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APPENDIX A

DEFINING COST-EFFECTIVENESS

This Appendix briefly discusses cost-effectiveness, also known as "payback." The idea behind cost-effectiveness in the context of energy-conserving rehabilitation is that, over a certain period, the repair or modification must pay for itself in savings. Generally, the payback can be estimated through a present value (PV) calculation—i.e., the value today of a stream of payments or savings made over time.

To calculate the PV of the cost of a repair, the PJ or energy conservation program must have the information to solve the following equation:

$$C_{PV} = S_{PV}$$

where

$$S_{PV} = S \left[\frac{1}{1 - (1+r)^t} \right] \frac{1}{r}$$

and	C_{PV}	=	PV cost of the repair
	t	=	Minimum life expectancy of repair
	r	=	Appropriate discount rate
	S	=	Estimated \$ value of energy savings from the repair each year
	S_{PV}	=	PV of the annual savings over time t

When the savings over the life expectancy of the repair (usually 5 to 10 years) exceeds the cost of the repair, the repair is cost-effective.

- The PV cost of the repair is easy to calculate. If it is paid up front, it is simply the cost. If it is paid for over time, as an amortizing or no-interest loan, another PV calculation must be performed to estimate cost of the loan over time, using a similar calculation.*
- The life expectancy of the repair, however, depends on the particular climate and type of installation. The equation uses the minimum life expectancy because affordable housing may not be as durable as more expensive construction, and because it provides the most conservative estimate of cost-effectiveness.
- The discount rate is usually the interest rate at which the homeowner (or the PJ, depending on who is paying for the repair) could have invested the money if he or she were to receive it in a lump sum.
- The estimated savings is itself a function of the discount rate, the current fuel price, and the actual reduction in fuel consumption, expressed as a dollar amount or a percentage. Estimates for certain types of repair usually are calculated through engineering studies; they are estimates for a class of repair, not for the repair to a particular home.

* The equation is:

$$C_{PV} = P \left[\frac{1}{1 - (1+i)^n} \right] \frac{1}{i}$$

for a steady stream of payments where

C_{PV}	=	PV cost of the repair
P	=	Periodic payment amount
n	=	Number of loan payments
i	=	The annual interest rate/number of periods per year

EXAMPLE: If a homeowner will pay \$3,000 up front for repairs with a minimum life expectancy of 10 years, and the energy conservation agency calculates that the homeowner will save 20 percent on heating bills of \$2,000/year (i.e., \$400/year), are the repairs worth doing? The discount rate is 7 percent.

The C_{PV} equals \$3,000. The S_{PV} , calculated through the above equation, is only \$2,809—i.e., the value of a \$4,000 savings collected over 10 years is the same as \$2,809 received today and invested at 7 percent (compounded yearly) for 10 years. The repairs are *not* cost-effective.

EXAMPLE: The same homeowner receives \$3,000 as a low-interest loan, at 3 percent over 10 years, to pay for the repairs. Are the repairs worth doing?

Under these terms, the loan payments are \$28.97 monthly, or \$3,476.40 total. This is discounted by 7 percent, except that, because the payments are made monthly, the total cost is discounted by the monthly rate, 0.5833 percent, over 120 payments. The C_{PV} of \$3,476.40 paid out monthly for 10 years is \$2,509.64. The repairs *are* cost-effective.

Of course, PJs must recognize that, beyond the economic question of $C_{PV} = S_{PV}$, there is a political question of who is paying the price versus who receives the benefits. If a homeowner receives assistance as a grant, he or she will not care about the two sides of the equation; it will not matter how much the PJ pays for his or her benefit. Conversely, the PJ might find it more expedient to offer a lump-sum payment up front for repairs, rather than provide bill-paying assistance each year, especially if there are annual administrative costs that affect the equation. Thus, depending on the political needs of their energy-conserving housing rehabilitation program, PJs should consider the cost-benefit comparison in their decision of whether they still will pay for the repairs.

* The concept behind this lower C_{PV} is that a dollar received or spent in the future is less than a dollar received or spent today. A dollar received at the end of the year has the value of one dollar when it is received. A dollar invested today at 4 percent interest compounded monthly yields \$1.04 at the end of the year, in current terms (i.e., without inflation). Conversely, an investment of 96¢ today made at 4 percent yields a dollar at the end of the year.

Thus, the homeowner can either pay the PJ a dollar today, or can invest 96¢ today, pay the PJ the value of \$1.00 in a year, and save the current value of 4¢. Even with the interest payment for the loan, the C_{PV} is lower.

APPENDIX B

ENERGY CONSERVATION GLOSSARY

Below are basic definitions of energy conservation terms and procedures that PJs must understand to evaluate energy conservation programs and their housing rehabilitation techniques.

Batt Insulation. Rock wool or glass fiber insulation sold in sections (batts) that are usually 15 or 23 inches wide and 4 or 8 feet long. Batts come with or without a vapor retarder backing.

Blanket Insulation. Rock wool or glass fiber insulation sold in rolls, 15 or 23 inches wide. The installer cuts these rolls to the length desired.

Blower Door. A blower door tests how airtight a house's thermal envelope is. In essence, a blower door is a pressurizing unit that fits into the main door of the house. By artificially raising and lowering the air pressure inside the house, the blower door reveals infiltration and exfiltration points that can be repaired through weatherization (e.g., caulking) and insulation.

British Thermal Unit (BTU). The amount of heat energy needed to raise the temperature of 1 pound of water by 1°F. The BTU content of fuel indicates the heating volume of that type of fuel.

Bypass. An infiltration or exfiltration point (see below). Typical bypasses include interior partition wall junctions, chimney clearances, built-in closets and cabinets, basement doors and windows, dropped ceilings, window sashes, duct runs, and electrical fuse boxes—any place where the thermal envelope might be incomplete or broken.

Caulking. A flexible material used to fill gaps and seal joint of a building to retard the flow of air, water, and heat. (see weatherstripping).

Conduction. The flow of heat through one physical material to another or just out into the air. Heat flowing through the walls of a house travels by conduction.

Convection. Heating air to create a warm air current as a means of circulating heat through a space.

Convective Loop. Internal heat movements whereby the heat in heated air is transferred to cold air as that cold air moves into adjacent, isolated building cavities. Insulation and sealing can prevent convective loops.

Cooling Hours. The number of hours that the outdoor temperature is above a base temperature—usually 80°F—requiring indoor cooling.

Degree Day, Heating. The measure of cold-weather intensity. Heating demand for an area is measured in terms of number of degree days in a year. For any one day, there are as many Degree Days as degrees difference in temperature between the mean temperature for the day and 65°F.

Double-Glazed Window. A window equipped with two layers of glass, usually: (1) a single-layer primary window and a storm sash; or (2) a two-layer, insulated glass window unit.

Energy Audit. An on-site inspection or survey of a building to establish how energy is used and identify ways to improve energy efficiency. The audit covers building design, maintenance practices, mechanical equipment operation, air flow, and other factors.

Energy Review. The part of a rehabilitation inspection that considers the need for energy-saving modifications and determines whether such modifications would be cost-effective. It is similar to an energy audit.

Energy Standard. A design requirement or criterion for making cost-effective improvements to buildings to ensure more efficient utilization of energy.

Exfiltration. The escape of (heated) inside air from a housing unit through unintended openings in the thermal envelope of the house (see below).

Infiltration. The entry of outside air into a housing unit through unintended openings in the thermal envelope of the house (see below).

M-factor. M-factor refers to a building material's mass. The greater the mass, the more energy the material can store. Brick can absorb and hold more radiant heat than wood. The M-factor influences the building's reaction to temperature changes between night and day.

Payback Period. The amount of time necessary to recover the installation cost of an energy conservation measure, such as insulation, through savings in energy costs.

R-value. The R-value of a material is a measure of the material's ability to resist (and thus restrict) the transfer of heat. The higher a material's R-value, the better it serves as insulation. Generally, R-values are additive, but also exhibit diminishing returns after an efficient level of heat loss has been achieved. (See U-value).

Radiation. The emission of heat (sunlight or system-generated) in waves. As they strike materials, heat waves are either absorbed, reflected, or transmitted. Glass transmits light, but absorbs heat. (This is the "greenhouse effect.") Materials should be used (such as glazed skylights and east-facing windows) that maximize the heat gains from heat radiation.

Sealant. A flexible material placed in building joints to block the flow of air, heat, or moisture.

Storm Door. An extra door installed outside of an exterior primary or ordinary door to reduce heat loss and air infiltration.

Storm Window. An extra window, usually installed outside the primary window, designed to reduce heat loss and air infiltration.

Thermal Break. The layer of insulating material placed between the inner and outer frames of a metal-framed window or door to prevent heat flow through the frame.

Thermal Envelope. A thermal envelope is analogous to a balloon—a closed system of air. If the thermal envelope is broken because of poor air sealing at a duct, wall joist, etc., the house will lose heated or cooled air.

Triple-Track (Combination) Storm Window. A storm window unit with screens, principally designed for use with double-hung or sliding windows. It is permanently installed and can be easily opened for ventilation.

U-value. The reciprocal of the R-value. The rate of heat transmittance through a material of 1 square foot in area, measured in BTUs per hour, and based on an indoor-outdoor temperature difference of 1°F.

Weatherstripping. Flexible metal, rubber, felt, vinyl, or foam materials installed around the moving parts of windows and doors to prevent air leaks.

APPENDIX C

INTERNAL ASSESSMENT QUESTIONNAIRE FOR PJS CONSIDERING PARTNERSHIP WITH ENERGY AGENCIES

SERVICES

- What energy conservation services does your organization offer?
- What types of repairs does your organization provide? Do you provide any general repair services?
- What is the target population for the program? Does it focus on or exclude certain building types?

FINANCING

- What are the program's financial sources (Federal, State, local, private)? Are these funds specifically designated for energy conservation projects?
- What regulations apply to the use of these funds? What are the recordkeeping and monitoring requirements?
- Does the program charge residents for services? What financial assistance is available?

ORGANIZATION/PROCEDURES

- How are work crews assigned? How are jobs supervised?
- What is the turnaround for different types of weatherization jobs?
- What accounting procedures are used?
- What is the system of procurement and inventory controls?

WORK STANDARDS

- What training or licensing is required for project crews?
- Must completed houses pass a blower door test for air tightness or a flue gas test for furnace efficiency?
- Does your program use DOE weatherization guidelines?

RESOURCES

- What level of energy conservation expertise does your organization have in-house? Does your organization use contractors in the local community?
- Is your program affiliated with:
 - State agencies;
 - The local utility company;
 - Local financial institutions; or
 - Nonprofit organizations?

ENERGY CONSERVATION PROGRAM RESOURCES

Alliance to Save Energy

1725 K Street, N.W., Suite 509, Washington, DC 20006

The Alliance to Save Energy is a nonprofit coalition of business, government, environmental, and consumer leaders dedicated to increasing the efficiency of energy use. It conducts research, pilot projects, and education programs, and produces a number of guidebooks on energy efficiency programs.

American Council for an Energy-Efficient Economy (ACEEE)

2140 Shattuck Avenue, Suite 202, Berkeley, CA 94604

1001 Connecticut Avenue, N.W., Suite 801, Washington, DC 20036

ACEEE is a nonprofit organization that gathers, evaluates, and disseminates information to stimulate greater energy efficiency. It conducts studies, publishes books and reports, provides expert testimony, organizes conferences to facilitate the exchange of information, and produces an annual publications catalogue.

Association of Home Appliance Manufacturers

20 North Wacker Drive, Chicago, IL 60606

The Association produces the *Consumers Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment*, a directory of certified unitary air-conditioners, unitary air-source heat pumps, and sound-rated unitary equipment, a consumer selection guide for refrigerators and freezers, and a directory of certified refrigerators and freezers.

Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS)

P.O. Box 3048, Merrifield, VA 22116

CAREIRS provides information fact sheets on appliance labeling, windows, insulation, energy-efficient lighting, heat pumps, and other heating equipment such as automatic and programmable thermostats. It also produces other fact sheets, bibliographies, and contacts for conservation and renewable energy measures and products.

Local Electric and Gas Utility Companies

Public utility companies can assist with utility bill interpretation and analysis. They sponsor rebate and other incentive programs, provide technical assistance and guides on energy conservation, and maintain lists of qualified heating contractors.

State and Local Government Energy Offices, Housing Finance Agencies, Weatherization Agencies, and Code Officials

These agencies generally offer weatherization, home energy assistance, and energy-efficiency programs, including energy-efficient mortgage lending. They can also provide local/State energy conservation with advice and guides. Code officials have information on buildings codes as they relate to energy conservation measures.

U.S. Department of Energy

Energy Conservation Program Division

State Energy Conservation Program

Weatherization Assistance Program Division

Forrestal Building, 1000 Independence Avenue, S.W., Washington, DC 20585

The Energy Conservation Program performs activities to stimulate the development of energy-efficient technology through support of research, exploratory development, engineering feasibility studies, and pilot-scale evaluations. It also conducts data analysis, technology assessments, model development, and consumer information dissemination. The State Energy Conservation Program provides funding and

technical assistance to States in support of State and local energy conservation programs. The Weatherization Assistance Program Division provides funding for weatherization activities. The DOE can provide the following resources:

- **DOE Insulation Fact Sheet.** This publication gives detailed information on the uses of insulation in the home and includes a chart to determine insulation recommendations based on postal ZIP code.
- **Reports on the ZIP computer program.** The ZIP program allows for a more in-depth analysis of a particular building and includes options for entering local fuel costs. The two reports are:
ZIP - The ZIP-Code Insulation Program, Version 1.0: Economic Insulation Levels for New and Existing Houses by Three-Digit ZIP Code: Users' Guide and Reference Manual, by Stephen R. Petersen, ORNL/TM-1 1009, NISTIR 88-3801, Oak Ridge National Laboratory, Oak Ridge, Tennessee (January 1989). Contact: (615) 576-5454
ZIP - The ZIP-Code Insulation Program, Version 2.0: Economic Insulation Levels for New and Existing Houses by Three-Digit Zip Code: Users' Guide and Reference Manual (Revised edition), by Stephen R. Petersen, NISTIR 88-3801 -1, U.S. Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD (January 1991). Contact: (301) 975-2000
- **DOE Attic Radiant Barrier Fact Sheet.** This fact sheet explains radiant barriers and how they work. The series of tables provided in this publication are designed to help readers determine whether adding a radiant barrier is cost-effective. The tables are based on national average fuel costs and average heating and cooling equipment efficiencies; a worksheet is provided so that readers can use their own fuel costs and efficiencies if they differ from the values assumed in the tables.
- **DOE Weatherization Installation Standards.** This booklet provides detailed information on insulation materials and methods of installation in ceilings, walls, and floors and includes many sketches to help readers specify and inspect insulation jobs.
- **DOE Computerized Energy Audit.** DOE has developed a national energy audit for the Weatherization Assistance Program that is extremely useful in planning energy upgrades. The audit may be used on a portable computer that can be taken along during an inspection of a housing project and used later at the office. The audit's user-friendly screens let users enter much of the information discussed above concerning building envelope areas and existing levels of insulation. The computer program performs a series of calculations to make recommendations on what levels (if any) of insulation should be added to each of the envelope components. In addition to insulation, the program also includes recommendations on heating systems. The final output of the program is a prioritized list of energy improvements and a list of materials needed. Using this program eliminates the need for many calculations of the energy savings due to adding insulation and calculating payback periods.

The program can be obtained by contacting:

Ms. Veronica Johnson
EE-532
U.S. Department of Energy
Weatherization Assistance Program

The source of some of these citations is *Eye on Energy: Rehab for All Seasons*, U.S. Department of Energy and U.S. Department of Housing and Urban Development, 1992. An *Eye on Energy* video and companion guide will be completed and made available through HUD's Office of Environment and Energy in spring 1994.

Glossary of Terms

Adjusted Income	The HOME Program uses the income definitions in the Section 8 Program. Adjusted income is annual (gross) income reduced by deductions for dependents, elderly households, medical expenses, handicap assistance expenses, and child care. Adjusted income is used to compute the level of payment to tenants when HOME funds are used for rental assistance.
Affordability	As used in this guide, affordability refers to the requirements of the HOME Program that relate to the cost of housing both at initial occupancy and over established timeframes, as prescribed in the HOME Interim Rule. Affordability requirements vary depending on the nature of the HOME-assisted activity (i.e., homeownership or rental housing).
Annual (Gross) Income	The HOME Program uses the income definitions used in the Section 8 Program. Annual income includes earned income, income from assets, and income from other sources as defined by 24 CFR Part 813. Annual income is used to establish homeowner and tenant eligibility and for targeting purposes. The annual income definition used in Section 8 is more extensive than the income definitions used in the Community Development Block Grant Program.
Commitment	<p>The written, legally binding agreement between the participating jurisdiction (or other entity) and the project owner providing HOME funds to a project. For tenant-based rental assistance, the commitment is the rental assistance contract between the participating jurisdiction (or other entity) and the tenant or owner. Once a commitment occurs, HUD expects construction to start or a purchase to occur within 6 months.</p> <p>HUD recognizes the commitment when the project setup report is entered in the Cash and Management Information System.</p>
Community Development Block Grant (CDBG)	Federal funding that allows communities to create flexible, locally designed comprehensive community development strategies to enable them to develop viable urban communities (Title I, Housing and Community Development Act of 1974).
Community Housing Development Organization (CHDO)	A private, nonprofit organization that meets a series of qualifications prescribed in the HOME regulations. CHDOs must receive at least 15 percent of a participating jurisdiction's annual allocation of HOME funds. CHDO's may own, develop, or sponsor HOME-financed housing.
Comprehensive Housing Affordability Strategy (CHAS)	A Comprehensive Housing Affordability Strategy is a 5-year plan that articulates housing needs and investment strategies. It is updated annually. Virtually all HUD-funded housing programs must be consistent with an approved CHAS.
HOME-Assisted Units	Units within a HOME project where HOME funds are used and rent, occupancy, and/or resale restrictions apply.

HOME Funds	All appropriations for the HOME Program, plus all repayments and interest or other return on the investment of these funds.
HOME Investment Trust	The term given to the two accounts—one at the Federal level and one at the local level—that “hold” the participating jurisdiction’s HOME funds. The Federal HOME Investment Trust Account is the U.S. Treasury account for each participating jurisdiction. The local HOME Investment Trust Fund account includes repayments of HOME funds, matching contributions, and payment of interest or other returns on investment.
Housing Investment Partnership Act (HOME)	The act that created a formula-based allocation program intended to support State and local affordable-housing programs. The goal of the program is to increase the supply of affordable rental and ownership housing through acquisition, construction, reconstruction, and moderate or substantial rehabilitation activities (Title II, National Affordable Housing Act of 1990).
Housing Quality Standards (HQS)	The performance standards for housing as established in 24 CFR Part 882 and amended by the Lead Paint Regulations in 24 CFR Part 35.
HUD	U.S. Department of Housing and Urban Development.
Low-Income Family	Family whose annual (gross) income does not exceed 80 percent of the median income for the area (adjusted for family size). HUD may establish, on an exception basis, income ceilings higher or lower than 80 percent of median income for an area.
Moderate Rehabilitation	The term used in the HOME Program to refer to any rehabilitation of residential property at a total development cost equal to or less than \$25,000 per unit.
National Affordable Housing Act of 1990 (NAHA)	Enacted by Congress to authorize a new HOME Investment Partnership Act program, the National Homeownership Trust program, and programs to amend and extend certain laws relating to housing, community, and neighborhood preservation and related programs.
New Construction	For purposes of the HOME Program, new construction is any project with commitment of HOME funds made within 1 year of the date of initial certification of occupancy. Any project that includes the creation of additional dwelling units outside the existing walls of a structure is also considered new construction.
Participating Jurisdiction (PJ)	The term given to any State or local government that HUD has designated to administer a HOME Program. HUD designation as a PJ occurs if a State or local government meets the funding thresholds, notifies HUD that it intends to participate in the program, and obtains approval by HUD of a Comprehensive Housing Affordability Strategy.
Project	A site or an entire building or two or more buildings, together with the site or sites on which the building or buildings are located, that are under common ownership, management, and financing, and are to be assisted with HOME funds—under a commitment by the owner—as a single undertaking. If there is more than one site associated with the project, the sites must be within a four-block area.

Section 8 Existing Rental Assistance	A Federal program that provides rental assistance to low-income families who are unable to afford market rents. Assistance may be in the form of vouchers or certificates.
State Recipient	Any unit of local government designated by a State to receive HOME funds. The State is responsible for ensuring that HOME funds allocated to State recipients are used in accordance with the HOME regulations and other applicable laws.
Subrecipient	A public agency or nonprofit organization selected by a participating jurisdiction to <i>administer</i> all or a portion of the participating jurisdiction's HOME Program. A public agency or nonprofit organization that receives HOME funds solely as a developer or owner of housing is not a subrecipient.
Substantial Rehabilitation	The term used in the HOME Program to refer to the rehabilitation of residential property at a total development cost per unit greater than \$25,000 per dwelling unit.
Targeting	Requirements of the HOME Program relating to the income or other characteristics of households that may occupy HOME-assisted units.
Total Development Cost (TDC)	The sum of all costs for site acquisition, relocation, demolition, construction and equipment, interest, and carrying charges.
Very-Low Income Family	Family whose annual (gross) income does not exceed 50 percent of the median income for the area (adjusted for family size). HUD may establish income ceilings higher or lower than 50 percent of median income for an area on an exception basis.

HOME Model Evaluation

Energy Conservation and Housing Rehabilitation Under the HOME Program

How long have you been responsible for the activity for which this model was designed? 1 2 3 4 5

(1) 0-6 months (2) 7-12 months (3) 1-2 years (4) 2-3 years (5) Over 3 years

Instructions: For each question below circle one number of the scale of 1-5 and explain why you selected that number.

1. How well does this model meet its stated objective?
Explain: _____
_____ Not at All → Very Well
1 2 3 4 5
2. Is the model written clearly?
Explain: _____
_____ Unclear → Very Clear
1 2 3 4 5
3. Does the model cover issues relevant to its topic in sufficient depth?
Please specify where coverage of topics is insufficient or too extensive and explain why:

_____ Not Enough → Too Much
1 2 3 4 5
4. Does the model offer sufficient examples to illustrate concepts?
Explain: _____
_____ Not Enough → Enough
1 2 3 4 5
5. Is the model's advice practical for your organization?
Explain: _____
_____ Impractical → Very Practical
1 2 3 4 5
6. Does the model offer enough guidance on how to obtain additional information?
Explain: _____
_____ Not Enough → Enough
1 2 3 4 5
7. Would you recommend this model to other organizations?
Explain: _____
_____ Not At All → Highly
1 2 3 4 5

Additional Comments: _____

Please return completed evaluation to:

Office of Affordable Housing Program
Department of Housing and Urban Development
Room 7162, 451 7th Street, S.W.
Washington, DC 20410