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Bridging the Energy Efficiency Gap for Low-Income Households in Charlottesville

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Abstract: Residential energy usage in Charlottesville, Virginia, accounts for nearly 30% of the city's greenhouse gas emissions. Without significant changes, Charlottesville is unlikely to meet its goal of reducing emissions by 45% by 2030. Improving residential energy efficiency is key to lowering emissions and reducing energy costs for residents. However, the high upfront cost of these upgrades is unaffordable for over a third of Charlottesville households. As electricity prices rise due to Virginia's upcoming carbon dioxide cap-and-trade program, low-income households that can't afford efficiency upgrades will face higher energy bills and greater financial strain. This study explores the feasibility of a residential efficiency financing program designed to improve the affordability and accessibility of energy upgrades for low-income households in Charlottesville. Through a detailed benefit-cost analysis, various policy alternatives, including On-Bill Financing, Revolving Loan Fund, and Loan Loss Reserve, were evaluated for their effectiveness, equity, and implementation feasibility. The recommended option, On-Bill Financing, would allow Charlottesville Gas to cover the upfront costs of energy efficiency upgrades. Customers would repay the investment over time through their gas bills, thereby enjoying immediate reductions in energy consumption and costs. This policy would fairly enhance residential energy efficiency and provide critical financial assistance to households that otherwise couldn't afford these upgrades.

Keywords: energy efficiency financing, greenhouse gas emissions reduction, low-income household support, on-bill financing.

1. Introduction

On July 1, 2019, the Charlottesville City Council established ambitious targets to address the pressing global issue of climate change by committing to a 45% reduction in community-wide greenhouse gas (GHGs) emissions by 2030 from 2011 levels, and achieving carbon neutrality by 2050. This initiative responds to the threats posed by anthropogenic emissions, primarily from the consumption of fossil fuels such as coal, oil, and natural gas. These fuels, when burned for residential energy such as electricity and heating, emit GHS that trap heat in the atmosphere, contributing to global warming [1][2].

Residential energy use in Charlottesville accounts for 47% of total energy consumption, significantly higher than the national average, largely due to the city's modest industrial sector. Consequently, residential energy consumption is the largest source of GHGs emissions locally, representing 29.8% of Charlottesville's total emissions [3]. The global impacts of climate change, including sea level rise and more frequent natural disasters, further exacerbate the urgency to reduce emissions as outlined in the 2015 Paris Agreement [4].

However, the upfront cost of investing in residential energy efficiency upgrades is too high for more than one-third of households in the City of Charlottesville to afford. Without intervention, Charlottesville's low-income and cost-burdened households will continue to inefficiently use energy. The prohibitively high upfront cost of residential energy efficiency upgrades will lead an already disadvantaged population to become worse off as electricity prices rise and ultimately prevent Charlottesville from meeting its goal of reducing GHGs emissions 45 percent by 2030 [5].

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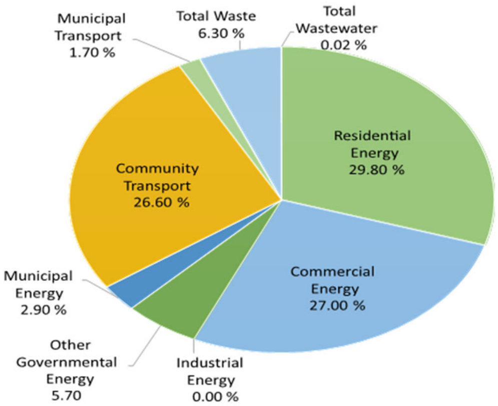

Figure 1:Charlottesville Greenhouse Gas Emissions by Sector [6]

2. Background

2.1 Virginia's Recent Climate Policy Changes

In 2020, the Virginia General Assembly approved the Clean Energy and Community Flood Preparedness Act, mandating the establishment of a carbon dioxide cap-and-trade program aligned with the Regional Greenhouse Gas Initiative (RGGI) standards, paving the way for Virginia to join RGGI [7]. RGGI is a program that sets regional carbon emission limits for electric power plants, requiring them to buy tradable emissions permits, thus integrating the social costs of their emissions into their operational costs, encouraging a shift towards cleaner energy production [8][9].

In the short term, this may lead to higher electricity prices in Virginia as power producers pass on the increased costs to consumers. While the Virginia Clean Economy Act introduces uncertainties to future electricity pricing, it is expected that prices will rise as the RGGI emissions cap tightens and as the state ramps up its investment in renewable energy [9][10][11].

Virginia's cap-and-trade system aims to support Charlottesville in achieving its 2030 GHGs emissions reduction target by incentivizing reduced energy consumption in response to rising prices. Households able to afford energy efficiency upgrades will likely increase their investments, whereas those unable to afford such upgrades will see a decrease in welfare, having to either pay more or reduce their energy use.

To mitigate potential negative impacts on low-income households, the Clean Energy and Community Flood Preparedness Act allocates 50% of the revenue from emissions permit sales to energy efficiency programs for low-income families [7][12]. However, given Charlottesville's relatively high median income, it is less likely that such programs will prioritize the city, making energy efficiency upgrades both more necessary and less affordable for its residents [13].

2.2 The Energy Efficiency Gap

Reducing energy costs through efficiency upgrades can significantly mitigate the financial burden for residents, especially those reliant on fossil fuels. According to American Council for an Energy-Efficient Economy, improving low-income housing to the average U.S. home's efficiency could eliminate about 35% of the energy cost burden for these households [14]. Similarly, the U.S. Department of Energy estimates annual savings of $200 to $400 for homeowners who make such upgrades, including sealing leaks and updating air conditioning systems [15]. The EPA advises local governments to address both the affordable housing crisis and residential GHGs emissions by developing energy efficiency programs targeted at affordable housing and low-income populations [15][16].

However, several barriers hinder the effectiveness of these programs, particularly for low-income families. The initial costs of energy efficiency upgrades are often too steep for about a third of Charlottesville households already burdened by housing expenses. While higher-income families can afford upfront costs and enjoy long-term savings, lower-income families typically lack the necessary capital [15]. Even rebates and partial loans may fall short, as they still require some upfront investment from the households.

Credit constraints further complicate access to energy efficiency upgrades. Lower-income households generally have lower credit scores, making them less attractive to lenders who view them as high-risk borrowers potentially more likely to default [17][18]. This discrepancy, known as information asymmetry, leads to credit rationing, where lenders hesitate to extend credit, limiting these households' ability to finance energy efficiency improvements [18][19].

Additionally, disparities in credit access have racial dimensions. Between 2007 and 2009, in the Thomas Jefferson Region which includes Charlottesville, White households were 10% more likely to be approved for mortgages than Black applicants at the same income level, highlighting a historical trend of discrimination in housing that could skew the benefits of energy efficiency programs towards White households [20]. This suggests that low-income energy efficiency initiatives may inadvertently favor better-served demographics, exacerbating existing inequalities.

Furthermore, low-income renters have little agency in making energy efficiency upgrades; this issue is particularly pronounced due to the split incentive that exists between landlords and renters. When renters pay for energy and utilities, landlords have no obvious incentive to make energy efficiency upgrades, as they will not be directly rewarded with energy cost savings over time [15]. Again, this challenge more severely affects non-White families, as Black, Asian, and Hispanic families in Charlottesville are less likely to own their homes and accordingly more likely to rent from landlords. In 2017, 55 percent of White households in the Charlottesville area owned their homes, while approximately 30 percent of Black, Asian, and Hispanic families owned their homes (see Figure 2) [21].

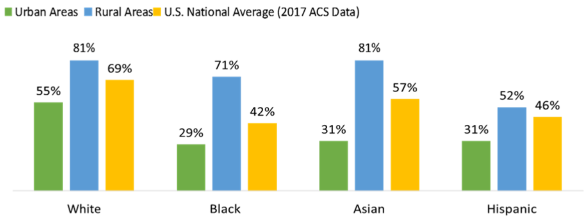

Figure 2: Homeownership Rates by Race in the Charlottesville Area [21]

An additional reason for the energy efficiency gap's persistence is consumer uncertainty and knowledge gaps surrounding the energy savings potential of energy efficiency upgrades [2]. Some Charlottesville residents may not have any knowledge about how or why energy efficiency upgrades help them save, and they may be distrustful of private companies who advertise energy efficiency programs to them. Others may not be confident in the potential of energy efficiency upgrades to generate cost savings due to uncertain future energy prices[18][19]. The aforementioned barriers justify government intervention to design an energy efficiency financing program that enhances the affordability and accessibility of energy efficiency upgrades in order to improve the welfare of Charlottesville's cost-burdened households and reduce residential greenhouse gas emissions.

Figure

3. Literature Review

3.1 Public and Private Financing Mechanism

While private financial markets cater to some consumers for energy efficiency upgrades, research shows that moderate-to-low-income households and tenants in affordable multifamily properties often find these options inadequate [22][23]. For instance, energy efficiency mortgage (EEM) programs offered by private banks were less accessible due to limited credit access, particularly before the 2008 housing market crash [19]. Moreover, many homeowners are hesitant to refinance mortgages through EEM programs due to existing debt exceeding their income [24], and these programs do not typically address financial barriers faced by renters. Renters encounter high upfront costs and deal with split incentives, as landlords may not benefit directly from investments in energy efficiency [24][25][26].

Municipally-provided and public-private energy efficiency financing programs have become increasingly prevalent, overcoming limitations seen in private programs and supported widely by economists and policymakers. These programs help households navigate capital and credit constraints [19]. However, there is debate about government involvement potentially crowding out private lending and adding transaction costs, although measuring such "crowding out" effects is challenging due to temporal and geographic variations [19][27][28].

Despite these debates, the failure of private markets to close the energy efficiency gap has prompted many governments and utilities to develop financing strategies like On-Bill Financing (OBF), credit enhancements, and direct lending over the past two decades to reduce the upfront costs of energy efficiency upgrades [26][29][30].

3.2 On-Bill Financing

A wealth of literature identifies On-Bill Financing (OBF) as an effective mechanism for financing energy efficiency upgrades, wherein loan repayments are made through existing monthly utility bill payments, ensuring that energy savings at least match or exceed the repayment amounts [14][26][31][32]. Studies suggest a lower default rate for OBF loans compared to other loan types, likely because consumers are already accustomed to paying utility bills regularly, which may psychologically encourage consistent payment behavior [31][32][33]. This regular payment habit facilitated by OBF allows for lower interest rates and longer loan terms in many existing programs, enhancing the program's accessibility to more customers [24][30][34].

OBF programs offer additional advantages that enhance the accessibility and affordability of energy upgrades. For instance, many OBF programs use utility bill payment history instead of credit scores to assess loan eligibility, which opens up access for households with lower credit scores [32]. Also, because OBF loans are billed as service charges rather than traditional debt, they do not adversely affect customers' overall credit availability [29]. Furthermore, tariff-based OBF programs, which tie the loan to the property meter and not to the homeowner, effectively address the split incentives between landlords and renters by ensuring that the investment benefits remain with the property, encouraging property owners to invest in energy efficiency regardless of tenant turnover [26].

While OBF programs are widely implemented across the U.S., tariff-based models are relatively recent and less evaluated in the literature, making their long-term effectiveness and scalability subjects of ongoing research [29][32][34]. Success of these programs largely depends on the willingness of utilities to manage the risks associated with providing energy upgrades [29][30].

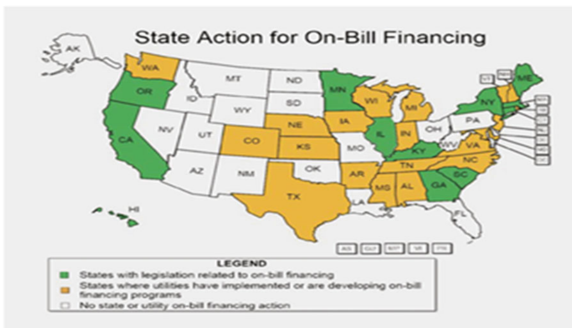

Figure 3: Legislative environment for OBF by state in 2022 [36]

3.3 Credit Enhancements and Direct Lending

Many government and utility-operated residential energy efficiency financing programs leverage credit enhancements like Loan Loss Reserves (LLRs) and direct lending through Revolving Loan Funds (RLFs) to help private lenders increase the accessibility of offered loans. For instance, LLRs provide public funds to private lenders if borrowers default on their loans, reducing the risk taken on by private lenders and increasing their lending to households with lower credit scores, many of which may be moderate-to-low-income [18]. The literature indicates that credit enhancements attract private lenders and capital to energy efficiency markets, thereby supplementing government funds for efficiency-related loans [30][32].

In contrast, RLFs offer direct loans to households for energy efficiency upgrades and are intended to be self-sustaining as households repay loans into the fund [30][35]. By offering lower interest rates than private loans, RLFs help reduce the high upfront cost associated with efficiency improvements, although the speed with which they "revolve" may limit the number of loans allocated to riskier borrowers [30].

4. Evaluative Criteria

4.1 Benefit Cost Analysis

This analysis will evaluate policy alternatives using a benefit-cost analysis (BCA) over a 25-year period, assuming 100 new participants every year and applying a 7% discount rate to calculate the net present value (NPV) of each option. Monetary values will be assigned to all quantifiable benefits and costs, utilizing market prices and shadow pricing where necessary.

Benefits will include:

- Energy savings for Charlottesville residents
- Reduced healthcare costs resulting from a reduction in air pollution
- Comfort and quality-of-life improvements resulting from efficiency upgrades

Costs will include:

- Administrative costs borne by program operator(s) (i.e., labor, office space, etc.)
- Energy efficiency upgrade resource costs for participating households
- The opportunity cost of the program (i.e., the next best use of the city's funding).

4.2 Equity

The propensity for each policy alternative to increase the affordability and accessibility of energy efficiency upgrades will be determined based on policy literature and case studies from other localities. This criterion will also consider the distribution of costs and benefits across stakeholders. Alternatives that allow low-income and cost-burdened households to receive the highest ratio of benefits to costs will be characterized as highly equitable. This criterion will score policy alternatives as generating high (5), medium (3), or low (1) equity.

4.3 Feasibility

This qualitative criterion evaluates the political and administrative feasibility, focusing on the likelihood of Charlottesville's city government adopting and implementing the proposed policy.

Political feasibility involves:

- Analyzing the stated views of city government officials.
- Examining the success of similar initiatives in other localities.

Administrative feasibility assesses:

- The capacity of city government, utility providers, landlords, and households to manage and implement policies.
- The need for capacity building and the sustainability of policies, based on city government documents.

Each policy alternative will be rated as high (5), medium (3), or low (1) in terms of feasibility.

5. Policy Alternatives & Evaluation

5.1 Alternative 1: On-Bill Financing

The OBF program mandates Charlottesville Gas to fund the upfront costs of residential energy efficiency upgrades using $8 million allocated by the city government, enough for 1,000 households over 10 years at an average cost of $8,000 each. Low-income and cost-burdened households will be prioritized, with eligibility based on utility bill payment history. Approved applicants will coordinate with contractors for installations, repaying the cost over up to 15 years at 0% interest via their monthly utility bills, with savings expected to offset payments [31][37].

The program attaches repayment obligations to the property meter, facilitating the transfer of responsibility if residents move, making it more accessible as it's treated as a service rather than a loan [29].

Benefit-Cost Analysis: The OBF program shows a positive NPV of $3,430,639 with benefits totaling $10,755,514.06 against costs of $7,324,875.33.

Equity: The program scores high in equity (5), addressing credit rationing by using utility bill payment history instead of credit scores to enhance access for low-income households. It balances benefits between renters and homeowners, with both parties gaining from energy savings and property value increases, respectively.

Feasibility: Feasibility is rated low-medium (2) due to the need for capacity building within Charlottesville Gas and the city government for OBF program management. While the utility's commitment to energy efficiency is shown through its existing pilot program with LEAP, its readiness to solely operate an OBF program is uncertain, which may affect the program's success and cost-effectiveness [29].The political landscape may also affect feasibility, particularly as public health spending becomes a priority [38].

5.2 Alternative 2: Revolving Loan Fund

The Revolving Loan Fund (RLF) program, operated by the city government, would provide loans to eligible households based on credit scores and other factors, allowing a portion of loans for applicants with lower scores to reach low-income and burdened residents. Households approved for the program would undertake efficiency upgrades independently or through contractors. They would repay the loan at 0% interest over up to 15 years through a new portal in the city's online billing system, with repayments replenishing the fund to sustain future loans [18][33].

Benefit-Cost Analysis: The RLF program passes the BCA with an NPV of $3,384,260.35 with benefits totaling $10,755,514.06 against costs of $7,371,253.71.

Equity: Rated medium with a score of 3, the RLF program aims to make efficiency upgrades affordable through 0% interest rates and extended loan terms, potentially enhancing low-income households' welfare. However, reliance on credit scores may limit access for those with poor credit histories, although the city's risk portfolio might mitigate this somewhat. Renters may be less inclined to participate due to the inability to pass on loans and lack of property value benefits, potentially skewing accessibility towards homeowners.

Feasibility: Rated medium with a score of 3, Charlottesville's familiarity with RLF management from past implementations suggests high administrative feasibility with minimal startup costs—likely requiring only one additional employee for management. The self-sustaining nature of the RLF promises low ongoing administrative costs. However, the initial $8 million needed may pose a challenge for political feasibility, especially given current fiscal constraints from the COVID-19 pandemic. Nonetheless, the program's alignment with the city's energy performance goals and climate objectives boosts its political acceptability, reflecting successful precedents in other localities.

5.3 Alternative 3: Loan Loss Reserve

With this alternative, the City of Charlottesville will establish a Loan Loss Reserve (LLR) with $1.6 million in city funds, aimed at enticing private lenders into the energy efficiency market by mitigating risk. The LLR will cover defaults, encouraging lenders to provide $8,000 loans to up to 1,000 households over 10 years, creating a safety net covering 20% of the total portfolio. Initially, the program proposes contracting with the University of Virginia Community Credit Union (UVA CCU) to manage the loans, with potential future expansion to include more lenders based on program success and capacity [39].

Benefit-Cost Analysis: The LLR program achieves an NPV of $2,968,961.93. Anticipated benefits are set to begin in 2026, reaching a total present value of $9,857,189.37 against estimated cost at $6,888,227.44.

Equity: This policy scores low-medium on equity with a rating of 2. The LLR might increase the overall availability of energy efficiency loans but does not guarantee targeting towards low-income households, who often have lower credit scores and might be excluded. Additionally, credit checks and potential debt accumulation could adversely affect these households' broader financial access. The structure also doesn't cater well to renters, who are less likely to commit to long-term loans for properties they don't own.

Feasibility: Rated medium-high with a score of 4, the feasibility of this alternative is strong due to the city's previous experience with similar public-private energy efficiency programs. The existing relationships with financial institutions like UVA CCU are expected to minimize transaction and administrative costs. However, the program's scale and administrative demands might require the city to allocate additional resources for managing multiple lender relationships.

6. Conclusion

6.1 Recommendation and Implementation

This analysis strongly recommends moving forward with On-Bill Financing (OBF) as the preferred policy alternative. OBF excels in equitably enhancing residential energy efficiency, directly addressing market inefficiencies that widen the energy efficiency gap. It aligns with Charlottesville’s goals to improve access to energy-efficient solutions in both affordable and renter-occupied housing, as stated in the city’s Climate Action Plan.

To implement OBF, a detailed proposal should be developed, including a clear timeline and program specifics. Initial discussions should involve key stakeholders in the city government, particularly those in the Environmental Sustainability Division, to refine the proposal and ensure feasibility. Following stakeholder consultations, the proposal should be presented to Charlottesville Gas and relevant city departments such as the Office of Budget and Performance Management, the Department of Finance, and the Utility Billing Office to secure support and integrate the program into the city’s FY 2022 budget.

Additionally, an information campaign should be launched to educate residents about the program's benefits and encourage participation, particularly among low-income and cost-burdened households. Effective marketing and engagement strategies will be critical to achieving desired participation rates. Given potential funding challenges, especially in light of the COVID-19 pandemic’s economic impact, alternative funding strategies should be considered if city council prioritization shifts. Exploring partnerships with financial institutions or adapting the proposal for other municipal utilities may provide viable alternatives.

6.2 Limitation

Residential energy efficiency financing programs are often evaluated qualitatively, focusing mainly on market penetration rates and features such as loan terms and interest rates. However, limited data on energy savings and market activity hampers comprehensive assessment of these programs' effectiveness [23][35].

A significant issue is the "rebound effect," where consumers use more energy following efficiency upgrades due to lower usage costs, leading to actual energy savings that are 5 to 40 percent lower than projected [18]. Additionally, the voluntary nature of these programs limits the ability to draw causal conclusions from their outcomes. Studies are typically quasi-experimental, and many participants might have pursued efficiency upgrades without financial incentives, complicating the measurement of the programs' true impact [19].

A study using a regression discontinuity design indicated that while subsidies increased participation, about 50 percent of participants would have invested in upgrades even without the subsidy, highlighting the challenge of ensuring that programs reach those who truly need financial support [41]. Policymakers need to carefully design these programs to target consumers who genuinely cannot afford or access upgrades on their own, maximizing the programs' intended benefits [40][41][42].

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