RFF REPORT

Borrowing to Save Energy

An Assessment of Energy-Efficiency Financing Programs

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Executive Summary

Residential and commercial buildings are responsible for 42 percent of energy consumption in the United States and a comparable percentage of U.S. carbon dioxide emissions. Experts have identified a number of building retrofits and equipment replacements that purportedly will yield future energy savings that more than cover the up-front investment costs. Why these seemingly cost-effective investments have not been made is a matter of vigorous debate. Numerous explanations ranging from incomplete and asymmetric information to irrational consumer behavior have been offered for this failure to invest, and numerous policies and approaches have been proposed and adopted to address the issue. This report focuses on one such approach: increased availability of debt financing for efficiency investments.

The importance of financing to enhancing energy efficiency is straightforward: even when investments in retrofits and new equipment pay off in future energy savings, the up-front expenditure is often substantial. To make these investments, most building owners require financing. If credit markets do not function efficiently because of a lack of information or other market failures, these problems contribute to the so-called energy-efficiency gap and may suggest a role for government.

In this report, we explain how markets for energy-efficiency financing work and describe the characteristics of the numerous government and utility financing programs operating in the United States. We explore the reasons financing for energy-efficiency improvements has so far been limited, including the possibility of credit rationing. Next, we discuss government's role in developing policies to spur investments in energy efficiency. Our analysis identifies gaps in knowledge and information, particularly about the energy-savings payoffs from financing and other energy-efficiency efforts. Accounting for these information shortfalls, we recommend a path forward.

Private Energy-Efficiency Financing Options

Private financing for energy-efficiency improvements to buildings in the commercial and institutional sectors can come from internal or external sources. Internal financing sources include capital and operating budgets, maintenance funds, and reserve accounts, while external funding can come from capital leases, operating leases, loans, bonds, and capital markets. Public institutions—such

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as municipalities, universities, schools, and hospitals—can also take advantage of tax-exempt municipal bonds and lease purchase agreements.

A successful private, third-party approach to energy-efficiency improvements has emerged to serve these sectors in recent years. In this approach, the property owner secures financing, and an energy services company, or ESCO, provides efficiency improvements, equipment upgrades, and maintenance—typically backed by a performance guarantee to help mitigate investment risk. The ESCO industry achieved revenues of around $4 billion in 2008 and is predicted to continue growing. Some companies work hand-in-hand with ESCOs to provide financing for the improvements, using energy performance contracts that are backed by the energy savings.

For the residential sector, private energy-efficiency lending is available from some community banks and credit unions, programs offered by contractors, a long-running Fannie Mae program, and from energy-efficient mortgages. Apart from these examples, privately offered loan products specifically for energy efficiency are rare, and few homeowners have participated in these programs.

Government and Utility Programs

More widespread are government- and utility-run energy-efficiency programs. Our inventory identified 52 state and 51 local governmental programs now in operation, and 103 utility programs that provide financing for homeowners and business in their service territories. These programs participate in the market for energy-efficiency financing by offering various credit enhancements such as loan loss reserves, loan guarantees, and interest-rate buydowns, and by direct lending using revolving loan funds.

A complete analysis of these programs would include evaluation of participation rates, loan performance, and the types of retrofits and improvements property owners make with the loans and, most importantly, estimation of energy savings. Such analysis is currently lacking as the necessary data is not widely available, but our research allows us to provide the following insights:

- With the exception of a few utility-operated residential loan programs, energy-efficiency financing from governments and utilities generally has reached only a very small subset of property owners, on the order of less than 1 percent to 5 percent of those eligible for a given program.
- With any type of loan, there is a risk of delinquency and default. Data from one residential program suggests that the costs associated with these risks vary widely by borrower: default rates in Pennsylvania's Keystone HELP program ranged from an average of 0.03 percent for those borrowers with the highest credit rating to 4.33 percent for those with the lowest. More analysis of the factors that explain these risks, in this program and others, would be useful. Particularly important for analysis would be the Fannie Mae Energy Loan program, which has operated nationally for nearly 20 years.
- The types of retrofits and improvements financed by homeowners through these programs vary widely. Some programs target "reactive" consumers replacing broken equipment such as furnaces and air conditioners, while others emphasize whole-house retrofits. The variability makes evaluation of the energy savings and costs of loan programs even more difficult than other government energy-efficiency programs.

Market Barriers

In our view, the limited market for energy-efficiency financing is more a result of the lack of underlying demand for energy-efficiency improvements by property owners than issues with the market for financing. A variety of factors suppress demand, including potential hidden costs and transaction costs associated with some products and retrofits, failure of consumers to make economically rational decisions, and an absence of good information about the payoffs from particular investments. The relatively low price of energy in many areas of the country also contributes. Facing competing spending priorities, many businesses and homeowners do not focus their attention on these costs.

While limited demand for energy efficiency dominates, some characteristics of the market for energy-efficiency financing are also important and may constrain the use of energy-efficiency financing products:

- Energy-efficiency loans are typically unsecured and thus inherently risky, leading to relatively high interest rates and lending that is mainly based on the credit-worthiness of the borrower—not the value of the investment.
- Obtaining these loans often involves significant transaction costs for borrowers and contractors who perform the retrofit work. Energy audits often are required before applying for a loan; the amount of paperwork can be substantial; there can be delays in getting loan approval; and repayment usually involves a new monthly bill for property owners. These extra transaction and administrative costs limit borrowers' interest in financing.
- In the residential and small business sectors, the value of energy-efficiency loans is low relative to the origination and processing costs. The small margins on these loans make them of limited interest to many lenders.
- Without a standardized energy-efficiency loan product, lenders are limited in their ability to take loans to a secondary market. Without access to secondary markets, there is no ability to recapitalize loan programs and increase the amount of money available. For government and utility loan programs, this inability to recapitalize has been a matter of some concern.
- Asymmetric information may lead to an adverse selection problem that contributes to credit rationing, although the extent to which this problem exists in energy-efficiency markets is an open question. The one factor that suggests it may exist to some extent is the lack of good information about the energy savings payoff from the investment. This lack of information may be contributing to a credit market failure.

The Information Gap: A Role for Government?

Many of the market barriers to energy-efficiency financing arise because lenders and borrowers lack good information about the payoffs from efficiency improvements. On the supply side, reliable estimates of energy savings from particular investments under alternative future energy price paths are not widely available to financial markets. Moreover, mortgage underwriting practices do not encourage collection of such information in the case of residential properties, nor do they encourage the appropriate use of it in the case of commercial properties. As a result, financial markets may not back investments with particularly high payoffs from energy savings because they cannot distinguish them from investments with low payoffs. This presents a type of credit rationing specific to energy-efficiency financing.

The lack of good information about the energy savings from building retrofits is also a probable contributor to property owners' lack of interest in energy efficiency more generally. This point has been made in several studies of the energy-efficiency gap. A good deal of uncertainty surrounds the payoffs from investments in insulation, air sealing, windows, HVAC equipment, new appliances, and more, and uncertainty about future energy prices exacerbates the problem. Many homeowners and business owners do not even know what options are available to them, much less have a good estimate of the energy savings that can be achieved.

The fact that missing or asymmetric information contributes to the general lack of demand for energy-efficiency improvements and to the limited market for energy-efficiency financing suggests a possible role for government. This role may include the provision of information that has been suggested by many economists and others – mandatory appliance and equipment labeling, subsidized energy audits for homes and businesses, requirements for energy disclosure in mortgage underwriting, and voluntary certification programs such as the Energy Star program for appliances. And in our view, it should also include detailed collection of data from the myriad energy-efficiency loan programs in operation, and careful analysis of those data.

A Path Forward

The lack of good information is not just stymieing private financing efforts. It also means that government and utility financing programs have not been adequately evaluated in terms of their cost-effectiveness in reducing energy use and CO_2 emissions. Sound policy decisions require an evaluation of these programs and their accomplishments vis-à-vis alternative energy-efficiency policies and programs. Are the revolving loan funds operated by many state governments a wise use of taxpayer money? Or would the money be better spent on other energy-efficiency efforts? Such questions cannot be fully answered without robust information on energy savings.

Gathering the right kind of information on energy savings is difficult. Financing programs yield more uncertain savings than other energy-efficiency programs supported by utilities and government because they tend to focus on multiple inter-related improvements and often leave the choice of specific improvements to the property owner. This complicates the use of traditional engineering approaches for evaluating energy savings and contributes to the substantial uncertainty as to what these programs are actually achieving. Yet analysis is possible, and it is essential for evaluating taxpayer- and ratepayer-funded programs and for stimulating private financing markets.

We suggest two approaches to energy data and analysis:

(1) Utilities that have had long-standing loan programs should make available data for analysis, including monthly billing data on participants and nonparticipants. This micro-level data would provide the level of detail necessary to fully evaluate the net effects of program participation on actual measured energy use. Although customer privacy may be a concern, this could be addressed with confidentiality agreements. Regulated utilities taking energy savings credit for their many energy-efficiency programs may prefer not to open themselves up to the scrutiny of outside researchers, but improving the effectiveness and cost-effectiveness of these programs should be a paramount objective.

(2) Utilities, government, and other interested parties should conduct randomized controlled trials of policies and programs, including efficiency financing programs, to promote energy-efficiency investment

and analyze the results of these experiments. A general problem with evaluating voluntary programs is that it is difficult to separate the effect of program participation from the effects of other factors that might make people more likely to participate. With a randomized controlled trial, households or businesses would be randomly assigned to treatment or control groups, thus avoiding so-called selection bias. Treatments could include randomized encouragement to sign up for a loan program (like an on-bill financing program), and an evaluation that would track energy consumption of both treatment and control groups. With sufficient data points, the experiment could be structured to compare different types of loan programs and/or compare loans to other policies.

In addition to the essential information on energy savings, information is needed on the financial performance of energy-efficiency loans. To fully engage in energy-efficiency financing, markets need better systematic information on the factors that explain defaults, delinquencies, and overall loan performance. *The Fannie Mae Energy Loan data would provide the best data for residential loan program analysis as it is a long-running program—operating through several business cycles, including the most recent recession—and it is available nationally. A careful analysis of this program would be beneficial to private markets and to policymakers.*

A Cautionary Note

Better information on energy savings may be necessary but not sufficient to generate more lending for energy-efficient investments. High transaction costs and low margins may continue to be a barrier—for residential lending, in particular. Credit rationing also may arise because of other types of asymmetric information about borrowers, a feature of many consumer credit markets. Perhaps most importantly, energy consumers just may not have much incentive to make investments in energy efficiency due to relatively low energy prices, opportunity costs of investing in energy efficiency, and other hidden costs or quality issues associated with the investments themselves.

Is there a role for government to play in facilitating energy-efficiency financing or directly providing loans for energy improvements? As a second-best policy in the absence of direct pricing of CO_2 emissions, some energy-efficiency policies may be called for. Whether financing is one of them should be determined based on a full analysis of the cost-effectiveness of this approach compared with alternative policies. This brings us full circle to our call for a better and more rigorous analysis of the energy savings and costs of energy-efficiency financing programs. Not only is such analysis useful for private financial markets, it is critical for sound energy policy.

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Introduction

Residential and commercial buildings are responsible for 42 percent of energy consumption in the United States and a comparable percentage of U.S. carbon dioxide (CO_2) emissions. Many experts have identified a number of building retrofits and equipment replacements that purportedly will yield a discounted stream of future energy savings that more than covers the up-front investment costs. In one prominent example, McKinsey & Company (2009) finds that by 2020 building owners could save 12.4 quadrillion BTUs of energy—or roughly 29 percent of predicted baseline energy use in residential and commercial buildings—through these kinds of low- or negative-cost investments.

Why these seemingly cost-effective investments have not been made is a matter of vigorous debate. Explanations include hidden costs or uncertain benefits associated with new technologies; a lack of information in the marketplace; other market failures, such as the "split incentives" between landlords and tenants; and behavioral issues that suggest consumers may not act in fully rational economic ways when choosing appliances and equipment.

Some experts also have suggested that credit market failures may lead to underinvestment in energy efficiency. Even when investments in retrofits and new equipment pay off in future energy savings, the up-front expenditure is often substantial and may require financing. For residential consumers, simply adding insulation and upgrading a furnace can cost $10,000 or more, money that may not be readily available to many homeowners. Many energy-efficiency advocates call for "deep retrofits" that reduce energy consumption by 50 to 90 percent, and these upgrades can cost several times this amount (White 2011).[1] Commercial retrofits vary widely: simply replacing lighting and occupancy controls in a 250,000-square-foot office building can cost approximately $1 million, and more extensive retrofits may cost several million.

To make these investments, most building owners need to turn to capital markets. If those markets do not function efficiently because of a lack of information or other market failures, these problems could contribute to the so-called energy-efficiency gap. Our study focuses on this argument, evaluating the available energy-efficiency financing products and programs, and assessing market barriers to more widespread energy-efficiency financing.

We begin with a description of the private energy-efficiency financing landscape and then turn to a detailed examination of government and utility programs. We inventory the programs currently in existence, describe these programs' features, and discuss the outcomes of some programs. The market for energy-efficiency financing is limited; we offer reasons why and ask whether government has a role to play. The penultimate section of our study describes the importance of evaluation of energy

[1] The Rocky Mountain Institute runs a website, retrofitdepot.org, devoted to the subject of deep retrofits in commercial buildings.

savings from financing (and other energy-efficiency) programs. We then offer some concluding remarks.

Private-Sector Financing

Energy-efficient building improvements are funded through a variety of channels in the commercial and residential sectors. A survey by the Johnson Controls Institute for Building Efficiency indicates that most commercial building projects are undertaken with internal financing. Sixty percent of building managers participating in the 2010 survey reported that they planned to undertake energy-efficiency investments in the coming year through operating expenditures, while 52 percent planned to invest through capital expenditures. Only 7 percent planned to employ traditional debt financing. On average, between 2007 and 2010, building managers expected to spend between 5.2 and 6.2 percent of operating budgets and between 7.3 and 8.2 percent of capital budgets on energy efficiency (Johnson Controls 2010).

In another recent survey, residential energy auditors and contractors reported that only 17 percent of their customers, on average, take advantage of energy-efficiency financing opportunities to pay for retrofits (Palmer, Walls, et al. 2011). By contrast, an average of 58 percent of customers use cash or checks and 14 percent use credit cards; only 6.5 percent use a home equity loan. These numbers are roughly consistent with findings for general residential remodeling. Guerrero (2003) reports that an estimated 63 percent of home improvement expenditures are self-financed through savings, tax returns, or gifts, with 30 percent paid for through some form of external financing—18 percent from secured home equity loans or lines of credit and 12 percent through personal or unsecured debt.

Commercial and Public/Institutional Sectors

The most successful private, third-party approach to energy-efficiency improvements in the nonresidential sector is the energy services company (ESCO) model.[2] ESCOs provide efficiency improvements, equipment upgrades, and maintenance based on detailed analysis of a given property. The costs are meant to be recouped through energy savings, and ESCOs often provide a performance guarantee, so the building owner does not assume the risk that projected savings are not realized. This model often attracts building managers who will not act on their own due to uncertainty about performance of the efficiency enhancements and other economic factors, such as variability in energy prices. Goldman et al. (2002) estimate the U.S. ESCO industry completed between $1.8 and $2.1 billion worth of projects in 2000, growing at an annualized rate of 24 percent between 1990 and 2000. Satchwell et al. (2010) estimate that the ESCO industry achieved revenues of $4.1 billion in 2008 and project that it will continue to grow through 2011.

ESCOs themselves rarely provide financing. Instead, building owners are generally left to provide capital or acquire outside financing. ESCOs will work in partnership with lenders, though, and the performance guarantees offered by ESCOs can help reduce risk (Hinkle and Schiller 2009). Sources of funding internal to building owners' business include capital and operating budgets, maintenance funds, and reserve accounts. External funding can come from capital leases, operating leases, loans, bonds, and capital markets. Capital leases are agreements under which companies lease both the right

[2] For more information on the ESCO model, see Goldman et al. (2002), Hopper et al. (2005), ICF International and National Association of Energy Service Companies (2007), and Satchwell et al. (2010).

to use property and practical ownership of that property for a fixed period of time, often with an option to own or buy the property at the end of the lease term (Lee 2003). In the case of energy efficiency, leased property can include HVAC systems, boilers, lighting, sensors, and other equipment. Operating leases do not transfer ownership but rather the right to use property in exchange for regular payments for a fixed period of time (Lee 2003). Because the property is not technically an asset of the lessee in this case, payments for operating leases are frequently classified as operating expenses rather than liabilities.[3] As a result, operating leases usually have little impact on a building owner's credit rating or future ability to borrow, which makes them particularly attractive for energy improvements.

In the public and institutional sectors, building owners are able to use tax-exempt methods of sourcing capital, such as municipal bonds and tax-exempt lease purchase agreements. Municipal bonds lower the cost of financing because the investors supplying capital receive tax exemptions on bond interest, and the bonds are typically backed by all assets and revenue streams of the bond issuer, lowering risk. Tax-exempt lease purchase agreements are similar to capital leases in that they allow for lessees to use and purchase property by paying in installments rather than up front. These lease agreements are also exempt from federal taxes and are therefore available at lower rates.[4]

These municipality, university, school, and hospital building owners comprise the so-called MUSH market and the majority of ESCO customers. In 2008, this sector accounted for 69 percent of ESCO business by revenue (Satchwell et al. 2010).[5] Some members of the MUSH sector turn to financing for ESCO services because they own large facilities with aging infrastructure and have limited capital budgets. Using ESCOs for financing also avoids having to go through a bond issuing process to fund capital improvements, although the performance contracting arrangement poses some unique transaction costs related to measurement and verification of energy savings and other provisions which require a particular type of expertise. Federal mandates for reduced energy consumption create an additional incentive (Hopper et al. 2005)[6]. Moreover, "green" objectives may be more common for government agencies and universities than for the private sector, suggesting they may have an interest in lowering their energy use beyond a bottom-line financial motivation.[7] Financiers, in turn, are willing to lend to these markets for several reasons. First, generally large project sizes result in low transaction costs (relative to the up-front investment) compared with the residential and small commercial sectors. Second, standardized procedures for procurement simplify development of ESCO projects (Hinkle and Schiller 2009). And third, government backing, in the case of publicly owned

[3] For more information on the distinction between lease types, see Financial Accounting Standards Board (FASB 1976). The FASB guidelines are in the process of being modified to be more consistent with European guidelines, which are tougher on this type of off-balance sheet treatment. As a result, the expectation is that off-balance sheet treatment for operating leases will not be allowed in the future. Instead, such treatment will be reserved for service agreements (Carey 2012).

[4] For a more thorough discussion of these financing mechanisms, see EPC Toolkit for Higher Education (2009).

[5] In addition, federal government clients totaled 15 percent of industry revenues.

[6] Federal government agencies also use Utility Energy Services Contracts (UESCs), which are implemented by utilities rather than ESCOS, to improve the energy efficiency of their facilities. Utility involvement differentiates these arrangements in a number of ways: utilities are often willing to undertake smaller projects; utilities may be able to harness tax incentives for renewable energy investments; UESCs can be paid back through the utility bill; controls on the competitive bidding process are less strict; and UESC arrangements allow for more negotiation on performance guarantees, operations and maintenance, and measurement and verification than ESPCs (Shah 2009).

[7] As of January 2012, 674 universities and colleges have signed the American College and University Presidents' Climate Commitment, an agreement to achieve "climate neutrality" as soon as possible (see http://www.presidentsclimatecommitment.org/ for more information).

buildings, lowers the risk of default. A combination of these driving forces on both sides of the market has led to ESCOs' success serving clients in this space.

In contrast, commercial, industrial, and multi-family residential building owners' investments in energy-efficiency improvements through ESCOs is less common. Satchwell et al. (2010) estimate that in 2008, roughly 7 percent of ESCO industry revenues came from commercial and industrial clients, and only 6 percent came from projects in multi-family buildings. This may be partly attributable to capital constraints. For building owners whose predominant business is not real-estate ownership, internal competition for capital often favors investments directly related to the company's business model. ICF International and the National Association of Energy Services Companies (2007, 6) suggests the market "is hindered by the refusal of building owners to encumber their buildings with the debt required to finance comprehensive [Energy Performance Contracting] projects." Jaffee and Wallace (2009) point out that commercial property underwriting standards and the practices used to assess the energy risk exposure of buildings also create a disincentive for building owners to invest in energy efficiency. As part of the mortgage approval process, lenders calculate the net operating income of a building but in that calculation, the energy costs effectively are offset by tenant reimbursements for those costs through rental payments. Although tenants may be willing to pay higher rents in more energy-efficient buildings, lack of certainty in those energy costs creates several barriers. More broadly, split incentives between building owners and tenants and the short-term leases often used in the commercial sector together translate to limited interest in energy efficiency and a low aggregate demand for ESCO services (ICF International and National Association of Energy Services Companies 2007).

Nontraditional finance mechanisms intended to overcome some of these barriers to investment by building owners and tenants do exist. Agreements that bundle the services provided by ESCOs with financing are generically referred to as Energy Service Performance Contracts (ESPCs). In some cases the financing is arranged by a separate company that is not an ESCO. One example, the Energy Services Agreement (ESA), is a financing approach promoted by the company Metrus that works in concert with ESCOs. Through the ESA, Metrus contracts with a building owner to provide capital to cover efficiency-improvement expenses and recoup it through reduced energy costs, taking on the risk traditionally assumed by ESCOs or building owners. In addition, Metrus assumes responsibility for maintaining the equipment and retains ownership of any assets purchased for improvements, then selling the equipment to the client at expiration of the ESA. In this way, the ESA is similar to an operating lease, eliminating the need for building owners to make capital expenditures or take on debt associated with equipment investments. Metrus hires a traditional ESCO to audit the client's facility, select and install equipment, and provide ongoing maintenance, which can be important for realizing promised energy savings. Metrus also offers a variation, the Efficiency Retrofit Lease, which does not include maintenance services and is similar to other capital leases (Metrus 2011a).

Transcend Equity has created a similar mechanism, the Managed Energy Services Agreement, targeted to serve real-estate investment trusts (REITs) and private investors in commercial real estate with office portfolios of 250,000 square feet or more. Through each agreement, Transcend assumes the portfolio's utility payments and receives regular payments from tenants based on historical utility costs, occupancy fluctuations, and actual energy prices. Meanwhile, Transcend invests its capital or that of outside investors in improvements to commercial facilities, assuming risk of underperformance and using energy savings to recoup its up-front investment (Transcend 2011). Unlike Metrus, Transcend claims that it uses a transparent approach to project development rather than the more proprietary ESCO model (Gossett 2011).

In cases where ESCOs, financiers, or companies like Transcend will not assume risk of underperformance, insurers may support energy-efficiency investments by mitigating performance risk. Although this type of insurance existed in the 1990s and did not mature into a successful product, Energi Insurance Services is attempting to revive this service by offering ESCOs an Energy Savings Warranty, enabling ESCOs to provide stronger performance guarantees to customers (Energi Insurance Services 2011).

Despite the emergence of these innovative financing mechanisms, their use—like that of traditional sources of capital—is still limited in the commercial and industrial sectors. This may be due partly to the extra costs building owners must incur to pay the companies arranging the financing, installing retrofits, and taking on risk of underperformance. On the other hand, the MUSH sector appears to be adopting the approach to some extent and the model is a relatively new one; in time, more commercial building owners may turn to ESAs and other kinds of arrangements with third-party providers. A recent announcement by President Obama to use performance contracts to finance energy upgrades to more than 1.6 billion square feet of office space in federal buildings valued at roughly $2 billion may boost the prominence of performance contracting, leading to more widespread use by the private sector. . In fact, as part of the announcement, some private companies and organizations also signed on to similar commitments, including aluminum producer Alcoa, which pledged to improve energy efficiency by 25 percent across 30 million square feet of industrial plant space by 2020 (Yehle 2011).

The Residential Sector

Homeowners interested in financing energy improvements have a variety of options available, although they are not served by ESCOs or ESCO-like businesses. For buyers, the cost of home improvements can often be rolled into a mortgage. Mortgage holders may be eligible for a home equity line of credit or have the ability to refinance their mortgages and include project costs in the new mortgage. Contractor financing and credit cards are also often available. The interest rates, loan terms, and underwriting standards of these loan products vary significantly.

Some homeowners may not find an attractive loan from these general finance products, however. In that case, homeowners can sometimes avail themselves of financing specific to energy efficiency in the private sector. Retail bank activity in energy-efficiency lending is dominated by community banks and credit unions. Among many such programs, Umpqua Bank, a community bank in the Pacific Northwest, offers a program they call GreenStreet Lending, which provides energy-efficiency home equity loans and lines of credit as well as unsecured consumer loans for residential customers and two different loan types for businesses. Also in the Pacific Northwest, Puget Sound Cooperative Credit Union offers an unsecured loan product for energy-efficiency and renewable energy projects. This credit union offers loans up to $35,000 with interest rates between 4.74 and 7.99 percent and terms up to 15 years (Puget Sound Cooperative Credit Union 2011). Similarly, San Diego Metropolitan Credit Union offers the Energy Efficient & Solar Loan Program with interest rates between 5.99 and 10.24 percent for energy-efficiency loans of up to $25,000 and terms up to 15 years. In many cases, community banks and credit unions partner with governments and utilities to offer loan products for energy efficiency.[8]

Some large financial institutions also offer loan products through contractors, most of which can include energy improvements but are mainly for general renovations. Wells Fargo has been active in working with contractors, for example, but the bank does not have a specific energy-efficiency loan.

The Electric and Gas Industries Association (EGIA), a nonprofit, member-based organization that promotes energy efficiency and renewable energy, has forged two partnerships to offer financing for home improvement projects. In conjunction with GE Money, it offers financing through GEO*Smart*, in which contractors or utilities offer secured, unsecured, or revolving credit loans.[9] Unsecured loans are available up to $25,000; interest rates vary but are often in the 7.99–9.99 percent range, and a "same as cash" option is available for up to 12 months. Loan terms up to 20 years are available. EGIA contractors also can offer Express Loan, a product from EnerBank funding loans of up to $45,000 for 10 years at 18 percent interest. Like the GEO*Smart* loan, these can be offered "same as cash" for the first 18 months if the contractor pays a premium (Energy Upgrade California 2011). Unlike the GEO*Smart* loan, however, the Express Loan is not limited to energy-related improvements. EGIA reports that over the past five years, it has facilitated more than $800 million in home improvements through the financing products it offers (EGIA 2011).

Fannie Mae offers an Energy Loan product from three approved vendors. One is AFC First, a lender dedicated exclusively to energy efficiency and renewable energy that operates both privately and in association with government and utility programs. The AFC First product is an unsecured loan of up to $25,000 with a fixed interest rate of 14.99–15.99 percent and a term of up to 10 years (AFC First 2011). The second approved lender is Energy Finance Solutions, which offers a similar consumer loan at rates of 14.49–18.75 percent, serviced by the third approved lender, Viewtech Financial Services (Energy Finance Solutions 2011). Viewtech was the first lender authorized by Fannie Mae when it introduced its Energy Loan product in 1994. Since that time, Viewtech has serviced more than 40,000 loans worth $500 million. Currently, approximately 60–70 percent of the new Energy Loans processed by Viewtech come with some kind of government or utility interest rate buydown; the remainder are loans at the established Fannie Mae rates (McClain 2011). All three of these Fannie Mae approved lenders serve as the originators and servicers for several government and utility programs discussed later in this report.

In the absence of an interest rate buydown, the Fannie Mae rates are high relative to those charged by GEOSmart and other programs that work through private contractors.10 These latter programs generally make up for the lower interest payments they earn by charging fees to contractors for program participation; in turn, these fees are likely passed on to consumers in the form of higher prices for services and equipment. Under the mantle of consumer protection, Fannie Mae forbids contractors who participate in its programs from offering lower rates, arguing that such practices

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[8] We do not have information on the number of loans made by all of these banks, but between November 2008 and August 2011, GreenStreet Lending issued 173 residential loans, split roughly evenly between secured and unsecured arrangements, valued at more than $2.4 million; 83 secured commercial loans were made over the same time period, for a total of more than $31 million (Alfano 2011).

[9] In a revolving loan, the agency or utility makes loans directly and replenishes the fund with the repayments.

[10] The Fannie Mae rates were increased significantly in the summer of 2011, according to McClain (2011), who believes that rates in the 11–12 percent range would be a more accurate reflection of portfolio performance, expenses, and risk. This is substantially higher than current mortgage rates, which are close to 4 percent and rates of return on Treasury bills, which are less than 1 percent but is comparable to current average annual credit card rates.

violate truth-in-lending laws. The essential concern is that customers who take out a contractor loan for energy-efficiency improvements may be paying more for exactly the same service than customers who pay with cash or a credit card. By most observers' accounts, the Fannie Mae programs make up only a small fraction of total lending for residential energy efficiency; the contractor loan programs dominate.

Evaluating and comparing the advantages and disadvantages of the two approaches is beyond the scope of this report but could be worthwhile for purposes of understanding the best direction for future residential energy-efficiency lending. Experts argue that working through contractors is essential for financing programs to be effective (Carey 2011). But since most do not focus solely on energy efficiency, the energy benefits from these programs are unclear, and the extra costs that are paid to offer these rates need to be accounted for in a full assessment of program costs and effectiveness.

Energy-efficient mortgages are a final form of efficiency-oriented finance provided by private banks. The energy-efficient mortgage program began in 1992 as a government-backed facility to stretch traditional underwriting guidelines so borrowers could purchase more expensive but efficient homes; in theory, this efficiency would lead to lower energy expenses, which would offset higher mortgage payments. Originally set up as a pilot program sponsored by the Federal Housing Administration (FHA), the product expanded nationwide in 1995. Variations of the concept are also offered by Fannie Mae, Freddie Mac, the Department of Veterans Affairs, and the Rural Development Agency (Burke 2000). Collectively, these programs offer a variety of secured loan products through private lenders to purchase new, efficient homes or fund improvements to existing homes. In practice easy access to mortgage credit from the late 1990s until the financial market collapse in 2008 substantially limited the benefits from participating in this program.

Despite widespread availability, few borrowers have participated in these programs. Possible explanations include lack of awareness on the part of consumers, lenders, and real estate agents; high transaction costs that complicate the financing process; and lack of incentives for industry representatives to market the products (Gerarden 2008). Mortgage risk is a potential deterrent, too: Blackman and Krupnick (2001) have conducted relevant research on location-efficient mortgages, a similar loan product designed for properties in transit-rich communities where reduced transportation costs could offset higher mortgage payments. In an analysis of over 8,000 FHA mortgages from the Chicago region they find that borrowers with more efficient locations are not less likely to default on their mortgage than other borrowers. This suggests loosening underwriting criteria based on locational efficiency raises mortgage default risk. To overcome some of these shortcomings, the FHA has recently launched a new loan product, the FHA PowerSaver, which is described in the next section.

Notwithstanding these examples, privately offered loan products specifically for energy efficiency are rare. In most cases, lenders offer traditional loan products without consideration of energy-related impacts. When lenders do offer preferential loans for energy-efficiency improvements, they are most often offered in conjunction with a government or utility program to promote energy efficiency using some form of loan subsidy. We discuss these programs in the next section.

Government and Utility Financing Programs

State and local government agencies and public utilities across the U.S. are engaged in energy-efficiency financing in a variety of ways. They have established revolving loan funds and loan loss reserves, set up loan guarantee programs, funded interest rate buydowns, and established property-assessed clean energy (PACE) programs. Our research identified 291 individual energy-efficiency finance programs on the books in 2011 (see Box 1). We focus here on a subset of 226, eliminating programs that finance a very limited number of efficiency options, such as geothermal or air source heat pumps, or that are on the books but appear to not be in operation.

Box 1. Compiling an Inventory of Government and Utility Financing Programs

Our inventory of financing programs was developed through Web-based research, starting with the Database of State Incentives for Renewables and Energy Efficiency, an effort managed by North Carolina State University under a grant from the National Renewable Energy Laboratory (see http://www.dsireusa.org/). Beyond this, we used the U.S. Department of Energy's website on the Better Buildings program (see http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/partners.html) and individual state, local, utility, and private lender websites. Information on performance of the programs, including loans made and estimates of energy savings, is virtually impossible to get for most programs. We conducted a short survey and obtained some detailed performance information from 33 programs, which we discuss later in the report. We also conducted phone interviews with a handful of program administrators and relied on published reports of financing programs (e.g., Brown 2009; Fuller 2009; Fuller et al. 2009; Hayes et al. 2011; and case studies conducted by the Home Performance Resource Center, available at www.hrpcenter.org/best-practices). While our inventory is reasonably complete, some smaller programs (such as some operated by electric cooperatives) may be missing from our tally.

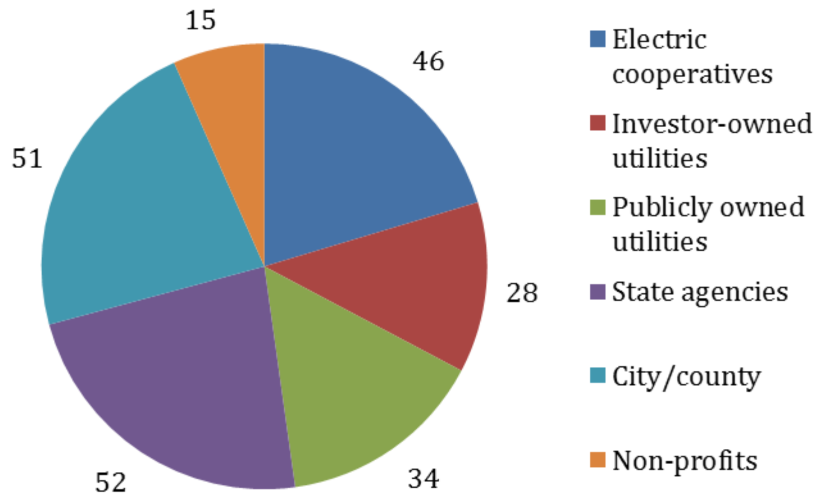
Some of these programs have been in existence for many years. The Sacramento Municipal Utility District (SMUD) has operated a loan program since 1977, Austin Energy since 1982, and Southern California Gas Company since 1998, to name just three. The Energy and Resource Conservation Loan Program, offered by many of the electric cooperatives in the Touchstone Energy Alliance, has been around for 30 years. Our research suggests many of the older programs tend to be operated by utilities and cooperatives. Although new utility programs have been established in recent years, government programs have increased more rapidly due in large part to the infusion of federal government stimulus funds from the 2009 American Recovery and Reinvestment Act (ARRA). We identified 55 programs that have been initiated since 2009, 48 of which are administered by state government agencies, city or county governments, or local nonprofit organizations.[11]

[11] We were unable to uncover the start date for many programs, particularly the programs run by electric and gas utilities and cooperatives, thus we cannot provide the full age distribution for all 291 energy-efficiency financing programs in our inventory. The 55 programs started since 2009 are almost certainly an underestimate of the total number started in this period, but because identifying the start date of the newer programs is easier, it might not be a serious underestimate.

There are 178 financing programs that cover the residential sector; 125 of these are residential-only programs, and the remaining 53 cover other sectors as well. Ninety-eight programs provide financing to the commercial building sector, with most of these programs also available to other sectors (only 11 are commercial only). We were able to identify 60 programs that include the industrial and/or agricultural sectors in their programs; all of these programs also provide financing in other sectors, most commonly for commercial properties.

Figure 1 shows the breakdown of the 226 programs by lead administrative agency.[12] There are approximately as many government programs, 103, as there are programs run by electric and gas service companies, 108. Only 15 programs are run by nonprofit organizations. In many programs, the administering agency works with a private lender, particularly in programs in which the government agency or utility buys down a private lender's market interest rate.

Figure 1. Energy-Efficiency Financing Programs, by Administering Organization



Government Programs

The government-run programs are distributed approximately equally across state and local governments. There are 52 state programs in 25 states; in some cases, the state operates separate programs for the commercial and residential sectors, but often, states have what seem to be somewhat duplicative programs. Maryland, for example, operates separate loan programs for homeowners and commercial businesses, but its Department of Housing and Community Development runs a third program that provides loans to homeowners, owners of multi-family buildings, and business owners. In New York, NYSERDA currently operates two programs that provide financing to the residential sector, although one is scheduled to be discontinued in early 2012. The state programs are operated by a variety of agencies and public-benefit corporations, including state housing authorities, economic development agencies, state energy offices or energy efficiency offices, and environmental protection departments.

[12] Some programs have a lead agency but multiple partners. For example, a municipal government agency may work with a local nonprofit group and a private lender to provide loans to homeowners or local businesses.

The 51 local government efficiency financing programs operate in 23 states. Of these, we identified 30 that have received grants through the Better Buildings Neighborhood Program, which received stimulus funds through the ARRA. In some cases, the grant money was used to set up a new program, but often it provided supplemental funding for programs already in operation. Many of the local government programs are operated out of special agencies set up to promote energy efficiency and conservation. For example, the city of Phoenix has established the "Energize Phoenix" program, a quasi-government agency that works in partnership with the local energy service provider and Arizona State University, with Better Buildings program funding. In other communities, programs operate out of planning departments or economic development agencies. The Better Buildings program in rural Fayette County, Pennsylvania, for example, is housed in the Redevelopment Authority of Fayette County.

Other sources of funding for state and local financing programs vary. Some of the 51 local government financing programs we identified have used grants from the Energy Efficiency and Conservation Block Grant program, also funded by ARRA stimulus funding. But because these grants are used for a variety of other efforts, too, it is difficult to trace how much of the money goes to efficiency-financing programs. State government funding sources include state general revenues, state Treasury investment funds, electric ratepayer funds that get transferred to a state energy office or other government agency to manage, and state bonds. Among these ratepayer funds are revenues from the sale of CO_2 emissions allowances in the Regional Greenhouse Gas Initiative (RGGI) in some of the 10 states that are members of RGGI.[13]

Of the various forms of state and local financing, property-assessed clean energy (PACE) programs are somewhat unique. In this type of program, a city or county establishes an energy financing district that enables the local government to raise money, usually through the issuance of bonds, to fund clean energy projects. The financing is repaid through an assessment on the property tax bills of building owners who participate in the program and retrofit their properties. Thus the "loan" is secured through a lien on the property; like property taxes, this assessment is paid first before other claims against the property in the event of foreclosure.[14] When a property is sold, the new owner assumes repayment of the loan.

The first PACE programs were launched in California in late 2008. Berkeley set up a pilot program that provided financing for solar photovoltaic projects on residential properties, and Palm Desert launched a similarly designed program that also included energy-efficiency upgrades and was available for both residential and commercial properties.[15] Between 2008 and 2010, four more programs were set up in California (in San Francisco, Yucaipa, Sonoma County, and Placer County) along with three programs elsewhere in the United States (Babylon, New York, Boulder County, Colorado, and Jefferson City, Missouri). In 2011, Efficiency Maine Trust put $20 million of ARRA money into a program to provide funding for local PACE programs; a total of 97 communities in the state have passed a PACE ordinance as of mid-October 2011.[16]

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[13] New Jersey recently dropped out of RGGI so there are now nine states.

[14] Only delinquent assessments are due, not the full PACE lien; the remaining balance is to be paid by the next property owner (Natural Resources Defense Council et al. 2010). In some locations in today's real estate market, however, property sales can be delayed a long time.

[15] Fuller et al. (2009) have a thorough and helpful review of how PACE programs operate and the experience with these early programs, with particular attention paid to the Berkeley program.

[16] Our tally of 291 energy-efficiency and renewables financing programs counts the Maine PACE program as one program, not 97.

As described in Box 2, most residential PACE programs have been on hold since July 2010 because of a ruling by the Federal Housing Finance Authority (FHFA), though advocates continue to work to revive the programs. More optimism surrounds commercial PACE. The optimism for this sector seems to revolve around two factors. First, the FHFA has no jurisdiction over commercial mortgages. Second, whereas almost all residential PACE programs are funded by revenue bonds, some commercial PACE programs allow for or require owner-arranged financing with a private lender, who often sells the debt in the form of commercial mortgage-backed securities. This is possible because commercial PACE loans are much larger than residential loans.

Box 2. What Happened to Residential PACE Programs?

In July 2010, the Federal Housing Finance Agency (FHFA) directed Fannie Mae and Freddie Mac to take several actions in regard to PACE programs, including adjusting loan-to-value ratios, tightening borrower debt-to-income ratios, and requiring prior approval from mortgage holders for any PACE loan (FHFA 2010). In a May 2010 letter, the FHFA stated that PACE loans "pose unusual and difficult risk management challenges for lenders, servicers, and mortgage securities investors" (FHFA 2010). The FHFA claimed that PACE programs do not have the "traditional community benefits" of other local taxes. The agency also maintained that the lending in PACE programs is based on collateral rather than ability to pay, posing a serious problem given the uncertainty that the home improvements actually produce "meaningful reductions in energy consumption" (FHFA 2010).

Several states, cities, and environmental advocacy groups filed suits against the FHFA after the decisions by Fannie Mae and Freddie Mac to refuse mortgages with PACE loans. Initial rulings in New York sided with the FHFA, but an August 2011 decision in California sided partially with the plaintiffs in ordering FHFA to carry out a public notice and comment process.

A few programs are still operating. Despite the fact that obligations under Babylon's Long Island Green Homes program share the senior lien status of PACE loans that have been effectively banned by FHFA, the program has continued to operate due to its unique legal grounding. The Sonoma County program is still in operation and making loans, using funding from its treasury. The Palm Desert program is accepting applications but requires each applicant to sign a disclosure agreement certifying that the agreement will not violate the terms of the participant's mortgage or other loans secured by the property; it is unclear if additional loans have been made since the FHFA ruling. Finally, Efficiency Maine's statewide PACE program, instituted in April 2011, offers loans with subordinate status, avoiding conflict with the FHFA ruling. Subordination of PACE loans is being dismissed by several in the finance community, who argue the secondary market will not invest in such a program (Barclays Capital 2009).

A consortium of businesses has come together to implement commercial PACE programs in Miami-Dade County, Florida, and Sacramento, California, under this model. Ygrene, the project administrator, is leading the effort by selecting energy auditors, certifying contractors, developing underwriting criteria, and attracting private financing. In Miami-Dade County, Lockheed Martin will oversee retrofit work, Energi Insurance Services will guarantee energy savings of improvements made by contractors, and Barclays will provide financing. In California, Figtree Energy Resource Company has launched the multi-jurisdiction PACE program. In January 2012, the company announced the issuance of its first taxable municipal bond, sold to capital markets with no government funding. The bond was for $725,000 to fund seven commercial energy-efficient and renewable-energy projects in four California cities.[17]

Despite the promise of this model in the eyes of some observers, it is unclear whether the optimism surrounding commercial PACE is warranted. Typical commercial mortgages have restrictive covenants that require building owners to seek the mortgage holder's consent before acquiring any superior tax liens. Some in the industry feel this will limit the market (McGinnis 2011).

Utility Programs

Electric and natural gas service providers operate 103 programs that offer financing opportunities to customers in their service territories. With 46 programs in 2011 according to our tally, electric cooperatives have the greatest number, followed by publicly owned utilities with 34 and investor-owned utilities with 28 (Figure 1). There are 930 cooperatives and 2,000 publicly owned utilities in the United States compared with only 220 investor-owned utilities, so this could partially explain the larger number of financing programs for the first two groups.[18]

Money for investor-owned utility programs usually comes from ratepayer funds, including system benefits charges. System benefits charges were established in the mid-to-late 1990s in those states where retail electricity markets were opened to competition as a way to pay for utility public benefits programs, including research and development and energy efficiency. These charges are added to the still-regulated distribution component of retail electricity bills, and a portion is used to pay for residential and commercial energy-efficiency retrofit programs, including financing. In some states, these revenues go primarily to state-run or chartered agencies, such as NYSERDA in New York or Efficiency Maine Trust in Maine. In other states, these funds stay with the utilities that operate their own efficiency programs.

Like investor-owned utilities, cooperatives and publicly owned utilities also may collect money for their programs from ratepayers, typically by including program costs as expenses in traditional rate cases. Some jurisdictions allow for energy-efficiency expenses to be added to the utility rate base and recouped through capitalization; however, we found no evidence that this approach is employed by efficiency loan programs.

In the Northeastern states that are part of RGGI, revenue from the sale of RGGI CO_2 allowances typically provides funds for energy-efficiency financing. Also of note, in January 2010, Congress passed the Rural Energy Savings Program Act (H.R. 4785/S. 3102), which created a $4.9 billion loan program under which cooperatives could borrow from the U.S. Department of Agriculture's Rural Utility Service at a 0 percent interest rate and in turn make loans to their members at no more than 3 percent.[19]

In all these programs, collection may come on the utility bill or as a separate loan repayment. Bell et al. (2011) identify 31 programs employing utility bill repayment, commonly referred to as on-bill

[17] More information is available at http://www.figtreecompany.com/news/.

[18] Cooperatives serve the fewest customers—18 million in 2010 compared with 104 million for investor-owned utilities and 21 million for publicly owned utilities (National Rural Electric Cooperative Association 2010).

[19] Information on the program, including the text of the bill, is available at http://www.nreca.coop/press/NewsReleases/Pages/20100719RuralEnergySavings.aspx. The added 3 percent is for establishment of loan loss reserves, as the cooperatives assume the risk of defaults, and for administrative costs.

financing. New York has passed legislation requiring on-bill financing offerings statewide. The California Public Utility Commission recently announced a draft plan that would use on-bill financing as a mechanism to attract private capital to lend directly to building owners and renters (Copithorne 2011). This approach simplifies repayment by borrowers.

In addition, some advocates posit that the risk of default is lowered by the threat of service shutoff in the event of nonpayment. Evidence of default rates below 2 percent for most on-bill financing programs may support this conclusion (Bell et al. 2011); however, one small program profiled in the study had default rates of 6.8 percent. In addition, consumer advocates in some states doubt utilities can or will cut off delinquent customers (Brown 2009). Despite the potential advantages of on-bill financing to both customers and utilities, demand for these programs appears to be small. More than half the on-bill financing programs identified by Bell et al. (2011) attracted less than 0.5 percent of the given utility's customer base.

How Governments and Utilities are Involved in Financing

Government and utility efficiency-financing programs may operate as revolving loan funds, or they may take the form of various credit enhancements, including loan loss (and late payment) reserve accounts, loan guarantees, and interest rate buydowns. With credit enhancements, private lenders make the loans and the government or utility money is used only to help provide incentives. By funding a loan loss reserve account, for example, a government agency reduces the risk that private lenders have to take on with energy-efficiency loans, making these lenders more likely to lend at lower rates or to less creditworthy borrowers. Buying down private-market interest rates makes an energy-efficiency loan more attractive to borrowers.

The three lenders authorized to offer the Fannie Mae Energy Loan, described in the private-financing section, work with several government agencies and utilities to buy down the interest rate by half or more.[20] Viewtech Financial Services has worked in partnership with Southern California Gas Company's financing program since 1998, processing and servicing over 21,000 loans for the company. AFC First works with several utilities and state agencies, including Progress Energy in South Carolina, four utilities in Connecticut, and state programs in Pennsylvania (Keystone HELP) and Kentucky (Kentucky Home Performance). In each of these cases, AFC First handles loan origination and servicing. In some cases, program funding is used to buy down the Fannie Mae Energy Loan interest rate, which is currently at 14.99 percent for customers with the highest credit scores.[21] In others, such as Keystone HELP, program funding is used as the source of loan capital. Interest rates in the Keystone HELP program for example, ranged between 2.99 and 8.99 percent in 2011; in the Connecticut programs, rates are as low as 0 percent.

Several state and local government programs work with local banks and credit unions, as do nonprofit organizations. The Local Energy Alliance Program in Charlottesville, Virginia, for example, works with the University of Virginia credit union, offering loans at 7 percent. Another nonprofit, Clean Energy Works Oregon buys down interest rates at three authorized lenders so that consumer energy-efficiency loans are offered at 5.99 percent. As these are almost always unsecured loans, a market interest rate would be quite a bit higher.

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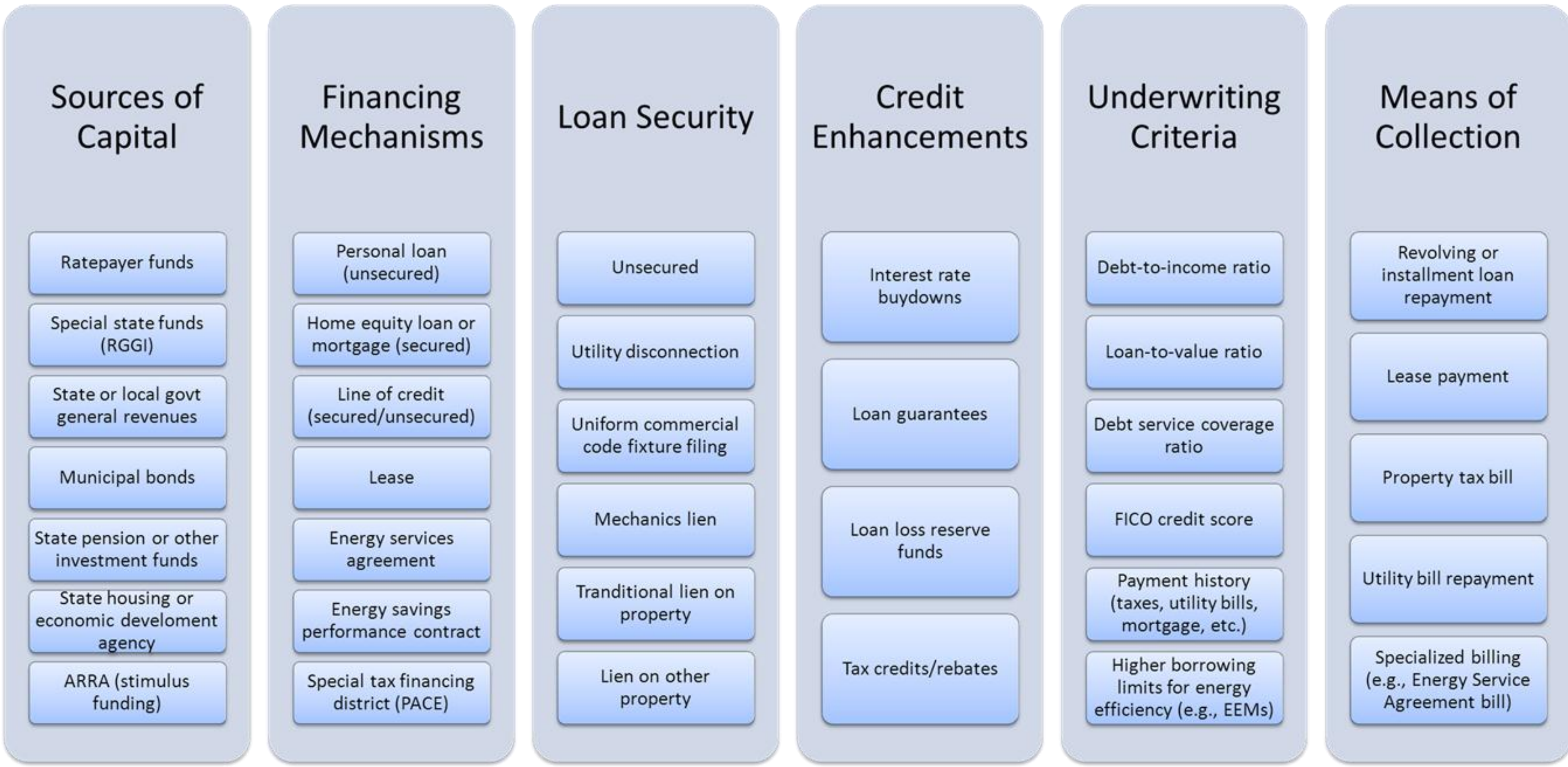
[20] According to McClain (2011), between 60 and 70 percent of the new Fannie Mae energy loans receive some kind of buydown.

[21] For customers with lower credits scores, Fannie Mae charges two other interest rates, which are currently 2 and 4 percentage points higher.

Many of the state and local government programs also use their funds to establish loan loss reserve funds or set up loan guarantees as a further credit enhancement. The Energy Impact Illinois program, for example, has loan loss reserves for residential, multi-family and commercial building energy retrofits. Michigan Saves, Clean Energy Works Oregon, and Energy Works Kansas City, among other programs, also use loan loss reserves. Out of 86 Better Buildings loan programs, Brown (2011) found that 14 had established loan loss reserve funds. Most electric cooperatives make loans directly, rather than working with local banks or credit unions, and thus they establish loan loss reserves to protect themselves against late payments and defaults. Several cooperatives that are members of the Touchstone Energy Alliance offer the Energy and Resource Conservation Loan Program. The Tennessee Valley Authority cooperatives have a program called EnergyRight, which includes rebates and loans for installation of heat pumps. Funding from the Rural Utility Service is often used by cooperatives to establish direct loan programs.

Figure 2 synthesizes all the various elements of energy-efficiency financing programs: the possible sources of capital funds for the programs, collection methods for repayment of loans, loan securitization, underwriting criteria, the types of credit enhancements that might be used, and the basic financing mechanisms. The figure highlights the many different aspects of energy-efficiency financing but also shows how some program features are linked. For example, underwriting criteria for an unsecured loan are likely to include FICO scores, payment histories on taxes, and the like, whereas underwriting criteria for a secured loan that uses the real estate as collateral will consider the loan-to-value ratio, among other factors. Likewise, collecting repayment on utility bills and using utility disconnection as loan security are features usually associated with utility programs, which mostly use ratepayer funds as a source of capital.

Figure 2. Elements of Energy-Efficiency Financing Programs



Source: Figure constructed based on Fuller et al 2009. For other studies with key characteristics of financing programs, see Brown 2008; Brown and Conover 2009; Fuller 2009; U.S. Department of Energy 2010.
Notes: RGGI=Regional Greenhouse Gas Initiative; PACE=property-assessed clean energy.

Federal Financing Programs

While our focus is on the many state and local government and utility programs, we briefly mention two influential federal government programs, one offered through the Small Business Administration (SBA) and one through the U.S. Department of Housing and Urban Development.

Section 7(a) Loan Guarantees. The SBA provides financing for energy-efficiency improvements made by small businesses through its Section 7(a) loan guarantee program. The SBA is not a direct lender. Instead, participating private lenders pay a fee to the SBA, and in return, the SBA provides a guarantee for qualifying small business loans that covers 75 percent of the loan amount on loans above $100,000 and 80 percent for loans below $100,000 in the event of default.

One of the appealing features of SBA 7(a) loans is the fact that the guarantee portion of the loan can be sold on the secondary market. According to Freehling (2011), this feature makes banks more willing to lend for terms greater than seven years—and at fixed interest rates—because they do not have to find deposits to match the structure and term of the loans. There is growing interest in using the program for energy-efficiency financing, in part because the SBA has expanded the definition of a small business and raised the amount eligible for a guarantee.[22]

PowerSaver Program. The U.S. Department of Housing and Urban Development announced plans in November 2010 to develop a two-year pilot energy-efficiency loan guarantee program called PowerSaver. The program allows homeowners to borrow up to $25,000 for energy-efficiency improvements through lenders that participate in FHA's Title I Property Improvement Program. FHA will guarantee 90 percent of the loan amount in the event of default, with lenders responsible for the remaining 10 percent. Eligibility is restricted to borrowers with minimum credit scores of 660 and a debt-to-income ratio no greater than 45 percent. Also, the combined loan-to-value ratio for all loans on the home cannot exceed 100 percent. The department anticipates processing 30,000 PowerSaver loans in the pilot program. In spring of 2011, 17 approved lenders were announced for the program. These lenders will be directed to make loans in priority markets where local policies and programs have been established to improve building energy efficiency.

Results from Government and Utility Loan Programs

What have these government and utility loan programs achieved? In this section, we examine results along three dimensions: number and value of loans, loan performance, and the types of efficiency improvements the loan recipients have made.

Program participation and value of loans. Table 1 presents results from a select group of state government energy-efficiency financing programs. These numbers were gathered primarily through an RFF survey of financing program administrators conducted during the April–August 2011 period. The survey asked only for basic information on residential and commercial loans made in the programs. Of the 140 surveys distributed, 33 fully completed surveys were returned. The last column in the table shows the customer base for each program, or in the case of the state programs, the number of housing units in the state or area served. These numbers are included to indicate each program's potential market and also put some of the numbers in the second column into perspective for comparison purposes: the electric cooperatives and publicly owned utilities serve a much smaller

[22] The SBA also operates the Section 504 loan program, which provides long-term, fixed-rate financing through Certified Development Companies (CDC). CDCs administer loans and provide 40 percent of the financing, with 50 percent provided by the bank, and 10 percent by the business itself.

number of customers than the investor-owned utilities, which partially explains their smaller number of loans.

The Sacramento Municipal Utility District loan program has made the greatest number of loans, 142,000 since 1977, for an annual average of 4,176. It also has the highest participation rate as measured by the number of total loans issued divided by the current customer base. By this measure, more than 20 percent of current SMUD customers have had energy-efficiency retrofits.[23] The average loan value in the SMUD program over its lifetime is relatively small, however, at only $3,151.[24] This is explained partly by inflation – i.e., loan values are in nominal dollars thus figures from the 1970s and 1980s are lower than later years – but may also be a result of the relatively high interest rates in the SMUD program, which have ranged between 7 and 10 percent over the years. By comparison, the Connecticut programs have a 0 percent interest rate and an average loan value of $11,100. While other factors can contribute to the differences, consumers should be expected to increase the amount they borrow, all else equal, when interest rates are lower. The other larger programs in Table 1 are the Keystone HELP, SoCal Gas, and Austin Energy programs, which have averaged between 1,560 and 1,860 loans of $7,000–$9,000 per year.

With the exception of the SMUD program, energy-efficiency financing programs have reached only a very small subset of property owners. This is consistent with findings in several other studies. Neme et al. (2011) estimate that state- and utility-sponsored programs currently reach less than 2 percent of homes each year. And according to the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, less than 1 percent of homes have had energy retrofits specifically to save energy (Lee 2010). However, Fuller et al. (2010) report that a Bonneville Power Administration program, which operated from 1980-1992, achieved 56 percent participation by eligible customers over the life of the program. This program offered free audits, up to 85 percent rebates for improvements, and zero percent interest rates.

Table 2 summarizes results for the set of PACE programs for which we were able to obtain data. The Berkeley program granted 13 loans in less than a year at a total cost of $326,000. Interestingly, there were initially 40 applications for loans, but 27 withdrew because they were able to secure lower-cost financing elsewhere, mainly through home equity loans (City of Berkeley Planning and Development Department 2010). The other five programs summarized in the table have thus far issued a total of 3,916 loans equaling more than $76 million. The Sonoma County program is the largest, with $51.5 million worth of loans over a 2 1/2 – year period.

[23] For a program that has been in operation 34 years, it is difficult to measure a true participation rate because the housing stock changes each year. It is clear that the SMUD program has reached more customers than most of the other programs, however.

[24] Loan values have gone up in more recent years. Fuller (2009) reports that the average loan in the SMUD program was $8,750 in 2007.

Table 1. Results from Selected Residential Energy-Efficiency Financing Programs

	Number	Value	Loan Period	Customer Base[1]
Sacramento Municipal Utility District	142,000	$447.4 million	1977–2011	594,000
Nebraska Energy Office[2]	26,328	$218.5 million	1990–2011	1,826,000
Southern California Gas Company	21,423	$188.9 million	1998–2011	5,800,000
Keystone HELP (Pennsylvania)	7,434	$58.0 million	2006–2010	5,567,000
Connecticut Home Energy Solutions (Pilot)	1,250	$14.5 million	2010–2011	1,350,000
Oregon Energy Loan Fund[3]	124	$2.0 million	1980–2008	1,676,000
Clean Energy Works Oregon	500	$6.3 million	2009–2011	823,000
Green Jobs Green New York[4]	96	$780,000	2011	8,108,000
Minnesota Rental Energy Loan Fund	611	$4.6 million	1983–2011	742,000
Minnesota Home Energy Loan Program	1,246	$9.2 million	1993–2011	2,347,000
Butler Rural Electric Cooperative (Ohio)	200	$2.1 million	1983–2010	11,000
Salem Electric Cooperative (Oregon)	243	$1.3 million	1998–2011	19,000
Santee Cooper (South Carolina)	5,932	$28.7 million	1982–2011	163,000
Richland Energy Services (Washington)	2,400	$23 million	1991–2011	21,000
Austin Energy	15,247	--	1982–2008	330,000
TOTAL	225,034	$1.0 billion	N/A	29,377,000

1 For utilities and cooperatives, the numbers are total customers in the service territory (available at http://www.nreca.coop/MEMBERS/MEMBERDIRECTORY/Pages/default.aspx and http://www.eia.gov/electricity/sales_revenue_price/pdf/table10.pdf). For state programs, the numbers are housing units from the U.S. Census Bureau. Clean Energy Works Oregon is available only in Clackamas, Jackson, Josephine, Multnomah and Washington Counties. For the Minnesota rental program, we multiplied the total number of housing units in Minnesota by the national average percentage of rental properties of 31.6% from the U.S. Census Bureau's American Housing Survey.
2 These numbers encompass both residential and commercial loans.
3 This program issued 347 commercial loans totaling $193.8 million.
4 As of February 2011.
Sources: Most figures obtained from program administrators in response to RFF Financing Survey, conducted April–August 2011. Additional information from Austin Energy (2009) for Austin program and from Hayes et al. (2011) for Nebraska and Clean Energy Works Oregon programs.

Table 2. Results from Selected PACE Programs

	Number of Residential Loans	Number of Commercial Loans	Value	Loan Period
Babylon, NY	614	N/A	$5.9 million	Oct. 2008–Nov. 2011
Berkeley, CA	13	N/A	$326,000	Nov. 2008–Nov. 2009
Boulder County, CO	612	29	$13 million	Apr. 2009–Jul. 2010
Maine PACE	95	N/A	$1.26 million	Apr. 2011–Nov. 2011
Palm Desert, CA	216	4	$5 million*	Nov. 2008–Jul. 2010
Sonoma County, CA	2,379	78	$51.5 million**	Mar. 2009– Sept. 2011

* Numbers for Palm Desert are from first two phases of the program; phase 3 started February 2010, was suspended, but restarted in August 2010 with additional requirement that borrowers must consult with their mortgage holder before signing for PACE loan.

** Numbers for Sonoma are total projects; 1,716 contracts (i.e., loans) have been signed for these projects; thus sometimes a contract covers multiple projects.

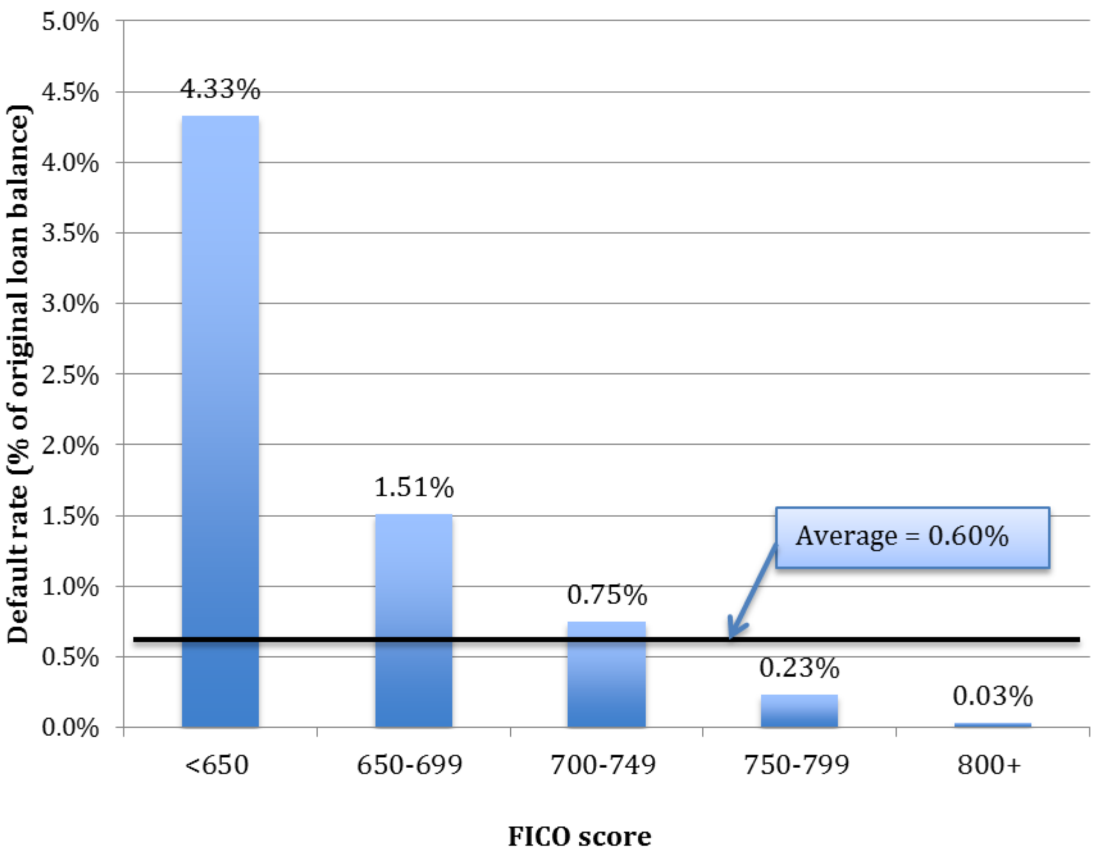
Sources: City of Berkeley Planning and Development Department 2010; Dale 2011; Fischer 2011; Fuller et al. 2009; www.sonomacountyenergy.org/; and www.cityofpalmdesert.org/Index.aspx?page=484.

Loan performance. An important difference between financing and other kinds of incentives for energy-efficiency improvements is that with any type of loan, there is a risk of delinquency and default. Yet to our knowledge, a careful analysis of results from a variety of financing programs that includes evaluation of default and delinquency rates has not been conducted.

In the absence of a fuller analysis, some summary information on loan performance is available from Pennsylvania's Keystone HELP program (Figure 3). The overall default rate from the Keystone program is quite low at just 0.60 percent.[25] Defaults vary greatly by credit score, however: the default rate on loans for which the borrower has a FICO below 650, at 4.33 percent, is more than seven times the average. Keystone HELP does not have many of these loans on its books. Like most unsecured loan programs, it tends to lend to homeowners with very high credit scores. Eighty-four percent of the value of the loans made in the program has gone to people with FICO scores above 700.

[25] The default plus 90-day delinquency rate is 1.31 percent (State Energy Efficiency Action Network 2011a).

Figure 3. Default Rates in Keystone HELP Program



Source: State Energy Efficiency Action Network 2011a.

Evaluation of loan performance from other programs would be worthwhile. For example, with approximately 90,000 loans made since 1994, the Fannie Mae Energy Loan program would provide useful data for analysis of loan performance because it includes information from a variety of locations over a long time period. These data could be used to characterize how loan default or delinquencies vary with characteristics of borrowers, loan terms, and the types of investments that the loans were used to finance. Matching these data to data about properties could also provide information about how loan performance varies with features of the property. The Fannie Mae data have not been made available to researchers that we know of, but would be a useful resource for learning from past experience.

Types of retrofits and improvements. Energy-efficiency loan programs differ in the types of projects they will finance. Many, including the Keystone program, mostly target "reactive" consumers—that is, homeowners with a broken furnace or other equipment. These programs often work through contractors who have been trained to offer the loan option, along with the efficient equipment it covers, when answering service calls. Others are only available for whole-house retrofits, and some programs take a middle ground, requiring insulation and air sealing, for example, along with any HVAC equipment upgrades. Still others give homeowners flexibility in their choices but offer larger incentives—such as free audits, lower interest rates, and longer loan terms—for whole-house retrofits.

Many experts feel that tapping the reactive consumer market is important for penetration of energy-efficient equipment upgrades through financing (Carey 2011). Others believe that moving the market toward the whole-house approach is critical (von Schrader 2011). There are clearly trade-offs. Offering financing only for whole-house retrofits should generate larger reductions in energy use, but fewer consumers may participate, and the costs of such a program may be high. Influencing reactive consumers may yield smaller energy savings per consumer, but more widespread participation could compensate for these lower savings and potentially achieve the same energy use outcome at less cost. The issue highlights the importance of full evaluation of programs to assess their cost-effectiveness and effectiveness in reducing energy use.

The latitude afforded participants in choosing particular upgrades and retrofits means that the programs may lead to very different outcomes in terms of energy use. As an example, we were able to obtain and compare limited information on the options chosen by homeowners in the Connecticut Home Energy Solutions program and the Long Island Green Homes PACE program.

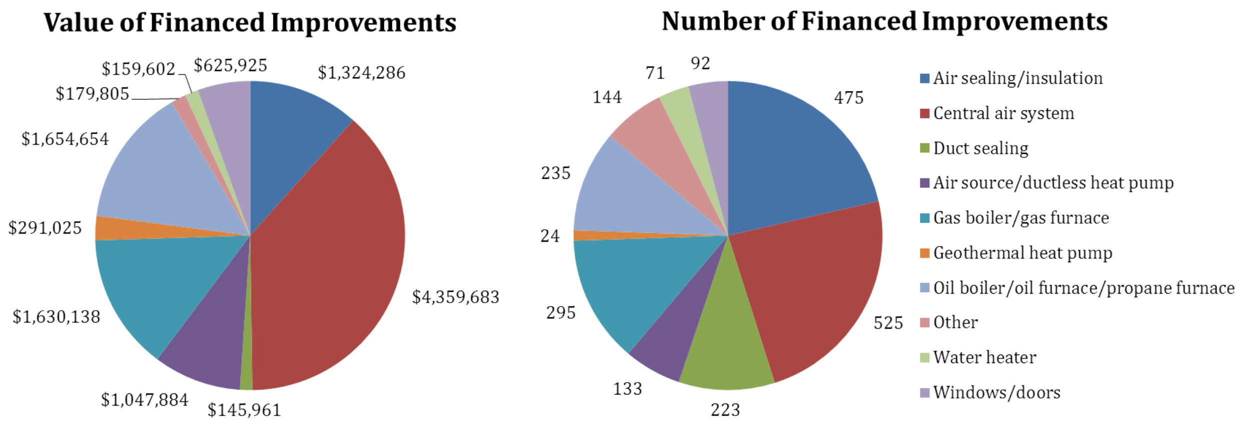
Figure 4 shows the number of projects and the value of projects by type for the 10-month period between June 2010 and April 2011 in the Connecticut program.[26] During this period, a total of 908 loans were made, paying for 2,217 energy improvement projects.[27] Central air systems accounted for 24 percent of all projects during the period and 38 percent of the dollar value of all improvements, although it is unclear from the data whether these are new or replacement installations. At just over 21 percent, air sealing and insulation projects were second in terms of the number of projects; duct sealing, air sealing, and insulation together accounted for nearly 32 percent of all projects. However, these projects comprised a much smaller percentage of value, less than 13 percent. Oil and gas boilers and furnaces showed up as significant, in both number and value.

Table 3 shows results from the Long Island program. As we showed in Table 1, 614 projects have been completed in this program over the 2008–2011 period, totaling $5.9 million. Approximately 58 percent of the value of the investments in the program has gone toward some kind of insulation or air sealing. This is a contrast to the Connecticut program, where the air sealing, insulation, and duct sealing accounted for less than 13 percent of the value of improvements (albeit over a much shorter time period). HVAC investments accounted for 26 percent of the value of improvements in the Long Island program, compared with more than 78 percent in the Connecticut program.

[26] In July 2011, Connecticut launched the Clean Energy Investment and Finance Authority, which receives about $30 million annually from a variety of sources and its programs include the Green Connecticut Loan Guaranty Program, which provides financing for energy efficiency and clean energy projects for households, non-profits, and small businesses (Clean Energy Finance and Investment Authority 2011)

[27] Thirty percent of the projects covered one energy-improvement measure, 37 percent two measures, 24 percent three measures, and only 9 percent more than three measures.

Figure 4. Financed Improvements in the Connecticut Home Energy Solutions Program, June 2010–April 2011



Source: Clark 2011.

Table 3. Financed Improvements in the Long Island Green Homes Program, October 2008–November 2011 (% of total loan value)

Attic insulation & air sealing	35
HVAC	26
Basement insulation	12
Wall insulation	11
Lighting	1
Solar hot water	9
Miscellaneous	5
TOTAL	100

Source: Dale 2011.

Knowing the types of improvements allows for some estimates of energy savings, which are typically based on engineering calculations and assumptions about baseline energy use and demand for energy services, such as heating and cooling after the retrofit.[28] Actual estimates of energy savings from financing programs, using energy bills before and after retrofits and comparing program participants to a control group, have not been conducted to our knowledge. A few programs provide public information on their total energy savings, but it is unclear how they calculate these savings, especially given the variability in property owners' project choices and the many other factors that

[28] For a description of how energy-efficiency savings are calculated for particular measures in Connecticut, see United Illuminating and Connecticut Light and Power (2010).

affect building energy use. The data regarding central air systems in Connecticut, for example, highlights one important issue: if the homes previously did not have such systems, would homeowners have purchased less efficient systems if the low-interest loan was not available or no system at all? If the latter, energy use may be higher for these households than it would have been in the absence of the loan. We return to this important issue of energy savings measurements and program evaluation below.

Why Is the Market for Energy-Efficiency Financing Limited?

Several factors related to the risks and costs of lending for energy-efficiency projects may keep lenders from offering financing to commercial and residential building owners. At the same time, building owners also have concerns about the costs of borrowing, and even bigger concerns or uncertainty about the payoff to efficiency investments more generally that stem from a variety of factors. We discuss the role of each of these supply- and demand-side factors in limiting the market for energy-efficiency finance.

Supply-Side Factors

Several factors discourage lenders from making energy-efficiency loans. We focus on four: credit risk, transaction and administrative costs, limited secondary markets, and the possibility of credit rationing.

Credit Risk. The paramount consideration for lenders when making loans for energy efficiency is credit risk. Efficiency loans are typically unsecured due to the difficulty in using many types of efficiency investments as collateral. Loaning on energy savings – in effect, using the savings in annual energy costs as collateral to secure the loan – is not common practice for a variety of reasons, including the inherent uncertainty associated with energy savings and future energy prices. This leaves lenders focusing on standard measures of credit risk, including FICO scores and debt-to-income ratios for homeowners. Most residential loan programs look for a minimum FICO score of 650, which covers just over 70 percent of U.S. adults with credit rates (State Energy Efficiency Action 2011a). Some programs will lend to people with scores below 650 at a higher interest rate to compensate for the higher level of risk of delinquency or default. This focus on credit scores naturally limits the size of the market as some potential borrowers will simply not qualify.

In commercial property markets, mortgage underwriting practices do not account for the risks created by a commercial building's energy costs, and thus lenders do not have a formal way of accounting for investments in energy efficiency when writing mortgages. As we explained in our review of private markets, energy costs are a "wash" in the net operating income calculations that lenders make: they are a component of operating costs but are assumed, in most cases, to be offset by tenant lease payments (Jaffee and Wallace 2009). Thus lenders evaluate overall risks rather than energy risks, often requiring loan-to-value ratios no higher than 0.65 and debt service coverage ratios no lower than 1.25.

Moreover, it is difficult to assess credit risk for some types of commercial property owners. In general, it is easiest to assess credit risk for large corporations with bond ratings, but these types of companies own relatively little of the commercial real estate market. Ownership is spread among individuals, religious and other nonprofit organizations, property management companies, partnerships, and limited liability corporations. The latter, which are widely used for property ownership, may appear to pose extra risks for lenders, with only the building serving as collateral for the loan and little recourse available for recovering investments in the event of default.

Transaction/Administrative Costs. For residential and small commercial projects, high administrative costs also play a role in tempering the enthusiasm that lenders have for making loans. The typical loan size for an unsecured energy-efficiency-related loan in the residential market is generally less than $10,000 (State Energy Efficiency Action Network 2011b), and the transaction costs of originating and servicing these loans can be substantial. Some estimates suggest that origination fees can be as high as $300–$400, with monthly servicing fees in the range of $10 (State Energy Efficiency Action Network 2011b; Carey 2012). To make it worthwhile to bear these costs, most mainstream lenders are looking for signs that they can make high volumes of loans—portfolios worth at least several to tens of millions of dollars—before entering the market. Thus far, those signs are missing.

Contractor performance risk, including work done slowly or not to the customer's satisfaction, can also add to the overall cost of energy-efficiency loans and further limit the size of the market. In the commercial sector, the performance guarantees provided by ESCOs help to mitigate this risk, but as we explained, thus far ESCOs have not made great inroads into the commercial market.

Secondary Markets. Low volumes of loans and lack of standardized loan products make it difficult to bundle energy-efficiency loans and sell them on the secondary market. Without standardized terms, markets are unable to adequately evaluate the riskiness and value of energy-efficiency loan portfolios. The fact that the loans are typically unsecured further complicates matters. Institutional investors, an important source of long-term capital, are generally not interested in investing in securities that are backed by energy-efficiency loans because of the lack of standardization, unfamiliarity with the underlying loans, and legal restrictions on the amount of risk that most pension funds, insurance companies, and other institutional investors can take on. Without the ability to access the secondary market, lenders lose an important option for recapitalizing their loan funds.

Credit Rationing. A rich literature exists in economics on the potential for misallocation in credit markets, including credit rationing. Much of this literature is anchored in the notion of information asymmetries that generate both adverse selection and moral hazard problems. The adverse selection problem has received the most attention. If lenders cannot distinguish ex ante between high-risk and low-risk borrowers, high-risk borrowers will masquerade as low-risk. In equilibrium in such markets, many of the low-risk borrowers may end up dropping out because the terms offered are not favorable to them (Akerlof 1970; Stiglitz and Weiss 1981). If the lender increases the interest rate to protect against losses, more low-risk borrowers drop out, lowering the average creditworthiness of the remaining borrowers in the pool and eventually reducing lenders' profits. In these settings, credit rationing is typically an equilibrium outcome – i.e., many low-risk borrowers do not get loans.[29] This same adverse selection problem can exist in commercial property financing: more creditworthy building owners may often choose to pay directly for efficiency measures using internal capital rather than take on third-party financing. This leaves the less credit-worthy borrowers in the marketplace.

It is difficult to measure the extent to which credit rationing exists in practice. Empirical studies of consumer credit markets usually have a difficult time differentiating rationing from equilibria in which

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[29] If the low-risk borrower's wealth is high enough, he may offer collateral in exchange for a lower interest rate. There is a cost incurred with the use of collateral, however, though Besanko and Thakor (1987) point out that it may serve as a deterrent to moral hazard once the contract is in place.

the observed data simply show an absence of borrowing. Jappelli (1990) attempts to get around this problem by using data from the Federal Reserve Board's Survey of Consumer Finances on individuals who have been rejected for loans and those who have been discouraged from applying for loans and finds that these two categories account for approximately 20 percent of households in the survey. He interprets this as a measure of the extent of credit rationing and uses the data to look at the factors that explain it, including income, wealth, age, education, and other factors.

The underlying cause of credit rationing is information failures, which some experts have argued are relatively minor in developed countries. The wide availability of credit scores, credit histories, bill repayments, and other information gives lenders the ability to distinguish between different borrowers with different levels of risk (Vogel and Adams 1997). In a calibrated model of consumer lending, Athreya et al. (2011) show how this improved information reduced the extent of credit rationing in the 2000s and was responsible for many of the observed outcomes in consumer credit markets during that period, including rising debt, lower average interest rates, and increased dispersion in interest rates.

The extent of potential credit rationing for energy-efficiency loans has not been studied empirically, though the problem has been mentioned as a potential reason for the energy-efficiency gap by several economists (Gillingham et al. 2009; Allcott and Greenstone 2012). While the vast array of consumer credit information available applies equally to energy-efficiency loans, the lack of information available about the payoff from the efficiency improvements may contribute to credit market failures and rationing. Investments with particularly high payoffs in terms of energy savings may not be made because lenders cannot distinguish them from investments with low payoffs. This is particularly true if the borrowers with high payoffs happen to have poor credit. Based on their FICO score or other measures of risk, they may be rationed even though the large savings in energy expenditures they would reap from the investment actually makes default less likely. In the commercial sector, the same argument may hold: buildings with lower energy costs may be lower risk for default on a loan but this may not be reflected in the loan-to-value or debt service coverage ratio.

The economic rationale for government involvement in energy-efficiency financing hinges on credit market failures and rationing, thus to determine if policy intervention is warranted we need a better understanding of how well these markets are working and the degree to which rationing exists. We discuss this potential role for government in greater detail later in the report.

Demand-Side Factors

The limited volume of lending for energy-efficiency investments is not just due to supply-side factors but also appears to be a function of limited demand for financing and, most importantly, for energy-efficiency improvements themselves.

Homeowners exhibit a general propensity to shy away from increased debt to finance home improvements. Guerrero (2003) reports that 63 percent of expenditures on home remodeling projects is financed with money from savings, tax returns, or gifts. Homeowners may be reluctant to borrow for energy investments because of the high transaction costs, additional monthly payment, and the costly (in terms of time and money) energy audit that may be required. Loan products that focus exclusively on energy-efficiency enhancements may be unappealing to homeowners who are bundling these upgrades with a larger home remodeling effort.

Property owners also may be reluctant to borrow money to invest in efficiency enhancements because they do not believe that such investments will pay off in terms of a higher sales price when it comes time to sell. Residential property appraisals required by mortgage lenders typically do not explicitly account for energy costs, nor do mortgage underwriting standards (Institute for Market Transformation no date). As a result, the appraised value of a house with more efficient appliances and better insulation than an otherwise identical house next door may not fully reflect its differences, even though they could result in substantially reduced energy costs.[30] Providing energy bills to potential buyers could be one way to communicate this information, but it may be an imperfect signal.[31] As a result of this problem, homeowners may choose to invest in non-energy related property upgrades that more clearly pay off in resale value. Commercial mortgage underwriting presents a similar problem – as we explained above, energy costs are a "wash" in the net operating income calculations that lenders make when evaluating a loan. Although a growing body of evidence exists that more efficient commercial buildings, as measured by Energy Star and LEED certifications, command higher rents, have lower vacancy rates, and sell at higher prices than other buildings (Miller et al. 2008; Eichholtz et al. 2010, forthcoming; Fuerst and McAllister 2011), it is not clear whether these findings are widely known.

Commercial building owners may have limited demand for efficiency financing for other reasons as well. Owners whose predominant business is not real estate ownership are likely to face internal competition for capital. Usually, that competition favors investments directly related to the company's business model. Moreover, there may be limited demand for energy-efficiency financing because businesses do not want such loans to show up as debt on their balance sheets.

Other types of entities that own real estate may also face some limitations. We discussed LLCs above. Real estate investment trusts, which account for between 10 and 15 percent of all institutionally-owned commercial real estate (NAREIT 2012), are highly regulated entities that operate like mutual funds, and the Internal Revenue Service requires them to distribute 90 percent of their earnings to investors each year. It is possible that this may reduce the incentive for REITs to undertake energy-efficiency investments because it limits their ability to obtain outside capital. Some observers have argued the opposite: it should encourage investments that reduce building operating costs as a means of improving the property's funds from operations (Parker and Chao 1999). But given the inherent uncertainties in energy payoffs, other options for reducing costs may be preferred.[32]

But probably the biggest factor constraining demand for energy-efficiency financing is the lack of demand for the energy-efficiency improvements themselves.[33] Building owners are slow to make building retrofits that appear to pay for themselves in energy savings, and the reasons fall into three categories: uncertain benefits and missing costs, market failures, and behavioral explanations.

Uncertain Benefits and Missing Costs. Consumer reluctance to invest in apparently cost-effective energy-efficiency enhancements may arise partly because they are not accounting for important aspects of either the benefits or costs of the investments. Complicating evaluation of benefits, there may be substantial uncertainty about the future trajectory of energy prices, the size of the expected

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[30] Real estate appraisers typically rely on sales prices of comparable properties in doing their appraisals.

[31] The SAVE Act, proposed legislation that mandates energy-efficiency evaluations and reporting as a part of mortgage underwriting, would take this one step further by requiring that assessment of future energy costs be part of the evaluation of the cost of owning a particular property, much the same way insurance costs are factored into mortgage underwriting (Institute for Market Transformation 2011).

[32] The fact that REITs own portfolios of properties also may allow them to achieve economies of scale in equipment purchases and other costs incurred in building retrofits. Companies such as Transcend, which offer energy service agreements, have targeted REITs for this reason. Nonetheless, as we pointed out above, inroads have been limited thus far.

[33] Kapur et al. (2011) also find that lack of demand for retrofits is an important barrier to greater use of financing for energy-efficiency upgrades in the commercial sector.

energy savings (especially given heterogeneity in consumers' baseline energy use and location), and the evolution of energy-efficiency technologies (Van Soest and Bulte 2001). This uncertainty creates a positive option value for waiting to make improvements.[34] The risks that an investment will not pay off are also higher for investments that need to be in place a long time before energy savings cover the initial investment cost.

Benefits also are harder to calculate when the property owner must trade off some measure of quality for energy efficiency. Consider, for example, the difference between lighting quality from a compact fluorescent light bulb and an incandescent bulb. Compact fluorescent lights may take a few seconds to warm up, produce a different lighting color and intensity, and may produce an audible sound in certain lighting fixtures, an issue that also occurs with some light emitting diode (LED) bulbs. The degree of consumer sensitivity to these and other quality variations associated with more energy efficient products will affect market demand for these products and willingness to pay for increased efficiency. In addition to uncertain benefits, hidden costs bedevil typical calculations of the value of energy-efficiency improvements. These include transaction costs, such as the cost of homeowner time for an energy audit or installation, as well as opportunity costs associated with the money spent on energy efficiency. For example, homeowners may be more interested in updating their kitchens and bathrooms or adding a deck than in insulating their homes and upgrading their HVAC system. For commercial building owners, the positive net present value of investments in a building upgrade may be forgone for other projects that have an even higher return on investment.

If the apparent energy-efficiency gap can be largely explained by these factors, there is no justification for policy to promote greater investment in efficiency. However, if there are market failures, such as those described in the next two sections, investment in energy efficiency is suboptimal, and policy to encourage greater investment is justified.

Inefficient Energy Pricing and Other Market Failures. Energy consumers may have inefficiently low incentives to conserve energy if energy prices do not reflect social marginal costs either due to price regulation or the presence of environmental externalities. One of the most recognized externalities is global warming as a result of CO_2 emissions from the combustion of fossil fuels (Tietenberg 2009). The lack of a U.S. federal policy to limit emissions of CO_2 and other greenhouse gases means that prices for electricity and other sources of energy are generally lower than socially optimal levels, contributing to a lack of demand for efficiency enhancements. Also, in much of the United States, the price of electricity is set by cost-of-service regulation, and prices do not vary seasonally or by time of day. As a result, electricity prices can fall well below marginal costs at times of peak consumption and rise above marginal costs at other times. As a result, there is little incentive to make investments in more efficient air conditioning and other appliances used more intensely during peak periods. Even when prices vary over time, consumers may respond by shifting appliance use from peak to off-peak periods rather than investing in more efficient appliances.[35]

Other potential market failures also may contribute to an inefficiently low level of investment in energy efficiency.[36] Chief among these are a variety of different kinds of information problems.

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[34] Hassett and Metcalf (1993) discuss this option value which is ignored by most net present value calculations. Sanstad et al. (1995) take issue with this argument suggesting that the implicit discount rate in the Hassett and Metcalf analysis that accounts for option value is actually lower than observed implicit rates.

[35] But Brennan (2011) argues that at sufficiently high prices of energy, one would be more likely to purchase an optional energy-using device (like air conditioning) if it is highly efficient than if it is not.

[36] For a more detailed discussion, see Gillingham et al. (2009).

To improve the energy efficiency of their buildings, building owners need information about current building energy use, opportunities for improving that efficiency, and the costs of implementing those options. Building owners may be able to obtain that information through energy audits or energy assessments, but very few do, even when the audits are offered for free or at subsidized rates. One reason may be the expectation that acting on the information will be costly (Palmer, Walls et al. 2011).

Sometimes information is available but not equally to all parties. Manufacturers of efficient energy-using equipment, for example, typically have better information than consumers do about the energy use of their equipment versus other options, but they may have difficulty credibly communicating that information to potential consumers (Howarth and Sanstad 1995). When buyers are unable to confirm that information, they may ignore it in their purchase decision (Howarth and Andersson 1993).

New energy-efficient technologies, about which information is not widely available, may offer broad societal benefits from "learning-by-using" that extend beyond the initial adopter (Mulder et al. 2003; Gillingham et al. 2009). When this is the case, the incentive to adopt that technology will be too low from a social perspective. This phenomenon goes beyond considerations of energy-efficiency attributes and could apply more broadly to new products.

Property owners may be less likely to make energy-efficiency investments when renters pay the energy bills. Recent empirical studies support this conclusion: Gillingham et al. (2012) find that owner-occupied homes in California tend to be better insulated than rentals, and Davis (forthcoming) finds that rented dwellings are less likely to contain Energy Star appliances than owner-occupied homes. Allcott and Greenstone (2012) point out, however, that this so-called split incentive problem cannot account for much of the energy-efficiency gap. Given that 29 percent of households residing in rental units are responsible for paying their own energy bills, Allcott and Greenstone use the findings in the studies by Gillingham et al. (2012) and Davis (forthcoming) studies to estimate that split incentives in the residential market create about a 1 percent increase in energy use above what it would otherwise be. Split incentives are also common in the commercial space, where investment decisions and operating expenses are under the control of different parties, and the relatively short nature of leases reduces tenant incentive to invest in efficiency (ICF International and National Association of Energy Services Companies 2007).

Behavioral Issues.[37] The growing field of behavioral economics has produced literature suggesting that psychological or other factors may create systematic biases in consumer decisionmaking away from choices that would be considered economically optimal (Gillingham et al. 2009).[38] While they could apply to firms, typically these behavioral explanations are considered more relevant for consumers because competitive forces tend to help to discipline firm behavior (Shogren and Taylor 2008).

One suggested explanation for these behavioral failures is that energy costs of using a product are not salient to consumers when they make a purchase, whereas up-front costs of a new appliance or a retrofit project are; thus consumers often ignore the energy costs (Wilson and Dowlatabadi 2007;

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[37] A more detailed discussion of behavioral economics and energy use can be found in Gillingham et al. (2009) and Gillingham and Sweeney (2011).

[38] Behavioral issues do not always result in under consumption of energy efficiency from an economic perspective. Sexton and Sexton (2011) find evidence that conspicuous conservation leads to greater expenditures Prius's over other hybrid cars because they are easily identified as hybrids and facilitate conspicuous conservation.

Allcott et al. 2011). Empirical evidence is lacking (Allcott et al. 2011), but studies in other contexts have shown that taxes and shipping costs lack salience (Hossain and Morgan 2006; Chetty et al. 2009).

Experimental evidence also suggests that consumers overvalue losses relative to gains of equal size, exaggerate the probability of unlikely outcomes, and discount the probability of more likely outcomes. In the energy-efficiency context, the uncertainty of energy savings from an upgrade and the possibility that those savings will be smaller than expected lead consumers to undervalue savings and lag in adopting energy-efficiency technologies. Research suggest that loss aversion subsides with experience (Erev et al. 2008), but there may be little opportunity to gain such repeat experience with purchases of long-lived durables, particularly when information about their energy use relative to other models of the same piece of equipment is not readily apparent.

So-called bounded rationality and heuristic decisionmaking also may contribute to biases in consumers' energy-efficiency investments. Bounded rationality refers to limits on consumers' cognitive abilities to process all the information necessary to make a fully optimal choice. Heuristic decisionmaking occurs when consumers use some attributes of a multi-attribute choice to limit the choice set for consideration (Tversky 1972). If consumers eliminate high-priced but energy-efficient appliances from their set of choices, for example, they may not make fully optimal choices.

What Role for Government?

A primary motivation for government policy in the energy sector is to mitigate the anthropogenic contribution to greenhouse gases in the atmosphere by reducing emissions of CO_2 from fossil fuel combustion. Imposing a price on CO_2 emissions through an emissions charge or tradable permit system would raise energy prices and thereby increase the payoff to investment in energy efficiency. Some estimates suggest that a fee of $25 per ton of CO_2, for example, would raise national average electricity prices by 20 percent and the retail price of natural gas by approximately 10 percent (Palmer, Paul, and Woerman 2011).

Failure to price CO_2 emissions is but one of a number of possible explanations for the energy-efficiency gap as described. In fact, most of the literature focuses not on environmental externalities but on apparent forgone private opportunities to save money by investing in energy efficiency. Thus, even in the presence of a policy to price CO_2, additional policies to promote investment in energy efficiency may be desirable to address the gap. And if pricing CO_2 is infeasible, energy-efficiency policies may be a useful second-best approach.

What types of policies are needed depends on the nature and extent of the market failure or behavioral issue to be addressed. Policies directed at increasing the supply of financing for energy efficiency are generally premised on the belief that the apparent underinvestment in energy efficiency is largely due to lack of access to credit. As explained earlier, this credit rationing theoretically results from information asymmetries in credit markets. While the extent of credit rationing remains uncertain, such rationing may suggest a role for government intervention because some worthwhile investment projects go unfunded and the market return is less than the social return from investment.

Several studies have addressed the role for government when there is credit rationing (though not in the context of energy efficiency), including Gale (1990), Williamson (1994), Innes (1991), and Minelli and Modica (2009). These studies set up slightly different theoretical models with different underlying assumptions, but each finds that there can be a rationale for government intervention in some cases. The specific form intervention should take varies, however, and some forms of intervention reduce efficiency in credit markets rather than improve it.

Gale (1990), for example, finds that loan guarantees offered on high-risk loan contracts make those contracts more attractive. This reduces the likelihood that high-risk borrowers will masquerade as low-risk and drive the low-risk borrowers out of the market. Loan guarantees can be welfare-enhancing in this setting. But in a model in which lenders incur screening costs to place borrowers into separate pools, Williamson (1994) finds that government loan guarantees at best have no effect because they do not alter the incentives of borrowers.[39] Williamson shows that interest rate subsidies are the preferred approach. More recent work by Minelli and Modica (2009) models a scenario that does not allow for screening or signaling (as in Williamson) such that borrowers can be easily separated into pools. They find that either loan guarantees or interest rate subsidies can improve welfare. These authors compare these credit market policies to direct investment subsidies and find them to be superior; while all three policies yield the same benefits, the investment subsidy is higher cost.[40]

Not all economists who study credit markets advocate government involvement in the market. Vogel and Adams (1997) point out loan guarantees come with new institutions and added transaction costs that increase the overall costs of lending. These authors also highlight the "additionality" problem—i.e., the difficulty knowing how much additional lending is spurred by the government policy over and above what would have taken place otherwise. "Crowding out" of private lending with government lending could be taking place and even substitution within a lender's portfolio in order to take advantage of loan guarantees. These could be issues for energy-efficiency loans. As we explained above, there are some private options for energy-efficiency financing. It is not clear in the markets in which government programs operate that they have not simply displaced some private lending that would otherwise have occurred, whether it be through contractor loan programs, bank loan products, or simple credit card borrowing.

The work by Athreya et al (2011) highlights the key role that information can play in improving credit market outcomes. When lenders have better information about borrowers, they can structure the terms of loans so as to minimize the adverse selection problems and limit the extent of credit rationing. Athreya et al. and other authors have documented the major changes in consumer credit markets in recent years as a result of improved information. While the improved information these authors discuss concerns borrower risk, these same lessons may apply in the energy-efficiency financing space to information about the payoffs from energy investments. If the availability and reliability of such information were improved, it's possible that this could lead to better lending practices for energy-efficiency investments.

As we explained above, a lack of information may be at the heart of the energy-efficiency gap, even beyond issues with credit markets. Thus, provision of information may serve multiple purposes, and government intervention may be more cost-effective if directed in this way rather than in loan guarantees, interest rate subsidies, and direct government loans. In highlighting the information issue for energy-efficiency financing in commercial buildings, Jaffee and Wallace (2009) suggest the use of

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[39] In some cases, Williamson finds that loan guarantees can make matters worse, altering market interest rates in such a way as to exacerbate credit rationing. Williamson's results are similar to earlier findings by Innes (1991).

[40] This is consistent with recent results in Walls (2012), who models energy-efficiency loans and subsidies using a version of the National Energy Modeling System, an integrated economic model of the U.S. energy system developed by the U.S. Energy Information Administration. She finds that the subsidy has a greater impact on investment, energy use, and CO_2 emissions, but the loan is found to be more cost-effective.

energy-efficiency and energy-volatility scores to help evaluate default risks for buildings with different energy characteristics. Such information could help financial markets evaluate the payoffs from efficiency investments. Requirements that building owners disclose their energy bills, which have been established in a few cities in recent years, may serve the dual purpose of providing a baseline by which potential payoffs from retrofits can be judged and also help real estate markets incorporate energy costs into building values.

More generally, many economists have argued that information provision should be the main tool for addressing the energy-efficiency gap, in particular for addressing problems such as missing or asymmetric information, split incentives or learning-by-using (Gillingham et al. 2009, Parry et al. 2010). There is some evidence that voluntary energy-efficiency programs (such as Energy Star) that focus on providing information about energy-efficiency characteristics have been effective at reducing energy consumption (Howarth et al. 2000). Thus information provision may play an important role beyond just helping to reduce credit rationing and help to motivate greater investment in energy efficiency more generally, but more study of the forms this information should take to be effective is needed.

Evaluation, Measurement, and Verification

In order to structure financing around the energy savings from particular investments, it is necessary to have a reliable estimate of those savings. Such estimates are not widely available, however, and even where they are available, they are plagued with uncertainty due to uncertain future energy prices and variability in the outcomes from building retrofits and upgrades. Not only is this a problem for financial markets, it highlights the paucity of good evaluations of the many taxpayer- and ratepayer-funded loan programs that are in operation. How can we know whether those programs are providing value for the dollars invested and evaluate them vis-à-vis alternative approaches to improving energy efficiency?

In this section, we describe the methodological approaches to measuring and verifying energy savings and evaluating energy-efficiency programs and end with a suggestion for ways forward.

Engineering Approaches

Generally, regulators require utility energy-efficiency programs periodically to demonstrate how much energy they are saving and at what cost.[41] Evaluations tend to focus on two concepts of energy savings: gross savings, which are attributable to all investments made by consumers who availed themselves of program benefits, and net savings, which are specifically a result of the program. Net savings essentially net out inframarginal consumers who would have purchased the energy-efficient appliance or equipment without the incentive payment.[42]

Standard practices. To provide program administrators with guidance about how to perform these evaluations, a number of state regulators and efficiency program managers have developed procedures, protocols, and best practices for calculating savings or adopted those that have been developed by others (e.g., Hall et al. 2009; Massachusetts Electric and Gas Energy Efficiency Program

[41] Utilities also may have to show ex ante that the energy-efficiency programs they plan to undertake are expected to have positive net benefits from energy savings.
[42] We used the term "additionality" in our earlier discussion of government loan programs; this is another term often used to make the same point. Some programs also seek to measure the extent to which energy-efficiency programs induce consumers who do not participate in those programs to make investments in more efficient equipment as well; this effect is referred to as "spillover."

Administrators 2010; Vermont Energy Investment Corporation 2011). Many of these guidance documents draw on the International Performance Measurement and Verification Protocol (EVO 2009).[43] This document endorses four options for measuring energy savings. Three of these are based on engineering calculations with varying degrees of field testing and larger systems modeling to better capture interactions of different upgrades (such as lighting and heating) and building features (such as heating upgrades and insulation). A fourth option calls for whole-facility comparison of energy use before and after a particular intervention, but this option is infrequently used.[44] In many cases, the engineering formulas assume that demand for the energy service, be it lighting, heating, or cooling, is unchanged after the efficiency enhancement—essentially assuming away any rebound in demand for energy services in response to lower cost. The formulas also focus on gross savings from particular investments and not attribution of savings to particular policies or interventions. Thus, additional information or assumptions are needed to translate gross savings into net savings, to attribute savings to particular programs and to assess the lifetimes over which those savings are likely to persist.[45]

While the IPMVP provides guidance on methodology, there are differences in how states follow these guidelines. The technical manuals from different states often use different approaches and assumptions for calculating energy savings from similar technology improvements and the differences can vary widely. Loper et al. (2010) find that estimates of lifetime energy savings for compact fluorescent light bulb replacements in a living room differ by a factor of 4 between California (lowest) and Vermont (highest). Some regulators allow utilities to use so-called deemed savings numbers, or predetermined values of energy savings associated with particular devices or appliance upgrades rather than go through the modeling and field testing in the IPMVP. Kushler et al (2012) report that 36 out of 42 states surveyed report using deemed values to calculate gross energy savings. And many states do not often translate gross savings into net savings. Kushler et al. (2012) find that 12 of 44 states surveyed report only gross savings. Even states that do make the translation typically just ask participants if they would have undertaken the investment in the absence of the program, which is a problem because consumers may not be a reliable source of such information.

Measurement Challenges for Loan Programs. The engineering approach requires information on what specific energy-efficiency measures were adopted as well as information or assumptions about characteristics of appliances and equipment that would have been in place without the program. For an incentive or subsidy program that focuses on a particular technology, such as lighting or refrigerators, using an engineering model to calculate energy savings is reasonably straightforward. Loan programs introduce more uncertainty into these calculations for several reasons.

First, under residential loan programs that require a home energy audit, homeowners generally are allowed to pick and choose from a menu of recommendations for upgrades and retrofits. Exactly which measures they undertake may not be known to loan program administrators. In addition, when a homeowner chooses multiple measures, they can interact in ways that complicate engineering calculations and contribute to the uncertainty. Lastly, for some retrofits, the quality of the installation

[43] Energy Service Performance Contracts rely heavily on the IPMVP for calculating energy savings from particular types of investments.

[44] One common reason for not using changes in actual energy consumption data is that the savings from many energy-efficiency interventions may be a small part of household-level energy consumption and thus difficult to detect in a comparison of building-level energy use before and after the intervention. Selection of the right control group, a sufficiently large sample size, and use of proper statistical analysis can minimize these problems.

[45] This set of activities related to translation of net to gross, attribution of savings to programs, and determing the effective lifetime over which savings can reasonably be expected to persist are core parts of the evaluation of energy-efficiency programs that go beyond measurement and verification.

can have a substantial effect on savings. All these factors suggest that an empirical evaluation of actual energy consumption data is preferable to an engineering approach.

Empirical Approaches

An alternative approach to evaluating the energy savings that result from particular energy-efficiency interventions, including loan programs, is statistical or econometric analysis using actual building energy use data from a wide set of buildings. The basic idea is to statistically compare actual energy use for some period of time before and after an efficiency improvement is made, controlling for the many other factors that affect energy use, such as weather, energy prices, occupancy, and other relevant factors. Ideally, one would compare the data from buildings with upgrades to changes in energy consumption for a well-matched control group of nonparticipants. With the control group, one can conduct a "difference-in-difference" model estimation that isolates the effects of the energy-efficiency intervention on energy demand of those subject to the intervention.[46]

Analyses of this kind have not been conducted for efficiency financing programs, to our knowledge, but a few peer-reviewed studies of other programs are available. These studies are described briefly in Box 3.

The approach can present some hurdles with respect to data requirements. While utilities presumably have information on energy consumption for electricity and natural gas, they may not have information on household characteristics, appliances, or occupancy. Nonutility entities that operate energy-efficiency programs requiring audits may have good information about household appliances and building characteristics for participants—and they even may be able to obtain energy bill data for program participants who agree to provide access. But they typically will not have comparable data for a control group of nonparticipants. In addition, because efficiency loan programs are voluntary, it may be difficult to find instruments that provide a clean identification of the effects of the efficiency intervention separate from other factors that might be correlated with participation.[47] Also, to be detectable by a statistical approach, changes in energy consumption resulting from the intervention must be sufficiently large not to be lost in the random variation in energy consumption. Despite these difficulties, the value in such an approach is high. Moreover, detailed engineering studies are themselves often difficult and time-consuming, with large information requirements.[48]

A recent study by Deutsche Bank and Living Cities (2011) carefully collected billing data and information on retrofits for a set of multi-family apartment buildings in New York City and compared ex post energy savings with ex ante engineering predictions of energy savings. The goal of the study was to provide insights on risks from using savings to underwrite energy loans and ways to bound

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[46] Structuring one of these analyses can be tricky when efficiency programs are voluntary and thus the effects of the program may be difficult to disentangle from the effects of other factors that might be correlated with propensity to adopt the program. Such cases may require additional econometric techniques, such as instrumental variables.

[47] The U.S. Department of Energy (2011) is using an experimental design with randomized controlled trials to measure the effects of low-income weatherization programs and different messages to encourage energy savings. This is one way to get around the selection issue.

[48] Some studies have used a statistically adjusted engineering approach, which uses econometrics to estimate the relationship between changes in energy consumption before and after a program (as shown on bills) and engineering estimates of expected energy savings from particular interventions (Train et al. 1985; Train 1992). The coefficients on the engineering estimates, or "realization rates," provide an estimate of how much of the savings anticipated by engineering models actually are reflected in bills. Two issues with the statistically adjusted engineering approach are that it is contingent on the engineering measures of savings, and estimates vary widely, even for a given energy-efficiency measure. Also, the estimate does not provide information that is particularly useful for policy analysis because policymakers cannot affect engineering savings directly like they can aspects of program design.

predictions of savings to mitigate those risks. The study used data from 231 buildings that had energy-efficiency retrofits either through NYSERDA programs or the federal Weatherization Assistance Program. Data from energy bills for both heating fuel and electricity were normalized for weather and buildings were classified by vintage and heating system type. Empirical estimates of savings were based on simple differences in these weather-adjusted measures.

Box 3. Examples of Econometric Studies of Energy Efficiency

Studies that have conducted econometric analysis of household (or firm) energy consumption using individual level data include Jacobsen and Kotchen (forthcoming), Ayres et al. (2009), Allcott (2011), and Costa and Kahn (2010).

Jacobsen and Kotchen (forthcoming) analyze electricity and natural gas consumption data at the household level for new homes constructed in Gainesville, Florida just prior to and just after a building code change in 2002. They find that, all else equal, building codes are responsible for a 4 percent reduction in electricity consumption and a 6 percent reduction in natural gas consumption. They also find that their estimates of energy savings are higher but not statistically different from what engineering models suggest.

Econometric methods also have been used in several studies to look at the use of social norms to encourage energy efficiency and conservation. Perhaps the best-known example is the use of mail flyers to provide households with information about their own recent monthly electricity use, average monthly electricity use of peers and monthly electricity use of highly efficient households. Typically this information is coupled with tips about investments or behavior changes that could be made to save energy. Research by Ayres et al. (2009), Allcott (2011), and Navigant Consulting (2011) has demonstrated that this type of intervention can reduce energy consumption by roughly 2–3 percent on average at relatively low average cost to the utility that runs the program. Costa and Kahn (2010) find that the effects of these interventions on energy consumption vary with political leanings. The programs analyzed by these authors use randomization to assign households to treatment and control groups, which eliminates problems of selection. This work shows how a careful econometric analysis of energy use before and after an intervention can be carried out.

The study finds that while ex ante predictions based on engineering models suggest that most retrofits will save between 25 and 50 percent of pre-retrofit energy use, ex post findings typically fall in the 10–40 percent range. The authors exploit the strong statistical relationship between ex post savings and ex ante energy consumption to develop a method for capping predicted savings results from engineering estimates. They then show how this method can be used to reduce the risk of default when expected energy savings are used to underwrite loans.

The Deutsche Bank and Living Cities study is a reasonable first step for estimating energy savings using real-world empirical data. The careful construction of a dataset on individual buildings that includes actual energy bills before and after retrofits, the precise retrofits undertaken, and various characteristics of the buildings retrofitted is exactly what is needed in order to perform a careful evaluation. Unfortunately, a single observation on (annual) energy consumption before and after retrofits for only 231 buildings and the lack of a control group of buildings with no retrofits means that the dataset is insufficient for a rigorous statistical analysis.[49] The study authors find in their statistical model that the only variable with explanatory power is the pre-retrofit energy consumption variable, not building age or other characteristics or the type of retrofit undertaken. This is troubling for loan underwriting because it suggests that the investment itself has no identifiable impact on the savings.

Econometric estimates of energy savings resulting from appliance and equipment upgrades and building retrofits would provide more certainty regarding what these types of investments have achieved in practice and thus greater insight into what is achievable in the future. This information would be useful to building owners who are trying to assess the payoffs to particular investments and to prioritize among them. It would also be useful to evaluate the effectiveness of particular energy evaluators or advisors and building software. In the financial market setting, potential investors could use this information to estimate the value of particular types of projects, and lenders could use it to structure loan payments that track energy savings over time.

Empirical approaches would also allow for a careful cost-effectiveness analysis of taxpayer or ratepayer funded loan programs. The results of these studies could form the basis for guidance on how they stack up relative to other incentive approaches and potentially on how to restructure the programs to make them more cost-effective. Empirical estimates of savings are also an important input to more sound estimates of the avoided greenhouse gas emissions from these policy efforts.

Because empirical studies are costly, it is not cost-effective to undertake one for every efficiency loan program, especially small ones. However, the insights provided by these studies could be used to develop economic models or combined economic and engineering models that better reflect how interventions affect investments and behaviors that influence policy outcomes.

Concluding Remarks

The private market for debt financing targeted at energy-efficiency investments is small, and the value of the expected energy savings from these investments generally is not factored into lending decisions. Nonetheless, many studies suggest an abundance of opportunities for investments in energy efficiency that would more than pay for themselves in future energy savings. Assuming these opportunities exist, lenders might be able to make profitable loans if they did account for savings in their loan approval processes. This practice may in turn lead to greater targeting of investments with high levels of energy savings rather than lending based almost entirely on credit risk.

An important reason why lenders are reluctant to lend based on energy savings is that good information is lacking on the likely payoffs from particular energy-efficiency investments. Most of the available information is from engineering models that fail to take into account consumer behavior and are based on specifications that may differ from performance in the field. While some studies look at changes in energy consumption over time among adopters of an efficient technology or participants in particular incentive programs, they rarely compare these changes to those experienced by a control group of nonadopters or nonparticipants.

[49] Although monthly billing data is available for electricity, the study authors aggregate into an annual figure and weather-normalize it for purposes of comparing a single measure of pre- and post-retrofit energy use. In addition, only about half of the buildings have a full set of information available for both electricity and fuel oil consumption, further reducing the sample size.

More empirical study of energy-efficiency programs can help to fill this information gap. Utilities with long-standing loan programs should provide data for analysis, including monthly billing data on both loan program participants and nonparticipants. Customer privacy could be addressed with confidentiality agreements, if necessary. Many utilities have made such data available for a variety of research purposes (Ayres et al. 2009; Costa and Kahn 2010; Allcott 2011; Jacobsen and Kotchen forthcoming). Regulated utilities that have their own approaches to measuring energy savings for their many efficiency programs may prefer not to open themselves up to the scrutiny of outside researchers, but improving the effectiveness and cost-effectiveness of these programs should be a paramount objective.

Beyond analyzing results from existing programs, the best way to increase our understanding of the energy savings from efficiency investments is to conduct randomized controlled trials of policies and programs, including efficiency financing programs, to promote such investment. With the exception of building codes and minimum efficiency standards for appliances, most energy-efficiency measures are voluntary; as such it is difficult to separate the effect of program participation from the effects of other factors that might make an individual or business owner more likely to participate in the program. With a randomized controlled trial, households or businesses would be randomly assigned to treatment or control groups, thus avoiding this selection bias issue. Treatments could include randomized encouragement to sign up for a loan program (like an on-bill financing program), and an evaluation would track energy consumption of both treatment and control groups. With sufficient data points, such an experiment could be structured to compare different types of loan programs. The experiment also could compare a loan program to another type of incentive to encourage efficiency investments, such as product rebates or tax credits. While these studies are costly and time-consuming, they can yield important insights about the efficacy of new approaches to policy design. They may also provide more reliable information to financial markets.

Developing new empirical measures of energy savings is particularly important for programs that focus on building retrofits because building owners can choose from a wide range of investments, some of which may be hard to capture in an engineering analysis. Homeowners may seal air ducts, add insulation in attics, replace windows and doors, and undertake a number of minor improvements to the building envelope. While home energy audits do use some software packages to project energy savings from various measures, the packages differ widely, and their projections are not typically compared to actual savings (Palmer et al. 2011). Moreover, the quality of the workmanship may affect the extent to which these measures actually save energy, as well as homeowner maintenance. Similar problems can exist in commercial buildings.

Better information on energy savings may be necessary but not sufficient to generate more lending for energy-efficient investments. Several issues discussed in the body of this report would remain. In the residential and small commercial sector, transaction costs associated with getting a loan could still limit a building owner's willingness to borrow. High loan origination and processing costs on the lenders' side could also limit willingness to lend. It is important to understand that these are typical features of consumer lending and not necessarily a problem to be solved by government.

Simple disclosure requirements about building energy use may also go a long way to spur building owners to invest in energy efficiency to improve the resale value of their homes and commercial properties. New disclosure requirements for commercial buildings in selected cities may provide a natural experiment to evaluate this possibility.

A better understanding of the risks associated with past energy-efficiency focused lending programs could also help to generate more interest in lending for these activities. The Fannie Mae Energy Loan program has made over 90,000 loans over nearly two decades; this program would provide useful data for analysis of loan performance because it includes information from a variety of locations over a long time period. These data could be used to characterize how loan default or delinquencies vary with characteristics of borrowers, loan terms such as interest rates and the types of investments that the loans were used to finance.

Is there a role for government to play in facilitating energy-efficiency financing or directly providing loans for energy improvements? As a second-best policy in the absence of direct pricing of CO_2 emissions, some energy-efficiency policies may be called for. Whether financing is one of them should be determined based on a full analysis of the cost-effectiveness of this approach compared with alternative policies. Financing may be an “enabler” of energy efficiency but not a driver in and of itself. This brings us full circle to our call for a better and more rigorous analysis of the energy savings and costs of energy-efficiency financing programs. Not only is such analysis useful for private financial markets, it is critical for sound energy policy.

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