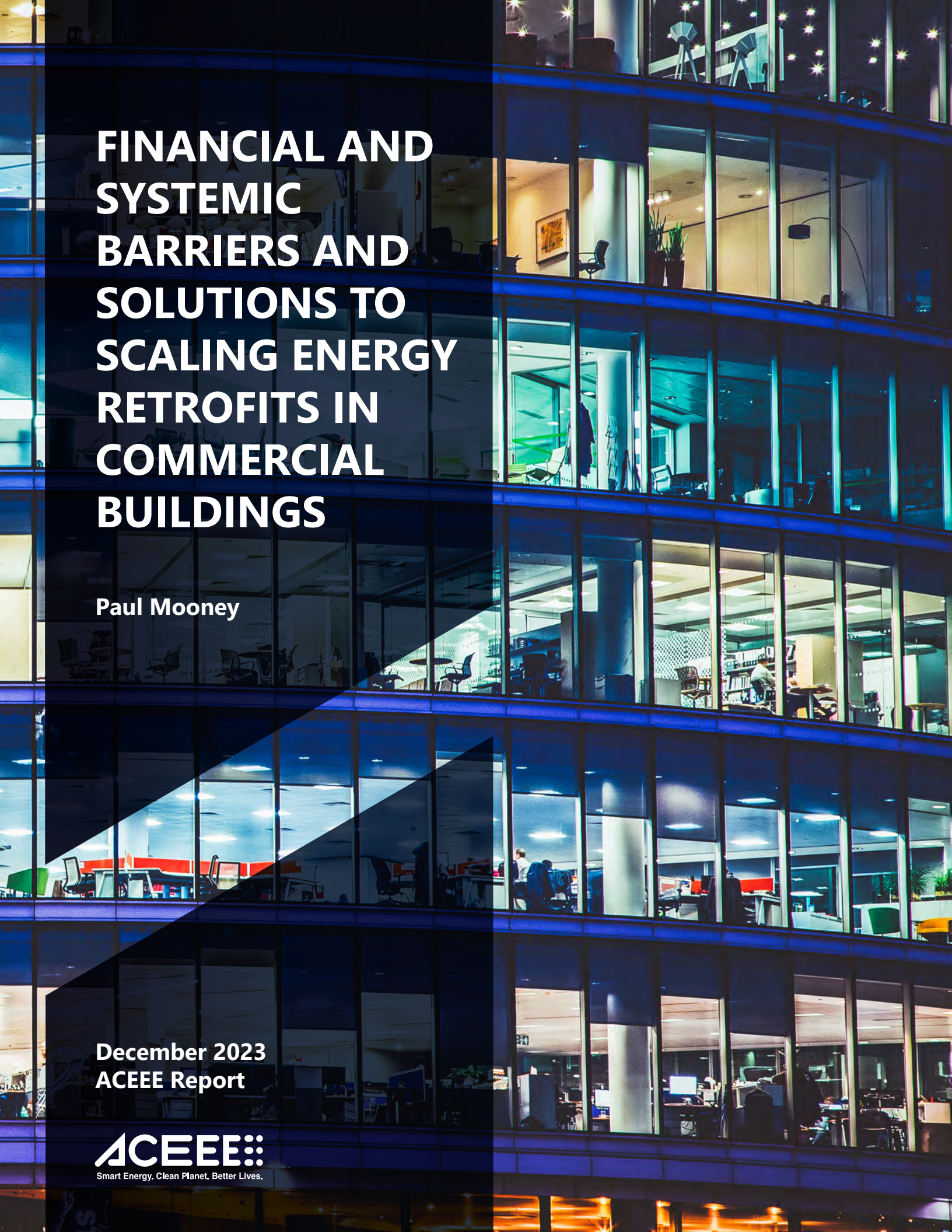

FINANCIAL AND SYSTEMIC BARRIERS AND SOLUTIONS TO SCALING ENERGY RETROFITS IN COMMERCIAL BUILDINGS

Paul Mooney

December 2023
ACEEE Report

ACEEE
Smart Energy. Clean Planet. Better Lives.

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About ACEEE

The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

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Executive Summary

KEY FINDINGS

- The lagging adoption of energy efficiency in commercial buildings is due to the structure of the commercial real estate and finance sectors, in which separate actors do not cooperate to reduce consumption.
- The alternative financing options and business models available on the market do not fix these fundamental barriers, and thus retrofits in commercial buildings remain uncommon despite their proven financial advantages.
- Overcoming these challenges requires the separate actors to have common interests, which can be accomplished through collaboration, stronger regulations, and more complete information sharing among utilities, real estate investors, governments, and employees.

Energy efficiency (EE) improvements to existing buildings, often referred to as retrofits, are critical to reducing emissions. Reducing energy consumption in commercial buildings must be approached in a way that accounts for differences in how they are owned and operated compared to residential ones. Taking a structural look at the commercial real estate (CRE) and finance sectors, what quickly emerges are the conflicting interests of separate entities, whether between firms, within firms, or between different owners at different times. While financing and business models aimed at easing adoption of EE have enabled many retrofits so far, structural barriers remain, suggesting that business innovation alone cannot decarbonize the building sector. Rather, the interests of these separate entities—that is, building owners, financial institutions, governments, and utilities—must be aligned for this change to occur. To help unite the interests of these separate actors, we suggest five strategies:

- Use existing relationships between businesses such as downtown associations or business improvement districts (BIDs) to address multiple building owners at the same time.
- Create a collaborative national database for industry stakeholders to share usage and cost information, allowing transparent information sharing and encouraging more adoption of EE.
- Facilitate greater transparency in permitting to identify opportunities to retrofit buildings without disruption to tenants.
- Use community development financial institutions (CDFIs) to allow utilities to originate EE loans with less administrative burden.
- Leverage the federal government's status as a guarantor of mortgages to set environmental standards for investment portfolios.

This report is intended for three audiences. The first is utilities seeking to design effective programs to promote and finance retrofits. Designing EE programs that inspire client participation requires understanding the challenges of EE in the CRE industry. It also requires understanding the motivations of utilities' clients as firms, as well as understanding the firms as collections of individual employees with their own incentives. Because this report is primarily written for utilities, the section outlining potential solutions predominantly focuses on actions that utilities can take.

The second audience is people working in the CRE sector who wish to better understand the difficulties of adopting EE in the workplace. The third target is a general audience. The shortcomings of government finance detailed here have impacts ranging far wider than commercial building retrofits. Further, the CRE industry model explored here can be applied to other industries. The impact of firm structure on innovation is true in any workplace and does not apply only to retrofit initiatives. Finally, our critique of securitization as a decarbonization method has implications for other initiatives seeking to reduce carbon emissions through financial mechanisms.

Introduction

Improving energy efficiency (EE) in existing buildings is critical to saving energy and reducing carbon emissions. Increasing the number of comprehensive retrofits—that is, implementing building improvements that reduce energy use and adopting electrification measures in existing commercial buildings—is a core strategy for reducing U.S. carbon emissions by 50% by 2050 (Ungar and Nadel 2019). Many other co-benefits, such as improved health, resilience, and safety, offer building owners compelling reasons to invest and participate in building retrofit programs. Moreover, EE investments are financially competitive, with annual savings typically well above stock market returns. Despite the demonstrated monetary and non-monetary benefits, however, U.S. commercial buildings are not being retrofitted at the pace needed. This lag in EE investment is referred to as the energy efficiency gap (EEG).

The barriers to EE investment in commercial real estate (CRE) are well established. Dating back to the early 1970s, researchers have repeatedly noted how split incentives, a lack of information, and cost (expressed in high upfront cost, discount rates,[1] payback periods, etc.) stand in the way of drastically improving EE in buildings (Blumstein et al. 1980). However, these are not the *causes* of our economy not valuing EE, but rather the result:

> The observation that organizations have high implicit discount rates when making energy efficiency decisions is merely a restatement of the existence of the efficiency gap. […] Simply observing that implicit discount rates are high tells us nothing about *why* they are high. […] The high discount rate is not a barrier, but a restatement of the phenomena to be explained. (Sorrell et al. 2000)

In fiscal terms, EE is very alluring indeed, with building projects typically offering a 20–25% internal rate of return (Lai et al. 2022). However, despite the individualistic incentives offered to these companies, uptake lags far behind what is needed to decarbonize the U.S. building stock. This conflicts with the classical economic assumption that competition in the market creates efficiency. If the whole point of the free market is efficiency, then why is it so inefficient?

To adequately explain the existence of the EEG, a deeper analysis of our economy is required. This report systematically analyzes the U.S. CRE sector in order to show the root causes of the repeatedly observed barriers to a greener building stock. Rather than focus on the fact that the payback period is a frequently cited issue, we ask instead how our industries are structured to not value long-term improvements. Rather than focus on the lack of information among decision makers, we ask instead how the hierarchy of firms actively discourages workplaces from taking on EE projects. We hypothesize that the structure of the

[1] See Appendix A for a brief, accessible overview of discount rates.

economy requires firms, and sometimes individual workers at those firms, to take outsized responsibility when making EE investments, while the benefits are shared among all stakeholders.

We then evaluate the various financing techniques that could be used to overcome some of these barriers. We show their various strengths and weaknesses and conclude that, while these solutions are useful for individual customers, they have not succeeded in encouraging EE investments to the needed scale. We also provide a history of financing efforts to rapidly scale EE by integrating it into the mainstream finance sector, and why these efforts were unable to succeed. Additionally, we provide a case study of an ambitious retrofitting project currently underway in Ithaca, New York, including the perspectives of business partners, public employees, and grassroots organizers involved in this unique initiative.

In the report's final section, we prescribe strategic partnerships and information sharing methods that can mitigate some of the constraints imposed by the economy. These approaches are aimed at uniting the incentives of separate actors to enable a coordinated effort to adopt EE in commercial buildings, ultimately reducing carbon pollution from the buildings sector.

Systemic Barriers to Retrofits

MULTI-SPLIT INCENTIVES

A Two-Dimensional Value Chain

In writing about the investment activities of CRE holders, scholars frequently cite the split incentives between commercial building tenants and owners. A split incentive is when the benefit of a transaction is not accrued by the payer, discouraging the transaction. For residential buildings, this frequently manifests in renters having difficulty getting an absentee landlord to do repairs, since the landlord pays for the repair and the tenant enjoys the benefits. In the case of retrofits, a building owner has less incentive to put money into retrofitting a building if tenants pay the utility bills, as the savings go to the tenants. Figure 1 shows this basic stakeholder model.

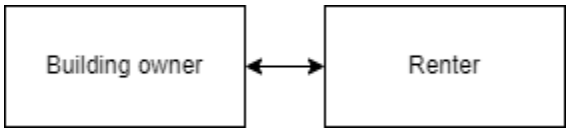

Figure 1. Basic real estate model

This split incentive is not present in every commercial lease: In a gross lease, the building owner pays the bills, while in a net lease, the renter does. However, when looking at the overall landscape of commercial buildings, the impacts of this split incentive are palpable. One study examined the likelihood of retrofit adoption depending on different ownership types, including owner-occupied buildings, government-owned buildings, and privately owned buildings that rented to tenants. The ownership type had a significant effect on retrofitting: Buildings that are owner-occupied were over four times as likely to be retrofitted than buildings rented out to tenants (Kontokosta 2016).[2]

The splitting of incentives does not end here. Besides the division of interests between owner and occupant, there are other divisions of interests as well, including between the companies that operate the buildings, those that invest in them, and those that maintain them. Several authors have expanded the CRE sector further, characterizing it as a network of several industries, each with its own separate set of incentives (Lutzenhiser et al. 2000; Jin

[2] Empirical survey research on how ownership type impacts retrofitting decisions for commercial buildings is limited to this one study. However, the same dynamic was observed in an empirical case study, while another study demonstrated it using game theory (Jafari and Valentin 2018; Liang, Peng, and Shen 2016). Future research could be done on the likelihood of retrofits among different lease types (gross or net). In the Kontokosta study, the types of leases were not gathered.

et al. 2014; Morrissey, Dunphy, and MacSweeney 2014; Sorrell et al. 2000; Whitney, Dreyer, and Riemer 2020).

Figure 2 shows a more detailed CRE market model synthesizing these sources and mapping market actors along two axes. The *y*-axis is an upstream–downstream axis that indicates the actor's stage in the production process. For example, raw material suppliers are first, as they provide the most basic components of buildings. Moving down further, we have those who produce and sell parts of buildings, those who design buildings, those who do the physical construction, and, finally, the end users who rent building space. The *x*-axis tracks the proximity to the building sector. While construction companies provide physical labor, investors and facility personnel maintain the customer-side relationships of the industry. Moving further to the right, we have providers of utilities that keep buildings occupiable, and, finally, regulatory actors who sustain the structure of the building industry. Arrows indicate which of these actors interact directly.

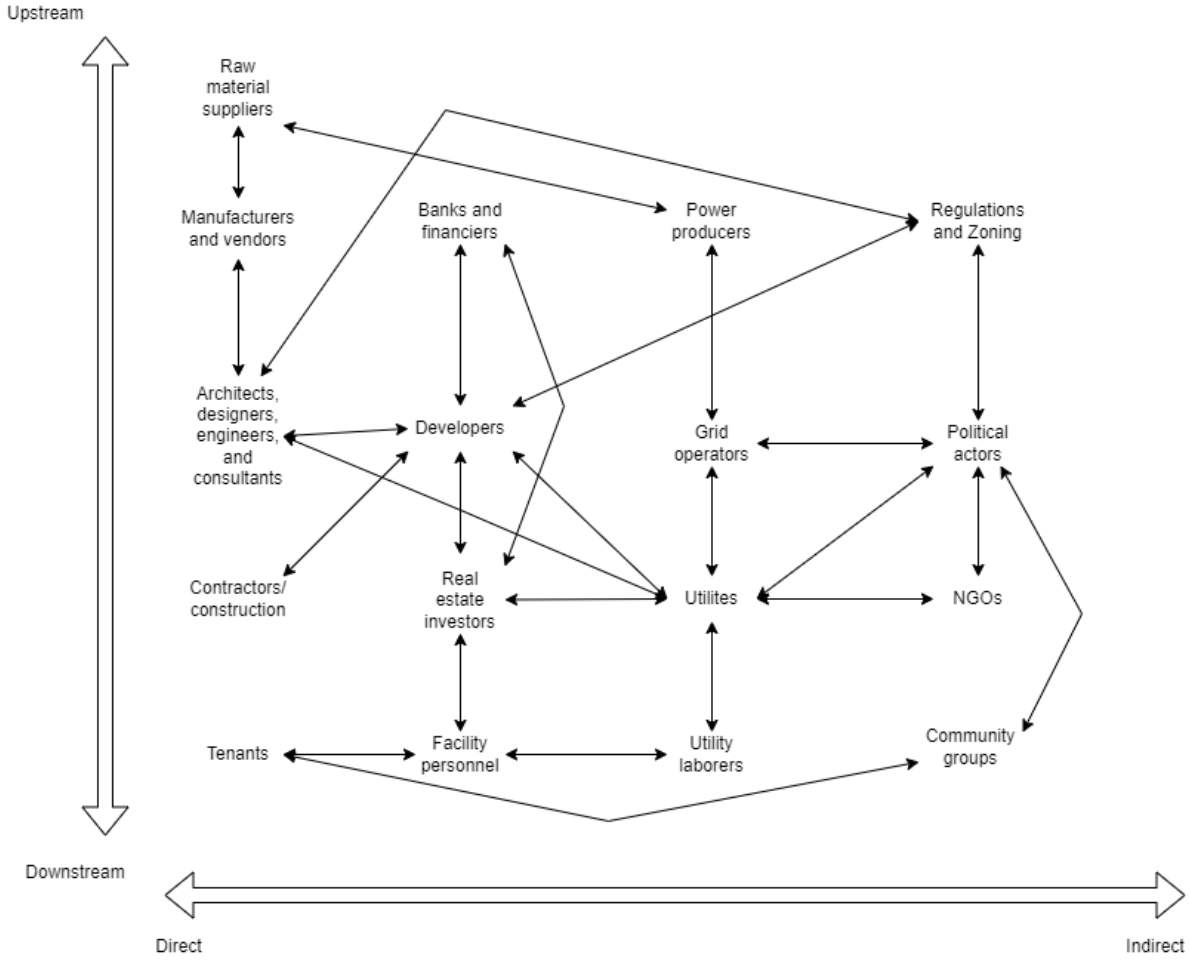

Figure 2. Model of the commercial real estate market

This more complex illustration of the CRE market allows for a more complete understanding of the larger split incentive issue in the sector. As noted by Sorrell et al. (2000), the separate

nature of each of these different industries incentivizes individual firms to cut costs with each other, prioritizing the individual firm's financial performance over the efficiency of the overall value chain. Under this model, there is a much larger web of split incentives that tamp down investment at each point. Contractors are given a budget by developers, and with that budget, try to maximize their profits rather than pass savings on to future tenants. Real estate investors work to achieve financial returns within a defined investment window, as opposed to working with utilities and contractors to enhance EE. While many of these actors could finance retrofits, they would be taking on the cost of the retrofit, while the benefits of it would be split among many actors. Thus, the cost-cutting nature of firms deters EE in this complex web of stakeholders.

The effects of this multidimensional dispersal of incentives can be seen within a single building. As described in one study, "The complexity of organizational structures, confounded with leasing agreement specifications, led to ineffective and delayed decision making at the building-level. For example, waste management in tenant spaces involved 'four people... making it more and more complicated to have a simple conversation about bins'" (Whitney, Dreyer, and Riemer 2020).

Split Incentives within Organizations: Dimensions Three and Four

Traditional economics assumes that firms maximize their outcomes as a single entity; for example, that a building owner will seek to maximize their savings from that building, and that a retrofit will be implemented if it makes financial sense. However, this relies on an assumption that "the firm" is itself a decision-making entity with its own mind (DeCanio 1993). Rather, firms are made up of separate departments that have their own goals and metrics of success; these departments are in turn made up of individuals with their own incentives, values, workloads, and careers. Research into the organization of firms reveals a second network of split incentives that arises through the siloing of firm operations into different departments, and the hierarchical organization within these divisions.

Starting with the hierarchy of companies, investments into EE require employees who do not directly benefit from retrofits to stake their jobs and professional reputations on championing them. Multiple studies have found that workers who championed retrofit measures faced negative consequences, including losing their jobs due to projects failing to meet expectations, while workers who championed retrofits that were successful experienced no personal benefits (Maiorano 2018; DeCanio 1994). Thus, the safer option for workers was not to suggest EE activities. Similarly, another study of facility managers found an overwhelming expectation for them to "'just do your job,' but not [...] be involved in key decisions, whether it's energy efficiency or something else" (Curtis, Walton, and Dodd 2017).

Lateral divisions within organizations also impede retrofitting activities. This is because retrofits require disrupting the status quo of the business. No matter how high, monthly energy costs are considered operational expenses, which are an assumed cost of doing business. On the other hand, retrofits are considered extra expenses. The energy bills are paid systematically by one department, while facility upgrades require cross-department

coordination and additional effort from the workers who implement them (Sorrell et al. 2000). For an employee at a CRE company, it can be easier to simply let the accounting department process unnecessarily high energy bills month after month than to undertake a big retrofitting project, particularly if their job has nothing to do with facility management. These lateral divisions can also lead to "turf battles" between departments, as retrofit activities can temporarily shift power dynamics within companies (DeCanio 1994).

The impact of lateral division on retrofitting activities has also been measured empirically. In one study, the author observed two American universities: In one, each of the individual colleges (college of engineering, college of arts and sciences, etc.) were responsible for their own budgets and made their retrofitting decisions separately; in the other, retrofitting decisions were made centrally by the university administration.

Between the two schools, the centrally run one was much more active in making investments and kept more up-to-date on retrofit technologies (Cebon 1992). In contrast, each of the separate colleges at the other university had to manage its own separate budget and thus was unable to make such deep investments. The individual colleges also had fewer facilities experts on staff, and work was often repeated between buildings as each college had to hire separate auditors. In addition, given the smaller budget, a deeper retrofit was a relatively larger project to take on, and thus the budget-conscious and risk-averse nature of individual colleges deterred EE investments. While departments in the decentralized school showed a better understanding of their own facilities and department needs (such as ventilation hoods for chemistry programs), the buildings were, on the whole, much less efficient and the adoption of new technologies was much slower.

Time: A Fifth Dimension of the Industry

As with all investments, retrofits have costs and benefits. Traditional economic theory states that investments are favorable if the benefits outweigh the costs within the defined investment window. As shown previously, EE is quite the worthwhile investment on paper. In addition, the increasing effects of climate change pose additional business risk. Despite these factors, the industry as a whole is not making the investments needed at the pace needed. How can this be explained through economics?

As economists looking at environmental issues frequently note, ecologically destructive human activity can be seen as a problem of externalities. An externality is a side effect of economic activity that is not reflected in the transactions involved. Some externalities are created immediately, as with littering: The price of producing single-use plastic does not reflect the cleanup costs incurred by the city when some of these food containers inevitably end up on the ground. This is because plastic manufacturers are separate entities and are not accountable to the government. Other externalities, such as emissions and water pollution, have delayed effects. These externalities rely on the division of responsibilities as well as on time: Future generations will have to deal with their cleanup, and viewing economic issues only in the time frame of our own lives separates us from the people of the future and allows these externalities to go unabated.

As stated earlier, investments are favorable if the benefits outweigh the costs *within the defined investment window.* Because companies hold their investments for limited time frames (typically 5–10 years), they have no financial reason to be concerned with a building's carbon emissions once it is sold. Therefore, there is a split incentive between the current owner of a building and the next owner of a building. To understand EE and all environmental issues from an economic lens, we must understand this view of time as a split incentive and hold it as a base assumption. This factor plays into the decision making of each of the stakeholders we discussed earlier and further impedes the needed upgrades to our building stock.

Temporal Siloing in Investing

Starting with building owners, the extremely quick turnover of CRE restricts all investment to a roughly 10-year time frame. In the CRE sector, it is industry standard for buildings to be sold every 5–10 years (Francke 2018); as a result, investments in the buildings need a payback period of 3–5 years for owners to dedicate the labor and capital to making them more efficient (Benson et al. 2011; Gliedt and Hoicka 2015; Christensen, Robinson, and Simons 2018). This is an extremely high bar for any investment to clear—and it is a bar that is created by the short time frame. A retrofit that leads to 20% savings on energy bills but takes 10 years to pay off is very worthwhile if a building is held for 20 years, as it will save two years' worth of energy bills.[3] However, if it is held for only 5–10 years, the investment will at best break even.[4] Thus, retrofits require building owners to hold the financial responsibility and risk of retrofitting, while the financial benefits are accrued by future owners and the ecological benefits are felt by future generations.

Some CRE investors do hold buildings for longer time periods in their portfolios. Real estate investment trusts (REITs) are companies that own income-producing buildings. Investors can buy shares of these companies—which are typically publicly traded (Nareit 2023)—making large-scale real estate investment available to individuals. In the United States, however, REITs are required to pay at least 90% of their taxable income as shareholder dividends each year. This means that they are required to prioritize a steady cash flow from rents to pay steady dividends, but not to retrofit buildings.

[3] The first 10 years are spent paying it off. In the second 10 years, you would save 20% each year, so 20% × 10 years = 200% of annual energy expenses.

[4] While retrofits do increase the value of buildings with lower operating costs, the "soft benefits" of a greener corporate image, and future-proofing for a gas-less future, the premiums on resale price have so far been unsuccessful at directing substantial resources toward efficiency on their own.

So, while REITs do have a slightly longer holding period on average than other CRE investors, systemic barriers still exist that cause their commercial buildings to have low retrofit rates.[5] Buildings leased by a private owner were found to be 17% as likely to be retrofitted as owner-occupied buildings, while REIT-owned buildings are 25% as likely (Kontokosta 2016). REITs do have a longer holding period, but they are still subject to the same ownership dynamics shown to disincentivize EE investment.

In addition, the longer holding period of REITs does not give them longer-term incentives, as REITs themselves are extensions of the short-term focus of real estate investment. Because REITs are usually publicly traded companies, their total value (market capitalization) is determined by their value on the stock market. While their corporate structure incentivizes them to hold properties for longer periods of time, it also requires them to constantly have a high share price and a steady cash flow to retain their value for investors (Aalbers, Fernandez, and Wijburg 2020). So, while REITs hold buildings for longer periods of time, they still have to pay dividends each quarter, so EE investments have to compete with the very structure of their business.

Temporal Siloing in the Workplace

Temporal siloes exist in workplaces, with facility departments that have annual budgets or businesses that have inconsistent revenue.[6] Even businesses with steady, dependable revenue have to weather periods of economic downturn. An EE investment then brings risk and uncertainty to the temporal silo in which it is made. As explained by a facilities manager, upgrading facilities becomes much more difficult if they have to justify the upgrade to "someone from finance" (Curtis, Walton, and Dodd 2017). Given the assumption that management will do whatever saves money, this does not make sense. But by understanding that finance department employees have to manage expenses on a quarterly and annual basis, this resistance from the department is expected.

When faced with the uncertainty of an investment, managers have the choice between demanding certainty (not investing in anything without a definite, fast payback) or managing complexity (collaborating between departments and employees to try to make budgets work) (Maiorano 2018). When certainty is demanded (which it often is), the investment gets pushed to the next period of investment, oftentimes over and over again.

[5] While private commercial investors have a range of 5–10 years, REITs have a 10-year holding period on average (Feng, Hardin, and Wang 2021). This slightly longer holding period is relevant, as REITs are typically publicly traded. The other publicly available option for real estate investment is through a mutual fund, which has a typical holding period of one year for CRE.

[6] For example, a business that works on a small number of contracts at a time or a seasonal business.

THE FINANCIAL SYSTEM

Heightened Lending Rates

In the simplest terms, when building owners finance projects, they borrow funds from a financial institution (usually a bank). This lender gives borrowers an interest rate depending on the amount, time period of the loan (called the "term"), and the credit risk of the borrowers. Credit risk measures the risk of default, or the likelihood that borrowers will be unable to pay back the loan. This risk is calculated by the lending institution based on a borrower's reported assets, expenses, revenues, existing debt, and other financial information.

A factor that is not necessarily considered in traditional mortgages is the impact of the proposed investment on the borrower's projected expenses. In simpler terms: Let us say you apply for a loan to install a building electrification package that will save you 20% on your energy bills each year. When the bank calculates the rate for your loan, it is not required to calculate the 20% reduction in your energy bills into their modeling, even though those 20% savings will free up cash to pay back your loans, decreasing the likelihood you will default on a loan. This is not always a problem for larger commercial borrowers, as the scale of the projects mean that banks may underwrite changes to expenses subsequent to the execution of the business plan. Ideally, all lending would consider EE, making it more accessible to smaller businesses and residences; legislation to require energy usage in mortgages—such as the Sensible Accounting to Value Energy (SAVE) Act—has been introduced, but not passed (Bennet 2014).

Recent research shows that mortgages underwritten by energy-efficient properties are significantly less likely to default, since lower energy bills free up funds for mortgage payments (European Commission, Directorate-General for Energy 2022). Therefore, even though efficient buildings are cheaper to operate, unless this finding is factored into mortgage terms, they are less accessible to buyers than they should be.

Upfront Costs

Extensive audits are needed for building owners to make informed decisions regarding their investments. The smaller the upgrade, the more expensive the audit is compared to the rest of the project. As a result, smaller businesses frequently cite the audit cost itself as a barrier to making retrofits (Mathew et al. 2005). However, audits are not strictly necessary for the implementation of a retrofit. They are instead required to provide financial information for the building owner and lender, where they both operate as cost-minimizing agents. As shown earlier, cost-minimizing incentives deter EE investments. We discuss methods to circumvent these high upfront costs later.

Lack of Investment Insurance

In traditional financing, there is no guarantee that EE investments will save investors money, as energy-savings insurance (ESI) is not commercially available for most borrowers.[7] ESI could be sold by insurance companies to guarantee a certain level of savings, lessening the risk for the individual investor. Although the scholarly literature has discussed and modeled ESI for more than 20 years, it has not seen a commercial rollout in the United States (Mills 2003; O'Neill, Quinn, and Jones 2016; Töppel and Tränkler 2019; Baltuttis et al. 2020).[8]

Unvalued Risk Hedging

Firms also contribute to the inadequate financial evaluation of EE investments by considering only the payback period, and not how decreasing energy consumption reduces exposure to the financial risk of energy price volatility. By evaluating retrofits as a risk mitigation project, firms could realize the value of EE. However, this would require new valuation tactics; like ESI, these methods are present in the literature but not widely adopted in the industry.[9,10]

Resistance to Change Within the Finance Industry

Thirteen years ago, Jackson outlined a method for building owners to better value EE (Jackson 2010). In a section titled, "If it's better, why isn't it already used?" Jackson argues that the financial sector is remarkably slow at adopting new practices, citing the 40-year timeline of quantitative risk management, from its 1952 conceptual framework release by Harry Markowitz to the 1994 RiskMetrics service release by JP Morgan (Jackson 2010).

To expand on this point, the financial industry, like any industry, is subject to the same intra-firm disincentives discussed earlier. In the EE financing context, incorporating the asset risk of retrofits into loans would require significant labor. Banks do not have EE experts on staff and would have to hire outside consultants; this would require the development of new risk

[7] As we discuss later, some companies guarantee energy savings, though they predominantly serve large institutional clients such as municipalities and hospitals.

[8] Chapparo et al. (2020) details an initiative by the Inter-American Development Bank to implement ESI in Chile.

[9] Examples include using value-at-risk and bottom-up approaches to determining optimal investment levels subject to risk tolerance, expected energy price volatility, and other factors (Jackson 2010; Buhl, Gaugler, and Mette 2018).

[10] The effort required to incorporate EE into loans is referred to as the transaction cost of information (Sorrell et al. 2000). Transaction costs are the costs required to make an exchange happen. For example, for a business to buy an upgraded lighting package, employees have to do research on the different options and then present the options to leadership; the vendor has to have a sales representative market the product; the bank involved in financing has to underwrite the loan and fill out other paperwork. The asset performance of retrofits is far outside the expertise of a bank's financial analysts, thus increasing the transaction cost of this information.

models and the roll out of new financial products. In addition, developing such products would likely require a particular employee or team dedicating effort to it—analogous to the EE champion in other workplaces. They would then own the risk of how well the product performs. Workers in the finance industry, too, have an incentive to maintain the status quo.

Taking Jackson's argument and incorporating this framework of organizational behavior, we see that finance is a reactive rather than proactive lever of change. This point has been made many times in EE research. The certainty required to adopt new technology and financial methods is self-defeating, as each industry player avoids taking on the risk of being an early adopter (Lutzenhiser et al. 2000). Investors require certain evidence that EE is a successful investment based on its performance in the marketplace, not just its natural efficacy (European Commission, Directorate-General for Energy 2022). In recent years, the risk of stranded assets has motivated electrification in Europe (European Commission, Directorate-General for Energy 2022).[11] In other words, risk-averse building owners require total market transformation to invest in new technology.

CONCLUSION

As this section shows, the sluggish pace of EE investing is not an unfortunate side effect of market imperfection but rather the direct effect of the short-term nature of CRE investing. While on a macro level, we can understand EE's mutual benefit, on an individual level, we live and work in a structure in which EE investment is (in economic terms) irrational behavior. Whether between firms on a market level, employees and departments on a firm level, or between owners of buildings on a temporal level, the profit-maximizing incentives of CRE investing actively discourage long-term, GHG-reducing investment.

[11] A stranded asset is something a company owns that is now a liability. In the context of Europe, many countries are trying to use less gas imported from Russia following the invasion of Ukraine. Thus, for a utility based in Germany, residential gas distribution infrastructure may become a stranded asset, and the utility may want to electrify as much as possible before that happens.

Financing Methods for Commercial Retrofits

In this section, we outline financing mechanisms that have been developed to make decarbonization more accessible to customers. As we detail, these solutions have worked for many customers since their conception. However, they have not changed the landscape of finance on a fundamental level and do not solve the systemic barriers of industries and firms; they thus fail to reach the scale we need. An overarching theme among the solutions is that they work on a case-by-case basis. Again, they have helped numerous customers and have facilitated the retrofitting we have seen in the U.S. building stock so far. But, as research shows, with a case-by-case approach, retrofitting remains an expensive, boutique, and uncommon savings option.

EXISTING METHODS AND THEIR SHORTFALLS

Traditional Financing

Companies can finance their decarbonization without the help of special loans and programs. Typically, companies first try to pay for investments without taking loans at all. In the best scenario, a company can pay for the investment with money it makes through its everyday operations; this is called financing with cash flow from operations. If this is not possible, as with big investments such as retrofits, the second priority is money the company has saved, or financing with retained equity. The barrier to these types of financing is that companies typically do not have piles of money laying around to invest with. Competitive markets reduce excess revenue in firms, as such revenue is reinvested into the company's operation and competitiveness. Given this, EE projects are typically financed with debt.

When financing with debt, you buy something with money you do not have, so the business goes to the bank and gets a loan, which is then paid off by the cash flow from operations. A barrier to debt financing is that it requires companies to put more debt on their balance sheets, which businesses typically try to limit. In the case of smaller businesses, owners may be averse to taking on more bank debt. For example, mechanics who have owned their own shop for many years and have paid off their initial business loans do not have an active line of credit with a bank; they are thus unlikely to take out a loan with interest if they do not have to.

SIMPLIFIED PAYMENT PROGRAMS

Relying on traditional financing makes retrofitting unlikely. Policymakers have responded by developing financing frameworks that better fit the needs of their customers, as we now describe.

Property-Assessed Clean Energy (PACE) Loans

PACE loans are loans for retrofits that are paid back through higher property taxes. Under this system, the local government provides the building owner with funds to spend on a decarbonizing project. Whether the funds come from public dollars or private capital, the local government is always the conduit (Nandivada 2014).

Under a PACE loan, building owners can get retrofits for no money down, and then repay the lender as an added cost on their property bills. The important distinction between PACE and traditional financing is that PACE loans are attached to the property itself, not the owner who took out the loan. This makes the loans more accessible and less risky for many customers. By attaching the loan to the property, banks can factor in the property's value when underwriting the loan, allowing borrowers with lower credit scores to access financing. Because the loan is attached to the property and not the person, building owners can sell the property without having to pay off the rest of the loan, as it is paid off by the next customer. In the United States, states must pass legislation that allows them to set up a PACE program. As of December 2023, 38 states and the District of Columbia have passed PACE-enabling legislation, and 30 states and the District of Columbia have active PACE programs.[12]

While PACE loans have worked for many customers, the CRE sector's short turnaround time makes PACE incompatible with the typical business model of an institutional CRE investor. Because a PACE loan raises the cost of owning a building, a preexisting PACE loan lowers the building's resale value. While the long-term savings can make PACE loans more than worth their investment, short-term CRE investors are less interested in purchasing and selling properties with PACE loans attached.

PACE loans also have seniority to other loans. This means that if you cannot pay both your monthly mortgage and PACE loan, the PACE loan takes priority. Therefore, the bank that issued your mortgage must approve of you getting a PACE loan. A lot of banks will not do this because they are avoiding financial losses rather than considering environmental benefits in their decision making. Freddie Mac and Fannie Mae, the government-created financial institutions tasked with aiding in the stability of our housing market, will not buy mortgages with PACE loans (Fannie Mae 2020; Freddie Mac n.d.). For PACE to become a scalable solution, the financial sector would have to prioritize the environmental benefits of PACE loans over the interests of individual banks.

On-Bill Solutions

On-bill programs are similar to PACE in that they allow customers to get the building upgrades they need without having to make a down payment or go through the traditional financing process. In this case, the loans are repaid through the monthly utility bills. In an on-bill repayment (OBR) model, the loan is provided by the utility itself.

There are two OBR types: OBR tariffs and OBR loans. OBR tariffs are attached to the property's meter and not to the business or person who originated the loan. They are thus similar to PACE loans, in that they allow borrowers to pass off the upgrade costs to the next

[12] For more details on which states have PACE legislation, visit pacenation.org.

owner if they sell before the upgrade is repaid. OBR loans do not allow this; if an OBR loan is unrepaid at the time of sale, the remaining amount must be paid at that time (Nandivada 2014). On-bill financing (OBF) is similar to OBR, but the funding comes from a third party.

All these options run into obstacles that prevent their further adoption. To accommodate lending, utilities have to change their payment and IT systems. Utilities might lack the capacity or desire to get into financial lending and instead work with outside financiers to facilitate OBF programs. Also, like PACE, these programs must be permitted by state legislatures and then set up by utilities. Institutional CRE investors run into the same problem here that they do with PACE loans: OBR will result in them either having to pass on an additional charge to the next buyer, which lowers the resale price, or having to pay off the rest of the OBR loan when they sell, which lowers their return.

Energy Services

Customers can eschew financing altogether and simply pay a contractor a monthly fee for energy equipment and system maintenance. This is done with an energy service performance contract (ESPC) through an energy service company (ESCO). These are most common among municipalities, universities, schools, and hospitals (the MUSH sector). This is because ESPCs have high upfront costs and need strong credit; in addition, the lessened profit motive of the MUSH sector means that industry actors can be more willing to spend on infrastructure upgrades (Nandivada 2014). A big advantage that ESPCs have with these customers is that MUSH actors are in control of huge facilities, yet they are not CRE companies. For MUSH customers, having outside contracts can be preferable to expanding their facilities department to take on an ambitious project. The costs are also less risky, since the contracts often have clauses stating that the ESPCs cannot be paid more than the energy saved, which guarantees savings for the customer.

The ESPC is not as popular with small businesses because of the upfront installation cost. Smaller buildings have less in energy savings under these contracts compared to the administrative and labor costs of setting up the account, equipment, and performing maintenance. For owners of smaller buildings, Energy Efficiency as a Service (EEaaS) programs allow customers to put no money down and guarantee monthly savings. Since they first became available in 2009, EEaaS programs have been able to penetrate markets previously unpenetrated by traditional ESPC models (which date back to the 1980s). While EEaaS also has difficulty reaching businesses under a certain size, the model has allowed for a lot of decarbonization work infeasible with other financing models. For more on EEaaS, see ACEEE's 2022 report *Utilities and Energy Efficiency as a Service: The Potential for Win-Win Partnerships* (Henner and Howard 2022).

SECURITIZATION

As discussed earlier, the financial barriers of high upfront costs and interest rates come from the boutique nature of EE loans. This nature contrasts with other types of loans—such as mortgages, car loans, and oil and gas project financing—which have standard models to cut down on origination costs. Further, the extra labor of extensive audits and underwriting for a

loan based on nonfinancial information prevents EE loans from accessing the lower interest rates available to debt that can be sold on the secondary market.[13] The process of securitizing EE loans would address both of these issues.[14] However, while academic literature has discussed the development of such a system since 1995, it has yet to materialize in the market at scale (Kats et al. 1996). We outline the few projects that have piloted this model below.

Before securitization can begin, EE loan originators must circumvent the high upfront costs of auditing properties. They can do this by developing actuarial pricing (Mills 2003). An actuarial pricing table is a model that lets a lender formulate an estimate of cost and risk based on a set of inputs. These estimates will not be completely accurate, as they are measured without a building visit, but they have two distinct advantages. The first is that they are risk-based figures rather than the deterministic figures[15] of energy audits, so they are more compatible with financial institutions. The second is that, because of the model's simplicity, it can be rolled out at a much larger scale. Further, the more the model is used on buildings, the more balanced and accurate it becomes for estimating total cost as too-high estimates are canceled out by too-low estimates.[16] This balancing effect is called the law of large numbers.

Securitization also requires standardization. An oft-cited barrier to retrofitting is the lack of standardization, as each project is different depending on the building's specifics, location, and use, and documentation of retrofit outcomes is uncommon (Palm and Backman 2020). Many retrofits are performed by smaller companies without extensive documentation[17] and larger ESCOs that have information are unwilling to share it due to competition between firms of the same type. In one study, only 6 of the 70 ESCOs researchers contacted participated in the study, as a key part of a private firm's competitive model is to not share information that can be leveraged against it (Benson et al. 2011).

In the securitization context, the market must establish a standardized definition of EE security to allow effortless comparison between assets and their risk and return levels. Developing a robust EE security market in the United States would also require credit enhancement from the federal government, in the same way that Fannie Mae and Freddie

[13] See Appendix B for a brief, accessible overview of the secondary mortgage market.

[14] See Appendix C for a brief, accessible overview of securitization.

[15] Meaning that they are calculated without randomness.

[16] In statistics terms: The lender assumes that the model's accuracy will take a normal distribution. The model can, after rollout, be adjusted and calibrated to handle skew and other distortions using market data.

[17] If the contractor is two guys and a truck, they are not keeping performance information to potentially share with researchers years later.

Mac mediate and guarantee the mortgage-backed security (MBS) market. A hurdle to this is the historic lack of support from these banks for EE investments, both in the case of PACE loans and, as we will discuss later, in Warehouse for Energy Efficiency Loans (WHEEL).

The benefit of securitization for borrowers would be more accessible financing, with lower upfront costs and interest rates for EE loans. If there were an active, open market for EE loans, then utilities, banks, contractors, states, and other potential providers of EE financing would be keener to lend for these purposes since they could then resell these debts. With this simplified process of EE lending, there would also be more lenders offering these services.[18]

The process of developing a securitization system is a lot of work and to succeed, it needs to have a lot of customers. In an industry that is reactive rather than proactive, efforts to develop EE securitization are exceedingly rare and have yet to succeed at scale anywhere in the world—despite having theoretical frameworks for developing them that date back decades. In the following, we outline the various attempts at securitization in the United States.

Enron

Setting up actuarial pricing for EE is expensive, severely limiting the number of businesses in a position to develop them to large energy companies. In the late 1990s and very early 2000s, a large energy company called Enron was doing exactly this through its subsidiary, Enron Energy Services (EES). EES wanted to develop actuarial pricing for EE in order to roll out efficiency services for the clients it signed to long-term flat-rate energy services. This would let EES provide EE to its clients that were expected to have high energy costs, hedging the future cost of energy (Mathew et al. 2005). EE securitization would then be a next step once the actuarial system was rolled out and working. However, Enron declared bankruptcy in 2001 due to large-scale corporate fraud unrelated to its EE operations, ending these plans.

Warehouse for Energy Efficiency Loans (WHEEL)

Industry support for EE securities sank further in 2008 when securitized mortgages were a central cause of the global financial crisis.[19] However, it was during this bearish market that the first EE securitization program took place. The WHEEL program is a public–private partnership between state governments and financial institutions (and one nonprofit) that brought about the first-ever issuing of EE securities.

[18] See Sweatman and Managan (2010) for a detailed theoretical model of EE securitization.

[19] See Appendix D for a brief, accessible overview of why securitized mortgages were a central cause of the 2008 global financial crisis.

WHEEL was born out of a need for more investors in state-issued EE loans. In 2006, Pennsylvania started the Keystone Home Energy Loan Program (HELP) to provide residents with accessible EE financing. Keystone HELP was extremely successful at issuing loans. Typically, loans issued by a state are kept on that state's balance sheet. However, Keystone HELP was so successful that this was no longer possible (Bellis 2017).[20]

In need of a buyer for this debt, Pennsylvania went to Fannie Mae. However, given the novelty of the asset and it being 2009—right after this type of debt set off the biggest recession since the Great Depression—Fannie Mae offered an untenably low price for the loans. Pennsylvania then sought to securitize these loans instead, partnering with other states with EE loans to build a portfolio large enough for diversified securities.

When the participating states[21] issue EE loans they can warehouse them with WHEEL.[22] Then, when WHEEL has enough loans, it releases a round of securities. Figure 3 shows a model of this program. So far, WHEEL has released only one round of securities (in 2015). Because loans are originated by states, new loans take much longer to originate (compared to the private sector) as funds must be approved by political and bureaucratic processes. In addition, the asset type is still very new, and there is thus considerable market uncertainty and investor hesitancy (Gonyeau 2019). Only a proven track record of success from these securities can address this problem. Updates on WHEEL have not followed and a future round of securities is uncertain.

[20] Under the Keystone HELP program, loans were originated by AFC First Financial then sold to the Pennsylvania Treasury. The program generated so many loans that the Treasury began nearing its diversification limit—that is, the largest percentage possible that such loans can take on the state's balance sheet and still ensure financial stability.

[21] Pennsylvania, New York, Kentucky, Ohio, and Florida

[22] The warehouse itself is held by Citigroup.

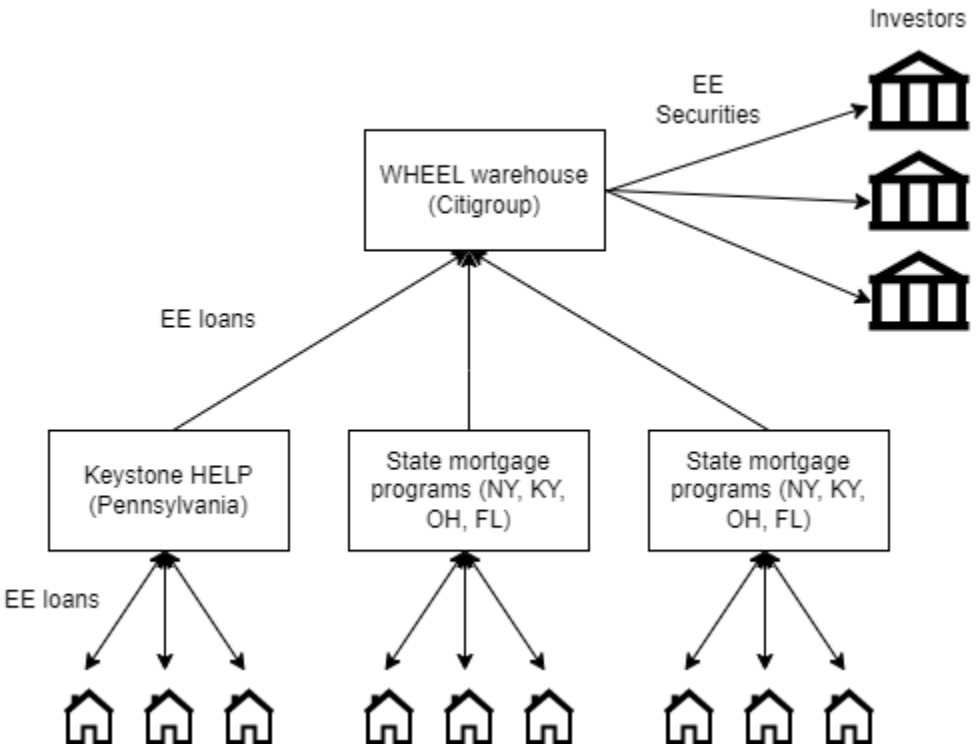

Figure 3. Warehouse for Energy Efficiency Loans (WHEEL) program model

BlocPower and the Green New Deal of Ithaca, New York

The most recent securitization effort is currently underway through BlocPower, an energy technology and finance company. BlocPower offers energy services to building owners, but it has achieved its largest growth by signing contracts with cities undergoing large-scale retrofitting initiatives. As a part of its business model, BlocPower has partially crowdfunded its work through Climate Impact Notes, which are securities based on the financing that BlocPower provides to its clients. As with MBSs, payments from BlocPower's customers fund the dividends of the Climate Impact Notes.

So far, security sales have made up only a small portion of BlocPower's financing, raising $2 million in 2021 and another $3 million in 2023 (BlocPower 2022; 2023). Comparatively, BlocPower raised $250 million in equity and debt financing through 2022, and in March 2023 announced another fundraising round of $150 million (*ACHR NEWS* 2023).[23] Because EE as a securitized asset is new and unproven, sales of its Climate Impact Notes have to remain a small portion of its fundraising at this time. Still, given the slow growth of EE securitization,

[23] BlocPower's investors include Goldman Sachs, Kapor Capital, Microsoft's Climate Innovation Fund, Andreessen Horowitz, and American Family Insurance Institute for Corporate and Social Impact.

having BlocPower offer these securities is a big step forward.[24] The company is also looking to bundle and securitize more of its EE loans in the future.

BlocPower's city partnerships have facilitated some of the most ambitious retrofitting efforts to date, most notably in Ithaca, New York, which passed a city-wide Green New Deal (GND) in 2019 to aim for carbon neutrality by 2030. In addition to its ambition, this effort is also unique due to its inception as a grassroots organizing effort, as opposed to being a product of top-down government decision making or a profit-driven venture. Since grassroots organizing is the impetus for this decarbonization effort, the history of that organizing is essential to understand the full value chain of Ithaca's retrofits and BlocPower's business model.

The initial push for a GND was led by student interns at the Office of Energy Management and Sustainability at Ithaca College. This group organized environmentalist supporters on campus and in the surrounding community to formally ask the city's Common Council to pass a GND for the city at a March 2019 meeting.[25] Aided by a mayor and council supportive of both community efforts and environmental causes, a GND was crafted and passed unanimously by the Common Council just three months later (Ithaca Common Council 2019).

Luis Aguirre-Torres, an energy and green finance expert, was hired by the city as its director of sustainability to lead the effort. Outside financing for the project was needed, as taking on the debt required for this project is not feasible within the finances of any local government, let alone one with a third of its population below the poverty line (Census Bureau 2021). Initially, Aguirre-Torres attempted to raise funds from community development financial institutions (CDFIs).[26] However, these publicly backed institutions did not have the funds needed to finance the project, as its scale is much larger than what a CDFI normally takes on.[27]

[24] Unlike MBSs, BlocPower's securities do not have tranches or pools, and all of the securities are of the same risk level. This is because the securities are not mature assets, so they are sold in batches that are too small to break up into tranches and pools.

[25] Personal communication with Rebecca Evans, acting director of sustainability at the City of Ithaca and former campus sustainability coordinator at Ithaca College.

[26] Community development financial institutions (CDFI) are backed by the U.S. Treasury and provide funds for community development projects. CDFIs leverage a mix of public and private funds to provide financing to economically distressed areas. For more information, visit https://www.ofn.org/what-is-a-cdfi/.

[27] Personal communication with Luis Aguirre-Torres.

Aguirre-Torres then sought outside financing, partnering with BlocPower and Alturus, a private equity firm.[28] BlocPower provides funding for the residential buildings, while Alturus provides funding for commercial buildings; BlocPower manages the program in connection with the City of Ithaca.[29] While BlocPower has already worked with many cities and towns to retrofit buildings, the project with Ithaca is the first aimed at the entire municipality.

To get a retrofit under Ithaca's GND, building owners submit their building information to BlocPower, which then provides them with options for upgrades and financing. BlocPower also sends over an engineer to conduct an audit of the building. Once the building information is gathered, local subcontractors then bid for the individual building contract. BlocPower pays the upfront cost for the retrofit and leases the equipment to the building owner for a 15-year term, with the subcontractor providing maintenance as part of the lease. Figure 4 details BlocPower's business model from an individual homeowner's perspective.

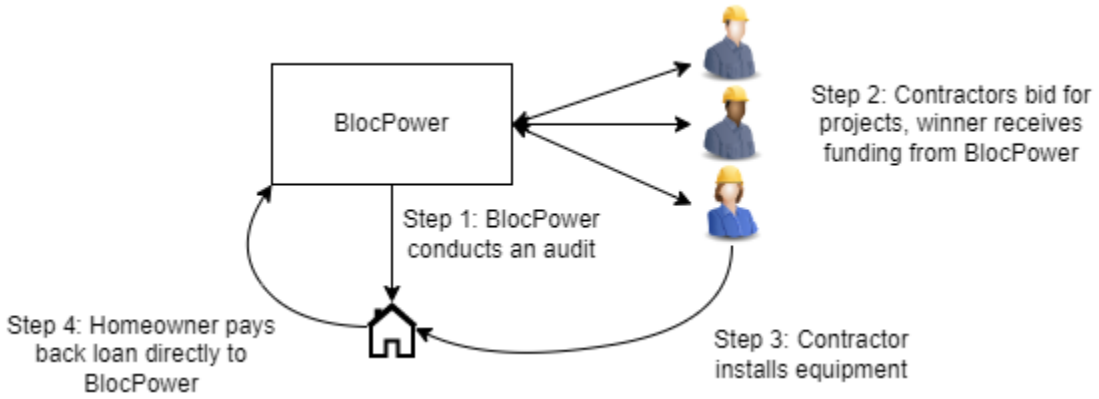

Figure 4. BlocPower business model

While BlocPower has not developed actuarial pricing, it has other advantages that allow it to decrease upfront costs and scale retrofitting more effectively. First, the city partnerships that it has developed allow for economy of scale with the retrofits. Because the whole city is under one coordinated project, the auditing and installation processes can be optimized, and equipment can be purchased in bulk. The volume of work also allows contractors to maintain relationships with businesses and communities, lowering transaction costs.

[28] To avoid a single company having outsized control over the city's building stock, the request for proposals (RFP) for the Ithaca GND required businesses to take on partners in order to win the contract.

[29] Adjacent to the City of Ithaca is the Town of Ithaca, a smaller but distinct municipality that passed its own GND in March 2020. Under its plan, building owners are eligible to participate in the program BlocPower has with the City of Ithaca.

Second, the project is aided by technological advancements. BlocPower has developed proprietary modeling software that specifically addresses the financial risks of a retrofit project. As stated previously, a tool that does this has been long awaited and is not yet widely available on the market. BlocPower's modeling tool allows for the quantification of financial risk using energy information, giving risk-based results from deterministic engineering information, which is needed to secure adequate financing. Additionally, software developed by the nearby Cornell University allows auditors to access furnace information quicker.

Finally, financial help from the State of New York has cut upfront costs, with the state providing $1.5 million to pay for audits. The state also provided funds for a loan-loss reserve, which is a pool of funds that pays out to investors if a borrower defaults.[30] For the Ithaca project, all borrowers with a low credit score[31] were automatically covered by the loan-loss reserve. The advantages to this are twofold. First, it enhances the creditworthiness of the project, attracting investors and lowering rates. Second, it allows for more financing to be available for low-income homeowners, as it covers their credit risk and decreases the financial auditing costs.

Problems with Securitization

From a financial perspective, BlocPower has achieved what many businesses have tried and failed to do: generate savings for low-income homeowners, improve the building stock and economic opportunities in these underinvested areas, and do it all without public funding, but rather by leveraging the power of private capital.

From another perspective, however, BlocPower's role in Ithaca's GND is as a privatized para-government agency stepping in to address the failures of government at all levels,[32] aided by environmentalists who provided lucrative opportunities to venture capital firms that sell decarbonization solutions as an innovative product.

The City of Ithaca, like any city, has neither the funds on hand nor the debt capacity to make the needed investments. Seeking funding, the City went to nearby CDFIs, which are publicly backed institutions that provide needed funds for community development. The lack of CDFI funds for this project was a failure, although the recently established Greenhouse Gas Reduction Fund (GGRF)—an Inflation Reduction Act program that can provide capital to

[30] Reserve funds were provided by the New York State Energy Research and Development Authority (NYSERDA) public-benefit corporation, which gave $2.5 million each to BlocPower and Alturus. BlocPower also procured an additional $3 million from the Kresge Foundation for its reserve (Harris 2023a).

[31] Defined in this case as a credit score under two standard deviations below the mean.

[32] Except for in the City and Town of Ithaca.

CDFIs, green banks, and other nonprofit financial institutions—may address this problem in the future. In this case, given the CDFI failure, the decarbonization effort had to be funded by private investors, which function differently than government bodies and do not necessarily have public interests in mind.

Both BlocPower and Alturus are private firms that emphatically emphasize their altruism. BlocPower in particular frames itself as a champion of racial justice. BlocPower founder Donnell Baird said of Ithaca, "We're going to go in there and try and make it Wakanda" (Harris 2023a). New York City Mayor Eric Adams once said at a BlocPower event with Baird, "BlocPower is saying Black power" (New York 2022). In a press release from October 2021, BlocPower announced a plan to "hire 1,000 George Floyds," in reference to the company providing job training to people from disadvantaged neighborhoods (BlocPower 2021).

Alturus, for its part, differentiates itself from other private equity firms, which are often known to operate by purchasing companies, laying off staff, and liquidating assets to provide returns for shareholders. Managing Director Gopal Vemuri said of Alturus' operations in Ithaca, "We're not Apollo, we're not KKR, we're not the barbarians at the gate here," referencing the predatory reputation gained by other private equity firms (Harris 2023a).

While BlocPower and Alturus may both be staffed by people with good intentions and have feel-good pun-based names, the promises and good will of the finance industry are not a secure foundation on which to build the energy transition. For one thing, the retrofits are leased to the building owners but owned by BlocPower. Thus, a private company will own a significant portion of Ithaca's infrastructure within buildings. Should a municipality enter into this type of agreement with BlocPower or a similar company, the company could change ownership through outright sale or an initial public offering (IPO); as a result, the equipment in homes and buildings could be sold to different owners without any public oversight.

In addition, reporting on BlocPower has not been wholly positive. In Ithaca, for example, as of September 2023—two years into the project—only a single heat pump has been installed, lagging behind targets, and another Ithaca customer reported that communication from BlocPower had ceased and that retrofitting of their community center was unlikely (Harris 2023b).

Such reports do not reflect on BlocPower's business model itself, as another company could attempt similarly ambitious projects without such problems. However, as stated in "A Two-Dimensional Value Chain," each private company added to the value chain of buildings creates another splitting of the incentives to improve building stock. While BlocPower claims that its main goal is to save customers money, and to take a cut of those savings, there are

no financial guarantees for participants in Ithaca's program.[33] Thus, once a customer is locked into a contract, it creates another split incentive between the building owner and BlocPower, the owner of pieces of the building's infrastructure.

In any case, the needed decarbonization of U.S. building stock requires scaling beyond a municipal level; it requires scaling on a national level. Fully relying on the private sector to provide the funds and equipment for the energy transition for buildings would mean the government giving up its mandate to ensure a sustainable economy, instead relying on the private market to provide the necessary capital. In the case of Ithaca, the system of public finance has already failed to provide for the one municipality that has taken the necessary steps to reduce emissions.

Fully relying on the private sector would have many implications for building decarbonization. Here, we focus on two. First, relying on the private sector for the funds to decarbonize would shift the responsibility of decarbonizing to the private sector. The private sector has decarbonization targets less ambitious than those of governments, has not historically prioritized sustainability, and is not accountable to the general public (Gabor 2019). Thus, a reliance on the private market without adequate public funding to compete will slow the urgently needed energy transition.

Second, funding EE through private finance would rely on the volatile health of the private market. EE investments are part of corporations' environmental, social, and corporate governance (ESG) portfolio, which has a role in the portfolios of most investors as a premium and ultimately disposable investment. This allows the value of ESG assets to have incredible gains during periods of good market conditions, but also crash during periods of market downturn (Niedens 2023). While the surge in ESG popularity has increased the funds dedicated to clean energies, the energy transition requires long-term, stable funding, which the value of emerging assets cannot sustain on its own. With CRE in particular, investors in 2023 are in a crisis, as demand for office space remains below pre-COVID levels. In a period of oversupply in the CRE market, premiums such as EE are less likely to be pursued. Thus, EE's status as a product premium deprioritizes it in decision making.

The financialization of EE must be understood as part of the greater financialization of real estate. This is the process that turns our buildings from tangible assets that are maintained to ensure quality-of-life into investment vehicles through which short-term returns are sought. Turning buildings from physical assets that provide palpable value to financial ones that produce monetary returns is the same process that gave rise to the corporate landlords, which are themselves a cause of underinvestment in EE (Aalbers, Fernandez, and Wijburg

[33] Personal communication with Rebecca Evans and Luis Aguirre-Torres.

2020).[34] Financialization cannot be expected to solve the problems it helped create simply by making a new product.

As a final note, it is important to understand the intersection between environmental justice and economic justice. Both principles teach us to center the most vulnerable, whether they live in low-income neighborhoods, are economically disenfranchised, or both. For environmental justice to make progress, it must be aligned with economic justice. Rather than provide necessary infrastructure through tax dollars paid to a publicly accountable body, which in turn supports the taxpayers, the private service model connects private funds to neglected public sectors in exchange for rent. This rent then enters the capital market, where it benefits those who already own capital (Moreno 2014). This process further solidifies privatization as a primary way to achieve climate goals and reinforces the overall process. Increased public funding under the federal Inflation Reduction Act can help address this problem, but on its own it will address only a portion of the overall need (Kresowik 2023).

CONCLUSION

The financing mechanisms we discussed here are entirely focused on the financial barriers to investment. By removing the upfront cost of retrofits and repaying through savings, solutions such as PACE loans, OBF, and EEaaS allow efficiency to make economic sense to a wider set of customers. Companies such as BlocPower are innovating the private market by combining EE services and private investment to scale these solutions to entire municipalities.

However, none of these solutions address the barriers inherent in the structure of businesses and industries outlined earlier in this report. Since the innovation of financial products can remove only one part of the barrier to a more sustainable building stock, these products can undo only a sliver of the building stock's energy inefficiency and remain niche choices years (and decades) after their rollout.

Because public funding is inadequate, private sector financing remains the only way forward for many customers. More scalable options to leverage the full capacity of capital markets are gaining popularity after many years of discussion. Despite the promise these options hold for individual municipalities, fully relying on the private market for both equipment and funding would mean giving up on public provision of decarbonized buildings. This would open up decarbonization to the risk of market volatility; remove public accountability, as select corporations would increasingly control environmental protection; and leave

[34] See the "Multi-Split Incentives" section (p. 3).

unaddressed the needs of market segments (e.g., low-income households) that the market deems too risky.

Strategic Partnerships, Open Information, and Stronger Policy to Scale Retrofitting

The economic root cause of sluggish retrofitting is a separation of incentives, between firms, within firms, and over time. Thus, the mitigation strategies we outline here focus mainly on uniting the incentives of separate actors. We also offer recommendations to make more information available, based on the recommendation of other authors and to limit the uncertainty that deters EE investments. By allowing for greater information exchange, we can lift the barriers to cooperation among separate actors. Stronger policies and regulations will also be needed to make these changes possible.

LEVERAGE EXISTING BUSINESS PARTNERSHIPS

Local business partnerships already exist throughout the country. These include main street associations, business improvement districts (BIDs), and historic districts. Building owners in these partnerships can leverage their existing frameworks to implement retrofits more accessibly and on a larger scale. Such partnerships benefit from physical proximity and often have the same utility suppliers; BIDs in particular have shared funds and administrative capacity for space improvements. By bargaining as a single group of businesses, they might also receive better financing options.

The risk of retrofitting could also be pooled if each business pays into and receives benefit from a single program. While such a framework does not yet exist, creating one could seriously reduce the individual building risk. Under such a program, building owners would pay a rate depending on their building size and an estimate of their efficiency, and receive savings from their bills regardless of how much of those savings were actually realized. This would offer ESI without having to provide a pool of capital, as the separate businesses would be pooling their risk and insuring one another. Barriers to this include the administrative overhead to develop a framework in which businesses pay into one shared account, getting businesses to agree to participate, and the moral hazard that comes from pooled risk. However, for smaller tight-knit downtowns, a pooling program could be an option.

NATIONAL DATABASE OF RETROFITTING OUTCOMES

The accuracy of retrofit audits is limited by a lack of performance data. Many researchers have noted this, with one going so far as to say that submitting data on cost, estimated performance, and measured performance to a public database should be a prerequisite to receiving monetary environmental incentives (Benson et al. 2011; Lai et al. 2022; Mathew et al. 2005). This would help standardize definitions of retrofits, give the efficacy of different retrofits by region, and also provide a clearer view of how much progress has been made upgrading the existing building stock. This collection of data would be similar to the European Union (EU) energy performance certification system, which has been in place since 2010.

Although there have been public efforts to establish such a database, they have fallen short of industry needs. In 2013, the Department of Energy (DOE) developed the Buildings

Performance Database (BPD) to provide open information on building performance (Chen 2013). While the BPD has been useful for many stakeholders, it does not offer information specific to the efficacy of retrofits. In 2015, researchers at the DOE-funded Lawrence Berkeley National Laboratory published a database specifically on the performance of EE measures in commercial buildings to encourage their adoption, but it relies on simulation-generated data, as real-world empirical data are hard to come by (Lee, Hong, Piette, et al. 2015; Lee, Hong, Sawaya, et al. 2015).

To succeed, a database would have to be easily incorporated into the standard retrofitting process. This would require partnerships between government agencies that collect data, contractors that perform retrofits, and utilities, which would submit anonymized energy usage data. With this information, energy savings could be better predicted. Another benefit to the increased information is that contractors could move closer to the actuarial pricing model, which would require less auditing labor.

ENVIRONMENTAL STANDARDS FOR ISSUERS OF FEDERALLY BACKED MORTGAGES

As noted previously, the financial potential of EE alone does not reliably spur investment. Thus, regulations to require decarbonization should be considered to reach sustainable practices. Building performance standards (BPS) establish performance requirements—such as energy intensity or an efficiency rating—for new and existing buildings. BPSs are beginning to be implemented in select jurisdictions globally; in the United States, three states and more than 10 municipalities have implemented them.[35]

Mortgage portfolio standards would similarly impose science-backed targets for building performance using financial regulation. This would require implementation by the federal government and would apply to loans it backs through Fannie Mae, Freddie Mac, the Federal Housing Administration, and the U.S. Department of Agriculture; together, these constitute the overwhelming majority of U.S. mortgages.[36] Requirements could be imposed on building portfolios, allowing financiers to develop a package that is most feasible across their portfolio. This would allow banks to optimize their decarbonization strategy for their portfolio on their own terms, while still requiring them to reach environmental goals. With this approach, the federal government can leverage its massive role in the real estate market as a guarantor of mortgages.

[35] For more information on BPS, see ACEEE's research report *Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals* at https://www.aceee.org/research-report/b2303.

[36] The mortgage market is concentrated in the residential sector, with financing less common among commercial buildings. Still, an MPS would spur the decarbonization of many commercial properties, as well as aid the needed growth of the EE sector.

MPSs have been proposed in the EU already and have the potential to be adopted into member states' environmental plans.[37] European adoption is supported by the EU's certification process, which routinely documents the energy performance of buildings. The United States lacks such a system, further illustrating the need for information on building performance.

TRANSPARENCY AND PARTNERSHIPS TO IDENTIFY OPPORTUNITIES IN THE BUILDING LIFECYCLE

A building is more likely to be retrofitted during times of turnover, such as when it is sold, when it is being renovated, or in between tenants, as the buildings are vacant (Curtis, Walton, and Dodd 2017; Mathew et al. 2019). Thus, retrofit programs can be more effective if they are able to target building owners during these times. This would require transparency in licensing approvals so that EE providers are aware of opportunities to retrofit buildings. If EE providers have access to the approval of major renovations, they can more effectively target their outreach.

Without public intervention, providers could also partner with CRE providers individually to work with them during periods of turnover. For example, if a building is being sold through a real estate agency, a deal between that agency and the local utility could allow for a retrofit to be installed prior to the new owner moving in, with the price of the retrofit included in the financing of the building. As a result, real estate agencies could then act as a one-stop shop—a simplified business model that allows for easier and greater EE adoption.

LENDING PARTNERSHIPS BETWEEN CDFIS AND UTILITIES TO FACILITATE LENDING

CDFIs and utilities are institutions that would, in theory, loan money for retrofits, but each institution has obstacles in its way. For CDFIs, this obstacle is a lack of funds. For utilities, it is the fact that they are not banks; they typically do not have loan departments, and setting one up would cost a lot of money and be a huge initiative to take on. These problems could be addressed concurrently if utilities could loan funds for retrofits through CDFIs. The bank could service loans originated by the area's utilities in any particular CDFI's area of focus. Through such a program, utilities could more conveniently finance projects in the area. While forming a partnership like this would require administrative labor for both parties, this

[37] The European Central Bank (ECB) formally recommended MPSs in its opinion on the recast of the Energy Performance of Buildings Directive (EPBD), a decarbonization regulation for EU member states' building stock in January 2023 (European Central Bank 2023). This opinion was later supported in March 2023 by the European Parliament; the process to formally adopt the directive is still underway (European Parliament 2023). The EU is unable to create laws for member states, but it can issue directives that require member states to make laws in order to reach a certain standard.

cooperative solution is less burdensome for CDFIs than acquiring funds through alternative routes and less burdensome for utilities than developing lending capacity. Also, because utilities already collect detailed information on retrofit projects and their energy savings as part of their monitoring, reporting, and verification (MRV) activities, they can easily share this information with the lender.

CONCLUSION

Within the CRE sector, tangible changes that can facilitate greater EE adoption are well within the power of our governments, financial institutions, private contractors, and utilities. To accomplish these changes, however, these separate actors must work together to increase their influence. A group of adjacent businesses can accelerate their electrification if a trusted representative can negotiate a package that covers all of them. A lending program facilitated by a CDFI through utility funding can more effectively deploy financing. Such partnerships can also be indirectly encouraged by increasing the available information. With greater transparency in building permitting, EE programs can more effectively reach customers. With more rigorous reporting on building performance, the efficacy of retrofits will be better understood, and stronger regulations can be established accordingly.

These changes, if made, would also have spillover effects to other environmental issues. For example, if main street partnerships are able to retrofit entire downtowns as an entity, then procuring rooftop solar, adopting heat- and flood-resistant landscaping, and other environmentally beneficial changes are possible. With a national database on retrofitting outcomes, greater information sharing on other issues will be closer in reach. While the suggestions here are prescribed with CRE in mind, they have application to a much wider set of environmental topics.

Conclusion

The EE movement was born in the wake of the 1973 oil crisis. Since then, commercial buildings have had an ever-increasing set of options for retrofitting. While these business models have provided great savings for many customers, market transformation has always been out of reach due to barriers that have remained largely unchanged since that time.

To face these challenges, we need to take a step back and understand them from a systems perspective. Rather than focus on discount rates and payback periods, we need to look at the CRE sector itself. When we do this, we see that it is a splintered field of separate companies cutting costs and that these companies are made up of individual humans with their own incentives and goals. All of the actors in this multidimensional web are making decisions with a long ecological impact while considering extremely short timelines. Given all this, scaling EE in CRE is clearly unsolvable solely through financial products.

The disparate incentives of self-interested actors in each dimension of the industry are causing these problems, and the solutions must unite these incentives rather than work against them. This means allowing utilities, governments, CRE investors, and myriad contractors, building staff, and tenants to work collaboratively for their mutual interests of more efficient energy use. Achieving this collaboration might involve combinations of various tools and approaches:

- The local business relationship frameworks already in place for other purposes
- An industry-wide collaborative database to advance development of EE valuation
- Transparency between tenants, owners, and contractors to take advantage of convenient times for retrofitting
- A better use of public funds that supports the ecological goals of local and state governments through a standard for real estate portfolios with mortgages backed by the federal government
- Lending programs in which utilities and CDFIs work together so that utilities can better deploy capital in targeted areas

When encouraging retrofits, we argue for a systems perspective. Effectively addressing the need for EE requires a lens that recognizes the underlying causes of the split incentives, incomplete information, and high upfront cost that every EE advocate faces. This view also requires us to understand the shortcomings of current public support for infrastructure investment, as well as the consequences of abdicating this responsibility to private finance. Ultimately, a systemic understanding of EE in CRE and elsewhere requires that we understand GHG reduction not as a siloed issue, but as coexistent with environmental and economic justice.

Appendix A: A Brief, Accessible Overview of Discount Rates

In corporate finance, a discount rate is the rate that companies use to compare different investment options. Let us say a CRE investment firm expects the money it invests in other companies, bonds, or the stock market to grow by 8%[38] a year and invests on a 10-year horizon (meaning: it is thinking up to 10 years in the future). If an EE project is to compete for capital in the company's portfolio, it must come close to or beat this discount rate.

This CRE developer is now considering a retrofit package that will cut annual energy costs in one of its buildings by 20%. This 20% is way higher than 8%; so far, it looks like a good investment. However, the retrofit costs the same amount as two years of energy bills, so it will take 10 years to pay for itself. This is a realistic payback period for an energy retrofit package.

The company has two options: It can take the retrofit and break even, or it can invest in something else and make 8% annual returns for 10 years. With compounding interest, this would provide the company with roughly 115% return on investment (ROI), compared to the retrofit's 0% ROI. For the retrofit to compete for capital in this scenario, the company would have to invest on a longer timeline, where the retrofit's savings can be reinvested after 10 years. However, CRE investors typically hold buildings for only 5–10 years before selling, so this longer timeline does not happen.

[38] Eight percent is commonly used as a discount rate as it is roughly the average annual growth rate of the stock market, with a little premium since these companies get in at the ground floor on projects.

Appendix B: A Brief, Accessible Overview of the Secondary Mortgage Market

The Primary Mortgage Market

The primary mortgage market is what we think of as the mortgage market. When a person or business goes to a bank (or other financial institution) and takes out a mortgage, that is the primary mortgage market.

For example, let us say you borrow $250,000 from Bank A, and you pay it back over 20 years at 5% interest. Figure B1 shows this model.

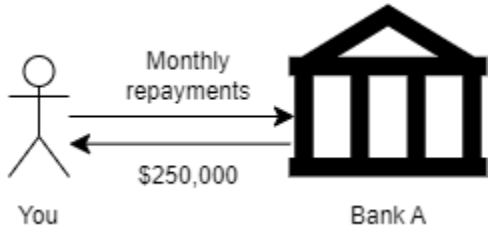

Figure B1. Basic mortgage structure

The Secondary Mortgage Market

On the secondary mortgage market, banks sell existing mortgages from the primary market to each other. So, let us say Bank A sells your loan to Bank B. Bank A gets some money up front, for a slight premium or discount, depending on market conditions. You then pay your loan back to Bank B. (You do not get a say in this.) Figure B2 shows this model.

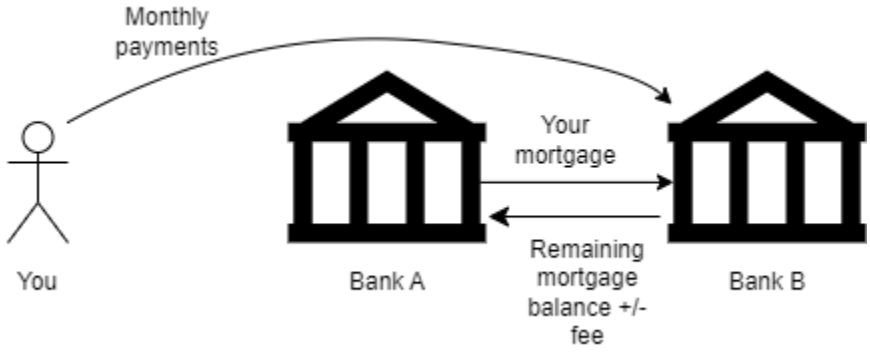

Figure B2. A mortgage sold on the secondary market

This secondary market exists for all types of debt: credit card debt, car loans, small business loans, oil and gas loans, and so on. But for the purpose of this report, we focus only on mortgages.

Why Two Markets?

Why does the secondary market exist? There are several reasons.

Liquidity

When ordinary people and small businesses need cash, they get a loan. Banks can take out loans too, but this puts debt on their balance sheet. If (for whatever reason) Bank A needs funds right now but does not want to take out more debt, it can sell your loan to Bank B, get the cash it needs, and not add debt.

Diversifying Risk

If a bank holds a bunch of mortgages of one type, they are exposed to that real estate market. Let us say Bank A mostly has commercial mortgages in a city, and Bank B has residential mortgages in suburbs a few states away. Bank A is exposed to the CRE market of that city. When commercial property values in that city are high, Bank A is doing great. They are issuing mortgages left and right, and they can charge a higher rate, too, since the customers are expecting such high returns. However, if this city's economy starts to decline, there is a risk that some of the companies Bank A lent to will not be able to pay back the loan on time or might go bankrupt altogether. If enough borrowers do this, Bank A is in trouble as well.

To avoid this, Bank A buys some mortgages from Bank B so that if the city's commercial properties are not doing so well, the mortgages from the suburbs a few states over will still bring in cash. Bank B will also be buying mortgages from Bank A and other real estate markets to diversify its risk.

Speculation

If Bank A expects Bank B's housing market to shoot up in the next few years, it may want to get more exposure to that market. It therefore buys some loans from Bank B. According to Bank A's calculations, it is buying these mortgages at a discount and, in a few years, it expects them to be worth more, at which point it can sell the mortgages at a premium to Bank C.

Bank B can use the money from its sale to Bank A to buy mortgages from other banks (to diversify its risk), or it can lend the money to more homeowners in its area and bet further on its local real estate market.

Appendix C: A Brief, Accessible Overview of Mortgage Securitization

As discussed in Appendix B, a large market exists for buying and selling mortgages and other kinds of debt. The main expense of selling individual mortgages is the amount of time bankers spend reviewing the underwriting documents and running their own risk models to make decisions about how much they are willing to pay for a mortgage. But what if you are buying hundreds of mortgages? What if you work for an investment company that does not work with mortgages, but you want some exposure to the real estate market? What if you want to investment only in mortgages with the lowest risk of default?

Mortgage-backed securities (MBSs) were created to address these issues. Securitization is a process that reviews mortgages, puts them into groups according to their risk level, has an outside ratings agency certify the risk levels, and then sells the mortgages to investors.[39]

So, let us say that Bank A has a lot of mortgages, and it wants to sell MBSs. Bank A would set up a separate company that it legally controls called a special purpose vehicle (SPV). Generally, an SPV is a company that exists to do only one thing. In the securitization context, the SPV makes and sells securities. This is for risk management, since the SPV has a balance sheet that is separate from Bank A. Since the securities are sold through the SPV, if Bank A goes under, the money paid on the mortgages goes to the people who bought the securities, not the lenders to which Bank A owes money.

Once Bank A creates the SPV, it transfers the loans it wants to securitize to it. The SPV then groups the mortgages, based on their risk level, into *pools*. Different investors want different risk levels. For example, a pension fund wants safe loans, since it always needs to be paying out funds, and people do not want their pensions gambled with. An investment firm seeks bigger returns, so it might buy a higher-risk pool for a discount. These pools are further broken up into *tranches*—that is, the different priority levels for payment in case of a default. The lowest tranches have the highest returns, but if the debtors cannot pay, the lowest tranches get paid last. Figure C1 shows a simple model.

[39] As Appendix B mentions, this can be done with all kinds of debt, and not just mortgages. MBSs are a subspecies of asset-backed securities (ABSs). The securitization process also varies state by state. As noted, our discussion here offers a very simplified version of the securitization process.

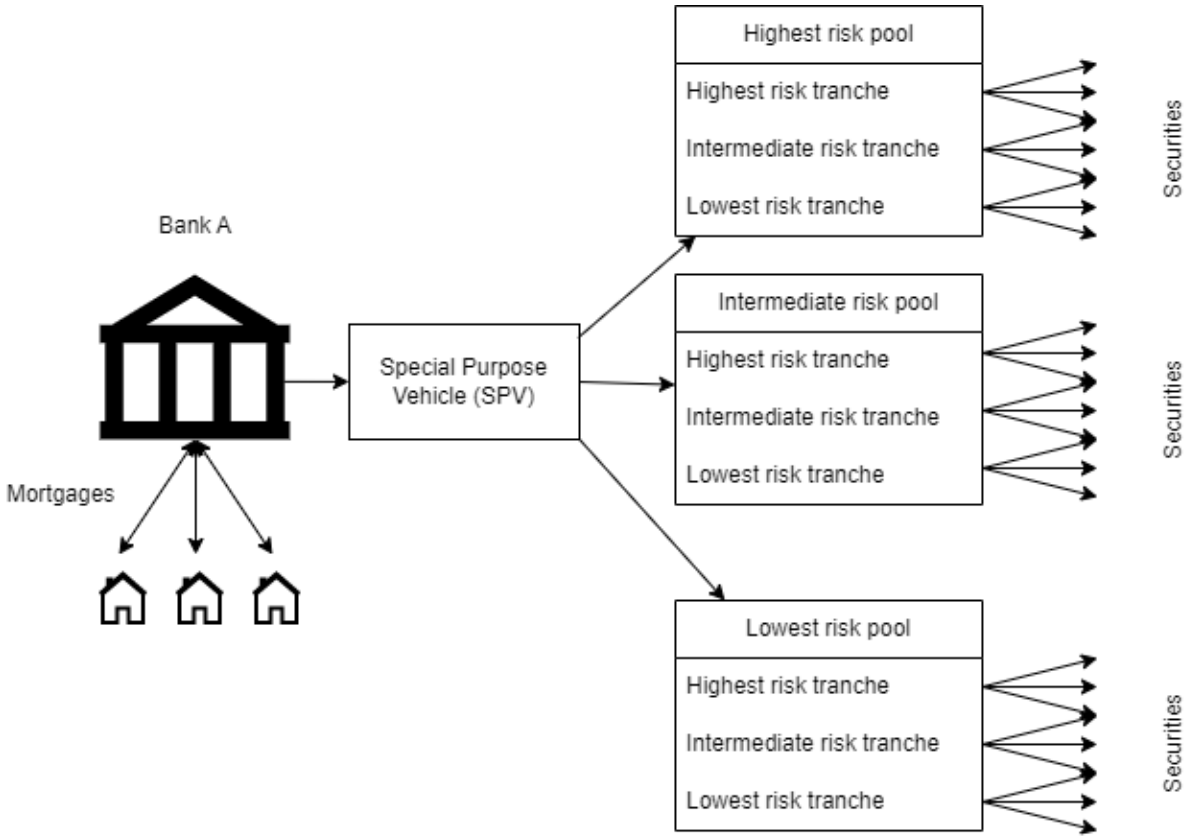

Figure C1. Basic securitization model

Next, Bank A needs to verify that these securities are indeed secure by having them rated by a ratings agency. Bank A takes these proposed securities to any of the three dominant ratings agencies (Moody's, Fitch, or S&P Global); that agency then reviews the loans and gives them a rating so that buyers can be assured of their risk level without having to review all the loans themselves.

Following are three of the main benefits of securitization.

Liquidity

Securitization brings the market *liquidity*—that is, the ability for money to enter or exit a market or company. Prior to securitization, money enters the market by buying and selling houses, which happens less frequently and is out of the bank's control. With securities, the bank can quickly raise money by selling these assets, like selling stocks or bonds. Mortgage issuers can then get money much faster and easier.

Lower interest rates

MBS buyers can choose the exact risk level they want, which is a premium service for an investor. This encourages the bank to issue more mortgages to sell, which they do by lowering the interest rates they offer to future home buyers.

Risk management

Securitization *de-risks* the investment for MBS buyers because the securities are sold through the SPV, and buyers need not worry about the bank's risk. It is also de-risking for the bank, since the bank has already received payment for the mortgage from the sale of the MBS and now does not have to worry about the borrowers paying off their mortgage. Thus, securitization is a completely risk-free way to issue and sell mortgages—aside from the unlikely event that this risk-free perception allows for a gigantic financial bubble that grows until the whole system of MBSs collapses and causes a global financial crisis, which has only happened once (in 2008).

Appendix D: A Brief, Accessible Overview of Why Mortgage Securitization Was a Central Cause of the 2008 Global Financial Crisis

From 2001–2006, a bubble formed in the U.S. housing market. That is, housing prices rose and rose, but the prices were not backed up by real value; instead, people just expected prices to keep rising further, so they invested more into the housing market, which drove prices higher, until one day it all broke down and crashed the economy. The causes of this bubble are numerous and outside the scope of this report. As is the case with all bubbles, mainstream financial knowledge largely lacked awareness of the bubble's existence. Indeed, in the opinion of private finance leaders, the Federal Reserve, Freddie Mac and Fannie Mae, and individual home buyers all over the country, the U.S. housing market was a safe and profitable investment.

So, all investors wanted a piece of the action—and not just those investors who primarily focus on housing. As Appendix C explains, MBSs let investors who do not trade in mortgages get exposure to the housing market. So, given this heavy demand for mortgages, investment banks (such as Lehman Brothers) were buying up all the mortgages they could to package them and sell them as securities.

With a demand for mortgages and rising home prices all over the country, mortgage issuers had an incentive to issue a lot of mortgages, even to borrowers that could not quite pay them back. Helped by low interest rates, lax lending standards, and no downpayments needed,[40] mortgage issuers were able to issue a lot of these sub-prime mortgages, which they could sell for a high premium to eager security issuers.

The banks then took these securities to the ratings agencies, which rated them way more safe than they actually were. Because ratings agencies get paid for each rating, they had a financial incentive to rate these securities highly. Plus, if they did not do so, either of the other two dominant ratings agencies would do it. Demand for MBSs was so great that banks began developing financial instruments to make more sales of securities without issuing more mortgages,[41] further eroding the stability of the financial system. Fannie Mae and

[40] This was through downpayment assistance programs (DPA). In a DPA, a seller gave a donation to a charity, the charity gave the money to the buyer for the downpayment, and the seller raised the price of the house to get the downpayment back (Government Accountability Office 2005). The seller then paid the charity a fee for helping it kind of commit fraud (Internal Revenue Service 2006). This is now illegal.

[41] The three most common were collateral debt obligations (CDOs), synthetic CDOs, and credit default swaps (CDSs). A full explanation of how these work is beyond the scope of this report.

Freddie Mac also purchased and guaranteed many of these securities, which accelerated their adoption.

Thanks to both a lack of oversight and corruption by the financial regulator—the Securities and Exchange Commission (SEC)—the MBS frenzy operated as an open secret throughout the financial system's disparate arms until 2007, when housing prices started to decline and subprime mortgage holders began to fall behind on their mortgage payments. The MBSs and other financial assets that these mortgages were based were now worthless. Banks that had too many of these assets (and were overleveraged in other ways, too) either went bankrupt or were bailed out by taxpayers.

For a time following this period, MBSs were toxic investments and no one wanted any part of them. But, by 2012, the market for them had stabilized (Board of Governors of the Federal Reserve System (US) 2023; Department of the Treasury 2012).

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