*Impact*

*A regulatory impact analysis must accompany every economically significant federal rule or regulation. The Office of Policy Development and Research performs this analysis for all U.S. Department of Housing and Urban Development rules. An impact analysis is a forecast of the annual benefits and costs accruing to all parties, including the taxpayers, from a given regulation. Modeling these benefits and costs involves use of past research findings, application of economic principles, empirical investigation, and professional judgment.*

# The Impact of Home Energy Retrofit Loan Insurance: A Pilot Program

**Alastair McFarlane**
U.S. Department of Housing and Urban Development

## Summary of Impact Analysis

The *PowerSaver* pilot program will increase the availability of affordable financing for consumers who want to make energy-saving improvements to their homes. The program results from a congressional directive to conduct a pilot of energy-efficient mortgage innovation. The U.S. Department of Housing and Urban Development (HUD) responded to the directive with *PowerSaver*, a program in which the Federal Housing Administration (FHA) offers insurance for home improvement loans to finance improvements that foster lower energy consumption. The FHA guarantee will motivate both lenders and loan investors to participate in financing energy-efficient improvements and to create a secondary market.

The pilot program is expected to result in the extension of as much as $300 million in FHA-insured, energy-efficient property improvement loans over 2 years and a resulting energy savings as high as $213 million (in present discounted value) with a cost of $174 million, a total net benefit of $39 million. Over 20 years, the annualized net benefit is $2 million per year. In scenarios using alternative assumptions, the private benefits of the program could be greater or even negative. The social benefits, however, are significant and include reduced greenhouse gas emissions, reduced morbidity, and increased knowledge generated concerning the loan program.

## Need for Policy Change

Affordable financing for home energy improvements can unlock substantial energy, economic, and environmental benefits for individual consumers and for society. Despite the benefits of residential energy efficiency, relatively few homes are as efficient as they could be. Estimates suggest that less than 5 percent of single-family homes have been fully retrofitted for energy efficiency (Choi Granade et al., 2009). Multiple obstacles impede retrofit activity, including inadequate information on the costs and benefits of home energy improvements, limited availability of qualified contractors to perform retrofits, various behavioral barriers, and a lack of access to capital to finance the upfront costs of energy improvements. The undersupply of financing may lead to an overconsumption of energy and a resulting environmental degradation.

### Lack of Alternatives to FHA Loans

The types of loans currently available are all problematic. Unsecured consumer loans or credit card products for home improvements typically charge high interest rates. Home equity lines of credit require owners to be willing and able to borrow against the value of their homes during a period when home values are flat or declining in many markets. Funds for subsidized revolving loans are generally limited in availability and do not always cover home improvements. Utility "on bill" financing (in which a home energy retrofit loan is amortized through an incremental change on a utility bill) has been resisted by most utilities and only serves a handful of markets on a small scale. Property Assessed Clean Energy (PACE) financing programs (in which financing for retrofits is amortized through an incremental increase in property tax or similar bills) have generated resistance from federal financial system regulators because of their general requirement to have priority over all existing liens on a property, including the first mortgage. With the exception of a few small programs serving specific markets, affordable financing for home energy improvements that reflects sound lending principles does not exist (HUD, 2010).

The programs that generally reflect sound lending principles, such as the Fannie Mae Energy Loan, are typically provided as unsecured consumer loans. The lack of securitization results in higher costs for consumers and a less liquid market for financing than a more conventional mortgage product.

For mainstream mortgage financing for home energy improvements to be more available and affordable, a viable secondary market for such products is necessary to generate liquidity through capital markets investment. Piloting the viability of a secondary market for a federally insured home energy retrofit loan program is thus an appropriate goal for the *PowerSaver* program.

### Market Barriers and Market Failures in Energy-Saving Investment

Market barriers and market failures in energy conservation investment in the residential sector are evident. A market barrier is a cost of doing business that is specific to a market and is uncommonly large. In the case of energy-efficient investment, a market barrier could be any private cost of adopting energy-efficient technology[1] that inhibits the diffusion of the technology compared with

[1] See Sutherland (1991) for a description of the barriers to energy efficiency in the residential sector.

other types of investment. The existence of a market does not require government intervention. By definition, however, a market failure may require government policy to intervene so the market will reach a socially optimal level of investment. Market failures in energy conservation stem from incentive structures that lead the market to underprovide energy-efficient investment.

Analyzing market barriers may give us insight into why some retrofit projects are not undertaken. Some researchers hypothesize that the simple net present value model that engineers and manufacturers use overestimates the return on an energy retrofit. In their own studies, these researchers have found that taking account of a wider set of variables have led them to conclude that no "energy paradox" exists; not investing in energy-efficient technology is an economically rational decision. Despite such studies, significant debate continues regarding whether investment in energy-saving technology occurs at efficient levels.

Two commonly cited market barriers are (1) uncertainty and (2) high required rates of return. An energy-efficient investment is an irreversible investment for which the returns are uncertain. Given the fluctuations in energy prices, consumers may be hesitant to bet on the future direction of energy prices until an obvious long-term trend has emerged. The greater the volatility, the longer investors will postpone their investment in energy-saving equipment. Hassett and Metcalf (1995) found that, accounting for uncertainty, levels of investment in energy-saving technology appear to be optimal.

High rates of return are required for energy investments by households because discount rates are high. Discount rates have been estimated for energy-efficient investments and have been found to range from 20 percent to 800 percent (Jaffe and Stavins, 1994). In contrast, Metcalf and Hasset (1999) found that the median return to an energy-efficient investment (attic insulation) is 9.7 percent. Their result is consistent with a Capital Asset Pricing Model (CAPM) estimate of a discount rate and provides little evidence of an energy paradox. It is reasonable, however, to doubt the application of CAPM to household decisions (Sutherland, 1991). A household faces market barriers such as illiquidity and high risk that they cannot diversify, so they are likely to demand a higher compensation than the prevailing average return on business investments.

The undersupply of energy-efficient investment can also be explained by three market failures (Jaffee and Stavins, 1994). First, information concerning the energy-saving technology may be in short supply.[2] Yet, having information on the range of opportunities provided by energy conservation retrofits is critical to optimal decisionmaking concerning the adoption of a technology.[3] Second, consumers may face artificially low energy prices, which discourage energy-efficient investment. Examples of artificially low energy prices are subsidized electricity prices, environmental externalities resulting from residential use, and average cost pricing of energy that does not reflect the marginal cost of supply. Third, a major incentive problem leading to an undersupply of energy-efficient investment in the residential sector is the inability of current homeowners to recapture the full value of their investment on resale. Most households make home purchase decisions infrequently, so it is not likely that they will have a sufficient background in property investment to accurately

[2] Information has characteristics of a public good. Because the supplier of information will be unable to recoup the costs of providing the information, then the market may undersupply information on retrofit technology.

[3] The empirical analysis of DeCanio and Watkins (1998) suggests the importance of informational diffusion.

assess the value of an energy retrofit. If the homebuyer is not willing to pay for energy efficiency because its value is not transparent, then the homeowner will underinvest in energy efficiency.

Finally, one of the most pressing market failures, the overproduction of emissions, merits a separate discussion.

### Negative Environmental Externalities of Energy Consumption

The primary market failure in the residential energy sector is the overproduction of emissions. The household, however, does not internalize the public damage that energy consumption brings to the environment, which leads to a "common resources" market failure in which households over-consume energy (CBO, 2003). The proposed mortgage associated with the *PowerSaver* program is not the optimal solution because it does not impose the marginal damage of energy consumption on polluters. Extending the loan for retrofits, however, could reduce the negative externalities of energy consumption. The opportunities to reduce residential energy consumption, with resulting reductions in both greenhouse gas emissions and particulate matter, are significant (EPA, 2011). According to the U.S. Energy Information Agency (EIA, 2011), the residential sector accounts for 21 percent of the energy consumed in the United States and 20 percent of U.S. carbon dioxide emissions behind electricity generation, transportation, and industrial use. The FHA loan addresses this market failure by lowering the private costs to energy-saving investment.

## Summary of Notice

The Consolidated Appropriations Act of 2010 directs HUD to conduct an "Energy Efficient Mortgage Innovation" pilot program. The Act provides $25 million in appropriated funds to support such an initiative. Named the Retrofit Pilot Program, this initiative will be conducted for loans originated during a 2-year period. FHA has limited participation in the program to no more than nine lenders and has defined the eligible markets that lenders may serve. FHA envisions that the pilot program will provide insurance for up to 24,000 loans during the 2 years, with an expected average loan size of $12,500.

The FHA Title I Home Improvement Loan program provided an appropriate basis for the Retrofit Pilot Program.[4] Therefore, FHA provides a set of modifications to the current Title I Property Improvement program that yield a new product for use in the pilot. Although most of the proposed changes are relatively minor, as a group, and in combination with the appropriated funds, they create an innovative pilot program. FHA proposes augmenting these changes with incentives for lenders to participate, using funding appropriated under the Act.

### Risk Mitigation

Many of the changes that FHA made to the Title I Property Improvement program were for mitigating the risk of loans originated in the Retrofit Pilot Program. Creating liquidity through

[4] The Title I program insures loans to finance the light or moderate rehabilitation of properties and the construction of nonresidential buildings on the property.

securitization requires confidence on the part of the loan investors. First, FHA adopted stricter underwriting standards (a minimum credit score and a maximum combined loan-to-value ratio) to limit the probability of default. Although these proposed changes will prevent some consumers from being able to access the program, the changes are appropriate for securitized loans. Second, FHA proposes that the holder of the note will be accountable to FHA for origination and underwriting errors and that the servicer of the loan will be accountable to FHA for servicing errors. Clarity regarding FHA claim payments made because of servicer errors will mitigate risk for potential loan investors. Third, FHA proposes to disallow dealer loans[5] under the pilot program. Dealer loans have been disproportionately correlated with poor loan performance under Title I and other home improvement loan programs in the past. In summary, all these changes adjust the Title I Property Improvement program to enable the program to encourage home improvements that increase energy performance.

## Interest Cost to Borrowers

Under the Retrofit Pilot Program, as under the Title I Home Improvement Loan program, the market will determine the loan interest rate. Recent reported interest rates for Title I Property Improvement loans have been 6 and 8 percent. FHA anticipates that most borrowers under the pilot program will be able to access financing at rates at or below the current interest rate for Title I loans. HUD will use the funds appropriated under the 2010 Consolidated Appropriations Act to support activities that lower costs to borrowers. FHA proposes to allow other parties to pay discount points or other financing charges in connection with loans under the pilot program.[6] FHA projects that nominal interest rates could be reduced significantly as a result of this practice.

## Changes To Improve Home Energy Performance

Under the Retrofit Pilot Program, the loan proceeds may be used primarily for measures that improve home energy performance for single-family, attached, and semidetached owner-occupied homes. Condominiums and fee-simple ownership properties are also eligible. Up to 25 percent of the loan may be used for nonenergy home improvements.

FHA proposes limiting loan maturities to 15 years, except in the case of renewable energy improvements, which may be financed with 20-year loans. This change better aligns the term of financing with the useful life and benefits of typical home energy improvements.

The funds will be disbursed to the borrower(s) in two increments: (1) 50 percent of the proceeds shall be disbursed at loan funding/closing, and (2) the remaining 50 percent of the proceeds shall be disbursed after the energy retrofit improvements have been completed and verified. This schedule ensures that work may begin but also that the work completed has been approved under the pilot program.

[5] In general, dealer loans made under the Title I Property Improvement program are marketed by home improvement contractors and executed in the form of retail sales installment contracts.

[6] Under the Title I Property Improvement program, the lender may not require or allow any party, other than the borrower, to pay discount points or other financing charges in connection with the loan transaction.

### Targeting Communities

FHA determined that the most effective means for testing the program is to target communities that are best suited to deploy the program. FHA therefore intends to target the pilot program to communities that received competitive grant funding under the Department of Energy's Better Buildings Neighborhood Program. This program supports place-based retrofit initiatives; that is, those initiatives that integrate consumer education and marketing, audits and other information tools, workforce capacity, quality assurance, and financing. FHA is also willing to consider additional markets proposed by the lenders seeking to participate in the program. Targeting the pilot program by choosing communities with an established retrofit program will bias the results of the experiment. FHA decided, however, that evaluating a large number of loans was more important than evaluating a wide variety of communities.

## Benefits and Costs

A reduction of energy expenditures is one primary benefit to borrowers in the Retrofit Pilot Program. The American Council for an Energy-Efficient Economy found that residential retrofits deliver an "array of benefits beyond energy savings," including greater comfort, convenience, health, safety, and noise reduction (Amman, 2006). These nonenergy benefits have been estimated to be worth from 50 to 300 percent of annual household energy bill savings.

### Cost of Energy-Efficient Investment

The cost of a retrofit includes not only the cost of the energy-efficient investment, but also the cost of financing the investment. The upfront development cost is assumed to be $10,000. We assume that the average loan is characterized by a term of 15 years, a down payment of 3 percent, an interest rate of 5 percent, and a 1-percent annual insurance premium. The sum of the undiscounted mortgage and insurance premium payments is $14,785. For a consumer with a discount rate of 7 percent, the present value of the cost of the investment would be $9,980. For a consumer with a discount rate of 3 percent, the present value of the cost of the loan would be $8,640.

### Private Benefits of More Energy-Efficient Homes

The net benefit of an energy-saving retrofit depends on the cost of the retrofit, the resulting reduction in energy consumption, the future direction of energy prices, and the consumer's discount rate. The potential reduction in energy consumption from the retrofit (technical efficiency) provides us with the value of annual saving at current energy prices. Pike Research (2010) analysis found a 36-percent reduction in annual energy bills from an average retrofit of $3,960. The annual bill savings is $597, which is 15 percent of the original energy-efficient investment. Pike's estimate of savings is in line with other studies; the median technical potential for reduced energy consumption in the residential sector is 33 percent for electricity and 40 percent for gas (Nadel et al., 2004).

We assume a retrofit cost of $10,000 that provides energy savings over a period of 20 years. We expect a higher level of benefits than described in most studies because the level of investment is correspondingly higher. For example, if the annual savings were 10 percent of the investment, then the annual savings would be $1,000 (0.1 x $10,000), or 42 percent of a household's annual energy expenditures ($2,400 from the 2008 Consumer Expenditure Survey). Although the savings is outside the average by a few percentage points, a high return would be expected for high levels of investment.

Assuming an energy price growth of 1 percent annually and a discount rate of 7 percent, a present value of energy saving would be $12,210 over 20 years. The benefit-cost ratio would be 1.22 ($12,210/$10,000),[7] which is not far from that of other studies. For example, Clinch and Healy (2001) estimated a benefit-cost ratio of 1.24 for a discount rate of 8 percent and their estimate is about the midpoint of other studies on energy efficiency. When the discount rate is 3 percent, our benefit-cost ratio is 1.67, which is below Clinch and Healy's of 2.14 for a discount rate of 3 percent. Data from the federal Weatherization Assistance Program indicate that every $1 invested in weatherization reduces household energy bills by $1.80 (Eisenberg, 2010).

The annual benefit, as measured by the potential reduction in energy expenditure, depends on energy prices: as energy prices rise, the energy efficiency is worth more. The longer the life of the investment, the greater the sum of the benefits. Finally, because benefits are discounted at a higher rate (that is, when the future is worth less to a consumer), then the sum of the present value of benefits will be less. For a discount rate of 7 percent, no energy price growth, and a lower energy bill savings of 37 percent, then the investor would only break even after 20 years. The net benefits of an energy-efficient retrofit are not always positive under the scenarios considered above. A project lifetime of 15 years would lower the benefit-cost ratio to 0.87. On the other hand, high benefit-cost ratios are attainable under realistic scenarios: an expected energy price growth of 3 percent, a discount rate of 3 percent, and a reduction of energy bills of 42 percent would yield a benefit-cost ratio of 2.02.

Offering a loan to pursue the retrofit has two effects on costs: it adds to the cost through the interest cost and, at the same time, postpones the costs of the investment. The net effect on cost to the consumer depends on the difference between the cost of the loan and the consumer's discount rate. The benefit-cost ratio is higher with the loan if the consumer's discount rate is higher than the mortgage interest rate, and it is lower when the discount rate is lower than the mortgage interest rate. We expect the loan to have positive effects on investment. First, the consumer discount rates have consistently been at least as high as discount rates in the context of energy-saving investment. Second, even if the interest cost adds to the costs of the investment, many consumers do not have the necessary funds to undertake significant investments without a loan. The benefit-cost ratio of the loan-financed investment is 1.34 at a discount rate of 3 percent, 1.22 at 7 percent, and 1.16 at 10 percent.

## Emissions

Decreasing energy consumption will reduce emissions of pollutants (such as particulate matter) that cause health and property damage and greenhouse gases (such as carbon dioxide) that cause global warming. Data from the Department of Energy (2010) suggest that residential retrofits through the Weatherization Assistance Program reduced carbon dioxide emissions by an average

[7] For a variety of estimates, see table 1, HUD (2011).

of 2.65 tons per home per year. Over the life of the measures, weatherization is expected to save 53 metric tons of carbon dioxide emissions per home. Encouraging investment in energy-efficient housing is one of the only policy instruments available to HUD for influencing energy consumption in the built environment.

## Health Benefits

Health benefits resulting from reduced mortality and morbidity are one of the benefits of energy efficiency. Greater energy efficiency allows households to afford energy for heating during severe cold or for cooling during intense heat. Being able to afford energy reduces the risk of both death and illness for vulnerable populations.

## Aggregate Benefits and Costs

We calculate the aggregate benefits by multiplying the per-loan benefits by the number of loans. In the 2-year Retrofit Pilot Program, FHA would provide insurance on an estimated 24,000 home energy retrofit loans. We assume that loans are distributed evenly over that period (1,000 per month). If we take the annual saving of $1,000, 1-percent price growth, and 7-percent discount rate as a base case, then the present value of the technical efficiency of the retrofit is $12,210, and the total benefits would be $147 million annually (12,000 x $12,210). Three primary leakages to the energy-conserving purpose of the pilot program are (1) a rebound in energy use, (2) the extent to which the loan product is a windfall versus an incentive, and (3) the use of a portion of the loan for purposes other than retrofits.

### Rebound Effect

Whatever the predicted technical efficiencies of an energy retrofit, a household's actual savings is likely to be smaller because of a behavioral response known as the "rebound effect." By increasing energy efficiency, the retrofit reduces the expense of physical comfort and increases the demand for comfort. In fact, the retrofit could be driven by a demand for more heating in the winter and more cooling in the summer. Although it is difficult to pinpoint an agreed-upon proportion, Clinch and Healy (2001) found that the rebound effect is usually less than 50 percent. Sorrel (2007) found an upper-end estimate of the rebound effect for space heating and cooling to be 30 percent. Likewise, Boardman (1994) found that 70 percent of the benefits of energy-efficient improvements reduce energy consumption, while 30 percent go toward increased health and comfort. Assuming a rebound effect of 30 percent yields a comfort benefit of $3,660 and an energy savings of $8,550 per participant and, given 12,000 loans annually, there would be $44 million in comfort benefits and $103 million in private energy savings for each year of the program.

The size of the rebound effect does not reduce the benefit to a consumer of energy efficiency, but it informs us of how those benefits are allocated between reduced energy costs and increased comfort. The rebound effect, however, has implications for measuring the public benefit of reducing energy consumption. If the primary goal of an energy efficiency investment program is to reduce emissions, then the amount of benefits going toward reduced energy consumption is critical.

### Windfall Effect

If participants had invested without the loan guarantee, then the program would result in a transfer to consumers (or windfall) equal to the decrease in the cost of capital. We have discussed, however, the existence of significant market imperfections and the lack of affordable financing; it is, therefore, reasonable to assume that a large proportion, if not all, of the loans would incentivize new investments. Indeed, the most complete study of the energy conservation tax credit illustrates the effectiveness of federal incentives that reduce the cost of capital by encouraging investment in energy efficiency (Hasset and Metcalf, 1995).

### Nonretrofit Investment

The *PowerSaver* loan is not required to finance investments in only energy efficiency. Up to 25 percent may be diverted to other home improvements. If, however, all households elect to use only 75 percent of the proceeds of the loan to finance energy retrofits, then the energy-related benefits will be proportionally lower. The most common proportion of the loan devoted to energy retrofits is expected to be 75 percent. In this case, the total private energy benefits of the program would be $110 million annually and the energy savings would be $77 million annually. The nonretrofit allowance, however, does offer some benefits. First, the allowance is useful in marketing the loan and may result in a greater diffusion of the loan product. Second, efficiencies may exist for consumers in the nonretrofit portion of the loan: consumers who need to finance renovations made necessary by the retrofit will not be required to pay the transactions costs for an additional loan.

### Net Aggregate Effect

The net benefit to the consumer of the loan-financed investment is equal to the total energy benefits (energy savings plus comfort benefits) less the cost of the investment and the financing costs (see exhibit 1). For example, for an annual saving of $1,000 (42 percent reduction of energy bills), the net benefit to the consumer of the loan-financed $10,000 investment is $2,230; for an annual of reduction of $888 (37 percent), the net benefit to the consumer is $860.

The aggregate net benefit to consumers is obtained by multiplying the individual net benefit by the expected number of loans. We expect 12,000 loans annually. Exhibit 1 presents three scenarios: one in which all of the energy benefits are realized by the program, one in which 75 percent of the benefits are realized, and one in which 60 percent are realized. The 100-percent scenario assumes there are no leakages: all investment is in energy retrofits. The 75-percent

**Exhibit 1**

Present Value of Energy Benefits and Costs for 1 Year of Pilot Program ($ millions)

| Retrofits Induced by Pilot (%) | 42% Reduction in Annual Energy Bill | | | 37% Reduction in Annual Energy Bill | | |
|---|---|---|---|---|---|---|
| | Total Energy Benefits ($M) | Total Costs ($M) | Net Benefits ($M) | Total Energy Benefits ($M) | Total Costs ($M) | Net Benefits ($M) |
| 100 | 147 | 120 | 27 | 130 | 120 | 10 |
| 75 | 110 | 90 | 20 | 98 | 90 | 8 |
| 60 | 88 | 72 | 16 | 78 | 72 | 6 |

*Assumptions: $2,400 annual energy bill, 7-percent discount rate, 12,000 participants annually, $10,000 cost of retrofit, 5-percent mortgage interest rate, 1-percent periodic insurance premium.*

scenario assumes the maximum allocation toward nonconservation uses, with borrowers investing 25 percent of the loan proceeds in other improvements. The 60-percent scenario also assumes nonenergy leakage but also assumes that 40 percent would have been invested without the loan (windfall effect). It is reasonable, however, to assume that a large proportion, if not all, of the loans will generate benefits. Because a small share of homeowners historically has invested in home energy improvements, HUD believes that the likelihood that households that receive a loan would have renovated otherwise is small.

The estimated energy saving over the lifetime of the program, given a 100- and 75-percent incentive effect, is provided in exhibit 2.

To measure the social value of an investment in energy efficiency, one must add the expected social benefits of reduced energy consumption. An indepth analysis by Clinch and Healy (2001) of domestic energy efficiency found the benefit-cost ratio to be 2.38 (when the discount rate is 8 percent). Energy reduction benefits represent most of the benefits (52.1 percent), followed by health benefits (29 percent), comfort benefits (10.9 percent), and emissions reduction[8] (7.6 percent). Their results can be used to estimate the value of nonenergy benefits. Adding reduced emissions raises the benefit-cost ratio of energy benefits (savings plus comfort) by 12 percent (7.6/(52.1+10.9)) from 1.22 to 1.37. The benefit of reduced emissions per consumer is $1,465 ((1.37-1.22)) x $10,000). With 12,000 loans, this benefit amounts to $18 million and increases annual net benefits from $27 million to $44 million (in the 100-percent scenario) or increases the benefit amount from $20 million to $38 million (in the 75-percent scenario).

**Exhibit 2**

Total Energy Benefits and Costs of Program ($ millions)

| | 100% Participation | | | 75% Participation | | |
|---|---|---|---|---|---|---|
| | Total Energy Benefits ($M) | Total Costs ($M) | Net Benefits ($M) | Total Energy Benefits ($M) | Total Costs ($M) | Net Benefits ($M) |
| Year 1 | 147 | 120 | 27 | 110 | 90 | 20 |
| Year 2 | 137 | 112 | 25 | 103 | 84 | 19 |
| Total | 284 | 232 | 52 | 213 | 174 | 39 |
| Annualized | 26 | 11 | 2 | 20 | 8 | 2 |

*Assumptions: 42-percent reduction in annual energy bill, 7-percent discount rate, over 21 years.*

# Transfers

Transfers are neither costs nor benefits, because they do not add to or detract from social welfare but instead redistribute income.

## FHA

It is difficult to calculate a precise estimate of the credit subsidy rate for this program absent any data or experience. However, we do have estimates for the Title I Property Improvement program

[8] The authors assume a rebound effect of 40 percent. The benefits from reducing emissions may be greater in the current analysis in which the rebound effect is assumed to be 30 percent.

on which the pilot is based. FHA estimated the credit subsidy rate for the Title I Property Improvement program to be -0.76 percent and the expected claim rate to be 4.51 percent. The underwriting and operating features of the pilot program will not contribute to a higher risk profile than the Property Improvement program on which it is based. Thus, the Property Improvement estimates can be used to illustrate the effect of the pilot program. If the credit subsidy rate were -0.76 percent and the loan volume $150 million annually, then the FHA could expect $1.14 million (0.76 x $150 million) from the pilot. We expect this program will generate positive transfers for FHA.

### Consumers

The transfer to consumers is equal to the difference between the FHA interest rate and the interest rates on alternative types of loans available for retrofits. If the next best interest rate for the consumer were fairly low, at 9 percent, but above what is expected for a Title I Property Improvement loan, then this loan would represent a transfer of approximately $2,000 per household ($12,027 - $9,984). Such a transfer, or windfall, would apply for households that would have financed an energy retrofit without the incentive of an FHA loan. In a previous discussion, however, we concluded that most households would not invest without the FHA loan.

## Conclusions

The purpose of the *PowerSaver* pilot program is to test and demonstrate the feasibility of low-cost financing for secured home energy retrofit loans. Although other financing options are available for consumers, these alternative programs typically experience minimal usage. Among the many broader objectives of this program are creating a market for a new type of loan, reducing market barriers to investment in energy efficiency, and limiting the carbon footprint of the housing stock. If FHA is able to learn from the pilot and launch a broader program, then it may achieve these broader objectives.

## References

Boardman, Brenda. 1994. “Strategies for Action.” In *Domestic Energy and Affordable Warmth*, edited by Thomas A. Markus. London, United Kingdom: Taylor & Francis.

Choi Granade, Hannah, Jon Creyts, Anton Derkach, Phillip Farese, Scott Nyquist, and Ken Ostrowski. 2009 (July). *Unlocking Energy Efficiency in the U.S. Economy*. Amsterdam, Netherlands: Mckinsey & Co.

Clinch, J. Peter, and John D. Healy. 2001. “Cost-Benefit Analysis of Domestic Energy Efficiency,” *Energy Policy* 29: 113–124.

Congressional Budget Office (CBO). 2003. *The Economics of Climate Change: A Primer*. Washington, DC: Congress of the United States, Congressional Budget Office.

DeCanio, Stephen J., and William E. Watkins. 1998. “Investment in Energy Efficiency: Do the Characteristics of Firms Matter?” *Review of Economics and Statistics* 80: 95–107.

Eisenberg, Jeff. 2010 (March). Background Data and Statistics. Weatherization Assistance Program Technical Memorandum. Prepared for the U.S. Department of Energy. Oak Ridge, TN: Oak Ridge National Laboratory.

Hasset, Kevin A., and Gilbert Metcalf. 1995. "Energy Tax Credits and Residential Conservation Investment: Evidence From Panel Data," *Journal of Public Economics* 57: 201–217.

Jaffee, Adam B., and Robert N. Stavins. 1994. "Energy Efficient Investments and Public Policy," *The Energy Journal* 15 (2): 43–65.

Joint Center for Housing Studies of Harvard University. 2009. *State of the Nation's Housing 2009.* Cambridge, MA: Harvard University, Joint Center for Housing Studies.

Metcalf, Gilbert E., and Kevin A. Hassett. 1999 (August). "Measuring the Energy Savings From Home Improvement Investments: Evidence From Monthly Billing Data," *Review of Economics and Statistics* 81 (3): 516–528.

Nadel, Steven, Anna Monis Shipley, and R. Neal Elliott. 2004. *The Technical, Economic and Achievable Potential for Energy-Efficiency in the U.S.—A Meta-Analysis of Recent Studies.* Presented at the 2004 ACEEE Summer Study on Energy Efficiency in Buildings.

Pike Research LLC. 2010. *Energy Efficient Homes*. Boulder, CO: Pike Research LLC.

Sorrel, Steven. 2007 (October). *The Rebound Effect: An Assessment of the Evidence for Economy-Wide Energy Savings From Improved Energy Efficiency*. London, United Kingdom: UK Energy Research Centre.

Sutherland, Ronald J. 1991. "Market Barriers to Energy-Efficiency Investments," *Energy Journal* 12 (3): 15–34.

U.S. Department of Energy (DOE). 2010 (April 27). "Weatherization Assistance Program: Know the Facts." http://www.waptac.org/data/files/public_information/wapfacts.docx (accessed October 20, 2011).

U.S. Department of Housing and Urban Development (HUD). 2011 (June). "Impact Analysis of Federal Housing Administration Proposed Pilot Program: 'PowerSaver' Home Energy Retrofit Loan Insurance FR–5450–N–01." http://portal.hud.gov/hudportal/documents/huddoc?id=ia-powersaverretrofit.pdf (accessed October 20).

U.S. Energy Information Agency (EIA). 2011 (March). "Buildings Energy Data Book." http://buildingsdatabook.eren.doe.gov/ (accessed October 20).

U.S. Environmental Protection Agency (EPA). 2011a. "Features and Benefits of Energy Star Qualified New Homes." http://www.energystar.gov/index.cfm?c=new_homes.nh_features (accessed October 20).

———. 2011b. "Climate Change." www.epa.gov/climatechange/ (accessed February 28; updated February 16).

## Additional Reading

Carliner, Michael, Liza Bowles, and Joe Nebbia. 2008 (December). *The Valuation of Energy Efficiency in Homes*. Prepared for the U.S. Department of Housing and Urban Development. Davidsonville, MD: Newport Partners LLC: 4–5.

Thorne Amman, Jennifer. 2006 (May). *Valuation of Non-Energy Benefits To Determine Cost-Effectiveness of Whole House Retrofits Programs: A Literature Review*. Washington, DC: American Council for an Energy-Efficient Economy.