Equitable Green Financing for Sustainable Housing: Evaluating R-PACE and Alternative Policies

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Executive summary

The U.S. housing market grapples with the dual imperatives of affordability and sustainability intensifying as energy costs rise and climate risks grow. Programs must balance improving energy efficiency and disaster resilience with ensuring affordability and equity. The Residential Property Assessed Clean Energy (R-PACE) program emerges as a mechanism in this context, providing financing for energy upgrades and disaster mitigation through property tax assessments. This paper critically evaluates R-PACE and alternative financing mechanisms- Weatherization Assistance Program (WAP) and traditional home equity loans using three evaluation criteria—Financial Risk and Market Stability, Financial Accessibility and Equity, and Program Transparency and Administrative Efficiency. The study examines the strengths, limitations, and gaps of R-PACE, drawing on case studies in R-PACE from California, Florida, and Missouri, offering insights into program variations and their implications for low and medium income households.

The findings reveal that R-PACE offers a unique mechanism theoretically expanding access to underserved income groups. However, in practice, participation is skewed toward higher-income homeowners. Risks such as refinancing challenges, tax delinquency, and foreclosure pose significant threats to financial stability as well. The paper identifies key equity concerns and structural inequities in program design that disproportionately impact low and medium income households. Recommendations include equity-focused outreach, borrower safeguards to mitigate foreclosure risks, and centralized administrative models to enhance transparency and efficiency. Additional policies such as rent stabilization and utility cost-sharing can address tenant inequities. By integrating these reforms, R-PACE can evolve into a more inclusive and effective policy framework, filling critical gaps in existing financing mechanisms. This paper concludes that while R-PACE holds transformative potential for sustainable housing, its success depends on addressing its systemic challenges to achieve both sustainability and affordability in housing markets.

Introduction

Housing markets across the United States are progressively confronting the twin imperatives of affordability and sustainability, with the need to provide financially accessible housing while ensuring energy efficiency, environmental sustainability, and resilience to climate risks. As utilities and housing costs rise, low and medium income households face heightened financial pressures, often forcing trade-offs between basic needs and essential upgrades to their homes (Nelson & Gebbia, 2018; Taylor & Knuth, 2023). In regions where energy burdens, i.e. the share of household income spent on energy bills, can exceed 20% for vulnerable populations, retrofits and energy-saving upgrades are urgently needed to stabilize household budgets (J. Deason et al., 2021; Millar & White, 2024).

However, the financial burden of retrofits— which can range between $10,000 to $50,000 per home— often falls on those least able to afford them (Rose & Wei, 2020). Subsequently, many households sacrifice energy upgrades altogether, leading to worsening housing conditions and higher utility bills, compounding the risk of evictions and foreclosures (Grind, 2017). This tension between affordability and sustainability creates a cycle of financial vulnerability, where homes become energy-inefficient and costly to maintain, impacting both housing quality and economic stability. For instance, (Taylor & Knuth, 2023) show that Residential Property Assessed Clean Energy (R-PACE) financed hurricane mitigation projects in Florida enhance resilience but also raise property taxes, contributing to higher foreclosure risks for households already struggling to stay afloat. In California, PACE assessments—which are tied to property taxes and secured by super-lien status—have made it difficult for homeowners to refinance mortgages or sell properties, leading to financial distress and potential foreclosures (Brown et al., 2019; Millar & White, 2024). These challenges highlight a fundamental tension between improving housing quality through retrofits and maintaining affordability.

Moreover, renters, who are among the most economically vulnerable, often experience split incentives—landlords invest in property improvements, but the benefits, such as lower energy bills, may not always trickle down to tenants (J. Deason et al., 2022). Such policies can inadvertently contribute to low-carbon gentrification, where retrofitted homes become more expensive, displacing low-income tenants and compounding the risk of eviction (Boria, 2020; Grind, 2017). The uneven distribution of benefits across homeowners and renters reflects broader structural inequities in the housing market (Anjum, 2022).

This interaction between affordability, sustainability, and housing quality necessitates a careful policy response. Financing mechanisms like R-PACE aim to fill the gap by eliminating upfront costs, but they also introduce new risks—such as tax delinquency, foreclosure, and administrative burdens—that disproportionately impact low-income households (Rose & Wei, 2020). Additionally, the lack of public awareness and transparency around R-PACE has led to criticism of the program, further complicating its

adoption (Leonhardt & Acree, 2024). As the U.S. moves toward a net zero carbon future, policies like R-PACE are pivotal, but their long-term success hinges on striking the right balance between financial accessibility, market stability, and equity (Attia, 2018). The state of California, where PACE financing originated, has seen substantial increases in solar adoption and energy-efficient retrofits but has also encountered challenges such as tax delinquencies, foreclosure risks, and public resistance (Millar & White, 2024). In Florida, where R-PACE has expanded to include hurricane mitigation projects, the program has been both lauded for its disaster preparedness efforts and criticized for placing additional financial strain on homeowners (Taylor & Knuth, 2023).

The relevance of this paper lies in examining R-PACE as a financial mechanism as administered in various states (Florida, California, and Missouri), and adjacent alternative policies, in the realm to understand the implications of these policies from an equity lens. The literature reveals that R-PACE, while innovative in its approach to financing energy upgrades, disaster resilience, and renewable energy adoption, presents significant challenges that need to be carefully addressed through equitable program design. Evaluating R-PACE and adjacent policies through criteria encompassing financial risk and market stability, financial accessibility and equity, program transparency and administrative efficiency highlights both its strengths and limitations in achieving sustainable housing outcomes, thereby identifying its most effective implementation framework for the City of Atlanta.

Literature review

In this section, I first begin with defining and understanding "equity" from the literature, then I proceed to understand the aspects of housing problem from that lens, then I introduce the R-PACE financing and alternate policies/programs discussing their mechanisms, from there I set my evaluating criteria from the narrative created and issues identified. The three evaluation criteria for this paper are: Financial Risk and Market Stability, Financial Accessibility and Equity, and Program Transparency and Administrative Efficiency. These criteria are further fragmented to 7 sub-criteria to assess the programs in depth.

Equity in the Context of Housing and Green Financing

In the context of housing and green financing policies, equity refers to more than fairness; it encompasses distributional, procedural, and structural equity. Equity refers to the fair distribution of benefits and burdens associated with housing interventions across various income groups and demographic sector (Anjum, 2022). Distributional equity focuses on the fair allocation of benefits—such as reduced energy burdens—across income groups and marginalized communities (Anjum, 2022). Procedural equity ensures transparent access to financing and participation in decision-making, reducing barriers for low-income and minority households (Keeley & Benton-Short, 2018; Rempel et al., 2024). Structural equity addresses systemic barriers—such as discriminatory lending practices and access to affordable financing— that prevent historically disadvantaged populations

from accessing programs that promote energy efficiency and disaster resilience (Frischkorn & Waxman, 2024; Rempel et al., 2024).

In housing policy, equity intersects with environmental and energy justice, focusing on the ability of all residents to access safe, sustainable housing while mitigating risks of displacement or financial hardship (Rose & Wei, 2020). In particular, R-PACE programs aim to make energy-efficient upgrades more accessible by removing upfront financial barriers (Brown et al., 2019), but have often exacerbated existing inequities as low-income homeowners and renters remain disproportionately excluded due to design flaws in the program (J. Deason et al., 2022). In California, where R-PACE has been most widely implemented, studies show that wealthier homeowners have dominated program participation, while low-income households struggle to access the benefits (J. Deason et al., 2022; Rose & Wei, 2020). Similarly, procedural equity has been undermined by misleading marketing practices, leaving homeowners unaware of the long-term financial commitments involved (Grind, 2017). Understanding equity from this lens highlights the need for policy mechanisms that align environmental goals with housing affordability, ensuring that the benefits of energy savings, disaster resilience, and increased property values do not exacerbate existing social inequalities (Taylor & Knuth, 2023).

Aspects of the Housing Problem through the Lens of Equity

The housing affordability crisis in the U.S. has worsened over recent decades, with rising housing costs outpacing wage growth, disproportionately affecting low and medium income households (Millar & White, 2024). The housing market is characterized by high energy burdens, rising utility costs, gentrification, and foreclosure risks (Boria, 2020; Nelson & Gebbia, 2018). For low and medium income households, high energy bills represent a significant financial burden, often forcing families to choose between essential needs and utility payments (J. Deason et al., 2021). Many low income households reside in energy-inefficient homes with high utility bills. Studies indicate that upgrading homes to meet energy-efficiency standards through retrofits can reduce these energy burdens (Nelson & Gebbia, 2018). Retrofitting homes with energy-efficient appliances, solar panels, and insulation offers long-term savings, but the upfront costs create barriers to participation for vulnerable populations (Leonhardt & Acree, 2024; Taylor & Knuth, 2023). These challenges are compounded by split incentives between renters and landlords—landlords may not invest in energy upgrades, knowing tenants will benefit from reduced energy costs (J. Deason et al., 2022).

Further complicating the housing crisis is the impact of disaster risks on housing affordability and stability. Another critical issue is the risk of foreclosure and tax delinquency associated with financing upgrades through R-PACE. Property owners who cannot sustain higher property tax payments face an increased risk of financial distress and loss of their homes (Rose & Wei, 2020). Additionally, super-lien provisions—which give R-PACE loans priority over mortgages—further complicate refinancing and property transactions, creating market liquidity issues (Millar & White, 2024). Florida's hurricane

mitigation R-PACE program has enabled homeowners to fortify their homes against natural disasters, but the accompanying increase in property tax assessments has pushed many households closer to tax delinquency and foreclosure (Taylor & Knuth, 2023). In California, PACE assessments tied to property taxes have created market friction, making it difficult for homeowners to refinance their mortgages or sell their properties (Leonhardt & Acree, 2024). These challenges highlight the tension between improving housing quality and maintaining affordability, particularly for those least able to bear the financial burden (Millar & White, 2024).

Tenants also face indirect consequences of housing upgrades. While landlords benefit from increased property values and reduced energy costs, renters often do not receive corresponding reductions in rent or utility bills (J. Deason et al., 2021). This split incentive problem exacerbates economic disparities and limits the trickling down of benefits to vulnerable populations (Taylor & Knuth, 2023). Housing policy solutions that promote energy efficiency and disaster preparedness must therefore be designed to mitigate foreclosure risks, ensure tenant benefits, and align with housing affordability goals.

Understanding the target policy – R-PACE

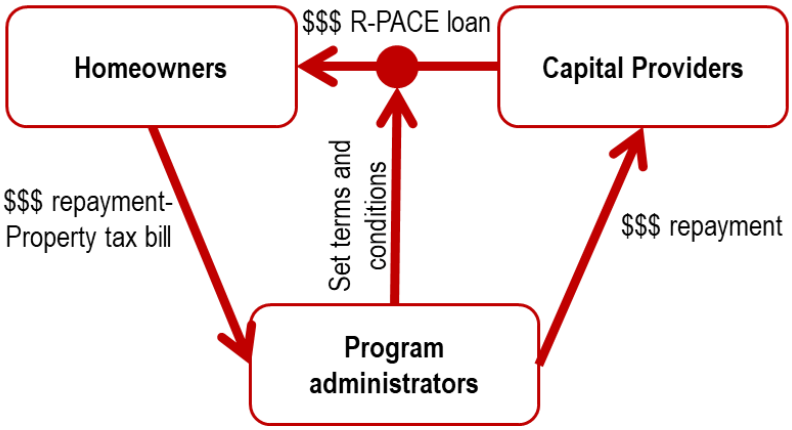

Figure 1 Capital flow and mechanism of R-PACE

The R-PACE program offers a unique financing mechanism for homeowners, enabling them to fund energy efficiency upgrades, renewable energy systems, and disaster mitigation retrofits through property tax assessments rather than traditional loans. Unlike conventional financing, R-PACE loans are attached to the property, not the individual borrower, allowing the repayment obligation to transfer to subsequent property owners upon sale (Rose & Wei, 2020). This design theoretically makes R-PACE more accessible to homeowners with limited access to traditional credit, as it eliminates credit score

requirements and upfront payments (Brown et al., 2019; Millar & White, 2024). Instead, the loan amount is repaid through annual property tax bills over a set term, often spanning 10 to 30 years (J. Deason et al., 2021). Additionally, since the loan is paid back via property taxes, the risk accruing to the lenders is low and hence these loans have a much lower interest rate as well.

Several quirks and caveats set R-PACE apart from traditional financing mechanisms. The super-lien status of R-PACE loans gives them priority over existing mortgages in the event of default, complicating refinancing and property transactions, as mortgage lenders and potential buyers may perceive the property as a higher financial risk (Kennedy et al., 2020; Leonhardt & Acree, 2024). This reduced market liquidity can create significant financial challenges for homeowners seeking to sell or refinance their properties (Grind, 2017). Furthermore, because R-PACE loans are secured through property taxes, they carry the risk of tax delinquency, which can lead to foreclosure if payments are missed (Taylor & Knuth, 2023).

Another distinction surfacing from literature is the administrative costs involved in R-PACE financing. While traditional loans are often overseen by regulated financial institutions with clear underwriting processes, R-PACE programs operate through public-private partnerships that rely on contractors and private lenders to market the program. This, in the past, has led to misleading sales practices and information asymmetries, with homeowners sometimes unaware of the full scope of their financial commitments (Grind, 2017; Millar & White, 2024). Additionally, while traditional loans provide borrowers with federal consumer protections, such as the Truth in Lending Act, R-PACE financing initially lacked equivalent regulatory oversight, exposing homeowners to higher risks (Rose & Wei, 2020). Recent reforms in states like California have introduced consumer protection measures and transparency requirements, but challenges remain (Leonhardt & Acree, 2024).

Thus, while R-PACE provides a flexible, accessible financing option for energy upgrades, it introduces significant caveats—particularly related to liquidity, refinancing risks, and administrative burdens. Moreover, public perception of R-PACE has been marred by misleading marketing practices, with many homeowners unaware of the financial implications until they encounter difficulties refinancing or selling their homes (Brown et al., 2019; Grind, 2017).

State wise variations in R-PACE

The R-PACE program has taken root in several U.S. states, each tailoring the program to meet local environmental challenges and market conditions.

California, as the pioneer of R-PACE, introduced the program in 2008 to encourage energy efficiency and solar energy adoption. The state's early success with R-PACE is attributed to strong municipal support and the alignment of the program with California's

ambitious climate goals (Millar & White, 2024). R-PACE has been particularly effective in driving solar panel installations and improving energy efficiency in residential properties, with some counties reporting a tripling of solar installations after the program's implementation (Ameli et al., 2017). However, the program faced public backlash due to the super-lien status of loans, which complicated refinancing and home sales, prompting the state to introduce consumer protection reforms through Senate Bill 555 (Leonhardt & Acree, 2024; Liaw, 2024). These reforms enhanced underwriting requirements and transparency, ensuring homeowners fully understood the financial commitments involved (Millar & White, 2024).

In Florida, R-PACE was adapted to meet the state's disaster mitigation needs. The program finances hurricane-resistant upgrades, such as impact-resistant windows and roof reinforcements, making it especially relevant in a region prone to severe weather events (Taylor & Knuth, 2023). Florida's success with R-PACE lies in its ability to integrate the program with disaster preparedness initiatives, creating dual benefits of energy efficiency and resilience. However, the program has also encountered challenges, with homeowners reporting increased tax obligations leading to delinquencies (Rose & Wei, 2020). In response, some Florida municipalities have introduced educational campaigns to improve public awareness and trust in the program, ensuring participants are better informed about repayment obligations (Taylor & Knuth, 2023).

Missouri offers another unique case, where R-PACE was deployed in smaller cities and rural areas to support energy-efficient retrofits in older housing stock. While the program has not reached the same scale as in California or Florida, Missouri's approach demonstrates the potential for small-scale R-PACE programs to succeed by addressing specific regional needs (Rose & Wei, 2020). The state has focused on streamlining administrative processes to reduce costs and make the program more accessible to low-income households, offering valuable insights into the importance of administrative efficiency for scaling such initiatives (Millar & White, 2024).

Alternate policies and programs

Several financing mechanisms exist alongside R-PACE loans, each with distinct operational structures, benefits, and drawbacks. These alternatives address specific housing challenges, such as energy burden reduction, access to renewable energy, and financial barriers, but differ from R-PACE in their design and accessibility.

1. The Weatherization Assistance Program (WAP) provides grants for energy retrofits, specifically targeting low-income households to lower energy burdens through measures like insulation upgrades, window replacements, and HVAC improvements (J. Deason et al., 2022). Unlike R-PACE loans, WAPs do not create additional debt obligations or repayment burdens for participants, promoting distributional equity by ensuring that vulnerable households benefit from energy savings. However, WAPs are limited in scale due to budget constraints and eligibility requirements, often resulting

in administrative bottlenecks and delays in service delivery (Nelson & Gebbia, 2018). Additionally, because WAPs focus primarily on low-income households, they may not address broader community needs for sustainability upgrades (J. Deason et al., 2022).

2. Community solar programs offer shared access to renewable energy installations, allowing renters and homeowners to benefit from solar energy without installing panels on their individual properties (Winecoff & Graff, 2020). These programs promote inclusiveness by removing the ownership barrier, making renewable energy available to renters, who are often excluded from PACE-financed upgrades. However, community solar participants generally do not receive the full economic benefits of individual solar ownership, as the savings are shared among multiple users. Additionally, the administrative complexity of managing shared installations and the variability of solar output can limit the predictability of savings for participants (Winecoff & Graff, 2020).
3. Traditional home equity loans provide capital to homeowners by leveraging their property's equity, typically requiring high credit scores and significant financial stability (Rose & Wei, 2020). These loans allow homeowners to access funds for energy upgrades with lower interest rates compared to unsecured financing. However, unlike R-PACE loans, which tie repayment to property taxes, home equity loans are repaid monthly and create additional debt burdens. This structure can exclude low-income homeowners with limited equity or credit issues, highlighting a critical accessibility gap in traditional financing options (Leonhardt & Acree, 2024). Furthermore, because home equity loans remain tied to the borrower, they do not transfer with property ownership as R-PACE obligations do, making them less attractive for homeowners planning to sell their properties in the near future (Rose & Wei, 2020).
4. The Residential Energy Efficiency Tax Credit incentivizes homeowners to invest in energy-efficient upgrades by offering tax breaks for eligible improvements (Taylor & Knuth, 2023). While this policy reduces the net cost of energy retrofits, it differs from R-PACE by requiring homeowners to cover the full cost of upgrades and then claim the tax credit during the next tax cycle. This structure creates cash flow challenges for low-income households that cannot afford the upfront investment, even with the promise of a tax refund (J. Deason et al., 2021). Additionally, complex application processes and limited public awareness have constrained the uptake of these tax incentives, especially among vulnerable populations (Taylor & Knuth, 2023).

These alternatives to R-PACE financing offer unique benefits and limitations, ranging from non-debt-based solutions like WAPs and community solar to debt-financing options such as home equity loans and tax credits. While they address specific challenges in energy retrofitting and access to renewable energy, they differ from R-PACE in terms of administrative complexity, repayment structures, and inclusivity.

Evaluation Criteria

In this sub-section, I discuss various criteria under larger themes, based on which I will evaluate the R-PACE program across states and other adjacent programs in the US.

The three major themes are: Financial Risk and Market Stability, Financial Accessibility and Equity, and Program Transparency and Administrative Efficiency. These themes capture critical aspects of the program's impact. Financial Risk and Market Stability assesses risks like liquidity issues, tax delinquency, and property value changes. It explores the extent to which R-PACE creates or mitigates financial instability for participants and the housing market at large. Financial Accessibility and Equity evaluates the equitability of financing access for various income groups and the extent to which the benefits of R-PACE improvements trickle down to tenants in rental properties. This theme aims at inclusivity and the equitable distribution of benefits across different demographic and socio-economic groups. Program Transparency and Administrative Efficiency addresses the clarity and awareness of R-PACE's terms and conditions among participants and examines the administrative burdens associated with applying for and managing R-PACE financing. This theme evaluates how effectively the program is communicated and managed, and how these factors influence stakeholder participation and satisfaction.

Access to Financing for Different Strata

Access to financing is a crucial criterion for evaluating housing programs like R-PACE. R-PACE loans offer unique access by eliminating credit score requirements and upfront payments, theoretically expanding financing to low and medium income households (Kennedy et al., 2020; Rose & Wei, 2020). However, the actual distribution of loans indicates that higher-income households are more likely to participate, leaving many low income homeowners unable to access the benefits due to lack of awareness and trust in the program (J. Deason et al., 2022; J. A. Deason, 2022) In contrast, programs such as the Weatherization Assistance Program (WAP) provide direct grants for retrofits, ensuring participation by the most vulnerable populations, though at a smaller scale due to limited funding (Nelson & Gebbia, 2018). Similarly, community solar programs address equity concerns by offering renters and homeowners access to renewable energy without installation costs, though the financial benefits are more modest compared to individual ownership (Winecoff & Graff, 2020).

Impact on Property Values

One of the promises of programs like R-PACE financing is the potential for increased property values through energy upgrades and disaster mitigation (Bjørneboe et al., 2018; Brown et al., 2019). Research from California shows that properties with R-PACE-financed improvements, such as solar panels and efficient HVAC systems, often see appreciation in value (Goodman & Zhu, 2016). PACE-funded home improvement projects in Florida are capitalized into home values, increasing property prices by an average of 27% (Bellon et al., 2024). However, the expansion of the property tax base is partially offset by an increase in tax delinquency rates among borrowers (Bellon et al., 2024). Thus, studies also caution that the imposition of liens and higher property tax burdens could deter buyers, offsetting the benefits of increased energy efficiency (Bellon et al., 2024; Rose & Wei, 2020). Moreover, gentrification risks emerge when property upgrades raise values in

ways that displace low income tenants (Boria, 2020; Grind, 2017), a trend observed in regions with aggressive PACE adoption (Taylor & Knuth, 2023). Balancing value appreciation with affordability is critical for ensuring the long-term sustainability of R-PACE and similar programs.

Liquidity and Refinancing

A recurring challenge with R-PACE loans is the impact on property liquidity and refinancing. Because R-PACE loans attach to the property and hold super-lien status, they take precedence over existing mortgages in the event of default, complicating mortgage refinancing and property sales (Leonhardt & Acree, 2024; Liaw, 2024). Studies from California highlight how some homeowners, unaware of the lien implications, encounter difficulties refinancing or selling their properties, creating financial stress (Millar & White, 2024). In contrast, traditional home equity loans, while not tied to property taxes, also introduce liquidity risks as they require strong credit scores and sufficient home equity, making them inaccessible to many households (Rose & Wei, 2020). These structural differences emphasize the need for R-PACE programs to balance accessibility with flexibility in refinancing and property transactions.

Tax Delinquency and Risk of Foreclosure

R-PACE's repayment model, through property tax assessments, introduces significant risks related to tax delinquency and foreclosure (Kennedy et al., 2020). As property taxes increase to cover loan repayments, low income households face heightened risks of delinquency and foreclosure if they cannot meet the higher tax obligations (Bellon et al., 2024; Millar & White, 2024). This issue is particularly acute in Florida, where PACE loans used for disaster mitigation have led to complaints about unexpected tax burdens and foreclosure risks (Taylor & Knuth, 2023). In comparison, WAPs and community solar programs avoid these risks by subsidizing costs directly or spreading payments across multiple participants, reducing financial strain on individual households (J. Deason et al., 2022). These programs express minimizing financial risks to ensure long-term participation and equity.

Tenant Impact and Benefits Trickling Down

The split incentive problem—where landlords benefit from property upgrades, but tenants do not receive corresponding reductions in utility bills or rents—remains a persistent challenge in housing programs (J. Deason et al., 2021). While R-PACE-financed improvements can enhance energy efficiency and property value, renters rarely experience these benefits directly, as the savings are not always passed on through rent reductions (Taylor & Knuth, 2023). Similarly, traditional loan mechanisms that focus on property owners do little to address tenant needs. In contrast, community solar programs provide renters with access to renewable energy savings, although the financial benefits remain limited compared to direct upgrades (Winecoff & Graff, 2020). Equity gaps must be filled

to ensure that the benefits from housing improvements and financial programs such as R-PACE trickle down to the tenant population.

Program Awareness and Transparency

Transparency and public awareness are essential for ensuring broad participation in housing programs like R-PACE. However, studies show that many homeowners enter R-PACE agreements without fully understanding the financial implications, leading to dissatisfaction and mistrust (Grind, 2017). Misleading marketing practices by contractors have compounded these issues, prompting states like California to introduce consumer protection reforms to improve transparency (Millar & White, 2024). Similar concerns exist in other programs, such as the Residential Energy Efficiency Tax Credit, where complex eligibility requirements and limited awareness hinder participation among low-income households (Taylor & Knuth, 2023). By comparison, WAPs and community solar programs benefit from clearer administrative processes, though limited outreach efforts still constrain participation (J. Deason et al., 2022).

Administrative Burdens and Costs

The administrative efficiency of housing programs plays a crucial role in their success. R-PACE programs operate through public-private partnerships, often resulting in complex administrative processes and higher costs for participants(Leonhardt & Acree, 2024). While contractor-driven marketing can enhance program reach, it also introduces risks of fraud and miscommunication (Grind, 2017). Similarly, the Residential Energy Efficiency Tax Credit faces administrative challenges, with application complexities limiting uptake among eligible participants (Taylor & Knuth, 2023). In contrast, WAPs are designed with simpler processes but are constrained by limited funding, which reduces their impact and reach (Nelson & Gebbia, 2018). Community solar programs also face administrative hurdles related to the coordination of multiple participants, but they offer lower individual costs by spreading expenses across subscribers (Winecoff & Graff, 2020).

Policy Evaluation

In this section, I examine the potential effects of the R-PACE program from the aforementioned three evaluation criteria: Financial Risk and Market Stability, Financial Accessibility and Equity, and Program Transparency and Administrative Efficiency. By analyzing R-PACE's strengths, limitations, and gaps relative to these alternatives, I identify what the program excels at, where it falls short, and the gaps it fills in the realm of housing in energy efficiency financing. Furthermore, I explore the potential of R-PACE to address underserved areas and provides policy recommendations to enhance its design and implementation. This comparative analysis serves to inform policymakers on how to maximize the program’s benefits while mitigating its risks.

Potential Effects of R-PACE

The R-PACE program holds significant promise in addressing financing gaps for energy-efficient housing improvements, especially for lower- and medium-income households. Unlike mechanisms such as the Weatherization Assistance Program (WAP) or home equity loans, R-PACE eliminates credit score barriers, providing broader theoretical accessibility. However, its practical application reveals critical challenges and limitations.

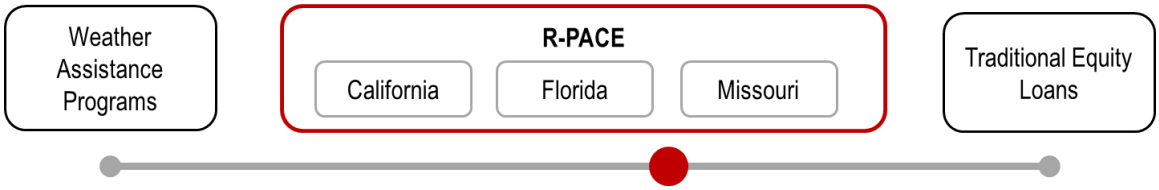

Figure 2 R-PACE fills the gap between WAPs and Traditional Equity Loans

Access to financing energy-efficient upgrades varies significantly across existing programs, highlighting gaps in meeting the needs of different income group homeowners. WAPs directly target low-income populations (families with incomes at or below 200% of the federal poverty level), prioritizing those most vulnerable to high energy burdens (J. A. Deason, 2022). This eligibility restriction ensures resources are allocated to those in need, effectively reducing energy burdens and improving living conditions for low-income households. Additionally, grant programs such as WAP face funding limitations and hence a limited scale of benefits (J. Deason et al., 2022). On the other end, traditional home equity loans, while accessible to higher-income groups, exclude financially vulnerable homeowners due to their stringent credit requirements (Rose & Wei, 2020). Positioned between these two alternatives, R-PACE bridges, and has the potential to bridge, the gap by eliminating credit score barriers and upfront costs with a long term lower interest rate loan, theoretically making financing accessible to lower and medium income households- that earn enough to not qualify for grant programs for green financing like WAP, but lower to not qualify for traditional equity loans either.

Table 1 Evaluation rubric for comparison of various programs based on the set evaluation criteria.

Themes	**Financial Risk and Market Stability**			**Financial Accessibility and Equity**		**Program Transparency and Administrative Efficiency**	
Program/ criteria	***Liquidity and Refinancing***	***Tax Delinquency and Risk of Foreclosure***	***Impact on Property Values***	***Access to Financing for Different Strata***	***Tenant Impact and Benefits Trickling Down***	***Program Awareness and Transparency***	***Administrative Burdens and Costs***
R-PACE (California)	R-PACE programs in California have significantly impacted property liquidity due to their super-lien status, which prioritizes loan repayment over mortgage obligations. This has caused refinancing complications, especially for homeowners unaware of lien implications (Leonhardt & Acree, 2024). The property tax-based repayment model of R-PACE introduces significant foreclosure risks, particularly for low-income homeowners who struggle with increased tax obligations. California's consumer protection reforms, including underwriting requirements, have mitigated some of these risks but have not eliminated them (Millar & White, 2024). R-PACE programs in California have been shown to enhance property values by funding energy-efficient and disaster-resilient upgrades (Goodman & Zhu, 2016).			R-PACE removes credit score barriers, theoretically expanding access to low-income homeowners. However, data from California and Florida show that higher-income groups dominate participation due to better awareness and trust in the program (Brown et al., 2019; J. Deason et al., 2022). The split incentive problem is prevalent in R-PACE programs, where landlords benefit from property upgrades, but renters do not receive corresponding utility savings. California's regulatory reforms have attempted to address these concerns but have not fully resolved them (Leonhardt & Acree, 2024).		California has made strides in improving R-PACE transparency through legislative reforms, requiring clear disclosures and underwriting standards (Millar & White, 2024). However, misinformation and aggressive contractor practices remain a challenge, as seen in Florida, where many homeowners report confusion about loan terms (Taylor & Knuth, 2023). California's centralized regulatory framework has reduced some of these burdens but still faces challenges in scaling the program efficiently (Millar & White, 2024).	

Themes	Financial Risk and Market Stability			Financial Accessibility and Equity		Program Transparency and Administrative Efficiency	
Program/ criteria	*Liquidity and Refinancing*	*Tax Delinquency and Risk of Foreclosure*	*Impact on Property Values*	*Access to Financing for Different Strata*	*Tenant Impact and Benefits Trickling Down*	*Program Awareness and Transparency*	*Administrative Burdens and Costs*
R-PACE (Florida)	Similar challenges of liquidity are reported in Florida, where the integration of hurricane mitigation retrofits into R-PACE financing adds complexity to refinancing processes (Taylor & Knuth, 2023). In Florida, the property tax-based repayment model of R-PACE has resulted in higher rates of tax delinquency and foreclosure (Taylor & Knuth, 2023). In Florida, rising property tax assessments linked to R-PACE loans have deterred buyers, offsetting potential property value			This issue of split incentive problem- where landlords benefit from property upgrades, but renters do not receive corresponding utility savings- is particularly evident in Florida, where rising property taxes exacerbate tenant displacement risks (Taylor & Knuth, 2023).		The decentralized administration of R-PACE programs often results in high administrative costs and inefficiencies, particularly in states like Florida, where multiple contractors are involved (Taylor & Knuth, 2023).	
R-PACE (Missouri)	Missouri's smaller-scale R-PACE program appears to have fewer liquidity challenges, thanks to simpler administrative processes (Millar & White, 2024). Missouri has reported more stable property value impacts, likely due to the program's smaller scale and targeted application (Rose & Wei, 2020).			Missouri's simplified administrative model has improved access for low-income households but remains limited in scope (Millar & White, 2024).		Missouri's simpler program structure has improved transparency but lacks the comprehensive consumer protections seen in California (Rose & Wei, 2020). Missouri has minimized administrative costs by focusing on smaller-scale implementations and streamlined processes (Rose & Wei, 2020).	

Themes	Financial Risk and Market Stability			Financial Accessibility and Equity		Program Transparency and Administrative Efficiency	
Program/ criteria	*Liquidity and Refinancing*	*Tax Delinquency and Risk of Foreclosure*	*Impact on Property Values*	*Access to Financing for Different Strata*	*Tenant Impact and Benefits Trickling Down*	*Program Awareness and Transparency*	*Administrative Burdens and Costs*
Weatherization Assistance Program (WAP)	In contrast, WAPs avoid these risks entirely by providing grants rather than loans, ensuring that participants do not face additional financial burdens (J. Deason et al., 2022). WAPs, by contrast, eliminate foreclosure risks as they do not impose repayment obligations (Nelson & Gebbia, 2018). WAPs also contribute to property value appreciation by improving energy efficiency without increasing tax liabilities (J. Deason et al., 2022).			WAPs directly target low-income populations, ensuring equity in participation but face funding constraints (Nelson & Gebbia, 2018). WAP has specific eligibility criteria that focus on low-income households. WAP targets families with incomes at or below 200% of the federal poverty level, prioritizing those most vulnerable to high energy burdens (Deason et al., 2022). Additionally, WAP's scale of benefits is also smaller due to funding limitations due to it being a grant program (J. Deason et al., 2022).		WAPs excel in transparency due to their direct grant-based model but suffer from low public awareness due to limited outreach efforts (J. Deason et al., 2022). WAPs face significant administrative bottlenecks due to limited resources and high demand, delaying service delivery (Nelson & Gebbia, 2018).	
Traditional Home Equity Loans	Traditional home equity loans, while not tied to property taxes, also affect liquidity by requiring substantial creditworthiness, excluding many low-income homeowners (Rose & Wei, 2020). Traditional home equity loans are less prone to foreclosure risks but require substantial financial stability, which limits their accessibility for low-income groups (Rose & Wei, 2020). Traditional home equity loans, while increasing property values through similar upgrades, do not share R-PACE's risks related to tax assessments but exclude low-income homeowners from participating (Rose & Wei, 2020).			Traditional home equity loans, while accessible to higher-income groups, exclude financially vulnerable homeowners due to stringent credit requirements (Rose & Wei, 2020). Traditional home equity loans do not address tenant benefits directly, as they are tied to property ownership (Rose & Wei, 2020).		Traditional home equity loans benefit from established financial regulations but are less transparent in terms of eligibility and application processes for vulnerable populations (Leonhardt & Acree, 2024). Traditional home equity loans, administered through established financial institutions, are more efficient but less flexible in accommodating low-income applicants (Rose & Wei, 2020).	

This program represents an innovative financing mechanism that combines the goals of promoting energy efficiency, enhancing disaster resilience, and enabling property owners to make critical upgrades. Exceling in addressing upfront cost barriers, it enables property owners to finance energy-efficient upgrades and disaster-resilience improvements through property tax assessments. This design removes traditional creditworthiness constraints, expanding theoretical accessibility to low and medium income households. However, in practice, the program often skews toward wealthier participants with greater financial literacy equipped to manage financial risks, as seen in California and Florida (Brown et al., 2019; Taylor & Knuth, 2023). The lack of targeted outreach efforts and public education campaigns has further exacerbated inequities, leaving many vulnerable groups unaware or mistrustful of the program. To realize its full potential, R-PACE must integrate both people-focused and place-based strategies, ensuring tailored outreach and support for underserved communities. Further, there is a requirement for guardrails for homeowners that may engage in the program without complete knowledge and have a risk of foreclosure due to not being able to pay.

The reliance on property tax systems for repayment presents a double-edged sword for R-PACE. The super-lien status of R-PACE loans, which prioritizes their repayment over existing mortgages, reduces risk for capital providers and ensures lower interest rates while introducing financial risks for participants, such as tax delinquency and foreclosure. These risks are particularly pronounced in California and Florida, where participants often underestimate the financial implications of the program (Leonhardt & Acree, 2024). Missouri's smaller-scale implementation demonstrates fewer instances of these risks but limits its scalability and impact (Rose & Wei, 2020). Despite its challenges, R-PACE's attachment to property tax assessments allows for long-term loans—aligned with the lifespan of energy-efficient improvements—making financing more affordable. The path to ameliorating the risk of increased financial risk for borrowers is to heighten literacy about the program, transparency and administrative efficiency. Transparency and administrative efficiency remain pressing concerns for R-PACE. In California, legislative reforms mandating clear disclosures have improved program transparency, but aggressive contractor practices and complex loan terms continue to undermine public trust (Leonhardt & Acree, 2024). Florida's efforts to improve program awareness through educational campaigns have not adequately addressed mistrust among low-income participants (Taylor & Knuth, 2023). Missouri provides a potential model for improvement, with its streamlined program structure fostering better public understanding and reducing administrative variability (Rose & Wei, 2020). A centralized administrative model, like WAP's structure, could enhance transparency, standardize implementation, and reduce misuse.

An area where R-PACE shows mixed outcomes is its impact on property values. In California, energy-efficient upgrades funded by R-PACE have increased property values enhancing their market appeal, particularly through the installation of solar panels and disaster-resilient features. However, this benefit is often offset by higher tax assessments, which deter potential buyers in low-income areas. Florida demonstrates a similar pattern, where disaster-resilience retrofits increase home values but create affordability challenges

(Taylor & Knuth, 2023). Missouri's limited program size makes it difficult to draw strong conclusions about its impact on property values.

The split incentive problem further highlights the limitations of R-PACE, particularly for renters. In many cases, landlords benefit from property upgrades while tenants face higher rents without receiving corresponding utility savings. This issue is pronounced in California and Florida, where tenant displacement and affordability concerns have been reported (Boria, 2020; Grind, 2017). For R-PACE to fulfill its equity goals, policies must be implemented to ensure that renters benefit directly from energy upgrades, such as utility cost-sharing or rent stabilization measures. There could be underwriting ensured to oversee that savings trickle down to the tenants as well.

Recommendations for R-PACE Improvement

To maximize R-PACE's potential while addressing its limitations, targeted reforms are necessary. First, equity-focused outreach efforts must be prioritized. Tailored campaigns should be developed to engage underserved communities, particularly lower and medium income households. Collaborations with local organizations and community groups can enhance program awareness and trust, ensuring more equitable participation. Second, borrower safeguards must be implemented to mitigate foreclosure risks and tax delinquency. Mandatory financial counseling sessions and improved financial literacy initiatives can ensure participants fully understand the implications of the program. Streamlined processes, such as uniform loan terms and rigorous contractor oversight, can further protect participants from financial pitfalls. Additionally, deferred repayment options for households experiencing financial hardships can enhance housing stability. Third, administrative centralization should be considered to improve program transparency and efficiency. A city or state administered model, like WAP, could standardize implementation, reduce contractor-driven variability, and ensure compliance with program standards. Uniform disclosure requirements, third-party audits, and robust oversight mechanisms would enhance public trust and reduce misuse. Missouri's simpler administrative model offers valuable insights into achieving this balance. Fourth, addressing the split incentive problem is critical to ensuring equitable benefits for renters. Policies such as rent stabilization, utility cost-sharing agreements, or performance-based landlord incentives can ensure tenants share in the savings generated by energy-efficient upgrades. Additionally, underwriting standards could prioritize retrofits that directly reduce tenant utility costs, furthering program inclusivity in rental markets. Finally, scalability and sustainability should remain central to R-PACE's evolution. Policymakers must balance the program's innovative features with mechanisms that address its risks, ensuring it remains accessible and effective across diverse income groups. By incorporating lessons from WAP and traditional loans, R-PACE can become a more comprehensive and equitable solution for financing energy efficiency in housing.

Despite its challenges, R-PACE fills critical gaps in traditional financing mechanisms. Its ability to fund energy retrofits without upfront costs addresses a major

barrier for many homeowners, particularly in areas prone to climate risks. R-PACE bridges the gap between existing policies such as WAP and Traditional equity loans by offering a scalable model that, with appropriate reforms, could serve a wider demographic. To enhance its effectiveness and equity, several policy recommendations are necessary and must be taken into account. By learning from the strengths of WAP and addressing its own limitations, R-PACE can evolve into a more inclusive, transparent, and effective policy framework. This approach is particularly critical as cities like Atlanta consider implementing such programs to meet their energy and housing goals.

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