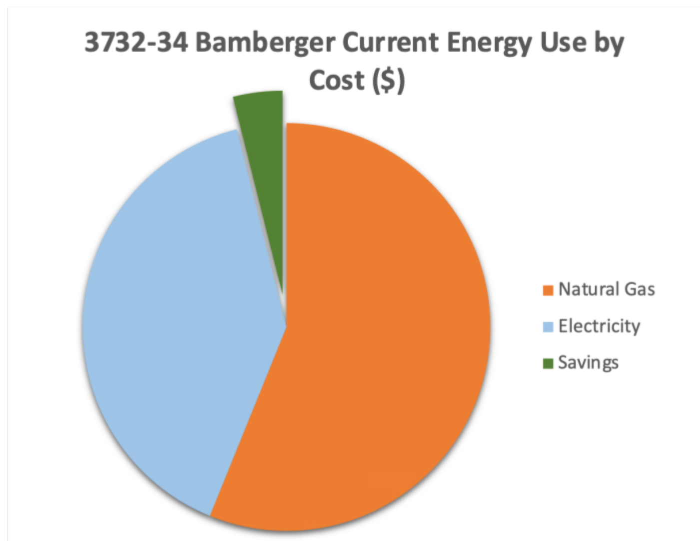


Summary


3732-34 Bamberger Annual Electrical Usage (kWh) Distribution by Load Type
Baseload
Heating/Winter usage
Cooling
Savings


3732-34 Bamberger Annual Natural Gas Usage (Therms) Distribution by Load Type
Baseload
Heating
Increase


3732-34 Bamberger Current Energy Use by Type (kBtu)
Natural Gas
Electricity
Savings


3732-34 Bamberger Current Energy Use by Cost ($)
Natural Gas
Electricity
Savings

3732-34 Bamberger Energy Use Summary Table

Weather-normalized Annual Usage

	Electricity kWh		Natural Gas therms	
Pre-EEM use	28,039		2,594	
Post-EEM use	24,298	87%	2,670	103%
Savings	3,741	13%	(76)	-3%
	Site kBtu		**Site kBtu**	
Pre-EEM use	95,669	27%	259,400	73%
Post-EEM use	82,905	23%	267,000	75%
Savings	12,764	4%	(7,600)	-2%
Total Savings	5,164	1%		
	Cost ($)		**Cost ($)**	
Pre-EEM cost	$ 3,518		$ 4,156	
Post-EEM cost	$ 3,065	87%	$ 4,308	104%
Savings	$ 453	13%	$ (152)	-4%
Total Savings	$ 301	4%		

Other Results

Individual EEMs

ERG inspected the changes in the energy use profiles for movement the expected direction for each of the energy efficiency improvements, in the buildings in which they were installed. This evaluation is shown in the table at right.

Improvement	Expected Result	3169-71 Alfred	3606-08 Bamberger	3732-34 Bamberger
LED Lighting	Baseload Elec decrease	Yes	Yes	Yes
96% Efficient furnaces:	Heating natural gas improvement	2x - Yes	4x - half of units show improvement	
Furnaces w/ECM motors	Winter and summer Elec decrease	2x - Partial, summer only	4x - half of units show improvement	4, Partial, winter only
Programmable Thermostats	Heating and Cooling Improvements	Yes	No - 1/4 show cooling & 1/2 show heating savings	
Water Heaters	Baseload Natural Gas decrease	Yes		
Windows	Heating and Cooling Improvements		No - 1/4 show cooling & 1/2 show heating savings	No
16 SEER A/C	Elec Cooling Improvement		4x - No 1/4 show cooling improvements	2x - No
Ducts sealed	Heating and Cooling Improvements			2x - No
Electric Panel Upgrade	No change expected		Installed	
Faucet and shower aerators	Slight natural gas baseload reduction	Yes	No - 1/4 show baseload reductions	No