CALIFORNIA ENERGY COMMISSION
1516 NINTH STREET
SACRAMENTO, CA 95814-5512
www.energy.ca.gov

September 13, 2012

Alfred M. Pollard
General Counsel
Federal Housing Finance Agency
400 Seventh Street S.W., Eighth Floor
Washington, D.C. 20024
RegComments@fhfa.gov

Re: **Comments on the Federal Housing Finance Agency's Notice of Proposed Rulemaking concerning Enterprise Underwriting Standards for mortgage assets affected by Property Assessed Clean Energy programs – RIN 2590-AA53**

Dear Mr. Pollard:

This letter responds to the request of the Federal Housing Finance Agency (FHFA) for comments on its Notice of Proposed Rulemaking (NPR) concerning underwriting standards for the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac) (together, the Enterprises) relating to mortgage assets affected by Property Assessed Clean Energy (PACE) programs. At the outset, the California Energy Commission believes that FHFA's proposed rule unlawfully infringes on the plenary police powers of the states, in violation of the 10th Amendment to the United States Constitution. The rule would effectively prevent states from using their taxing authority as a tool to reduce municipal resource needs even though compelling state interests are at issue, such as avoiding the need to construct new power plants, promoting environmental protection and sustainability and a stable supply of electrical energy, or reducing the cost of living in a community. To the extent that PACE programs are structured to ensure that the combined cost of property taxes and utility bills are less after PACE improvements than before, FHFA's rejection of these programs is legally "arbitrary and capricious", and not narrowly tailored to the asserted purpose of protecting the Enterprises' investment.

The Energy Commission believes that the FHFA should recognize that PACE programs are uniquely suited to facilitate real and lasting energy efficiency upgrades to existing buildings; that PACE programs do not pose substantial risks to property owners, property purchasers, or mortgage holders of properties with PACE assessments, and in fact decreases the likelihood of default; that FHFA's proposed rule will effectively end residential PACE programs; and that the public interest in achieving the energy, environmental, and economic benefits of PACE programs outweighs the risks posed by such assessments. However, the Energy Commission appreciates the proffered Risk Mitigation Alternatives, and supports the development of PACE programs throughout California using a more thoroughly developed version of the Third Risk-Mitigation Alternative.

BACKGROUND: PACE IN CALIFORNIA

California has led the nation on energy policy since the late 1970's. Important policies such as minimum energy efficiency standards in building construction and appliances have helped California to maintain a steady rate of per capita energy consumption over a thirty year period.[1] The systemic benefits of these policies have been significant, and building upgrades are a crucial component in continuing these policies. For example, the California Air Resources Board, the agency charged with implementing California's landmark climate change legislation, the Global Warming Solutions Act of 2006[2], highlighted the importance of building efficiency improvements in its AB 32 Scoping Plan, in which it anticipates that 15 percent of total targeted reductions will come from improvements in the energy efficiency of California's building stock.[3] In addition, the California Long Term Energy Efficiency Strategic Plan (the Strategic Plan), a document adopted jointly by the California Public Utilities Commission and the Energy Commission to guide energy efficiency policy over the short and long term, calls for aggressive efficiency targets, including a 20% reduction in energy use in existing homes by 2015 and a 40% reduction in energy use in existing homes by 2020.[4]

Building efficiency improvements, more than any other carbon mitigation strategy, offer immediate and attractive benefits to consumers, the economy, and the State. Building efficiency upgrades save consumers money on their utility bills, offer relief to a battered home construction industry, allow California utilities to purchase less energy overall, and mitigate the longer term impacts of climate change. Supporting home energy efficiency and renewable generation upgrades should be a crucial component of any plan for economic recovery – a fact acknowledged by the United States Congress in allocating $16.8 billion of the 2009 American Recovery and Reinvestment Act to bolster energy efficiency efforts across the nation.[5]

Since it first obtained legal standing in Berkeley, California in 2008,[6] PACE financing has been recognized throughout the nation as a potential breakthrough mechanism to enable energy efficiency retrofits of existing buildings. California has been instrumental in passing legislation to support PACE financing, beginning with the passage and signing of California Assembly Bill (AB) 811 and successive PACE legislation.[7] This legislation collectively authorized public

[1] See California Energy Commission *2011 Integrated Energy Policy Report* 8 (adopted Feb. 8, 2012), *available at* http://www.energy.ca.gov/2011publications/CEC-100-2011-001/CEC-100-2011-001-CMF.pdf. All supporting documentation is also included in attachments to this comment letter.
[2] AB 32 (Chapter 488, Statutes of 2006), codified at Cal. Health & Saf. Code § 38550, et seq.
[3] California Air Resources Board, Climate Change Scoping Plan 17, 41-44 (Dec. 2008), available at http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf.
[4] California Public Utilities Commission, California Long Term Energy Efficiency Strategic Plan 11 (Sept. 2008), available at http://www.cpuc.ca.gov/NR/rdonlyres/D4321448-208C-48F9-9F62-1BBB14A8D717/0/EEStrategicPlan.pdf.
[5] American Recovery and Reinvestment Act of 2009, Division A, Title IV (Pub.L. 111-5).
[6] Berkeley Municipal Code, ch. 7.98, 2008, Special Tax Financing Law.
[7] AB 811 (Chapter 159, Statutes of 2008), codified at Cal. Streets & Hwys. Code §§ 5898.12, 5898.14, 5898.20, 5898.21, 5898.22, 5898.30; see also AB 474 (Chapter 444, Statutes of 2009) (clarifying disclosure requirements and expanding PACE authority from cities and counties to any public agency); SB 1340 (Chapter 649, Statutes of 2010) (expanding PACE to electric vehicle infrastructure installation and prohibiting a property owner from participating in PACE if the total assessment on the property exceeds 5% of the property's market value).

agencies in California, including cities, counties, and special districts, to determine that it would be convenient, advantageous, and in the public interest to designate all or a portion of the city within which authorized city officials and property owners may enter into contractual assessments to finance the installation of distributed general renewable energy sources or energy efficiency improvements that are permanently affixed to real property. California's PACE legislation further provided that a property owner could not participate in a PACE program if it would result in the total amount of any annual property taxes and assessments exceeding five percent of the property's market value, as determined at the time the owner's contractual assessment was approved.[8]

The California Energy Commission is the primary energy policy and planning agency of the State of California. The Energy Commission has a statutory mandate to reduce energy consumption in California,[9] and employs a range of measures to do so, including setting efficiency standards in new residential buildings,[10] distributing funding for energy efficient improvements and retrofits,[11] and making recommendations for reducing energy use in California.[12] The Energy Commission is also tasked with improving efficiency in existing buildings, as part of a comprehensive effort to achieve California's efficiency targets, with components that include cost-effective energy efficiency improvements, public and private sector energy efficiency financing options, public outreach and education, and green workforce training.[13]

Since 2008, California state and local agencies and entities, including the Energy Commission, have embraced PACE as an important and necessary tool in meeting the State's energy and environmental policies and goals. In 2010, furnished with millions of dollars in federal stimulus funds, the Energy Commission proposed a $30 million Municipal Financing Program for funding PACE programs in five California municipalities.[14] The Municipal Financing Program was expected to leverage $370 million, create 4,353 jobs, save over 336 million kilowatt-hours of energy, and avoid the emissions of 187,264 tons of greenhouse gasses over the term of the contracts.[15] Unfortunately, this program came to a halt when, on July 6, 2010, FHFA issued a public statement categorizing PACE assessments as "loans" and instructing the Enterprises to take actions that would prohibit PACE financing on properties carrying mortgages to be purchased by the Enterprises. As a direct result of FHFA's actions, the Energy Commission

---

[8] Cal. Streets and Hwys. Code § 5898.15(a).

[9] Cal. Pub. Res. Code §§ 25006, 25007, 25402; *see also* California Energy Commission, 2011 Integrated Energy Policy Report 51, 63-66 (adopted Feb. 28, 2012), *available at* http://www.energy.ca.gov/2011publications/CEC-100-2011-001/CEC-100-2011-001-CMF.pdf (stating California's commitment to meet new electricity demand first with energy efficiency and proposing strategies for improving efficiency in existing buildings).

[10] Cal. Pub. Res. Code § 25402(a) and (b).

[11] Cal. Pub. Res. Code § 25943 (for the distribution of federal stimulus funding).

[12] Cal. Pub. Res. Code §§ 25402.6, 25403.

[13] AB 758 (Chapter 470, Statutes of 2009), codified at Cal. Pub. Res. Code § 25943.

[14] California Energy Commission Municipal Financing Program, Program Opportunity Notice No. 400-09-401.

[15] Angela Gould, Proposed Cancellation of Program Opportunity Notice 400-09-401, at 3 (July 2010), available at http://www.energy.ca.gov/business_meetings/2010_packets/2010-07-28/2010-07-28_Item_05/2010-07-28_Item_05_Staff_Paper.PDF.

ended the Municipal Financing Program for PACE funding and sought alternative avenues for allocating federal stimulus funds.[16]

PACE IS A KEY COMPONENT IN IMPLEMENTING CALIFORNIA'S ENVIRONMENTAL AND ENERGY POLICY

It is critical for the FHFA to recognize that PACE is a key component in any statewide home energy upgrade portfolio of programs, and by extension, a key component of the successful implementation of state environmental and energy policies. While some limited financial products do exist to address this barrier, none does so as effectively as PACE for a number of reasons. First, as PACE is tied to the property securely through a priority lien, local governments are in a position to secure attractive rates for bonds offered to finance PACE programs. Second, as the implementers of these programs are often public agencies and not institutions motivated by profit, these governments are more likely to pass the lower cost of capital on to program participants, collecting only the spread on interest rate necessary to support the administrative activities of PACE programs. Third, by enabling PACE assessments to remain with the property through the lien instrument (rather than following the property seller), home and business owners are encouraged to invest in permanent improvements lasting 30 years or more to a property they may only intend on occupying for ten years or less. Fourth, attaching the assessment to the property allows for loan terms that match the expected life of the improvements. This is critical, as longer term loans result in lower monthly debt servicing burdens to lendees. As the monthly cost of financing decreases, the monetary savings resulting from the energy improvement can cover a greater portion, or even all, of the debt burden putting home owners in either a cash-neutral or cash-positive position with respect to the financing.[17] Upgrading homes so they cost less to operate renders their owners less likely to default on their mortgages, not more.

In the NPR, FHFA states that it does not "challenge the legal authority of states and localities to implement first-lien PACE programs if they wish."[18] This statement, however, ignores the practical effect of the proposed rule and previous guidance. In practice, the proposed rule will effectively end first-lien PACE programs and their associated benefits, severely hampering the ability of states to meet their energy and environmental goals. As explained above, FHFA's July 2010 directive to the Enterprises resulted in an end to the Energy Commission's Municipal Financing Program for funding PACE programs because of the pervasiveness of the Enterprises' role in the residential mortgage market. Moreover, since the Enterprises own or guarantee the vast majority of residential mortgages, FHFA's actions will not only end PACE with respect to the mortgages owned by the Enterprises, but will set the standard for the entire secondary mortgage market. FHFA should recognize the wide-ranging impact its proposed rule would have on the ability of states and local governments to effectively reduce energy consumption and associated greenhouse gas emissions in existing homes.

---

[16] Minutes of the July 28, 2010, California Energy Commission Business Meeting (Item 5), available at http://www.energy.ca.gov/business_meetings/2010_minutes/2010-07-28_MINUTES.PDF.
[17] Cash-neutral or cash-positive indicates a situation where the monthly monetary savings resulting from the energy improvements are equal to or greater than the monthly debt burden associated with the financing.
[18] 77 Fed. Reg. 36105 (June 15, 2012).

THE CALIFORNIA ENERGY COMMISSION SUPPORTS THE IMPLEMENTATION OF PACE THROUGH THE "THIRD RISK-MITIGATION ALTERNATIVE -- H.R. 2599 UNDERWRITING STANDARDS"

The Energy Commission recognizes that many of the aspects of PACE that make it an important tool in achieving California's energy efficiency and environmental policy goals, are also the aspects that are of concern to the FHFA. FHFA's proposed rule offered three risk mitigation alternatives that are designed to address those concerns. Of the three risk mitigation alternatives we support the structured implementation of PACE through the "Third Risk-Mitigation Alternative -- H.R. 2599 Underwriting Standards" (Alternative #3).

The Energy Commission believes the "First Risk-Mitigation Alternative -- Guarantee/Insurance" offered by the FHFA would require a more developed insurance and guarantee market for PACE than currently exists, and may be more appropriate as an option in the future. The "Second Risk-Mitigation Alternative -- Protective Standards," is the functional equivalent of the proposed rule, in that requiring a 35% equity cushion is impractical in today's housing market, resulting in very few qualifying homes. It therefore does not represent a viable option that would allow PACE to continue with any reasonable scope.

Alternative #3, unlike the other two risk mitigation alternatives, presents a reasonable and practically implementable solution that balances the importance of PACE financing to meeting California's energy and environmental goals with FHFA's desire to minimize financial risk to the Enterprises in the event of a default on either the PACE assessment or the mortgage itself. The FHFA follows the draft of Alternative #3 with the following statement:

> FHFA has reservations about the Third Risk-Mitigation Alternative, including whether it could practically be implemented by FHFA and the Enterprises given that certain elements of the alternative appear to be inherently vague and/or dependent upon assumptions that FHFA lacks a sound basis (and the requisite staff and resources) to provide or evaluate.

The Energy Commission supports any FHFA sponsored efforts to develop an alternative to the Proposed Rule that will allow PACE programs to continue under Alternative #3. In this spirit, the following comments respond to the specific concerns FHFA raised regarding Alternative #3. The Commission encourages FHFA to adopt Alternative #3 as its Final Rule on mortgages involving PACE financing.

1. <u>Cost-Effectiveness Methodology and Assumptions</u>

FHFA's first specific stated concern regarding Alternative #3 is that:

> [W]hile the alternative would require that "The total energy and water cost savings realized by the property owner and the property owner's successors during the useful lives of the improvements, as determined by [a mandatory] audit or feasibility study * * * are expected to exceed the total cost to the property owner and the property owner's

> successors of the PACE assessment," no methodology for computing the costs and savings is provided. Assumptions as to applicable discounts rates are significant and indeed can be determinative—especially since PACE-funded projects may be cash-flow negative for the first several years.[19]

This comment seems to indicate that FHFA is not sure which cost-effectiveness methodology to apply, and is unsure what assumptions to make with respect to that methodology. First, there are multiple cost effectiveness tests that might be employed to implement subsection (c)(xv): a simple payback period calculation, a net present value calculation, a return on investment calculation, and a life-cycle cost analysis. The FHFA could adopt a simple payback period analysis (for example, the cost savings of the implemented energy efficiency and/or renewable generation measures be equal to or greater than the initial costs of those measures before the end of the measure's useful life). Many existing energy efficiency finance programs use this method, or a variation of it, to determine cost effectiveness, and FHFA should look to these programs for further guidance. For example, the Energy Efficient Mortgage program[20] and the PowerSaver Program,[21] administered through the U.S. Department of Housing and Urban Development (HUD) and the Federal Housing Administration (FHA), require that energy efficiency and renewable generation home improvements be "cost effective." These programs could serve as a model for an appropriate cost-effectiveness methodology for a revised version of Alternative #3. Moreover, energy cost escalators and discount rates are readily available through the U.S. Department of Energy and are updated on an ongoing basis, to help establish uniform assumptions.[22]

However, it is not necessary for FHFA to make any assumptions for the cost-effectiveness calculations at all. Rather FHFA can clarify the "audit or feasibility study" requirement in subsection (c)(xi). It is important to have consistency in audit protocols at the state level. Accordingly, the Energy Commission recommends that the language be changed to require "a residential energy audit conducted according to state-adopted protocols." Therefore, the revised subsections would read:

> . . .
>
> xi. The improvement funded by the PACE transaction has been the subject of ~~an audit or feasibility study~~ a residential energy audit that:
>
> a. Has been commissioned by the local government, the PACE program, or the property-owner and completed no more than 90 days prior to presentation of the proposed PACE transaction to the mortgage holder for its consent; and

---

[19] 77 Fed. Reg. 36109 (June 15, 2012).

[20] Information on the Energy Efficient Mortgage Program is available at http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/eem/energy-r. An overview of the Energy Efficient Mortgage Program, the Homeowner Guide, and Mortgagee Letter No. 2005-21 are attached to this comment.

[21] Information on the PowerSaver Program is available at http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/title/ti_home. The PowerSaver Program notice in the Federal Register and frequently asked questions are attached to this comment.

[22] See the U.S. Department of Energy's Energy Escalation Rate Calculator, which is available for download at http://www1.eere.energy.gov/femp/information/download_blcc.html#eerc.

b. Has been performed by a person authorized pursuant to state or local law if required, or who has been certified as a building analyst by the Building Performance Institute or as a Home Energy Rating System Rater by a Rating Provider accredited by the Residential Energy Service network; or who has obtained other similar independent certification; and

c. ~~Includes each of the following:~~

~~1. Identification of recommended energy conservation, efficiency, and/or clean energy improvements;~~

~~2. Identification of the proposed PACE funded project as one of the recommended improvements identified pursuant to paragraph 1. supra;~~

~~3. An estimate of the potential cost savings, useful life, benefit-cost ratio, and simple payback or return on investment for each recommended improvement; and,~~

~~4. An estimate of the estimated overall difference in annual energy costs with and without the recommended improvements;~~ is conducted according to state-adopted protocols;

. . .

xv. The total energy and water cost savings realized by the property owner and the property owner's successors during the useful lives of the improvements, as determined by the ~~audit or feasibility study~~ residential energy audit performed pursuant to paragraph xi. *supra* are expected to exceed the total cost to the property owner and the property owner's successors of the PACE assessment;

. . .

Many states, often through state agencies like the Energy Commission, have existing and well-established energy audit protocols and procedures to measure the cost-effectiveness of energy efficiency improvements to buildings.[23] This requirement would also force states lagging in this area to either adopt a federal standard or existing multistate standard for residential energy audits, or develop their own. Revising the requirement to require a state-level certified protocol will allow states with more aggressive energy and environmental policies (such as California) to use state-specific energy audit protocols and procedures designed to support those policies. Ultimately, this would eliminate the need to have FHFA make assumptions or adopt methodology for determining the cost-effectiveness of an energy efficiency improvement, allowing the states to exercise their expertise in matters of energy efficiency to adopt appropriate auditing protocols, such as California's Home Energy Rating System (HERS) Program.[24]

2. Weighted Average Expected Useful Life

FHFA's second specific stated concern regarding Alternative #3 is that:

> Similarly, while the maximum term of the PACE obligation is determined with reference to a "weighted average expected useful life of the PACE improvement or

[23] See, e.g., Cal. Pub. Res. Code § 25942; Cal. Code Regs., tit. 20, § 1670 et seq.

[24] Cal. Pub. Res. Code § 25942; Cal. Code Regs., tit. 20, §§ 1670-1675.

> improvements," neither H.R. 2599 nor any of the commenters explained how the weights are to be determined, and most appear to assume that "expected useful lives of energy conservation and efficiency and clean energy measures approved by the Department of Energy" will be available and reliable for all PACE-funded projects, which FHFA believes is uncertain.[25]

It is not entirely clear from the NPR what FHFA's concern is, but it appears to be either that FHFA is uncertain on how to determine the useful life of any one measure, or that FHFA is not sure how to weight these measures when bundled. Neither concern is a significant hurdle in the implementation of Alternative #3. Regarding the first, there is substantial guidance available through the U.S. Department of Energy and other sources such as the National Institute of Science and Technology regarding the expected useful life (EUL) of building energy efficiency and renewable generation measures.[26] Regarding the second concern, the "weighted average" calculation itself could be accomplished by simply taking the cost associated with an individual measure, dividing it by the total initial cost of all improvements, multiplying that number by the individual measure's expected useful life, repeating for all measures, and then adding those numbers together to calculate the weighted useful life. Soft costs such as fees and permit costs that are required by particular measures would be included in the initial cost of that particular measure.

FHFA has also expressed some concern regarding the inclusion of individual measures that may not appear, when individually analyzed, to be "cost effective." Buildings are interactive systems – the inclusion or addition of an energy efficiency measure can potentially have substantial impact on the performance of other existing and proposed measures.[27] Therefore, any cost effectiveness analysis should not be required on a measure-by-measure basis, but rather for the proposed bundle of measures in conjunction with existing systems and features that impact energy consumption and will remain in the structure.

3. <u>Enforcement</u>

FHFA's third specific stated concern regarding Alternative #3 is that:

> Additionally, a clear method for enforcing standards set forth in such a program would be beneficial.[28]

This appears to be two concerns: 1) How can FHFA be certain local jurisdictions are enforcing the underwriting standards set forth in Alternative #3, and 2) How will Enterprises ascertain that the assessments have been made in accordance with the underwriting standards set forth in Alternative #3? The Energy Commission recommends relying on the land-title recordation

---

[25] 77 Fed. Reg. 36109.
[26] See the various energy assessment tools available through the Federal Energy Management Program (http://www1.eere.energy.gov/femp/technologies/eep_eccalculators.html) including the Building Life Cycle Cost Program developed by the National Institute of Standards and Technology (http://www1.eere.energy.gov/femp/information/download_blcc.html#eerc).
[27] Accordingly, California's Building Energy Efficiency Standards establish "energy budgets" for the whole building, which must be met. (Cal. Code Regs., tit. 24, § 151, subd. (a)3.,(b).)
[28] 77 Fed. Reg. 36109.

mechanism to address both concerns. Currently, subsection (c) in Alternative #3 begins with the statement: "The Enterprises shall not consent to first-lien PACE obligations except those that (a) are (or promptly upon their creation will be) recorded in the relevant jurisdiction's public land-title records, and (b) meet all of the following conditions." The Energy Commission recommends revising the language at the beginning of subsection (c) to clarify that the recordation must include a notarized statement that the assessment resulted from a program that meets the specified conditions in the regulation. Thus, the revised subsection (c) could read:

> c. The Enterprises shall not consent to first-lien PACE obligations except those that (a) are (or promptly upon their creation will be) recorded in the relevant jurisdiction's public land-title records, and (b) that such recordation include a notarized statement, under penalty of perjury, from the property owner that the assessment was made pursuant to a program that meets all of the following conditions ~~meet all of the following conditions~~ –

Using statements on title would bring relevant state and local statutes and their associated remedies regarding making false notarized and land title statements into a potential enforcement role. These actions could include common law actions for fraud as well as actions on state or federal False Claims Acts, where remedies include civil penalties, rescission, or damages, in addition to prosecution for perjury. Using the title statement to enforce the standards is the most streamlined and transparent option since a review of the title report would typically be conducted as part of the purchase of a mortgage by the Enterprises and most other mechanisms that might be employed (for example, certification by local entities to the Enterprises) would require additional staff time from state and local agencies, as well as the Enterprise staff time required to review those programs and/or certifications.

CONCLUSION

The California Energy Commission urges FHFA to issue a Final Rule that facilitates the responsible implementation of PACE through the "Third Risk-Mitigation Alternative -- H.R. 2599 Underwriting Standards." The Energy Commission believes this Alternative, with the proposed revisions, will result in a Final Rule that will minimize risk to the Enterprises while allowing states like California to continue utilizing the important PACE tool to meet their energy and environmental goals.

///
///
///

Thank you for considering these comments. If you have any questions please contact Staff Counsel Kristen Driskell at (916) 654-3951 or by e-mail at Kristen.Driskell@energy.ca.gov. Energy Commission staff members are available to answer any questions that FHFA staff may have regarding these comments. The Commission looks forward to continued dialogue with FHFA on efforts to facilitate homeowner access to PACE financing.

Sincerely,

Robert P. Oglesby
Executive Director
California Energy Commission

cc: Robert Weisenmiller, Chair
Karen Douglas, Commissioner
Carla Peterman, Commissioner
Andrew McAllister, Commissioner
Janell Beland, Undersecretary, California Natural Resources Agency

Attachment 1

Excerpts from the California Energy Commission's

2011 Integrated Energy Policy Report (adopted Feb. 8, 2012):

- Pages 7-9 from the Executive Summary
- Pages 51-52 from Chapter 3: Achieving Cost-Effective Energy Efficiency for California: Assembly Bill 2021 Progress Report
- Pages 63-66 from Chapter 4: Achieving Energy Savings in California Buildings

state's need for conventional transportation fuels. There are two crude oil import infrastructure projects proposed in Southern California that are at early stages of development, Berth 408 at Pier 400 in the Port of Los Angeles, and Berth T126 at Pier Echo in the Port of Long Beach. Based on Energy Commission analysis, the Southern California market should require construction of only one of these crude oil import facilities over the forecast period. However, oil imports at the high end of the range will require expanded capability to receive crude oil imports within the next four to five years to ensure sufficient supplies of conventional transportation fuels.

For alternative transportation fuels, demand for biofuels is expected to grow as a result of the federal Renewable Fuels Standard 2 mandates and the state's Low Carbon Fuel Standard. Certain biofuels (ethanol in low-level blends, biodiesel, renewable diesel, and renewable gasoline) will require only modest fueling infrastructure investment and little to no modifications to motor vehicles to enable greater use. California's infrastructure to receive, distribute, and blend ethanol is robust and adequate to accommodate a continued growth of ethanol use over the next several years. Although California's biodiesel infrastructure is currently inadequate to accommodate widespread blending of biodiesel, with sufficient lead time (12 to 24 months) modifications could be completed that would enable expansion of biodiesel use. An initial $100 million investment from the Energy Commission and private sources should accelerate the development of several biofuel production projects in California by 2017.

Other alternative transportation fuels like electricity, natural gas, and hydrogen will require considerable investment over the next several years in fueling infrastructure and vehicles that run on these fuels. Significant public and private investments are being made in California's electric charging infrastructure, and federal economic stimulus funds matched with Energy Commission program funds and other private and public funds are providing the charging infrastructure to support the deployment of plug-in electric vehicles in California. The Energy Commission has also allocated funds to upgrade and install fueling infrastructure for 20 natural gas stations, 11 hydrogen stations, and 50 E85 (85 percent ethanol) dispenser stations.

California's Clean Energy Goals

In his 2012 State of the State address, Governor Brown stated that "California is leading the nation in creating jobs in renewable energy and the design and construction of more efficient buildings and new technologies." This commitment to clean energy was echoed by President Obama in his 2012 State of the Union remarks calling for Congress to set "a clean energy standard that creates a market for innovation."

California's ambitious energy and environmental policy goals are important strategies to promote energy independence, increase energy reliability and safety, reduce statewide greenhouse gas emissions, and help create clean energy jobs. The *2011 Integrated Energy Policy Report* discusses issues associated with the state's clean energy goals to increase energy efficiency, renewable electricity, distributed generation, combined heat and power, and alternative and renewable transportation fuels. In addition, the report discusses the important roles that interagency coordination, and research and development will play in achieving these goals.

Energy Efficiency

Energy efficiency remains California's top priority for meeting new electricity needs and is a key strategy for increasing jobs and reducing greenhouse gas emissions from the electricity sector. Past and current government energy policies and programs have made California a national leader in energy efficiency; in the last three decades, California's policies, programs, and efficiency standards for buildings and appliances have contributed to keeping California's per capita electricity consumption relatively constant while use in the rest of the United States has increased 40 percent. The Energy Commission staff estimates that standards have also saved customers $66 billion in electricity and natural gas costs (in 2010 dollars) since 1975. President Obama, noting in his 2012 State of the Union address that more efficient use of energy saves money, asked Congress to send him a bill to: "Help manufacturers eliminate energy waste in their factories and give businesses incentives to upgrade their buildings. Their energy bills will be $100 billion lower over the next decade, and Americans will have less pollution, more manufacturing, and more jobs for construction workers who need them."

California's energy efficiency policies include achieving all cost-effective energy efficiency; reducing energy use in existing buildings built before the advent of building and appliance efficiency standards; and making all new residential construction in California "zero net energy" (a combination of greater energy efficiency and on-site clean energy production to reduce building energy use to "net zero") by 2020, and all new commercial construction zero net energy by 2030.

Achieving All Cost-Effective Energy Efficiency

To further California's goal of achieving all cost-effective energy efficiency, Assembly Bill 2021 (Levine, Chapter 734, Statutes of 2006) requires the Energy Commission, in consultation with the California Public Utilities Commission, to develop statewide energy efficiency potential estimates and targets for California's investor-owned and publicly owned utilities and report on their progress toward these targets in the *Integrated Energy Policy Report*. In December 2011, the Energy Commission staff released the *Achieving Cost-Effective Energy Efficiency for California 2011–2020* final report, which summarizes utility progress and recommends improvements for publicly owned utility efficiency efforts. Investor-owned utilities reported 4,607 GWh of annual energy savings and 837 MW of peak savings for 2010, which exceeded the California Public Utilities Commission 2010 savings goals of 2,276 GWh and 502 MW. Reported natural gas savings were 46 million therms, just short of the California Public Utilities Commission's natural gas savings goal for 2010 of 48 million therms. Publicly owned utilities achieved 74 percent of the 2010 energy savings target and provided 523 GWh of electric energy savings, a decrease of 19 percent from 2009, and 94 MW of peak savings, 20 percent less than in 2009.

For future savings potential, the *Achieving Cost-Effective Energy Efficiency for California 2011–2020* report estimates 9,525 GWh of cost-effective savings potential for the publicly owned utilities for 2011–2020. This target, however, only represents about 42 percent of net annual savings from all publicly owned utilities. The two largest publicly owned utilities will be updating their savings potential and targets at a later date.

Forecasted savings from several individual utilities meet the AB 2021 goal of 10 percent savings over 10 years, but the combined publicly owned utility targets achieve only 6.8 percent savings from forecasted 2020 base energy use. For most utilities, market savings potential was calculated using a 50 percent customer measure incentive level. Energy Commission staff analysis indicates that when a 75 percent incentive level is used, nearly all utilities would meet the 10 percent consumption reduction goal contained in AB 2021. This suggests that the publicly owned utilities can meet the consumption reduction goal but may require a higher level of program effort and budget than was factored into their targets. However, the issue of cost-effectiveness is a key factor in setting incentive levels and determining which efficiency measures to include in programs. Increasing incentive levels to 75 percent may not be cost-effective for all utilities.

Reducing Energy Use in Existing Buildings

Existing buildings also provide a tremendous opportunity for low-cost energy savings, reduced greenhouse gas emissions, and job creation. More than half of California's 13 million residential units and more than 40 percent of commercial buildings were built before implementation of the state's building standards. Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009) directed the Energy Commission to develop, adopt, and implement a comprehensive statewide program to reduce energy consumption in existing buildings and report on that effort in the *Integrated Energy Policy Report*.

Efforts by the Energy Commission, the California Public Utilities Commission, local governments, and utilities to coordinate residential and commercial building retrofit programs under the Energy Upgrade California™ brand are providing the foundation for the AB 758 program. Next steps are to complete needs assessments for both residential and non-residential buildings, identify what must be done in program component areas (including lessons learned from pilot programs), and develop action plans for moving forward with AB 758 program development.

The Energy Commission will also work with the California Public Utilities Commission to emphasize joint efforts to achieve improved compliance with building and appliance standards to ensure that energy efficiency measures and equipment are properly installed and delivering savings. The Energy Commission will also develop regulations to improve compliance with appliance efficiency standards using its authority under Senate Bill 454 (Pavley, Chapter 591, Statutes of 2011), which allows the Energy Commission to adopt an enforcement process for violations of appliance efficiency regulations and impose civil penalties of up to $2,500 for each violation.

Achieving Zero Net Energy Homes and Buildings

The Energy Commission, the California Public Utilities Commission, and the Air Resources Board have adopted a goal of achieving zero net energy building standards by 2020 for residential buildings and 2030 for commercial buildings. According to the California Public Utilities Commission, California has more zero net energy buildings than any other state. To support the state's zero net energy goals, in September 2011 the California Public Utilities Commission released its *2010–2012 Zero Net Energy Action Plan* for the commercial building sector.

The Energy Commission is contributing to zero net energy goals by regularly updating its building efficiency standards to reflect new technologies and strategies with the goal of achieving 20 to 30 percent energy savings in each triennial update, and by updating appliance standards to include electronics and other devices plugged into electrical outlets that represent an increasing portion of California's energy use. In 2010, appliance efficiency standards alone saved an estimated 18,761 gigawatt hours of electricity, representing nearly 7 percent of California's electric load, and saved consumers about $2.6 billion in energy costs.

Governor Brown noted in his 2012 State of the State address: "Our state keeps demanding more efficient cars, machines, and electric devices. We do that because we understand that fossil fuels, particularly foreign oil, create ever rising costs to our economy and our health." To meet the demand for more efficient electric devices, the Energy Commission in early 2012 adopted standards for the estimated 58 million battery chargers sold each year in California that, when implemented, will save state ratepayers an estimated $306 million each year, provide annual electricity savings of more than 2,000 GWh, and eliminate 1 million metric tons of carbon emissions.

Renewable Energy

California has more than 10,000 MW of renewable generating capacity on-line, with estimated technical potential (which does not reflect economic,

This chapter summarizes the Energy Commission final staff report Achieving Cost-Effective Energy Efficiency for California

2011–2020, including key points from the report, progress on utilities' energy efficiency savings and measurement and verification efforts, and policy recommendations.[62]

California has demonstrated a strong commitment to cost-effective energy efficiency for the last 30 years with the adoption of progressive policies, programs, and activities. In 2003, the state's first *Energy Action Plan* established the state's loading order, calling for electricity needs to be met first with increased energy efficiency and demand response. Assembly Bill 32 made customer-side energy efficiency a key strategy for reducing greenhouse gas emissions to 1990 levels by 2020.

62 California Energy Commission, *2011 AB 2021 Progress Report: Achieving Cost-Effective Energy Efficiency for California,* December 2011, www.energy.ca.gov/2011publications/CEC-200-2011-007/CEC-200-2011-007-SF.pdf.

In 2005, Senate Bill 1037 (Kehoe, Chapter 366, Statutes of 2005) made energy efficiency a priority strategy for electric utilities to meet their resource needs. SB 1037 requires the California Public Utilities Commission (CPUC) and the Energy Commission to identify potentially achievable cost-effective electric and natural gas energy efficiency savings and set goals for investor-owned utilities (IOUs) to achieve this potential.[63] Both agencies must review the procurement plans to ensure the consideration of energy efficiency and other cost-effective supply options. In addition, SB 1037 requires all publicly owned utilities, regardless of size, to report annually to their customers and to the Energy Commission on investments in energy efficiency programs.

Assembly Bill 2021 (Levine, Chapter 734, Statutes of 2006) added more specific legal directions for increasing California's energy efficiency programs. AB 2021 requires each publicly owned utility to:

- Beginning in 2007 and every three years thereafter, identify all potentially achievable cost-effective electricity energy savings. Using the efficiency potential estimates, establish annual targets for energy efficiency savings for the next 10-year period.

- Report on program cost-effectiveness and third-party energy evaluation, measurement, and verification (EM&V) of program savings.

AB 2021 directs the Energy Commission to:

- Include a summary of the publicly owned utilities' savings and evaluation, measurement, and verification (EM&V) studies in the *Integrated Energy Policy Report (IEPR)*.

- In consultation with the CPUC as the regulator of IOUs' energy efficiency programs, provide a triennial statewide estimate of energy efficiency potential and targets for a 10-year period.

- Provide recommendations to publicly owned utilities, Legislature, and the Governor of possible improvements by the publicly owned utilities.

In response to AB 2021, the Energy Commission released the fifth annual final staff report *Achieving Cost-Effective Energy Efficiency for California 2011–2020 (2011 AB 2021 Progress Report)* on December 21, 2011. The following section provides an overall summary of the utilities' progress on energy efficiency program savings, EM&V reporting, and a more detailed description of setting energy efficiency targets, followed by recommendations for improvement of these efforts.

Staff Assessment of Utilities' Progress

Investor-Owned Utilities' Progress

The IOUs administer efficiency programs under the CPUC's Decision 09-09-047, which approved the IOUs' efficiency program portfolios for 2010–2012 with a total budget of $3.1 billion. The combined IOUs reported 4,607 gigawatt hours (GWh) of annual energy savings, 837 megawatts (MW) of peak savings, and 46 million therms of natural gas savings in 2010, which exceeded their 2010 CPUC-mandated goals. The 2010 natural gas savings fell just a bit short of the CPUC's natural gas goals for 2010.

The 2010 IOU savings numbers are still *ex ante* savings, that is, self-reported savings that have not

63 The terms for energy efficiency "targets" and "goals" are used interchangeably. There is an established convention (at least since 2004) that the CPUC and IOUs use the term "goals." Publicly owned utilities have adopted the term "targets" since that is the term used in AB 2021.

equipment. Using cost effective efficiency requirements, the Energy Commission's goal is to achieve a 20 to 30 percent energy savings for each triennial Building Standards update. As an initial step, the 2013 Building Standards will address high-efficacy building envelopes, lighting, and heating, cooling and water heating systems, and energy demand response management technologies.

No matter how much demand is reduced, however, some amount of onsite generation will be required. As part of its policy setting responsibility under Senate Bill 1 (Murray, Chapter 132, Statutes of 2006) and its management responsibility for the New Solar Homes Partnership, the Energy Commission developed standards and tools for achieving high-performance rooftop photovoltaic (PV) systems. These standards and tools are designed to promote high-efficiency solar energy system components, effective installation practices, and calculation and demonstration of expected system performance. They will serve as the foundation for considering upcoming building standards for rooftop PV systems.

The joint agency strategy for achieving the ZNE goals calls for establishing not only mandatory standards in each triennial update of the Building Standards, but voluntary "reach standards." The reach standards further a "market pull strategy" by establishing higher standards than required, which can be used when developing minimum standards in subsequent cycles. These reach standards are often met by a substantial portion of newly constructed buildings, demonstrating their feasibility, cost-effectiveness, and value in the market. In developing these standards, the Energy Commission collaborates with the CPUC and the utilities' new construction programs to incentivize builders to meet the reach standards. In addition, they are included as voluntary measures in the California Green Building Standards Code (Title 24, Cal. Code Regulations, Part 11).

Other governmental agencies incorporate the reach standards as locally mandated requirements in their regulations and programs. For example, local governments are including them in local green building and energy ordinances, and the California Tax Credit Allocation Committee has incorporated these standards in its regulations governing qualification for federal and state tax credits for affordable housing projects. Several benefits accrue when a substantial portion of the marketplace constructs buildings that meet the reach standards. Industry gains expertise in delivering greater building efficiency. Also, costs tend to decline for the more efficient features as they become mainstream rather than premium and as suppliers and installers compete to provide them.

Strategies for Existing Buildings

More than half of California's 13 million residential units and more than 40 percent of the commercial buildings were built before 1978, when the state first implemented Building Energy Efficiency Standards. These existing buildings, and the rest built under previous vintages of the Building Code, provide a huge opportunity for low-cost energy savings. The *AB 32 Scoping Plan* concluded that improving the energy efficiency of existing residential and commercial buildings is the most important way to reduce GHG emissions in the electricity and natural gas sectors. The CPUC's Long-Term Energy Efficiency Strategic Plan set major goals for achieving deep, whole building energy savings in existing residential and commercial buildings. Efficiency improvements in existing buildings are also a priority goal of both the CCEF initiative and Governor Brown's Clean Energy Jobs Plan.

The Legislature at several points in time has directed the Energy Commission to develop policies and programs to pursue improved efficiency in existing buildings, including to develop a statewide Home Energy Rating System Program (Senate Bill 1922 [Lewis, Chapter 553, Statutes of 1994]), develop and report to the Legislature recommendations for improving the energy efficiency of existing buildings in California (Assembly Bill 549 [Longville, Chapter 905, Statutes of 2001]), investigate options and develop a plan to decrease peak electricity demand for air conditioners across the state (Assembly Bill 2021 [Levine, Chapter 734, Statutes of 2006]), and establish a program requiring nonresidential building owners to benchmark the energy use of their buildings in comparison to other similar buildings and disclose the benchmarking data and ratings to prospective buyers, lessees, and lenders (Assembly Bill 1103 [Saldaña, Chapter 533, Statutes of 2007] and Assembly Bill 531 [Saldaña, Chapter 323 , Statutes of 2009]). Building on this prior legislation, Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009) directed the Energy Commission to develop, adopt, and implement an ongoing, comprehensive, statewide program to reduce energy consumption in existing buildings, including the adoption of regulations for energy ratings and improvements in existing buildings.

This comprehensive portfolio of programs is required to implement a variety of complementary techniques, applications, and practices to achieve greater energy efficiency in homes and businesses. AB 758, for example, authorizes (among other things) the program to provide:

- Energy assessments to identify and recommend opportunities for saving energy use in individual buildings.
- Energy efficiency financing options and other financial incentives.
- Information and education to property owners to help them implement energy efficiency improvements.
- Systematic workforce training to ensure that workers employed to provide the services needed under the program will be well trained and supported to deliver high-quality work.

The Energy Commission is required to evaluate the most effective ways to report the energy assessment results and efficiency improvement recommendations to the property owners, including prioritizing the energy efficiency improvements and determining how different types of financial incentives and financing can be used to accomplish the improvements. The bill also directs the Energy Commission to evaluate the appropriate methods to inform and educate the public about the need for and benefits of making energy efficiency improvements.

AB 758 calls for the Energy Commission to develop and implement the program in collaboration with the CPUC and industry stakeholders. The CPUC is directed to investigate the ability of investor-owned utilities to provide financing to their customers for energy-efficiency improvements and to report to the Legislature the progress of the utilities in implementing the program.

Contemporaneously with the passage of AB 758, the federal government passed the American Recovery and Reinvestment Act (ARRA). ARRA funding provided California additional resources to develop and conduct programs aimed at saving energy, creating jobs, and contributing to California's economic recovery through energy efficiency upgrade projects in existing buildings. The Energy Commission designed the ARRA-funded programs to incorporate the same approaches that were called for by AB 758 as a way to pilot those approaches. The ARRA programs emphasized collaborations of local governments and industry to deliver energy assessments, ratings, efficiency improvements, and quality assurance. ARRA also funded the nation's largest workforce development effort, meshing the well-established state and local workforce development infrastructure with statewide efforts to implement energy efficiency upgrades in existing buildings.

In an unprecedented collaboration, the Energy Commission, CPUC, local governments, and utilities came together to closely coordinate residential and commercial building upgrade programs under the Energy Upgrade California™ brand. The collaborative pilot programs provided a number of components authorized by AB 758, including:

- Public Awareness and Outreach
- Workforce Development
- Financing Options and Financial Incentives (Rebates)
- Energy Performance Ratings and Disclosure
- Efficiency Recommendations and Improvements (including Quality Assurance)

Major efforts have occurred all over California to implement and pilot each of these AB 758 program components. These efforts leveraged the ARRA funding to collaborate on the details of delivering energy efficiency upgrades in existing buildings. In the area of clean energy financing options, for example, the ARRA-funded programs have allowed California to establish revolving loan programs that will remain in operation after the ARRA funding ceases, provide loan loss reserves to encourage lenders to provide financing for energy efficiency upgrades, and pilot Property Assessed Clean Energy (PACE) financing in concert with local property assessments. On August 2, 2011, Governor Brown signed Assembly Bill X1 14 (Skinner, Chapter 9, Statutes of 2011), authorizing the State Treasurer to administer a new $50 million program to provide loan loss reserves for energy upgrades consistent with Energy Commission guidelines. This new program represents a major opportunity for the Energy Commission, State Treasurer's Office, CPUC, and other partners to create financing solutions for building owners wanting to implement energy upgrade projects. In addition, on January 10, 2012, the CPUC issued an Administrative Law Judge's ruling on energy efficiency financing requesting comments on a CPUC Energy Division staff proposal on energy efficiency financing activity in 2013–2014, a report prepared for the CPUC on energy efficiency financing needs and gaps, and a proposal by the Environmental Defense Fund on on-bill repayment.[79]

The Energy Commission's next steps are to complete needs assessments for both residential and nonresidential buildings, identify what must be done in each of AB 758's program component areas (taking advantage of the lessons learned from the ARRA piloting), and develop action plans for moving forward with AB 758 program development. The AB 758 program will be developed in three phases. Phase 1 (2010–2012) will include developing infrastructure and implementation plans; Phase 2 (2012–2014) will support market development and partnerships; and Phase 3 (2014 and beyond) will include development of statewide ratings and upgrades requirements.[80] The implementation plans developed under Phase 1 will include detailed schedules of activities, and each Phase will include ample opportunity for public input. Key areas of focus include recommending improvements to the Home Energy Rating System program, developing the Commercial Building Energy Asset Rating System (BEARS), and building strategies for effective rating, labeling, and disclosure of energy-efficiency information. Attention will also focus on improving compliance with and enforcement of California's Building Energy Efficiency Standards requirements for alterations of existing buildings. As a condition for accepting ARRA State Energy Program funding, each state's governor

79 California Public Utilities Commission, *Administrative Law Judge's Ruling Regarding Energy Efficiency Financing,* January 10, 2012, docs.cpuc.ca.gov/efile/RULINGS/157047.pdf.

80 For more information on the program, see: www.energy.ca.gov/ab758/.

committed to putting advanced state energy codes into effect (such as the Energy Commission's 2008 and subsequent Building Energy Efficiency Standards) and developing approaches to achieve high levels of compliance with those standards.

AB 758 directed the Energy Commission and the CPUC to collaborate on how to best deliver financing and design utility programs for upcoming funding cycles to advance the comprehensive AB 758 program.

Efficiency Improvements in Appliances

The Appliance Efficiency Standards (Appliance Standards) are another strategy for reducing energy use in newly constructed and existing buildings. While permanently installed equipment and appliances are a substantial part of the building's energy use,[81] electronics and other devices plugged into outlets make up a growing portion of California's energy use. Unfortunately, the energy use (and thus the true cost) of appliances and electronic devices is often invisible to the consumer, and manufacturers lack the direct incentive (of having to pay for the energy their products consume) to design products that use energy efficiently.

The Energy Commission's Appliance Standards can address this issue by setting cost-effective minimum efficiency requirements for appliances, electronics, and other devices. These efficiency standards set the bar at a level that affects only the least efficient products. Since 1976, the Energy Commission has adopted standards covering a wide range of appliances, including all major household appliances, air conditioners, furnaces, and water heaters. In many instances, California standards have subsequently been adopted as national standards by the United States Department of Energy (U.S. DOE).

Historically, California's energy efficiency standards have resulted in significant reductions in energy consumption. The Energy Commission estimates that appliance efficiency standards adopted between 1976 through 2005 saved 18,761 gigawatt hours (GWh) in 2010.[82] This represents 6.7 percent of California's electric load and is roughly the amount of energy produced by California's two largest power plants. At an average rate of 14 cents per kilowatt hour, appliance efficiency regulations saved California consumers about $2.68 billion in 2010.

Despite the success of appliance efficiency standards, the amount of energy consumed by devices plugged in by building occupants ("plug load") has been climbing rapidly.[83,84] To address these growing plug loads, the Energy Commission has initiated and completed several rulemakings covering products

81 The breakdown of 2009 annual household electricity consumption by end use is: lighting, 22 percent; refrigerators and freezers, 20 percent; television, computer, and office equipment, 20 percent; air conditioning, 7 percent; pools and spas, 7 percent; dishwasher and cooking, 4 percent; laundry, 4 percent; space heating, 2 percent; water heating, 3 percent; and miscellaneous, 11 percent. California Energy Commission, *2009 California Residential Appliance Saturation Study,* October 2010, page 3, www.energy.ca.gov/2010publications/CEC-200-2010-004/CEC-200-2010-004-ES.PDF.

82 Savings from California's appliance efficiency standards are forecasted to grow to 27,116 GWh a year by 2020. This would represent 8.6 percent of projected load in 2020. At the current rate of 14¢ per kilowatt hour, this would save the state about $3.8 billion for 2020, see: www.energy.ca.gov/2009_energypolicy/index.html.

83 C.D. Barley, C. Haley, R. Anderson, and L. Pratsch, November 2008, *Building America System Research Plan for Reduction of Miscellaneous Electrical Loads in Zero Energy Homes*, National Renewable Energy Laboratory and U.S. Department of Energy, NREL/TP-550-43718, page 5, www.nrel.gov/docs/fy09osti/43718.pdf.

84 U.S. Energy Information Administration, March 28, 2011, *Share of Energy Used by Appliances and Consumer Electronics Increases in U.S. Homes*, available at: www.eia.gov/consumption/residential/reports/electronics.cfm.

Attachment 2

Excerpts from the California Air Resources Board's

Climate Change Scoping Plan (Dec. 2008):

Pages 15-17, 41-44 from Section II. Recommended Actions

II. RECOMMENDED ACTIONS

Achieving the goals of AB 32 in a cost-effective manner will require a wide range of approaches. Every part of California's economy needs to play a role in reducing greenhouse gas emissions. ARB's comprehensive greenhouse gas emissions inventory lists emission sources ranging from the largest refineries and power plants to small industrial processes and farm livestock. The recommended measures were developed to reduce greenhouse gas emissions from key sources and activities while improving public health, promoting a cleaner environment, preserving our natural resources, and ensuring that the impacts of the reductions are equitable and do not disproportionately impact low-income and minority communities. These measures also put the state on a path to meet the long-term 2050 goal of reducing California's greenhouse gas emissions to 80 percent below 1990 levels. This trajectory is consistent with the reductions that are needed globally to help stabilize the climate. While the scale of this effort is considerable, our experience with cultural and technological changes makes California well-equipped to handle this challenge.

ARB evaluated a comprehensive array of approaches and tools to achieve these emission reductions. Reducing greenhouse gas emissions from the wide variety of sources can best be accomplished though a cap-and-trade program along with a mix of complementary strategies that combine market-based regulatory approaches, other regulations, voluntary measures, fees, policies, and programs. ARB will monitor implementation of these measures to ensure that the State meets the 2020 limit on greenhouse gas emissions.

An overall limit on greenhouse gas emissions from most of the California economy – the "capped sectors" – will be established by the cap-and-trade program. (The basic elements of the cap-and-trade program are described later in this chapter.) Within the capped sectors, some of the reductions will be accomplished through direct regulations such as improved building efficiency standards and vehicle efficiency measures. Whatever additional reductions are needed to bring emissions within the cap are accomplished through price incentives posed by emissions allowance prices. Together, direct regulation and price incentives assure that emissions are brought down cost-effectively to the level of the overall cap. ARB also recommends specific measures for the remainder of the economy – the "uncapped sectors."

Key elements of California's recommendations for reducing its greenhouse gas emissions to 1990 levels by 2020 include:

- **Expanding and strengthening existing energy efficiency programs as well as building and appliance standards;**
- **Achieving a statewide renewables energy mix of 33 percent;**
- **Developing a California cap-and-trade program that links with other Western Climate Initiative partner programs to create a regional market system;**
- **Establishing targets for transportation-related greenhouse gas emissions for regions throughout California and pursuing policies and incentives to achieve those targets;**
- **Adopting and implementing measures pursuant to existing State laws and policies, including California's clean car standards, goods movement measures, and the Low Carbon Fuel Standard; and**
- **Creating targeted fees, including a public goods charge on water use, fees on high global warming potential gases, and a fee to fund the administrative costs of the State's long-term commitment to AB 32 implementation.**

The recommended greenhouse gas emissions reduction measures are listed in Table 2 and are summarized in Section C below. The total reduction for the recommended measures slightly exceeds the 169 $MMTCO_2E$ of reductions estimated in the Draft Scoping Plan. This is the net effect of adding several measures and adjusting the emission reduction estimates for some other measures. The 2020 emissions cap in the cap-and-trade program is preserved at the same level as in the Draft Scoping Plan (365 $MMTCO_2E$).

The measures listed in Table 2 lead to emissions reductions from sources within the capped sectors (146.7 $MMTOCO_2E$) and from sources or sectors not covered by cap-and-trade (27.3 $MMTCO_2E$). As mentioned, within the capped sectors the reductions derive both from direct regulation and from the incentives posed by allowance prices. Further discussion of how the cap-and-trade program and the complementary measures work together to achieve the overall target is provided below.

Table 2 also lists several other recommended measures which will contribute toward achieving the 2020 statewide goal, but whose reductions are not (for various reasons including the potential for double counting) additive with the other measures. Those measures and the basis for not including their reductions are further discussed in Section C.

Table 2: Recommended Greenhouse Gas Reduction Measures

Recommended Reduction Measures	**Reductions Counted Towards 2020 Target ($MMTCO_2E$)**	
ESTIMATED REDUCTIONS RESULTING FROM THE COMBINATION OF CAP-AND-TRADE PROGRAM AND COMPLEMENTARY MEASURES		**146.7**
California Light-Duty Vehicle Greenhouse Gas Standards • Implement Pavley standards • Develop Pavley II light-duty vehicle standards	31.7	
Energy Efficiency • Building/appliance efficiency, new programs, etc. • Increase CHP generation by 30,000 GWh • Solar Water Heating (AB 1470 goal)	26.3	
Renewables Portfolio Standard (33% by 2020)	21.3	
Low Carbon Fuel Standard	15	
Regional Transportation-Related GHG Targets[16]	5	
Vehicle Efficiency Measures	4.5	
Goods Movement • Ship Electrification at Ports • System-Wide Efficiency Improvements	3.7	
Million Solar Roofs	2.1	
Medium/Heavy Duty Vehicles • Heavy-Duty Vehicle Greenhouse Gas Emission Reduction (Aerodynamic Efficiency) • Medium- and Heavy-Duty Vehicle Hybridization	1.4	
High Speed Rail	1.0	
Industrial Measures (for sources covered under cap-and-trade program) • Refinery Measures • Energy Efficiency & Co-Benefits Audits	0.3	
Additional Reductions Necessary to Achieve the Cap	34.4	
ESTIMATED REDUCTIONS FROM UNCAPPED SOURCES/SECTORS		**27.3**
High Global Warming Potential Gas Measures	20.2	
Sustainable Forests	5.0	
Industrial Measures (for sources not covered under cap and trade program) • Oil and Gas Extraction and Transmission	1.1	
Recycling and Waste (landfill methane capture)	1.0	
TOTAL REDUCTIONS COUNTED TOWARDS 2020 TARGET		**174**

Other Recommended Measures	**Estimated 2020 Reductions ($MMTCO_2E$)**
State Government Operations	1-2
Local Government Operations	TBD
Green Buildings	26
Recycling and Waste • Mandatory Commercial Recycling • Other measures	9
Water Sector Measures	4.8
Methane Capture at Large Dairies	1.0

[16] This number represents an estimate of what may be achieved from local land use changes. It is not the SB 375 regional target. ARB will establish regional targets for each Metropolitan Planning Organization (MPO) region following the input of the Regional Targets Advisory Committee and a public consultation process with MPOs and other stakeholders per SB 375.

will continue to evaluate the potential impacts of these shifts and identify potential solutions.

Table 6: California Light-Duty Vehicle Greenhouse Gas Standards Recommendation
(MMTCO$_2$E in 2020)

Measure No.	Measure Description	Reductions
T-1	Pavley I and II – Light-Duty Vehicle Greenhouse Gas Standards	31.7
	Total	**31.7**

3. Energy Efficiency

Maximize energy efficiency building and appliance standards, and pursue additional efficiency efforts including new technologies, and new policy and implementation mechanisms. Pursue comparable investment in energy efficiency from all retail providers of electricity in California (including both investor-owned and publicly-owned utilities).

Energy-efficiency measures for both electricity and natural gas can reduce greenhouse gas emissions significantly. In 2003, the CPUC and CEC adopted an Energy Action Plan that prioritized resources for meeting California's future energy needs, with energy efficiency being first in the "loading order," or highest priority. Since then, this policy goal has been codified into statute through legislation that requires electric utilities to meet their resource needs first with energy efficiency.[32]

This measure would set new targets for statewide annual energy demand reductions of 32,000 gigawatt hours and 800 million therms from business as usual[33] – enough to power more than 5 million homes, or replace the need to build about ten new large power plants (500 megawatts each). These targets represent a higher goal than existing efficiency targets established by CPUC for the investor-owned utilities due to the inclusion of innovative strategies above traditional utility programs. Achieving the State's energy efficiency targets will require coordinated efforts from the State, the federal government, energy companies and customers. ARB will work with CEC and CPUC to facilitate these partnerships. A number of these measures also have the potential to deliver significant economic benefits to California consumers, including low-income households and small businesses. California's energy efficiency programs for buildings and appliances have generated more than $50 billion in

[32] SB 1037 (Kehoe, Chapter 366, Statutes of 2005) and AB 2021 (Levine, Chapter 734, Statutes of 2006) directed electricity corporations subject to CPUC's authority and publicly-owned electricity utilities to first meet their unmet resource needs through all available energy efficiency and demand response resources that are cost effective, reliable and feasible.

[33] The savings targeted here are additional to savings currently assumed to be incorporated in CEC's 2007 demand forecasts. However, CEC has initiated a public process to better determine the quantity of energy savings from standards, utility programs, and market effects that are embedded in the baseline demand forecast.

savings over the past three decades. Tables 7 and 8 summarize the reduction of greenhouse gas emissions.

Efficiency

Achieving the energy efficiency target will require redoubled efforts to target industrial, agricultural, commercial, and residential end-use sectors, comprised of both innovative new initiatives that have been embraced by CEC's energy policy reports and CPUC's long-term strategic plan, and improvements to California's traditional approaches of improved building standards and utility programs.

High-efficiency distributed generation applications like fuel cell technologies can also play an important role in helping the State meet its requirements for reduction of greenhouse gas emissions. Key energy efficiency strategies, grouped by type, include:

Cross-cutting Strategy for Buildings

- "Zero Net Energy" buildings[34]

Codes and Standards Strategies

- More stringent building codes and appliance efficiency standards
- Broader standards for new types of appliances and for water efficiency
- Improved compliance and enforcement of existing standards
- Voluntary efficiency and green building targets beyond mandatory codes

Strategies for Existing Buildings

- Voluntary and mandatory whole-building retrofits for existing buildings
- Innovative financing to overcome first-cost and split incentives for energy efficiency, on-site, renewables, and high efficiency distributed generation

Existing and Improved Utility Programs

- More aggressive utility programs to achieve long-term savings

Other Needed Strategies

- Water system and water use efficiency and conservation measures
- Local government programs that lead by example and tap into local authority over planning, development, and code compliance
- Additional industrial and agricultural efficiency initiatives
- Providing real time energy information technologies to help consumers conserve and optimize energy performance

With the support of key State agencies, utilities, local governments and others, the CPUC has recently adopted the *California Long Term Energy Efficiency Strategic*

---

[34] Zero net energy refers to building energy use over the course of a typical year. When the building is producing more electricity than it needs, it exports its surplus to the grid. When the building requires more electricity than is being produced on-site, it draws from the grid. Generally, when constructing a ZNE building, energy efficiency measures can result in up to 70% savings relative to existing building practices, which then allows for renewables to meet the remaining load.

Plan.[35] Released September 2008, this Plan sets forth a set of strategies toward maximizing the achievement of cost-effective energy efficiency in California's Electricity and Natural Gas sectors between 2009 and 2020, and beyond. Its recommendations are the result of a year-long collaboration by energy experts, utilities, businesses, consumer groups, and governmental organizations in California, throughout the west, nationally and internationally.

For many of the above goals and others, the Strategic Plan discusses practical implementation strategies, detailing necessary partnerships among the state, its utilities, the private sector, and other market players and timelines for near-term, mid-term and long-term success. While the Strategic Plan is the most current and innovative summary of energy efficiency strategies needed to meet State goals, additional planning and new strategies will likely be needed, both to achieve the 2020 emissions reduction goals and to set the State on a trajectory toward 2050.

Other innovative approaches could also be used to motivate private investment in efficiency improvements. One example that will be evaluated during the development of the cap-and-trade program is the creation of a mechanism to make allowances available within the program to provide incentives for local governments, third party providers, or others to pursue projects to reduce greenhouse gas emissions, including the bundling of energy efficiency improvements for small businesses or in targeted communities.

Solar Water Heating

Solar water heating systems offer a potential for natural gas savings in California. A solar water heating system offsets the use of natural gas by using the sun to heat water, typically reducing the need for conventional water heating by about two-thirds. Successful implementation of the zero net energy target for new buildings will require significant growth in California's solar water heating system manufacturing and installation industry. The State has initiated a program to move toward a self sustaining solar water heater industry. The Solar Hot Water and Efficiency Act of 2007 (SHWEA) authorized a ten year, $250-million incentive program for solar water heaters with a goal of promoting the installation of 200,000 systems in California by 2017.[36]

Combined Heat and Power

Combined heat and power (CHP), also referred to as cogeneration, produces electricity and useful thermal energy in an integrated system. The widespread development of efficient CHP systems would help displace the need to develop new, or expand existing, power plants. This measure sets a target of an additional

---

[35] California Public Utilities Commission. *California Long Term Energy Efficiency Strategic Plan.* September 2008. http://www.californiaenergyefficiency.com/docs/EEStrategicPlan.pdf (accessed October 12, 2008).

[36] Established under Assembly Bill 1470 (Huffman, Chapter 536, Statues of 2007).

4,000 MW of installed CHP capacity by 2020, enough to displace approximately 30,000 GWh of demand from other power generation sources.[37]

California has supported CHP for many years, but market and other barriers continue to keep CHP from reaching its full market potential. Increasing the deployment of efficient CHP will require a multi-pronged approach that includes addressing significant barriers and instituting incentives or mandates where appropriate. These approaches could include such options as utility-provided incentive payments, the creation of a CHP portfolio standard, transmission and distribution support payments, or the use of feed-in tariffs.

Table 7: Energy Efficiency Recommendation - Electricity
($MMTCO_2E$ in 2020)

Measure No.	Measure Description	Reductions
E-1	Energy Efficiency (32,000 GWh of Reduced Demand) • Increased Utility Energy Efficiency Programs • More Stringent Building & Appliance Standards • Additional Efficiency and Conservation Programs	15.2
E-2	Increase Combined Heat and Power Use by 30,000 GWh	6.7
	Total	**21.9**

Table 8: Energy Efficiency Recommendation - Commercial and Residential
($MMTCO_2E$ in 2020)

Measure No.	Measure Description	Reductions
CR-1	Energy Efficiency (800 Million Therms Reduced Consumption) • Utility Energy Efficiency Programs • Building and Appliance Standards • Additional Efficiency and Conservation Programs	4.3
CR-2	Solar Water Heating (AB 1470 goal)	0.1
	Total	**4.4**

4. Renewables Portfolio Standard

Achieve 33 percent renewable energy mix statewide.

CEC estimates that about 12 percent of California’s retail electric load is currently met with renewable resources. Renewable energy includes (but is not limited to) wind, solar, geothermal, small hydroelectric, biomass, anaerobic digestion, and landfill gas. California’s current Renewables Portfolio Standard (RPS) is intended to

[37] Accounting for avoided transmission line losses of seven percent, this amount of CHP would actually displace 32,000 GWh from the grid.

Attachment 3

Excerpts from the California Public Utilities Commission's

California Long Term Energy Efficiency Strategic Plan (Sept. 2008):

Pages 9-11 from Section 2. Residential Sector Including Low Income

2. RESIDENTIAL SECTOR INCLUDING LOW INCOME

2.1 CORE RESIDENTIAL

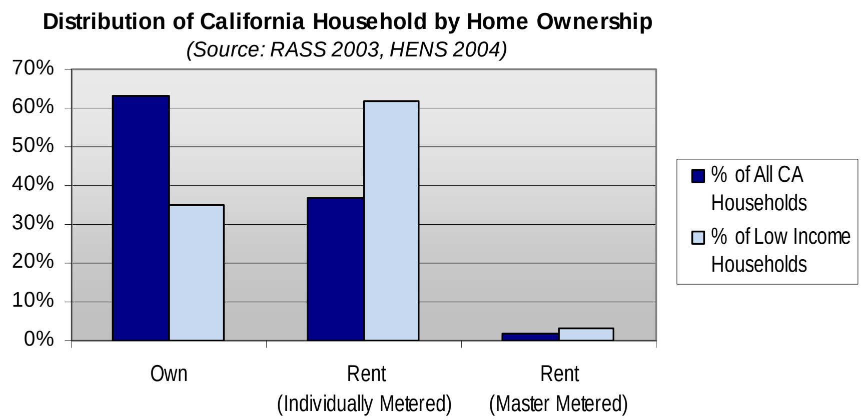
2.1.1 VISION

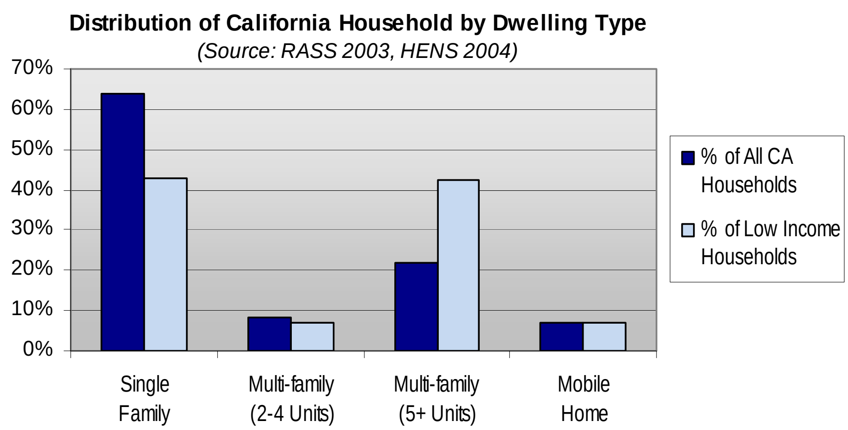
Residential energy use will be transformed to ultra-high levels of energy efficiency resulting in Zero Net Energy new buildings by 2020. All cost-effective potential for energy efficiency, demand response and clean energy production will be routinely realized for all dwellings on a fully integrated, site-specific basis.

2.1.2 PROFILE

In 2008, energy demand for California's 12.6 million households was over 25,000 MW. The residential sector represents approximately 32% of total state electricity consumption and 36% of its total natural gas consumption. Electricity demand is expected to grow to almost 31,000 MW by 2018.[23]

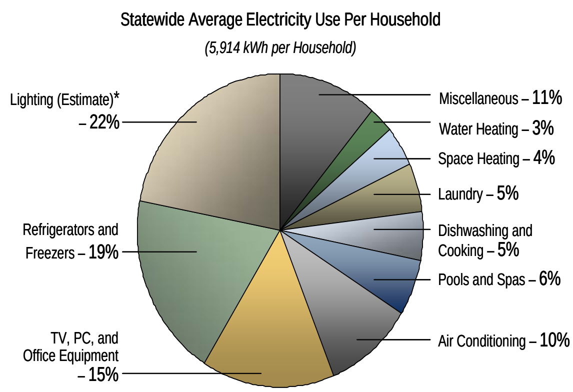
Approximately one-third of all households live in multi-family structures, and two-thirds in single family homes. The balance of renters to homeowners is about 42% to 58%, respectively. Most or all of these households qualify for utility energy efficiency programs targeting residential customers.[24] About one-third (approximately 4 million) of these households qualify for additional low income energy efficiency (LIEE) programs extended to households with annual incomes less than or equal to 200% of Federal Poverty Guidelines.[25]

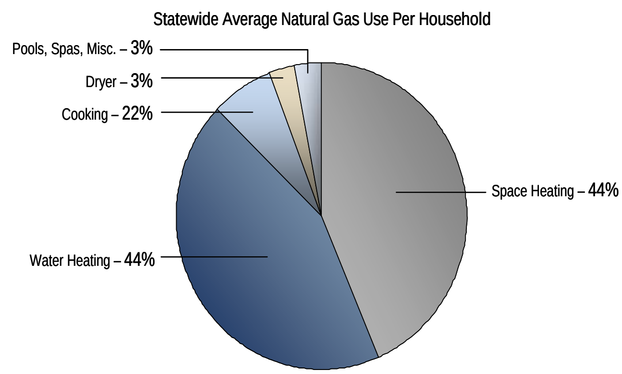




Pursuant to a legislative mandate to reduce energy usage in California, the Energy Commission adopted California's Appliance Efficiency Regulations in 1976 (Title 20) and Part 6 of Title 24 of the California Code of Regulations, the Energy Efficiency Standards for Residential and Nonresidential Buildings in 1978, (Title 24).[26] The Title 24 standards are updated triennially to incorporate new energy efficiency technologies and methods. The Title 20 standards are updated more frequently.

The utilities have responded to the diverse needs of California's residential sector by offering a wide range of energy efficiency programs that impact every level of the residential market, including rebates for efficient products, such as lighting, air conditioners, and refrigerators; training and education to architects, engineers, building managers and building inspectors; and work to enhance the Energy Commission's building and appliance codes and standards. The utilities also have introduced a number of innovative whole-house or community-wide programs such as the SCE Sustainable Communities program which targets new residential developments and the Design for Comfort Program that provides efficiency assistance to affordable housing developments that are undergoing renovation.





VISION

Over the past two utility program cycles (2004/2005 and 2006/2008), the utilities have focused heavily on residential lighting, which accounts for the largest electricity end use in the residential sector. As a result, the bulk of residential efficiency savings has come from lighting programs such as measures that encourage the use of compact fluorescent light (CFL) bulbs. In the past few years, the CFL market has undergone a major transformation, as evidenced by the ubiquity of CFL products in the retail market and recent energy measurement and verification studies.

A major transformation of the lighting market will be completed through the passage and implementation of AB 1109, the 2007 California Lighting Efficiency and Toxics Reduction Act.[27] AB 1109 requires a 50% increase in efficiency for residential general service lighting by 2018 through phased increases in the Energy Commission's Title 20 regulations, with the first phase of the standards taking effect by January 1, 2010.[28] These changes in the lighting market provide will allow opportunities to redirect utilities' residential energy efficiency resources towards new lighting technologies and other innovative programs focused on whole-building efficiency measures.

Likewise, the strategies set forth in this *Plan* will create longer-term savings from the built environment with a goal of continual incorporation of advances into codes and standards or the private marketplace. The 2009-2011 IOU program cycle will lay the foundation for aggressive, long-term strategies to change the way residential buildings are constructed, used and maintained.

2.1.3 GOALS

Goal		Goal Results
1. New construction will reach "zero net energy" (ZNE) performance (including clean, onsite distributed generation) for all new single and multi-family homes by 2020.	➡	By 2011, 50% of new homes will surpass 2005 Title 24 standards by 35%; 10% will surpass 2005 Title 24 standards by 55%. By 2015, 90% will surpass 2005 Title 24 standards by 35%. By 2020, all new homes are ZNE.
2. Home buyers, owners and renovators will implement a whole-house approach to energy consumption that will guide their purchase and use of existing and new homes, home equipment (e.g., HVAC systems), household appliances, lighting, and "plug load" amenities.	➡	Energy consumption in existing homes will be reduced by 20% by 2015 and 40% by 2020 through universal demand for highly efficient homes and products.
3. Plug loads will be managed by developing consumer electronics and appliances that use less energy and provide tools to enable customers to understand and manage their energy demand.	➡	Plug loads will grow at a slower rate and then decline through technological innovation spurred by market transformation and customer demand for energy efficient products.
4. The residential lighting industry will undergo substantial transformation through the deployment of high-efficiency and high-performance lighting technologies, supported by state and national codes and standards.	➡	Utilities will begin to phase traditional mass market CFL bulb promotions and giveaways out of program portfolios and shift focus toward new lighting technologies and other innovative programs that focus on lasting energy savings and improved consumer uptake.

Transformation of markets for new multi-family homes can be achieved through strategies targeting the Commercial or Residential sectors or a combination of both, since rental buildings are commercial enterprises as well as dwelling units. In this first *Plan,* with the exception of the approximately 50 percent of LIEE-eligible households living in multi-family housing, there is no specific focus on strategies to upgrade efficiency in existing multi-family dwellings. This is a recognized shortcoming and strategies for this market must be addressed in greater detail in the next iteration of this *Plan*.

The leadership and active participation of many organizations are also necessary to achieve the vision for the residential sector. The Energy Commission must continue to lead the efforts to continually enhance and expand the building and appliance codes with active technical support and expertise from the IOUs, national laboratories, and the building industry.

In addition, the United States Department of Energy (DOE) and the United States Environmental Protection Agency (EPA) play critical roles in residential energy efficiency efforts. Moreover, significant attention must be directed towards manufactured (or "prefabricated") housing, a substantial and growing component within new housing stock, which is built under federal code set by the United States Department of Housing and Urban Development.

Extensive R&D efforts and partnership programs will push the market further. For technological advances in buildings, appliances and plug loads, the IOU's Emerging Technologies program and the Energy Commission's ratepayer-funded Public Interest Energy Research (PIER) program must work cooperatively with the national laboratories and private industry to achieve the advances envisioned in this *Plan*.

ATTACHMENT 4

Excerpts from
Program Opportunity Notice # 400-09-401: Municipal Financing Program:

Introduction
Goals and Objectives

PROGRAM OPPORTUNITY NOTICE

MUNICIPAL FINANCING PROGRAM

PON # 400-09-401
www.energy.state.ca.gov/contracts
State of California
California Energy Commission
October 2009

I. Introduction

BACKGROUND

The American Recovery and Reinvestment Act 2009 (ARRA) was enacted by Congress to preserve and create jobs and promote economic recovery, to assist those most impacted by the recession, to provide investments needed to increase economic efficiency by spurring technological advances, and to make investments that will have long-term economic benefits. ARRA gives preference to projects that promote and enhance these objectives of the Act in an expeditious manner.

The U.S. Department of Energy (DOE) encourages states to develop State Energy Program (SEP) strategies that align with the following national goals: increasing jobs, reducing US oil dependency through increases in energy efficiency and deployment of renewable energy technologies, promoting economic vitality through an increase in "green jobs," and reducing green house gas emissions. The DOE encourages states to focus their program efforts on market transformation initiatives and actions that align with these national goals. Market transformation is defined as: "Strategic interventions that cause lasting changes in the structure or function of a market or the behavior of market participants, resulting in an increase in adoption of energy efficiency and renewable energy products, services, and practices."[1]

The DOE has allocated the Energy Commission $226 million in ARRA funding for the SEP. State law authorizes the Energy Commission to use these SEP funds for energy efficiency, energy conservation, renewable energy, and other energy-related projects and activities authorized by ARRA. Because ARRA has a set of the unique policy demands and limitations regarding the life of the funds, the Energy Commission is seeking projects through a number of mechanisms and for a number of different programs. The Energy Commission reserves the unfettered right to decide which of all of the possible bidders and projects solicited will tend to maximize the beneficial use of the ARRA funds. Therefore bidders are admonished that there is no guarantee that their project will be funded even if their proposal is the highest ranked proposal under this PON.

Among other SEP funding opportunities, the Energy Commission has decided to seek projects in the following program areas under three concurrent solicitations:

1. Municipal Financing Program ("AB 811-type programs") PON No. 400-09-401
2. California Comprehensive Residential Building Retrofit Program PON No. 400-09-403
3. Municipal and Commercial Building Targeted Measure Retrofit Program PON No. 400-09-402

Collectively, the three solicitations shall be referred to as the "Solicitations."

---

[1] See **http://www.energy.ca.gov/recovery/documents/SEP_Recovery_Act_Guidance_DE-FOA-00000521.pdf**

The Solicitations contain many new ARRA and SEP requirements. Bidders are advised to carefully read and review all sections of this PON as the proposal and the contracting requirements have changed significantly from past Energy Commission solicitations.

PURPOSE OF THIS PON

This solicitation is solely for the Municipal Financing Program, one of the four program elements eligible for ARRA SEP funding under the Energy Commission's *State Energy Program Guidelines* adopted by the Energy Commission on September 30, 2009. SEP funds awarded through this PON will be directed to establishing and/or continuing city-, county-, or region-wide financing programs to implement energy retrofits in existing residential, commercial and industrial buildings. The specific goals, objectives and program strategies for this PON are described in Section II.

KEY ACTIVITIES AND DATES

Key activities and times for PON are presented below. This is a tentative schedule; please call the Contracts Office to confirm dates.

ACTIVITY	ACTION DATE
PON Release	October 8, 2009
Pre-Bid Conference	October 20, 2009
Deadline for Written Questions	October 22, 2009
Distribute Questions/Answers and Addenda (if any) to PON	October 27, 2009
Notice of Intent from bidders due by COB	October 30, 2009
Deadline to Submit Proposals by 5:00 p.m.	~~November 30~~ December 7, 2009
Clarification Interviews (If necessary)	TBD
Notice of Proposed Award	~~December 22, 2009~~ January 21, 2010
Energy Commission Business Meeting	~~January 27, 2009~~ February 24, 2010
Contract Start Date	~~February~~ March 1, 2010
Project Implementation Deadline (By Law)	March 31, 2012
Contract End Date	March 31, 2012

AVAILABLE FUNDING

There is up to $95 million of ARRA SEP funds available for the contracts resulting from the solicitations: this PON, the RFP for the California Comprehensive Residential Building Retrofit Program, and the RFP for the Municipal and Commercial Building Targeted Measure Retrofit Program. To be considered for funding, each Proposal shall request no more than $20 million and no less than $2 Million from a solicitation. Requested funding should reflect the level of effort proposed. The Energy Commission anticipates funding one or more separate agreements as a result of this solicitation. An organization may submit a separate proposal for funding under any of the Solicitations, and may receive a separate award under more than one solicitation. The Energy Commission also reserves the right to: make no awards under any one or more solicitations; or to award all funds under one or more solicitations; or to award funds to one bidder.

The Energy Commission reserves the right to reduce the amount of funds available under the Solicitations.

In addition, ARRA funding may be reallocated as necessary to best achieve the overall goals of ARRA and state law and policy. Funds identified for the Solicitations may be reallocated and used for another purpose only after the Solicitations have closed and awards have been made or the Solicitations have been modified or cancelled.

ELIGIBLE BIDDERS

Eligible bidders include cities, counties, or groups of cities and counties in California that are in the process of establishing or have already established a municipal financing program for the purposes of funding energy efficiency and on-site solar electric or other on site renewable energy generation improvements in accordance with California Streets and Highways Code Sections 5898.20 – 5898.32 and/or other applicable municipal financing laws. The scope of eligible bidders may be expanded with changes in the law. The Municipal Financing Program will accept proposals from any entity authorized under California law to establish a municipal financing program of the types described in this PON.

PRE-BID CONFERENCE

There will be one Pre-Bid Conference; participation in this meeting is optional but encouraged. The Pre-Bid Conference will be held at the date, time and location listed below. Please call (916) 654-4392 or refer to the Energy Commission's website at www.energy.ca.gov to confirm the date and time.

October 20, 2009
9:00 am
California Energy Commission
Hearing Room A
1516 9th Street
Sacramento, CA 95814
Telephone: (916) 654-4392

PARTICIPATION THROUGH WEBEX, THE ENERGY COMMISSION'S ON-LINE MEETING SERVICE

- Please be aware that the meeting's WebEx audio and on-screen activity may be recorded.

REGISTRATION

- To register for this event, go to
- https://energy.webex.com/energy/onstage/g.php?d=920665554&t=a

1. Click the "Register" button at the bottom of the page.

2. Provide your information as requested.

3. You will receive a confirmation email message that contains the details to join the event.

COMPUTER LOG ON

Follow the instructions in your confirmation email to join the meeting a few minutes early.

TELEPHONE ONLY (No Computer Access)

If you cannot join the meeting via computer, you can listen to the audio via phone by calling toll free 1-866-469-3239 and entering the Meeting Number **920 665 554** followed by the # key. When asked for your Attendee ID number, please press the # key. You will then be entered into the call of the meeting on a muted line.

If you have difficulty joining the meeting, please call the WebEx Technical Support number at (866) 229-3239.

QUESTIONS

During the solicitation process, questions of clarification about this PON must be directed to the Contracts Officer listed in the following section. You may ask questions at the Pre-Bid Conference, and you may submit questions via mail, electronic mail, FAX, and by phone. However, all questions must be received by 5:00 pm on Thursday, October 22, 2009. After this date, question and answer sets will be mailed to all parties who submitted questions (so long as they also provided their address), requested a copy of this PON from the Energy Commission Contracts Office and all parties that left their address with the Contracts Officer at the Pre-Bid conference. The questions and answers will also be posted on the Energy Commission's website at: http://www.energy.ca.gov/contracts/index.html.

Any verbal communication with an Energy Commission employee concerning this PON is not binding on the State and shall in no way alter a specification, term, or condition of the PON.

CONTACT INFORMATION

Elizabeth Stone, Contracts Officer
California Energy Commission
1516 Ninth Street, MS-18
Sacramento, California 95814
Telephone: (916) 654-5125
FAX: (916) 654-4423
E-mail: estone@energy.state.ca.us

FEDERAL AND STATE LAWS, REGULATIONS, AND GUIDELINES

Bidders responding to this solicitation should be familiar with Federal and State laws, regulations, and guidelines that apply to the SEP, including but not limited to the following:

Federal

The American Recovery and Reinvestment Act of 2009
http://www.energy.ca.gov/recovery/documents/HR1.pdf.

Department of Energy State Energy Program Funding Opportunity Announcement DE-FOA-0000052
https://www.fedconnect.net/FedConnect.

Title 10 Code of Federal Regulations (CFR) Part 420: State Energy Program
http://www.gpoaccess.gov/cfr/index.html

- Davis-Bacon Act (40 U.S.C. 3141, et. seq.)
- National Environmental Policy Act (42 U.S.C. 4321, et. seq.)
- National Historic Preservation Act of 1966 (16 U.S.C. 470f)

Office of Management and Budget reporting requirements

- http://www.whitehouse.gov/omb/assets/memoranda_fy2009/m09-21.pdf
- http://www.whitehouse.gov/omb/assets/memoranda_fy2009/m09-21-supp1.pdf
- http://www.whitehouse.gov/omb/assets/memoranda_fy2009/m09-21-supp2.pdf

Council of Economic Advisers' Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009 May 2009
http://www.whitehouse.gov/assets/documents/Estimate_of_Job_Creation.pdf.

State

Streets and Highways Code Sections 5898.20 - 5898.32 (California Assembly Bill 811)
http://www.energy.ca.gov/recovery/documents/ab_811_bill_20080721_chaptered.pdf.

California Energy Commission State Energy Program Guidelines
http://www.energy.ca.gov/2009publications/CEC-150-2009-004/CEC-150-2009-004-CTD.PDF.

California Home Energy Rating System Program regulations
http://www.energy.ca.gov/2008publications/CEC-400-2008-011/CEC-400-2008-011-CMF.PDF

KEY WORDS AND DEFINITIONS

Important definitions for this solicitation are presented below:

Word/Term	Definition
ARB	California Air Resources Board, which has responsibility for overseeing implementation of the Assembly Bill (AB) 32 Climate Change Scoping Plan
ARRA	The American Recovery and Reinvestment Act of 2009.
ARRA Accountability and Transparency Board	Established by ARRA to coordinate and conduct oversight of Federal spending to prevent waste, fraud and abuse by establishing accountability and insuring that the recipients and uses of all funds are transparent to the public.
ARRA Committee	Energy Commission's American Recovery and Reinvestment Act (ARRA) Ad Hoc Committee
Bidder	A respondent to this Solicitation (also referred to as "applicant" in the SEP Guidelines)
Budgetary Range	Minimum funding level, preferred funding level, maximum funding level
Building Commissioning	Building commissioning on existing buildings, also known as retro-commissioning, usually focuses on energy-using equipment such as mechanical equipment, lighting, and related controls with the goal of reducing energy waste, obtaining energy cost savings for the owner, and identifying and fixing existing problems, using diagnostic testing and operations and maintenance tune-up activities.
CCM	Energy Commission Contract Manager
CPUC	California Public Utilities Commission, which directs the administration of public goods charge energy efficiency programs by the IOUs, including a range of programs directed at existing residential buildings.
CSD	California Department of Community Services and Development, which administers the federal Weatherization Assistance Program in California.
DGS	California Department of General Services
DOE	U.S. Department of Energy, which has responsibility for overseeing ARRA funding (including SEP) aimed at creating jobs by improving energy efficiency
Economically Disadvantaged Area	Area where the unemployment rate exceeds the California statewide average unemployment rate for June 2009. Other characteristics, such as higher than average foreclosure rate

	and lower than average income levels, may also be considered in identifying economically disadvantaged areas.
Energy Commission	California Energy Commission
EPA	U.S. Environmental Protection Agency, which has responsibility in collaboration with DOE for administering the suite of Energy Star programs, including Home Performance with Energy Star
Equipment	Products, objects, machinery, apparatus, implements or tools that have a useful life of at least one year, have an acquisition unit cost of at least $5,000, and are purchased with ARRA SEP funds.
HERS Phase I (HERS I)	The requirements, procedures and protocols established by the Energy Commission for conducting field verification and diagnostic testing of newly constructed homes or alterations to existing homes to verify compliance with the California Building Energy Efficiency Standards, as specified by Title 20, Sections 1670-1675, Title 24, Parts 6 and 1, and Residential Reference Appendices, RA2 and RA3.
HERS Phase II (HERS II)	The requirements, procedures and protocols established by the Energy Commission for conducting California Whole-House Home Energy Ratings and California Energy Audits for existing and newly constructed homes, as specified by Title 20, Sections 1670-1675 and the HERS Technical Manual.
HERS Program	California Home Energy Rating System Program as specified in the California Code of Regulations, Title 20, Section 1670-1675.
HERS Provider	An organization that has been approved by the California Energy Commission to administer a HERS Program pursuant to the California Home Energy Rating System Program regulations.
HERS Rater	A person who has been trained, tested and certified by a HERS Provider to perform the functions specified in the California Home Energy Rating System Program regulations.
HPwES	Home Performance with Energy Star
HUD	U.S. Department of Housing and Urban Development, which has responsibility for overseeing many financing and grant funding programs to promote energy efficiency in low and moderate income housing.

IOU	Investor Owned Utilities (privately owned utilities regulated by the California Public Utilities Commission)
Joint Powers Authority	An institution permitted under California law whereby two or more public authorities (e.g., local governments) can operate collectively.
PON	This entire document which is a Program Opportunity Notice.
Proposal	Formal written response to this PON from Bidder
SEP	State Energy Program
Solicitation	The competitive method used to solicit proposals for funding under this Program Opportunity Notice.
Source Energy	Energy that is used at a building site and consumed in producing and in delivering energy to the site, including, but not limited to, power generation, transmission and distribution losses.
State	State of California
Validation Action	An action in the superior court of the county in which the principal office of the public agency is located to determine the validity of any matter authorized to be determined pursuant to Chapter 9 of the California Code of Civil Procedure. Details regarding Validation Action can be found in California Code of Civil Procedure Sections 860-870.5.

II. Goals and Objectives

About this Section

This section explains the goals and objectives of the Municipal Financing Program that is the subject of this solicitation. This section summarizes the key program design concepts that Bidders should respond to in their program proposals. More detailed explanations of the requirements for the Bidder's response to this solicitation are specified in Section III.

Background

Municipal Financing Program (AB 811-type programs) Concept

California Streets and Highways Code Sections 5898.20 - 5898.32 (enacted by Assembly Bill (AB) 811, Statutes of 2008) allows the legislative bodies of cities, counties, or groups of cities and counties in California to create a municipal financing program in which property owners may enter into contractual assessments to finance the installation of energy efficiency or distributed renewable energy generation improvements that are permanently fixed to residential (including multi-family), commercial, industrial, or other real property. Under these municipal financing programs property owners repay the assessments with their property taxes, and the liens associated with the assessments are given priority over previously-recorded private liens (such as a mortgage).

These municipal financing programs are a potentially important tool in the State's goal to increase energy efficiency and renewable energy generation in California, and they will decrease or eliminate the upfront costs property owners must normally incur in installing such improvements.

The purpose of the Energy Commission's Municipal Financing Program is to assist cities, counties and groups of cities and counties in implementing or continuing their own municipal financing programs, and to do so in a way that will further the objectives of ARRA, DOE and the State of California. To this end, the Energy Commission will work with local governments to ensure that their programs are structured to be cost-effective, sustainable, transparent and able to achieve the greatest energy savings for the amount invested. The Municipal Financing Program will provide funds and support in the manner that will best help achieve those goals.

Role of Local Governments

Local governments, including Joint Power Authorities, awarded funds under the Municipal Financing Program will administer their programs, oversee quality control, and report to the Energy Commission on progress, effectiveness and energy savings. The local governments must initiate their municipal financing programs using the process described in California Streets and Highways Code Sections 5898.20 - 5898.32 and/or other applicable laws, perform any legal validation actions, secure program funding, and administer the program or contract with a turnkey service to administer the program on their behalf. Local governments should use the ARRA SEP funds to lessen the financial burden they face in creating and administering municipal financing programs, to increase lender confidence, and to lower interest rates and increase bond ratings to make financing attractive to property owners.

Loading Order and Eligible Improvements

To encourage the greatest possible benefit for the money invested, municipal financing programs must require, and offer financing for, and also may incentivize, the installation of energy efficiency improvements as a condition of financing on-site solar electric (photovoltaic) generation or other on-site renewable energy generation. Installing energy efficient improvements first will lead to:

a) Installation of smaller and less costly solar electric systems;

b) Meeting a greater portion of the building's electricity load with the same size solar electric system; and

c) Maximizing energy savings for combined energy efficiency and solar electric projects, while providing potential positive cash flow for the total project.

The use of ARRA SEP funding will be awarded on the condition that projects that result from financing that was supported or facilitated by ARRA SEP funding achieve a minimum of 10% reduction in total building energy use through energy efficiency in order to qualify for financing for on-site renewable energy projects. The 10% reduction shall be determined using the Home Energy Rating System (HERS) Phase II index for residential buildings once HERS II-approved HERS Providers and certified HERS Raters are available in the region. The Energy Commission may approve other methods for determining the 10% reduction as it determines necessary. The Energy Commission strongly encourages bidders to require greater than a 10% total building energy use savings as a stipulation of financing on-site renewable energy installation.

Energy Audits and Quality Assurance

Energy audits and building commissioning as necessary components of a municipal financing program will help property owners make well-informed decisions and lead to more focused and cost-effective retrofits. Documentation of the HERS Rating, Energy Audit or the investigation phase of building commissioning also educates and informs realtors, lenders, appraisers and potential buyers at time of sale of the building about the improvements that were made to the property, thereby substantiating the value added to the property and lien that remains with the property. HERS ratings, Energy Audits and commissioning investigation costs should be included as project costs for financing to the extent that they are not covered by ARRA SEP funds or through partnership with a utility.

Under the Municipal Financing Program, residential audits or ratings consistent with the California Home Energy Rating Program will be provided for homeowners, and commercial energy audits or the investigation phase of building commissioning will be conducted and funded for commercial property owners. ARRA funds may be used to cover the costs of energy audits or building commissioning investigations.

In addition, energy efficiency and distributed renewable energy generation improvements funded through a municipal financing program must be installed properly and in good working order to ensure the cost-effectiveness, energy savings and reputation of the program. Programs awarded funds through the Energy Commission's Municipal Financing Program must have a means of ensuring and demonstrating the quality of installed energy improvements. Contractors installing improvements must comply with state and local licensing laws, obtain building permits, and properly field-verify any measures for which Title 24 Building Energy Efficiency Standards field verification protocols have been established.

VERIFICATION AND REPORTING

Because one of the metrics of a program's success is the amount of energy saved, a quantifiable measure of this savings must be demonstrated through the bidder's program.

ARRA funds have stringent requirements regarding transparency, which any programs funded through the Energy Commission's Municipal Financing Program must follow. Any ARRA-funded programs may also be susceptible to an audit. Bidders must comply with federal reporting obligations, as specified in the federal ARRA and SEP guidelines.[2]

PROPERTY QUALIFICATIONS

As financing is tied to the property and not the borrower, municipal financing programs to date have tended to require screening processes that generally have been less extensive than those for traditional loans. Given that the subprime lending crisis has been a major contributor to the current economic downturn, a major concern for both local governments and lenders in the development of municipal financing programs has been the potential for participants in a municipal financing program to incur more debt than they are able to repay.

To guard against this possibility, municipal financing programs should screen applicants for creditworthiness. This may include requiring a specific loan-to-value ratio, ensuring that property taxes have been paid in full and on time, or determining that applicants do not owe more than the value of the property.

LEGAL CONSIDERATIONS

Mortgage provisions restricting the voluntary addition of a priority lien by the property owner are sometimes included in the contract between a lender and borrower. These

[2] See **http://www.energy.ca.gov/recovery/documents/SEP_Recovery_Act_Guidance_DE-FOA-00000521.pdf** and **http://www.whitehouse.gov/omb/assets/memoranda_fy2009/m09-21.pdf**.

provisions are not present in all mortgages. Proposals must indicate how their programs will address such provisions for residential and commercial property owners. This may include requiring notification and/or approval from the primary mortgage lender.
In addition, proposals must describe the legal status of their programs. This includes, but is not limited to, resolutions or other official decisions made by Bidder's governing body regarding the proposed program, legal opinions obtained and the status of any validation actions brought to determine the legal validity of the proposed program.

SUSTAINABILITY

Programs funded through the Municipal Financing Program must demonstrate sustainability and long-term viability. A major focus of the SEP is market-transformation, strategic and temporary interventions that effect lasting changes in the way we use our energy resources. In order to effect lasting changes, programs must be carefully structured to continue after the SEP funds are no longer available. Sustainability may be achieved through the establishment of revolving financing funds or other methods.

REGIONAL FOCUS

The Energy Commission encourages collaboration among communities, on a county-by-county basis or through a joint powers authority, to create a larger and more effective municipal financing program. Municipal financing programs that operate on a countywide or regional scale will have the greatest opportunity for economies of scale and ease of pooling financing if bond sales are planned. Larger programs will have lower administrative costs while reaching more property owners throughout the State.

[Program Proposal Requirements, Proposal Format and Required Documents, Administrative Information, ARRA Specific Important Information, Evaluation Process and Criteria, and Attachments Omitted]

Attachment 5

Angela Gould (California Energy Commission)

Proposed Cancellation of Program Opportunity Notice 400-09-401

(July 2010)

STAFF PAPER

Proposed Cancellation of Program Opportunity Notice 400-09-401

Angela Gould
Renewable Energy Office
Efficiency and Renewable Energy Division
California Energy Commission

Business Meeting
Hearing Room A, California Energy Commission
July 28, 2010

JULY 2010
CEC-400-2010-009

Introduction

Since it was first conceived in Berkeley, California in 2007, Property-Assessed Clean Energy (PACE) financing has been recognized throughout the nation as a potential breakthrough mechanism to enable retrofits of existing buildings. In its December 2009 issue[1], Scientific American identified PACE financing as one of twenty "World Changing Ideas." At the time of this writing, twenty-three states enable the creation of PACE districts to finance permanent energy efficiency, water efficiency and renewable energy improvements.

The three California agencies responsible for developing and implementing energy efficiency and climate change policy and programs (Energy Commission, Air Resources Board, and California Public Utilities Commission) agree that achieving energy efficiency retrofits in existing buildings is a very high priority for the State. The Energy Commission has begun work to develop and implement a comprehensive program to achieve greater energy savings in California's existing residential and nonresidential building stock as part of its directive under Assembly Bill 758[2] (Chapter 470, Statutes of 2009). In addition, ARB's AB 32 Scoping Plan identifies improvement of the energy efficiency of existing residential and nonresidential buildings as the single most important activity to achieve reduced greenhouse gas emission reductions in the electricity and natural gas sectors. California's Energy Action Plan, Integrated Energy Policy Report, and Long Term Energy Efficiency Strategic Plan place high priority on achieving dramatically greater energy efficiency in existing buildings, including achieving an average energy savings of 40% in all California residential buildings by 2020. Such high levels of energy efficiency retrofits and the expansion of onsite solar electric and other renewable energy will not be possible without major expansion in the availability of effective financing to homeowners and nonresidential building owners.

PACE financing overcomes several barriers that block home and building owners from making investments in energy efficiency and onsite solar electric improvements. Firstly, PACE financing enables the amortized repayment of the cost of the improvements over time in parallel with the accomplishments of energy bill reductions resulting from the improvements. This allows the home/building owner to experience an immediate and ongoing positive cash flow.

In addition, repayment of the financing is an assessment on the property rather than a personal obligation of the property owner, and the assessment remains with the property if it is sold. This dramatically reduces the uncertainty and risk normally associated with the financing of energy efficiency and onsite solar projects. With other types of financing, repayment of the outstanding principle comes due at the time that the property is sold. Given that property owners are uncertain about how long they will own their buildings, and buildings are on average owned for as little as five to seven years, under other types of financing owners cannot be assured that they will receive enough energy bill savings to cover the costs of substantial energy improvements prior to their need to sell the property.

---

[1] http://www.scientificamerican.com/article.cfm?id=world-changing-ideas
[2] http://www.energy.ca.gov/ab758/documents/ab_758_bill_20091011_chaptered.pdf

Also, most other types of financing readily available to property owners have shorter terms compared to the useful life of the improvements, so even if the buildings remain with the same owner for the entire term of the financing, the owner will likely not be reimbursed through energy savings by the time the principle must be fully repaid. PACE financing has the added advantage of providing funding for improvements without a down payment and enabling property owners to qualify more easily than with other financing.

California Supports PACE

California is a leader and innovator in the development and implementation of the PACE financing concept. In California, multiple cities and counties have directed both their own dwindling general funds and their ARRA Energy Efficiency and Conservation Block Grant funding to establishing PACE programs in an attempt to create jobs, save energy and meet their greenhouse gas emission reduction goals. The approach has been piloted in the City of Berkeley, City of Palm Desert and County of Sonoma (another important pilot of PACE financing has occurred in the County of Boulder, Colorado), and at least four other local governments in California have since followed suit, establishing their own PACE districts.

The success of these programs and the promise of PACE financing to enable local governments to create a means to take climate change action, improve the infrastructure represented by their local building stock, improve the local economy, create jobs and put their citizens back to work has resulted in a groundswell of interest in localities throughout California and across the nation. In planning how California should utilize its ARRA SEP funding, the Commission recognized the potential for empowering local governments through further piloting of strong programs that utilize PACE financing as an important tool to enhance the ability of achieving comprehensive and targeted residential and nonresidential retrofits. In early dialogue with DOE and Congressional leaders regarding California placing an emphasis on PACE financing via such local pilots, the Energy Commission received strong encouragement to follow up California's early leadership in PACE financing to take the next steps to expand these capabilities in model projects that other local governments in California and throughout the nation can learn from and replicate.

As a result, the Energy Commission invested $110 million of its ARRA SEP funding in pursuing a three-part competitive program solicitation for 1) municipal (PACE) financing, 2) municipal and commercial building targeted retrofits, and 3) comprehensive residential building retrofits. The Energy Commission designed the Municipal Financing Program to develop expanded PACE financing in California, which would in turn support comprehensive energy efficiency retrofits, simulate the green workforce and provide a foundation for the Commission's work under Assembly Bill 758. $30 million of the $110 million ARRA SEP total has been awarded to five proposals under the Municipal Financing Program and was expected to leverage $370 million, create 4,353 jobs, save over 336 million kilowatt-hours of energy, and avoid the emissions of 187,264 tons of greenhouse gasses over the contract period, which ends March 31, 2012.

Further support for PACE came in October 2010, when Vice President Biden announced that the Administration was backing the use of ARRA funding for PACE financing programs, which formed a major component of the Recovery through Retrofit Report[3].

PACE in California is enabled by Assembly Bill (AB) 811, Statutes of 2008, which allows cities and counties in California to create a program in which property owners may enter into contractual assessments to finance the installation of energy efficiency or renewable energy generation improvements that are permanently fixed to residential (including multi-family), commercial, industrial, or other real property. AB 474 (Statutes of 2009) expanded the law, including an authorization to fund water efficiency improvements. Under these municipal financing programs, property owners repay the assessments with their property taxes, and the liens associated with the assessments are given priority over previously-recorded private liens (such as a mortgage). In a lender letter issued September 18, 2009, Fannie Mae acknowledged this senior status, saying that, "Servicers should treat [PACE assessments] as any tax or assessment that may take priority over Fannie Mae's lien."[4]

Fannie Mae and Freddie Mac Target PACE

The position taken in September 2009 was reversed on May 5, 2010, when Fannie Mae issued a lender letter and Freddie Mac issued an industry letter; both letters advised their single-family loan sellers and servicers that "loans" with a priority lien over the primary mortgage are prohibited for their mortgage holders. No exceptions were indicated for property owners who had already joined PACE programs, or for PACE programs that were receiving federal funding through DOE.

DOE, the Office of the Vice President, private stakeholders and others worked with the Federal Housing Finance Agency (FHFA), which oversees Fannie Mae and Freddie Mac, to obtain clarification to the May 5 letters that would provide exemptions for PACE programs already in operation and for DOE-approved programs (i.e., programs receiving SEP or EECBG funding) following federal guidelines, released by DOE[5] on May 7, 2010, for the design of PACE programs that would provide protection against default on the contractual assessments and primary mortgages, safeguarding homeowners and lenders. DOE's Guidelines build from the October 18, 2009 "Policy Framework for PACE Financing Programs"[6] issued by the White House. The guideline provisions are expected to be met by the five awarded proposals under the Municipal Financing Program.

On July 6, 2010, FHFA unlawfully undermined the authority of local governments to issue priority lien tax assessments in a statement[7] that directed Fannie Mae and Freddie Mac to take punitive actions against homeowners who participate in PACE financing programs, although it did instruct the government-sponsored entities "to waive their Uniform Security Instrument prohibitions against such senior liens" for homeowners who already had PACE assessments on

[3] http://www.whitehouse.gov/assets/documents/Recovery_Through_Retrofit_Final_Report.pdf
[4] https://www.efanniemae.com/sf/guides/ssg/annltrs/pdf/2009/ll0709.pdf
[5] http://www1.eere.energy.gov/wip/pdfs/arra_guidelines_for_pilot_pace_programs.pdf
[6] http://www.whitehouse.gov/assets/documents/PACE_Principles.pdf
[7] http://www.fhfa.gov/webfiles/15884/PACESTMT7610.pdf

their properties. Because Fannie Mae and Freddie Mac purchase a large percentage of the nation's new home mortgages and also influence many other lenders, the new direction on PACE assessments is expected to severely harm citizens who would want to take advantage of this innovative method for financing energy improvements. Several existing PACE programs in California have already suspended their residential programs as a result.

The Office of the Comptroller of the Currency (OCC) followed with a bulletin[8], also on July 6, that referenced the FHFA statement and supplied somewhat vague guidance to national banks to exercise caution with their mortgage holdings in areas with PACE programs, including the suggestion of punitive actions against home and business owners. Because the bulletin was so generally worded and because OCC oversees banks that supply commercial mortgages, there is concern that a local government operating a commercial PACE program could find its residents subject to more stringent lending criteria for residential mortgages as a result. The White House, DOE and others are seeking clarification from the OCC on this matter, but until this clarification is issued, commercial PACE financing is on shaky ground.

FHFA's and OCC's recent direction flies in the face of over a century of lawful priority lien tax assessments issued by local governments to finance public benefits. In addition, in its July 6 statement, FHFA incorrectly asserts that:

- PACE assessments are "loans"
- PACE assessments "do not have the traditional community benefits associated with taxing initiatives" and
- "First liens for such loans represent a key alteration of traditional mortgage lending practice. They present significant risk to lenders and secondary market entities, may alter valuations for mortgage-backed securities and are not essential for successful programs to spur energy conservation."

PACE assessments are properly characterized as assessments because they are tied to the property itself. Loans, on the other hand, are made to an individual borrower and remain with that borrower; they are not tied to property. Regarding the second false statement, California law establishes the public benefit of PACE: "Energy and water conservation efforts, including the promotion of energy efficiency improvements to residential, commercial, industrial, agricultural, or other real property are necessary to address the issue of global climate change,"[9] and "the Legislature declares that a public purpose will be served by a voluntary contractual assessment program that provides the legislative body of any public agency with the authority to finance the installation of distributed generation renewable energy sources and energy or water efficiency improvements that are permanently fixed to residential, commercial, industrial, agricultural, or other real property."[10] FHFA's third false statement, that PACE assessments present a significant risk to lenders and secondary market entities, is contradicted by the fact that properties with assessments have a lower default rate than the average. Pilot PACE programs have been consistent with other tax assessments: properties in Sonoma County with a

---

[8] http://www.occ.treas.gov/ftp/bulletin/2010-25.html
[9] California Streets and Highways Code, 5898.14 (a) (1)
[10] California Streets and Highways Code, 5898.14 (b)

PACE assessment have a default rate of 1.2%, compared to 3.5% in the general housing stock, and properties in Berkeley's PACE program have no defaults.

Clearly, FHFA's and OCC's confrontational stance on PACE demonstrates a blatant disregard for the authority of local governments to make lawful property assessments and a lack of appreciation for the public value of this innovative financing mechanism for low risk investment in energy efficiency and distributed renewable energy generation. Unfortunately, the efforts of the White House and DOE to encourage sensible policies, with respect to coordinating PACE assessments and mortgage financing, fell on deaf ears at FHFA and OCC. This failure at FHFA and OCC has caused actions to be initiated to correct the problem: the California Attorney General, supported by Governor Schwarzenegger, filed suit on July 14, 2010, against Fannie Mae, Freddie Mac and FHFA, and federal legislation may be introduced that would override FHFA's and OCC's objections to PACE. FHFA's actions have also been publicly opposed by, among others, the California Public Utilities Commission[11] and the Mayors of San Diego and San Francisco[12].

Effect on the Municipal Financing Program

Program Opportunity Notice #400-09-401, which detailed the requirements of the Municipal Financing Program and solicited proposals, specifically targeted projects to implement or expand local programs incorporating first-priority PACE liens. No other types of financing programs were requested from or proposed by the sixteen local governments that submitted proposals to this solicitation.

In the aftermath of FHFA's direction and OCC's guidance, DOE and the Governor's Recovery Task Force have called on the California Energy Commission to explore other financing options with SEP funds:

> DOE: "The DOE and Administration continue to support pilot PACE financing programs. Recovery Act grantees are not expressly prohibited from using funds to support viable PACE financing programs, however the practical reality is that residential PACE financing programs with a senior lien priority face substantial implementation challenges in the current regulatory environment. In light of the clear opposition from the regulators for PACE financing programs with a senior lien priority, prudent management of the Recovery Act compels DOE and Recovery Act grantees to consider alternatives to programs in which the PACE assessment is given a senior lien priority."[13]
>
> Governor's Recovery Task Force: "On October 8, 2009, your Commission issued Solicitation Number 400-09-401 and is now in the process of contracting with several entities as part of your Municipal Financing Program. However, due to recent decisions by Fannie Mae, Freddie Mac, and the Federal Housing Finance Agency that would

[11] http://www.cpuc.ca.gov/NR/rdonlyres/413755D4-58CD-412E-A428-3E2AE7718298/0/PACELetter_071310.pdf
[12] http://www.sacbee.com/2010/07/16/2893861/fannie-and-freddie-put-brakes.html
[13] http://www2.eere.energy.gov/WIP/PACE.HTML

prevent the continuation of PACE programs, it is evident that the efforts of the [Energy Commission] to use the PACE financing model no longer constitutes a viable option.

"I am calling on the [Energy Commission] to adapt to the changed regulatory landscape in a way that will allow full obligation of the reallocated funds by September 30, 2010. If the [Energy Commission] does not respond to the challenges recently imposed by aforementioned federal entities, the [Energy Commission] is teetering on failing to honor both Governor Schwarzenegger's Executive Order and the federal mandate to put Recovery Act funds to work for the American people as quickly and efficiently as possible. Every day that passes without action by the [Energy Commission] increases the chance that stimulus funds so vital to California's recovery could be rescinded. The Governor has indicated in the past that any rescission of Recovery Act funds is unacceptable. Therefore, it is incumbent upon the [Energy Commission] to immediately find ways to encumber State Energy Program funds in a manner that prioritizes expediency and viability."[14]

The Energy Commission strongly supports the intent of the Municipal Financing Program's PON to develop and pilot in regions around the state PACE financing, the authority for California local governments to provide PACE financing through property assessments, and the extensive efforts at the local level over the past year plus to develop this innovative approach, as demonstrated by the awards made under this PON.

At this time, however, staff believes that it is necessary to broaden the range of financing approaches beyond PACE so that ARRA funds can be put to use at the earliest possible time. Staff believes that it is imperative that the Energy Commission act with all possible haste to encumber the funds under the Municipal Financing Program in a manner that allows alternate financing options in order to ensure that the benefits of this program are not lost.

Staff Recommendations

To this end, the staff recommends adopting the proposed amendments to the *State Energy Program Guidelines* (*SEP Guidelines*), to allow flexibility in the type of mechanisms used to finance the energy efficiency, water efficiency and distributed renewable energy generation retrofits under the Municipal Financing Program. The revised *SEP Guidelines* will be considered by the Energy Commission for approval at the August 6, 2010, Business Meeting.

Similarly, the staff recommends adopting similar amendments to the *Energy Efficiency and Conservation Block Grant Guidelines (EECBG Guidelines)* to permit the same flexibility where the projects initiated by local jurisdictions support or seek leverage from municipal financing options.

Staff further recommends that the Energy Commission cancel PON #400-09-401 along with the Notice of Proposed Awards (NOPA) issued for the solicitation, because the feasibility and viability of the selected projects have been virtually eliminated by the FHFA and OCC determinations. In order to meet the fast-approaching obligation and expenditure deadlines

[14] July 15, 2010 letter from Rick Rice of the California Recovery Task force to Chairman Karen Douglas

associated with the ARRA SEP, cancellation of the PON would release the $30 million currently encumbered by the NOPA and make it available for the Energy Commission to respond quickly to the changing regulatory landscape. Coupled with the flexibility in the proposed amendments to the *SEP Guidelines*, the Energy Commission would be able to redirect the funding to other activities permitted by the federal SEP grant, including investments in statewide and local energy efficiency financing programs that incorporate financing options not at risk from the FHFA and OCC determinations. Investment in alternative financing options would allow the State to continue laying the foundation for comprehensive energy efficiency retrofits as part of the Commission's Assembly Bill 758 program and developing California's clean energy workforce.

Attachment 6

California Energy Commission

Minutes of the July 28, 2010, California Energy Commission Business Meeting

STATE OF CALIFORNIA
California Energy Commission

Minutes of the July 28, 2010, Energy Commission Business Meeting.

The meeting was called to order at 10:06 by Chairman Karen Douglas. The Pledge of Allegiance was lead by Chairman Douglas.

Present:
Karen Douglas, Chairman
James D. Boyd, Vice Chair
Jeffrey D. Byron, Commissioner
Robert B. Weisenmiller, Commissioner
Anthony Eggert, Commissioner

Six Energy Commission employees received Superior Accomplishment or Sustained Superior Accomplishment Awards that were presented by Executive Director Melissa Jones. The honorees were Bill Pennington and Angela Gould of the Efficiency and Renewable Energy Division, and Carolyn Cass, Doris Yamamoto, Anish Gautam and Pedro Gomez of the Energy Research and Development Division.

1. CONSENT CALENDAR. (Items on the Consent Calendar will be taken up and voted on as a group. A commissioner may request that an item be moved and discussed later in the meeting.)

    a. AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY. Possible approval of Contract 500-10-016 for $30,000 with the American Council for an Energy Efficient Economy to co-sponsor two conferences that provide an opportunity to showcase the Public Interest Energy Research Program's successful emerging technologies and energy efficiency research and to facilitate their commercialization and marketability. (PIER electricity funding.) Contact: Dustin Davis.

    b. PERRY SMITH, LLP. Possible approval of Amendment 1 to Contract 150-09-004 with Perry Smith, LLP, to add conflict of interest terms and conditions to the original agreement. Contact: Mark Hutchison.

Commissioner Byron moved and Vice Chair Boyd seconded approval of the Consent Calendar. The vote was unanimous. (5-0)

2. INLAND EMPIRE ENERGY CENTER (01-AFC-17C). Possible approval of a petition to amend the California Energy Commission decision for the Inland Empire Energy Center to adjust the air quality conditions of certification to be consistent with the South Coast Air Quality Management District RECLAIM/Title V permit for the project. Contact: Dale Rundquist. (10 minutes)

Item 2 was removed from the agenda and will be heard at a future Business Meeting.

3. TURBO AIR, INC. DECERTIFICATION. Possible adoption of the proposed Order and Decision of the Efficiency Committee recommending that two models of Turbo Air, Inc., commercial refrigerators be removed from the Energy Commission's appliance database. Interested parties may participate, but any submissions are limited to the existing evidentiary record (California Code of Regulations, Title 20, section 1236(b).) Contact: Pippin Brehler. (15 minutes)

Commissioner Eggert moved and Commissioner Byron seconded adoption of the proposed Order and Decision, with direction to staff to work with the manufacturer to minimize the impact of the decision. The vote was unanimous. (5-0)

4. STATE ENERGY EFFICIENT APPLIANCE REBATE PROGRAM (CASH FOR APPLIANCES). Possible adoption of revised guidelines for the Cash for Appliances Program to expand the rebate program by offering new appliance categories with the goal of distributing available stimulus funds. Revisions would extend rebates to dishwashers, freezers, central air conditioners and heat pumps, furnaces, and solar water heating systems. Revisions would also add rules for verifying the proper installation, disposal, and recycling of central heating, ventilating and air conditioning (HVAC) systems and solar water heating systems that are required under the current Guidelines for white good appliances. Contact: Lorraine White. (10 minutes)

Commissioner Eggert moved and Vice Chair Boyd seconded adoption of the revised guidelines with errata. The vote was unanimous. (5-0)

5. STATE ENERGY PROGRAM: Possible adoption of resolution to cancel Program Opportunity Notice (PON) No. 400-09-401 (Municipal Financing Program), and Notice of Proposed Awards, in response to direction of the United States Department of Energy (DOE). DOE directed the states to consider financing options in addition to Property Assessed Clean Energy (PACE) financing. The DOE issued this direction in response to regulatory uncertainty created by recent determinations by the Federal Housing Finance Agency (FHFA) affecting PACE financing. Staff recommends cancellation of PON 09-401 because the 400-09-401 solicitation only allowed for financing through first-priority liens, such as PACE, which FHFA has opined violates the Fannie May and Freddie Mac Uniform Security Instrument prohibitions against senior liens. Contact: Claudia Chandler. (10 minutes)

Commissioner Eggert moved and Commissioner Byron seconded adoption of the resolution. The vote was unanimous. (5-0)

6. POWER SOURCE DISCLOSURE PROGRAM - ORDER INSTITUTING RULEMAKING. Possible approval of an Order Instituting Rulemaking to modify existing regulations to govern the requirements of the Power Source Disclosure Program. The new regulations will allow for necessary formatting changes to clarify the Power Content Labels that retail sellers of electricity are required to disclose to their customers under the California Public Utilities Code sections 398.2-398.5, enacted by Assembly Bill 162 (Ruskin, Chapter 313, Statutes of 2009). Contact: Lorraine Gonzalez. (5 minutes)

Vice Chair Boyd moved and Commissioner Weisenmiller seconded approval of the Order Instituting Rulemaking. The vote was unanimous. (5-0)

7. RENEWABLES PORTFOLIO STANDARD 2006 PROCUREMENT VERIFICATION REPORT. Possible approval of the *Renewables Portfolio Standard (RPS) 2006 Procurement Verification Report.* This report transmits the RPS procurement verification findings for 2001-2006 to the California Public Utilities Commission. Contact: Gina Barkalow. (10 minutes)

Vice Chair Boyd moved and Commissioner Weisenmiller seconded approval of the report. The vote was unanimous. (5-0)

8. CLIPPERCREEK, INC. Possible approval of Agreement ARV-10-001for a grant of $1.9 million to ClipperCreek, Inc. to update approximately 3,000 existing California electric vehicle charging stations to the new SAE-J1772. In addition, ClipperCreek will refurbish inductive and paddle infrastructure that will remain on site where they are being used by current electric vehicles. ClipperCreek will install meters on the charging infrastructure, as directed by the local utility, to allow monitoring and utility control. (ARFVTF funding.) Contact: Jennifer Allen. (5 minutes)

Vice Chair Boyd moved and Commissioner Eggert seconded approval of Agreement ARV-10-001. The vote was unanimous. (5-0)

9. ALTEX TECHNOLOGIES CORPORATION. Possible approval of Grant Agreement PIR-09-016, awarding $1,435,693 to Altex Technologies Corporation to develop a waste vegetable oil-driven combined heat and power system for fast food restaurants. (PIER electricity funding.) Contact: Jean Baronas. (5 minutes)

Commissioner Byron moved and Vice Chair Boyd seconded approval of Agreement PIR-09-016. The vote was unanimous. (5-0)

10. POTTER DRILLING, INC. Possible approval of Agreement PIR-09-019 for a cost-share grant of $380,000 to Potter Drilling, Inc. to develop and test a non-contact geothermal well drilling technology. Potter Drilling received a DOE ARRA grant under FOA-0000075 for this project. (PIER electricity funding.) Contact: John Hingtgen. (5 minutes)

Commissioner Eggert moved and Commissioner Byron seconded approval of Agreement PIR-09-019. The vote was unanimous. (5-0)

11. ELECTRIC POWER RESEARCH INSTITUTE, INC. Possible approval of Agreement PIR-10-022 for a grant of $400,000 to Electric Power Research Institute, Inc., (EPRI) to demonstrate the effectiveness of airflow management in data centers to reduce air conditioning costs. The project is estimated to reduce data center electricity consumption by 15 percent annually. (PIER electricity funding.) Contact: Anish Gautam. (5 minutes)

Commissioner Byron moved and Vice Chair Boyd seconded approval of Agreement PIR-10-022. The vote was unanimous. (5-0)

12. TRUSTEES OF THE CALIFORNIA STATE UNIVERSITY. Possible approval of eight grant applications, totaling $617,245, from the Public Interest Energy Research (PIER) program's Energy Innovations Small Grant's Solicitation 09-01. (PIER electricity funding.) Contact: Matt Coldwell. (10 minutes)

Vice Chair Boyd moved and Commissioner Byron seconded approval of the eight grant applications. The vote was unanimous. (5-0)

   a. 09-01-27, Robert A. Hogue, Menlo Park, CA, Low Cost Energy Storage for Solar Thermal Power Plants, $42,245. This project will model the feasibility of using the ground underneath solar collectors as an energy storage medium, which would replace conventionally used thermal storage.

b. 09-01-51, University of California, Davis, Light-assisted Biomass Fuel Cell, $95,000. This project will test the feasibility of a light-assisted biofuel cell that converts chemical energy stored in biomass from municipal waste water into usable electricity.

c. 09-01-30, Lightwave Photonics, Inc., Encinitas, CA, Growth of Cavity Light Emitting Diode on a Reflective Substrate, $95,000. This project will test the feasibility of removing a conventional secondary processing step in LED manufacturing, by bonding a highly reflective surface into the LED to increase light extraction and electrical efficiency, while reducing manufacturing costs.

d. 09-01-19, Semprius, Inc., Durham, NC, Concentrated Photovoltaic Module with Low-Cost Thermal Management, $95,000. This project will to test the feasibility of eliminating the need for conventional thermal management in concentrated photovoltaic applications by using the solar interconnects between cells for heat-transfer.

e. 09-01-73, Wind Harvest International, Davis, CA, Modeling of Straight Bladed Vertical-Axis Wind Turbines, $50,000. This project's objective is to improve the design of the company's currently marketed vertical-axis wind turbine by modeling the performance of tightly spaced turbines and establishing the proper blade angles and connecting structures.

f. 09-01-28, San Jose State University, San Jose, CA, Modeling of Wind Power Generation on High-Rise Buildings, $50,000. This project's objective is to model and test the feasibility of developing a system of wind deflectors and wind fences to control the turbulent air flow on top of urban high-rise buildings and evaluate the use of wind deflectors and wind fences for the reduction of turbine noise and improving public safety.

g. 09-01-66, Thermofluidics, United Kingdom, Solar Heat Engine Driven Hydraulic Ram for Low-Cost Irrigation, $95,000. This project will test the feasibility of a pollution free and sustainable method for pumping irrigation water without electricity by developing a solar heat engine-driven hydraulic ram.

h. 09-01-49, Paula Moon & Associates, Naperville, IL, Co-Production of Electrical Power and Lithium from Geothermal Fluids, $95,000. This project will test the feasibility of a process to extract lithium from geothermal fluids. If successful, this project could help geothermal energy become more cost-competitive with other energy sources, and lower the cost of lithium for battery applications.

13. CALIFORNIA CERTIFIED ENERGY RATING AND TESTING SERVICES (CalCERTS). Possible approval of CalCERTS as a Home Energy Rating System (HERS) provider for HERS Raters conducting California Whole-House Home Energy Ratings and California Home Energy Audits, and CalRatePro as HERS Rating Software. Contact: Jim Holland. (5 minutes)

Commissioner Weisenmiller moved ad Commissioner Byron seconded approval of CalCERTS as a HERS provider. The vote was unanimous. (5-0)

14. **Minutes:** July 14, 2010, Business Meeting Minutes.

Commissioner Byron moved approval of the July 14 Minutes with one correction: the vote on Item 2, should read '(4-0)' rather than '(5-0)'. Commissioner Weisenmiller seconded. The vote was 4-0-1. Vice Chair Boyd abstained.

15. **Commission Committee Presentations and Discussion:**

Vice Chair Boyd reported on the recent Plug-In 2010 Conference.

16. **Chief Counsel's Report:** None.

17. **Executive Director's Report:** None.

18. **Public Adviser's Report:** None.

19. **Public Comment:** None.

20. **Internal Organization and Policy.** No discussion.

Appearances.
Ms. Charmaine Yu, Coblentz, Patch, Duffy & Bass for TurboAir
Mr. Nick Gillespie, Whirlpool (by telephone)
Mr. Peter Ucovich, Sacramento County, California First
Mr. Manuel Alvarez, Southern California Edison
Mr. John Haig, Sonoma County
Ms. Liz Yager, Sonoma County
Mr. Nehemiah Stone, Benningfield Group
Mr. Tim Tutt, Sacramento Municipal Utilities District
Mr. Ian McGowen, 3 Degrees (by telephone)
Ms. Jennifer Martin, Center for Resource Solutions (by telephone)
Ms. Laura Genao, Southern California Edison
Mr. Michael Bachand, CalCERTS, Inc.

There being no further business, the meeting was adjourned at 1:55 p.m.

Respectfully submitted,

HARRIET KALLEMEYN
Secretary to the Commission

Attachment 7

Energy Efficient Mortgage Program:

7a. Overview of Energy Efficient Mortgage Program

7b. Energy Efficient Mortgage Home Owner Guide

7c. U.S. Department of Housing and Urban Development, *HUD's Energy Action Plan and Energy Efficient Mortgages,* Mortgagee Letter 2005-21 (May 6, 2005)

Energy Efficient Mortgage Program

FHA's Energy Efficient Mortgage program (EEM) helps homebuyers or homeowners save money on utility bills by enabling them to finance the cost of adding energy efficiency features to new or existing housing as part of their FHA insured home purchase or refinancing mortgage.

Purpose

In 1992, Congress mandated a pilot demonstration of Energy Efficient Mortgages (EEMs) in five states. In 1995, the pilot was expanded as a national program.

EEMs recognize that reduced utility expenses can permit a homeowner to pay a higher mortgage to cover the cost of the energy improvements on top of the approved mortgage. FHA EEMs provide mortgage insurance for a person to purchase or refinance a principal residence and incorporate the cost of energy efficient improvements into the mortgage. The borrower does not have to qualify for the additional money and does not make a downpayment on it. The mortgage loan is funded by a lending institution, such as a mortgage company, bank, or savings and loan association, and the mortgage is insured by HUD. FHA insures loans. FHA does not provide loans.

Type of Mortgage:

EEM is one of many FHA programs that insure mortgage loans--and thus encourage lenders to make mortgage credit available to borrowers who would not otherwise qualify for conventional loans on affordable terms (such as first time homebuyers) and to residents of disadvantaged neighborhoods (where mortgages may be hard to get). Borrowers who obtain FHA's popular Section 203(b) Mortgage Insurance for one to four family homes are eligible for approximately 96.5 percent financing, and are able to add the upfront mortgage insurance premium to the mortgage. The borrower must also pay an annual premium.

EEM can also be used with the FHA Section **203(k) rehabilitation** program and generally follows that program's financing guidelines. For energy efficient housing rehabilitation activities that do not also require buying or refinancing the property, borrowers may also consider HUD's **Title I Home Improvement Loan** program.

How to Get a EEM:

To apply for an FHA insured energy efficient mortgage, contact an **FHA approved lender**.

Eligible Customers:

All persons who meet the income requirements for FHA's standard Section 203(b) insurance and can make the monthly mortgage payments are eligible to apply. The cost of the energy improvements and estimate of the energy savings must be determined by a home energy rating system (HERS) or an energy consultant. The cost of an energy inspection report and related fees may be included in the mortgage. Cooperative units are not eligible.

EEM can also be used with FHA's Section 203(h) program for mortgages made to victims of presidentially declared disasters. The mortgage must comply with both Section 203(h) requirements, as well as those for EEM. However, the program is limited to one unit detached houses.

Eligible Activities:

EEM can be used to make energy efficient improvements in one to four existing and new homes. The improvements can be included in a borrower's mortgage only if their total cost is less than the total dollar value of the energy that will be saved during their useful life. Other eligibility requirements may be found in the **Homeowner's Guide**.

Eligibility Requirements

- The borrower is eligible for a maximum FHA insured loan, using standard underwriting procedures. The borrower must make a 3.5 percent downpayment. This 3.5 percent downpayment is based on the sales price or appraised value. Any upfront mortgage insurance premium can be financed as part of the mortgage.
- Eligible properties are one to four unit existing and new construction. EEMs may be added to some other loan types, including streamline refinances.
- The cost of the energy efficient improvements that may be eligible for financing into the mortgage is the lesser of A or B as follows:

  A. The dollar amount of cost-effective energy improvements, plus cost of report and inspections, or

  B. The lesser of 5% of:

  - The value of the property, or
  - 115% of the **median area price** of a single family dwelling, or
  - 150% of the conforming Freddie Mac limit.
- To be eligible for inclusion in the mortgage, the energy efficient improvements must be cost effective, meaning that the total cost of the improvements is less than the total present value of the energy saved over the useful life of the energy improvement.
- The cost of the energy improvements and estimate of the energy savings must be determined by a home energy rating report that is prepared by an energy consultant using a Home Energy Rating System (HERS). The cost of the energy rating report and inspections may be financed as part of the cost effective energy package.
- The energy improvements are installed after the loan closes. The lender will place the money in an escrow account. The money will be released to the borrower after an inspection verifies that the improvements are installed and the energy savings will be achieved.
- The maximum mortgage limit for a single family unit depends on its location, and it is adjusted annually. Look online to find FHA's **maximum mortgage limits** by county.

Technical Guidance:

EEM is authorized under Section 513 of the Housing and Community Development Act of 1992. Program regulations are listed on the **EEM mortgagee letter** web page.

For More Information:

Visit the **FHA Resource Center** to search the FAQs, ask a question or send an email.

Return to EEM Home

HUD > Program Offices > Housing > Single Family > Energy Efficient > Energy Efficient Mortgage Homeowner Guide

Energy Efficient Mortgage Home Owner Guide

THE ENERGY EFFICIENT MORTGAGE means comfort and savings. When you are buying, selling, refinancing, or remodeling your home, you can increase your comfort and actually save money by using the **Energy Efficient Mortgage (EEM)**. It is easy to use, federally recognized, and can be applied to most home mortgages. EEMs provide the borrower with special benefits when purchasing a home that is energy efficient, or can be made efficient through the installation of energy-saving improvements.

Homeowners with lower utility bills have more money in their pocket each month. They can afford to allocate a larger portion of their income to housing expenses. If you have more cash, why not buy a better, more comfortable home? There are two options with the Energy Efficient Mortgage.

The TWO SIDES of the EEM COIN

Finance Energy Improvements!

- Cost-effective energy-saving measures may be financed as part of the mortgage!
- Make an older, less efficient home more comfortable and affordable!

Increase Your Buying Power!

- Stretch debt-to-income qualifying ratios on loans for energy-efficient homes!
- Qualify for a larger loan amount! Buy a better, more energy efficient home!

WHO BENEFITS from the ENERGY EFFICIENT MORTGAGE?

Buyers:

- Qualify for a larger loan on a better home!
- Get a more comfortable home NOW.
- Save money every month from Day One.
- Increase the potential resale value of your home.

Sellers:

- Sell your home more quickly.
- Make your house affordable to more people.
- Attract attention in a competitive market.

Remodelers/Refinancers:

- Get all the EEM benefits without moving.
- Make improvements which will actually save you money.
- Increase the potential resale value of your home.

Pay for energy improvements easily, through your mortgage. Your lender can increase your loan to cover energy improvement costs. Monthly mortgage payments increase slightly, but you actually save money because your energy bills will be lower!

HERS, or Home Energy Rating Systems

A **HERS report** is similar to a miles-per-gallon rating on a car. HERS are programs which provide evaluations of an individual home's energy-efficiency. A HERS report is prepared by a trained Energy Rater. Factors such as insulation, appliance efficiencies, window types, local climate, and utility rates are used to rate the home and calculate energy costs.

A HERS Report Includes:

- Overall Rating Index of the house as it is.
- Recommended cost-effective energy upgrades.
- Estimates of the cost, annual savings, and useful life of upgrades.
- Improved Rating Index after the installation of recommended upgrades.
- Estimated annual total energy cost for the existing home before and after upgrades.

A Rating Index is between 1 and 100. A lower index indicates greater efficiency. Cost-effective upgrades are those which will save more money through energy savings than they cost to install.

A HERS rating usually costs between $300 and $800. This could be paid for by the buyer, seller, lender, or real estate agent. Sometimes the cost of the rating may be financed as part of the mortgage. No matter how the rating is paid for, it is a very good investment because an EEM could save you or your buyer hundreds of dollars each year.

THIS IS WHY the EEM WORKS

Energy-efficient homes cost less to own than non-efficient homes, though they may start off with higher price tags.

	Older existing home	Same Home with energy improvements
Home price (90% mortgage, 8% interest)	$ 150,000	$ 154,816
Loan amount	$ 135,000	$ 139,334
Monthly payment*	$ 991	$ 1,023
Energy bills	+ $ 186	+ $ 93
The true monthly cost of home ownership	$ 1,177	$ 1,116
Monthly savings		- $ 61

Estimated mortgage payments are based upon principle and interest only, and do not include taxes and insurance. Value indicated here is for comparison only, and will vary from home to home.

Many homes qualify for energy upgrades. This home qualified for $4,816 in upgrades. With the EEM, lenders recognize the savings the upgrades will bring. Borrowers may use these potential savings like extra cash, and add the cost of upgrades into the mortgage, paying them off easily as part of the monthly mortgage payment. Once the upgrades are installed the potential savings turn into real savings.

Another EEM option is for the lender to allow higher qualifying ratios for borrowers who will occupy a property meeting certain standards for energy efficiency. When the home has been built or retrofitted in conformance with the International Energy Conservation Code (IECC) standards for 2000 or later, then the lender may "stretch" the borrower's qualifying ratios. A debt-to-income ratio "stretch" means that a larger percentage of the borrower's monthly income can be applied to the monthly mortgage payment. That means the buyer has more borrowing power based up on the same income.

WHAT the EEM DOES for a BUYER'S BORROWING POWER

For a standard home without energy improvements:

Buyer's total monthly income	$5,000
Maximum allowable monthly payment 29% debt-to-income ratio	$1,450
Maximum mortgage at 90% of appraised home value	$207,300

For an energy-efficient homes (2000 IECC)*:

Buyer's total monthly income	$5,000
Maximum allowable monthly payment 33% debt-to-income ratio	$1,650
Maximum mortgage at 90% of appraised home value	$235,900

Added borrowing power due to the Energy Efficient Mortgage: **$28,600**

**Interest rate 7.5%, downpayment of 10%, 30-year term, principal & interest only (tax & insurance not factored.)*

In other words:

This buyer got into a home worth thousands of dollars more, just because it was energy efficient. That could mean a home with more space, in a better location, or in better overall condition.

FHA's Energy Efficient Mortgage Program

The FHA Energy Efficient Mortgage covers upgrades for new and existing homes and is now available in all 50 states. Key features includes:

- Loan limits may be exceeded
- No re-qualifying
- No additional down payment

- No new appraisal

The FHA 203(k) loan enables a home buyer to obtain a single loan to finance both property acquisition and to complete major improvements after loan closing and can be combined with FHA's EEM.

CASE STUDY:

Customer Quote: "*The EEM was the second best thing that ever happened to me. The first best was actually being able to buy a home. This is our first home, and the EEM saved us a lot of headaches because we knew what we needed to do to the house. It's nice and comfortable now. Even my dogs are happy. I am very impressed.*" *-Pat Theard*

First-time home buyers Patricia and Mynette Theard purchased their home in California. It was built in 1940, and sold for $150,000. They got an FHA loan for 95% of the value of the property. The lender saw an opportunity for them to improve on their investment and recommended an Energy Efficient Mortgage.

A HERS Rating on the home recommended $2,300 in energy improvements including ceiling, floor and furnace duct insulation, plus a setback thermostat. The lender set aside an extra $2,300 for the improvements, bringing the total loan amount from $142,500 to $144,800. The loan closed, the Theards moved in, and the improvements were installed. The monthly mortgage payment increased by $17, but the Theards are saving $45 each month through lower utility bills.

Ask your lender about an Energy Efficient Mortgage. If they are not knowledgeable about the EEM, encourage them to learn about it, or find another lender.

WHICH BUYERS and HOMES ARE ELIGIBLE?

All buyers who qualify for a home loan qualify for the EEM. The EEM is intended to give the buyer additional benefits on top of their usual mortgage deal. The lender will use the energy efficiency of the house, as determined by a HERS rating, to determine what these benefits will be.

Energy Efficient Mortgages can be used on most homes. Availability is not limited by location, home price or utility company. Your lender will help you choose which loan type is best for you.

Get an EEM on:

- Older homes qualifying for upgrades
- New or old homes not requiring upgrades
- New construction

SOME THINGS to KEEP in MIND

It is best to have the HERS Rating done as early in the loan process as possible. This way, the Rating can be performed while other aspects of the loan are being processed. Closing the loan should not be delayed. You may get a larger tax deduction with the EEM because the interest on mortgage payments is tax deductible. This can save you more money than paying for energy upgrades with a credit card, bank loan, or cash, none of which are usually tax deductible.

Each house is as unique as its owner. Benefits derived from the EEM will vary from one house to another, and the benefits in the examples in this book may not apply in all cases. Your lender will be your best source of information on your own EEM benefits.

CASE STUDY:

Adding Energy Improvements through a Home Refinance

"*It's wonderful. We're just amazed at the difference. We've hardly used the furnace all winter. The house is much quieter too. It makes sense for everyone to do it." -Caroline Chang*

In the fall of 1995, Caroline and Tommy Chang decided to refinance their 35-year-old home to take advantage of lower interest rates. Their lender suggested they get a HERS Rating on the home so they could finance energy improvements through their new mortgage deal as well.

The lender increased the loan by $8,760 to cover the cost of energy improvements. Their final loan amount was $176,400, which is higher than they could have gotten with out the EEM. The loan closed and the improvements were installed. These included double-paned windows, wall insulation, ceiling insulation, furnace duct repairs and insulation, and a few smaller items. These improvements, combined with their lower mortgage interest rate, mean the Changs will be saving about $230 per month. They will be more comfortable too!

A house could be your biggest investment ever. Use the Energy Efficient Mortgage and invest wisely.

To find out how, call the organizations listed on the back cover.

Disclaimer Statement

Pacific Gas and Electric Company and the Department of Energy do not endorse nor imply endorsement of any product, service, individual or company mentioned and/or involved in this publication. Anyone undertaking to rely on particular details contained herein shall do so at his/her own risk and should independently use and/or verify their applicability to a given situation.

Publication developed by:

Pacific Gas and Electric Company
Consumer Energy Management
123 Mission Street
San Francisco, CA 94111
Phone: 800) 933-9555

Pacific Gas and Electric

Produced cooperatively by:
U.S. Department of Energy
Office of Building Technology
State and Community Programs
1000 Independence Avenue SW
Washington, DC 20585
Phone: (800) 363-3732

Department of Energy

Alliance to Save Energy

1200 18th Street, NW Suite 900
Washington, DC 20036
Phone: (202) 857-0666

Federal Citizen Information Center

Pueblo, CO 81009
Phone: (719) 948-4000 (for catalogs only)

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
WASHINGTON, DC 20410-8000

ASSISTANT SECRETARY FOR HOUSING-
FEDERAL HOUSING COMMISSIONER

May 6, 2005

MORTGAGEE LETTER 2005-21

TO: **ALL APPROVED MORTGAGEES**

SUBJECT: **HUD's Energy Action Plan and Energy Efficient Mortgages**

The Department of Housing and Urban Development's Energy Action Plan calls for the promotion of the FHA's Energy Efficient Mortgage (EEM) as a priority single family insured loan product. The EEM program recognizes that the improved energy efficiency of a house can increase its affordability by reducing the operating costs. Cost-effective energy improvements result in lower utility bills, conserve energy and, thus, make more income available for the mortgage payment. This Mortgagee Letter consolidates and clarifies existing policies on the EEM program and describes enhancements to the EEM product that have been made to make it more widely available. In addition, this Mortgagee Letter announces that to obtain "stretch ratios" for qualifying borrowers, the property must meet the 2000 International Energy Conservation Code (IECC).

The EEM program allows a borrower to finance 100 percent of the expense of a cost-effective "energy package," i.e., the property improvements to make the house more energy efficient. A cost-effective energy package is one where the cost of the improvements, including maintenance, is less than the present value of the energy saved over the useful life of those improvements. The borrower does not need to qualify for the additional financing or provide additional downpayment. There is also no need for a second appraisal that reflects the expense of the energy package and the improvements may be applied to retrofit an existing house or improve the energy efficiency of proposed construction. The present value test is a statutory requirement and, thus, actual energy savings cannot be used to determine cost effectiveness in lieu of the present value calculation of the energy savings.

The EEM may be used with Sections 203(b), 203(k)(rehabilitation mortgages), 234(c)(units in condominium projects), and 203(h)(mortgages for disaster victims) loans for both purchases and refinances, including streamline refinances. Both new and existing 1-4 family unit properties are eligible, including 1-unit condominiums and manufactured housing. The allowable EEM dollar amount is for the entire property and not based on a per unit basis for multiple unit properties.

How is the energy package designed?

The energy package is the set of improvements agreed to by the borrower based on recommendations and analysis performed by a qualified home energy rater using a tool known as a Home Energy Rating System (HERS). The HERS must both meet the minimum requirements of the Department of Energy (DOE) approved ratings guidelines and must have achieved passing results from DOE's Building Energy Simulation Test (BESTTEST) or subsequent testing requirements.

The home energy rater must be trained to perform the physical inspection and/or diagnostic test that provide the data on the home used to develop the energy package. The home energy rater using the HERS prepares a written home energy rating report. The report, which must be provided to the homebuyer/homeowner as well as the mortgage lender, is based on the information developed from a physical inspection of the existing property to be retrofit, or from the plans and specifications of the house to be built. It provides estimates of both the costs of the improvements and the expected energy savings.

For new construction, the energy package includes those cost-effective energy improvements over and above the requirements of the 2000 International Energy Conservation Code, formerly known as the Model Energy Code. More information on this energy code can be obtained from the Department of Energy's website at http://www.energycodes.gov. The details of the energy package and supporting information are presented in a HERS Rating Report.

How is the EEM underwritten?

The mortgage is initially underwritten as if the energy package did not exist, i.e., by using standard FHA underwriting standards, qualifying income ratios, and maximum mortgage/minimum cash investment requirements without regard to the energy package. For an EEM on new construction, as well as those homes that were built to the 2000 IECC or are being retrofitted to that standard, the borrower, in addition to the cost of the improvements, can get "stretch ratios" of 33% and 45%. Also, for new construction, when qualifying the borrower, the cost of the energy package should be subtracted from the sales price (since the builder has included those improvements in the sales price) and the qualifying ratios calculated on this lower amount.

Once it is determined that both the borrower and the property qualify for a mortgage to be insured by FHA, the mortgage lender, using the energy rating report and an EEM worksheet[1] will determine the dollar amount of the cost-effective energy package that may be added to the loan amount. This dollar amount cannot exceed 5 percent of the property's value (not to exceed $8,000) or $4,000, which ever is greater. Regardless of the property's value, every borrower who otherwise qualifies can finance at least $4,000 of the costs of the Energy Package if the cost exceeds $4,000. The calculated amount will be added to the approved base loan amount to total the final FHA insured loan amount before adding any upfront mortgage insurance premium. The FHA maximum loan limit for the area may be exceeded by the cost of the energy efficient improvements.

For a streamline refinance, the borrower's principal and interest (P&I) payment on the new loan including the energy package may be greater than the principal and interest (P&I) payment on the current loan, provided the estimated monthly energy savings as shown on the HERS report

[1] See Attachment A for suggested format

exceeds the increase in the P&I.

FHA's TOTAL mortgage scorecard may also be used for underwriting EEMs. If the lender obtains an "accept" or "approve" on a mortgage loan application, FHA will recognize the risk rating from TOTAL and permit the increase to the mortgage payment without re-underwriting or rescoring provided that the lender' s Direct Endorsement (DE) underwriter attests that he or she has reviewed the calculations associated with the energy efficient improvements, and found the mortgage and the property to be in compliance with FHA's underwriting instructions.

The appraisal does not need to reflect the value of the energy package that will be added to the property for either new or existing construction. On a streamline refinance made without an appraisal, the original principal balance substitutes for an appraised value. On a Section 203(k), the after-improved value is to be used for the EEM process.

For existing properties, energy-related weatherization items (see handbook HUD 4155.1, Rev 5,1-7(C)(2) for maximum additions to the mortgage amount) may be combined with the Energy Efficient Mortgage, where the maximum dollar amount allowed under an EEM does not cover the cost of the entire energy package. The weatherization amount would be the cost of the improvements not covered by the EEM amount. With a 203(k), the excess improvements would be included in the rehabilitation work.

When is the EEM mortgage eligible for endorsement?

On *existing* properties, the FHA EEM is insurable immediately after closing. The installation of the energy package does not need to be completed before FHA insures the mortgage. However, for *new construction* the energy package must be completed before the mortgage is eligible for insurance (or after construction is complete when using FHA's Construction-Permanent mortgage).

What are FHA's requirements for escrow accounts under the EEM Program?

For *existing properties*, the lender at closing is to establish an escrow account for the energy improvements. Any funds remaining in the escrow account at the end of the construction period must be applied to pay down the loan principal. For *new construction*, there will not be an escrow account as the energy package is to be installed as part of the total construction, which must be completed prior to loan closing.

If the energy package is part of a Section 203(k) rehabilitation loan, then the escrowed amounts of the energy package must be included in the Rehabilitation Escrow Account.

In all cases, the lender is to execute form HUD 92300, Mortgagee Assurance of Completion, to indicate that the escrow for the energy efficient improvements has been established.

What are the requirements for installing the energy package?

On *existing construction*, the energy package is to be installed within 90 days of the loan closing. If the work is not completed within 90 days (180 days is allowed for Section 203(k) rehabilitation mortgages), the lender must apply the EEM funds to a prepayment of the mortgage principal. The borrower cannot be paid for labor (sweat equity) on work that they perform, and the borrower cannot receive cash back from the mortgage transaction. On *new construction*, the installation of the energy package is included in the total construction of the house, and therefore is to be complete at loan settlement.

If the work that is done differs from the approved energy package, a change order along with a revised HERS Report must be submitted to the DE Underwriter for approval. If the changes still meet the cost-effectiveness test, no further analysis is required. If not, the funds for the work not included in the approval energy package must be used to pay down the loan principal.

What are the requirements for assuring completion of the energy package as proposed?

The lender is responsible for notifying FHA through the FHA Connection or equivalent that the improvements have been made and that the escrow has been cleared. The lender, the rater, or an FHA fee inspector may inspect the installation of the improvements. The borrower may be charged an inspection fee in accordance with the appropriate Homeownership Center (HOC) fee schedule.

What is included in the Report on the energy package?

The energy package report must provide the following information:

1. Address of the Property
2. Name of client
3. FHA Case number (if applicable)
4. Name of Lender (if applicable)
5. Type of Property
6. Whether the property is new construction or existing
7. Date of the physical inspection of the existing property or, for new construction, the date of the plan review.
8. Description of the current energy features of the property or proposed features if new construction. This must include, at a minimum, a description of the insulation R values in ceilings, walls, and floors; infiltration levels and barriers (caulking, weather-stripping, and sealing); a description of the windows (storm windows, double pane, triple pane, etc.) and doors; and a description of the heating (including water heating) and cooling systems.
9. Description of the energy package - For existing properties, those cost-effective improvements recommended to improve the energy efficiency of the property. For new construction, those cost-effective improvements to be included in the home that are over and above the requirements of 2000 IECC.
10. Estimated cost of the energy package, the useful life, and the costs of any maintenance over the useful life of the improvements.
11. The estimated present annual utility cost before the installation of the energy package (for existing property). For new construction, the estimated annual utility costs of a reference house built to 2000 IECC .

12. Estimated expected annual utility costs after the installation of the energy package.
13. Estimated annual savings in utility costs after the installation of the energy package, including the present value of the savings.
14. Names and signatures of the person(s) who inspected the property and of the person(s) who prepared the report, and the date the report was prepared.
15. The following Certification, signed by the person(s) who inspected the property and the person(s) who prepared the report:

    "I certify to the best of my knowledge and belief, the information contained in this report is true and accurate and I understand that the information in this report may be used in connection with an application for an Energy Efficient Mortgage to be insured by the Federal Housing Administration of the U.S. Department of Housing and Urban Development."

Are there additional fees associated with the EEM program?

FHA does not set the fees for the Home Energy Rating, including the physical inspection, the HERS Report, and any post-installation tests. The fees charged to the borrower for the Home Energy Rating must be customary and reasonable for the area. These fees may be included and financed as part of the energy package if the entire package, including those fees, is cost-effective. If not, such fees are considered allowable closing costs. With a Section 203(k), the rating fee and inspections would be in addition to the consultant's fee.

How will FHA know that this is an EEM?

There are two EEM designations in the FHA Connection and each is described below. Also, a copy of the HERS report is to be included in the case binder submitted for endorsement and placed behind the mortgage credit analysis worksheet (MCAW). In the Remarks section of the MCAW, the lender is to indicate that the loan is for an EEM, show the cost of the energy package and the final loan calculations.

The categories of EEMs available in the FHA Connection are:

- <u>New Construction/HERS Improvements</u>: For homebuyers purchasing a home to be built and financing the cost of eligible energy efficient improvements into the mortgage. The borrower is also eligible for stretch ratios when manually underwriting the loan application if the property is built according to the 2000 IECC.

- <u>Existing Construction/HERS Improvements</u>: For homebuyers and those refinancing their mortgages and financing the eligible energy efficient improvement into the mortgage. The borrower is also eligible for stretch ratios when manually underwriting the loan application if the property was built to or is now being retrofitted to the 2000 IECC.

HUD has requested public comment on the information collection requirements contained in this mortgagee letter and upon expiration of the comment period will submit the requirements to the Office of Management and Budget (OMB) for approval under the Paperwork Reduction Act of 1995 (44 U.S.C. 3501-3520). When assigned, the OMB control number will be announced by HUD. In accordance with the Paperwork Reduction Act, HUD may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the collection displays a currently valid OMB control number.

If you have any questions regarding this Mortgagee Letter, please contact your Homeownership Center (HOC) in Atlanta (888-696-4687), Denver (800-543-9378), Philadelphia (800-440-8647), or Santa Ana (888-827-5605).

Sincerely,

Assistant Secretary for Housing-
Federal Housing Commissioner

Energy Efficient Mortgage Worksheet

Borrower's Name:___________________________________ FHA Case #: ______________________
Property Address: ___________________________________
____

A. Qualifying Mortgage Amount	1. Mortgage (w/o MIP) (line 11d of the MCAW-PUR or line 10g from MCAW WS)	A. $_______________________
B. EEM Amount	*The Home Energy Rating Report will provide the information on the Recommended Energy Package, its cost, and the present value of the energy saved.* The cost of the Energy Package (not to exceed $8,000) can be added to A if the cost is less than the Present Value of the energy saved:	
	Compare Cost and PV of energy savings: 1.Cost of Energy package $____ 2. PV of Energy Saved $ _____ 3. Is PV more than Cost? Y / N If Yes, Continue:	
	1. If Cost is less than $4,000, enter the Cost in B. *(or)*	B. $ _______________________
	2. If the Cost is more than $4,000, but 5% of the value is less than $4,000, enter $4,000 in B. *(or)*	
	3. If the Cost is less than 5% of the value, but 5% of value is more than $4,000 enter the lesser of the cost or $8,000 *(or)*	
	4. If the Cost is greater than 5% of value, enter the lesser of 5% of value or $8,000 in B	
C. Final EEM Mortgage Amount (w/o MIP)	**Add A and B**	**C. $ _____________________**

REMARKS:
____
____
____
____

Attachment 8

PowerSaver Program:

8a. Federal Housing Administration (FHA): Notice of FHA PowerSaver Home Energy Retrofit Loan Pilot Program (76 Fed. Reg. 17936)

8b. FHA PowerSaver, Frequently Asked Questions (FAQs) for Consumers

8c. FHA PowerSaver, Frequently Asked Questions (FAQs) for Lenders

Dated: March 22, 2011.

David Epperson,

Chief Information Officer, National Protection and Programs Directorate, Department of Homeland Security.

[FR Doc. 2011–7595 Filed 3–30–11; 8:45 am]

BILLING CODE P

DEPARTMENT OF HOMELAND SECURITY

United States Immigration and Customs Enforcement

Agency Information Collection Activities: Revision of an Existing Information Collection; Comment Request

ACTION: 60-Day Notice of Information Collection for Review; Secure Communities IDENT/IAFIS Interoperability State and Local Agency Assessment; OMB Control No. 1653–0040.

The Department of Homeland Security, U.S. Immigration and Customs Enforcement (ICE), will be submitting the following information collection request for review and clearance in accordance with the Paperwork Reduction Act of 1995. The information collection is published to obtain comments from the public and affected agencies. Comments are encouraged and will be accepted for sixty days until May 31, 2011.

Written comments and suggestions regarding items contained in this notice, and especially with regard to the estimated public burden and associated response time should be directed to the Office of the Chief Financial Officer/OAA/Records Branch, U.S. Immigration and Customs Enforcement, 500 12th Street, SW., STOP 5705 Washington, DC 20536–5705.

Comments are encouraged and will be accepted for sixty days until May 31, 2011. Written comments and suggestions from the public and affected agencies concerning the proposed collection of information should address one or more of the following four points:

(1) Evaluate whether the proposed collection of information is necessary for the proper performance of the functions of the agency, including whether the information will have practical utility;

(2) Evaluate the accuracy of the agencies estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used;

(3) Enhance the quality, utility, and clarity of the information to be collected; and

(4) Minimize the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology, e.g., permitting electronic submission of responses.

Overview of this information collection:

(1) *Type of Information Collection:* Revision of a currently approved information collection.

(2) *Title of the Form/Collection:* Secure Communities IDENT/IAFIS Interoperability State and Local Agency Assessment.

(3) *Agency form number, if any, and the applicable component of the Department of Homeland Security sponsoring the collection:* Form 70–003, Form 70–004, Form 75–001 and Form 75–002; U.S. Immigration and Customs Enforcement.

(4) *Affected public who will be asked or required to respond, as well as a brief abstract:* Primary: State and Local Correctional Facilities and Officials. 8 U.S.C. 1231(a) gives the Department of Homeland Security (DHS), U.S. Immigration and Customs Enforcement (ICE) authority to remove criminal aliens who have been ordered as such. DHS/ICE is improving community safety by transforming the way the Federal government cooperates with state and local law enforcement agencies to identify, detain, and remove all criminal aliens held in custody. Secure Communities revolutionizes immigration enforcement by using technology to share information between law enforcement agencies and applying risk-based methodologies to focus resources on assisting all local communities remove high-risk criminal aliens. In order for the Secure Communities Initiatives to meet its goals, ICE must collect detailed business requirements and input from its state and local law enforcement partners. This assessment determines the fingerprint procedures and technological capabilities of state and local jails governance, as well as basic jail booking statistics. This information is used in order to prioritize local sites and deliver the implementation strategy of the Secure Communities Initiative.

(5) *An estimate of the total number of respondents and the amount of time estimated for an average respondent to respond:*

No. of respondents	Form name/Form No.	Average burden per response (in hours)
3,500	Secure Communities Initiative Survey—State/Form 70–003	0.3333
3,500	Secure Communities Initiative Survey—Local/Form 70–004	0.3333
300	Secure Communities Initiative Survey—DOC Facilities 75–001	0.3333
56	Secure Communities Initiative Survey—DOC Officials/Form 75–002	0.3333

(6) *An estimate of the total public burden (in hours) associated with the collection:* 2,453 annual burden hours.

Comments and/or questions; requests for a copy of the proposed information collection instrument, with instructions; or inquiries for additional information should be directed to: Office of the Chief Financial Officer/OAA/Records Branch, U.S. Immigration and Customs Enforcement, 500 12th Street, SW., STOP 5705 Washington, DC 20536–5705.

Dated: March 25, 2011.

John Ramsay,

Forms Program Manager, Office of Asset Administration, U.S. Immigration and Customs Enforcement, Department of Homeland Security.

[FR Doc. 2011–7550 Filed 3–30–11; 8:45 am]

BILLING CODE 9111–28–P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

[Docket No. FR–5450–N–03]

RIN 2502–ZA09

Federal Housing Administration (FHA): Notice of FHA PowerSaver Home Energy Retrofit Loan Pilot Program

AGENCY: Office of the Assistant Secretary for Housing-Federal Housing Commissioner, HUD.

ACTION: Notice.

SUMMARY: This notice announces HUD's FHA Home Energy Retrofit Loan Pilot Program (Retrofit Pilot Program or Pilot Program) known as FHA PowerSaver. The Consolidated Appropriations Act, 2010 directs HUD to conduct an Energy Efficient Mortgage Innovation pilot program targeted to the single family housing market. The Retrofit Pilot Program meets this statutory directive and provides funding to support that effort. The announcement of this pilot program follows a November 10, 2010, **Federal Register** notice in which HUD submitted for public comment its proposal to conduct the Retrofit Pilot Program. This announcement of the final structure of the Pilot Program takes into consideration the public comments received in response to the November 10, 2010, notice.

DATES: *Effective Date:* May 2, 2011May 2, 2011

FOR FURTHER INFORMATION CONTACT: Patricia McBarron, Office of Single Family Housing Development, Office of Housing, Department of Housing and Urban Development, 451 7th Street, SW., Washington, DC 20410–8000; telephone number 202–708–2121 (this is not a toll-free number). Persons with hearing or speech impairments may access this number through TTY by calling the toll-free Federal Information Relay Service at 800–877–8339.

SUPPLEMENTARY INFORMATION:

I. Background

On November 10, 2010 (75 FR 69112), HUD published in the **Federal Register** a notice that announced its proposal to conduct the Retrofit Pilot Program. The Consolidated Appropriations Act, 2010 (Pub. L. 111–117, approved December 16, 2009, 123 Stat. 3034) (2010 Appropriations Act), which appropriated Fiscal Year (FY) 2010 funds for HUD, among other agencies, appropriated $50 million for an Energy Innovation Fund to enable HUD to catalyze innovations in the residential energy efficiency sector that have the promise of replicability and help create a standardized home energy efficient retrofit market. Of the $50 million appropriated for the Energy Innovation Fund, the 2010 Appropriations Act stated that "$25,000,000 shall be for the Energy Efficient Mortgage Innovation pilot program directed at the single family housing market." (*See* Pub. L. 111–117, at 123 Stat. 3089.)

As discussed in detail in the November 10, 2010, notice, in considering how to structure the pilot program directed by the 2010 Appropriations Act, HUD looked to the findings of the Administration's Recovery Through Retrofit Report,[1] which specifically addressed retrofitting homes for energy efficiency, and the suitability of building the pilot program by supplementing FHA's Title I Property Improvement Loan Insurance program (Title I program). HUD determined that both the Administration's Recovery through Retrofit Report and FHA's Title I program provided the appropriate foundation for structuring the Retrofit Pilot Program. (See 75 FR 69113–69114.) With respect to the Title I program, HUD determined that utilizing the existing FHA Title I program, with additional grant funds and new requirements, is the most efficient and effective opportunity it could deploy to deliver federally insured financing to homeowners in markets that are ready and able to utilize it.

FHA's Title I program is authorized by section 2 of Title I of the National Housing Act (12 U.S.C. 1703), and its regulations are codified in 24 CFR part 201.

II. The November 10, 2010, Proposal

As provided in the November 10, 2010, notice, FHA's goals for the Retrofit Pilot Program are: (1) To facilitate the testing and scaling of a mainstream mortgage product for home energy retrofit loans that includes liquidity options for lenders, resulting in more affordable and widely available loans than are currently available for home energy retrofits; and (2) to establish a robust set of data on home energy efficiency improvements and their impact—on energy savings, borrower income, property value, and other metrics—for the purpose of driving development and expansion of mainstream mortgage products to support home energy efficiency retrofits. After determining the viability of the Title I program to achieve these goals, FHA also determined that several changes to the program are necessary for the purposes of the Retrofit Pilot Program. These changes are described in detail in Section II.F. of the November 10, 2010, notice. (*See* 75 FR 69115).) Broadly, the modifications to the Title I regulations are intended to protect consumers, provide low-cost financing, and generate lender and secondary market participation in home energy retrofit loans.

In the November 10, 2010, notice, HUD solicited public comment on the proposed structure of the Retrofit Pilot Program, and also invited interested lenders to advise HUD of their interest, as described in Appendix A of the notice, so that HUD may contact them and explore their interest and the possibility of their participation in the pilot program.

At the close of the public comment period on December 27, 2010, HUD received 49 public comments. HUD reviewed the comments, which are addressed in section IV of this notice, and made some changes to the Retrofit Pilot Program in response to public comment and further consideration of issues by HUD. The changes made to the Retrofit Pilot Program are addressed in Section III, which immediately follows.

III. Changes to the Proposed Retrofit Pilot Program

HUD has made the following changes to the November 10, 2010, notice:

1. *Lender grant funds.* The final notice specifies all of the purposes for which lenders may use grant funds. They are: (1) Supporting costs associated with creating or enhancing staffing and/or systems necessary to deliver or report on PowerSaver-insured loans; (2) Funding costs of loan marketing, origination, and/or underwriting; (3) Offsetting costs associated with appraisals and other approved methods of property valuation; and (4) For lenders that will also service their own loans, reducing servicing costs.

In addition, this notice clarifies that HUD grant funds may not be used to directly subsidize or otherwise "write-down" the interest rate on PowerSaver loans. Non-Federal grant funds may be used for this purpose.

2. *Eligible properties (definition of "single family property improvement loans").* This notice broadens the definition of eligible properties to include both attached and semidetached single unit, owner-occupied principal residences, in addition to detached properties of that type. Further, HUD has clarified that condominium units that otherwise meet the criteria of an eligible single family property are also

[1] On October 19, 2009, the Administration released the Recovery Through Retrofit Report (RTR Report), which builds on the foundation laid out in the American Recovery and Reinvestment Act (Pub. L. 111–5, approved February 17, 2009) to expand green job opportunities in the United States and boost energy savings for middle class Americans by retrofitting homes for energy efficiency. The White House Council on Environmental Quality, along with 12 federal departments and agencies (including HUD) and 6 White House offices, developed the report through an interagency process. The RTR Report recognizes that the funding of residential retrofit projects will help create jobs for retrofit workers, while also helping homeowners save money by lowering their utility bills. The report can be found at *http://www.whitehouse.gov/assets/documents/Recovery_Through_Retrofit_Final_Report.pdf.*

eligible properties under the pilot program.

3. *New eligible improvements.* This notice adds replacement windows that meet the most recent Energy Star specifications to the list of eligible improvements that may be funded with a PowerSaver loan.

4. *Revisions to eligible improvements listed in the November 10, 2010, notice.* This notice makes the following revisions with respect to eligible improvements listed in the November 10, 2010, notice:

a. Ground source heat pump systems (instead of "geothermal heat pumps" as in the November 10, 2010, notice) must be installed in accordance with ANSI/ACCA Standard 5 QJ–2010; and

b. Wind turbines must:

(i) Have a nameplate capacity of not more than 100 kilowatts;

(ii) Have performance and safety certification to:

- The International Electromechanical Commission (IEC) standards from an accredited product certification body, or
- Certification to the American Wind Energy Association (AWEA) standards from the Small Wind Certification Council (SWCC) or a nationally recognized testing laboratory; and

(iii) Be installed by an installer with North American Board of Certified Energy Practitioners Small Wind Installer Certification or small wind turbine installation training from an accredited training organization.

5. *Use of loan proceeds to fund other improvements.* Section V.F.4(b) of the notice also specifies that homeowners may use up to 25 percent of PowerSaver loan proceeds to fund, with certain specified exceptions, property improvements identified in Title I Letter 470 as eligible improvements under the Title I program. A copy of Title I Letter 470 may be downloaded at: *http://www.hud.gov/offices/adm/hudclips/letters/title1/index.cfm.*

6. *Property valuation.* This notice specifies that lenders may use a Fannie Mae and Freddie Mac Form 2055 Exterior-Only Inspection Residential Appraisal Report (most recent version) to determine property value for the purposes of establishing property valuation. The notice also specifies that lenders may be able to use Automated Valuation Models (AVMs) to establish property value for certain borrowers, subject to FHA approval on a case-by case basis. HUD will discuss this issue further with lenders in the review of their Expression of Interest. HUD notes, however, that potential purchasers of PowerSaver loans from originating lenders may have additional or more restrictive criteria regarding the use of AVMs, which lenders seeking to sell loans to such entities may be required to meet.

7. *Charges to borrower to obtain a loan.* This notice specifies the list of charges and fees that may be charged in connection with a PowerSaver loan and which may be financed as part of a PowerSaver loan.

8. *Criteria for dealer loans.* This notice generally affirms that "dealer loans" are not allowed as part of the PowerSaver pilot. However, home improvement contractors may provide information to homeowners as to how they may obtain a PowerSaver loan, including the identity of lenders who are participating in the program.

9. *Insurance claim procedure.* This notice continues to provide that the holder of the note will be accountable to HUD for origination/underwriting errors, and that the servicer will be accountable to HUD for servicing errors, as long as the servicer is a HUD-approved lender. However, based on further internal HUD consideration on how best to effectuate this requirement, this notice clarifies that the insured lender must enter into an agreement with its servicer, under which the servicer agrees to be liable to HUD for such errors, and which identifies HUD as a third-party beneficiary of such agreement.

IV. Discussion of Public Comments on the Proposed Retrofit Pilot Program

Comments were submitted by lenders and representatives of the lending industry; home performance contractors and representatives of the home performance/contracting industry (including one pension fund); local officials and representatives of state energy agencies; environmental and public health organizations; providers of energy services and technologies; community development financial institutions; and members of the general public. This section presents a summary of the significant issues raised by the commenters on the November 10, 2010, notice and HUD's responses to these issues.

A. Comments on Geographic Scope

In listing the locations that received funding under the Department of Energy (DOE) Better Buildings program, all of which are automatically eligible locations for lenders to serve in the pilot program, the Proposed Notice inadvertently excluded Nashville, Tennessee, from the list. This notice corrects this error; Nashville is an automatically eligible location for a lender to serve under the pilot program. In addition, in December 2010, DOE announced that the following State Energy Programs were integrated into BetterBuildings: Alabama, Maine, Massachusetts, Michigan, Nevada, Washington, and Virginia. As a result, these states are automatically eligible locations for lenders to serve under the pilot program.

Finally, this notice provides that areas where the Home Performance with Energy Star program is available are automatically eligible locations for lenders to serve under the pilot program.

Several commenters suggested that certain communities that are not covered under DOE's Better Buildings Program should be eligible markets for lenders to serve in the pilot program. As noted in the November 10, 2010, notice, HUD strongly encourages lenders to serve such markets, provided lenders can demonstrate, through their Expressions of Interest in participating, that such locations are viable markets for the deployment of PowerSaver-insured loans. On December 16, 2010, HUD posted additional guidance on its Web site to assist lenders in this area: *http://www.hud.gov/offices/hsg/sfh/title/additionalsaverinformation.pdf.*

B. Comments on Lender Eligibility

Several commenters recommended that HUD allow institutions that may not be FHA-approved lenders, such as community development financial institutions and state energy agencies, to be eligible lenders under the pilot program. HUD hopes and expects that a wide range of entities will express interest in participating in the pilot program, including entities that have not participated in FHA programs in the past. However, as required by the National Housing Act, any entity that wishes to make loans insured by FHA under the pilot program must hold a valid Title I contract of insurance and be approved by the Secretary. HUD notes that approved Title II lenders may obtain Title I eligibility under an expedited process.

C. Comments on Lender Grant Funds

Several commenters suggested uses of the incentive grant funds available to lenders under the pilot program in addition to the uses specified in the November 10, 2010, notice. Some commenters recommended allowing grant funds to be used to support a lender's costs associated with creating or enhancing systems necessary to deliver PowerSaver loans.

HUD agrees with this suggestion and this notice specifies that such use is allowed with grant funds under the pilot program. In addition, this notice specifies that lenders may use grant funds to offset costs associated with appraisals.

Several commenters suggested that HUD grant funds be available to lenders to set up loan loss reserves. Due to the current insurance structure, HUD does not view this as a viable or optimal use of HUD grant funds for the purposes of the pilot program and declines to make this change. HUD notes that many communities have access to other funds through DOE and other sources that may be available for such purposes. HUD is encouraging lenders to work in partnership with other entities through the pilot program and will evaluate lender Expressions of Interest to participate in part on the extent to which lenders propose to do so. HUD's intention is to provide lenders the flexibility to use funds so long as any use delivers demonstrable benefit to borrowers, such as by making loans more affordable or available. One commenter recommended that HUD ensure that lenders who propose to use grant funds to lower the interest rate on PowerSaver loans they originate do not "over subsidize" loans. HUD will work closely with each lender to size and scope the lender's grant payments so that the payments have the most beneficial impact in the market. As stated in the November 10, 2010, notice, the amount of payment to each lender and the eligible uses of funds by each lender will be determined by HUD based on the lender's Expression of Interest. A significant factor in determining payment amounts to each lender will be the number of loans the lender anticipates making during the 2-year period of the pilot program. Lenders were required to report to HUD on their use of incentive payments funds.

D. Comments on Selection of Lenders

One commenter recommended that HUD require lenders to secure the approval of their Expressions of Interest from "existing energy efficiency program officials" before submitting them to HUD and suggested HUD share Expressions of Interest with "state energy offices" in states that each lender proposes to serve. HUD declines to make this change, as lender Expressions of Interest are nonbinding, and so may change as lenders finalize the details of their participation in discussions with HUD, and may contain proprietary information. The same commenter encouraged HUD to ensure participating lenders collaborate closely with state energy efforts and other initiatives that are currently supporting home energy improvements in markets the lender proposes. HUD does in fact intend to do this, as suggested in the November 10, 2010, notice (with reference to the importance of partnerships with public sector agencies), and will evaluate lender Expressions of Interest in part on this basis.

E. Comments on Eligible Properties (Definition of "Single Family Property Improvement Loans")

Several commenters recommended broadening the definition of eligible properties under the pilot program. The following property types were recommended: attached and semidetached single unit, owner-occupied principal residences; manufactured homes; and multifamily properties. HUD agrees with the suggestion to allow attached and semidetached single unit, owner-occupied principal residences, in addition to detached properties of that type. Such properties are fully within any common definition of "single family housing" and represent an important segment of the housing stock in many communities. This notice reflects this change. Further, HUD has clarified that condominium units that otherwise meet the criteria of an eligible single family property are also eligible properties under the pilot program.

HUD declines to make further changes to eligible property types. HUD fully agrees with the statements by commenters that many manufactured homes and multifamily properties and their residents would benefit from energy improvements. However, as noted in the November 10, 2010, notice, the PowerSaver pilot program is being implemented under the statutory directive from Congress to create a pilot program directed at the single family housing market.[2] HUD also notes that other HUD programs are designed to support manufactured and multifamily housing.

F. Comments on Eligible Use of Loan Proceeds

Several commenters addressed the subject of eligible uses of loan proceeds. Some commenters recommended that the list of eligible improvements directly related to home energy performance be revised and expanded. Others recommended that HUD allow borrowers flexibility to use loan proceeds to fund costs associated with improvements that are not on the list. With respect to the first set of comments, HUD has made a revision to the list of eligible improvements. Specifically, this notice adds replacement windows that meet the most recent Energy Star specifications to the list of eligible improvements that may be funded under the PowerSaver program.

In addition, this notice makes the following revisions with respect to eligible improvements on the list provided in the November 10, 2010, notice:

1. Ground source heat pump systems (instead of "geothermal heat pumps" as in the November 10, 2010, notice) must be installed in accordance with ANSI/ACCA Standard 5 QJ–2010; and

2. Wind turbines must:

(a) Have a nameplate capacity of no more than 100 kilowatts;

(b) Have performance and safety certification to:

- The IEC standards from an accredited product certification body, or
- Certification to the AWEA standard from the SWCC or a nationally recognized testing laboratory; and

(c) Be installed by an installer with North American Board of Certified Energy Practitioners Small Wind Installer Certification or small wind turbine installation training from an accredited training organization.

Other commenters recommended that the list of eligible improvements include "home energy management systems" and "home lighting systems." HUD declines to make these changes. While HUD agrees that improvements consistent with these terms can improve home energy performance, Title I Letter 470 provides that property improvement for the purposes of the program must "[i]n general * * * be permanent, hard wired or hard plumbed to the property." Another commenter recommended stronger and more prescriptive requirements with respect to insulation, sealing, skylights, and air conditioning systems. HUD declines to make these changes. HUD believes that these recommendations generally represent a more aggressive set of requirements than is reasonable and necessary to apply across the board to a national pilot program. HUD recognizes that in every area of energy-related home improvements, technology and practice is continually improving. At this early stage in the development of a market for energy efficient home improvements, HUD believes the list of eligible improvements as revised in this notice strikes the right balance between improving home energy performance and ensuring a sufficiently broad range of homeowners and communities can benefit from the pilot program.

[2] The Consolidated Appropriations Act, 2010 (Pub. L. 111–117, approved December 16, 2009, 123 Stat. 3034). Specifically, *see* Public Law 111–117, at 123 Stat. 3089.

One commenter recommended that power purchase agreements (PPAs) or contracts with third-party owners to use electricity generated by on-site photovoltaic systems, be allowed as eligible improvements, subject to certain conditions. HUD is supportive of innovative efforts to expand the deployment of clean energy in the residential sector, specifically including through PPAs, subject to certain borrower disclosures and protections. The recommendation represents a broader interpretation than generally has been made of the term "property improvement." (The Title I program on which the pilot program is based is authorized to support property improvements.) HUD believes that this proposed recommendation is worthy of further consideration and is interested in better understanding the underwriting and operational issues, whether the recommendation is an eligible activity under the Title I program, and the risks and protections for homeowners as well as FHA. While HUD declines to make the recommended change at this time, it may reconsider this decision in the future based on additional analysis.

With respect to recommendations regarding more flexible use of loan proceeds, HUD agrees with commenters that flexibility is appropriate and likely necessary to encourage and enable many homeowners to fund home energy improvements, which many will likely do as part of a broader remodeling or renovation of their home. HUD also agrees with one commenter that suggested it would be important to ensure homeowners can make basic health and safety-related improvements at the time of a home energy improvement job. At a nascent stage of consumer awareness and interest in home energy improvements, HUD believes it is important to make financing products as appealing and marketable as possible, while maintaining the focus on the policy goal of more energy efficient homes. HUD notes that leading state and local home energy improvement loan programs, as well as the Fannie Mae Energy Loan product, allow significant flexibility in the use of loan proceeds on this basis.

Section V.F.4(b) of this notice specifies that homeowners may use up to 25 percent of PowerSaver loan proceeds to fund certain property improvements identified in Title I Letter 470 as eligible improvements under the Title I program. A copy of Title I Letter 470 may be downloaded at: *http://www.hud.gov/offices/adm/hudclips/letters/title1/index.cfm.*

HUD recognizes that such flexibility may add some complexity to aspects of the evaluation of the pilot program. However, HUD believes the reporting requirements of the program, which will generate data on the specific energy improvement measures funded with each loan, will be sufficient to meet the evaluation goals in this area.

Also with respect to eligible uses of loan proceeds, several commenters recommended that HUD require that homeowners avail themselves of a home energy audit or rating to be eligible for a PowerSaver loan. HUD declines to require audits/ratings in connection with PowerSaver loans at this time. Audit/rating approaches, protocols, technologies, and data appear to vary substantially. HUD is concerned that there is not an industry consensus or uniform standard for energy audits/ratings. (HUD notes that one commenter suggested such standards are in development by one industry group and may be available in early 2011; HUD will be interested in following this development.) DOE is currently piloting the new Home Energy Score program, which includes an energy audit component. Once the Home Energy Score pilot program is complete, HUD may revisit the required use of an energy audit. In addition, it is HUD's understanding that comprehensive audits/ratings can cost as much as $500, adding a significant additional expense; one commenter suggested allowing the cost of audits to be financed as part of the PowerSaver loan. For these reasons, a required audit or rating, as recommended, may disadvantage certain homeowners and communities.

HUD generally agrees with these commenters that audits/ratings can enable homeowners to better understand the most cost effective energy savings improvements for their particular home. For these reasons, the November 10, 2010, notice strongly encouraged the use of audits; this notice affirms this encouragement. Furthermore, as suggested in the November 10, 2010, notice, HUD will consider the extent to which audits will be required or encouraged by lenders in lender Expressions of Interest to participate in the pilot program. In addition, this notice allows the cost of an energy audit/rating to be financed as part of the PowerSaver loan.

G. Comments on Property Valuation

Several commenters addressed the property valuation requirement, which is necessary to ensure homeowners do not have total mortgage debt (including the PowerSaver loan) in excess of the current value of their home at the time of PowerSaver loan origination. One commenter recommended that HUD allow lenders to use a Fannie Mae and Freddie Mac Form 2055 Exterior-Only Inspection Residential Appraisal Report, on which the November 10, 2010, notice specifically solicited comment. This notice adopts this recommendation. Some commenters also recommended that Automated Valuation Models (AVMs) be allowed for use in establishing property valuation. HUD recognizes that AVMs can be an effective tool in certain markets and may be appropriate to use with respect to borrowers who have built some equity in their homes. The notice specifies that lenders may use AVMs to establish property value for certain borrowers, subject to FHA approval, on a case-by-case basis. HUD will discuss this issue further with lenders in the review of their Expression of Interest.

Some commenters raised the concern that appraisals would add inordinate cost to a PowerSaver loan and to the time to close a loan. HUD is sensitive to this concern and agrees that the cost and time associated with appraisals may pose a challenge to the marketability of PowerSaver loans. The availability of various options for determining property valuation, as noted above, addresses this concern. A sound basis for determining property value is essential for determining a borrower's combined-loan-to-value ratio and for establishing PowerSaver loans as viable for capital markets investment and liquidity, which is a stated goal of the pilot program. As noted above, lenders may propose to use incentive grant funds to offset costs associated with appraisals and other approved methods of property valuation. In addition, this notice specifies that appraisal costs may be financed as part of the PowerSaver loan.

Some commenters recommended that an energy audit suffice for establishing the property value. HUD declines to makes this change, as energy audits are not currently recognized by the housing finance industry as a viable tool for determining home value. HUD is interested in working with stakeholders and exploring the extent to which energy audits may be able to provide reliable information to inform determinations of home value and borrower ability to afford and repay mortgage loans. Finally, one commenter suggested that an audit should eliminate an appraisal requirement for an unsecured PowerSaver loan. The notice clarifies that, as under the Title I Property Improvement program, PowerSaver loans of less than $7,500 are not required to be secured and appraisal is not required for such loans.

H. Credit Requirements for Borrowers

Some commenters recommended modest tightening or relaxing of the minimum credit score and maximum total debt-to-income for borrowers receiving PowerSaver loans. HUD declines to make any changes to these features of the program at this time. Homeowners' response and loan performance, among other factors, during the pilot program may warrant adjustments to credit requirements in the future.

I. Requirements for Dealer Loans

Several commenters suggested that HUD allow "dealer loans," as defined by the FHA Title I Property Improvement Home Loan program, be allowed under the PowerSaver pilot program. The Title I Property Improvement Home Loan program regulations at § 201.2 define a "dealer loan" as "a loan where a dealer, having a direct or indirect financial interest in the transaction between the borrower and the lender, assists the borrower in preparing the credit application or otherwise assists the borrower in obtaining the loan from the lender." HUD agrees with these commenters that responsible home improvement contractors can be effective in educating homeowners about home energy loan financing options, which is typically important to maintaining homeowner interest in a financing option.

While HUD declines to make this change, home improvement contractors may provide information to homeowners as to how they may obtain a PowerSaver loan, including the identity of lenders who are participating in the program.

J. Evaluating the Success of the Retrofit Pilot Program

Several commenters made recommendations regarding HUD's planned evaluation of the PowerSaver pilot program. Some suggested that HUD require homeowners to sign a disclosure in connection with a PowerSaver loan to allow access to pre- and post-installation utility bill information. HUD recognizes the importance of accessing utility bill information and is exploring options for accessing it in a manner that ensures homeowner privacy. This notice does not require homeowners to provide utility bill information; HUD will discuss this issue individually with participating lenders in the review of lender Expressions of Interest.

One commenter suggested that HUD participate in efforts by DOE, the Environmental Protection Agency, and industry groups to develop metrics and standards for data collection and program evaluation and to coordinate to the extent feasible with DOE's Home Energy Score Pilot Program. HUD appreciates and agrees with this recommendation and has already been in discussions along these lines with DOE and others.

K. Other Comments

Several commenters recommended increasing the maximum loan amounts overall or with respect to unsecured loans. HUD declines to make changes to the loan limits. HUD believes that the $25,000 loan limit is sufficient to cover all or most of the cost of a comprehensive retrofit or the cost of a renewable energy system—and in the latter case a variety of subsidies and incentives are available to fund costs that the loan cannot. With respect to unsecured loans, the primary purpose of the PowerSaver pilot program is to establish the viability of a mainstream mortgage product for home energy improvement loans; unsecured loan products and credit card options of various types are already available in the market. Because the current Title I Property Improvement Home Loan program does not require loans under $7,500 to be secured, primarily because it would add infeasible cost to such small loans, HUD is retaining that feature, with no change, and no additional incentives to originate (as one commenter recommended) in the PowerSaver pilot program.

Some commenters broadly suggested that HUD require contractors who perform home energy improvements funded by PowerSaver loans to be certified on some basis or that broader "quality assurance" procedures be required. HUD is sympathetic to the concerns expressed by the commenters and generally agrees that high quality assurance procedures can enhance the prospects that a home improvement job will be performed properly and professionally. HUD understands that a number of communities implementing comprehensive home energy improvement programs are imposing or incentivizing such requirements.

HUD will ask lenders that submit Expressions of Interest in participating in the program to describe the extent to which contractor certification and overall quality assurance is reflected in programs serving the lender's proposed target market(s) and will evaluate Expressions of Interest in part on this basis. In addition, HUD will encourage lenders to adopt sound practices in this area. Such practices include:

(1) Verification that contractors have demonstrated business experience as home improvement contractors;

(2) Documentation on file of basic information such as trade name, places of business, type of ownership, type of business, and names and employment histories of the owners and staff;

(3) Provision of current financial statement prepared by someone who is independent of the contractor and is qualified by education and experience to prepare such statements, and a commercial credit report on the contractor;

(4) Procedures for supervising and monitoring contractors' activities with respect to loans insured under the Pilot Program; and

(5) Evidence of homeowner satisfaction with work performed by the contractor under the Pilot Program.

HUD declines to make these or other quality assurance requirements mandatory, however. HUD believes that such a requirement would add unnecessary administrative burden on lenders in the Pilot Program. In addition, HUD expects that it will be able to work closely with lenders, as well as local communities, to monitor and help ensure quality assurance under the Pilot Program given that only a limited number of lenders will participate. In addition, HUD may revisit the issue of quality assurance during its evaluation of the pilot program to determine whether changes should be made to the Pilot Program along the lines suggested by the commenters.

Several commenters encouraged HUD to implement a "streamlined application procedure" for PowerSaver loans. HUD recognizes the importance of ensuring homeowners can close on PowerSaver loans in a timely manner. HUD will utilize the Title I Property Improvement Home Loan program platform and system for the PowerSaver pilot program. This system, while different from the system used for FHA Title II loan products, should enable lenders to make a timely turnaround of loan applications. In addition, HUD will consider lenders' expected loan procedures and expected turnaround time in evaluating their Expressions of Interest to participate in the pilot program.

One commenter suggested that HUD allow PowerSaver loans to be in third lien position in cases where the borrower has a home mortgage loan in first position, a home equity loan in second position, and sufficient home equity to take on a PowerSaver loan without exceeding 100 percent combined loan to value. HUD declines to make this change; the Title I regulations at 24 CFR 201.24(a)(1)(iii) specify that, in general, liens securing Title-insured loans "need not be a first lien on the property; however the lien securing the Title I loan must hold no less than the second lien position." The regulations authorize a Title I loan to hold a third lien position in specified limited circumstances: (1) Where the first and second mortgage were made at the same time; or (2) the second mortgage was provided by a state or local agency in conjunction with a downpayment assistance program.

V. The Home Energy Retrofit Loan Pilot Program (FHA PowerSaver)

A. Authority

The Retrofit Pilot Program is authorized by the Energy Innovation Fund of the 2010 Appropriations Act, which directs HUD to conduct an Energy Efficient Mortgage Innovation pilot program targeted to the single family housing market (Pub. L. 111–117, at 123 Stat. 3089). The Pilot Program is based on the requirements of Title I, section 2 of the National Housing Act (12 U.S.C. 1703). Under section 2(a) of the National Housing Act, HUD is authorized to provide loan insurance in order to help homeowners finance alterations, repairs, and improvements in connection with existing structures or manufactured homes. HUD's implementing regulations are codified at 24 CFR part 201.

B. Duration and Geographic Scope

1. *Duration.* The Retrofit Pilot Program will be conducted for loans originated during a period of 2 years commencing on May 2, 2011. HUD, however, may extend the duration of the Pilot Program, after its commencement, beyond the 2-year period to accurately assess the Pilot's effectiveness. In making such determination, HUD will look closely at the results of its evaluation of the program as described in Section VI of this notice. HUD will announce any such extension through **Federal Register** notice.

2. *Geographic scope.* The success of the Retrofit Pilot Program and its potential to inform further efforts to expand financing for energy efficient home retrofits will be advanced by focusing on properties located in communities that have already taken affirmative steps to address energy efficiency retrofits. HUD is aware that a number of communities have already developed the programmatic infrastructure to help ensure that the critical nonfinancial components of a holistic retrofit initiative are in place. In selecting communities in which to conduct the Pilot Program, HUD will target communities that have already developed a robust home energy efficiency retrofit infrastructure.

DOE's Energy Efficiency and Conservation Block Grants (EECBG) program is authorized under Title V, Subtitle E of the Energy Independence and Security Act (EISA), signed into law on December 19, 2007. Through formula and competitive grants administered by DOE, this program empowers local communities to make strategic investments to meet the Nation's long-term goals for energy independence and leadership on climate change.

With funding for the EECBG program provided by the American Recovery and Reinvestment Act, DOE initiated the Retrofit Ramp-up Program, now known as the Better Buildings program, a demonstration program directed to stimulating activities and investments that can: (1) Deliver verified energy savings from a variety of projects in the local jurisdiction of the applicant, with a particular emphasis on efficiency improvements in residential, commercial, industrial, and public buildings; (2) achieve broader market participation and greater efficiency savings from building retrofits; (3) highly leverage grant funding in order to significantly enhance the resources available for supporting the program; (4) sustain themselves beyond the grant monies and the grant period by designing a viable strategy for program sustainability; (5) serve as pilot building-retrofit programs that demonstrate the benefits of gaining economy of scale; and (6) serve as examples of comprehensive community-scale energy-efficiency approaches that could be replicated in other communities across the country.

Under the Better Buildings Program, approximately $485 million was allocated by DOE through competitive grants to initiatives in the following locations: Austin, TX; Berlin, Cambridge, Chestertown, Cumberland, Denton, Easton, Elkton, Frostburg, Oakland, Princess Anne, Dundalk, Westminster, Havre de Grace, Salisbury, Takoma Park, and University Park, MD; Fayette County, PA; Bedford, NY; Berlin, Nashua, and Plymouth, NH; Boulder County, City and County of Denver, Garfield County, and Eagle County, CO; Camden, NJ; Chicago region, IL; Cincinnati, Ohio, and northeast Kentucky; a consortium of 14 Connecticut Towns: Bethany, Cheshire, East Haddam, East Hampton, Glastonbury, Lebanon, Mansfield, Portland, Ridgefield, Weston, Westport, Wethersfield, Wilton, and Windom; Detroit, Grand Rapids, and southeast MI; Greensboro, NC; Indianapolis and Lafayette, IN; Kansas City, MO; Los Angeles, San Francisco Bay Area, Sacramento, San Diego, and Santa Barbara County, CA; Lowell, MA; Madison, Milwaukee, and Racine, WI; Maine statewide; Missouri statewide; Nashville, TN; New York statewide; Omaha and Lincoln, NE; Oregon statewide; Philadelphia, PA; Phoenix, AZ; Riley County, KS; San Antonio, TX; Seattle, and Bainbridge Island, WA; select Southeastern cities: Atlanta, GA; Carrboro, Chapel Hill, and Charlotte, NC; Charleston SC; Charlottesville, VA; Decatur, GA; Hampton Roads/Virginia Beach, VA; Huntsville, AL; Jacksonville, FL; New Orleans, LA; Toledo, OH; and the U.S. Virgin Islands. In addition, in December 2010, DOE announced that the following State Energy Programs were integrated into BetterBuildings: Alabama, Maine, Massachusetts, Michigan, Nevada, Washington, and Virginia.

The locations listed above are all eligible markets for lenders to serve in the Pilot. In addition, this notice provides that areas where the Home Performance with Energy Star program is available are automatically eligible locations for lenders to serve under the pilot program. Those areas are listed here: *http://www.energystar.gov/index.cfm?c=home_improvement.hm_improvement_hpwes_partners.*

FHA will consider lenders' interest in other communities, subject to an assessment of such communities' infrastructure for implementing residential retrofit programs. As noted in the November 10, 2010, notice, HUD strongly encourages lenders to serve such markets, provided lenders can demonstrate, through their Expressions of Interest in participating, that such locations are viable markets for the deployment of PowerSaver-insured loans. On December 16, 2010, HUD posted additional guidance on its Web site to assist lenders in this area: *http://www.hud.gov/offices/hsg/sfh/title/additionalsaverinformation.pdf.* HUD expects to consult with DOE in such cases.

HUD considered targeting the pilot to a smaller number of markets, which may have increased the likelihood of lender competition within some markets, potentially benefitting consumers. HUD determined that such an approach could limit the number and diversity of lenders that could participate in the program overall, however. HUD determined it was important for the Pilot to be open to a reasonably wide range of lenders—by size and type, as well as service area—especially given the challenging conditions facing lenders in the current environment, which may create barriers to participation for some, even if interested. In selecting lenders to participate, HUD will evaluate the extent to which lenders intend to provide loans at the most favorable rate to consumers, thus directly addressing a major benefit that lender competition would potentially foster.

C. Lender Eligibility

Lender participation in the Retrofit Pilot Program is voluntary. Of the pool of interested lenders that meet the criteria described in Section II of the November 10, 2010, notice and reiterated below, HUD intends to select a limited number of lenders to participate in the Retrofit Pilot Program. HUD is currently undertaking efforts to identify FHA-approved lenders that may be suitable candidates for participation in the Retrofit Pilot Program. HUD reserves the right to terminate a lender's participation in the Retrofit Pilot Program for unacceptable performance. Examples of unacceptable lender performance could include violating the program's underwriting and credit criteria, failing to meet HUD reporting requirements, and high defaults among originated loans under the program. To be eligible, lenders must satisfy the following criteria:

1. *Approval as an FHA Title I or Title II program lender.* Lenders must hold valid Title I contracts of insurance and be approved pursuant to the requirements of 24 CFR part 202 to originate, purchase, hold, service, or sell loans insured under the Title I program regulations at 24 CFR part 201. However, approved Title II lenders may obtain Title I eligibility under an expedited process by contacting HUD and submitting the Title I approval package described at *http://www.hud.gov/offices/hsg/sfh/lender/title1ap.cfm.*

2. *Experience with similar lending initiatives.* Lenders must be able to demonstrate experience with the type of lending initiative being undertaken in the Retrofit Pilot Program. In particular, HUD will consider the extent to which lenders have experience in successfully originating and/or servicing small loans, home equity loans, second liens, FHA section 203(k) rehabilitation loans, and Title I Property Improvement Loans. Lenders that do not have experience in such lending may still be able to participate in the Pilot Program to the extent they can demonstrate how their other experience is relevant to determining their ability to participate in the pilot, and provided they agree to meet the Title I requirements before participation in the pilot program.

3. *Computer system capabilities.* Lenders must have the technical capability to interface with FHA through FHA Connection. In addition, lenders must have the technical capability to interface with any other computer systems utilized by FHA or its contractors pertaining to the Retrofit Pilot Program.

4. *Audit capabilities.* Lenders must have a demonstrated capacity to provide timely reports to FHA on origination and performance of retrofit loans. FHA envisions requiring monthly reports on loan and portfolio performance. In addition, a lender must be able to provide an electronic loan package to HUD for a random sample of loans chosen for quality reviews.

5. *Collaborative capacity.* Lenders must have demonstrated capacity to work with public sector agencies, nonprofit organizations, and utilities or home improvement contractors.

D. Lender Grant Funds

HUD recognizes that even with federal mortgage insurance such as would be available under the Pilot Program, small loans for home energy retrofits may have relatively high transaction costs for lenders, discouraging some from offering such loans and forcing others that do offer them to increase costs to borrowers. HUD will utilize the appropriated funds provided under the 2010 Appropriations Act to provide lender incentive payments to support activities that lower costs to borrowers. Eligible uses of such payments are: (1) Supporting costs associated with creating or enhancing staffing and/or systems necessary to deliver or report on PowerSaver insured loans; (2) Funding costs of loan marketing, origination, or underwriting; (3) Offsetting costs associated with appraisals and other approved methods of property valuation; and (4) For lenders that will also service their own loans, reducing servicing costs.

HUD will also consider other proposed uses of such funds. Any use of funds must show, to HUD's satisfaction, bona fide benefit to borrowers. The amount of payment to each lender and the eligible uses of funds by each lender will be determined by HUD based on the lender's Expression of Interest. A significant factor in determining payment amounts to each lender will be the number of loans the lender anticipates making during the 2-year period of the Pilot Program. Lenders will be required to report to HUD on their use of incentive payment funds. HUD anticipates that the amount of grant funds will not exceed $5 million per lender.

In addition, this notice clarifies that HUD grant funds may not be used to directly subsidize or otherwise "write down" the interest rate on PowerSaver loans. Non-Federal grant funds may be used for this purpose.

Grant funds may be available to lenders who request them, but are not required for participation. Lenders who do not seek funds may still participate in the Pilot Program.

E. Selection of Lenders

As noted above, lenders interested in potentially participating in the Retrofit Pilot Program were required to submit an Expression of Interest using the template in Appendix A and by following the instructions provided in the November 10, 2010, notice.

In evaluating Expressions of Interest and selecting lenders to participate, HUD will first review each Expression of Interest to verify that the lender is eligible to participate in the program. HUD will then evaluate the Expressions of Interest from all eligible lenders primarily by weighing the following factors in the Expression of Interest: (1) The lender's anticipated loan volume and target markets; (2) the lender's business model for participating in the pilot; (3) the lender's capacity (experience and/or potential) to work in public-private partnerships; and (4) the extent to which the lender intends to deliver the most favorable loan product to consumers. HUD anticipates that these primary weighting factors will have generally equal weighting significance. In addition, HUD may consider the following factors in selecting lenders to participate: (1) Diversity of lender type and target market; and (2) impact on low-income households and communities.

F. Differences Between Retrofit Pilot Program and Existing Title I Program

With the exceptions discussed below, the Retrofit Pilot Program will be governed by the Title I program regulations at 24 CFR part 201. This notice does not make any changes to the current Title I Property Improvement Program. The differences specified in this notice are only applicable to lenders selected to participate in the Pilot Program.

Lenders selected to participate in the Retrofit Pilot Program must enter into a Retrofit Pilot Program Agreement by which they commit to adhere to the Title I program regulations, except as modified in this notice and in subsequent refinements, such modifications being applicable only to loans insured under the Retrofit Pilot Program. There will also be other requirements applicable to the Retrofit Pilot Program; for example, insuring Retrofit Pilot Program loans only in communities selected for the Pilot Program.

In summary, the changes described below, in combination with the appropriated funds, have the effect of creating an innovative pilot program that accords with Congress' direction in the Act. These changes fall into the following categories: (1) Changes designed to enhance underwriting of program loans; (2) changes related to FHA administration of the program, specifically in the areas of loan servicing, claim procedures, and reporting; (3) changes to target the pilot program specifically for its purpose of improving home energy performance; and (4) changes to provide additional benefits to borrowers. Finally, as noted, FHA will augment these changes with grant funds for lenders, using funding appropriated under the 2010 Appropriations Act. In summary, these changes adjust the current flexible framework for the Title I program to enable it to encourage and directly support home improvements that improve energy performance, while reducing barriers to making financing under the program more widely available and more affordable.

1. *Definition 24 CFR 201.2.* For purposes of the Retrofit Pilot Program, the following terms have the following meanings.

a. *Single family property improvement loans.* Only "single family property improvement loans" as that term is defined in 24 CFR 201.2 are eligible for FHA insurance and the Retrofit Pilot Program. Properties must also be principal residences as defined in 24 CFR 201.2. For purposes of the Retrofit Pilot Program, the term includes detached, semidetached, and attached single family properties. Condominium units that otherwise meet the criteria of an eligible single family property are also eligible properties under the pilot program.

Loans used to finance the property improvements for manufactured homes and multifamily properties[3] are not eligible for the Retrofit Pilot Program, but remain eligible for Title I program insurance under 24 CFR part 201.

[3] Manufactured home improvement loan and multifamily property improvement loan are terms defined in § 201.2.

2. *Loan maturities (24 CFR 201.11).* Under the Title I program regulations at 24 CFR 201.11 an insured loan may have a term as long as 20 years. Under the Retrofit Pilot Program, loan terms generally will be limited to 15 years to better align the term of financing with the useful life of, and benefits from, most energy retrofit improvements. Under the Pilot Program, loan terms that are for 20 years can be used only for certain specified improvements: renewable energy measures, ground source heat pump systems, and other improvements as approved by HUD. *See* "Eligible use of loan proceeds" in Section V.D.4(b) below.

3. *Interest and discount points (24 CFR 201.13).* Under the Title I program regulations at 24 CFR 201.13, 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. This restriction, while helping to assure that borrowers have a personal stake in the repayment of the loan, also has the effect of hindering state and local efforts to support home energy retrofits by lowering the cost of capital to consumers, such as through interest rate write-downs. The Retrofit Pilot Program expressly contemplates that third parties (including state and local governments, private organizations, and nonprofit organizations) may pay discount points or other financing charges in connection with the Title I loan transaction and encourages third parties to work with participating lenders on this basis. In addition, as noted, lenders may utilize HUD incentive payments for this purpose under the Pilot Program.

The interest shall be calculated on a traditional mortgage interest basis.

4. *Property improvement loan eligibility (24 CFR 201.20).*

a. *Borrower eligibility (24 CFR 201.20(a)).* As under Title I loans, Retrofit Pilot Program borrowers shall have at least a one-half interest in one of the following:

(i) Fee simple title of the property; or

(ii) A properly recorded land installment contract.

Unlike the Title I program, lessees of the property will not be eligible to participate in the Pilot Program. The limitation of eligibility to owner-occupied properties is designed to reduce the variables in the Pilot Program for purposes of evaluation, as well as to help ensure compliance with the minimum property loan-to-value ratios described in section V.F.5. below.

b. *Eligible use of the loan proceeds (24 CFR 201.20(b)).* Similar to the Title I program, loan proceeds shall be used only for the purposes disclosed in the loan application. Under the standard Title I loan, proceeds shall be used only to finance property improvements that substantially protect or improve the basic livability or utility of the property. Further, HUD has established a list of items and activities that may not be financed with the proceeds of any property improvement loan.

A list of eligible measures is attached as an appendix to this notice. Homeowners may use up to 25 percent of the PowerSaver loan proceeds to fund, with the following exceptions, any property improvement that is identified in Title I Letter 470 as an eligible improvement under the Title I program. The following property improvements, although listed in Title I Letter 470 as eligible improvements under the Title I program, are not eligible for funding with PowerSaver loan proceeds:

- Barns
- Boathouses
- Boatslips
- Bookcases (built-in)
- Cabinets (unless the improvement would result in health benefits)
- Choir lofts
- Decks, Gazebos
- Docks
- Door chimes
- Driveways
- Lattice work
- Piers
- Porches
- Safes/vaults

A copy of Title I Letter 470 may be downloaded at: *http://www.hud.gov/offices/adm/hudclips/letters/title1/index.cfm.* If a lender has any doubt as to the eligibility of any item or activity, the lender must request a determination from FHA before making a loan. HUD strongly encourages the use of home energy audits and other tools to enable consumers to determine the most beneficial improvements they should seek to undertake.

5. *Property valuation (24 CFR 201.20).* The combined loan-to-value ratio of any previously existing mortgage and PowerSaver loan cannot exceed 100 percent. As under the Title I Property Improvement program, this requirement does not apply in cases involving PowerSaver loans of less than $7,500 and not secured by the property. Lenders may either use a Fannie Mae and Freddie Mac Form 2055 Exterior-Only Inspection Residential Appraisal Report (most current version) or an Automated Valuation Model (AVM) to establish property value. Any use of AVMs by any lender participating in the pilot program must be approved by FHA on a case-by-case basis. HUD will

discuss this issue further with lenders in the review of their Expression of Interest. HUD notes, however, that potential purchasers of PowerSaver loans from originating lenders may have additional or more restrictive criteria regarding the use of AVMs, which lenders seeking to sell loans to such entities may be required to meet.

6. *Credit requirements for borrowers (24 CFR 201.22).* In addition to the requirements under the Title I program, all borrowers participating in the Retrofit Pilot Program must have a decision credit score of 660 or higher. The decision credit score used by FHA is based on methodologies developed by the FICO Corporation. FICO scores, which range from a low of 300 to a high of 850, are calculated by each of the three National Credit Bureaus and are based upon credit-related information reported by creditors, specific to each applicant. Lower credit scores indicate greater risk of default on any new credit extended to the applicant. The decision credit score is based on the middle of three National Credit Bureau scores or the lower of two scores when all three are not available, for the lowest scoring applicant.

The borrower's total debt-to-income ratio cannot exceed 45 percent, as under the Title I program. HUD recognizes that requiring a minimum credit score for participation in the pilot program will mean that some homeowners cannot participate. However, given that this is a pilot program, HUD has determined to limit the Retrofit Pilot Program to borrowers with these credit scores in order to make an initial assessment of the interaction of credit ratings and repayment in connection with home energy retrofit loans.

7. *Charges to borrower to obtain loan (24 CFR 201.25).* The regulations provide for a HUD-established list of fees and charges that may be included in a property improvement loan. A slightly different list of fees and charges is established for the Retrofit Pilot Program in an appendix to this notice. The list indicates which of those fees and charges may be financed as part of a PowerSaver loan.

8. *Conditions for loan disbursement (24 CFR 201.26).* In addition to current Title I requirements pertaining to disbursement of loan proceeds, the Retrofit Pilot Program funds shall 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 as evidenced by an executed Completion Certificate for Property Improvements (form HUD–56002) by the borrower(s), and a lender-required inspection.

9. *Dealer loans (24 CFR 201.27).* Under the Title I program, a dealer loan (defined at 24 CFR 201.2) "means a loan where a dealer, having a direct or indirect financial interest in the transaction between the borrower and the lender, assists the borrower in preparing the credit application or otherwise assists the borrower in obtaining the loan from the lender."

Dealer loans will not be permitted in the Retrofit Pilot Program. The reason for this limitation is that dealer loans have been disproportionately correlated with poor loan performance under Title I and other home improvement loan programs in the past. While HUD recognizes that there are many responsible dealers who can and would provide financing through dealer loans in a responsible manner, it is limiting the Retrofit Pilot Program to "direct loans." "Direct loans" is defined under the Title I program (at 24 CFR 201.2) as "a loan for which a borrower makes application directly to a lender without any assistance from a dealer." HUD believes that home improvement contractors and others whose activity may be described under the definition of "dealer" for the Title I program will play an important role in ensuring the pilot's success by performing the actual work related to the retrofits.

However, home improvement contractors may provide information to homeowners as to how they may obtain a PowerSaver loan, including the identity of lenders who are participating in the program.

10. *Loan servicing (24 CFR 201.41).* Under the Title I program, lenders remain responsible for proper collection efforts, even though actual loan servicing and collection may be performed by an agent of the lender. In addition to these requirements, the servicer of a Retrofit Pilot Program loan, whether the servicer is the original lender or a subsequent servicer, as under FHA's major single family program (commonly referred to as the Title II program), is fully responsible for the required servicing responsibilities. As under the Title II program, "the mortgagee shall remain fully responsible for proper servicing, and the actions of its servicer shall be considered to be the actions of the mortgagee." HUD emphasizes that the servicer shall also be fully responsible for its actions as a servicer. HUD intends to seek recovery from servicers if FHA losses are attributable to servicing errors.

In addition, as noted, lenders that also service loans they originate under the pilot program may utilize HUD incentive payments under the program to reduce servicing costs that deliver bona fide benefits to borrowers.

11. *Insurance claim procedure (24 CFR 201.54).* Under the Title I program, HUD requires that insurance claims be fully documented.

Under the Pilot Program, the holder of the note will be accountable to HUD for origination/underwriting errors, and the servicer will be accountable to HUD for servicing errors, as long as the servicer is a HUD-approved lender. To effectuate this, the insured lender must enter into an agreement with its servicer, under which the servicer agrees to be liable to HUD for such errors, and which identifies HUD as a third-party beneficiary of such agreement.

VI. Evaluating the Success of the Retrofit Pilot Program

As stated in the November 10, 2010, notice, HUD's goals for the Pilot Program are: (1) To facilitate the testing and scaling of a mainstream mortgage product for home energy retrofit loans that includes liquidity options for lenders, resulting in more affordable and widely available loans than are currently available for home energy retrofits; and (2) to establish a robust set of data on home energy efficiency improvements and their impact—on energy savings, borrower income, property value, and other metrics—for the purpose of driving development and expansion of mainstream mortgage products to support home energy retrofits.

HUD's evaluation of PowerSaver will be focused on the extent to which the pilot program achieves those goals. To address the first goal, HUD, through its internal staff and systems, will closely assess lender performance and experience in marketing, originating, servicing and selling PowerSaver loans. As a pilot program in which a small number of lenders will participate, PowerSaver will afford HUD an unusual ability to learn from lenders as they deploy PowerSaver loans. As the PowerSaver program launches and lenders establish marketing plans, loan interest rates, and strategies for holding and/or selling loans, HUD will be in position to assess market impacts as they develop. HUD, working with its lender partners in the pilot program, will get a sense of the factors that contribute to (or impede) consumer demand for home energy efficiency improvement financing. In addition, as noted, lenders will be reporting regularly to HUD on loan performance and the uses of loan proceeds for various improvements. Thus, HUD will have a sense of performance and preference within specific lender programs and markets, as well as potential trends across the portfolio of lenders. HUD will not attempt to rush to conclusions, and will expect possible changes in trends as the pilot program matures and expands.

As a pilot program, one of the principal purposes of the Pilot is to generate data on key questions that can help make the case for additional mainstream mortgage products to support home energy retrofits, including first mortgage options. HUD is therefore committed to a robust evaluation program in connection with the Pilot. (The evaluation will also enable HUD to assess the success of possible modifications to the existing Title I program before initiating, through rulemaking, any changes to the Title I regulations.)

To address the second goal, HUD will focus on three overarching questions: (1) Did homes reduce their energy consumption after retrofits were completed? (2) Did homeowners realize lower energy bills as a result of the retrofits? and (3) Were home values affected as a result of the retrofits? Data from the PowerSaver Pilot Program suggesting answers to these questions will help fill a major void and start to establish a basis for analyzing other financing.

This component of the evaluation will be conducted by a third party with which HUD will contract. That entity will be under contract as the pilot program launches and lenders begin to make loans. HUD anticipates that a critical component of this part of the evaluation will be the third party's ability to access pre- and post-retrofit utility data from at least a sample of PowerSaver homeowners. HUD is aware of effective practices for third parties to access this information, on a confidential basis, and will encourage the evaluation contractor to utilize such practices, including those developed and implemented by DOE.

HUD acknowledges that the issues identified can be challenging impacts to evaluate, for reasons ranging from "rebound effects" to consumer concerns about access to utility billing data. HUD believes that it must attempt to do so, however, and believes that additional, useful information at a meaningful scale can be obtained through the PowerSaver program. HUD believes that continued progress on mainstream mortgage financing options for home energy retrofits requires attention to these issues.

HUD recognizes that an evaluation of PowerSaver could also consider other important questions. HUD will explore, internally and with its contractor, the feasibility of adding to the core evaluation scope, potentially including: (1) Lender costs for originating and servicing; (2) impact of interest rates on consumer participation; (3) relative effectiveness of nonfinancial programmatic elements (consumer education, product marketing, auditing tools, and workforce quality assurance); and (4) the extent to which specific home energy improvements are chosen and the results from specific measures.

The results of the evaluation program will heavily inform HUD's determination of whether to make the PowerSaver pilot program a permanent FHA program, subject to any desired changes and pursuant to any appropriate rulemaking process that HUD may determine is necessary. A successful pilot program, and a sound basis for making PowerSaver a permanent program would be reflected in an evaluation that HUD believes demonstrates that: (1) Lenders demonstrate that there is a market for PowerSaver loans in their communities that they can serve on a viable continuing basis, facilitated to the extent necessary by an ability to sell or securitize PowerSaver loans; (2) the best available data suggests that PowerSaver loans are resulting in more home energy retrofits (and related jobs and economic benefits), lower energy use, and lower energy bills; and (3) FHA systems and staff indicate that FHA can continue and potentially expand the program in a safe and sound manner.

VII. Findings and Certifications

Paperwork Reduction Act

The information collection requirements in this notice have been approved by the Office of Management and Budget (OMB) under the Paperwork Reduction Act of 1995 (44 U.S.C. 3501–3520) (PRA) and assigned OMB Control Number 2502–0596. In accordance with the PRA, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information, unless it displays a currently valid OMB control number.

Executive Order 12866, Regulatory Planning and Review

OMB reviewed this notice rule under Executive Order 12866 (entitled "Regulatory Planning and Review"). As was the case with the November 10, 2010, notice, this notice has been determined to be an "economically significant regulatory action," as defined in section 3(f)(1) of the Order. The revised impact analysis for this notice is available at *http://www.hud.gov/offices/adm/hudclips/ia/.* The following provides a brief summary of the finding relating to the aggregate costs, benefits, and transfers of the pilot program contained in the analysis:

Introduction. As discussed more fully in the accompanying impact analysis, HUD envisions that the pilot program will provide insurance for up to 24,000 loans over the 2-year period of the pilot program, with an expected average loan size of $12,500. The program is therefore expected to result in the extension of up to $300 million in FHA-insured energy efficiency property improvement loans over the 2-year period and a resulting energy-saving valued at as much as $630 million (in present discounted value).

Benefits. The aggregate net benefits are obtained by multiplying the individual net benefits by the expected number of loans and adding the expected social benefits of reduced energy consumption. As a base case, HUD assumes a consumer household with annual savings of $1,000, a 0 percent price growth, and a 7 percent discount rate. The present value of a technical retrofit for this base case scenario is $11,400. Assuming a rebound effect of 30 percent yields a comfort benefit of $3,400 and energy savings of $8,000 per participant.[4] As noted, approximately 24,000 loans are expected over 2 years. For the base case scenario, this would equal $41 million in comfort benefits and $96 million in energy savings for each year of the program. The benefits of the FHA program may not equal the sum of the benefits of all retrofits financed through the program, but only reflect the benefits of the retrofits that would not have occurred without the program; however, the existence of significant market imperfections and the lack of affordable financing make it reasonable to assume that a large proportion, if not all of the loans, will generate benefits.

Costs. The cost of receiving the energy-savings is the upfront investment plus the costs of financing the investment. The cost per investment is thus equal to the size of the loan, or $14,880 on average.

Transfers to Consumers. The transfer to consumers is equal to the difference

[4] The "rebound effect" refers to the fact that the reaction of the consumer to the energy-saving technology will not necessarily reduce energy consumption by what is technically possible. By increasing energy efficiency, the retrofit reduces the expense of physical comfort and will thus increase the demand for comfort. In fact, the retrofit may have been driven for a demand for more heating in the winter or cooling in the summer. The size of the rebound effect will depend on the income of the household and the path of energy prices.

between the FHA interest rate and the interest rates on other loans available for the same purpose. As discussed, alternative means of financing are limited and come with higher interest costs. However, if the next best interest rate for the consumer were fairly low at 10 percent, then this loan would represent a transfer of approximately $5,000 per household. Aggregated over 12,000 participants, the aggregate annual consumer transfer through lower interest costs would be $62 million.

The docket file is available for public inspection in the Regulations Division, Office of General Counsel, Department of Housing and Urban Development, 451 7th Street, SW., Room 10276 Washington, DC 20410–0500. Due to security measures at the HUD Headquarters building, please schedule an appointment to review the docket file by calling the Regulations Division at 202–402–3055 (this is not a toll-free number). Individuals with speech or hearing impairments may access this number via TTY by calling the Federal Information Relay Service at 800–877–8339.

Environmental Impact

A Finding of No Significant Impact (FONSI) with respect to the environment was prepared in accordance with HUD regulations at 24 CFR part 50, which implement section 102(2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4332(2)(C)). Individual mortgage insurance actions taken under the pilot program are categorically excluded under HUD's regulations at 24 CFR 50.19(b)(17) and not subject to the federal laws and authorities cited in 24 CFR 50.4, other than 24 CFR 50.4(b)(1) and (c)(1), and 24 CFR 51.303(a)(3). The FONSI is available for public inspection between the hours of 8 a.m. and 5 p.m. weekdays in the Regulations Division, Office of General Counsel, Room 10276, Department of Housing and Urban Development, 451 7th Street, SW., Washington, DC 20410. Due to security measures at the HUD Headquarters building, please schedule an appointment to review the FONSI by calling the Regulations Division at 202–708–3055 (this is not a toll-free number). Individuals with speech or hearing impairments may access this number via TTY by calling the toll-free Federal Information Relay Service at 800–877–8339.

Dated: March 24, 2011.

Joseph F. Smith,

General Deputy Assistant Secretary for Housing—Federal Housing Commissioner.

Appendix A
Allowable Charges and Fees

Fees & Charges that May be Financed	**Fees and Charges that May be Collected, but May Not be Financed**
An origination fee, not to exceed five percent of the loan amount.[1]	Discount points paid by the borrower or third party to the lender, but only if the lender can demonstrate a clear relationship between the discount points being charged and a compensating decrease in the interest rate on the loan.
Fees for architectural and engineering services.[1]	A fee for the services of a qualified closing agent to act on behalf of the lender in closing a direct loan transaction.
Building permit costs.[1]	Title I loan insurance charges assessed by the lender.
Credit report costs.[1]	Premiums for flood insurance that may be required in connection with a property improvement loan.[1]
Title examination costs.[1]	Premiums for credit life insurance or credit disability insurance.
Fees for determining whether the property is in a special flood hazard area.[1]	Title insurance costs.
Recording fees, recording taxes, filing fees, and documentary stamp Recording fees, recording taxes, filing fees, and documentary stamp taxes.	Payments into a tax and insurance escrow account for the current year.
Fee for inspection of the property by the lender or its agent, not to exceed $125.[1]	Other fees necessary to establish the validity of a lien.
Appraisal fees.[1]	Survey costs.[1]
Energy Audits.[1]	A handling charge to refinance an existing Title I loan, not to exceed one percent of the new loan amount.[1]
Such other items as may be specified by the Department.	A fee for approving an assumptor and preparing the assumption agreement, not to exceed one percent of the unpaid principal balance on the loan.[1]
	A fee for recording a release of the lender's security in the property, if permitted under State law.
	Such other items as may be specified by the Department.

* Typical fees & charges that may be collected at the time of application.

Appendix B
Eligible Improvements
Under Retrofit Pilot Program[5]

Improvement	Standard Home Energy Improvement Standards
Whole House	Whole house air sealing measures, including interior and exterior measures, utilizing sealants, caulks, insulating foams, gaskets, weather-stripping, mastics, and other building materials in accordance with BPI standards or other procedures approved by the Secretary. Reference: **http://www.bpi.org/standards.aspx**
Insulation: Attic	Attic insulation measures that— **(A)** include sealing of air leakage between the attic and the conditioned space, in accordance with BPI standards or the attic portions of the DOE or EPA thermal bypass checklist or other procedures approved by the Secretary; **(B)** add at least R-19 insulation to existing insulation; **(C)** result in at least R-38 insulation in DOE climate zones 1 through 4 and at least R-49 insulation in DOE climate zones 5 through 8, including existing insulation, within the limits of structural capacity, except that a State, with the approval of the Secretary, may designate climate zone sub regions as a function of varying elevation; and (Map Page: **http://www.energystar.gov/index.cfm?c=home_sealing.hm_improvement_insulation_table**) **(D)** cover at least-- (i) 100 percent of an accessible attic; or (ii) 75 percent of the total conditioned footprint of the house. BPI Standards reference: **http://www.bpi.org/standards.aspx**
Insulation: Wall	Wall insulation that— **(A)** is installed in accordance with BPI standards or other procedures approved by the Secretary; **(B)** is to full-stud thickness or adds at least R-10 of continuous insulation; and **(C)** covers at least 75 percent of the total external wall area of the home. BPI Reference: **http://www.bpi.org/standards.aspx**

[5] Section V.F.4(b) of this notice provides that homeowners may use up to 25 percent of the PowerSaver loan proceeds to fund, with certain specified exceptions, property improvements that, although not listed in this appendix, are identified in Title I Letter 470 as an eligible improvement under the Title I program. A copy of Title I Letter 470 may be downloaded at: http://www.hud.gov/offices/adm/hudclips/letters/title1/index.cfm If a lender has any doubt as to the eligibility of any item or activity, the lender must request a determination from FHA before making a loan. HUD strongly encourages the use of home energy audits and other tools to enable consumers to determine the most beneficial improvements they should seek to undertake.

Improvement	**Standard Home Energy Improvement Standards**
Insulation: Crawl Space	Crawl space insulation or basement wall and rim joist insulation that is installed in accordance with BPI standards or other procedures approved by the Secretary and— **(A)** covers at least 500 square feet of crawl space or basement wall and adds at least-- (i) R-19 of cavity insulation or R-15 of continuous insulation to existing crawl space insulation; or (ii) R-13 of cavity insulation or R-10 of continuous insulation to basement walls; and **(B)** fully covers the rim joist with at least R-10 of new continuous or R-13 of cavity insulation. BPI Reference: **http://www.bpi.org/standards.aspx**
Duct Sealing	Duct sealing or replacement and sealing that— **(A)** is installed in accordance with BPI standards or other procedures approved by the Secretary; and **(B)** in the case of duct replacement and sealing, replaces and seals at least 50 percent of a distribution system of the home. BPI Reference: **http://www.bpi.org/standards.aspx** Reference: **http://www1.eere.energy.gov/buildings/windowsvolumepurchase/**
Skylight Replacement	Skylight replacement that meets most recent Energy Star specifications.
Door Replacement	Door replacement that meets most recent Energy Star specifications.
Storm Doors	Storm doors.[This change made at request from OMB]
Window Replacement	Replacement windows that meet the most recent Energy Star specifications.
Storm Windows	Storm windows that meet the requirements for low-e storm windows under the Department of Energy Windows Volume Purchase Program.
Heating System Gas/Propane/Oil Boiler / Furnace	Heating system replacement that meets most recent Energy Star specifications.
Air Conditioner	Central air conditioner or air-source heat pump replacement with a new unit that meets most recent Energy Star specifications.
Water Heater (gas, propane, electric, tank less)	Replacement of a natural gas, propane, or electric water heater that meets most recent Energy Star specifications.
Roofs Metal & Asphalt	Metal or asphalt roofs that meet most recent Energy Star specifications.
Improvement	**Renewable Energy Home Improvement Standards**
Ground Source Heat Pump Systems	Ground source heat pump systems must be installed in accordance with ANSI/ACCA Standard 5 QJ-201.

Improvement	Standard Home Energy Improvement Standards
Water Heater (solar)	Solar water heating property must be Energy Star Qualified, or certified by the Solar Rating and Certification Corporation or by comparable entity endorsed by the state in which the system is installed.
Fuel Cells and Micro turbine Systems	Efficiency of at least 30% and must have a capacity of at least 0.5 kW.
Solar Panels (Photovoltaic Systems)	Photovoltaic systems must provide electricity for the residence, and must meet applicable fire and electrical code requirement.
Wind Turbine Residential	A wind turbine must (i) have a nameplate capacity of not more than 100 kilowatts; (ii) have performance and safety certification to: • The International Electrotechnical Commission (IEC) standards from an accredited product certification body, or • Certification to the American Wind Energy Association (AWEA) standards from the Small Wind Certification Council (SWCC), or a Nationally Recognized Testing Laboratory (NRTL); and (iii) be installed by an installer with North American Board of Certified Energy Practitioners Small Wind Installer Certification or small wind turbine installation training from an accredited training organization.

[FR Doc. 2011–7551 Filed 3–30–11; 8:45 am]
BILLING CODE 4210–67–C

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

[Docket No. FR–5420–N–04]

Notice of Regulatory Waiver Requests Granted for the Fourth Quarter of Calendar Year 2010

AGENCY: Office of the General Counsel, HUD.

ACTION: Notice.

SUMMARY: Section 106 of the Department of Housing and Urban Development Reform Act of 1989 (the HUD Reform Act) requires HUD to publish quarterly **Federal Register** notices of all regulatory waivers that HUD has approved. Each notice covers the quarterly period since the previous **Federal Register** notice. The purpose of this notice is to comply with the requirements of section 106 of the HUD Reform Act. This notice contains a list of regulatory waivers granted by HUD during the period beginning on October 1, 2010, and ending on December 31, 2010.

FOR FURTHER INFORMATION CONTACT: For general information about this notice, contact Camille E. Acevedo, Associate General Counsel for Legislation and Regulations, Department of Housing and Urban Development, 451 7th Street, SW., Room 10282, Washington, DC 20410–0500, telephone 202–708–1793 (this is not a toll-free number). Persons with hearing- or speech-impairments may access this number through TTY by calling the toll-free Federal Information Relay Service at 800–877–8339.

For information concerning a particular waiver that was granted and for which public notice is provided in this document, contact the person whose name and address follow the description of the waiver granted in the accompanying list of waivers that have been granted in the fourth quarter of calendar year 2010.

SUPPLEMENTARY INFORMATION: Section 106 of the HUD Reform Act added a new section 7(q) to the Department of Housing and Urban Development Act (42 U.S.C. 3535(q)), which provides that:

1. Any waiver of a regulation must be in writing and must specify the grounds for approving the waiver;

2. Authority to approve a waiver of a regulation may be delegated by the Secretary only to an individual of Assistant Secretary or equivalent rank, and the person to whom authority to waive is delegated must also have authority to issue the particular regulation to be waived;

3. Not less than quarterly, the Secretary must notify the public of all waivers of regulations that HUD has approved, by publishing a notice in the **Federal Register**. These notices (each covering the period since the most recent previous notification) shall:

a. Identify the project, activity, or undertaking involved;

b. Describe the nature of the provision waived and the designation of the provision;

c. Indicate the name and title of the person who granted the waiver request;

d. Describe briefly the grounds for approval of the request; and

e. State how additional information about a particular waiver may be obtained.

Section 106 of the HUD Reform Act also contains requirements applicable to waivers of HUD handbook provisions that are not relevant to the purpose of this notice.

This notice follows procedures provided in HUD's Statement of Policy on Waiver of Regulations and Directives issued on April 22, 1991 (56 FR 16337). In accordance with those procedures and with the requirements of section 106 of the HUD Reform Act, waivers of regulations are granted by the Assistant Secretary with jurisdiction over the regulations for which a waiver was requested. In those cases in which a General Deputy Assistant Secretary granted the waiver, the General Deputy Assistant Secretary was serving in the absence of the Assistant Secretary in accordance with the office's Order of Succession.

This notice covers waivers of regulations granted by HUD from

FHA PowerSaver

Frequently Asked Questions (FAQs) for Consumers

What is the FHA PowerSaver program and when will it be available?

PowerSaver is a new insurance program from the Federal Housing Administration (FHA) that will enable homeowners to make cost effective, energy saving improvements to their homes. PowerSaver will provide federal loan insurance and other incentives to participating lenders to deliver low-cost home energy improvement loans. Homeowners will be able to borrow up to $25,000 for terms of 15 years (up to 20 years for certain improvements) to make proven home energy improvements of their choice, based on a list developed by FHA and the U.S. Department of Energy (DOE).

PowerSaver will begin as a nationwide two-year pilot program, launching in 2011. FHA is currently seeking lenders to participate in the program. In selecting participating lenders, FHA will consider the market areas lenders propose to serve. Generally, FHA will require lenders to target market areas that have already taken affirmative steps to expand home energy improvements, such as educating consumers about the benefits of home energy improvements and ensuring qualified contractors are available to do the work. FHA anticipates announcing the participating lenders and communities in early 2011.

What are the benefits of PowerSaver loans for consumers?

More homeowners are seeking the practical, money saving benefits of more energy efficient homes. PowerSaver loans will enable homeowners to make cost-effective energy improvements of their choice that will lower their home's energy use and should result in lower energy bills and less greenhouse gas emissions. For many consumers, PowerSaver loans will be less expensive and easier to access than other kinds of financing for home improvements, such as credit cards and home equity loans. This is because FHA is providing mortgage insurance and other incentives to lenders to lower costs for homeowners.

How can a homeowner obtain a PowerSaver loan for home energy improvements?

FHA is soliciting expressions of interest from lenders to make PowerSaver loans. Lenders will define the markets they intend to serve with the product. Qualified borrowers in those markets will access PowerSaver loans directly from participating lenders in their communities. Participating lenders and eligible markets will be announced in early 2011.

What are the expected interest rates, closing costs and fees for PowerSaver loans?

While FHA cannot set the loan interest rate, it expects that PowerSaver loans will be available at affordable and competitive rates. FHA will select lenders in part based on their commitment to provide the most affordable financing to consumers. In addition, FHA will allow – and encourage – local communities and private organizations to help lower interest rates and other costs to consumers.

Fees and costs associated with PowerSaver will be customary for home loans and most can be financed as part of the PowerSaver loan, including origination fees, building permits, inspections and appraisals.

Is there a prepayment penalty?

No.

Is the interest payment tax deductable?

Generally, yes, if the loan is secured.

Is an energy audit required?

FHA strongly encourages – but does not require – PowerSaver borrowers to utilize an energy audit to make the most informed choice about the most appropriate energy improvements to their home.

What types of home energy improvements can borrowers make with PowerSaver?

All PowerSaver loans must be used to make cost-effective energy saving improvements, based on a list published by FHA and DOE. Examples include insulation, duct sealing, energy efficient doors, windows, HVAC systems and water heaters, solar panels and geothermal systems. The list of eligible improvements is available in Appendix B of the Federal Register Notice (FR 5450-N-01) posted on the HUD website at http://portal.hud.gov/portal/page/portal/HUD/program_offices/administration/hudclips.

What are the basic borrower criteria for PowerSaver loans?

PowerSaver loans are available to homeowners who have the wherewithal and motivation to make energy improvements to their home.

- Minimum credit score: 660
- Maximum total debt to income ratio: 45%
- Maximum combined loan-to-value (first mortgage loan balance & PowerSaver): 100%
- Property type: Existing 1-unit, owner-occupied, detached, principal residence properties only.
- Appraisal requirement: Exterior-only inspection residential appraisal or other FHA accepted method of property valuation.

What measures have been taken to protect consumers who are interested in the PowerSaver program?

PowerSaver has been carefully designed to meet a need in the marketplace for borrowers who have the ability and motivation to take on modest additional debt to realize the savings over time from a home energy improvement. PowerSaver loans are only available to borrowers with good credit, manageable overall debt and at least some equity in their home.

Also, PowerSaver, like the underlying FHA Title I program, provides up to 90 percent insurance against loan default. Lenders are responsible for the remainder, which provides strong market-based incentives to lenders to perform high-quality underwriting. FHA will carefully select PowerSaver lenders and closely review their activities.

How do PowerSaver loans compare to other similar products in the marketplace?

PowerSaver helps fill a gap in the marketplace. There is no widely available and affordable home mortgage product specifically for home energy improvements. Current consumer options are generally limited to unsecured personal loans, credit cards, contractor liens (which generally have higher interest rates), and home equity lines of credit (which generally are limited to borrowers with very high credit scores and significant home equity.)

Given the widely varying consumer credit profiles, financial capacity and current home values, more than one financing option is needed to increase the scale of home energy improvements nationwide. For many homeowners and communities PowerSaver should provide an appealing option.

FHA PowerSaver

Frequently Asked Questions (FAQs) for Lenders

What is the FHA PowerSaver program and when will it be available?

PowerSaver is a new insurance program from the Federal Housing Administration (FHA) to enable homeowners to make cost effective, energy saving improvements to their homes. PowerSaver will provide federal loan insurance and other incentives to participating lenders to deliver low-cost home energy improvement loans. Homeowners will be able to borrow up to $25,000 for terms of 15 years (up to 20 years for certain improvements) to make proven home energy improvements of their choice, based on a list developed by FHA and the U.S. Department of Energy (DOE).

PowerSaver will begin as a nationwide two-year pilot program, launching in 2011. FHA is currently seeking lenders to participate in the pilot program. In selecting participating lenders, FHA will consider the market areas lenders propose to serve. Generally, FHA will require lenders to target market areas that have already taken affirmative steps to expand home energy improvements, such as educating consumers about the benefits of home energy improvements and ensuring qualified contractors are available to do the work. FHA anticipates announcing the participating lenders and communities in early 2011.

How will lenders benefit from participation in the FHA PowerSaver program?

According to industry forecasts and experts such as the Harvard University Joint Center for Housing Studies, more homeowners are interested in making their homes energy efficient. And local communities across the country are investing in consumer education programs to help homeowners make the right home energy improvement decisions and identify qualified contractors.

Still, options are limited for financing home energy improvements, especially for the many homeowners who are unable to take out a home equity loan or access an affordable consumer loan. PowerSaver provides lenders with a new product option to serve these homeowners and participate in a potentially growing market.

FHA will also provide:

1. Incentive payments to participating lenders primarily to help lower the cost of loans for consumers. Funds generally will be available to directly lower
   - loan interest rates for borrowers; and
   - servicing costs for originating lenders that also service PowerSaver loans– that also lead to lower interest rates for borrowers.
2. Streamlined insurance claims payment procedures.

Is there a secondary mortgage market for FHA PowerSaver loans?

While some lenders may choose to hold PowerSaver loans they originate, FHA recognizes that others may wish to sell them. PowerSaver was designed to enable liquidity for originating lenders. FHA will be working with Ginnie Mae and other entities on secondary market options for PowerSaver loans as the program gets off the ground, with the goal of further expanding the affordability and availability of PowerSaver loans.

How can local communities work with lenders to participate in the PowerSaver program?

FHA strongly encourages communities interested in expanding home energy improvements to encourage lenders serving their market areas to apply for participation in the PowerSaver program. In addition, under the PowerSaver program, local communities – including public agencies, nonprofit organizations and private sector entities – may provide funding that enhances the benefits of PowerSaver loans for consumers: local sources of funds could help support marketing, fund quality energy audits, offset servicing costs or reduce loan interest rates, for example.

What are the eligibility and underwriting criteria for PowerSaver loans?

PowerSaver loans are available to homeowners who have the wherewithal and motivation to make energy improvements to their home.

- Minimum credit score: 660
- Maximum total debt-to-income ratio: 45%
- Maximum combined-loan-to-value (first mortgage loan balance & PowerSaver): 100%
- Property Types: Existing 1-unit, owner-occupied, detached, principal residence properties only.
- Appraisal requirement: Exterior-only inspection residential appraisal or other FHA accepted method of property valuation.
- Loan Term: 15 years (20 years for renewable energy improvements)
- Lien position: Generally secured by mortgages or deeds of trust subordinate to the first mortgage, when one exists, and must hold not less than second lien position. Loans under $7,500 are not required by FHA to be secured, but lenders may opt to secure them.
- Maximum loan: $25,000
- Financing Costs: PowerSaver allows public agencies, nonprofits and private institutions to help lower the cost of financing for consumers with grants and other funds.
- Eligible Improvements: All PowerSaver loans must be used to make cost-effective energy saving improvements, based on a list published by FHA and DOE. Examples include insulation, duct sealing, energy efficient doors, windows, HVAC systems and water heaters, solar panels and geothermal systems. The list of eligible improvements is available in Appendix B of the Federal Register Notice posted on the Federal Register website at http://federalregister.gov.
- Energy Audit: While FHA does not require an energy audit homeowners should be encouraged to obtain one from a qualified professional. The results can help homeowners choose the most cost effective improvements.

What is required for lenders to participate in the PowerSaver Program and how do they apply?

Lenders must be FHA-approved as FHA Title I lenders to be eligible to participate in PowerSaver. Lenders that are FHA-approved Title II lenders that are not Title I approved will be required to obtain Title I approval in order to participate and may do so under an expedited process.

To be selected for participation in the PowerSaver program lenders must be able to demonstrate relevant experience, and have the:

1. Technical capability to interface with FHA through FHA Connection and any other computer systems utilized by FHA or its contractors pertaining to PowerSaver;
2. Ability to provide timely reports to FHA on loan origination and performance; and
3. Capacity to work in partnerships with public sector agencies, nonprofit organizations, utilities, and/or home improvement contractors.

FHA lenders of all types and size that have the commitment and capacity to provide PowerSaver loans are encouraged to apply for participation in the program. In selecting lenders to participate, FHA will evaluate:

1. Anticipated loan volume and target markets;
2. Goals and approach for participating;
3. Capacity (experience and/or potential) to work in public-private partnerships; and
4. Intent to deliver the most favorable loan product to consumers.

The following factors may also be considered:

1. Diversity of lender type and target market, by geography and/or
2. Commitment to serve lower-income households and communities.

Lenders will be required to describe specifically how they will use PowerSaver funds and demonstrate the resulting consumer benefit. FHA will closely monitor the use of funds to ensure they result in bona fide benefit to borrowers.

To apply to participate in PowerSaver, lenders must submit an "Expression of Interest" to FHA using the template and instructions located in Appendix A of the Federal Register Notice posted on the Federal Register website at http://federalregister.gov. Lenders that fail to do so will not be considered for participation. The Expression of Interest must be emailed to FHA at FHAPowerSaver@hud.gov.

What are the lender reporting requirements for the FHA PowerSaver program?

Lenders will be required to provide timely reports to FHA on the origination and performance of PowerSaver loans. FHA envisions requiring monthly reports on loan and portfolio performance. Lenders must be able to provide an electronic loan package to FHA for a random sample of loans chosen for quality reviews. FHA may also require reporting on the specific home energy improvements financed with each PowerSaver loan, using a standard template that FHA will provide to participating lenders.

How does PowerSaver compare to PACE (Property-Accessed Clean Energy) financing?

PowerSaver loans are subordinate to first mortgages, if there is a first mortgage, unlike most versions of PACE financing. In addition, PowerSaver loans are originated by FHA approved lenders, whereas PACE assessments are typically levied by local governments. As a result, Power Saver loans generally are secured by mortgages or deeds, not property tax assessments, as under PACE. Notwithstanding these differences, communities and homeowners that had been planning on utilizing PACE financing and now may not have that option, may consider PowerSaver as an alternative.

How does PowerSaver relate to the FHA Title I Property Improvement program?

FHA developed PowerSaver utilizing the statutory authority and regulatory framework for the FHA Title I Property Improvement program. This pilot is funded from the Energy Innovation Fund established in the Consolidated Appropriations Act, 2010. The PowerSaver program provides incentives and additional underwriting criteria that the Title I program does not, and PowerSaver loans can only be used for improvements that result in better home energy performance. PowerSaver is a separate program. However, certain features and limitations of the Title I program apply, including the:

- 90 percent limitation on FHA mortgage insurance; and
- Maximum insurance coverage of 10 percent in aggregate of the total amount of a lender's Title I loan portfolio.

The Title I Property Improvement program remains unchanged.

Attachment 9

U.S. Department of Energy, Federal Energy Management Program

Building Life-Cycle Cost (BLCC) Programs (Overview)

U.S. Department of Energy - Energy Efficiency and Renewable Energy
Federal Energy Management Program

Building Life-Cycle Cost (BLCC) Programs

The National Institute of Standards and Technology (NIST) developed the Building Life-Cycle Cost (BLCC) Program to provide computational support for the analysis of capital investments in buildings. BLCC features several components, including:

- Building Life-Cycle Cost Program
- Energy Escalation Rate Calculator
- Handbook 135
- Annual Supplement to Handbook 135

Building Life-Cycle Cost Program

Register and download. BLCC 5.3-11 (for Windows, Mac OS X or Linux).

BLCC is programmed in Java with an XML file format. The user's guide is part of the BLCC Help system. BLCC version 5.3-11 contains the following six modules:

1. **FEMP Analysis; Energy Project**: For energy and water conservation and renewable energy projects under the FEMP rules based on 10 CFR 436.

2. **Federal Analysis; Financed Project**: For Federal projects financed through energy savings performance contracts (ESPCs) or utility energy services contracts (UESCs).

3. **OMB Analysis**: Projects subject to the Office of Management and Budget (OMB) Circular A-94 for non-energy, Federal Government construction projects, but not water resource projects.

4. **MILCON Analysis; Energy Project**: For energy and water conservation and renewable energy projects in military construction.

5. **MILCON Analysis; ECIP Project**: For energy and water conservation projects under the Energy Conservation Investment Program (ECIP).

6. **MILCON Analysis; Non-Energy Project**: For military construction designs that are not primarily intended for energy or water conservation.

BLCC conducts economic analyses by evaluating the relative cost effectiveness of alternative buildings and building-related systems or components. Typically, BLCC is used to evaluate alternative designs that have higher initial costs but lower operating costs over the project life than the lowest-initial-cost design. It is especially useful for evaluating the costs and benefits of energy and water conservation and renewable energy projects. The life-cycle cost (LCC) of two or more alternative designs are computed and compared to determine which has the lowest LCC and is therefore more economical in the long run. BLCC also calculates comparative economic measures for alternative designs, including net savings, savings-to-investment ratio, adjusted internal rate of return, and years to payback.

The software can evaluate Federal, state, and local government projects for both new and existing buildings. While BLCC is oriented toward building-related decisions, it can be used to evaluate alternative designs for almost any project type in which higher capital investment costs lower future operating-related costs.

Back to top

Energy Escalation Rate Calculator

EERC 2.0-11 (for Windows, Mac OS X or Linux)

The Energy Escalation Rate Calculator computes an average annual escalation rate for a specified time period, which can be used as an escalation rate for contract payments in Energy Savings Performance Contracts (ESPC) and Utility Energy Services Contracts (UESC). Escalation rates can be computed based on the Energy Information Administration (EIA) energy price projections used for calculating the FEMP discount factors and on EIA projections adjusted by NIST for potential carbon pricing.

Back to top

Handbook 135

Handbook 135, the Life-Cycle Costing Manual for FEMP, explains in detail the principles of life-cycle cost analysis and integrates them with FEMP criteria.

Back to top

Annual Supplement to Handbook 135

Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis 2011, Annual Supplement to Handbook 135, are embedded in the above software and also available as printed tables in this publication. The factors are calculated with the latest FEMP discount factors and energy price escalation rates for U.S. Census regions, rate types, and fuel types.

Back to top

Attachment 10

National Institute of Standards and Technology

Life-Cycle Costing Manual for the Federal Energy Management Program (NIST Handbook 135)

(Feb. 1996)

[Omitted Appendices B, C, and E]

NIST Handbook 135
1995 Edition

LIFE-CYCLE COSTING MANUAL
for the Federal Energy Management Program

Sieglinde K. Fuller
Stephen R. Petersen

Building and Fire Research Laboratory
Office of Applied Economics
Gaithersburg, MD 20899

February 1996
Supersedes 1987 Revision

Prepared for:
U.S. Department of Energy
Office of the Assistant Secretary for
Conservation and Renewable Energy
Federal Energy Management Program
Washington, DC 20585

U.S. DEPARTMENT OF COMMERCE, Ronald H. Brown, *Secretary*
Technology Administration, Mary L. Good, *Under Secretary for Technology*
National Institute of Standards and Technology, Arati Prabhakar, Director

National Institute of Standards and Technology Handbook 135, 1996 Edition
Natl. Inst. Stand. Technol. Handb. 135, 1996 Ed., 210 pages (Feb. 1996)
CODEN: NIHAE2

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1996

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402–9325

Bibliographic Information

Abstract

Handbook 135 is a guide to understanding the life-cycle cost (LCC) methodology and criteria established by the Federal Energy Management Program (FEMP) for the economic evaluation of energy and water conservation projects and renewable energy projects in all federal buildings. It expands on the life-cycle cost methods and criteria contained in the FEMP rules published in 10 CFR 436, Subpart A, which applies to all federal agencies. The purpose of this handbook is to facilitate the implementation of the FEMP rules by explaining the LCC method, defining the measures of economic performance used, describing the assumptions and procedures to follow in performing evaluations, giving examples, and noting NIST computer software available for computation and reporting purposes. An annual supplement to Handbook 135, *Energy Price Indices and Discount Factors for LCC Analysis*, NISTIR 85-3273-X is also published by NIST to provide the current discount rate and discount factors needed for conducting an LCC analysis in accordance with the FEMP rules. This annual supplement is required when using Handbook 135.

This new edition of Handbook 135 replaces the 1987 version. The new edition is extensively revised and organized around the key steps in an LCC analysis. There are no longer separate sections for new and existing buildings and for solar programs, as the methodology no longer distinguishes between these projects.

Keywords

benefit-cost analysis; building economics; building technology; capital investment decisions; cost effectiveness; economic analysis; energy conservation; energy economics; life-cycle cost analysis; public buildings; renewable energy; water conservation.

Ordering

Copies of this document are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, at (800) 553-6847 or (703) 487-4650. The document contains 212 pages, cover to cover.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EXHIBITS

CHAPTER 1

INTRODUCTION TO

LIFE-CYCLE COST ANALYSIS

CONTENTS

Chapter 1

INTRODUCTION TO LIFE-CYCLE COST ANALYSIS

1.1 WHY USE LIFE-CYCLE COST ANALYSIS?

Life-cycle cost analysis (LCCA) is an economic method of project evaluation in which all costs arising from owning, operating, maintaining, and ultimately disposing of a project are considered to be potentially important to that decision. LCCA is particularly suitable for the evaluation of building design alternatives that satisfy a required level of building performance (including occupant comfort, safety, adherence to building codes and engineering standards, system reliability, and even aesthetic considerations), but that may have different initial investment costs; different operating, maintenance, and repair (OM&R) costs (including energy and water usage); and possibly different lives. However, LCCA can be applied to any capital investment decision in which higher initial costs are traded for reduced future cost obligations. LCCA provides a significantly better assessment of the long-term cost effectiveness of a project than alternative economic methods that focus only on first costs or on operating-related costs in the short run.

Energy conservation projects provide excellent examples for the application of LCCA. There are abundant opportunities for improving the thermal performance of building envelope components (e.g., walls, windows, roofs) in new and existing buildings to reduce heat loss in winter and heat gain in summer. Similarly, there are many alternative heating, ventilating, and air conditioning (HVAC) systems which can maintain acceptable comfort conditions throughout the year, some of which are considerably more energy efficient (or use less expensive fuels) than others. When energy conservation projects increase the initial capital cost of a new building or incur retrofit costs in an existing building, LCCA can determine whether or not these projects are economically justified from the investor's viewpoint, based on reduced energy costs and other cost implications over the project life or the investor's time horizon.

But the use of LCCA does not stop when a cost-effective energy conservation project has been identified. There are almost always a number of cost-effective design alternatives for any given building system. For example, thermal insulation can be installed over a wide range of thermal resistance values in walls and roofs. Window systems are available over a wide range of thermal conductance values and with a variety of sun-blocking films. Many of these alternatives may be cost effective, but (usually) only one can actually be used in a given application. In such cases, LCCA can be used to identify the **most** cost-effective alternative for that application. This is generally the alternative with the lowest life-cycle cost.

LCCA can also be used to prioritize the allocation of funding to a number of independent capital investment projects within a facility or agency when insufficient funding is available to implement them all. This application involves the ranking of projects by their Savings-to-Investment Ratio (SIR) or by their Adjusted Internal Rate of Return (AIRR), supplementary measures of economic performance based on LCCA.

LCCA stands in direct contrast to the Payback method of economic analysis. The Payback method generally focusses on how quickly the **initial investment** can be recovered, and as such is not a measure of **long-term** economic performance or profitability. The Payback method typically ignores all costs and savings occurring after the point in time in which payback is reached. It also does not differentiate between project alternatives having different lives, and it often uses an arbitrary payback threshold. Moreover, the Simple Payback method, which is commonly used, ignores the **time-value of money** when comparing the future stream of savings against the initial investment cost.

LCCA is a powerful tool of economic analysis. As such, it requires more information than do analyses based on first-cost or short-term considerations. It also requires additional understanding on the part of the analyst of concepts such as **discounted cash flow**, **constant versus current dollars**, and **price escalation rates**. The alternative, however, is to ignore the long-run cost consequences of investment decisions, to reject profitable investment opportunities, and to accept higher-than-necessary utility costs.

There are other incentives to use LCCA for project evaluation. Tables of present-value factors for use with different types of cash flows greatly simplify the computational requirements of an LCCA. And NIST LCC computer programs will help you **organize, compute, document, and report** your analyses. This handbook will provide you with the basic understanding, examples, and discount factors that you will need to undertake a successful LCC evaluation. You should also recognize that the most difficult part of any analysis of energy and water conservation projects is usually the estimation of their annual energy-related and water-related savings and corresponding reductions in utility bills. This activity alone often requires as much as 90 percent of the effort needed to support a credible project analysis. Once you have mastered the basic principles of LCCA, you will find that the additional information that it provides to the decision maker is well worth the relatively small additional effort that it requires.

The LCCA methodology outlined in this handbook is limited to the economic analysis of project alternatives and the prioritization of independent projects when allocating a limited budget among such projects within a facility or agency. Engineering, design, and calculation of loads and energy usage for buildings and building systems are not covered in any detail in this handbook. Moreover, this handbook does not provide initial cost data; operating, maintenance, and repair (OM&R) cost data; or expected lives of building systems. However, resources are suggested for finding such data.

1.2 THE LCC METHOD AND SUPPLEMENTARY MEASURES OF ECONOMIC ANALYSIS

The life-cycle cost (LCC) method of economic analysis is the basic building block of LCCA. The LCC method, as applied in this handbook, is used to compute the LCC of a building system or combination of interdependent systems. The LCC is the total cost of owning, operating, maintaining, and (eventually) disposing of the building system(s) over a given study period (usually related to the life of the project), with all costs adjusted (discounted) to reflect the time-value of money. But the LCC of a building system has little value by itself. It is most useful when it can be compared to the LCC of other design alternatives which can perform the same function, in order to determine which alternative is most cost effective for this purpose. These alternatives are called "mutually exclusive" alternatives because only one alternative for each system evaluated can typically be selected for implementation.

In calculating the LCC for a building system (or combination of systems), all future costs are generally discounted to their present-value equivalent (as of the Base Date) using the investor's minimum acceptable rate of return as the discount rate. However, the LCC can also be estimated in annual value terms. An annual value is the cost resulting from amortizing all project costs evenly over the study period, taking into account the time-value of money. The LCC methodology outlined in Handbook 135 is based on the present-value method. However, the BLCC computer program, which supports the FEMP LCC calculation method, computes the LCC of a project alternative in both present-value and annual-value terms. (See appendix B for more information about the BLCC program.)

There are three supplementary measures of economic performance that are consistent with the LCC method of project evaluation which are used in Handbook 135. These are **Net Savings (NS)**, **Savings-to-Investment Ratio (SIR)** and **Adjusted Internal Rate of Return (AIRR)**. They are consistent with the LCC method because they are based on the same stream of costs and savings over the same study period. NS can be used in place of the LCC measure itself to determine the most cost-effective project alternative when evaluating two or more mutually exclusive project alternatives. Within any group of mutually exclusive project alternatives, the alternative with the lowest LCC will also have the highest NS. The SIR and AIRR measures are useful primarily for **ranking** independent projects (for example, a new roof on building A and a new heating system in building B) when faced with a budget that is insufficient to fund all of the cost-effective projects identified for a particular facility or agency. *The SIR and AIRR should not be used to identify the most cost effective project alternative (for example, the most economic level of* *insulation)*. The computation and proper use of these supplementary economic measures will be discussed further in chapters 6 and 7.

1.3 LCCA FOR FEDERAL PROJECTS

This handbook provides guidance to federal agencies for using LCCA to evaluate capital investment projects which reduce future operating and maintenance costs of federal facilities. The Federal Energy Management Program (FEMP) of the U.S. Department of Energy has published life-cycle costing rules and procedures in its Code of Federal Regulations, 10 CFR 436, Subpart A [1]. These FEMP rules are to be followed by all federal agencies, unless specifically exempted, in evaluating the cost effectiveness of potential energy and water conservation projects and renewable energy projects in federally owned and leased buildings. To the extent possible, these projects should be evaluated separately from non-energy and non-water related projects in federal buildings. The current DOE discount rate for energy- and water-related projects is published in the Annual Supplement to Handbook 135, *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis* [2]. This supplement is published each year at the beginning of the federal fiscal year.

For projects not related to energy or water, Office of Management and Budget (OMB) Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," [3] with annual updates to appendix C, provides the necessary methodology and discount rates. The underlying methodologies used by DOE/FEMP and OMB are essentially identical. However, the DOE/FEMP discount rate is different from the OMB discount rate, and the FEMP LCC rules include a maximum study period length of 25 years (plus any planning/construction period); OMB does not have a maximum study period length.

LCC analysts in the U.S. Department of Defense (DoD) should note that there is a Tri-Services memorandum of agreement (MOA) on "Criteria/Standards for Economic Analyses/Life Cycle Costing for MILCON Design," which is updated periodically. This memorandum is basically consistent with the FEMP LCC rule, as promulgated in 10 CFR 436. However, at present the MOA recommends (but does not require) the use of mid-year discounting for all annually recurring costs. It also recommends the lumping together of all initial investment at the midpoint of construction for projects which have a Service Date later than the Date of Study. This is different than the Handbook 135 approach, which uses the end-of-year discounting convention and recommends the phasing-in of investment costs as they are incurred over the planning/construction period. NIST publishes a special set of discount factor tables for DoD, *Present Worth Factors for LCC Studies in the Department of Defense* [4]. These tables, which are updated annually, are based on the mid-year discounting convention preferred by DoD. The BLCC computer program discussed in this handbook can be run in a "military construction (MILCON)" mode that follows the recommended method outlined in the Tri-Services MOA.

1.4 ORGANIZATION OF HANDBOOK 135

Table 1-1 lists 10 key steps in the LCCA of a capital investment project. Chapters 2 to 8 in Handbook 135 follow these steps, building up from the most basic requirements of project identification and documentation to considerations on how to use the LCC results for decision making. Appendices A to F expand on some of the subjects treated in the chapters and provide supporting information, tables, and worksheets. An index assists the user in locating specific topics. Definitions of key terms and a list of abbreviations are provided in a glossary at the very end of the handbook.

You will not need any computational tool more powerful than a four-function calculator to work through this handbook. A calculator with an exponential key (y^x) will allow you to solve some of the basic discounting and future-cost formulas presented in chapter 3, but the precalculated discount factors provided in this handbook and in the Annual Supplement to Handbook 135 will be sufficient for most applications.

Table 1-1
Key Steps in an LCC Analysis

1. Define problem and state objective
2. Identify feasible alternatives
3. Establish common assumptions and parameters
4. Estimate costs and times of occurrence for each alternative
5. Discount future costs to present value
6. Compute and compare LCC for each alternative
7. Compute supplementary measures if required for project prioritization
8. Assess uncertainty of input data
9. Take into account effects for which dollar costs or benefits cannot be estimated
10. Advise on the decision

Chapters

Chapter 2: *Getting Started* covers the steps in an LCCA that are required to get started, including defining the project objective and identifying feasible alternatives. It also discusses the importance of tailoring the level of effort to the needs of the project and establishing documentation requirements for the analysis.

Chapter 3: *Discounting and Inflation in LCC Analysis* establishes common assumptions and parameters for the economic evaluation of the alternatives. It also shows how to discount future costs to present value and to adjust costs for the effects of inflation and/or price escalation over time in a consistent fashion for each alternative being evaluated.

Chapter 4: *Estimating Costs for LCC Analysis*, treats the types of costs specific to the project alternatives to be analyzed, especially investment-related costs, non-fuel OM&R costs, energy and water costs, and the timing of those costs. It also discusses what to do with non-quantifiable effects.

Chapter 5: *Calculating Life-Cycle Costs* covers the procedures and gives examples for computing the total LCC for each project alternative and comparing the results in order to select the most economic alternative.

Chapter 6: *Calculating Supplementary Measures* provides formulas and examples for computing supplementary measures of economic analysis, such as Net Savings, Savings-to-Investment Ratio, Adjusted Internal Rate of Return, and Payback Period, for any one alternative relative to a designated base-case alternative.

Chapter 7: *Applying LCC Measures to Project Investments* addresses various uses of the LCC method and supplementary measures of economic performance to solve different types of capital investment problems related to energy and water conservation in buildings.

Chapter 8: *Dealing with Uncertainty in LCC Analysis* addresses uncertainty assessment in LCCA and focuses on how to use sensitivity analysis to deal with uncertain input data.

Appendices

Appendix A: *Special Topics in LCC Analysis* addresses the optimal timing of retrofit projects, fuel switching and variable energy usage, and the use of utility rate schedules in energy cost calculations. Each topic is illustrated with one or more examples.

Appendix B: *Software for LCC Analysis of Buildings and Building Systems* describes the NIST computer programs available for LCCA, discounting operations, and related computations.

Appendix C: *Worksheets for Life-Cycle Cost Analysis* provides worksheets for manual LCC computations and an illustration of how they may be used.

Appendix D: *Compendium of Discounting and Price Escalation Formulas* contains a variety of discounting formulas and price escalation formulas that are frequently used in LCCA, with a brief description and example of each.

Appendix E contains *Selected Tables of Energy Price Indices and Discount Factors 1995* from the Annual Supplement to Handbook 135, which are referenced or used in the examples in this handbook.

Appendix F provides a summary of the FEMP Program on *Evaluating Energy Savings Performance Contracts* (formerly known as "Shared Savings"), with an example of a net savings comparison between the use of agency funding and contractor funding for an energy project.

CHAPTER 2

GETTING STARTED

CONTENTS

Chapter 2

GETTING STARTED

2.1 PRELIMINARY CONSIDERATIONS

Life-cycle cost analyses can range widely in complexity. The specifics of each project dictate the degree of complexity warranted for the LCCA and its documentation. It is therefore useful to give some thought to planning the study before the data acquisition and computation phases.

2.1.1 Timing of Life-Cycle Cost Analysis

The planning, design, and construction process of a project comprises a myriad of decisions. Some of these decisions are economic in nature, others involve political, social, or aesthetic considerations. Design decisions usually have the greatest impact on total project costs early in this process. With each successive set of decisions, there tends to be less opportunity to make cost-saving changes in the design of a building or building system. Therefore, the earlier LCC considerations are included in the planning and design process, the greater the potential cost savings that can be expected.

2.1.2 Level of Effort

Since economic analysis itself requires resources—time and money—the effort should be tailored to the needs of the project. The scope of an analysis might vary from a "back-of-the-envelope" study to a detailed analysis with thoroughly researched input data, supplementary measures of economic evaluation, complex uncertainty assessment, and extensive documentation. The greater the potential savings, the greater the visibility of the project, and the greater the pressure to make a choice based on criteria other than economics, the more important it is to have a thoroughly researched, carefully performed, and well documented study.

This handbook presents a manual approach to conducting LCC analyses, using present value factors from the current edition of the Annual Supplement to Handbook 135 to perform present value calculations. Optional worksheets are provided in appendix C of this handbook for use with the manual approach. By reading this handbook and working through the examples manually you will develop a sufficient level of familiarity with LCCA principles to make sound investment decisions related to energy and water conservation projects in federal buildings.

Once you understand the basic principles of LCCA, however, it is recommended that you use the NIST computer software developed under the sponsorship of FEMP for performing life-cycle cost analyses of buildings and building systems. The use of these programs can greatly reduce the time and effort spent on formulating the analysis, performing the computations, and documenting the study. These programs, which provide a wide range of computational support, from the calculation of present-value factors to detailed LCC analysis and documentation, are described in appendix B.

2.1.3 Level of Documentation

LCC studies, whether small or large, need to be carefully documented in order to keep track of the evaluation process, to create a decision-supporting record, and to have information easily accessible for future studies. The format should be simple and easy to understand. Table 2-1 provides a list of items to be documented in an LCCA report. The extent of the documentation should be related to the complexity of the decision and in proper proportion to the scale of the overall project.

Table 2-1
Items to be Documented in an LCC Analysis

1 Project Description General information Type of decision to be made Constraints	**5 Computations** Discounting Computations of life-cycle costs Computations of supplementary measures
2 Alternatives Technical description Rationale for including them Non-monetary considerations	**6 Interpretation** Results of LCC comparisons Uncertainty assessment Results of sensitivity analysis
3 Common Parameters Study period Base date Service date Discount rate Treatment of inflation Operational assumptions Energy and water price schedules	**7 Non-monetary Savings or Costs** Description of intangibles **8 Other Considerations** Narrative **9 Recommendations**
4 Cost Data and Related Factors Investment-related costs Operating-related costs Energy usage amounts, by type Water usage and disposal amounts Timing of costs Cost data sources Uncertainty assessment	

2.2 DEFINE THE PROJECT AND STATE THE OBJECTIVE

The first step in a life-cycle cost analysis is to identify what has to be analyzed. It is important to understand how the analysis will be used and what type of decision is to be made in structuring the analysis and in selecting a method of economic evaluation.

2.2.1 Project Description

The project description should identify general information related to the building system being considered for design, replacement, or retrofit. This can include the type of building and activities within, occupant usage and comfort requirements (e.g., thermostat settings and lighting requirements), the types of energy and relevant rate schedules available at the building site, climatic variables affecting building energy use, and the type and energy efficiency of the existing or anticipated HVAC system (where relevant). It should list the technical criteria and desirable design features by which candidate alternatives will be evaluated, as well as technical and regulatory constraints.

2.2.2 Type of Investment Decision

In order to define and delineate the requirements of the economic analysis, it is helpful to identify the type of investment decision to be made for the project. The following list identifies the five primary types of investment-related decisions related to energy and water conservation projects in buildings that are addressed in this handbook. Table 2-2 lists examples for each of these investment types.

(1) Accept or reject a single project or system option
(2) Select an optimal efficiency level for a building system
(3) Select an optimal system type from competing alternatives
(4) Select an optimal combination of interdependent systems
(5) Rank competing projects to allocate a limited budget

An **accept/reject project** is an optional project which you would generally implement only when you can show it to be cost effective. For this type of investment decision you only evaluate the cost effectiveness of undertaking the project relative to not undertaking it. You do not compare one project alternative against another, as in the next three decision types.

The **optimal efficiency level** is the most cost-effective level of energy or water efficiency (or analogous performance parameter) for a building system. The efficiency of a system can vary over a wide range, but usually the higher the efficiency, the higher the initial investment cost. The most cost-effective level of energy or water efficiency for a building system is likely to vary from location to location depending on energy and water prices and the intensity of usage.

The **optimal system** is the most cost-effective system **type** for a particular application. The choice of system type may affect the energy performance of a building, but the selection is not based on energy or water efficiency considerations, per se. For example, the choice between an electric heat pump and a gas furnace is more likely to be based on relative energy prices and maintenance costs than on their relative energy efficiencies.

Interdependent building systems are systems which interact from an energy performance or energy cost standpoint. For example, the efficiency of the space heating system must be considered in evaluating the cost effectiveness of insulation in the exterior wall and roof systems. Heat gain from lighting fixtures will reduce the heating requirements and increase the cooling requirements of a building and thus must be considered in evaluating alternative HVAC systems for that building. When evaluating alternative designs for two or more interdependent systems at the same time, their interdependent effects must be included in the energy and economic analysis. This generally requires that total building energy usage be calculated for each alternative combination of systems considered, not the energy use for each system independently.

The first four decision types listed here are referred to in this handbook as **mutually exclusive** decisions because, while two or more alternatives may be considered for each system, only one alternative is selected for implementation. (You do not generally install two levels of insulation in a wall, or install two heating systems for the same space heating requirements.)

The fifth decision type is fundamentally different from these first four because it does not involve mutually exclusive choices. Instead, it deals with the **prioritization of independent projects** when a set of independent, cost-effective, projects has been identified but funding is insufficient to implement them all. In this situation, you rank the projects in decreasing order of cost effectiveness as a guideline to allocating available funding. In essence, your goal is to determine the most cost-effective subset of projects that can be implemented within the available level of funding.

Table 2-2
Types of Economic Decisions and Examples

1. **Accept or reject optional projects**
   - Add storm windows to existing single-pane windows
   - Install a solar water heater
   - Install a storm door
   - Install a night-setback thermostat
   - Install a water-saving commode

2. **Specify level of energy efficiency for a designated building system or component**
   - Specify insulation R-value in exterior wall
   - Specify seasonal efficiency rating of an air conditioning system
   - Specify size of collector area of a solar heating system
   - Specify annual fuel utilization efficiency for a furnace
   - Specify the U-value for a window system

3. **Select optimal system or component among competing designs**
   - Select type of heating and cooling system:
     electric heat pump or gas furnace with electric air conditioner
   - Select exterior wall construction:
     masonry or wood frame; rigid foam or mineral wool insulation
   - Select lighting fixture type

4. **Select optimal combination of interdependent systems or components**
   - Specify efficiency of heating and cooling systems *and* insulation R-values for building envelope
   - Specify type of lighting system *and* efficiency of heating and cooling systems
   - Select the size of a solar heating system *and* the efficiency of an auxiliary heating system

5. **Rank independent projects**
   - Select among numerous cost-effective energy and water conservation projects being proposed at a given government facility or institution
   - Select among numerous cost-effective energy and water conservation proposals from two or more government facilities or institutions

In chapter 7 you will see that the LCC measure by itself is generally sufficient to solve the first four of these investment decision types, while the Savings-to-Investment Ratio (SIR) or Adjusted Internal Rate of Return (AIRR) are most useful when solving the fifth type of investment decision.

2.2.3 Designating a Project as an Energy Conservation Project

In general, FEMP LCC evaluation criteria are applicable to all investments in energy and water conservation and renewable energy projects in federal facilities. This includes cogeneration projects and any project for which the type of energy to be used is to be determined in the economic analysis. To the extent possible, energy-related and non-energy-related investment decisions which are part of the same project should be evaluated separately. (Water-related decisions should be treated the same as the energy-related decisions discussed here.)

Thus,

- the economic evaluation of alternative candidates for a particular building or building system significantly affecting the energy use of a federal building should be conducted using the FEMP LCC criteria, including the DOE discount rate; and

- the economic evaluation of two substantially different buildings or building systems being considered for the same use, both incorporating approximately the same degree of energy conservation in design and using approximately the same amount of energy (so that the purpose of the evaluation is not primarily to assess energy-related savings) should generally be conducted using the criteria and discount rate specified in OMB Circular A-94.

However,

- if a project involves energy usage only peripherally, and the energy-related and non-energy-related parts of the investment cannot be broken out, the decision as to whether to use OMB Circular A-94 criteria or FEMP criteria is left to the judgment of the analyst.

An individual federal agency might wish to require that a specified percentage of project savings be energy savings before the FEMP LCC evaluation criteria can be applied. But the FEMP LCC rule does not specifically require such a screening criterion.

2.3 IDENTIFY FEASIBLE ALTERNATIVES

When selecting project alternatives for economic evaluation, it makes good sense to focus on technical features whose potential economic consequences and energy or water conservation attributes are significant. Given that energy costs often rise faster than other costs, it is expedient to look for alternatives that save future costs in return for a higher initial investment. It is essential to recognize that the problem solution can be no better than the best alternative identified for evaluation.

2.3.1 Identifying Constraints

Before identifying the alternatives to be evaluated, it is useful to consider any constraints that may exclude some alternatives from the economic analysis right at the outset. There may be physical, functional, safety-related, building-code-related, budgetary, and other constraints. For example, the building location may preclude the use of solar energy; natural gas may not be available at the building site; the building may be a historic building whose original appearance must be preserved; the available budget may be insufficient to allow the acquisition of a more energy-efficient system even if it is expected to be cost effective.[1]

[1]See appendix G for information on using energy savings performance contracts and other means of financing federal energy and water conservation projects.

Identifying constraints before beginning the analysis will save the time and effort that would have to be spent analyzing alternatives that are not practical.

2.3.2 Identifying Technically Sound Alternatives

Once the overall project has been described, the next step is to identify all **technically sound and practical alternatives**. Acceptable alternatives must not degrade the overall building performance: they must be comfort-compatible, reliable, serviceable, user-friendly, safe, and at a minimum, neutral with regard to occupant productivity and design aesthetics. They must satisfy the technical performance specifications set out in the project description. They should not make a significant negative impact on usable space in the building.

However, there are practical limits to the extent to which the search for technically sound alternatives must be conducted. For example, a technically sound project alternative which has both higher first costs and higher operating-related costs than other practical alternatives will not likely be cost effective. Such an alternative need not be considered further unless it offers benefits which are difficult to quantify in dollar terms but may nonetheless make it desirable from the investor's standpoint. Incorporation of such benefits into the final decision is discussed further in chapter 4. For some project alternatives that are not formally considered for further analysis, it may still be wise to identify them and the basic reason for not fully evaluating them in the project documentation.

2.4 SET THE STUDY PERIOD

The study period for an LCCA is the time over which the costs and benefits related to a capital investment decision are of interest to the investor. Since different investors have different time perspectives with regard to a capital investment project, there is no one correct study period for a project. But **the same study period must be used in computing the LCC of each project alternative** being compared for a given purpose. The study period begins with the base date and includes the planning/construction period (if any) and the service period (or beneficial occupancy period).

2.4.1 Base Date, Service Date, and Planning/Construction Period

Before establishing the relevant study period for an LCCA of two or more project alternatives, you must first define the relevant **base date** and **service date** for the analysis. The **planning/construction (P/C)** period is the elapsed time between the base date and service date.

2.4.1.1 The base date

The **base date** is the point in time to which all project-related costs are discounted in an LCCA. The base date is usually the first day of the study period for the project, which in turn is usually the date that the LCCA is performed. In this handbook the base date will always be synonymous with the beginning of the study period. In a constant dollar analysis, the base date usually **defines the time reference for the constant dollars** (e.g., 1995 constant dollars). It is **essential** that you use the same base date and constant-dollar year for all of the project alternatives to be compared. If you set the base date to the date that the LCCA is performed, then the constant-dollar basis for the analysis will be the current date, and you can use actual costs as of that date without adjusting for general inflation.

The simplest method of selecting a base date for a project analysis is to declare the year only (e.g., 1995). The implicit assumption in this case is that initial investment costs are incurred at the beginning of this year and that all future costs (whether investment-related or operation-related) are incurred during this year or during subsequent years throughout the study period, without assigning a particular date within those years. If the analysis warrants, you can specify the month or even the exact day for the base date, and specify all future costs in the same manner. Use of the simpler method is generally preferred when conducting an LCCA without the aid of a computer program.

If future costs are specified by year only, it is recommended that you discount those costs from the end of the year in which they occur. The supporting tables of discount factors for LCCA of federal energy conservation projects provided in the Annual Supplement to Handbook 135 assume end-of-year cash flows. However, the FEMP rules for LCC analysis (10 CFR 436) allow you to discount costs from any point in time during the year. If the timing of a future cost is identified more precisely within the year, you can discount that cost from the point of time identified or from the end of the year. You do not need to discount initial investment costs incurred on the base date because they are already in present value.

The base date is also important to the FEMP LCC methodology because it serves as the reference date for estimating all future costs. That is, future costs are calculated from their cost as of the base date with the use of appropriate price escalation rates. (See sections 3.3.3 on *Price Escalation* and 3.3.4 on *Real Escalation of Energy-Related Cash Flows*.)

Do not include "sunk costs." Sunk costs are costs that were incurred or committed to before the base date of your LCCA. By definition, sunk costs cannot be changed by the selection of any project alternative and thus cannot affect its LCC or the LCC of competing alternatives. This is an especially important consideration when setting up the base case for an existing building or building system against which new alternatives are to be evaluated. Only costs to be incurred **on or after the base date** should be included in the base case. If scrapping the existing system to accommodate a new system will generate a positive (or negative) cash flow, this should be included in the analysis since it will occur on or after the base date.

2.4.1.2 The service date

The service date is the date on which the project is expected to be implemented; operating and maintenance costs (including energy- and water-related costs) are generally incurred after this date, not before. (Energy and water costs incurred during construction or installation, or inherent in the building materials, are considered to be part of the initial investment cost and do not need to be specifically identified or evaluated in an LCCA.) For a new building the service date is sometimes referred to as the **occupancy date**.

In a simple LCCA, it may be convenient to assume that all initial investment costs are incurred on the base date and that the project (or building) is immediately put into service. That is, the base date and the service date are assumed to be the same, as shown in figure 2-1. In a more complex analysis, the service date can occur later than the base date, as shown in figure 2-2. Although manual calculations are more complex when the base date and service date do not coincide, LCC software (such as the BLCC program) perform the necessary calculations automatically.

Except in the case of replacing operating equipment for energy or water conservation purposes, you should use the **same service date for all project alternatives** if you intend to compare their LCCs. A project alternative that can be put into service sooner than another (e.g., a new office building) has additional benefits (e.g., its earlier availability to the user) and earlier operation-related costs (e.g., energy usage) which invalidate the direct comparison of LCCs. Replacing operating equipment for energy or water conservation purposes is considered to be an investment timing problem. Replacement timing is treated as a special topic in appendix A.

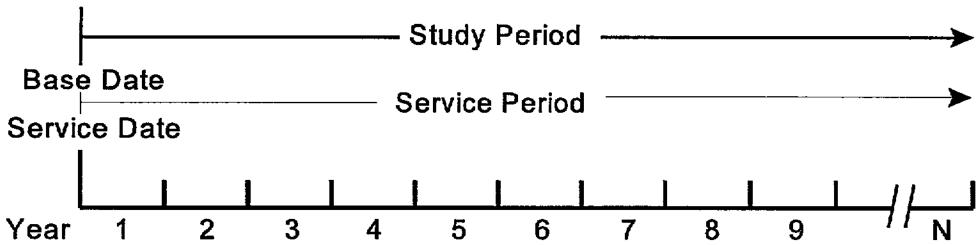


Figure 2-1
Coinciding Study Period and Service Period.

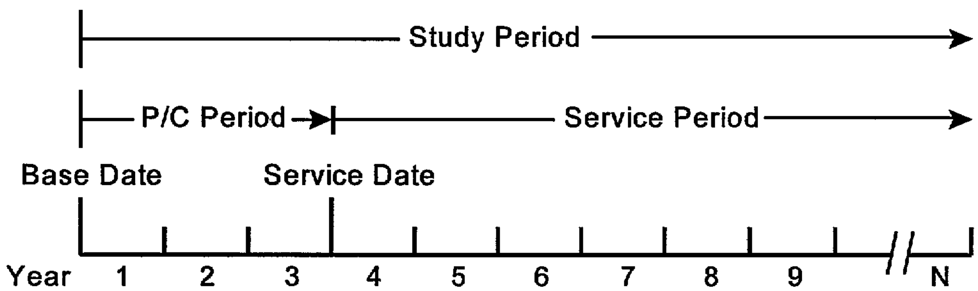


Figure 2-2
Phased-in Planning and Construction Period.

2.4.1.3 The planning/construction period

When there is a delay between the beginning of the study period and the service date, the intervening time is called the **planning/construction (P/C) period**. The P/C period is depicted in figure 2-2. In a FEMP LCCA only initial investment costs are incurred during the P/C period. You can phase in initial investment costs over the P/C period, or assign them all to any one point of time during the P/C period (for example, to the midpoint of the P/C period). In either case, **you must discount any initial investment costs occurring after the base date to their present value as of the base date.**

2.4.2 Length of Study Period and Service Period

The **study period** for an LCCA is the time over which the costs and benefits related to a capital investment decision are of interest to the decision maker. Thus, the study period begins with the base date and includes both the P/C period (if any) and the relevant service period for the project. The **service period** begins with the service date and extends to the end of the study period. In a FEMP LCCA, all operation-related costs are assumed to be incurred during the service period.

Sometimes the study period will coincide with the life of the project, and sometimes it will not, depending on the time horizon of the investor. But it is essential that you **use the same study period when evaluating mutually exclusive project alternatives**. However, the use of the same study period for each project is not required when ranking independent projects for funding allocation based on their SIR or AIRR.

The current maximum **service period** for a FEMP LCCA, as prescribed by 10 CFR 436, is **25 years**. The maximum **study period** is therefore 25 years **plus** the P/C period.

2.4.2.1 Study period determined by expected system life

Your LCCA may focus on the system itself in determining an appropriate common service period and study period for evaluating system alternatives. This is usually the case when the expected life of the system is shorter than the time-horizon of the investor. In this case, the FEMP rules in 10 CFR 436 require that the common service period be set equal to the life of the system alternative with the longest expected life (not to exceed 25 years). You should extend the life of any alternative which would end before the end of the common service period by assuming a **replacement of some or all of its components one or more times** during the service period. If you assume such replacements, they will usually have a residual value at the end of the study period which you should include in your calculations. (See chapter 4 for suggestions on how to determine residual values and sources for estimating project lives.)

2.4.2.2 Study period determined by investor's time horizon

While system service life may be the basis for setting an appropriate service period in most LCC analyses of federal energy and water conservation projects, the time horizon of the investor should also be considered. This is especially true for leased buildings and for buildings that are expected to be sold or extensively renovated before the end of the service period based on the expected life of the alternatives. Again, the service period of the LCCA cannot exceed 25 years for projects subject to FEMP LCC rules. Keep in mind that **the shorter the study period, the more critical becomes the estimate of the residual value** of the project. (However, if the building is scheduled for demolition or major rehabilitation at the end of the study period, the residual value may be zero.)

CHAPTER 3

DISCOUNTING AND INFLATION IN LCC ANALYSIS

CONTENTS

Chapter 3

DISCOUNTING AND INFLATION IN LCC ANALYSIS

Chapter 2 discussed the need to establish a **common study period, base date, and service date** when conducting an LCC analysis of two or more project alternatives. It is also essential that **the same discount rate and inflation treatment** be used in LCC analyses of multiple project alternatives. This chapter explains the fundamentals of discounting future costs to present value,[1] the use of **constant dollars** in an economic analysis as a way of treating inflation, and the adjustment of future costs for real price escalation. The methodology presented in this handbook for discounting and treating inflation is in accordance with the requirements of 10 CFR 436. It is identical to the methodology prescribed in OMB Circular A-94 and is consistent with most engineering-economics textbooks.

3.1 DISCOUNTING FUTURE AMOUNTS TO PRESENT VALUE

Project-related costs occurring at different points in time must be discounted to their **present value** as of the base date before they can be combined into an LCC estimate for that project. The discount rate used to discount future cash flows to present value is based on the investor's time-value of money. In the private sector, the investor's discount rate is generally determined by the investor's minimum acceptable rate of return (MARR) for investments of equivalent risk and duration. Since different investors have different investment opportunities, the appropriate discount rate can vary significantly from investor to investor. However, the discount rate to be used for energy- and water-conservation investments in federal buildings and facilities is established each year by DOE. The discount rate for other federal projects is established by the Office of Management and Budget. Section 3.1.2 describes federal discount rates in more detail.

3.1.1 Interest, Discounting, and Present Value

When we choose among potential project investments, we are sensitive to the timing of the cash flows generated by those investments. We generally prefer a dollar to be received (or saved) earlier rather than later. For example, we would prefer the annual yield schedule {$100, $100, $100, $100} to the annual yield schedule {0, 0, 0, $400}, even though they both have the same total cash amount. An investor prefers cash receipts earlier rather than later for two primary reasons: dollars generally loose purchasing power over time due to inflation, and cash amounts received earlier can be reinvested earlier, thereby earning additional returns.

When a cash amount is invested at a given interest rate, the future value of that cash amount at any point in time can be calculated using the mathematics of compound interest. Suppose that an initial sum of P_0 dollars is invested for t years at a rate of interest, i, compounded annually. In one year, the yield would be iP_0, which, added to the principal, P_0, would give us

$$P_1 = P_0 + iP_0 = P_0(1 + i) \tag{3.1}$$

[1] In some LCC analyses, all costs are converted to an annualized (or levelized) amount. However, the annualized method of discounting is not recommended for use in FEMP LCC analyses and is not discussed further in this handbook.

After t years, the future compound amount would be

$$P_t = P_0(1 + i)^t \tag{3.2}$$

Conversely, if we know the interest rate and the value of an interest-earning amount at the end of the first year, we can compute the initial investment amount using

$$P_0 = \frac{P_1}{(1 + i)^1} \tag{3.3}$$

And if we know the interest rate and the value of an interest-earning amount at the end of t years, we can compute the initial investment amount using

$$P_0 = \frac{P_t}{(1 + i)^t} \tag{3.4}$$

The discount rate is a special type of interest rate which makes the investor **indifferent** between cash amounts received at different points in time. That is, the investor would just as soon have one amount received earlier as the other amount received later. The mathematics of discounting is identical to the mathematics of compound interest. The discount rate, d, is used like the interest rate, i, shown in equations 3.3 and 3.4 to find the present value, PV, of a cash amount received or paid at a future point in time. Thus we can find the present value of a future amount received at the end of year t, F_t, using

$$PV = \frac{F_t}{(1 + d)^t} \tag{3.5}$$

For example, with a discount rate of 5 percent, the present value of a cash amount of $100 receivable at the end of five years is $78.35. To the investor with a 5 percent discount rate, these two amounts are time equivalent. The investor would have no preference between $78.35 received today and $100 received at the end of five years.

Project-related costs which occur at different points in time over a study period cannot be directly combined in calculating an LCC because the dollars spent at different times have different values to the investor. These costs must first be discounted to their present-value equivalent amounts; only then can the costs be summed to yield a meaningful LCC that can be compared with the LCC of other alternatives.

In section 3.3 on adjusting for inflation, the difference between **constant-dollar** and **current-dollar** cash amounts is addressed. For now, you should recognize that the discounting of future cash flows to present value is not the same as adjusting future costs for general inflation. Even when costs are expressed in constant dollars, they must be discounted to reflect the time-value of money, which is usually greater than the rate of general inflation. The discount rate used with constant-dollar amounts is different from the discount rate used with current-dollar amounts. A **real** discount rate (net of general inflation) is used **with constant-dollar amounts.** A **nominal** discount rate (inclusive of general inflation) is used with **current-dollar amounts.** However, the discounting formulas shown in section 3.2 of this chapter to convert future costs to present value are applicable to both cases.

3.1.2 DOE Discount Rate vs. OMB Discount Rate

For energy and water conservation and renewable resource projects under FEMP, the U.S. Department of Energy has legislative authority to establish the appropriate discount rate, using the procedure specified in 10 CFR 436. For fiscal year 1995 the **real** DOE discount rate is 3.0 percent (excluding general inflation); the **nominal** DOE discount rate is 6.6 percent (including general inflation). This distinction will be explained in section 3.3. **The current DOE discount rate is published each year on October 1 in the Annual Supplement to Handbook 135, Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis, 199X, NISTIR 85-3273**. The DOE discount rate applies only to investments in federally owned or leased facilities.

Most other federal projects, i.e., non-energy or water-related projects, are required to use OMB discount rates. These are specified in ***OMB Circular A-94*** (revised October 1992). Appendix C to Circular A-94 is updated annually on about March 1 to provide the current discount rates applicable for the 12 months following. The OMB discount rates are determined in part by the life of the investment and in part by who receives the benefits from the investment.

Once you decide whether the LCC analysis of a building system should be evaluated using the FEMP discount rate or the OMB discount rate, this rate should be used for all of the cost components (e.g., capital investment, energy, water, and OM&R costs) of that system. Do not use different discount rates to determine the present value of costs which will be added together or which will be compared with the costs of competing alternatives.

3.2 DISCOUNT FORMULAS AND DISCOUNT FACTORS

Table 3-1 summarizes the discounting operations most frequently used in an LCC analysis. These operations can be divided into two types:

(1) **A method for discounting one-time amounts** to present value. The definition of one-time amounts includes costs occurring at irregular or non-annual intervals. Examples of one-time costs are a capital replacement at the end of year 8, painting at five-year intervals, and a residual value at the end of the study period.

(2) **A method for discounting a series of annually recurring amounts** to a present value. Examples of annually recurring costs are routine maintenance costs occurring each year over the study period in the same amount (uniform amounts) and annual energy costs based on the same level of energy consumption from year to year but increasing from year to year at some known or estimated escalation rate (non-uniform amounts).

Each of the **discount formulas** shown in table 3-1 includes a future amount or an annually recurring amount, and a subformula which can be used to compute a corresponding **discount factor**. The computed discount factor is a scalar number by which an amount is multiplied to get its present value. The four discount factors shown in table 3-1 are those most often used in FEMP LCC analyses, i.e., the

- Single Present Value (SPV) factor,
- Uniform Present Value (UPV) factor,
- Uniform Present Value factor modified for price escalation (UPV*), and
- FEMP UPV* factor for use with energy costs.

Table 3-1
Present-Value Formulas and Discount Factors for Life-Cycle Cost Analysis.

PV formula for one-time amounts

The **Single Present Value (SPV) factor** is used to calculate the present value, PV, of a future cash amount occurring at the end of year t, F_t, given a discount rate, d.

$$PV = F_t \times \frac{1}{(1+d)^t}$$

$PV = F_t \times SPV_{(t,d)}$

The **SPV factor** for d = 3% and t = 15 years is **0.642**.

PV formula for annually recurring uniform amounts

The **Uniform Present Value (UPV) factor** is used to calculate the PV of a series of equal cash amounts, A_0, that recur annually over a period of n years, given d.

$$PV = A_0 \times \sum_{t=1}^{n} \frac{1}{(1+d)^t} = A_0 \times \frac{(1+d)^n - 1}{d(1+d)^n}$$

$PV = A_0 \times UPV_{(n,d)}$

The **UPV factor** for d = 3% and n = 15 years is **11.94**.

PV formula for annually recurring non-uniform amounts

$$PV = A_0 \times \sum_{t=1}^{n} \left(\frac{1+e}{1+d}\right)^t = A_0 \frac{(1+e)}{(d-e)}\left[1 - \left(\frac{1+e}{1+d}\right)^n\right]$$

The **Modified Uniform Present Value (UPV*) factor** is used to calculate the PV recurring annual amounts that change from year to year at a **constant** escalation rate, e (i.e., $A_{t+1} = A_t \times (1+e)$), over n years, given d. The escalation rate can be positive or negative.

$PV = A_0 \times UPV^*_{(n,d,e)}$

The **UPV* factor** for e = 2%, d = 3%, and n = 15 years is **13.89**.

PV formula for annually recurring energy costs (FEMP LCCA)

The **FEMP UPV* factor** is used to calculate the PV of annually recurring energy costs over n years, which are assumed to change from year to year at a **non-constant** escalation rate, based on DOE projections. FEMP UPV* factors are precalculated for the current DOE discount rate and published in tables Ba-1 through Ba-5 of the Annual Supplement to Handbook 135.

$PV = A_0 \times UPV^*_{(reg,\ ft,\ rt,\ d,n)}$

The **FEMP UPV* factor** for region (reg) = 3, fuel type (ft) = electricity, rate type (rt) = commercial, d = 3%, and n = 15 is **12.12** (1995).

These discount factors can be precalculated to reduce the amount of work needed in a manual LCCA. Exhibits 3-1 to 3-3 and appendix E show examples of precalculated discount factor tables for FEMP LCCA. A comprehensive set of discounting formulas is presented in appendix D.

Note: Once you decide that the LCC analysis of a building system is to be performed using either the FEMP discount rate or the OMB discount rate, this rate should be used for the present-value calculations of all of the cost components (e.g., capital investment, OM&R costs, as well as energy and water costs) for the base case and the alternatives. Do not use different discount rates to calculate the present value of costs that will be added together or that will be compared with the cost of competing alternatives.

3.2.1 Discounting One-Time Amounts

The **Single Present Value (SPV) factor**, when multiplied by the future one-time amount, will yield the present value of that amount.

Example: A replacement cost of $1,000 incurred at the end of year 5, discounted to present value using a 3 percent discount rate, yields a present value of $862.61.

$$PV = \$1{,}000 \times \frac{1}{(1 + 0.03)^5} = \$862.61 \tag{3.6}$$

Exhibit 3-1, a table taken from the Annual Supplement to Handbook 135, provides the computed SPV factors for time periods of 1 to 30 years, based on current (fiscal year 1995) discount rates for federal projects. The SPV factor shown in Exhibit 3-1 for 5 years at a 3 percent discount rate is **0.863,** which when multiplied by the future amount of $1,000, yields the same present value as equation 3.6 (with allowance for rounding), i.e.,

$$PV = \$1{,}000 \times 0.863 = \$863.00 \tag{3.7}$$

3.2.2 Discounting Annually Recurring Amounts

Annually recurring amounts may be either **uniform** amounts or **non-uniform** amounts. Uniform amounts have the same dollar value from year to year, whereas non-uniform amounts change from year to year, either decreasing or increasing at a **constant rate** or at a **variable rate**.

3.2.2.1 Annually recurring uniform amounts

The **Uniform Present Value (UPV) factor**, when multiplied by the annually recurring cost, yields the present value of the entire stream of costs over the designated number of years.

Example: An annual maintenance cost of $100 over 5 years, discounted to present value using a 3 percent discount rate, yields a present value of $457.97.

$$PV = \$100 \times \frac{(1 + 0.03)^5 - 1}{0.03(1 + 0.03)^5} = \$457.97 \tag{3.8}$$

Computed UPV factors for FEMP and OMB LCC analyses, based on the current federal discount rates, can be found in table A-2 of the Annual Supplement to Handbook 135. Exhibit 3-2 shows a reproduction of this table for FY 1995, when the FEMP discount rate was set at 3.0 percent. The UPV factor shown in Exhibit 3-2 for 5 years at a 3 percent discount rate is **4.58**, which, when multiplied by the annual amount of $100 yields the same present value as eq (3.8) (with allowances for rounding).

Exhibit 3-1
SPV Factor Table from Annual Supplement to Handbook 135

Table A-1. SPV factors for finding the present value of future single amounts (non-fuel, 1995)

Single Present Value (SPV) Factors

Year of Occurrence (t)	DOE Discount Rate 3.0%	OMB Discount Rates[a] Short Term[b] 2.5%	OMB Discount Rates[a] Long Term[c] 2.8%
1	0.971	0.976	0.973
2	0.943	0.952	0.946
3	0.915	0.929	0.920
4	0.888	0.906	0.895
5	0.863	0.884	0.871
6	0.837	0.862	0.847
7	0.813	0.841	0.824
8	0.789	0.821	0.802
9	0.766	0.801	0.780
10	0.744	0.781	0.759
11	0.722		0.738
12	0.701		0.718
13	0.681		0.698
14	0.661		0.679
15	0.642		0.661
16	0.623		0.643
17	0.605		0.625
18	0.587		0.608
19	0.570		0.592
20	0.554		0.576
21	0.538		0.560
22	0.522		0.545
23	0.507		0.530
24	0.492		0.515
25	0.478		0.501
26	0.464		0.488
27	0.450		0.474
28	0.437		0.462
29	0.424		0.449
30	0.412		0.437

[a] OMB discount rates as of March 1994. OMB rates are expected to be revised in February 1995.
[b] Short-term discount rate based on OMB discount rate for 7-year study period.
[c] Long-term discount rate based on OMB discount rate for 30-year study period.

Exhibit 3-2
UPV Factor Table from Annual Supplement to Handbook 135

Table A-2. UPV factors for finding the present value of future single amounts (non-fuel, 1995)

Year of Occurrence (t)	Uniform Present Value (UPV) Factors: FEMP Discount Rate 3.0%	OMB Discount Rates[a]: Short Term[b] 2.5%	Long Term[c] 2.8%
1	0.97	0.98	0.97
2	1.91	1.93	1.92
3	2.83	2.86	2.84
4	3.72	3.76	3.73
5	4.58	4.65	4.61
6	5.42	5.51	5.45
7	6.23	6.35	6.28
8	7.02	7.17	7.08
9	7.79	7.97	7.86
10	8.53	8.75	8.62
11	9.25		9.36
12	9.95		10.07
13	10.63		10.77
14	11.30		11.45
15	11.94		12.11
16	12.56		12.76
17	13.17		13.38
18	13.75		13.99
19	14.32		14.58
20	14.88		15.16
21	15.42		15.72
22	15.94		16.26
23	16.44		16.79
24	16.94		17.31
25	17.41		17.81
26	17.88		18.30
27	18.33		18.77
28	18.76		19.23
29	19.19		19.68
30	19.60		20.12

[a] OMB discount rates as of March 1994. OMB rates are expected to be revised in February 1995.
[b] Short-term discount rate based on OMB discount rate for 7-year study period.
[c] Long-term discount rate based on OMB discount rate for 30-year study period.

3.2.2.2 Annually recurring non-uniform amounts

The **Modified Uniform Present Value (UPV*) factor**, can be used to convert to present value annually recurring costs that change from year to year at a constant escalation rate, e, i.e., $A_{t+1} = (1+e)A_t$.

Example: A maintenance cost of $100 occurs annually and is expected to increase at 2 percent per year over 5 years. When discounted to present value using a discount rate of 3 percent, it will yield a present value of $485.62. Note that the annual amount is specified at the price level of the base date when using the UPV or UPV factors.*

$$PV = \$100 \times \frac{(1 + 0.02)}{(0.03 - 0.02)} \left[1 - \left(\frac{1 + 0.02}{1 + 0.03} \right)^5 \right] = \$485.62 \qquad (3.9)$$

The computed UPV* factor for 5 years, at a discount rate of 3 percent and a constant escalation rate of 2 percent, is **4.8562.**

UPV* factor tables which include constant escalation rates are not included in this handbook or the Annual Supplement to Handbook 135. The FEMP LCC methodology assumes that prices for goods and services other than energy change at approximately the rate of general inflation, so that in a constant-dollar analysis the real escalation rate is zero. (The use of constant dollars and real escalation rates in FEMP LCC analyses is covered in section 3.3.) The NIST DISCOUNT program can be used to calculate these factors using any combination of discount rate, escalation rates, and study period. See appendix B for more information on this program.

3.2.2.3 Annually recurring energy costs

The **FEMP Modified Uniform Present Value (FEMP UPV*) factor** is a special UPV* factor for use with annually recurring energy costs. FEMP UPV* factors are precalculated factors, based on the current DOE discount rate and on energy price escalation rates projected by DOE's Energy Information Administration. The DOE escalation rates vary by year, region, fuel type, and rate type. The forecast is based on a mid-range scenario with regard to the performance of the domestic economy and world oil prices over 30 years. The FEMP rules in 10 CFR 436 require that these DOE energv price escalation rates be used in LCC analyses of energy-conservation projects in federal facilities.

Current FEMP UPV* factors are published in the Annual Supplement to Handbook 135, tables Ba-1 through Ba-5. Separate tables are published for each of the four major census regions of the United States and for the U.S. Average. These FEMP UPV* factors, when multiplied by the annual energy cost (as calculated using energy prices as of the base date),[2] yield the present value of energy costs for the number of years indicated, given the current DOE discount rate. The FEMP UPV* tables for fiscal year 1995 are included in appendix F of this manual.

Example: Assume that you are evaluating an energy conservation project in a federal building located in Connecticut. The annual cost of natural gas for space heating is $20,000, using commercial gas prices as of the beginning of the study period (1995). The present value of these annual gas costs over 20 years can be computed by multiplying the annual cost of $20,000 by the appropriate FEMP UPV factor of 17.51. The present value is*

$$\$20{,}000 \times 17.51 = \$350{,}200 \qquad (3.10)$$

Table Ba-1 for census region 1, as published in the Annual Supplement to Handbook 135 for FY 1995, is shown in exhibit 3-3. The top of the table shows the states located in the census region covered in the table.

[2] See section 4.6.1 for more details related to the calculation of annual energy costs.

Since DOE forecasts of energy price escalation rates vary by **fuel type** (electricity, distillate and residual fuel oils, natural gas, LPG, and coal) and by **rate type** (residential, commercial, and industrial), FEMP UPV* factors are computed for each combination of energy type and rate type over study periods ranging from 1 to 30 years. The FEMP UPV* factor of **17.51** is found in the section headed "Commercial," in the column headed "NTGAS," in the row where N, the number of years, is equal to 20.

3.2.3 Discounting When There is a Planning/Construction Period

For LCC analyses in which a planning/construction (P/C) period occurs before the service date, special consideration must be given to **annually recurring costs** before discounting them to present value. For **one-time costs** occurring at any time during the study period, the SPV factor is used as shown above. That is, the present value at the base date is calculated with the appropriate SPV factor for the number of years between the base date and the time the cost is incurred. However, this is not the case with annually recurring costs. Annually recurring costs are not generally incurred during the P/C period, but instead are usually assumed **to begin at the date the project is put into service**. The use of a UPV or UPV* factor based on the full study period, which includes the P/C period, would implicitly include in the present-value calculation annually recurring costs that did not occur in the P/C period. To exclude those costs for the length of the P/C period, take the following steps:

(1) Look up (or calculate) the UPV (UPV*) factor for the number of years in the entire study period (including the P/C period).

(2) Look up (or calculate) the UPV (UPV*) factor for the years in the P/C period.

(3) Use the positive difference between the two factors as the appropriate UPV (FEMP UPV*) factor by which to multiply the annual recurring cost (specified in base-date prices).

This procedure will give the present value as of the base date of the annually recurring costs over the service period only.

Example: Assume that natural gas to be used in a new heating system in a commercial building in census region 1 is estimated to cost $20,000 per year, based on gas prices at the base date. This system is expected to be put into service three years after the base date and to continue in use for 20 years after the service date. Compute the present value, as of the base date, of the cost of natural gas over the 20 year service period.

(1) From exhibit 3-3, the FEMP UPV* factor for region 1, commercial natural gas, for 23 years (3 years P/C period plus 20 years of usage), is **19.79**.

(2) The corresponding FEMP UPV* factor for 3 years (the P/C period) is **2.94**.

(3) The appropriate FEMP UPV* factor for computing the present value of the natural gas usage over 20 years as of the base date is **16.85** (=19.79-2.94), which when multiplied by $20,000 yields a present value of $337,000.

Exhibit 3-3
UPV* Discount Factor Table from Annual Supplement to Handbook 135

Table Ba-1. UPV* Discount Factors adjusted for fuel price escalation, by end-use sector and fuel type, FY 1995
Discount rate = 3.0 percent (FEMP)

Census Region 1 (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont)

	RESIDENTIAL				COMMERCIAL					INDUSTRIAL					TRANSPORT	
N	ELEC	DIST	LPG	NTGAS	ELEC	DIST	RESID	NTGAS	COAL	ELEC	DIST	RESID	NTGAS	COAL	GASLN	N
-	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-
1	0.98	0.98	0.98	0.99	0.96	0.98	1.01	1.00	1.00	0.96	0.98	1.01	1.00	0.95	1.01	1
2	1.93	1.94	1.95	1.96	1.90	1.94	2.03	1.98	1.97	1.89	1.95	2.04	1.99	1.88	2.02	2
3	2.86	2.88	2.91	2.92	2.80	2.90	3.07	2.94	2.92	2.79	2.91	3.08	2.96	2.78	3.02	3
4	3.77	3.82	3.85	3.86	3.69	3.86	4.10	3.89	3.84	3.66	3.86	4.12	3.93	3.74	4.00	4
5	4.65	4.75	4.78	4.77	4.55	4.81	5.13	4.82	4.75	4.52	4.82	5.15	4.88	4.69	4.97	5
6	5.53	5.67	5.71	5.67	5.38	5.76	6.16	5.73	5.63	5.35	5.78	6.19	5.81	5.56	5.93	6
7	6.38	6.58	6.62	6.56	6.20	6.71	7.20	6.63	6.52	6.16	6.73	7.25	6.75	6.41	6.88	7
8	7.22	7.49	7.53	7.43	7.00	7.67	8.26	7.52	7.38	6.96	7.69	8.31	7.67	7.23	7.81	8
9	8.05	8.39	8.42	8.27	7.77	8.62	9.33	8.39	8.22	7.72	8.65	9.39	8.58	8.03	8.73	9
10	8.86	9.28	9.30	9.12	8.53	9.56	10.39	9.26	9.04	8.47	9.60	10.46	9.49	8.81	9.64	10
11	9.65	10.15	10.17	9.95	9.26	10.50	11.44	10.12	9.82	9.19	10.54	11.53	10.39	9.57	10.53	11
12	10.43	11.01	11.02	10.77	9.97	11.42	12.50	10.96	10.57	9.90	11.47	12.60	11.28	10.30	11.40	12
13	11.20	11.86	11.85	11.58	10.67	12.33	13.56	11.81	11.31	10.59	12.38	13.68	12.18	11.02	12.26	13
14	11.95	12.69	12.68	12.40	11.35	13.23	14.61	12.66	12.02	11.27	13.29	14.75	13.07	11.73	13.11	14
15	12.71	13.51	13.48	13.20	12.02	14.12	15.63	13.50	12.71	11.93	14.19	15.78	13.96	12.43	13.94	15
16	13.44	14.32	14.28	13.98	12.66	14.99	16.64	14.32	13.37	12.58	15.08	16.81	14.84	13.10	14.75	16
17	14.17	15.11	15.06	14.76	13.28	15.86	17.65	15.14	14.02	13.20	15.95	17.84	15.71	13.77	15.55	17
18	14.88	15.89	15.84	15.52	13.88	16.71	18.65	15.94	14.66	13.82	16.81	18.86	16.57	14.42	16.34	18
19	15.57	16.65	16.60	16.27	14.47	17.56	19.65	16.73	15.28	14.41	17.66	19.88	17.42	15.05	17.12	19
20	16.26	17.40	17.35	17.01	15.04	18.39	20.64	17.51	15.88	14.99	18.50	20.90	18.27	15.68	17.89	20
21	16.92	18.14	18.08	17.74	15.60	19.21	21.63	18.28	16.47	15.56	19.33	21.91	19.11	16.29	18.65	21
22	17.58	18.86	18.81	18.45	16.13	20.01	22.61	19.04	17.05	16.12	20.15	22.92	19.93	16.90	19.39	22
23	18.22	19.57	19.52	19.15	16.66	20.81	23.59	19.79	17.62	16.65	20.96	23.93	20.75	17.49	20.13	23
24	18.85	20.27	20.23	19.85	17.17	21.60	24.56	20.53	18.17	17.18	21.76	24.94	21.56	18.07	20.86	24
25	19.46	20.96	20.92	20.53	17.66	22.38	25.52	21.26	18.71	17.69	22.55	25.94	22.35	18.63	21.57	25
26/a	20.06	21.63	21.60	21.20	18.14	23.14	26.49	21.98	19.24	18.19	23.33	26.94	23.14	19.19	22.28	26
27/a	20.65	22.30	22.27	21.86	18.60	23.90	27.44	22.68	19.76	18.68	24.10	27.94	23.91	19.74	22.98	27
28/a	21.23	22.95	22.94	22.51	19.06	24.64	28.40	23.38	20.26	19.15	24.86	28.94	24.68	20.28	23.66	28
29/a	21.80	23.59	23.59	23.14	19.50	25.38	29.34	24.07	20.75	19.62	25.61	29.93	25.44	20.80	24.34	29
30/a	22.35	24.22	24.23	23.77	19.92	26.11	30.29	24.75	21.24	20.07	26.35	30.92	26.19	21.32	25.01	30

3.3 ADJUSTING FOR INFLATION

Inflation reduces the purchasing power of the dollar over time; deflation increases it. When future amounts are stated in actual prices as of the year in which they are expected to occur, they are said to be in **current dollars**. Current dollars are dollars of any one year's purchasing power, **inclusive** of inflation. That is, they reflect changes in the purchasing power of the dollar from year to year. In contrast, **constant dollars** are dollars of uniform purchasing power, **exclusive** of inflation. Constant dollars indicate what the same good or service would cost at different times if there were no change in the general price level—no general inflation or deflation—to change the purchasing power of the dollar.

To make a meaningful comparison between costs occurring at different points in time, those costs must be adjusted for changes in the purchasing power of the dollar. To measure costs with inflated or deflated dollars is meaningless, just as it would be meaningless to measure a building's dimensions with an elastic tape measure. The adjustment of costs from current to constant dollars is not the same as discounting future costs to present value. The former adjusts only for changes in the purchasing power of the dollar; the latter adjusts for an individual investor's time-value of money. The appropriate discount rate needed to adjust future costs to their present value will be different depending on whether future costs are stated in constant dollars or current dollars. Even when costs are expressed in constant dollars, the discount rate is usually positive, reflecting the real earning power of money over and above the general rate of inflation.

3.3.1 Two Approaches for Dealing with Inflation

The FEMP methodology for LCC analysis allows cash flows to be stated either in constant dollars or in current dollars. However, the constant dollar method is preferred and is the methodology supported by Handbook 135, the Annual Supplement to Handbook 135, and the BLCC computer program.

The constant dollar approach has the advantage of avoiding the need to project future rates of inflation or deflation. **The price of a good or service stated in constant dollars is not affected by the rate of general inflation**. For example, if the price of a piece of equipment is $1,000 today and $1,050 at the end of a year in which prices in general have risen at an annual rate of 5 percent, the price stated in constant dollars is still $1,000; no inflation adjustment is necessary. In contrast, if cash flows are stated in current dollars, future amounts include general inflation, and an adjustment is necessary to convert the current-dollar estimate to its constant-dollar equivalent. This adjustment is important because constant- and current-dollar amounts must not be combined in an LCCA.

There are two ways to arrive at constant dollar amounts in an LCCA. Both methods need to be looked at in combination with the discount rate.

Method 1: Estimate future costs and savings in **constant** dollars and discount with a "**real**" discount rate, i.e., a discount rate that **excludes** the rate of inflation, or

Method 2: Estimate future costs and savings in **current** dollars and discount with a "**nominal**" discount rate, i.e., a discount rate that **includes** the rate of inflation.

Both of these approaches will yield the same present value results, and thus support the same conclusion, provided consistent assumptions are made about the real discount rate and the rate of inflation. However, **it is generally easier to conduct an economic analysis in constant dollars** because the rate of inflation from year to year over the study period need not be estimated. The analyst chooses a reference date for fixing the value of the dollar and expresses all future amounts in dollars of the same value, for example, in constant 1995 dollars. The reference date is usually chosen to coincide with the beginning of the study period, but it could be any date.

It is important in this context to distinguish between a **present value** analysis, where future costs are adjusted to time-equivalent values, and a **budget analysis,** where funds must be appropriated for year-to-year disbursements. The purpose of a present-value analysis is to determine whether the overall savings justify the planned investment **at the time the investment decision is being made**. A budget analysis must include general inflation to assure that sufficient funding will be appropriated **in future years** to cover **actual** expenses. The current dollar method is generally more appropriate in private sector analyses when tax effects must be included, since taxes are computed on actual cash flows.

3.3.2 Derivation of the Real Discount Rate

Note: The current DOE discount rates (real and nominal) are published in the Annual Supplement to Handbook 135. You do not need to derive either of these rates. This section describes the underlying mathematical relationship between the real and nominal discount rates. The 10 CFR 436 states that the real DOE discount rate cannot be lower than 3 percent or greater than 10 percent.

In every-day business activities, discount rates are usually based on **market** interest rates, that is, **nominal** interest rates which include the investor's expectation of general inflation. **Market interest rates** generally serve as the basis for the selection of a **nominal** discount rate, which is used to discount future costs expressed in current dollars. In contrast, the **real** discount rate needed to discount constant dollar amounts to present value reflects only the **real earning power of your money**, not the rate of general inflation. The real discount rate, d, can be derived from the nominal discount rate, D, if the rate of inflation, I, is known. It is important to recognize that the real discount rate, d, is not found by simply subtracting the rate of inflation, I, from the nominal discount rate, D. Rather, the relationship is as follows:

$$d = \frac{1 + D}{1 + I} - 1 \qquad (3.11)$$

Example: Given an inflation rate, I, of 4.0 percent and a nominal discount rate, D, of 7.0 percent, the real discount rate, d, is computed as 2.9 percent, or more precisely

$$\frac{1 + 0.07}{1 + 0.04} - 1 = 0.02885 \qquad (3.12)$$

Likewise, if I and d are known, the nominal discount rate, D, can be calculated according to the formula

$$D = (1 + I)(1 + d) - 1 \qquad (3.13)$$

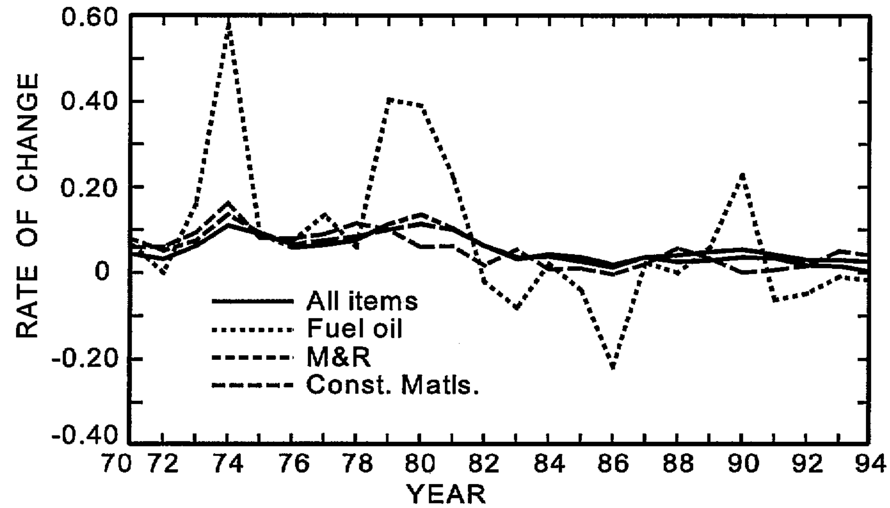
Example: Given an inflation rate of 4.0 percent and a real discount rate of 3.0 percent, the nominal discount rate would be 7.1 percent, or more precisely

$$(1 + 0.04)(1 + 0.03) - 1 = 0.0712 \qquad (3.14)$$

For a rough estimate of real or nominal discount rates, it is acceptable to just subtract or add the rate of inflation, but to assure that the results of an economic evaluation are exactly the same no matter whether cash flows are stated in current or in constant dollars, the rates need to be computed according to the above formulas.

3.3.3 Price Escalation

Few commodities have prices that change at exactly the rate of general inflation (that is, the rate of change in the price level of all items) year after year, but many commodities have prices which change at a rate close to that of general inflation over time. Figure 3-1 shows, for the years 1970 through 1994, the rate of general inflation and the rates of (nominal) price escalation for several commodities related to buildings: maintenance and repair costs, construction materials, and fuel oil.



Data Source: Consumer Price Indexes, U.S. Dept. Commerce, Bureau of Labor Statistics

Figure 3-1
Rate of Price Changes for Home-Related Items Compared with "All Items".

As is evident from figure 3-1, only for fuel oil have price escalation rates deviated substantially from the rate of general inflation over most of these years; rates of price change for the other home-related items shown have closely tracked the rate of change in the general price level so that the relative price change for these items is zero. For this reason, the FEMP LCC methodology, which recommends that future costs be expressed in constant dollars, generally assumes a zero real (differential) escalation rate for all non-energy-related.

3.3.3.1 Nominal price escalation

In order to estimate the actual cost of a particular commodity as of some future date, C_t, where t is the number of time periods between the base date and the date that the cost is incurred, the cost of that commodity as of the base date, C_0, must be adjusted to reflect the **nominal price escalation rate, E,** for that commodity over the t time periods, using the following formula:

$$C_t = C_0 (1 + E)^t \qquad (3.15)$$

Example: A replacement of $1,000 today, which escalates at a nominal rate of 3 percent per year will cost approximately $1,344 ten years from now.

$$C_{10} = \$1,000 (1 + 0.03)^{10} = \$1,344 \qquad (3.16)$$

The **nominal** rate of price escalation, E, can be, but is not necessarily, the same as the rate of **general** inflation, I, which represents the rate of increase in prices for all goods and services.[3]

3.3.3.2 Real price escalation

If the nominal rate of price escalation, E, for a particular commodity is different from the general rate of inflation, then a **real** (differential) rate of escalation, e, can be computed as

$$e = \frac{1 + E}{1 + I} - 1 \tag{3.17}$$

For example, given an inflation rate, I, of 4.0 percent and a nominal escalation rate, E, of 5.0 percent, the real escalation rate, e, is computed as 0.96 percent, or more precisely

$$e = \frac{1 + 0.05}{1 + 0.04} - 1 = 0.009615 \tag{3.18}$$

Or, given the real escalation rate, the **nominal escalation rate** can be computed as

$$E = (1 + I)(1 + e) - 1 \tag{3.19}$$

For example, given an inflation rate of 4.0 percent and a real escalation rate of 2.0 percent, the nominal escalation rate would be 6.1 percent, or more precisely

$$E = (1 + 0.04)(1 + 0.02) - 1 = 0.0608 \tag{3.20}$$

Just as the real discount rate, d, is not exactly the difference between the nominal discount rate, D, and the rate of general inflation, I, the real escalation rate, e, for a commodity is not exactly the difference between the nominal escalation rate, E, and the rate of general inflation, I.

In order to estimate the cost, C_t, of a particular commodity in constant base-year dollars as of some future point in time t, where t is the number of time periods between the base date and the date that the cost is incurred, the cost of that commodity today, C_0, must be adjusted to reflect the **real price escalation rate, e,** for that commodity over the t time periods, using the following formula

$$C_t = C_0 (1 + e)^t \tag{3.21}$$

Example: A replacement cost of $1,000 today, which escalates at a real rate of 1 percent per year (i.e., 1 percent greater than the general inflation rate), will cost approximately $1,105 ten years from now, in base-year constant dollars.

$$C_{10} = \$1,000\ (1 + 0.01)^{10} = \$1,105 \tag{3.22}$$

And if that replacement cost decreases in real terms (i.e., its nominal escalation rate is less than the rate of general inflation), then its future cost in constant base-year dollars will be less than its cost as of the base date.

---

[3] Just as the rate of general inflation may not be constant from year to year, E may not be constant from year to year. When E is not constant from year to year, the cost of a commodity in year t must be calculated by compounding the annual escalation rates as follows

$$C_t = C_0 (1+E_1)(1+E_2)(1+E_3) \ldots (1+E_t)$$

Example: If in the previous example, the real escalation rate were assumed to be -1 percent (i.e., 1 percent less than the general inflation rate), then that cost would be approximately $904 ten years later, in constant base-year dollars.

$$C_{10} = \$1,000\ (1 - 0.01)^{10} = \$904 \tag{3.23}$$

Table 3-2 summarizes the formulas used to calculate the real and nominal discount rates and escalation rates needed to adjust LCC cash flows for the underlying inflation rate (I).

Table 3-2
Summary of Inflation-Adjustment Formulas

Nominal Discount Rate:	D	=	(1 + d)(1 + I) - 1
Real Discount Rate:	d	=	(1 + D)/(1 + I) - 1
Nominal Escalation Rate:	E	=	(1 + e)(1 + I) - 1
Real Escalation Rate:	e	=	(1 + E)/(1 + I) - 1

3.3.4 Real Escalation of Energy-Related Cash Flows

For energy-related costs, the FEMP LCC methodology requires the use of DOE-projected real escalation rates by fuel type, rate type, and census region, as published in the Annual Supplement to Handbook 135. The FEMP UPV* factors published in that supplement, which incorporate these escalation rates, are automatically applied in an LCC analysis that is performed using the NIST BLCC and DISCOUNT computer programs. However, 10 CFR 436 does permit the use of alternative real escalation rates for a FEMP LCC analysis for those years for which the local energy supplier can give a firm estimate of the anticipated rate of price increase. In such a case, the computation of the appropriate UPV* factor is more complex and should generally be performed using the NIST BLCC computer program or software consistent with this program.

3.3.5 Illustration of Discounting Constant-Dollar and Current-Dollar Cash Flows

Use a real discount rate, d,
if you express cash flows in **constant** dollars, including only the differential rate of price escalation;

Use a nominal discount rate, D,
if you express cash flows in **current** dollars, including both the differential rate of price escalation and general inflation.

The following example shows that both approaches result in the same present value and thus support the same decision.

Example: Suppose you want to know the present value of an AC compressor that you expect to replace in 15 years. If it were replaced today, the price would be $5,000. Due to advanced manufacturing processes, you expect that the price of compressors will increase at a rate of 2 percent lower than general price inflation. You estimate the rate of general price inflation to be 5 percent per year. You know that your real discount rate is 3 percent. To sum

I	=	0.05	t	=	15 years
d	=	0.03	D	=	(1 + 0.03)(1 + 0.05) - 1 = 0.0815
e	=	-0.02	E	=	(1 - 0.02)(1 + 0.05) - 1 = 0.029

Constant dollars and **real** discount rate

$$PV = F_t \times \left[\frac{1 + e}{1 + d}\right]^t$$

$$= 5000 \times \left[\frac{1 - 0.02}{1 + 0.03}\right]^{15} \qquad (3.24)$$

$$= 5000 \times 0.4741$$

$$= \$2,370.30$$

Current dollars and **nominal** discount rate

$$PV = F_t \times \left[\frac{1 + E}{1 + D}\right]^t$$

$$= 5000 \times \left[\frac{1 + 0.029}{1 + 0.0815}\right]^{15} \qquad (3.25)$$

$$= 5000 \times 0.4741$$

$$= \$2,370.30$$

CHAPTER 4

ESTIMATING COSTS FOR LCC ANALYSIS

CONTENTS

Chapter 4

ESTIMATING COSTS FOR LCC ANALYSIS

4.1 RELEVANT EFFECTS

There are numerous costs associated with acquiring, operating, maintaining, and disposing of a building or building system. Which of these costs needs to be included is one of the first decisions to be made when performing a life-cycle cost analysis (LCCA) of alternative energy conservation strategies. To answer this question, it is necessary to look at the **economic effects** that will result from each design alternative. To the extent feasible, these effects need to be quantified in dollar terms. For effects that cannot be expressed as dollar amounts, a verbal account should be given so that they can be included in the analysis at least in a qualitative way.

It is not necessary to include all project-related costs in an LCCA of project alternatives. Only those costs that are **relevant** to the decision and **significant** in amount are needed to make a valid investment decision. Costs are relevant to the decision when they change from alternative to alternative. Costs that are approximately the same for each alternative are not a determining factor in the choice among the alternatives and therefore can be omitted from the LCC calculation. Inclusion of such costs will not produce erroneous results but may incur data collection and analysis costs which could be avoided. Costs are significant when they are large enough to make a credible difference in the LCC of a project alternative. Energy costs, for example, are likely to be relevant and significant in the analysis of alternative window designs for an office building but not in the analysis of low-flow bathroom fixtures. Assessing the relevance and significance of project costs in an LCCA is largely a matter of engineering judgment.

Sunk costs should be **excluded** from an LCCA. These are costs that have been incurred or committed to in the past and thus cannot be avoided by a future decision. For example, the cost of a recently replaced fuel tank for an oil heating system being converted to natural gas is a sunk cost (except for its salvage value, if any).

In the LCCA of federal energy and water conservation projects, tax effects and finance costs (i.e., interest charges) are generally not relevant and can be omitted from the LCCA. However, when evaluating alternative methods of funding energy and water conservation projects for federal facilities (e.g., full agency funding versus negotiated "shared savings" plans or utility demand-side management incentives), the relative cost effectiveness of the projects under each of these funding alternatives should be evaluated from an LCC perspective before deciding which method(s) of funding are most advantageous to the federal government. (This subject is discussed further in appendix G, "Evaluating Energy Savings Performance Contracts.")

4.2 COST CATEGORIES

There are various ways of classifying the cost components of an LCCA, depending on what role they play in the mechanics of the methodology. The most important categories in LCCA distinguish between investment-related and operational costs; initial and future costs; and single costs and annually recurring costs.

4.2.1 Investment Costs vs. Operational Costs

Life-cycle costs typically include both investment costs and operational costs. The distinction between investment and operation-related costs is most useful when computing supplementary economic measures such as the Savings-to-Investment Ratio and Adjusted Internal Rate of Return. These measures evaluate savings in operation-related costs with respect to increases in capital investment costs. This distinction will not affect the LCC calculation itself, nor will it cause a project alternative to change from cost effective to non-cost effective or vice versa. However, it may change its ranking relative to other independent projects when allocating a limited capital investment budget. (Budget allocation methods are discussed in section 7.5.)

All **acquisition costs**, including costs related to planning, design, purchase, and construction, are **investment-related costs**. The FEMP LCC methodology in 10 CFR 436 also requires that **residual values** (resale, salvage, or disposal costs) and **capital replacement costs** be included as investment-related costs. Capital replacement costs are usually incurred when replacing major systems or components, paid from capital funds. Operating, maintenance, and repair (OM&R) costs, including energy and water costs, are operational costs. Replacements which are related to maintenance or repair (e.g., replacing light bulbs or a circuit board) are usually considered to be OM&R costs, not capital replacement costs. OM&R costs are usually paid from an annual operating budget, not from capital funds.

4.2.2 Initial Investment Costs vs. Future Costs

The distinction between initial investment costs and future costs is most useful when computing the Simple or Discounted Payback measures. The costs incurred in the planning, design, construction and/or acquisition phase of a project are classified as **initial investment costs**. They usually occur before a building is occupied or a system is put into service. Those costs that arise from the operation, maintenance, repair, replacement, and use of a building or a system during its occupancy or service period are **future costs**. Residual values at the end of a system life, or at the end of the study period, are also future costs.

4.2.3 Single Costs vs. Annually Recurring Costs

It is useful to establish two categories of project-related costs based on their frequency of occurrence. This categorization determines the type of present-value factor to be used for discounting future cash flows to present value.

(1) **Single costs** (one-time costs) occur at one or more times during the study period at non-annual intervals. Initial investment costs, replacement costs, residual values, maintenance costs scheduled at intervals longer than one year, and repair costs are usually treated as single costs. The **SPV factor** is the appropriate present-value factor for single costs.

(2) **Annually recurring costs** are amounts that occur regularly every year during the service period in approximately the same amount, or in an amount expected to change at some known rate. Energy costs, water costs, and routine annual maintenance costs fall into this category. The appropriate present value factor for annually recurring amounts is the **UPV factor** or **UPV* factor**. If recurring costs are the same each year, the **UPV factor** is the appropriate present value factor. If the annual amounts are expected to change at a known rate, the **UPV* factor** is the appropriate present value factor.

4.3 TIMING OF CASH FLOWS

LCC analysis requires that all project-related costs be identified by time of occurrence as well as amount. However, it is a well-accepted convention in LCCA to use simplifying models of cash flows rather than to attempt to reproduce the exact timing of all costs. Thus costs which may occur at different times during the year may all be treated as occurring at the same time each year, in order to simplify the discounting operations. Computer-assisted LCCA makes it more convenient to compute single costs from their actual time of occurrence during the year.

4.3.1 FEMP Cash-flow Conventions

FEMP LCC rules (10 CFR 436) allow both single and annually recurring costs to be discounted either from the actual time of occurrence or from the end of the year in which they occur. The FEMP convention (as reflected historically in Handbook 135 and the discount factor tables in the Annual Supplement to Handbook 135) for manual calculations has been to discount all costs from the **end of the year** in which they occur. However, since LCC computer programs (e.g., BLCC) are now used for most LCC computations, other cash flow conventions are often used. The most appropriate cash flow convention for any given cost category varies with the complexity of the analysis, the computational basis (manual versus computer), and specific agency requirements.

When using manual methods, its is usually sufficient to discount all costs from the end of the year in which they occur. The present value tables provided in the Annual Supplement to Handbook 135 are based on this end-of-year discounting convention. With computer-aided analysis, the recommended method is to discount all single costs from the time of occurrence and to discount annually recurring costs from the end of each service year (consistent with the UPV or UPV* factors shown in this handbook). However, for military construction projects in the U.S. Department of Defense (subject to the Tri-Services Memorandum of Agreement [11], reproduced in appendix E), initial investment costs are usually discounted from the mid-point of construction, and annually recurring OM&R costs (including energy and water costs) are discounted from the mid-point of each service year. A special compilation of present value tables has been provided by NIST to DoD for this purpose [4].

4.3.2 Cash-flow Diagrams

A cash-flow diagram for a project alternative, as shown in figure 4-1, provides a convenient way of visualizing all relevant costs and their timing. A horizontal time-line represents the study period and marks each year and key dates; e.g., the base date, the occupancy or service date, and the end of the study period. Years can be marked in calendar-year terms (e.g., 1995) or in elapsed years from the base date (e.g., 1, 2, 3,...). There is no standard convention for showing costs on a cash flow diagram, but positive costs are typically shown above the horizontal time-line, and negative costs (e.g., residual values) are shown below the time-line. The cash flow diagram for project "A" in figure 4-1 shows a study period of 15 years, from January 1995 through December of 2009. An initial investment of $5,000 is shown at the base date, with a residual value of $200 at the end of the study period. Annually recurring OM&R costs of $600 (in base-date dollars) are shown, along with a one-time OM&R cost of $400.

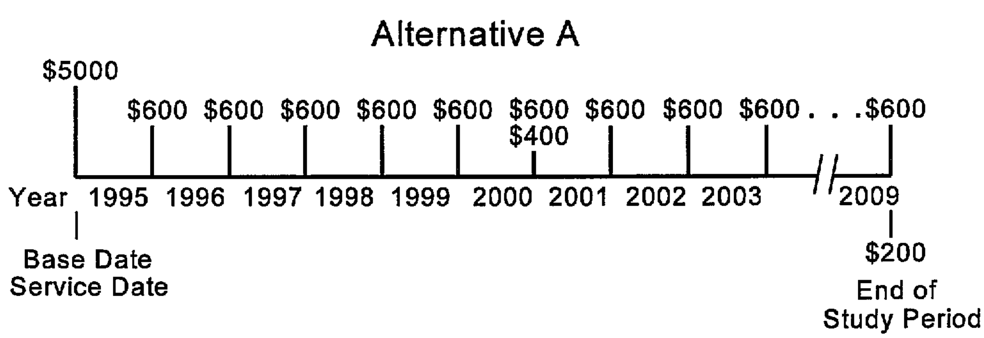


Figure 4-1
Cash-Flow Diagram.

4.4 USING BASE-DATE PRICES TO ESTIMATE FUTURE COSTS

Most cost data for an LCCA are likely to be estimates. The analysis is often performed early in the decision-making process before detailed initial cost data are available, and future costs by their nature are uncertain. The difficult task of obtaining estimates of future costs is made somewhat easier by the fact that the FEMP LCC methodology bases future cost estimates on their corresponding cost as of the base date of the LCCA, usually the date on which the analysis is performed. Section 3.3.3 provides the methodology used to convert prices (or costs) at the base date to prices (or costs) at a future date when appropriate price escalation rates are available. However, this step is not usually required in an LCCA, since price escalation rates are included in the present-value factors. (See section 3.2.2.2 for information on discounting non-uniform annual amounts.)

If there is reason to believe that the basic supply and demand conditions for a particular good or service remain the same as those for most other goods and services, it can be assumed that its price will change at roughly the rate of general price inflation. That is, the real price escalation rate is equal to zero. This means that **in a constant-dollar analysis**—where the rate of inflation is not included in the computations—**the future price of an item is identical to the base-date price**. One of the basic assumptions of the FEMP LCC methodology is that prices for all goods and services, other than for energy and water, will increase at approximately the same rate as general inflation. However, if there is a documentable basis for assuming that prices change at a rate different than general inflation (for example, when price escalation rates are established in a maintenance contract), these rates can be used in the analysis.

Even in the case of energy and water prices, the base-date price is used as the basis for estimating future prices in the FEMP LCC methodology. DOE provides price escalation rates for use in estimating future energy prices, but these are used with local energy price schedules as of the base date. DOE does not provide price escalation rates for water because these rates are very sensitive to existing and projected infrastructure conditions at the community level.

4.5 ESTIMATING INVESTMENT-RELATED COSTS

4.5.1 Estimating Initial Investment Costs

Initial investment costs are probably the least difficult of the project costs to estimate because they occur relatively close to the present time. Quotes for purchase and installation costs can often be obtained from local suppliers or contractors. You can also develop estimates by adding unit costs obtained from construction cost-estimating guides. Table 4-1 lists some of these guides. They are published as tables or made available in computerized form.

Since the estimates are based on different underlying assumptions and have different emphases, we recommend that you use the same data set for analyzing each of the alternatives being considered for a project in order to get consistent and comparable results.

Detailed estimates of construction costs are not necessary for preliminary economic analyses of alternative building designs or systems. Such estimates are usually not available until the design is quite advanced and the opportunity for cost-reducing design changes has been missed. For very large projects you may want to use a standard format for organizing construction cost data to facilitate the retrieval and review of the data. UNIFORMAT II [9], which has been published as a standard classification scheme by ASTM [10], organizes costs into three levels for each of 12 work categories (e.g., category 03, superstructure; category 06, interior construction; and category 12, site work). The hierarchical system allows for cost estimates

Table 4-1
Suggested Cost Estimating Guides for LCC Analysis*

BOECKH Underwriter's Valuation Manual
E. H. Boeckh Co., American Appraisal Association, Inc.
525 E. Michigan St., Milwaukee, WI 53201
(414) 780-2800

BNI BUILDING NEWS
BNI Publications
3055 Overland Ave., Los Angeles, CA 90034
(310) 202-7775

CERL M&R DATABASE
USACE Engineer Division HV
CEHND-ED-ES (Terry Patton)
P.O. Box 1600, Huntsville, AL 35807-5301
(205) 895-3373

DOLLARS AND CENTS OF SHOPPING CENTERS
The Urban Land Institute
625 Indiana Ave., NW, Suite 400, Washington, DC 20004-2930
(202) 624-7000

THE DOWNTOWN & SUBURBAN OFFICE BUILDING EXPERIENCE EXCHANGE REPORT (EER)
Building Owners & Managers Association International (BOMA)
1201 New York Ave., NW, Suite 300, Washington, DC. 20005
(202) 408-2662

MEANS BUILDING CONSTRUCTION COST DATA
MEANS FACILITIES M&R COST DATA
MEANS FACILITIES MAINTENANCE AND REPAIR COST DATA
R. S. Means Co., Inc.
100 Construction Plaza, Box 800, Kingston, MA 02364-0800
(617) 585-7880

NATIONAL CONSTRUCTION ESTIMATOR
BUILDING COST MANUAL
BERGER BUILDING COST FILE
Craftsman Book Company
P.O. Box 6500, Carlsbad, CA 92008
(619) 438-7828

RICHARDSON'S GENERAL CONSTRUCTION ESTIMATING STANDARDS
RICHARDSON'S PROCESS PLANT CONSTRUCTION ESTIMATING STANDARDS
Richardson Engineering Services
P.O. Box 9103, Mesa, AZ 85214-9103
(602) 497-2062

*Most of the listed publishers issue additional, more specialized, cost guides.

at a broader level at the beginning of the project and at a more detailed level as the design of the project progresses.

4.5.2 Estimating Capital Replacement Costs

The number and timing of capital replacements depends on the estimated life of the system and the length of the service period. You can use the same sources that provide cost estimates for initial investments to obtain estimates of replacement costs and expected lives. A good starting point for estimating future replacement costs is to use their cost as of the base date. In a FEMP LCCA conducted in constant dollars with real price escalation rates equal to zero, the future cost will be the same as the base-date cost. When a non-zero real price escalation rate is appropriate, consult section 3.3.3 to see how to compute future replacement costs and present values.

4.5.3 Estimating Residual Values

The residual value of a system (or component) is its **remaining value** at the end of the study period, or at the time that it is replaced during the study period. Residual values can be based on value in place, resale value, salvage value, or scrap value, net of any selling, conversion, or disposal costs.

The residual value of a system at the end of its expected useful life is likely to be small or even negative (due to removal or disposal costs) if the system needs complete replacement or the building is being demolished. However, for systems with expected lives extending beyond the end of the study period, the residual value should be based on their value in place, not on their "salvage" value as if they were to be removed from the building at that point. A building system which is functioning in place adds significant value to the building and this value should be reflected in its residual value. As a general rule of thumb, the residual value of a system with remaining useful life in place can be calculated by **linearly prorating its initial cost**. For example, for a system with an expected useful life of 15 years which was installed five years before the end of the study period, the residual value would be approximately 2/3 [=(15-5)/15] of its initial cost.

If you are estimating the residual value of a building system or component in constant dollars, using the initial cost as the starting point for your estimate, you will not need to adjust the residual value for price changes between the base date and the time that the residual value is realized, unless the price of similar systems changes at a rate significantly different than the rate of general inflation. If you are estimating the residual value in current dollars, you will need to adjust the residual value for general inflation and any real price increase. (Real and nominal price escalation calculations are shown in section 3.3.3.)

When the study period is very long, the residual value of the original system may be small and largely offset by disposal costs. Discounting further diminishes its weight in the analysis, and so it is often less important to improve the estimate of a residual value than of other input values. But when the study period is short, the estimate of the residual value may become a critical factor in assessing the cost effectiveness of a capital investment project, and thus it should be given careful consideration. The residual value estimate for a capital replacement, needed to extend the life of an alternative to the length of a common study period, may also be a critical factor in the LCCA and thus care should be given in estimating this value.

4.6 ESTIMATING OPERATIONAL COSTS

4.6.1 Estimating Energy Costs

Energy conservation projects are expected to reduce the annual energy consumption, and thus the long-run operational costs, of a building. But these savings are not used directly in computing the LCC of a project. Instead, the annual energy consumption for each project alternative is used in computing its corresponding present-value **energy cost**. Since energy costs are included in the LCC of each project, energy savings are reflected in the difference in LCC between alternatives.

The FEMP LCC rules in 10 CFR 436 require the following considerations when computing energy related costs in an LCCA:

- Measure the quantity of energy used (or saved) at the building site, by energy type (e.g., electricity, gas, oil). Do not use resource energy data, e.g., the amount of energy needed to generate and transmit the energy to the building site.
- Use current, local, energy price schedules for the type of fuel or energy used. Do not use national or regional average prices.
- Use DOE energy price escalation rates unless you have projected escalation rates from the utility supplying the energy.

Each of these topics is discussed in more detail in the following subsections.

4.6.1.1 Quantity of energy used

Estimating annual amounts of energy required for a given building function (or for the entire building) with and without an energy-conserving project is primarily an engineering function. These estimates can be based on technical specifications, energy-estimating equations and nomographs, or on computer simulations.

Energy consumption amounts should be estimated for each type of energy used by the building or building system being evaluated. In the simplest case, where there is a flat-rate energy price, annual energy quantities will be sufficient. However, if different prices are in effect during different usage periods (e.g., summer and winter), estimates of energy usage in each time period will also be needed. And if demand charges are relevant, monthly power demand amounts needed for demand charge calculations must also be estimated.

Computer simulation programs such as ASEAM (DOE), DOE-2 (DOE), BLAST (DoD), and ESPRE (EPRI) can be used to estimate energy usage in buildings over an entire year. When selecting a program, it is important to match the capabilities of the program to the type of building and systems to be evaluated. It is also important to consider whether you need annual, monthly, or hourly energy consumption data and monthly power demand data for computing energy costs. For example, if time-of-use rates are relevant, you must have hourly energy consumption data; monthly estimates will not be sufficient. You should use engineering judgment to verify that estimates of energy usage and corresponding energy savings for project alternatives are reasonable and consistent before proceeding to the economic analysis.

4.6.1.2 Local energy prices

Energy prices are needed to convert energy usage to annual energy costs. The FEMP LCC rule requires that an LCCA of an energy conservation project be based on **actual energy prices effective at the building site** rather than on regional or national average prices. Unit prices as billed by the local utility (or fuel delivery company), including relevant taxes or surcharges, should be used in computing annual costs for each fuel type used. The appropriate energy prices should be based on the utility's rate schedule **effective on the base date of the study**, even if the service period (and thus energy usage) does not begin until some later time. The FEMP methodology starts with energy prices as of the base date and converts those prices to their future cost equivalent in each year of the service period using price escalation rates for the specific fuel type, rate type, and region.

The appropriate energy price to be used in computing annual energy costs depends on the nature of the project alternatives to be evaluated. In cases where an energy conservation project changes the amount of a specific energy type used, and unit prices vary with usage amounts (e.g., a declining block-rate price schedule is imposed), the **price of the last unit used** in each billing period is the most appropriate energy price for the analysis. On the other hand, if two systems using different fuel types are being compared, the **average unit price** is more relevant. In this latter case, there may be no energy savings, just a switch in fuel types.

Other factors that should be considered in estimating annual energy costs (especially with regard to electricity usage) are:

- summer and winter rate differentials
- time-of-use rates
- block rate schedules (usually declining block rates)
- demand rates

The inclusion of these rate schedules in an economic analysis may require energy usage data by month instead of by year, and in the case of time-of-use rates, energy usage must be estimated on an hourly basis. For most larger buildings, peak power demand data, usually on a monthly basis, is needed to estimate monthly demand charges. You do not need to include fixed monthly energy charges (e.g., a "customer charge") in the energy cost analysis unless you are comparing systems using different fuel types.[1]

Section 3 of appendix A provides examples of computing annual energy costs when rate schedules depart from a flat unit energy price.

If annual energy consumption for a project is not expected to be constant over the entire service period, it will be necessary to compute annual energy costs separately for each year and discount these annual costs to present value individually as single amounts. The BLCC computer program facilitates this process by allowing the annual energy usage amounts to be scaled up or down from a base amount. An example of non-constant annual energy usage calculations is shown in appendix A.

4.6.1.3 DOE energy price escalation rates

FEMP rules require that DOE energy price escalation rates be used in LCC analyses of federal energy conservation and renewable resource projects. These rates are included in the FEMP UPV* factors for energy costs found in the Annual Supplement to Handbook 135. You do not need to compute future energy prices when computing an LCC for a project alternative. This section shows how to compute future energy prices if they are needed for cash flow projections or for computing payback measures which include energy price escalation.

Following the FEMP convention for calculating life-cycle costs in **constant-dollars** terms, you need to take into account only **real energy price escalation rates** when computing future energy costs. The energy

[1]BLCC versions 4.0 and later can include monthly kWh usage and kW demand data for a project alternative and can read block rate and demand rate schedules set up by the NIST ERATES program. The ERATES program can also be used to calculate an average kWh cost given a time-of-use kWh rate schedule and hourly kWh usage data. This average cost can then be used with BLCC along with the annual kWh consumption to calculate annual electricity costs.

price escalation rates provided by DOE (as published each year in the Annual Supplement to Handbook 135 and as used in the BLCC computer program) are real rates. To estimate future energy costs in constant dollars, use the appropriate energy price indices in tables Ca-1 through Ca-5 of the Annual Supplement to Handbook 135 (reproduced in appendix E) to adjust energy prices as of the base date.

Example: If the price for electricity as of the base date is $0.082/kWh, and the price index for electricity rates for the year 2000 is 0.97, then the constant-dollar estimate of the electricity price in the year 2000 is

$$\$0.08/\text{kWh} \times 0.97 = \$0.0776/\text{kWh} \tag{4.1}$$

When using the Ca tables in the Annual Supplement to Handbook 135, be sure to find the index that is appropriate to the DOE region, fuel type, rate type, and number of years in your analysis.

If you use real energy price escalation rates in a **current-dollar analysis**, you need to include the **estimated annual rate of inflation** with those rates. Tables S-1 through S-5 in the Annual Supplement to Handbook 135 provide price indices for inflation rates of 3, 4, 5, and 6 percent; you can use those price indices to estimate future energy costs in current dollars in the same way shown above for the constant dollar indices.

4.6.2 Water Costs

Water costs should be handled much like energy costs. There are usually two types of water costs: **water usage** and **water disposal**. Each of these types may have its own unit costs and price escalation rates. Water prices may also be subject to **block rate** price schedules. When block rate schedules are used, it is generally the price of the last block of usage in each pricing period that is most relevant for a water conservation study. The amount of water used or conserved should be measured at the building site. The water price schedule should also be the schedule in effect **at the building site**. Do not use regional or national average water prices. There are no DOE water price escalation rates. If projected price escalation rates for water are not available, then assume that they will increase at the same rate as general inflation. In a constant dollar analysis this means that you can use the standard UPV factors published in table A-2 of the Annual Supplement to Handbook 135. (This is the same table of factors used for non-fuel OM&R costs. The UPV table for FY 1995 is included in appendix E, table E/A-2, of this handbook.)

Water costs, like energy costs, are assumed to begin with the service date and continue through the service period until the end of the study period. Water use in the construction phase of a project is not explicitly included in the LCCA of a water conservation project, but should be included in the initial investment cost.

4.6.3 Estimating Other Operating, Maintenance, and Repair Costs

Operating, maintenance, and repair (OM&R) costs are often more difficult to estimate than other building expenditures. Since operating schedules and standards of maintenance vary from building to building, there is great variation in these costs, even for buildings of the same type and age. It is therefore especially important to use engineering judgment when estimating these costs.

OM&R costs generally begin with the service date and continue through the service period. Some OM&R costs are annually recurring costs which are constant from year to year or change at some estimated rate per year. The present value of annual recurring costs over the entire service period can be estimated using appropriate UPV or UPV* factors. (See section 3.2.2.) Others are single costs which may occur only once or at non-annual intervals throughout the service period. These must be discounted individually to present value. (See section 3.2.1.)

4.6.3.1 Estimating OM&R costs from cost estimating guides

Ongoing efforts to standardize OM&R costs have produced a number of helpful manuals and databases, examples of which are listed in table 4-1. Keep in mind that if OM&R costs are essentially the same for each of the project alternatives being considered, they do not have to be included in the LCCA.

Some of the data estimation guides listed in table 4-1 derive cost data from statistical cost-estimating relationships of historical data (BOMA, MEANS) and report, for example, average owning and operational costs per square foot, by age of building, geographic location, number of stories, and number of square feet in the building. The CERL M&R Database derives data from time-motion studies which estimate the time required to perform certain tasks. It covers four major building systems (architectural, electrical, plumbing, and HVAC) and provides indices for estimating the cost of keeping selected building components in good service condition. At the lowest level of data aggregation, the CERL database provides data for about 3,000 typical tasks needed to maintain and repair building components.

4.6.3.2 Estimating OM&R costs from direct quotes

A more direct method of estimating non-fuel OM&R costs is to obtain quotes from contractors and vendors. For cleaning services, for example, you can get quotes from contractors, based on prevalent practices in similar buildings. Maintenance and repair estimates for equipment can be based on manufacturers' recommended service and parts replacement schedules. You can establish these costs for the initial year by obtaining direct quotes from suppliers. For a constant-dollar analysis, the annual amount will be the same for the future years of the study period, unless, as is sometimes the case, OM&R costs are expected to rise as the system ages. In this latter case, the real (differential) escalation rate for that cost must also be included in the analysis.

4.6.4 Other Relevant Costs or Benefits

4.6.4.1 Utility rebates

Utility companies have been giving one-time or phased-in rebates to promote investment in more energy-efficient buildings or systems in support of their demand-side management (DSM) programs. If a rebate is granted after the base date of the study, you need to discount it to present value—just like any other cost or benefit—before subtracting it from initial investment costs.

4.6.4.2 Taxes and finance charges

Since this handbook deals with energy conservation projects in federal buildings, taxes need not be taken into consideration. Likewise, the cost of financing projects can be disregarded in an LCCA of this type unless the financing is specifically tied to the project. (This is not usually the case for federal buildings. If financing is provided by an energy savings performance contractor, an LCCA of the project financing is not required. See appendix G for more information on this subject.) In private-sector analyses, these factors should be included if they are expected to make a significant difference in the outcome of the analysis.

4.6.4.3 Non-monetary benefits and costs

Non-monetary benefits and costs are project-related effects for which you have no objective way of assigning a dollar value. Examples of non-monetary effects may be the benefit derived from a particularly quiet HVAC system or from an expected, but hard to quantify, productivity gain due to improved lighting. These items, by their nature, are external to the LCCA, and thus do not directly affect the calculation of a project's cost effectiveness. Nevertheless, you should consider significant non-monetary effects in your final investment decision, and they should be included in the project documentation.

In some cases you can provide an order-of-magnitude dollar value of a subjective benefit or cost. For example, the value of an attractive view from larger north-facing windows (which use more energy than smaller windows having the same thermal characteristics) might be estimated by looking at the rent differential of similar buildings with and without that feature. For a retrofit project having an LCC greater than its base case (which would thus be rejected on a dollar cost basis), but having significant non-monetary benefits, you can subjectively judge whether or not the non-monetary benefits outweigh the LCC penalty. If the decision-maker judges that the non-monetary benefits of a project are greater than its LCC penalty, the project can be accepted as "cost effective."

4.6.4.4 Revenues

LCC analysis is most appropriately used to evaluate the relative costs of design alternatives which satisfy a particular set of performance requirements. It is not generally appropriate for evaluating the cost effectiveness of alternative revenue-producing projects, such as buildings constructed to produce rental income. For example, you would not use an LCCA to determine whether to build a 20-unit apartment building or a 40-unit building. These decisions are better evaluated using Benefit-Cost Analysis and Rate-of-Return measures. However, if there are small differences in revenue between one design alternative and another, they can be included in the LCCA by adding them to (when negative) or subtracting them from (when positive) annual operation-related costs.

CHAPTER 5

CALCULATING LIFE-CYCLE COSTS

CONTENTS

Chapter 5

CALCULATING LIFE-CYCLE COSTS

In this handbook we define life-cycle cost analysis (LCCA) to include both the LCC method *per se* and certain supplementary measures: Net Savings, Savings-to-Investment Ratio, and Adjusted Internal Rate of Return. LCCA is the **standard method** required by the Department of Energy's Federal Energy Management Program (FEMP) for evaluating energy and water conservation investments in federal buildings. The FEMP criteria for performing LCCA, as published in 10 CFR 436, are summarized in table 5-1. The examples in chapters 5, 6, and 7 integrate LCCA and the FEMP LCCA criteria.

The basic LCC method is the most straightforward method of accounting for present and future costs of an energy-conservation project over its life-cycle. When using the LCC method for evaluating buildings or building systems, we typically look at two or more project alternatives for the same purpose (e.g., different R-values of insulation in an exterior wall or different HVAC systems), only one of which will be selected for implementation. To determine the **relative** cost effectiveness of these mutually exclusive alternatives, we need to compute the LCC for each alternative and the base case, compare them, and choose the alternative with the lowest LCC. Only when compared to the LCC of a base case or another alternative intended for the same purpose does the LCC provide useful information. The LCCs are comparable only if computed with the same economic assumptions and with the same study period, base date, and service date. In addition, it is essential that only alternatives that satisfy minimum performance requirements be considered for LCCA.

This chapter first describes the **LCC method** and then illustrates how to compute the life-cycle costs for a base case and an alternative. Chapter 6 explains how to calculate supplementary measures—**Net Savings (NS)**, **Savings-to-Investment Ratio (SIR)**, **Adjusted Internal Rate of Return (AIRR)**, and **Discounted** and **Simple Payback**. Chapter 7 demonstrates how these methods can be applied to typical cost-effectiveness decisions related to energy and water conservation projects in federal buildings.

5.1 THE LIFE-CYCLE COST (LCC) METHOD

LCCA allows you to organize and compute the costs of acquiring, owning, operating, maintaining, and ultimately disposing of a building or a building system. Once you have cost estimates, by year, for two or more competing alternatives, a discount rate, and a study period, you are ready to calculate the LCC for each alternative.[1] To calculate the LCC, first compute the present value of each cost to be incurred during the study period, using the DOE discount rate. Then sum these present values for each alternative to find its LCC. If other performance features are similar among the alternatives, the alternative with **the lowest LCC** is the preferred alternative; that is, it is the most cost-effective alternative for the application studied.

The calculations can be performed either manually or with a computer program. The NIST BLCC computer program, which can greatly facilitate FEMP LCC analyses for energy conservation projects, has the FEMP criteria built in and is largely self-documenting. More information about the BLCC program is presented in appendix B. Simple analyses can easily be done by hand or with the help of the worksheets from appendix C.

[1]All through this handbook we use the word "alternative" to include the base case when discussing the LCC method in a general way.

Table 5-1
Summary of Criteria for FEMP LCC Analyses

FEMP CRITERIA FOR ECONOMIC ANALYSIS	DESCRIPTION
	METHODOLOGY
Evaluation Method	Life-cycle cost analysis
Discounting Approach	Present value (PV) at the base date
Cost Measurement Basis	Constant dollars as of the base date
Cash-Flow Convention	End-of-year cash flows or when incurred
Evaluation Criteria	• Lowest life-cycle cost • Highest net savings • SIR > 1 for ranking • AIRR > FEMP discount rate for ranking
Uncertainty Assessment	Sensitivity analysis
	DATA AND PARAMETERS
Base Date	Date of Study / Beginning of study period
Service Date	Beginning of service period when building is occupied or system taken in service
Study Period	Planning/Construction period (if any) added to maximum 25-year service period
Discount Rate	A real rate, determined annually by DOE
Energy Prices	Local energy prices at the building site used to calculate annual energy costs for each energy type
Cost Escalation • Energy Prices • Non-Energy Prices	 DOE-projected differential energy price changes (included in FEMP UPV* discount factors for each energy type) 0% differential price change (unless justified by reliable projections)
	DOCUMENTATION
Basic Requirement	Written record for every economic analysis
Format	BLCC computer printouts; worksheets, additional records

5.1.1 General Formula for LCC

The following is the general formula for the LCC present-value model:

$$LCC = \sum_{t=0}^{N} \frac{C_t}{(1 + d)^t} \qquad (5.1)$$

where:

LCC	= Total LCC in present-value dollars of a given alternative,
$\mathbf{C_t}$	= Sum of all relevant costs, including initial and future costs, less any positive cash flows, occurring in year t,
N	= Number of years in the study period, and
d	= Discount rate used to adjust cash flows to present value.

5.1.2 LCC Formula for Building-Related Projects

The general LCC formula shown in eq (5-1) requires that all costs be identified **by year** and **by amount**. This general formula, while straightforward from a theoretical standpoint, can require extensive calculations, especially when the study period is more than a few years long and for annually recurring amounts, for which future costs must first be calculated to include changes in prices. A simplified LCC formula for computing the LCC of energy and water conservation projects in buildings can be stated as follows:

$$LCC = I + Repl - Res + E + W + OM\&R \qquad (5.2)$$

where:

LCC	= Total LCC in present-value dollars of a given alternative,
I	= Present-value investment costs,
Repl	= Present-value capital replacement costs,
Res	= Present-value residual value (resale value, scrap value, salvage value) less disposal costs,
E	= Present-value energy costs,
W	= Present-value water costs, and
OM&R	= Present-value non-fuel operating, maintenance, and repair costs.

This formula takes advantage of **UPV (uniform present value) factors** to compute the present value of annually recurring costs, whether constant or changing. By using appropriate UPV factors, the LCC can be calculated without first computing the future annual amount (including price escalation) of each annually recurring cost over the entire study period, summing all those costs by year and discounting them to present value. Instead, only the **annual amount in base year dollars (i.e., a one-time amount) and the corresponding UPV factor** need to be identified.

The following two examples apply the LCC method, combined with the FEMP criteria, to determine whether an investment in energy-saving features for a new HVAC system is economically worthwhile. Example 5-1 assumes that all initial investment costs occur **in a lump sum** at the base date, that there is only **one energy type**, and that the two candidate systems have **equal useful lives**. In example 5-2 we will relax these assumptions and illustrate an LCC calculation where some of the initial investment costs are **phased in** during a planning/construction (P/C) period, where **two fuel types** are used, and where the two candidate systems have **unequal useful lives.**

In both these examples, it is assumed that an existing HVAC system in a federally-owned building must be replaced. However, the application of LCCA would be identical for HVAC system selection in a new federal building.

5.2 SELECTION OF HVAC SYSTEM FOR OFFICE BUILDING: SIMPLE EXAMPLE

We look at a conventional HVAC system as our base case (BC) and compare it with an alternative (A) that includes several energy-saving features. The system with the lower LCC will be accepted as the cost-effective system. The HVAC system is to be installed in a federal office building in Washington, DC. All initial investment costs are assumed to be incurred at the beginning of the study period. The parameters and assumptions common to both the base case and the alternative are as follows:

Location:	Washington, DC; DOE Region 3
Discount Rate:	Current FEMP discount rate: 3% real for constant-dollar analysis
Energy Prices:	Fuel type: Electricity at $0.08/kWh, local rate as of base date Rate Type: Commercial
Discount Factor:	FEMP UPV* factor based on a 3% (real) discount rate
Useful Lives of Systems:	20 years
Study Period:	20 years
Base Date:	January 1995

5.2.1 Example 5-1a: Base Case—Conventional Design

The base case (BC) is a constant-volume HVAC system with a reciprocal chiller, without night-time setback and economizer cycle. The relevant cash flows as of today, the base date, are:

- **$103,000** Initial investment costs, assumed to occur in a lump sum
- **$ 12,000** Replacement cost for a fan at the end of year 12
- **$ 3,500** Residual value at the end of the 20-year study period
- **$ 20,000** Annual electricity costs (250,000 kWh at $0.08/kWh)
- **$ 7,000** Annual OM&R costs

The cash-flow diagram in figure 5-1 below shows these cost items and their timing for the base case. Initial investment costs are assumed to occur on January 1, 1995. The two other one-time amounts—the fan replacement and the residual value—are assumed to occur at the end of the respective years. Since this is a constant-dollar analysis and no real price escalation (that is, price escalation different from general inflation) is expected for either the fan replacement or the residual value, the 1995 dollar amounts can be used as estimates of the future costs of these items in years 2006 and 2014. Likewise, OM&R costs are expected to remain the same in constant-dollar terms so that equal annual amounts in base-date (January 1995) dollars can be used throughout the study period. As for the electricity cost, the annual amount in base-date dollars is all that is needed because the FEMP UPV* factor includes the energy price escalation rates projected by DOE.

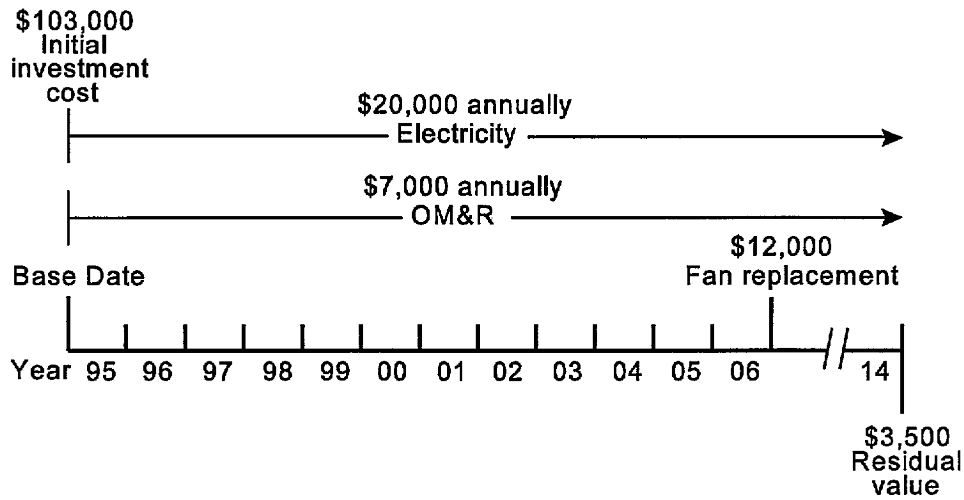


Figure 5-1
Cash Flow Diagram for the Conventional HVAC Design.

Table 5-2 summarizes the input data and calculations for the Base Case: the relevant amounts in base year dollars (column 2), the year of occurrence (column 3), and the appropriate discount factors (column 4). Column 5 shows the calculated present-value cost for each cost category and their sum, the total LCC for the Base Case.

Table 5-2
Data Summary for Conventional HVAC Design: Base Case—Simple Example

Cost Items (1)	BaseDate Cost (2)	Year of Occurrence (3)	Discount Factor (4)		Present Value (5)=(2)x(4)
Initial investment cost	$103,000	Base date	already in present value		$103,000
Capital replacement (fan)	$12,000	12	SPV_{12}	0.701	$8,412
Residual value	($3,500)	20	SPV_{20}	0.554	($1,939)[a]
Electricity: 250,000 kWh at $0.08/kWh	$20,000	annual	FEMP UPV^*_{20}	15.13	$302,600
OM&R	$7,000	annual	UPV_{20}	14.88	$104,160
Total LCC					**$516,233**

[a] The residual value is subtracted from the LCC.

In this example, the LCC of **$516,233** for the conventional design serves as a baseline against which the LCC of the energy-saving alternative system will be compared.

5.2.2 Example 5-1b: Alternative—Energy-Saving Design

The project alternative (A) is a system with constant air volume, with a reciprocal chiller, night-time setback for heating and air-conditioning, and economizer cycle. The relevant cash flows as of today, the base date, are:

- **$110,000** Initial investment costs, assumed to occur in a lump sum at the base date
- **$ 12,500** Replacement cost for a fan at the end of year 12
- **$ 3,700** Residual value at the end of the 20-year study period
- **$ 13,000** Annual electricity costs (162,500 kWh at $0.08/kWh)
- **$ 8,000** Annual OM&R costs

Since the types of cash flows and their timing are assumed to be the same for both the base case and the alternative, a cash flow diagram for the alternative would be analogous to the one in figure 5-1. Table 5-3 shows the summary of input data and calculations.

Table 5-3
Data Summary for Energy-Saving HVAC Design Alternative—Simple Example

Cost Items (1)	Base Date Cost (2)	Year of Occurrence (3)	Discount Factor (4)		Present Value (5)=(2)x(4)
Initial investment cost	$110,000	Base date	already in present value		$110,000
Capital replacement (fan)	$12,500	12	SPV_{12}	0.701	$8,762
Residual value	($3,700)	20	SPV_{20}	0.554	($2,050)
Electricity: 162,500 kWh at $0.08/kWh	$13,000	annual	FEMP UPV^*_{20}	15.13	$196,690
OM&R	$8,000	annual	UPV_{20}	14.88	$119,040
Total LCC					**$432,442**

The LCC decision criterion for choosing one design over another is that the system with the **lower LCC is the preferred system**. If you assume that the input values are reasonably certain and there are no significant non-monetary costs or benefits that need to be taken into account, then you would choose the energy-conserving HVAC system because its LCC of $432,442 is lower than the LCC of $516,233 of the conventional design.

Since the Net Savings measure is simply the difference in present-value LCC between a base case and an alternative, it can easily be calculated from the two LCC amounts. For the energy-saving design, the NS for the 20-year study period is thus

$$NS_A = \$516{,}233 - \$432{,}442$$
$$\mathbf{NS_A = \$\ 83{,}791.}$$

This means that the energy-saving design saves $83,791 in present-value dollars over the 20-year study period, **over and above** the 3 percent minimum acceptable real rate of return already taken into account through the discount rate. If the LCC of an alternative is lower than the LCC of the relevant base case, it must have positive Net Savings.

5.3 SELECTION OF HVAC SYSTEM FOR OFFICE BUILDING: COMPLEX EXAMPLE

A second example of an LCCA is presented here with more complex analytical requirements. Suppose that the initial cost of the HVAC system in example 5-1a is to be **phased in** during the two-year P/C period instead of being charged to the project as a lump-sum at the beginning of the study period. The study period will be extended by two years to 22 years to include a P/C period of two years and a service period of 20 years. Furthermore, suppose that the **useful lives** of the two systems are **different**: 15 years for the base case and 20 years for the alternative. A substantial portion of the base-case system will need to be replaced at the end of its useful life of 15 years, at a cost of $60,000, to prolong its useful life to at least 20 years. However, this replacement will increase its residual value to $20,000 at the end of the 20-year study period. Finally, assume that each system uses two different fuel types, electricity and natural gas.

5.3.1 Example 5-2a: Base Case—Conventional Design

The cash flow diagram in figure 5-2 reflects the assumptions for the base case. The study period in this example is 22 years because **the two-year P/C period is added** to the service period of 20 years. The base date is January 1, 1995. Initial investment costs are charged in two installments, at the end of 1995 and end of 1996. Capital replacement costs are charged for the fan unit after 12 years of service (end of 2008) and for plant renovation after 15 years of service (end of 2011). Annually recurring costs, such as energy costs and OM&R costs, begin to be incurred after the service date (January 1, 1997), and are discounted to present value from the end of each year thereafter until the end of the study period (end of 2016).[2]

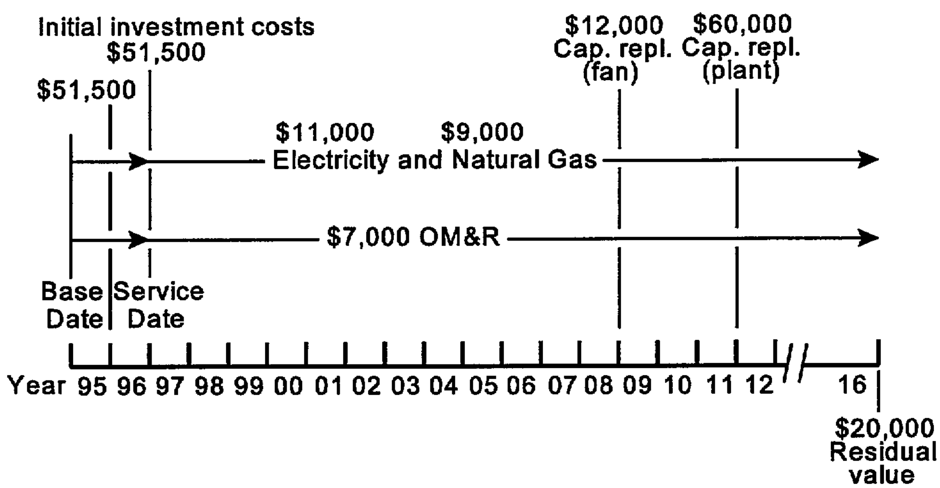


Figure 5-2
Cash Flow Diagram for the Conventional HVAC Design, Base Case.

[2]From a present-value standpoint, a cost occurring at the end of one time period is equivalent to the same cost occurring at the beginning of the next time period.

Table 5-4 shows these costs, their time of occurrence, the appropriate discount factors for a 3 percent discount rate, present values, and total LCC for the base case.

Table 5-4
Data Summary for Conventional HVAC Design: Base Case—Complex Example

Cost Items (1)	Base Date Cost (2)	Year of Occurrenc (from Base Date) (3)	Discount Factor (4)		Present Value (5)=(2)x(4)
Initial Investment Cost:					
1st Installment at midpoint of construction	$51,500	1	SPV_1	0.971	$50,007
2nd Installment at beginning of service period	$51,500	2	SPV_2	0.943	$48,564
Capital replacement (fan)	$12,000	14	SPV_{14}	0.661	$7,932
Capital replacement (plant)	$60,000	17	SPV_{17}	0.605	$36,300
Residual value	($20,000)	22	SPV_{22}	0.522	($10,440)
Electricity 125,000 kWh at $0.08/kWh	$10,000	annual	FEMP UPV*	14.28	$142,800
Natural Gas 1700 GJ at $5.93/GJ (≈1800 MBtu)	$10,080	annual	FEMP UPV*	17.03	$171,662
OM&R	$7,000	annual	UPV	14.03	$ 98,210
Total LCC					**$545,035**

When costs are phased in during the P/C period, the **base date** of the study and the **service date** do not coincide as they did in the previous example. Operational costs usually begin at the service date but must be discounted to the base date. To calculate the correct UPV factor when the service date is later than the base date, you subtract the UPV factor for the P/C period (two years in this example) from the UPV factor for the entire study period (22 years). This procedure is described in detail in chapter 3, section 3.2.3. In this example, the discount factor for calculating the present value of the electricity cost at a discount rate of 3 percent, for region 3, commercial sector, is derived as follows: Deduct from the FEMP UPV* factor for 22 years (16.21) the FEMP UPV* factor for 2 years (1.93) to get 14.28. The UPV* factor for commercial natural gas and UPV factor for non-fuel OM&R costs are derived in a similar fashion.[3]

5.3.2 Example 5-2b: Alternative—Energy-Saving Design

The cash-flow diagram for the energy-conserving alternative is analogous to the one shown in figure 5-2 for the base case. The major difference is that the energy-saving alternative does not require a plant replacement because its useful life is equal to the service period of 20 years.

Table 5-5 shows the data inputs and the computed life-cycle costs for the energy-conserving alternative. As before, the total LCC for the alternative is lower than for the base case. Net savings for the energy-

[3]FEMP UPV* factors are from table Ba-3 (Census region 3) in the Annual Supplement to Handbook 135. The UPV factors for OM&R costs are from table A-2 in the same report.

saving alternative are a positive amount of **$87,744** ($545,035 - $457,291) over the length of the study period.

Table 5-5
Data Summary for Energy-Saving HVAC Design Alternative—Complex Example

Cost Items (1)	Base Date Cost (2)	Year of Occurrence (from Base Date) (3)	Discount Factor (4)		Present Value (5)=(2)x(4)
Initial Investment Cost					
1st Installment at midpoint of construction	$55,000	1	SPV_1	0.971	$53,405
2nd Installment at beginning of service period	$55,000	2	SPV_2	0.943	$51,865
Capital replacement (fan)	$12,500	14	SPV_{14}	0.661	$8,262
Residual value	($3,700)	22	SPV_{22}	0.522	($1,931)
Electricity 100,000 kWh at $0.08/kWh	$8,000	annual	FEMP UPV*	14.28	$114,240
Natural Gas 1180 GJ at $5.93/GJ (≈ 1250 MBtu)	$7,000	annual	FEMP UPV*	17.03	$119,210
OM&R	$8,000	annual	UPV	14.03	$112,240
Total LCC					**$457,291**

5.4 SUMMARY OF THE LCC METHOD

The LCC method provides a consistent means of accounting for **all costs** related to a particular building function, building system, or related project over a given study period. In general, an LCCA is needed to demonstrate that the additional investment cost for a project alternative is more than offset by its corresponding reduction in operating and maintenance costs (including energy and water costs), relative to the base case. The following are key points which should be recognized when using the LCC method for project evaluation:

- Choose among two or more mutually exclusive alternatives on the basis of lowest LCC.
- All alternatives must meet established minimum performance requirements.
- All alternatives must be evaluated using the same base date, service date, study period, and discount rate.
- Positive cash flows (if any) must be subtracted from costs.
- Effects not measured in dollars must be either insignificant, uniform across alternatives, or accounted for in some other way.

CHAPTER 6

CALCULATING SUPPLEMENTARY MEASURES

CONTENTS

Chapter 6

CALCULATING SUPPLEMENTARY MEASURES

With the same set of input data and assumptions needed for an LCCA of two or more project alternatives—present and future costs, a discount rate, and a study period—it is possible to calculate supplementary measures of economic performance for those same alternatives. The supplementary measures described in this chapter are **Net Savings (NS)**, the **Savings-to-Investment Ratio (SIR), Adjusted Internal Rate of Return (AIRR), Discounted Payback (DPB),** and **Simple Payback (SPB)**. The first three of these supplementary measures, if computed and applied correctly, are consistent with LCCA; that is, they will give the same results when determining whether or not a project alternative is cost effective. However, when evaluating mutually exclusive project alternatives, only the Net Savings measure is always consistent with the LCC method in identifying the alternative with the lowest LCC.

Some of these supplementary measures are sometimes needed to meet specific regulatory requirements. For example, the FEMP LCC rules (10 CFR 436) require the use of either the SIR or AIRR for ranking independent projects competing for limited funding. And some federal programs, such as Energy Savings Performance Contracts, require the Simple Payback to be computed in project evaluations.

The supplementary measures described in this section are all **relative** measures of economic performance. That is, they are computed **for a project alternative relative to an identified base case**. The choice of the base case can have a significant effect on the value computed for these measures. Thus it is important to consider this choice carefully. In general, the base case has a lower investment cost and higher operational costs than the alternative being evaluated. In fact, the primary reason for the LCCA of a project or project alternative is **to demonstrate that its operational savings are sufficient to justify its additional investment cost**. For optional retrofit projects in existing buildings (e.g., replacement of existing light fixtures with high efficiency fixtures), the base case is usually the continuation of the existing situation, with no initial investment cost but (presumably) high energy or water costs. For new buildings, or mandatory retrofit projects (e.g., replacing a non-functioning HVAC system), the base case is generally the project alternative which has the lowest investment-related cost over the relevant study period.

It is also important that the **incremental** nature of the investment be understood when computing these supplementary measures with regard to a base case, especially when the base case has its own investment-related costs. These measures are not intended to determine the profitability of the entire investment in a project, but whether the investment **over and above** that required by the base case is justified.

In example 5-1b, the total present-value investment-related cost of the energy-conserving HVAC system is the sum of initial investment cost, replacement costs, and residual value:

$$\$116,712 \; = \; \$110,000 \; + \; \$8,762 \; - \; \$2,050$$

But the incremental investment-related cost is only $7,239, the difference between the investment costs of the energy-saving alternative and the base case:

$$\$7,239 \; = \; \$116,712 \; - \; (\$103,000 + \$8412 - \$1939)$$

Only the incremental investment must be justified by the operational savings.

This chapter describes each of the five supplementary measures and shows how to compute them. The measures are illustrated with examples using the data and assumptions provided in example 5-1. Further examples of how these measures are applied to typical investment decisions will be given in chapter 7.

6.1 NET SAVINGS (NS)

The Net Savings (NS) measure is a variation of the Net Benefits (NB) measure of economic performance of a project. The NB method measures the difference between present-value benefits and present-value costs for a particular investment over the designated study period. The NB measure is generally applied when positive cash flows (e.g., rent) are intended to justify the investment in a project (e.g., a new office building). The NS method is applied **when benefits occur primarily in the form of future operational cost reductions** (e.g., energy and water cost savings). The NS method calculates the net amount, in present-value dollars, that a project alternative is expected to save over the study period. Because the net savings are expressed in present-value terms, they represent savings over and above the amount that would have been earned from investing the same funds at the minimum acceptable rate of return (i.e., the discount rate).

The Net Savings for a project alternative, relative to a designated base case, can be calculated by simply subtracting the LCC of the alternative from the LCC of the base case. That is,

$$NS = LCC_{\text{Base Case}} - LCC_{\text{Alternative}}$$

As long as the NS is greater than zero, the project is considered to be cost effective relative to the base case. This is equivalent to requiring that the LCC of a project alternative be lower than the LCC of its base case. When evaluating multiple, mutually exclusive project alternatives, the alternative with the greatest NS will be the same alternative that has the lowest LCC. Thus **the LCC and NS methods are entirely consistent and can be used interchangeably.** The advantage of the LCC method relative to the NS method when evaluating multiple alternatives is that the former does not require that the base case be specifically identified.

NS can also be calculated from individual cost differences between the base case and alternative (e.g., differences between initial investment costs, between energy costs, and between OM&R costs). While this requires additional calculations compared to the simple method shown above, these intermediate calculations are needed to compute the SIR and AIRR. Thus computing NS using individual cost differences is useful as a check to ensure that the SIR and AIRR calculations are based on correct intermediate calculations. That is, the NS should be exactly the same whether computed by the comparison of LCCs or by using individual cost differences. The following presents the latter method of NS computation in detail.

6.1.1 General Formula for NS

Net Savings can be calculated using individual cost differences by applying the following general formula:

$$NS_{A:BC} = \sum_{t=0}^{N} \frac{S_t}{(1 + d)^t} - \sum_{t=0}^{N} \frac{\Delta I_t}{(1 + d)^t} \tag{6.1}$$

where

$\mathbf{NS_{A:BC}}$	=	NS, in present value dollars, of the alternative (A), relative to the base case (BC),
$\mathbf{S_t}$	=	Savings in year t in operational costs associated with the alternative,
$\mathbf{\Delta I_t}$	=	Additional investment-related costs in year t associated with the alternative,
t	=	Year of occurrence (where 0 is the base date),

d	=	Discount rate, and
N	=	Number of years in study period.

Note that while the summation index (t=0 to N) is shown for operational savings, such savings will normally not be incurred on the base date but only after the project is put into service.

6.1.2 NS Formula for Building-Related Projects

The general NS formula shown above requires that the savings and costs in each year be calculated and discounted to present value. This general formula can require extensive calculations, especially when future costs include price changes and when the study period is more than a few years long. A more practical NS formula for building-related projects takes advantage of present value factors (SPV, UPV, and UPV*) to compute the present value of each cost category before combining them into operation-related or investment-related cost categories:

$$NS_{A:BC} = [\Delta E + \Delta W + \Delta OM\&R] - [\Delta I_0 + \Delta Repl - \Delta Res] \qquad (6.2)$$

where

$\mathbf{NS_{A:BC}}$	=	Net Savings, that is, operation-related savings minus additional investment costs for the alternative relative to the base case,	
ΔE	=	$(E_{BC} - E_A)$	Savings in energy costs attributable to the alternative,
ΔW	=	$(W_{BC} - W_A)$	Savings in water costs attributable to the alternative,
ΔOM&R	=	$(OM\&R_{BC} - OM\&R_A)$	Savings in OM&R costs,
$\mathbf{\Delta I_0}$	=	$(I_A - I_{BC})$	Additional initial investment cost required for the alternative relative to the base case,
ΔRepl	=	$(Repl_A - Repl_{BC})$	Additional capital replacement costs,
Δres	=	$(Res_A - Res_{BC})$	Additional residual value, and

where **all amounts are in present value**.

Note that some of these terms may have negative values. It is important to preserve the appropriate signs when entering the input values in any of the equations for the supplementary measures.

6.1.3 NS Computation

Using the input values of example 5-1(a and b), *Selection of HVAC System for Office Building*, we calculate NS by subtracting the total additional investment costs from the total operational savings. Table 6-1 summarizes this procedure.

The resulting amount, **$83,791**, is the same amount that we calculated by deducting the total LCC of the alternative from the total LCC of the base case in example 5-1. The positive NS indicates that this project alternative is cost-effective when compared to the base case.

In chapter 7, applications of NS are shown for evaluating accept/reject decisions, as well as for levels of system efficiency, system selection, and interdependent systems. However, the NS computed for individual projects is not useful for ranking a number of independent projects subject to limited funding. See section 6.2 on the Savings-to-Investment Ratio for information on ranking independent projects.

Table 6-1
Computation of Net Savings for Energy-Saving HVAC Design—Simple Case

Cost Items	PV Base Case[a]	PV Alternative[b]	PV Difference
Operational Savings (BC-A)			
Electricity costs	$302,600	$196,690	$105,910
OM&R costs	$104,160	$119,040	($14,880)
Total savings			**$91,030**
Additional Investment Costs (A-BC)			
Initial investment cost	$103,000	$110,000	$7,000
Capital replacement (fan)	$8,412	$8,762	$350
Residual value	$1,939	$2,050	($111)
Total add. investment costs			**$7,239**

NET SAVINGS = $91,030 - $7,239 = **$83,791**

[a] Input values taken from table 5-2.
[b] Input values taken from table 5-3.

6.1.4 Summary of NS Method

- NS is a useful measure of economic performance for investments which reduce operational costs.
- NS is a relative measure; it must be calculated with respect to a designated base case.
- NS can be calculated from the difference in total LCC or in individual cost categories.
- Project alternatives must be evaluated over the same time periods and with the same discount rate.
- An investment is cost effective if its NS is positive; NS is only positive when the LCC of the alternative is lower than the base case.
- Significant effects not measurable in dollar terms need to be accounted for in some other way.

6.2 SAVINGS-TO-INVESTMENT RATIO (SIR)

The SIR is a measure of economic performance for a project alternative that expresses the relationship between its savings and its increased investment cost (in present value terms) as a ratio. It is a variation of the Benefit-to-Cost Ratio for use when benefits occur primarily as reductions in operation-related costs. Like the NS measure, SIR is a relative measure of performance; that is, it can only be computed with respect to a designated base case. This means that the same base date, study period, and discount rate must be used for both the base case and the alternative.

A project alternative is generally considered economically justified relative to a designated base case when its SIR is greater than 1.0. This is equivalent to saying that its savings are greater than its incremental investment costs, and that its net savings are greater than zero. However, it is important to recognize that when evaluating multiple, mutually exclusive, project alternatives, the alternative with the **lowest LCC** is the most cost effective alternative. The project alternative with the lowest LCC is **not** generally the alternative with the highest SIR. For example, a single layer of insulation in roof assembly is likely to have a higher SIR than a thicker layer, but the latter may be more cost effective on a LCC basis. **Do NOT use the SIR for choosing among mutually exclusive project alternatives.** The SIR for a project is most useful as a means of ranking that project along with other independent projects as a guide for allocating limited investment funding. This application is explained in detail in section 7.5.

6.2.1 General Formula for SIR

The general formula for the SIR is comprised of the same terms used in the differential cost formula for the NS computation:

(1) the operation-related savings attributable to the project alternative, and
(2) the additional investment-related costs attributable to the project alternative.

The general formula for the SIR simply rearranges these two terms as a ratio:

$$SIR_{A:BC} = \frac{\sum_{t=0}^{N} S_t \,/\, (1+d)^t}{\sum_{t=0}^{N} \Delta I_t \,/\, (1+d)^t} \qquad (6.3)$$

where

$SIR_{A:BC}$	=	Ratio of PV savings to additional PV investment costs of the (mutually exclusive) alternative relative to the base case,
S_t	=	Savings in year t in operational costs attributable to the alternative,
ΔI_t	=	Additional investment-related costs in year t attributable to the alternative,
t	=	Year of occurrence (where 0 is the base date),
d	=	Discount rate, and
N	=	Length of study period.

6.2.2 SIR Formula for Building-Related Projects

The general SIR formula shown above requires that the savings and incremental investment costs in each year be calculated and discounted to present value. This general formula can require extensive calculations, especially when future costs must first be calculated to include changes in prices and when the study period is more than a few years long. A more practical SIR formula for building-related projects is shown below. This formula takes advantage of present value factors to compute the present value of each cost category.

$$SIR_{A:BC} = \frac{\Delta E + \Delta W + \Delta OM\&R}{\Delta I_0 + \Delta Repl - \Delta Res} \qquad (6.4)$$

where

$SIR_{A:BC}$	=	Ratio of operational savings to investment-related additional costs, computed for the alternative relative to the base case,	
ΔE	=	$(E_{BC} - E_A)$	Savings in energy costs attributable to the alternative,
ΔW	=	$(W_{BC} - W_A)$	Savings in water costs attributable to the alternative,
$\Delta OM\&R$	=	$(OM\&R_{BC} - OM\&R_A)$	Difference in OM&R costs,
ΔI_0	=	$(I_A - I_{BC})$	Additional initial investment cost required for the alternative relative to the base case,
$\Delta Repl$	=	$(Repl_A - Repl_{BC})$	Difference in capital replacement costs,
ΔRes	=	$(Res_A - Res_{BC})$	Difference in residual value, and

where **all amounts are in present values**.

The numerator and denominator of this equation are identical to the corresponding savings and investment-related terms of NS eq (6.2) shown above.

According to the FEMP LCC rules as stated in 10 CFR 436, investment-related costs include capital replacement costs as well as initial investment costs, less the project's residual value at the end of the study period. The FEMP method of economic analysis evaluates the return on **all** incremental capital investment in the project over the study period, not just the incremental initial investment.

6.2.3 SIR Computation

In the NS calculations shown in table 6-1, the values of the terms needed to compute the SIR were found to be as follows:

Numerator:	PV of operational savings attributable to the alternative:	**$91,030**
Denominator:	PV of additional investment costs required for the alternative:	**$7,239**

Hence

$$SIR_{A:BC} = \frac{\$91,030}{\$7,239} = 12.6 \qquad (6.5)$$

A ratio of 12.6 means that the energy-conserving design will generate an average return of $12.6 for every $1 invested, *over and above the minimum required rate of return* imposed by the discount rate. The project alternative in this example is clearly cost effective. A ratio of 1.0 would indicate that the cost of the investment just equals its costs; a ratio of less than 1.0 indicates an uneconomic alternative which would cost more than it would save.

6.2.4 Summary of SIR Method

- An investment is cost effective if its SIR is greater than 1.0; this is equivalent to having net savings greater than zero.
- The SIR is a relative measure; it must be calculated with respect to a designated base case.
- When computing the SIR of an alternative relative to its base case, the same study period and the same discount rate must be used.
- The SIR is useful for evaluating a single project alternative against a base case or for ranking independent project alternatives; it is not useful for evaluating multiple mutually exclusive alternatives.
- Significant effects not measurable in dollar terms need to be accounted for in some other way.

6.3 ADJUSTED INTERNAL RATE OF RETURN (AIRR)

The AIRR is a measure of the **annual percentage yield** from a project investment over the study period. Like the NS and SIR measures, the AIRR is a **relative** measure of cost effectiveness. That is, it must be computed relative to a designated base case. This means that **the same** base date, study period, and discount rate must be used for both the base case and the alternative.

The AIRR is compared against the investor's **minimum acceptable rate of return** (MARR), which is generally equal to the **discount rate** used in the LCC analysis. If the AIRR is greater than the MARR, the project is economic; if it is less than the MARR, the project is uneconomic. If the AIRR equals the discount rate, the project's savings just equal its costs and the project is economically neutral.

You can use the AIRR for the same applications as the SIR. You can use it to decide whether to accept or reject a single project alternative (relative to a base case) or to allocate a given investment budget among a number of independent projects. Like the SIR, the AIRR should **NOT** be used to select among multiple, mutually exclusive project alternatives. **The alternative with the highest AIRR will NOT generally be the alternative with the lowest LCC.**

The AIRR, in contrast to the conventional Internal Rate of Return (IRR) measure, explicitly assumes that the savings generated by a project can be reinvested at the discount rate for the remainder of the study period. (If these savings could be reinvested at a higher rate than the discount rate, then the discount rate would not represent the opportunity cost of capital.) The IRR implicitly assumes that interim proceeds (savings) can be reinvested at the **calculated** rate of return on the entire project, an assumption which leads to **over-estimation of the project's yield if the calculated rate of return is higher than the reinvestment rate**. The AIRR and the IRR are the same only if the investment yields a single, lump-sum payment at the end of the study period, or in the unlikely case when the reinvestment rate is the same as the calculated IRR.

There is another consideration that advises against the use of the IRR: more than one rate of return may make the value of the savings and investment streams be equal, as required by the definition of the internal rate of return. This may be the case when capital investment costs (such as replacement costs) are incurred during later years, giving rise to negative cash flows in some years.

For these reasons, the AIRR is generally considered to be a more accurate measure of the rate of return on a capital investment and more consistent with the overall LCC method. In addition, it can be calculated directly by using a simple mathematical formula, whereas the IRR must be approximated by iteration.

6.3.1 Simplified Formula for AIRR

The most straightforward method of calculating the AIRR requires that the **SIR** for a project (relative to its base case) be calculated first. Then the AIRR can be computed easily using the following formula:

$$AIRR = (1 + r)\,(SIR)^{\frac{1}{N}} - 1 \qquad (6.6)$$

where r = the reinvestment rate and N = the number of years in the study period. Using the SIR of 12.6 calculated for example 5-1b, and a reinvestment rate of 3 percent (the MARR), the AIRR is found as follows:

$$AIRR_{A:BC} = (1 + 0.03)\,(12.6)^{\frac{1}{20}} - 1 = 0.1691 \qquad (6.7)$$

Since an AIRR of **16.9** percent for the alternative is greater than the MARR, which in this example is the FEMP discount rate of 3 percent, the project alternative is considered to be cost effective in this application.

6.3.2 Mathematical Derivation of the AIRR

Note: This section provides background information on the mathematical derivation of the AIRR measure. Its purpose is to provide a better understanding of the AIRR. It is not intended to be used for direct calculation of the AIRR. For direct calculation of the AIRR use the simplified formula in the previous section.

The AIRR can be defined mathematically as follows:

Find i for which

$$\frac{\sum_{t=0}^{N} S_t (1+r)^{N-t}}{(1+i)^N} - \sum_{t=0}^{N} \frac{\Delta I_t}{(1+r)^t} = 0 \qquad (6.8)$$

where

S_t = Annual savings generated by the project, reinvested at the reinvestment rate,
r = Rate at which available savings can be reinvested, usually equal to the MARR (i.e., the discount rate), and
$\Delta I_t/(1+r)^t$ = PV investment costs on which return is to be maximized.

In this equation, operational savings are reinvested at a given reinvestment rate (r) each year until the end of the study period and summed, to arrive at a "**terminal value**" of savings (TVS). All capital investment costs are discounted to present value (PVI) using that same reinvestment rate. The implicit interest rate (i) which makes the present value of TVS equal to PVI is the AIRR. In general, the interest rate which makes the present value of a future amount (F) equivalent to a present amount (P) can be found as follows:

$$i = \left[\frac{F}{P}\right]^{\frac{1}{N}} - 1 \qquad (6.9)$$

This equation can be used to find the AIRR when TVS, PVI, and N are known:

$$AIRR = \left[\frac{TVS}{PVI}\right]^{\frac{1}{N}} - 1 \qquad (6.10)$$

where

TVS = the terminal value of operational savings, and
PVI = the present value of capital investment costs.

6.3.3 Summary of AIRR Method

- The AIRR measures economic performance as an annual rate of return on investment.
- A single project alternative is cost effective relative to its base case when its AIRR is greater than the appropriate discount rate.
- The AIRR is a relative measure; it must be calculated with respect to a designated base case.
- When computing the AIRR of an alternative relative to its base case, the same study period and discount rate must be used.
- The AIRR, like the SIR, can be used to evaluate a single project alternative against a base case, and to rank independent projects when allocating a limited budget.
- Effects not measured in dollars are not included and need to be accounted for in some other way.

6.4 SIMPLE PAYBACK (SPB) AND DISCOUNTED PAYBACK (DPB)

There are two payback measures that are often used for economic analysis of a capital investment: Simple Payback (SPB) and Discounted Payback (DPB). Both SPB and DPB measure the time required to recover **initial investment costs**. They are expressed as the number of years elapsed between the beginning of the service period and the time at which cumulative savings (net of any incremental investment costs incurred after the service date) are just sufficient to offset the incremental initial investment cost of the project. Both of these payback measures are **relative** measures; that is, they can only be computed with respect to a designated base case.

DPB is the preferred method of computing the payback period for a project because it requires that cash flows occurring each year **be discounted** to present value before accumulating them as savings and costs. If the DPB is less than the length of the service period used in the analysis, the project is generally cost effective. This is consistent with the requirement that the LCC of the project alternative be lower than the LCC of the base case. In practice, however, the payback criterion typically applied (i.e, the number of years allowed for payback to occur) is usually a subjectively chosen time period considerably shorter than the project's expected service period. Furthermore, it is possible that capital replacement costs or increased OM&R costs can occur after the year of payback, which would negate the cost effectiveness of the project.

SPB, which is more frequently used, does not use discounted cash flows in the payback calculation. In most practical applications the SPB also ignores any changes in prices (e.g., energy price escalation) during the payback period. Like DPB, the acceptable SPB for a project is also typically set at an arbitrary time period often considerably less than its expected service period. The SPB for a project will generally be shorter than its DPB since undiscounted cash flows are greater than their discounted counterparts (assuming a positive discount rate).

Both these payback measures ignore all costs and savings, as well as any residual value, occurring after the payback date. **Payback is not a valid method for selecting among multiple, mutually- exclusive, project alternatives**; only the LCC and NS measures should be used for this purpose. Nor should payback measures be used to rank independent projects for funding allocation.

In general, payback is best used as a **screening method** for identifying single project alternatives that are so clearly economical that the time and expense of a full LCCA is not warranted. However, when uncertainty about the useful life of a project is a major consideration, the discounted payback method can also be used to determine an acceptable lower bound on its useful life.

6.4.1 General Formula for Payback

The payback period is the minimum number of years, y, for which

$$\sum_{t=1}^{y} \frac{(S_t - \Delta I_t)}{(1 + d)^t} \geq \Delta I_0 \qquad (6.11)$$

where

y = Minimum length of time (usually years) over which future net cash flows have to be accumulated in order to offset initial investment costs,
$\mathbf{S_t}$ = Savings in operational costs in year t associated with a given alternative,
$\mathbf{\Delta I_0}$ = Initial investment costs associated with the project alternative,
$\mathbf{\Delta I_t}$ = Additional investment-related costs in year t, other than initial investment costs, and
d = Discount rate.

If the discount rate is zero, y is the SPB; if the discount rate is non-zero, y is the DPB. This equation results in an integer solution to the payback period. While interpolation can be used to determine a non-integer solution (e.g., 2.35), the data do not generally support such precision.

6.4.2 Payback Formula for Building-Related Projects

The formula shown above is general in nature. A formula more specific to energy and water conservation projects in buildings can be stated as:

Find the minimum number of years, y, for which

$$\sum_{t=1}^{y} \frac{[\Delta E_t + \Delta W_t + \Delta OM\&R_t - \Delta Repl_t + \Delta Res_t]}{(1 + d)^t} \geq \Delta I_0 \qquad (6.12)$$

where

ΔE_t	=	$(E_{BC} - E_A)_t$	Savings in energy costs in year t,
ΔW_t	=	$(W_{BC} - W_A)_t$	Savings in water costs in year t,
$\Delta OM\&R_t$	=	$(OM\&R_{BC} - OM\&R_A)_t$	Difference in OM&R costs in year t,
$\Delta Repl_t$	=	$(Repl_A - Repl_{BC})_t$	Difference in capital replacement cost in year t,
ΔRes_t	=	$(Res_A - Res_{BC})_t$	Difference in residual value in year t (usually zero in all but the last year of the study period),
d	=		Discount rate, and
ΔI_0	=	$(I_A - I_{BC})_0$	Additional initial investment cost.

This equation provides the most accurate method for computing both Simple and Discounted Payback. It can require extensive computations when the payback period is long, especially when price escalation rates are required for the analysis. However, manual calculations are not necessary if the NIST BLCC program is used to compute SPB and DPB. Moreover, the BLCC program will compute the cumulative cash flows in every year of the study period to make sure that once payback has been reached it is not reversed by one-time costs incurred in a later year.

6.4.3 Payback Computation

The following example will show how equation 6.12 is solved manually. It is based on the data and assumptions that are used in example 5-1(a and b), with relevant assumptions and data (table 6-2) repeated here.

Location:	Washington, DC
Rate type:	Commercial
Base date:	January 1995
Service date:	January 1995
Study Period:	20 years
Discount rate:	3% real (FEMP rate for FY 95)
Treatment of Inflation:	Constant dollars

Table 6-2
Cost Data from Example 5-1: Selection of HVAC System for Office Building—Simple Case

Initial investment costs, assumed to occur in a lump sum at the base date	$103,00	$110,00
Replacement cost for a fan at the end of year 12	$12,000	$12,500
Residual value at the end of the 20-year study period	$3,500	$3,700
Annual electricity costs	$20,000	$13,000
Annual OM&R costs	$7,000	$8,000

To solve equation 6.12 for both SPB and DBP, it is convenient to use **energy price indices** for each year to convert the $7,000 annual energy savings ($20,000 - $13,000) at base-date prices to their future-cost equivalent. These energy price indices are provided in the "**Ca**" **series of tables** in the Annual Supplement to Handbook 135 for 1995. For this example, table Ca-3 provides the energy price indices for region 3 (Washington, DC, and the South), electricity, commercial rates, beginning in 1995. The Ca tables from the Annual Supplement to Handbook 135 for 1995 are provided in appendix F of this handbook. *Note that these price indices represent only real changes in prices from the base date (i.e., net of general inflation) since this study is conducted in constant dollars.* The price indices should be normalized so that the index for the energy price at the base date is 1.0.

Table 6-3 provides a summary of payback calculations for the first six years of the study period. The first column of this table shows the year of the study period. The second column shows the energy price indices taken from table Ca-3 for each year. These indices, multiplied by the annual energy savings at base date prices, provide the savings expected as of the end of each of the six years, as shown in column (3). (These costs are in constant dollars because general inflation is not included.) The fourth column shows the difference in annual OM&R cost, which is constant throughout the study period in constant-dollar terms. (That is, OM&R costs are assumed to be the same each year in constant dollars.) The fifth column shows cumulative savings, undiscounted (d=0%). These are used for computing SPB. The sixth column shows the present value of cumulative savings (d=3%). The seventh column shows the difference in initial investment cost between the base case and the alternative to be $7,000 ($120,000 - $113,000). This amount is shown for each year to make the calculation of net savings across each row more apparent. The eighth column shows the undiscounted net savings, which turn positive in the second year. The ninth column shows the discounted net savings which also turn positive in the second year. Thus both SPB and DPB occur in the second year, when net savings first become positive. (Interpolation can be used to determine the month as well, but is not normally needed.) An additional column for the difference in capital replacement costs could be included here but is not needed for this example since it is not incurred until year 12 and is not likely to reverse the solution for the payback period.

Table 6-3
Payback Analysis for Example 5-1

Service Year (1)	Energy Price Index[A] (2)	Annual Energy Saving (3)	Annual ΔOM&R (4)	Cumulative Savings d=0% (5)	Cumulative Savings d=3% (6)	Initial Investment Cost (7)	Net Savings d=0% (8)=(5)-(7) (8)	Net Savings d=3% (9)=(6)-(7) (9)
1	1.01	$7,070	($1,000)	$6,070	$5,893	$7,000	-$930	-$1,107
2	1.01	$7,070	($1,000)	$12,140	$11,615	$7,000	$5,140	$4,615
3	1.00	$7,000	($1,000)	$18,140	$17,106	$7,000	$11,140	$10,106
4	1.00	$7,000	($1,000)	$24,140	$22,437	$7,000	$17,140	$15,437
5	1.01	$7,070	($1,000)	$30,210	$28,673	$7,000	$23,210	$20,673
6	1.02	$7,140	($1,000)	$36,350	$33,815	$7,000	$29,350	$25,815

[A]This index represents the energy price level at the end of each service year, based on an index of 1.00 at the base date.

6.4.4 Alternative SPB Computation

In the limited case where ΔE_t, ΔW_t, and $\Delta OM\&R_t$ are assumed to be **the same** in every year (i.e., there is no price escalation and quantities of energy and water saved each year are the same) and there are no additional non-annually recurring OM&R or replacement costs, the SPB can be computed as follows:

$$SPB = \frac{\Delta I_0}{[\Delta E_0 + \Delta W_0 + \Delta OM\&R_0]} \tag{6.13}$$

Equation 6.13 is often used in practice. As a screening tool for qualifying projects that are clearly cost effective, this is acceptable. Applying this simplified SPB formula to example 5-1b, we get a SPB of **1.17** years for the energy-conserving HVAC alternative.

$$PB = \frac{\$110,000 - \$103,000}{(\$20,000 - \$13,000) + (\$7,000 - \$8,000)} = 1.17 \text{ year} \tag{6.14}$$

Since the additional replacement cost does not occur until year 12 and there is little difference in the residual value at the end of the 20 year life of both systems, an SPB in the second year of a 20-year study period is a strong indication that the project alternative is cost effective and may not warrant further economic analysis unless it is competing with other projects for limited investment funding.

6.4.5 Summary of Payback Methods

- SPB and DPB measure how long it takes to recover initial investment costs.
- DBP includes the time-value of money in the calculation.
- Payback is useful only as a rough guide for accept/reject decisions and is not recommended as a criterion for selecting among mutually exclusive alternatives or for ranking independent projects.

CHAPTER 7

APPLYING LCC MEASURES TO PROJECT INVESTMENTS

CONTENTS

Chapter 7

APPLYING LCC MEASURES TO PROJECT INVESTMENTS

The previous chapters of this handbook were devoted to the mechanics of LCC analysis and the special requirements of the FEMP rules of 10 CFR 436 for economic analysis of energy and water conservation projects in federal facilities. This chapter shows how to apply LCC analysis and supplementary economic measures (NS, SIR, and AIRR) to different types of investment decisions related to these projects.

Five types of capital investment decisions frequently encountered in evaluations of energy and water conservation projects are identified in chapter 2:

(1) Accept or reject a single project or system option
(2) Select an optimal efficiency level for a building system
(3) Select an optimal system type from competing alternatives
(4) Select an optimal combination of interdependent systems
(5) Rank independent projects to allocate a limited capital investment budget

The term "optimal," as used here, means the most cost-effective choice from available alternatives; it does not refer to technical performance and does not include project alternatives that are not available at the required time and place. The first four of these investment decisions are similar in that they all involve the evaluation of **mutually exclusive** alternatives. That is, of the two or more choices being considered (even an accept/reject decision must have a base case for comparison), only one alternative can be selected. The fourth decision involves the **simultaneous analysis** of two or more interdependent systems, where each system has two or more mutually exclusive alternatives. These first four decision types identify the most cost-effective project alternative(s) in the sense that they minimize life-cycle costs. However, they do not address the problem of a budget constraint: that is, how do you allocate a limited capital investment budget among a number of **independent** (competing) projects so as to maximize the effectiveness of that budget. This is the domain of the fifth decision type. Table 2-1 in chapter 2 provides examples for each of these decision types.

7.1 ACCEPT OR REJECT A SINGLE PROJECT ALTERNATIVE

An **accept/reject** decision relates to the economic evaluation of a project having a **single** design or system option which you are considering for purchase. No competing alternatives are considered in this analysis (although it is usually advisable to consider other alternatives). You will either accept this project or reject it, depending on its cost effectiveness. Examples might include the decision to

- install storm windows over existing single-pane windows,
- install an air-lock door in a building entryway, or
- replace an electric hot water heater with a gas-fired water heater.

Even a single project alternative must be evaluated against a base case. The base case for a single project alternative is generally the "do-nothing" alternative. This base case will typically have no initial investment cost, but higher operational (e.g., energy or water) costs than the project to be evaluated. In some cases the base case may require a capital replacement to prolong its life to the end of the study period selected for evaluating the project alternative.

When a project is being evaluated as an accept/reject proposition, each of the following economic decision criteria consistently indicate a cost-effective project:

- Life-Cycle Cost (LCC) of project less than LCC of base case
- Net Savings (NS) of project greater than zero
- Savings-to-Investment Ratio (SIR) greater than 1.0
- Adjusted Internal Rate of Return (AIRR) greater than the discount rate

Each of these criteria is used to solve the following example:

7.1.1 Example 7-1: Decision to Accept/Reject Storm Windows

Install 10 storm windows over existing single-pane windows in a ranger's house in a National Park located in the Western Region of the United States.

Initial cost (installed):	$800			
Base date:	January 1995			
Service date:	January 1995			
Expected life:	20 years			
DoE discount rate:	3% (real)			
Replacement schedule:	none			
Residual value:	zero			
Fuel oil price (January 1995):	$7.52/GJ (≈$1.11/gallon)			
Electricity price (January 1995):	$0.08/kWh (no demand charges)			
Location:	DoE Region 4 (West)			
Rate type for energy:	residential			
FEMP UPV* factors:	for distillate fuel oil:	17.88		
	for electricity:	16.75		
Annual building energy usage:	With existing windows:			
	space heating:	84.40 GJ	#2 fuel oil	(≈571 gallons)
	space cooling:	4.43 GJ	Electricity	(≈1,230 kWh)
	With storm windows:			
	space heating:	76.43 GJ	#2 fuel oil	(≈518 gallons)
	space cooling:	4.17 GJ	Electricity	(≈1,157 kWh)
Annual savings:	With storm windows:			
	space heating:	7.97 GJ	#2 fuel oil	(≈53 gallons)
	space cooling:	0.26 GJ	electricity	(≈73 kWh)

Additional considerations:
Additional window-washing requirements will be performed by occupants as a housekeeping chore at no additional cost to government. Occupant comfort on cold days will be improved.

7.1.1.1 LCC Solution

The LCC formula can be used to solve this accept/reject investment problem. This formula is applied to both the base case and the alternative to determine which has the lower LCC.

$$LCC = I_0 + Repl - Res + E + OM\&R \qquad (7.1)$$

where

LCC = Total LCC in present value dollars of a given alternative,
I_0 = Initial investment costs,
Repl = Present-value capital replacement costs,
Res = Present-value residual (resale value, scrap value, salvage value) less disposal costs,
E = Present-value energy costs, and
OM&R = Present-value non-fuel operating, maintenance, and repair costs.

LCC solution for "do-nothing" base case (do not install storm windows):

I_0 = 0
Repl = 0
Res = 0
E = 84.4 GJ x $7.52/GJ x 17.88 + 1230 kWh x $0.08/kWh x 16.75 = $12,996
OM&R = 0

LCC = $12,996

LCC solution for alternative (install storm windows):

I_0 = $800
Repl = 0
Res = 0
E = 76.43 GJ x $7.52/GJ x 17.88 + 1157 kWh x $0.08/kWh x 16.75 = $11,827
OM&R = 0

LCC = $800 + $11,827 = $12,627

Conclusion: The LCC for storm windows (**$12,627**) is lower than the LCC for existing windows (**$12,996**); installing storm windows is cost effective and should be accepted.

7.1.1.2 NS Solution

This accept/reject problem can also be solved by using the NS method. The NS is a measure of the expected long-run profitability of the project to be undertaken. You can calculate the NS by simply taking the difference between the LCC of the base case (do not install storm windows) and the LCC of the alternative (install storm windows), i.e.,

$$\$12{,}996 - \$12{,}627 = \$369$$

However, for this example we will use the NS formula for building-related projects presented in section 6.1.2. This helps us set up the same problem for solution with SIR and AIRR in the next sections.

$$NS_{A:BC} = [\Delta E + \Delta OM\&R] - [\Delta I_0 + \Delta Repl - \Delta Res] \qquad (7.2)$$

where:

$\mathbf{NS_{A:BC}}$	=	Present Value Net Savings, that is, operational savings minus additional investment costs for the alternative relative to the base case,	
$\mathbf{\Delta E}$	=	$(E_{BC} - E_A)$	Savings in energy costs attributable to the alternative,
$\mathbf{\Delta OM\&R}$	=	$(OM\&R_{BC} - OM\&R_a)$	Savings (or increase) in OM&R costs,
$\mathbf{\Delta I_0}$	=	$(I_A - I_{BC})$	Additional initial investment cost required for the alternative relative to the base case,
ΔRepl	=	$(Repl_A - Repl_{BC})$	Additional capital replacement costs, and
Δres	=	$(Res_A - Res_{BC})$	Additional residual value.

$\mathbf{\Delta E}$ = 7.97 GJ x \$7.52/GJ x 17.88 + 73 kWh x \$0.08 x 16.75 = \$1,169

$\mathbf{\Delta I_0}$ = \$800

NS = **\$1,169 - \$800 = \$369**

Conclusion: Net savings (**\$369** in present-value terms) is positive; the storm windows are cost effective. These net savings, or "profit", will be earned in addition to the 3 percent real rate of return implicit in the LCC calculations as a result of discounting.

7.1.1.3 SIR Solution

The SIR method can also be used to determine whether to accept or reject the storm window investment. It expresses the savings that can be achieved for each dollar invested in the energy-saving alternative. The SIR must be greater than 1.0 for the storm windows to generate more savings than costs. In this calculation we use the SIR formula for building-related projects as presented in section 6.2.2:

$$SIR_{A:BC} = \frac{\Delta E + \Delta OM\&R}{\Delta I_0 + \Delta Repl - \Delta Res} \qquad (7.3)$$

$$SIR = \$1{,}169/\$800 = 1.46$$

Conclusion: The storm windows' SIR of **1.46** passes the test for cost effectiveness. For each one dollar invested in the storm windows, \$1.46 will be saved, over and above the 3 percent discount rate reflecting the minimum acceptable rate of return.

7.1.1.4 AIRR Solution

The AIRR method can be used to evaluate the cost effectiveness of the storm windows when you are interested in a measure of project **yield per year**. If the AIRR for the storm windows is greater than the required rate of return (as reflected in the 3 percent discount rate in our example), it indicates that the annual yield of the energy-saving project exceeds that of the next best opportunity for investing your funds. The simplified formula for computing the AIRR, as presented in section 6.3.1, is used here to compute the AIRR of the storm windows.

$$\begin{aligned} AIRR &= (1 + r) \times (SIR)^{\frac{1}{20}} - 1 \\ &= (1 + 0.03) \times (1.46)^{\frac{1}{20}} - 1 \\ &= 0.0497 \\ AIRR &\approx 5.0\% \end{aligned} \tag{7.4}$$

Conclusion: The AIRR of **5.0 percent** (real) for the storm windows is greater than the real discount rate of 3.0 percent. The AIRR solution shows that the storm windows are cost effective, consistent with the results of the LCC, NS, and SIR analyses.

7.2 SELECT OPTIMAL EFFICIENCY LEVEL

The **optimal efficiency level** refers to the problem of selecting the most cost-effective level of energy performance (or other scalable performance parameter) for a building system. "Efficiency level" here means that a given set of performance requirements can be achieved with different amounts of resource input (e.g., energy or water); the lower the input requirement, the higher the efficiency. The energy efficiency of a building system can vary over a wide range while producing approximately the same level of thermal comfort, convenience, or light. Good examples of this type of decision include the selection of

- the level of insulation to be installed in a roof, wall, or floor of a building,
- the level of thermal performance for window systems,
- the seasonal efficiency of a furnace or boiler,
- the seasonal coefficient of performance (SCOP) for an air conditioner or heat pump system,
- the collector area of a solar heating system.

Generally we can assume that the more efficient the system, the higher its investment cost. This type of decision is different from the accept/reject decision shown above because the object is not to determine whether or not a particular efficiency level is cost effective. Instead, the objective is to determine which of the available efficiency levels is the **most cost effective** for the application being considered.

Consider the case of thermal insulation in the exterior envelope of a building. Insulation can generally be installed over a wide range of R-values (resistance values) in most exterior components, and in general the higher the R-value the lower the energy loss (or gain) through that component. However, these savings are subject to diminishing marginal returns; that is, each additional unit saves less than the one before. While the first units may be extremely cost effective, beyond some point it no longer pays to install additional insulation.

The optimal energy efficiency level for a building system, whether roof, walls, windows, lighting, or heating and cooling equipment, is generally the level which minimizes LCC or maximizes Net Savings. Both of these measures will give an identical solution if applied properly. Do NOT use the SIR, AIRR, or payback measures to determine this solution. The efficiency level with the highest SIR or AIRR (or shortest payback) will not be the economically optimal level. The SIR and AIRR measures usually decline with each additional unit of efficiency, since the additional energy savings generated tend to decline with each unit increase in efficiency.

7.2.1 Example 7-2: Decision on Optimal Level of Insulation

This example illustrates the computation of **LCC** and **NS** measures to determine the **optimal** R-value of attic insulation to be installed in a new house on a military base in Ohio. The key dates and assumptions are as follows:

Base date:	January 1995
Service date:	January 1995
Expected life:	25 years
Replacement schedule:	none
Residual value:	none
Electricity price:	$0.08/kWh (January 1995)
Location:	DoE Region 2 (Midwest)
Rate type for energy:	residential
FEMP UPV* for electricity:	19.58

Five different levels of batt insulation are being considered, ranging from R-11 to R-49. Note that the optimal R-value for any given building is determined by a number of factors, including climate, fuel prices, the efficiency and operating schedule of the heating and cooling equipment, the incremental cost of each level of insulation considered, and the study period and discount rate selected for the analysis.

Table 7-1 shows the initial cost and annual kWh usage for space heating and cooling for each R-value being evaluated. The annual kWh cost is found by multiplying the annual kWh usage by the unit kWh cost at the base date price ($0.08/kWh). Life-cycle energy costs, in present value dollars, are found by multiplying the annual kWh cost by the FEMP UPV* factor for electricity in DOE region 2. (This factor is taken from table Ba-2 of the Annual Supplement to Handbook 135 for 1995, reproduced in appendix F.) The LCC is the sum of initial cost and present-value life-cycle energy costs. R-38 has the lowest LCC (**$11,300**) and the highest Net Savings (**$3,741**) in this example. Thus R-38 is considered to be the economically optimal R-value for this particular application. (Of course, for other energy types or prices, or for a different set of heating and cooling requirements, the optimal R-value may be different.) Table 7-1 also shows the SIR for each level of insulation relative to the R-0 level. Note that the R-value with the highest SIR (R-11) is NOT the level of insulation with the lowest LCC.

One of the advantages of using the LCC method for solving the optimal-efficiency problem is that **you do not have to identify a base case**. Whether or not the R-0 is included in the analysis, the LCC of each of the other R-values will be the same. One of the advantages of using the Net Savings method is that you do not need to know the total annual energy usage for space heating and cooling; you can use the annual energy savings. But with the Net Savings method you must identify a base case from which the energy savings are referenced; in our example the base case is the R-0 level.

Table 7-1
Cost Data, LCCs, and Net Savings for Selecting Optimal Insulation Level

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Initial		Energy Cost		Total	Net	
R-Value	Cost ($)	Annual kWh	Annual ($)	Life (PV) ($)	PV LCC ($)	Savings ($)	SIR
R-0	0	9602	768	15,041	15,041	0	n/a
R-11	300	7455	596	11,678	11,978	3,063	11.21
R-19	450	7055	564	11,051	11,501	3,540	8.87
R-30	650	6804	544	10,658	11,308	3,733	6.74
R-38	800	6703	536	10,500	11,300	3,741	5.78
R-49	1000	6628	530	10,382	11,382	3,658	4.66

7.3 SELECT OPTIMAL SYSTEM TYPE

Optimal system selection refers to the problem of selecting the most cost-effective system **type** for a particular application. Examples of this investment decision category include

- selection of the HVAC system type (e.g., electric, gas, heat pump),
- selection of wall construction type (e.g., masonry, wood frame, or curtain wall), or
- selection of water heater type to be installed in a new building (e.g., gas, electric, solar).

The choice of system type may affect the energy use of the building, but the amount of energy used is not generally a primary consideration in the selection. For example, the choice between concrete-masonry construction and curtain wall construction for exterior walls of an office building may be dictated more by long-term maintenance costs and fire-safety considerations than by energy usage, but that choice will affect the heat loss and heat gain through the wall. The choice of fuel type for space heating also falls into this category, since it is not a matter of fuel utilization efficiency but of cost effectiveness in the particular application that is to be considered.

7.3.1 Example 7-3: Selection of Optimal Type of HVAC System

In example 7-3 we look at five different types of heating/cooling systems being considered for installation in a house on a military base in Ohio. The key dates and assumptions are as follows:

Base date:	January 1995
Service date:	January 1995
Expected life:	15 years
Replacement schedule:	none
Residual value:	none
Discount rate:	3% real
UPV factor for OM&R costs (15 years):	11.94
Location:	DOE Region 2 (Midwest)

Annual space heating load:	52.75 GJ (≈50 MBtu)	
Annual space cooling load:	21.10 GJ (≈20 MBtu)	
Fuel prices as of base date:	Electricity:	$22.20/GJ (≈0.08/kWh, $23.40/MBtu)
	Fuel oil:	$ 7.58/GJ (≈$1.12/gallon, $8.00/MBtu)
	LPG:	$10.43/GJ (≈$1.01/gallon, $11.00/MBtu)
	Natural gas:	$7.58/GJ (≈$0.80/therm, $8.00 MBtu)
Rate type for energy:	Residential	
FEMP UPV* factors:	Electricity:	12.80
	Fuel oil:	14.00
	LPG:	14.02
	Natural gas:	13.41

Four different fuel types are available at the site: electricity, fuel oil, LPG, and natural gas. We can assume that the optimal energy-utilization efficiency for each system type (i.e., the efficiency level with the lowest LCC) has already been determined before making the decision as to which system type is most cost effective for this house. To make this problem easier, each system is assumed to have the same expected life (15 years). The optimal heating/cooling system will depend on the annual space heating and cooling requirements, the price per GJ or MBtu of fuel, the seasonal efficiency of each system, OM&R costs, the study period, and the discount rate.

Table 7-2 shows, for five different HVAC system alternatives, the system-specific data needed for computing annual energy usage and life-cycle costs: initial costs, annual OM&R costs, and seasonal efficiency. Table 7-3 shows the LCC solution for each of the five systems. Initial costs are lowest for the electric base board (BB) system with window air conditioner and highest for the natural gas furnace. (The cost of the fuel oil and LPG furnaces include a storage tank. The cost of the natural gas furnace includes the installation of a pipeline from the street.)

Table 7-2
System Types, Costs, and Seasonal Efficiency Data
Used to Select Optimal Type of HVAC System (Example)

System Type	Initial Cost ($)	Annual OM&R Cost ($)	Seasonal Efficiency[a]
Electric BB/Window AC	2,500	75	1.00/3.0
Heat Pump (Central)	4,000	200	2.00/3.0
Oil Furnace/Central AC	4,500	125	0.82/3.0
LPG Furnace/Central AC	4,500	100	0.85/3.0
Nat Gas Furnace/Central AC	5,000	100	0.85/3.0

[a] Seasonal coefficient of performance for heat pump. Central systems are assumed to have an additional 10% duct loss.

Table 7-3
Present-Value Costs, LCC and NS Solutions for Selecting Optimal Type of HVAC System

System Type	Present Value Costs ($) Initial	OM&R	Energy	LCC ($)	NS ($)	SIR
Electric BB/Window AC	2,500	895	16,988	20,384	n/a	n/a
Heat Pump (Central)	4,000	2,388	10,548	16,936	3,447	3.30
Oil Furnace/Central AC	4,500	1,493	9,806	15,798	4,585	3.29
LPG Furnace/Central AC	4,500	1,194	12,304	17,998	2,386	2.19
Nat Gas Furnace/Central AC	5,000	1,194	9,230	15,424	4,960	2.98

In this example the natural gas furnace/central AC has the lowest LCC (**$15,424**) and highest Net Savings (**$4,960**) of the five systems and is therefore the most cost effective system choice for this specific application. Note, however, that it does not have the highest SIR. The heat pump, which ranks third in terms of LCC, has the highest SIR (**3.30**). The SIR is not a valid method for determining the HVAC system with the lowest LCC.

7.4 SELECT OPTIMAL COMBINATION OF INTERDEPENDENT SYSTEMS

Determining the optimal design or energy efficiency for a number of interdependent systems within a building generally requires a **simultaneous energy analysis** to properly account for the **interaction among the systems**. This interaction results when the use of one system affects the energy use of other systems in the same facility. For example, as the thermal envelope of a building becomes tighter (i.e., more insulation and more efficient window systems are employed), the energy savings from efficiency improvements to the heating/cooling system diminish, making the latter improvements less cost effective. Similarly, as the efficiency of the heating/cooling system is increased, the energy savings from the insulation and window improvements diminish, making these less cost effective as well.

Building system interactions that are most likely to have an impact on energy savings are those related to

- HVAC system efficiency,
- the thermal integrity of the overall building envelope, and
- lighting system efficiency and usage.

Interactions among the various envelope components themselves (including windows, walls, and roof) are less important, difficult to measure, and difficult to document. The time to pay most attention to system interactions is during the design phase of a new building. Retrofit projects in an existing building are usually more restrictive in terms of the number of systems that can be substantially modified at the same time.

It is not conceptually difficult to perform a simultaneous analysis of several building systems. This basically requires a **whole-building energy analysis** (using a load simulation program such as ASEAM, DOE-2, or BLAST) **for each combination** of system specifications to be evaluated. The calculated energy usage for the whole building reflects the interaction of these building systems. The difference in building energy usage from one combination of system specifications to another is the savings attributable to all of the changes. There is no need to estimate savings attributable to individual systems or conservation measures when performing this analysis. Some whole-building energy analysis programs can be set up in a parametric mode which automatically changes one or more system parameters (e.g., the R-value of wall insulation or heating system efficiency) with each run.

While whole-building energy analysis is not conceptually difficult, the number of potential system combinations to be evaluated can be very large and unwieldy. In general, **only practical and balanced combinations of alternatives need to be considered**. Thus it is unlikely that a low level of roof insulation and a high-efficiency window glazing would be used together. Unlikely system combinations should be eliminated to the extent possible before performing an energy analysis on the remaining combinations.

Once the energy usage of each combination of systems is estimated, an LCC analysis can be performed for each combination of system specifications. This LCC is based on the total initial investment costs, replacement costs, residual values, and OM&R costs for each combination of systems being evaluated, and the corresponding energy usage for that combination (all in present value terms). **The most cost-effective combination of building system specifications is the combination with the overall lowest LCC**.

7.4.1 Example 7-4: Selection of Optimal Combination of Thermal Envelope and HVAC System Efficiency

This example shows an LCC analysis for a hypothetical administration building being designed for a West Coast location. Five different levels of thermal efficiency (i.e., resistance to heat loss and heat gain) in the envelope system (E_1 through E_5), and three different levels of HVAC energy conversion efficiency (H_1 through H_3) are being considered for this building. Higher levels of efficiency have higher initial costs but use less energy than lower levels. Two energy types are assumed, natural gas for heating, electricity for cooling and for fans. Since the envelope and HVAC systems are interdependent from an energy usage standpoint, the energy analysis must be performed for the entire building rather than for the individual systems. The design objective in this example is to determine which envelope and HVAC system combination results in the lowest LCC.

The basic economic and technical assumptions needed for this analysis are as follows:

Base Date:	January 1995		
Service Date:	January 1995		
Expected life:	25 years		
Replacements:	none		
Residual value:	none		
Discount rate:	3% real		
UPV factor for OM&R costs:	11.94		
Location:	DOE Region 4 (West)		
Rate type for energy:	Residential		
Fuel prices as of Base Date:	Electricity:	\$22.00/GJ	(≈\$0.079/kWh, \$23.21/MBtu)
	Natural gas:	\$7.00/GJ	(≈\$7.39/MBtu)
FEMP UPV* factors:	for electricity:	20.05	
	for natural gas:	21.19	

Initial cost:

Envelope System	Initial Cost ($)	HVAC System	Initial Cost ($)
E_1	0	H_1	0
E_2	5,000	H_2	15,000
E_3	10,500	H_3	37,000
E_4	22,000		
E_5	40,000		

Annual natural gas usage (GJ) by envelope and HVAC alternative:

Envelope System	HVAC System ($)		
	H_1	H_2	H_3
E_1	1,285	1,124	1,058
E_2	1,221	1,068	1,005
E_3	1,163	1,018	958
E_4	1,112	973	915
E_5	1,067	933	878

Annual electricity usage (GJ) by envelope and HVAC alterative:

Envelope System	HVAC System ($)		
	H_1	H_2	H_3
E_1	350	300	266
E_2	332	285	253
E_3	318	272	242
E_4	306	262	233
E_5	298	255	226

Each level of envelope efficiency shown builds on the previous level, increasing the initial investment cost of the building but reducing annual heating and cooling requirements. Likewise, each HVAC system alternative shown has a higher initial investment cost but reduces the energy needed to satisfy a given heating and cooling load. The base level for both the envelope and the HVAC equipment is shown to have zero initial cost because it is assumed that these represent minimum acceptable levels of performance. Only investment costs **above these minimum levels** of performance are needed for this analysis. To make the problem easier to demonstrate, OM&R costs are assumed to be the same for each level of envelope efficiency and each level of HVAC system efficiency, no replacements are needed during the 25-year study period, and the residual value of each alternative is assumed to be zero. In addition, the potential reduction in the initial cost of the HVAC system due to a downsizing of maximum heating and cooling loads is also assumed to be negligible. Thus the LCC shown here is simply the sum of the initial cost of the envelope and system improvements plus the present value of natural gas and electricity costs for space heating and cooling. For example, the LCC of the combination E_2 and H_3 can be computed as follows:

$LCC_{E2,H3}$ =	\$15,000	(initial cost of E_2)
+	\$37,000	(initial cost of H_3)
+	1,005 GJ x \$7.00/GJ x 21.19	(PV cost of natural gas)
+	253 GJ x \$22/GJ x 20.05	(PV cost of electricity)
=	\$302,670	

The LCC for each envelope and HVAC system combination from example 7-4 is shown in table 7-4. The first column shows LCC calculations for each of the five thermal envelope alternatives, given the base-level HVAC system. If the base-level HVAC system H_1 were to be selected, the most cost-effective envelope alternative would be E_4, with an LCC of **\$321,920**. If HVAC system H_3 were to be selected, the most cost-effective envelope alternative would be E_3, with a total LCC of **\$296,346**. If the base-level thermal envelope E_1 were selected, the most cost-effective HVAC system would be H_3, with an LCC of **\$311,266**. But if E_5 were selected, the most cost-effective HVAC system would be H_2 with an LCC of **\$305,872**. The combination with the lowest LCC **(\$296,346)** is E_3,H_3.

Table 7-4
LCC Solution for Selecting the Optimal Combination of Building Envelope and HVAC System

Envelope System	HVAC System (\$) H_1	H_2	H_3
E_1	344,989	314,053	311,266
E_2	332,556	304,130	302,670
E_3	323,278	296,479	296,346
E_4	321,920	296,893	297,498
E_5	329,716	305,872	306,922

The LCC method is the most appropriate method for evaluating interactive system combinations. The **Net Savings** measure can also be used to determine the optimal combination; the combination with the highest NS is the same as the combination with the lowest LCC. However, in order to compute the Net Savings, a base case system combination must be identified first (e.g., E_1,H_1 in this example) and the Net Savings for each combination to be evaluated must be computed with respect to that base case. The choice of the combination with the highest SIR and AIRR, or the shortest Payback, will NOT yield the correct combination in most cases.

In this example the difference in the LCC for some combinations close to the optimal combination (E_3,H_3) is relatively small. The determination of the optimal combination is likely to be quite **sensitive to uncertain parameters** such as OM&R costs or future energy costs. Thus fine tuning of this method by examining large numbers of potential combinations of interdependent systems is probably not warranted either from a design cost or LCC standpoint. Still it is important to recognize that the interaction among building systems can affect the economics of design choices and to understand how to take these considerations into account.

7.5 RANKING INDEPENDENT PROJECTS FOR FUNDING ALLOCATION

Up to this point, this chapter has shown how LCC and related measures of economic analysis can be used to determine cost-effective choices **among mutually exclusive project alternatives**. These are applications where only one alternative for any given system is to be selected. This section addresses the use of economic analysis to rank two or more **independent** projects—all of which have already been shown to be cost effective—in order to allocate limited funding. Independent projects are projects that can be implemented in the same or different buildings without significantly affecting the cost effectiveness of one another.

Since all of the independent projects being considered have already been identified as cost effective, it would generally be advantageous to implement them all. However, there may be insufficient investment funding for this purpose and it is therefore important that the funding available be allocated to achieve the **greatest overall Net Savings**. The FEMP LCC rules (10 CFR 436) require the use of either the SIR or AIRR measures for establishing priority for ranking independent projects. Projects are ranked in order of SIR or AIRR and funded in descending rank order until the available funding runs out. If additional funding is made available at a later time, it will be allocated to the remaining projects (and any new projects introduced in the interim) using this same criterion. **The same results will be achieved by using either the SIR or AIRR for ranking projects.** In the remainder of this section only the SIR method will be demonstrated.

*Note that only the SIR and AIRR measures provide an acceptable method for ranking independent projects for funding purposes. Do **NOT** use the LCC, Net Savings, or Payback measures for individual projects as a means of ranking them with other independent projects.*

If **several interdependent projects** have been identified for potential funding, these are best evaluated by combining them into a single project with a combined SIR and ranking this project along with other independent projects. The **information on individual projects** within a set should be preserved to allow selections from the set when budget limitations preclude funding all projects within a set.

A practical advantage of using the SIR measure for ranking independent projects is that the same study period is not required for each project, as it is when evaluating mutually exclusive projects. This is especially important when funding projects are submitted by different analysts or for different buildings. For example, if new roof insulation in one building is evaluated with a study period of 25 years and a new computer-control system for HVAC equipment in a different building is evaluated with a study period of 15 years, the two projects can still be ranked by their individual SIRs when allocating funding. This advantage is based on the implicit assumption that any project can be replicated (i.e., replaced with a similar system having similar costs and savings) at the end of its life. However, when calculating SIRs for ranking independent projects, do NOT include project replication in the analysis (i.e., do not include project replacements in order to force a longer life).

If an SIR is calculated when performing an analysis of mutually exclusive alternatives for a given project (although it is not necessary for that analysis), the resulting SIR may not be appropriate for ranking that project with respect to other independent projects. If the project analysis included capital replacements in order to force a common study period, the project's SIR will need to be recalculated without the replacements before it can be used for project ranking.

7.5.1 Example 7-5: Simple SIR Ranking

Table 7-5 demonstrates the most straightforward application of the SIR ranking method. Six independent conservation projects are proposed for funding, but **only $7,000 is available** for funding conservation projects this year. All six projects have already been shown to be cost effective relative to their corresponding base cases in that they have an SIR greater than 1.0 and Net Savings greater than zero. If $16,000 were available to fund these projects, all six could be funded at a present-value Net Savings of $39,000.

Table 7-5
SIR Ranking of Independent Projects for Example 7-5

	Initial Cost ($)	Total Savings ($)	SIR	Net Savings ($)	Cumulative Investment ($)	Cumulative Net Savings ($)
Project A	1,000	10,000	10.0	9,000	1,000	9,000
Project F	1,000	5,000	5.0	5,000	2,000	14,000
Project E	2,000	8,000	4.0	6,000	4,000	20,000
Project C	3,000	10,000	3.3	7,000	7,000	27,000
Project B	5,000	15,000	3.0	10,000	12,000	37,000
Project D	4,000	6,000	1.5	2,000	16,000	39,000

The projects are listed in table 7-5 in declining order of their SIR. The column labeled "Cumulative Investment" indicates how far down the list the $7,000 funding will reach. Projects A, F, E, and C will be funded with a cumulative Net Savings of $27,000. No other combination of projects from this list that can fit into the $7,000 budget constraint can produce greater cumulative Net Savings.

7.5.2 Example 7-6: SIR Ranking of Indivisible Projects

In example 7-5 the top four projects, as ranked by SIR, fit **exactly** into the available capital investment budget. This may not always be the case. Table 7-6 shows eight independent projects which together have a total investment cost of $27,500. However, only $12,000 in capital funding is available this year. The projects are funded in declining order of SIR. But when project H (ranked 5th, with an SIR of 2.0 and an initial cost of $10,000) is reached, it cannot be funded within the remaining funding of $4,500 ($12,000-$7,500). If project H is **divisible** into smaller parts, each having the same SIR, then the remaining $4,500 should be invested in that project. But if H cannot be divided up, the solution to this problem becomes more complex. Project H should be **skipped over** for now, and project G, at $4,000, should be included. This leaves **$500 uninvested** if no other project can be broken down into smaller pieces.

The combination of projects B, C, D, F, and G have a total investment cost of **$11,500** and a combined Net Savings of **$20,300**. Alternatively, the $12,000 could be allocated to projects B and H, which have a total investment cost of **$12,000** and a combined Net Savings of **$18,000**. Since the ultimate objective is to fund the package of projects with the greatest overall Net Savings, the first package is selected. (Uninvested funding, if any, should not be included in the Net Savings. It can be ignored.)

Table 7-6
SIR Ranking of Indivisible Projects

Projects	Initial Cost ($)	Total Savings($)	Net Savings($)	SIR	Rank
A	3,000	4,000	1,000	1.33	8
B	2,000	10,000	8,000	5.00	1
C	2,000	6,000	4,000	3.00	2
D	2,500	6,000	3,500	2.40	4
E	3,000	4,500	1,500	1.50	7
F	1,000	2,800	1,800	2.80	3
G	4,000	7,000	3,000	1.75	6
H	10,000	20,000	10,000	2.00	5
Competing projects combinations:					
BCDFG	11,450	31,800	20,350		
BH	12,000	30,000	18,000		

7.5.3 Example 7-7: Ranking Variable-Size Projects With a Funding Constraint

In examples 7-5 and 7-6, each of the independent projects being considered for funding had already been evaluated **individually** to determine that they were cost effective investments before they were submitted for funding. Implicitly it is assumed that each of these projects had been **previously evaluated relative to other mutually exclusive alternatives**, and the most cost effective alternative (i.e., the alternative with the lowest LCC, not the alternative with the highest SIR) was selected for the funding competition. There are circumstances in which it may be advantageous to perform both the funding evaluation and the cost-effectiveness evaluation simultaneously.

Table 7-7 shows six independent projects, one of which, B, could be implemented at two different levels (or sizes), B_1 and B_2 (e.g., replacement windows with double glazing or triple glazing). Based on the Net Savings criteria for project cost effectiveness, it is clear that B_2 is the more cost effective alternative because it has higher Net Savings than B_1 (**$11,000** versus **$10,000**). If this list of projects were to be sent forward to another office for a funding decision, generally only the more cost effective alternative (B_2) would be included in the list of projects and B_1 would not be considered in the funding decision process. But, under limited circumstances, the funding allocation analysis can be made simultaneously with the analysis of the individual project alternatives. In general, a simultaneous analysis of this type should only be performed when (1) the available funding level is fixed, with no prospect for additional funding at a later date, and (2) the decision to allocate funding is made at the local level, not centrally (where simultaneous analysis of multiple projects with multiple, mutually exclusive, alternatives is impractical).

Before exploring this type of analysis further, consider the following problem: If project B is funded at the B_1 level, it will generally preclude level B_2 from being implemented later. For example, once double-pane replacement windows are installed, it will be impractical to upgrade them further. Installation of the lower efficiency alternative will have a long-term negative impact on the building's energy performance and energy-related costs.

Table 7-7
Ranking Variable-Size Projects

Project Alternative	Initial Cost ($)	PV Savings ($)	Net Savings ($)	SIR	Incremental SIR
A	12,000	60,000	48,000	5.0	
B_1	5,000	15,000	10,000	3.0	3.0
B_2	6,000	17,000	11,000	2.8	2.0
C	6,000	7,000	1,000	1.2	
D	3,000	12,000	9,000	4.0	
E	8,000	12,000	4,000	1.5	
F	5,000	14,500	9,500	2.9	

Thus, in the face of a **budget constraint** on energy conservation projects, two strategies might be considered first when dealing with projects of variable size:

(1) Try to **win an increase in the available budget** by showing that the current budget size precludes a cost-effective design option that will have a long-term effect on the building's performance.

(2) If **more funding is expected** at a later time, determine whether the variable-size project, or another project with a higher SIR, can be postponed without adversely affecting the overall building performance. This will allow the variable-size project to be implemented at its economic level, either now, or later when the funding becomes available.

If project B is an optional project and only considered at level B_2, a $20,000 budget would be allocated using the SIR ranking methodology as described above. Projects A, D, and F will be funded this year, with an aggregate Net Savings of $66,500. Project B (at the B_2 level) will be skipped over now but will be next in line for funding when it becomes available.

If project B is not an optional project that can be postponed, and the budget constraint is still $20,000, then project B must be evaluated **incrementally** to determine the best allocation of the budget. That is, the SIR for B_1 is calculated first ($15,000/$5,000 = **3.0**) and then the SIR for B_2 relative to B_1 is calculated ($2000/$1000 = **2.0**). Now the projects, including both B_1 and B_2, are ranked by SIR. (Note that even if the incremental SIR for B_2 were higher than the incremental SIR for B_1, B_1 would have to be implemented before B_2.) The optimal allocation of the $20,000 budget goes to A, D, and B_1, with an aggregate Net Savings of **$67,000**. No other combination of projects that fit within the budget constraint will produce a higher Net Savings.

The Net Savings for package ADF (**$66,500**) is lower than that for ADB_1 (**$67,000**). However, package ADF does not preclude project alternative B_2 from being implemented at a later time, which will then increase Net Savings by an additional **$1,000**. If the additional funding is expected soon, this delay is economically justified.

7.6 SUMMARY OF PROJECT EVALUATION MEASURES

Table 7-8 summarizes the proper application of LCC and supplementary economic measures to the five different types of capital investment problems discussed in this chapter. Each cell of the matrix shows whether or not the measure is appropriate for the corresponding decision type. Where it is appropriate, the evaluation criterion to be used for the decision is also shown.

The **LCC** measure itself is the most straightforward measure for evaluating the first four decision types shown in this matrix, those that involve a choice among mutually-exclusive system alternatives. The decision criterion is always the same for the LCC measure: **choose the alternative (or combination of interdependent system alternatives) with the lowest LCC**, unless significant non-monetary benefits from another alternative appear to justify the difference in LCC. An advantage of the LCC measure over the supplementary measures is that it does not require the identification of a base case when computing the LCC for each alternative. Still, two or more alternatives must be evaluated using consistent economic assumptions in order to use the LCC measure successfully.

The **NS measure** is an equally reliable and consistent measure for evaluating mutually exclusive alternatives. However, this measure does require that a base case be identified before the NS can be computed. Since NS is the difference between the LCC of any alternative and the LCC of the designated base case, the alternative with the greatest NS will be the same as the alternative with the lowest LCC.

The **SIR** and **AIRR** measures are of more limited usefulness. When evaluating mutually exclusive project alternatives, these measures are appropriate only for accept/reject decisions. In this case they are completely consistent with the LCC and NS measure if calculated correctly. When evaluating multiple, mutually exclusive, project alternatives (as in the case of system efficiency, system selection, and combinations of interdependent systems) the SIR and AIRR measures should NOT be used. It is especially important NOT to select the project alternative with the highest SIR or AIRR. Only the LCC and NS measures are appropriate for this purpose.

The **SPB** and **DPB** measures are primarily useful as screening tools. They are not consistent with the LCC methodology and will not consistently give the same result. When evaluating a project with multiple alternatives, it is especially important NOT to select the alternative with the shortest payback, as this is rarely the alternative with the lowest LCC.

The fifth type of project decision shown in table 7-8 is that of establishing project priority for independent projects already identified as cost effective. This is generally necessary when insufficient funding is available to implement all of these projects. When allocating a fixed budget among cost-effective projects, these projects should be ranked in declining order of their SIR or AIRR (both will give the same results if based on the same input values). Then the projects should be funded in that order until the budget is exhausted. Ultimately, the package of alternatives **with the greatest combined Net Savings** provides the most cost effective allocation of the investment budget. The LCC, Net Savings, and Payback measures for independent projects are inappropriate measures for ranking those projects.

Table 7-8
Economic Measures of Evaluation and Their Uses

Type of Decision	Appropriate LCC Economic Measures (Evaluation Criteria)				
	LCC	NS	SIR	AIRR	Payback
Accept / Reject	yes (minimum)	yes (> 0)	yes (> 1.0)	yes (> discount rate)	no
Level of Efficiency	yes (minimum)	yes (maximum)	no	no	no
System Selection	yes (minimum)	yes (maximum)	no	no	no
Combination of Interdependent Systems	yes (minimum combined LCC)	yes (maximum combined NS)	no	no	no
Project Priority (Independent Projects)	no	no	yes (descending order)*	yes (descending order)*	no

* Fund in descending order of SIR or AIRR until budget is exhausted. Select the group of projects that fits within budget and has the greatest aggregate Net Savings.

CHAPTER 8

DEALING WITH UNCERTAINTY IN LCC ANALYSIS

CONTENTS

Chapter 8

DEALING WITH UNCERTAINTY IN LCC ANALYSIS

Having computed a series of economic measures, whether by hand or by computer program, does not mean that the work of the analyst is completed. LCC analysis requires some thought as to what these measures mean and how they are going to be used. When you perform an LCC analysis, you might take "**best-guess**" estimates and use them in the LCC equations as if they were certain. But investments in energy conservation are long-lived and necessarily involve at least some uncertainty about project life, operation and maintenance costs, and many more factors that affect project economics. If there is substantial uncertainty concerning cost and time information, an LCC analysis may have little value for decision-making. It therefore makes sense to assess the degree of uncertainty associated with the LCC results and to take that additional information into account when making decisions. The FEMP rules in 10 CFR 436 propose that if uncertainty assessment "casts substantial doubt on the results of an LCC analysis, federal agencies are advised to obtain more reliable data or eliminate the alternative."

It needs to be pointed out that even though you may be uncertain about some of the input values, especially those occurring in the future, it is still better to include them in an economic evaluation rather than to base your decision on first costs only. **Ignoring uncertain long-run costs implies that they are expected to be zero**, a poor assumption to make.

8.1 APPROACHES TO TREATING UNCERTAINTY IN LCCA

Numerous treatments of uncertainty and risk appear in the technical literature. Table 8-1 lists a number of approaches often used to assess uncertainty with regard to investment decisions. When decision makers are faced with an investment choice under uncertain conditions, they are mostly concerned about accepting a project whose actual economic outcome might be less favorable than what is acceptable. But there is also the risk of passing up a good investment. All of the techniques in table 8-1 provide information, albeit at different levels of detail, to account for this uncertainty.

Deterministic approaches use single-value inputs, that is, they measure the impact on project outcomes of changing one uncertain key value or a combination of values at a time. The result shows how the change in input value changes the outcome, with all other things held constant.

Probabilistic approaches, by contrast, are based on the assumption that no single figure can adequately represent the full range of possible alternative outcomes of a risky investment. Rather, a large number of alternative outcomes must be considered and each such possibility must be accompanied by an associated probability. So, when probabilities of different conditions or occurrences affecting the outcome of an investment decision can be estimated, probability analysis can estimate the weighted average, or expected value, of a project's outcome. If the outcome is expressed in terms of a probability distribution, statistical analysis can be performed to measure the degree of risk. In the case of deterministic methods, the analyst determines the degree of risk on a subjective basis.

No single technique in table 8-1 can be labeled the "best" technique in every situation. What is best depends on the relative size of the project, availability of data, availability of resources (time, money, expertise), computational aids, and user understanding. In this chapter, we primarily discuss **sensitivity analysis** and **breakeven analysis**, which are deterministic approaches to uncertainty assessment. They are easy to perform and easy to understand and require no additional methods of computation beyond the ones used in LCC analysis. Since probabilistic methods have considerable informational requirements, they make uncertainty assessment much more complex and time-consuming, and before embarking on this course, it makes sense to test first the sensitivity of the analysis results to any changes in input values.

This is not to say that you should not use probabilistic methods if there is a serious question about the certainty of cost and time data, provided the size of the project or its importance warrant their use. NIST Special Publication 757, *Techniques for Treating Uncertainty and Risk in the Economic Evaluation of Building Investments* [12], describes in depth the techniques listed in table 8-1, both deterministic and probabilistic. It discusses the advantages and disadvantages of each technique to help the decision maker choose the appropriate one for a given problem. An introduction to these techniques is presented in a NIST videotape entitled *Uncertainty and Risk, Part II,* in a series on *Least-Cost Energy Decisions for Buildings* [13].

Table 8-1
Selected Approaches to Uncertainty Assessment in LCC Analysis

APPROACHES TO UNCERTAINTY ASSESSMENT	
Deterministic	**Probabilistic**
1. Conservative Benefit and Cost Estimating	1. Input Estimates Using Probability Distributions
2. Breakeven Analysis	2. Mean-Variance Criterion and Coefficient of Variation
3. Sensitivity Analysis	
4. Risk-Adjusted Discount Rate	3. Decision Analysis
5. Certainty Equivalent Technique	4. Simulation
6. Input Estimates Using Expected Values	5. Mathematical/Analytical Technique

Source: *Techniques for Treating Uncertainty and Risk in the Economic Evaluation of Building Investments* [12].

8.2 SENSITIVITY ANALYSIS

Sensitivity analysis can help in several ways to assess the uncertainty of an LCCA. It is a technique for determining which input values, if different, would make a crucial difference to the outcome of the analysis. It can also calculate a range of outcomes to determine the lower and upper bounds of a project's LCC or NS, or any other measure of economic evaluation. In a slightly different context, the same technique can be used to test various scenarios, perhaps using either a set of more pessimistic or more optimistic values than the expected ones.

There are several formal methodologies for performing sensitivity analysis, but to apply it in its simplest way, it is sufficient to

- vary uncertain input values, one at a time,
- recalculate the measure of evaluation (LCC, NS, SIR, AIRR, DPB), and
- look at the resulting change and draw conclusions about the degree of uncertainty.

The following sections will illustrate an application of sensitivity analysis, again using the input values of example 5-1, *Selection of HVAC System for Office Building—Simple Case.*

8.2.1 Identifying Critical Inputs

To identify input values critical to the LCC of the energy-conserving alternative in example 5-1b, simply increase the uncertain input values, one at a time, by a certain percentage, say 10 percent, and recalculate the LCC. Then compare the percentage changes in the LCCs that result from the change in the input values.

Note that federal agencies are directed to use the ***DOE energy price escalation rates and discount rate*** *as published, without testing for sensitivity.*

Table 8-2
Identifying Critical Inputs for Energy-Saving HVAC Alternative[a]

Cost Item	Input value increased by 10%	Change in LCC in PV $	Change in LCC in %
Initial investment cost	$121,000	11,000	+2.5
Capital replacement (fan)	$13,750	937	+0.02
Residual value	($4,070)	(205)	<-0.01
Electricity	$14,300	19,669	+4.5
OM&R	$8,800	11,904	+3.0

[a] The impact calculations are based on the following input data for the energy-saving HVAC alternative:
Discount rate: 3%
Study period: 20 years

Initial investment cost:	$110,000	Annual electricity cost:	$13,000
Capital replacement cost in year 12:	$12,500	Annual OM&R cost:	$8,000
Residual value (salvage):	($3,700)	Total LCC for Alternative	$432,442

From table 8-2 it is clear that in the case of the energy-conserving HVAC alternative the inputs critical to the economic outcome are electricity costs, OM&R costs, and initial investment costs. A 10 percent increase in electricity cost increases the LCC for the alternative by **4.5 percent**; a 10 percent increase in OM&R costs increases the LCC by **3 percent**, and a 10 percent increase in initial investment cost increases the LCC by **2.5 percent**. Changes in the other input values in table 8-2 have a much smaller effect on LCC. In this case, it may be advisable to spend additional time and money on determining the degree of uncertainty associated with the annual costs of electricity and OM&R. There is usually somewhat less uncertainty associated with initial investment cost because it occurs at or close to the base date.

8.2.2 Estimating a Range of Outcomes

One way to get a better understanding of what might be the risk of accepting an uneconomic project is to use the sensitivity analysis technique to calculate the range of possible outcomes. You can **estimate the upper and lower bounds** of an economic measure by recalculating the measure with the lowest and highest likely cost estimate. Knowing that the electricity cost has the greatest impact on LCC and, by the same token, on Net Savings, you want to determine the range of Net Savings for the energy-saving alternative, based on the most likely highest or lowest electricity cost. Let's assume that because of the uncertainty about how much electricity the alternative system will actually use, the present value of energy costs for the 20-year study period could be 20 to 40 percent higher or lower than the best-guess estimate you used.

In figure 8-1 the range of Net Savings is computed with input values based on these assumptions. Net Savings for the energy-saving alternative would drop to **$44,453** from the best-guess Net Savings of $83,791 if the alternative HVAC system used 20 percent more electricity than expected, and would increase to **$123,129** if its electricity consumption were 20 percent less than expected.

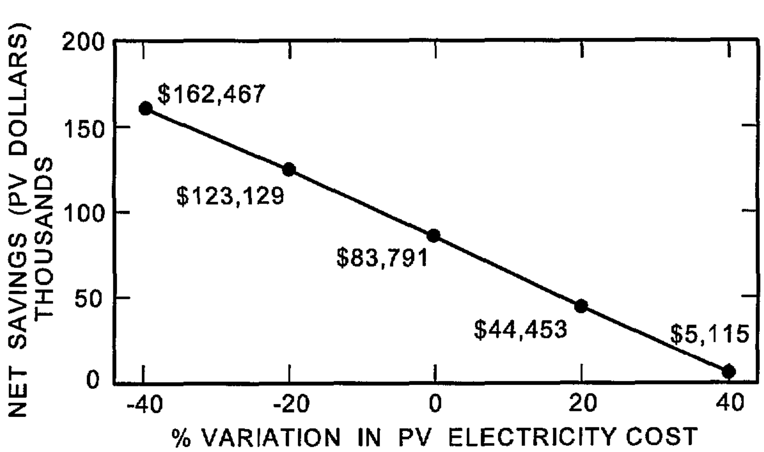


Figure 8-1
Sensitivity Analysis for NS of Energy-Saving HVAC Alternative.

Serving as an assessment of uncertainty, this test shows that even if the PV electricity cost increased by 20 percent because of higher-than-expected energy usage, the HVAC system with the night-time setback and economizer cycle would still be preferred over the conventional system. Even with a 40 percent increase in energy usage the system would still generate more savings (NS = **$5,115**) than it would cost when compared with the base case over a period of 20 years. By visually extending the line in figure 8-1 to the x-axis, you would however conclude that the breakeven point would be reached at an only slightly higher than 40 percent increase in the alternative's energy consumption.

8.2.3 Testing Possible Alternative Scenarios

The technique for testing the sensitivity of the analysis outcome to changes in input values can be extended to test various scenarios. In this case several input values, with varying degrees of uncertainty, may be looked at simultaneously and tested in combination. As before, you test one **combination** at a time, with all other values held constant. For example, a combination to be tested might be lower energy consumption combined with higher OM&R costs than in the best-guess scenario.

When testing different scenarios, you need to be aware that scenario analysis can be misleading if all pessimistic or all optimistic values are combined when calculating economic measures. Such combinations, which may not be very likely in the real world, would bias your decision towards, in one case, rejecting economic projects, and in the other case, accepting uneconomic projects.

8.2.4 Advantages and Disadvantages of Sensitivity Analysis

The major advantage of sensitivity analysis is that it can be performed when there are few resources and little time to use more sophisticated techniques. The results of a sensitivity analysis can easily be included in the analysis documentation as text, tables, or graphs.

The disadvantage is that sensitivity analysis provides no direct information on the likelihood of different outcomes. Decision makers still have to choose between alternatives on the basis of their own best judgment as to the likelihood of the various input values or scenarios occurring. Nevertheless, sensitivity analysis adds important information without requiring additional resources.

8.3 BREAKEVEN ANALYSIS

When a performance variable or an assumption is critical to the economic success of a project, decision makers often want to know the **maximum or minimum value** of an input that will allow the project to still break even. For example, with respect to the energy-saving HVAC system, you may want to know the **minimum amount of energy savings** the project needs to produce to cover the additional investment-related costs of the project. Or you may want to know the **maximum amount you can afford to pay for increased OM&R costs** for the energy-saving system and still break even relative to the savings achieved.

To perform a breakeven analysis, take the following steps:

- Construct an equation that sets operational savings equal to additional investment-related costs for a given alternative,
- Specify the values of all inputs except the breakeven variable,
- Solve for the breakeven variable algebraically.

The equation for a typical energy- and water-conserving project would set operational savings equal to investment-related costs:

$$S = \Delta C$$
$$[\Delta E + \Delta OM\&R + \Delta W] = [\Delta I_0 + \Delta Repl - \Delta Res] \quad (8.1)$$

where

S	=	Operational savings for the alternative relative to the base case,	
ΔC	=	Investment-related additional costs for the alternative relative to the base case,	
ΔE	=	$(E_{BC} - E_A)$	Savings in energy costs attributable to the alternative,
ΔOM&R	=	$(OM\&R_{BC} - OM\&R_A)$	Difference in OM&R costs,
ΔW	=	$(W_{BC} - W_A)$	Difference in water costs,
ΔI_0	=	$(I_{0A} - I_{0BC})$	Additional initial investment cost required for the alternative relative to the base case,
ΔRepl	=	$(Repl_A - Repl_{BC})$	Difference in capital replacement costs,
ΔRes	=	$(Res_A - Res_{BC})$	Difference in residual values, and

where **all amounts are in present values.**

8.3.1 Computation of Breakeven Value

The operational savings and investment-related additional costs for the energy-saving HVAC alternative were calculated in table 6-1, and are as follows:

Operational Savings:

ΔE	=	$105,910
$\Delta OM\&R$	=	($14,880)

Investment-Related Additional Costs:

I_0	=	$7,000
ΔRep	=	$350
ΔRes	=	($111)

Rearranging the terms of equation 8.1 and isolating the unknown value on the left hand side, you can solve for the breakeven value—in this example the minimum PV energy savings needed to offset the additional investment-related costs:

$$\Delta E = -\Delta OM\&R - \Delta W + [\Delta I_0 + \Delta Rep - \Delta Res]$$
$$\Delta E = -(-\$14{,}880) - 0 + [\$7{,}000 + \$350 - \$111]$$
$$\Delta E = \mathbf{\$22{,}119}$$

This means that the PV energy savings of the alternative system need to be **at least $22,119** for the project still to be economically worthwhile. This breakeven amount corresponds to the point in figure 8-1 where the NS line meets the x-axis and where NS equals zero.

The breakeven value for the OM&R costs of the energy-conserving alternative of this example are

$$\Delta OM\&R = -\Delta E - \Delta W + [\Delta I_0 + \Delta Rep - \Delta Res]$$
$$\Delta OM\&R = -\$105{,}910 - 0 + [\$7{,}000 + \$350 - \$111]$$
$$\Delta OM\&R = \mathbf{-\$98{,}671}$$

This breakeven result means that as long as the increase in OM&R costs for the energy-saving alternative stays below $98,671, the system remains preferable to the conventional system.

8.3.2 Advantages and Disadvantages of Breakeven Analysis

Breakeven Analysis has the advantage that it can be computed **quickly and easily** with the information already available from the life-cycle cost calculation. Breakeven values are especially useful as **benchmarks** for comparison against the predicted performance of uncertain variables. Knowing at what point a change in input value will render a project uneconomic gives decision makers an indication of the risk involved and allows them to take into account the uncertainty associated with input data. Thus breakeven analysis contributes implicitly to the assessment of project risk.

As already mentioned in chapter 4, section 4.6.4, breakeven analysis also provides a lower bound for benefits and an upper bound for costs when there are **nonmonetary** benefits and costs to be considered. For example, assume that the energy-saving HVAC alternative has the lower life-cycle cost but the conventional system has some nonmonetary benefit, such as much quieter operation. Having evaluated the monetary savings and costs, you know that the implicit dollar value of the conventional system's lower noise level would have to be around $83,000 (the difference in LCC between the two alternatives) to offset the net savings of the alternative.

The disadvantage of breakeven analysis is, as with sensitivity analysis, that it provides no measure of the likelihood of different outcomes.

APPENDIX A

SPECIAL TOPICS IN LCC ANALYSIS

CONTENTS

Appendix A

SPECIAL TOPICS IN LCC ANALYSIS

This appendix addresses several special topics related to the use of LCC analysis for project decisions. These topics include

- optimal timing of a retrofit project,
- fuel switching and variable annual energy usage, and
- utility rate schedules in energy cost calculations.

Each topic is illustrated with one or more examples.

A.1 OPTIMAL TIMING OF AN OPTIONAL RETROFIT PROJECT

When is it cost effective to replace a functioning building system with a more energy- (or water-) efficient system? For example, when does it pay to replace existing incandescent lighting fixtures with fluorescent fixtures? When replacing a functioning system with a new system, the investment cost that needs to be economically justified is the total installed cost of the new system. Contrast this requirement to the case of replacing a non-functioning system or selecting a system for a new building, where the choice is between two or more new systems, all of which have acceptable performance specifications. In the latter case, only the difference in investment cost between the lowest first-cost system and a more efficient system must be justified by the expected energy savings.

A.1.1 Example A-1: Timing of an Air Conditioner Replacement

An existing air conditioner uses 10 000 kWh per year at a current price of $0.10/kWh, expected to increase by 1 percent per year in real terms (i.e., over and above general inflation). The annual cost of electricity for space cooling using the existing system is $1,000. This air conditioner is expected to last for about five more years. Replacing the existing system with a new high efficiency air conditioner will cost $5,000 and reduce annual kWh hour consumption for space cooling by 40 percent. The new system is expected to last 20 years. Should we replace the air conditioner now or wait until it dies?

General rule for timing of replacements: As long as the annualized investment cost of a new system is less than its expected yearly savings, and the yearly savings are expected to remain constant or increase over time, it is cost effective to replace the existing system now.

The annualized investment cost of a project is found by multiplying the project's initial investment cost (less present value of residual value, if any) by the appropriate Uniform Capital Recovery (UCR) factor. The UCR factor should be based on the expected life of the new system, without replacements.

The formula for the UCR factor is:

$$\text{UCR factor} = \left[\frac{d(1 + d)^N}{(1 + d)^N - 1}\right]$$

where
d = the discount rate, and
N = the life expectancy of the system (or study period, if less).

Note: The UCR factor is the inverse of the UPV factor for the same number of years and same discount rate.

The UCR factor for an investment with a life of 20 years and a discount rate of 3.0 percent is .0672. For a new system with an investment cost of $5,000 the annualized investment cost is $336 ($5,000 x .0672). As long as the annual savings are expected to be at least $336, the replacement is economically justified. In this example, the annual savings are $400 (40 percent of $1,000) at today's energy prices. Thus the replacement system is cost effective in this example. If the annual savings were only $325 dollars at current prices, the replacement would not be cost effective now. But energy costs are expected to increase at 1 percent per year, so that by the end of the fourth year they are expected to grow to $338 ($325 x 1.01^4). Thus the optimal timing for this investment appears now to be at the end of the fourth year. In fact, energy prices should be monitored over the next few years to determine if and when the replacement actually becomes cost effective. (Note: The annual savings should include changes in OM&R costs, if any, as well as energy savings.)

The optimal timing of the system replacement does not depend on the remaining life of the existing system. This is because the cost of the existing system is a sunk cost (assuming that it has no salvage value when removed). Even if the existing system is expected to last for the life of the building, this general rule for timing of replacements holds.

The replacement timing problem can also be set up for solution using the LCC method of project evaluation. For the base case, assume the existing system operates at current energy consumption levels until it dies at the end of year five, and then is replaced by the new system operating at its lower energy usage rate. For the alternative case, assume that the existing system is replaced now and that the lower energy usage rate is realized immediately. Set the study period equal to the life of the new system (not to exceed the 25-year FEMP rule). The delayed replacement will have a residual value based on its remaining life at the end of the study period (five years in this example). If the LCC of the immediate replacement is lower than the LCC of the delayed replacement, the immediate replacement is economically justified.

The result of the LCC analysis method is sensitive to the valuation of the residual value of the delayed replacement and therefore may not give exactly the same results as the general rule for timing of replacements using the UCR factor. Furthermore, calculating the LCC of only two alternatives (immediate replacement and delayed replacement for five years) will not provide information about optimal project timing if the optimal timing falls somewhere between the two years. If the difference in the LCC of the immediate and delayed replacements is small, the optimal year of replacement may fall between those two years. In this case the LCC analysis must be repeated for delayed replacement in successive years to determine which replacement year yields the lowest LCC.

A.2 FUEL SWITCHING AND VARIABLE ENERGY USAGE

In most of the examples presented in this handbook, annual energy usage rates remain constant throughout the service period for any given project alternative. Some project evaluations involve switching from one fuel type to another after a certain number of years. Others involve phasing in of new systems which may increase or decrease annual energy usage over time. The following two examples show how to deal with variable energy usage in LCC analysis. The BLCC computer program discussed in appendix B provides a convenient way of handling such problems, since it allows the user to index annual energy usage of each type relative to nominal usage levels.

A.2.1 Example A-2: Fuel Switching

A coal-fired boiler is expected to be converted to natural gas five years from now to satisfy tightened emission standards. The boiler currently uses 1000 GJ (948 MBtu) of coal per year at a current cost of $3.00/GJ ($3.16/MBtu). After conversion to natural gas, the boiler is expected to use 900 GJ (853 MBtu) due to improved firing efficiency. The current natural gas price at the building site is $3.41/GJ

($3.60/MBtu). DOE energy price escalation rates for region 1 are available for industrial coal and gas. (These rates are implicit in the FEMP UPV* factors for those fuels published in the Annual Supplement to Handbook 135.) What is the present value of fuel usage for this boiler over the next 20 years, given the 1995 DOE discount rate (3 percent real) and projected DOE energy price escalation rates? Using the FEMP UPV* factors from table Ba-1 for 1995 (as reproduced in appendix F), the solution is calculated as follows:

PV energy cost = 1000 GJ x 3.00/GJ x 4.69 + 900 GJ x 3.41/GJ x 13.39 = **$55,164**

where

4.69	=	FEMP UPV* for region 1, industrial coal, 5 years		
13.39	=	18.27 - 4.88, derived from:		
		18.27	=	FEMP UPV* for region 1, industrial natural gas, 20 years
		4.88	=	FEMP UPV* for region 1, industrial natural gas, 5 years

Note that the FEMP UPV* for the natural gas usage for years 6 through 20 (13.39) is based on the difference between the FEMP UPV* factor for 20 years and the corresponding factor for 5 years. Note also that the FEMP UPV* factor for natural gas is applied to the current gas price, not the price at the time of the conversion.

A.2.2 Example A-3: Projects With Phased-in Energy Savings

A central steam plant with four boilers is being modified, with one boiler being replaced each year for the next four years. The boiler being replaced will be shut down at the beginning of the year and the new boiler will be put into service at the end of the same year. Each of the three active boilers will deliver one-third of the annual heating requirements during the replacement period. The existing boilers have a seasonal efficiency of approximately 60 percent. The new boilers will have a seasonal efficiency of approximately 80 percent. The boilers use natural gas at a current price of $7.00 per GJ ($7.39 per MBtu). The annual heating output requirement for the plant is 100 000 GJ (94,787 MBtu). What is the present value of the natural gas usage projected for the next 20 years, assuming a discount rate of 3 percent (real) and DOE energy price escalation rates for industrial usage in DOE region 1.

Year 1 energy usage:	166 667 GJ (100 000 GJ/0.6)
Year 2 energy usage:	152 779 GJ (0.6667 x 100 000 GJ/0.6 + 0.3333 x 100 000 GJ/0.8)
Year 3 energy usage:	138 888 GJ (0.3333 x 100 000 GJ/0.6 + 0.6667 x 100 000 GJ/0.8)
All subsequent years:	125 000 GJ (100 000 GJ/0.8)

Solution:

Find FEMP UPV* factors for four different periods (region 1, industrial natural gas, 1995 from table Ba-1 in appendix F):

Year 1	$UPV*_1$ for year 1	= 1.00
Year 2	$UPV*_2$ for year 2 - $UPV*_1$ for year 1 = (1.99 - 1.00)	= 0.99
Year 3	$UPV*_3$ for year 3 - $UPV*_2$ for year 2 = (2.96 - 1.99)	= 0.97
Years 4-20	$UPV*_4$ for year 20 - $UPV*_3$ for year 3 = (18.27 - 2.96)	= 15.31

Calculate present values:

PV =	$UPV*_1$ x 166 667 GJ x $7.00/GJ x 1.00	=	$ 1,166,669
+	$UPV*_2$ x 152 779 GJ x $7.00/GJ x 0.99	=	$ 1,058,758
+	$UPV*_3$ x 138 888 GJ x $7.00/GJ x 0.97	=	$ 943,050
+	$UPV*_4$ x 125 000 GJ x $7.00/GJ x 15.31	=	$13,396,250
		=	**$16,564,727**

A.3 IMPACT OF UTILITY RATE SCHEDULES ON LCC CALCULATIONS

Most of the examples in this handbook are based on a flat-rate energy price applied to annual energy usage. For some studies this may be appropriate, but for others this may introduce significant error into the analysis. There are several factors that should be considered in computing annual energy or water costs: (1) even flat rates may vary by time of year; (2) block rate schedules or time-of-use rates may have a significant effect on monthly and annual energy costs; and (3) demand charges applied to peak energy usage may make up a significant part of the total energy cost. Each of these topics is demonstrated by example here.

Before proceeding to these examples, consider the type of project and the objective of your economic analysis. If an energy conservation project has a relatively small impact on the whole building energy usage and on peak demand, a flat-rate energy price may be satisfactory for the analysis. In this case the rate used should reflect the price of the last unit of energy use in each relevant time period (e.g., the price of the last kWh used each month in the case of block rate schedules). You may still want to use different rates for different times of the year if these rates differ significantly. In such cases you must also specify the corresponding energy usage by time of year (e.g., usage during months when summer rates are in effect and usage during months when winter rates are in effect).

If the project causes the price of the energy or water units conserved to shift to a lower or higher block rate, or if the project involves a comparison of the cost of different energy types used for the same purpose (e.g., using gas or electricity to heat a house), then the relevant rate schedules must be considered in the economic analysis. Likewise, if the project affects peak power demand (or other service subject to a demand charge), demand charges must be considered in the analysis.[1]

The extent to which complex rate schedules can be meaningfully included in the economic analysis depends to some extent on the type of energy analysis that is performed in support of the project. To apply block rate schedules, monthly energy usage must be computed. To apply time-of-use rates, hourly energy usage for an entire year may be needed; at a minimum the energy consumption for each time period subject to a different rate must be available. To apply demand rates, peak power demand by month (or some other period specified by the utility) is required. The whole-building energy simulation program used to compute energy usage for each project alternative must match the task at hand, or the results will have no meaning.

The examples provided here are based on electricity usage and demand. This same methodology can be used for other services (e.g., water and natural gas) subject to variable rate schedules.

A.3.1 Energy Cost Calculations with Block Rates

The annual savings attributable to individual energy conservation projects often can be estimated without a detailed analysis of the electricity rate schedule. However, the price of the last unit of energy or water usage in the relevant billing period (i.e., the marginal price) must be used in these calculations. For example, consider this "declining" block rate schedule, where the kWh price for higher levels of usage each month is less than for the lower levels of usage.

[1]The NIST ERATES computer program, discussed in appendix B, provides a convenient means of assessing the impact of block rates, time-of-use rates, and demand rates on annual electricity costs. Block rate and demand rate schedules set up with the ERATES program can also be imported into the NIST BLCC program and be used to evaluate building energy usage subject to a wide range of rate schedule specifications.

Table A-1
Declining Block-Rate Schedule

Monthly kWh Consumption	Price per kWh
First 1000 kWH	$0.10
1001 - 5000 kWh	$0.08
All additional kWh	$0.05

In addition, there may be a fixed monthly "customer charge" independent of the amount of monthly energy usage.

If the building in which the conservation measure is to be installed uses a minimum of 7500 kWh/month, the annual electricity cost before and after the conservation measure is implemented can be calculated using the marginal $0.05/kWh rate. Since the purpose of the analysis is to calculate the annual savings in electricity costs (rather than the actual electricity bill), there is no need to calculate "before and after" electricity costs using the entire rate schedule. This method implicitly assumes that the energy savings are not large enough to change the marginal rate, i.e., to shift it to a lower block. If such a shift does occur, "before and after" electricity costs must be estimated using rates from each relevant part of the schedule and the corresponding kWh consumption at those rates. Use of the marginal rate for "before and after" energy costs will result in an incorrect calculation of the annual energy cost for each alternative. However, the difference in annual energy costs between the base case and alternative (i.e., the savings) will be computed correctly.

A.3.1.1 Example A-4: Use of a flat rate energy price with a conservation measure

Three different levels of roof insulation (designated by thermal resistance, or R-value) are being evaluated to determine which has the lowest LCC. The building is heated and cooled with an electric heat pump system. The block-rate schedule shown above applies in winter months (October through May); in summer months the marginal kWh rate for usage above 5000 kWh/month is $0.08/kWh. In addition, a fixed customer charge of $10.00/month is levied. Monthly kWh consumption with or without the insulation is not expected to drop below 5000 kWh/month.

This analysis requires two energy usage amounts for each level of insulation: the number of kWh per year used in the summer months, which are charged at $0.08/kWh, and the number of kWh per year that are used in the winter months, which are charged at $0.05/kWh. Table A-2 shows the relevant energy consumption data and the calculations needed to determine the annual savings for each level of insulation. Since the relevant price per kWh does not change within the range of monthly kWh usage examined, the price per kWh above 5000 kWh/month can be used to find the annual cost of electricity in each of the two time periods (winter and summer). While the actual cost of electricity for this building is not computed here (this would require inclusion of the customer charge and the higher kWh prices for the first 5000 kWh/month), these additional costs would be the same for each insulation level and thus will not affect the annual savings.

Table A-2
Annual kWh Consumption and Cost for Roof Insulation Retrofit

Insulation Level	kWh Consumption Winter	kWh Consumption Summer	kWh Cost Winter @$0.05	kWh Cost Summer @$0.08	Annual kWh Cost	Annual Savings
Existing	60 000	30 000	$3,000	$2,400	$5,400	---
add R-5	57 000	28 500	2,850	2,280	5,130	$270
add R-10	56 000	28 000	2,800	2,240	5,040	360
add R-15	55 500	27 700	2,775	2,216	4,991	409

A.3.1.2 Example A-5: Comparison of whole building energy costs

Compare the annual energy cost for a building using the kWh consumption shown in table A-2 at the "existing insulation" level and subject to the kWh rate schedule shown above with the annual energy cost for the same building heated with natural gas. Assume that the kWh usage for the gas-heated building is 5000 kWh/month in the winter months, so that total electricity usage during those months is 40 000 kWh (8 months x 5000 kWh/month). Assume that the total natural gas usage for the winter months is 179 GJ (170 MBtu) billed at a flat rate of $5.20 per GJ (5.49/MBtu), plus a monthly customer charge of $10.00. If the total energy cost for each of these two buildings is being compared, the energy costs should reflect the customer charges and the block rate structure applied to the electricity costs. The solution can be calculated as follows:

(1) All electric building

	12 months x $10/month customer charge	= $120
+	12 months x 1000 kWh/month x $0.10/kWh	= $1,200
+	12 months x 4000 kWh/month x $0.08/kWh	= $3,840
+	(60 000 kWh - 8 months x 5000 kWh/month)	= 20 000 kWh x $0.05/kWh = $1,000
+	(30 000 kWh - 4 months x 5000 kWh/month)	= 10 000 kWh x $0.08/kWh = $800
	Total annual energy cost	= **$6,960**

(2) Gas-heated building

Electricity cost:

	12 months x $10/month customer charge	= $120
+	12 months x 1000 kWh/month x $.010/kWh	= $1,200
+	12 months x 4000 kWh/month x $0.08/kWh	= $3,840
+	(30 000 kWh - 4 months x 5000 kWh/month)	(10 000 kWh x $0.08/kWh) = $800
	Annual electric cost	= **$5,960**

Natural gas cost:

	12 months x $10.00/month customer charge	= $120.00
+	179 GJ x $5.20 /GJ	= $931
	Annual natural gas cost	= **$1,051**

Total annual energy cost = **$7,011**

Conclusion: The annual energy cost of the all-electric building is **$51** lower than the building using both electricity and natural gas, at base-date energy prices.

If only the heating costs are to be compared, the 20 000 kWh (60 000 kWh - 40 000 kWh) used for space heating at $.05/kWh provides the annual cost of electric space heating. (The customer charge for electricity and the other kWh consumption costs will still be incurred if the heating system is switched to natural gas.) Compare this with the total annual natural gas cost, including both the monthly customer charge and energy charge for 179 GJ/year. The customer charge for natural gas must be included in this cost since this would be avoided entirely in the all-electric building.

Electric heating only:	
20 000 kWh x $0.05/kWh	= **$1,000**
Gas heating only:	
12 months x $10.00/month customer charge	= $120.00
179 GJ x $5.20 /GJ	= $931
Total natural gas cost	= **$1,051**

Both solution methods show that heating with natural gas would cost **$51** more per year at current prices than heating with the electric heat pump system, given the utility rates shown.

A.3.2 Energy Cost Calculations with Time-of-Use Rates

Time-of-use rate schedules for electricity prices are becoming increasingly common in the United States. Typically, under a time-of-use schedule, different kWh rates are levied for usage at different times of the day and for different days of the week. For example, kWh prices may be very low during night hours, moderate during evening hours and all day on weekends, and quite high during the peak demand hours of the day. These rate schedules may vary by month of the year as well, especially if the utility has a pronounced summer or winter peak.

Calculating annual electricity costs using time-of-use rates can be complicated, regardless of whether or not these are to be used in an LCC analysis. The most challenging part of time-of-use calculations is determining the number of kWh hours used in each pricing period. This usually requires an hourly analysis of the energy requirements of a building system for each design alternative being considered. Energy cost calculations with time-of-use rates are especially critical for projects which shift kWh usage from one period to another.

The NIST ERATES program, described in appendix B, can be used to calculate annual electricity costs using time-of-use rates. However, this requires hourly kWh consumption for each of the 8760 hours of the year saved as a data file by an hourly load simulation program. The NIST BLCC program cannot import time-of-use schedules from ERATES as it can block rate and demand rate schedules. However, the ERATES program will calculate the average annual kWh price and the total kWh used over the year, which can be used to compute the life-cycle electricity cost in an LCC analysis performed with BLCC or other LCC programs.

If a conservation project is expected to reduce kWh usage proportionally in each pricing period, the annual savings for that project can be calculated using the same average price per kWh for both the "before and after" cases. If the project is expected to affect kWh usage in some periods more than others (e.g., a clock thermostat to lower indoor temperature settings during unoccupied hours), the savings (or additional cost in the case of load shifting) must be calculated for each pricing period and summed to arrive at an annual rate.

A.3.2.1 Example A-6: Load shifting with time-of-use kWh rates

Table A-3 shows the time-of-use rate schedule and corresponding kWh usage in each pricing period to be used in evaluating a proposed thermal storage project. This project is expected to reduce electricity usage by 5000 kWh/year during on-peak pricing periods but increase off-peak kWh usage by 6000 kWh/year. The expected annual savings is $600 ($4,500 - $3,900). Note that the same result would be obtained by multiplying the annual kWh usage by the corresponding weighted average kWh price. But this weighted average price must be calculated separately for both cases (the Base Case and Alternative). A single average kWh price for the year will not give the correct result for this example because the project does not affect all periods proportionally.

Table A-3
Annual kWh Costs With Time-of-Use Rates (Example)

Rate Period	Base Case		Alternative	
	Annual kWh	Annual Cost	Annual KWh	Annual Cost
Off peak hours @ $0.025/kWh	10 000	$250	16 000	$400
Shoulder hours @ $0.050/kWh	25 000	1,250	25 000	1,250
Peak hours @ $0.150/kWh	20 000	3,000	15 000	2,250
Total annual cost	55 000	$4,500	55 500	$3,900
Weighted average kWh cost		**$0.082**		**$0.070**

A.3.3 Energy Cost Calculations with Demand Charges

Demand charges are energy costs that are related to peak usage, usually measured over a short time interval (e.g., 15 minutes). Peak energy use of this sort is called peak power demand, and for electricity is typically measured in kW. Demand charges are generally levied on a monthly basis. For large users (especially industrial users), demand charges can make up as much as half of the monthly and annual electricity cost. Residential electricity rates do not typically include a demand charge but this may become more common in future years.

Demand charges can be very simple to calculate when they are levied in direct proportion to peak demand. If demand charges are levied as a flat rate per kW, the reduction in annual demand costs attributable to an energy conservation project can be calculated once the corresponding reduction in monthly kW demand has been determined. Simply multiply the reduction in kW demand for each month by the monthly demand charge for that month and sum these charges for the 12 months of the year.

However, rate schedules with demand charges are often quite complex. "Ratchet" clauses that use peak kW demand in previous months in calculating the demand charge for the current month require careful analysis. In addition, demand charge schedules (like kWh rate schedules) can use block rates (with declining or increasing kW rates for different levels of demand) or time-of-use rates, where a higher demand charge would be levied during periods of peak utility demand, and lower or no charge levied during off-peak periods. As with the case of kWh cost calculations, the more complex the demand charge schedule, the more information about kW demand is required both with and without the project. This requires careful consideration when selecting and running an appropriate building energy simulation program.

The NIST ERATES program is able to perform calculations of some demand charges, depending on the complexity of the rate schedule. The monthly kW demand on which the monthly charge is to be calculated can be entered into a kW demand file for a particular building. The kW demand charges, either as flat rates or as block rates, are entered into a demand schedule file. ERATES will calculate the corresponding annual kW demand charge based on the monthly kW demand or on the highest kW demand for the year. ERATES can also use hourly data for an entire year (8760 hours) as the basis for calculating demand charges. Both on-peak and off-peak time periods, by month, can be included in this analysis. The NIST BLCC program can read demand rate schedules set up with the ERATES program and calculate annual demand charges, based on monthly kW demand data for the project being evaluated.

APPENDIX D

COMPENDIUM OF DISCOUNTING AND PRICE ESCALATION FORMULAS

CONTENTS

Appendix D

COMPENDIUM OF DISCOUNTING AND PRICE ESCALATION FORMULAS

The formulas included in this appendix are divided into four categories:

(1) Price escalation formulas (constant and variable escalation rates)
(2) Present value formulas
(3) Future value formulas
(4) Annual value formulas

These formulas can be used to find the cost of a given good or service at a future point in time or to find the present value, future value, or annual value of a single or annually recurring cash amount incurred at a given point(s) in time. They can also serve as the basis for calculating general discount factors and price escalation factors to be used in LCC studies. These formulas are intended for use with a hand calculator (with exponential calculation capabilities) or for inclusion into a computer program or spread-sheet analysis. The NIST LCC software (BLCC, Quick Input, and DISCOUNT) uses most of these formulas. The NIST DISCOUNT program is especially useful for solving individual discounting and price escalation problems on a microcomputer (see appendix B). Note: All of these formulas are based on the end-of-year discounting convention. The factors pertaining to each of these discounting or price escalation formulas (e.g., the single present value factor from the single present value formula) is found by computing the portion of the formula shown in large brackets.

Before using these formulas, it is important to distinguish between a base-year or future-year cost and its present value, future value, or annual value. Base-year costs and future-year costs are project-related costs related to each other by the intervening rate of general inflation and changes in relative (real) price levels. The present value, future value, or annual value of a cost occurring at a given point in time differs from that cost in that they are dependent on the investor's perceived time-value of money, as reflected in the discount rate. Thus these values may vary from investor to investor depending on the discount rate used in their computation.

The following abbreviations are used in these formulas:

F_t = future value in year t
P = present value
A = annual value (equal amount in each year, t = 1 to n)
A_0 = annually recurring amount at prices as of time 0, the base date
A_t = annually recurring amount at prices as of time t, relative to the base date
C_0 = one-time cost at base-date prices
C_t = one-time cost at prices as of time t, relative to the base date
d = discount rate
e = price escalation rate (constant)
e_t = price escalation rate for year t
t = time period index (integer), where 0 is the base date, 1 is year one,..., and n is the last year in the study period
i = time period index for time periods 1 to t.

Note: If d is expressed in real terms (exclusive of general inflation) then e must also be expressed in real terms. If d is expressed in nominal (market) terms (inclusive of inflation) then e must also include general inflation.

D.1 PRICE ESCALATION FORMULAS

Price escalation formulas are used to find a future cost of a good or service at the end of the *nth* time period (usually years), given its base-year cost and the annual rate of price escalation for that commodity. If the analysis is conducted in constant dollars, the price escalation rate should be expressed in real terms (exclusive of general inflation); if the analysis is conducted in current dollars, the price escalation rate should be expressed in nominal terms (inclusive of general inflation).

D.1.1 Constant Escalation Rate

Application: to find C_t when C_0 is known and e is constant from year to year.

Formula:

$$C_t = C_o \times (1+e)^t$$

Example:
C_0 = \$1,000
e = 3% (.03)
t = 10

$$\$1,344 = \$1,000 \times (1+.03)^{10}$$

D.1.2 Variable Escalation Rate

Application: to find C_t when C_0 is known and e varies from year to year.

Formula:

$$C_t = C_o \times \prod_{i=1}^{t} (1+e_i)$$

Example:
C_0 = \$1,000
e_1 = 1% (.01)
e_2 = 2% (.02)
e_3 = 3% (.03)
e_4 = 4% (.04)
e_5 = 5% (.05)
t = 5

$$\$1,159 = \$1,000 \times (1.01)(1.02)(1.03)(1.04)(1.05)$$

D.2 PRESENT-VALUE FORMULAS

Present value formulas are used to find the present value of future amounts, when discount rate and the number of time periods (usually years) between the present time and the time of payment are known.

D.2.1 One-time Amounts

D.2.1.1 Single Present Value (SPV) formula

Application: to find P when amount at end of year t is known.

Formula:

$$P = C_t \times \left[\frac{1}{(1+d)^t}\right]$$

Example:

C_{10} = \$1,000
d = 5% (.05)
t = 10

$$\$614 = \$1{,}000 \times \left[\frac{1}{(1+.05)^{10}}\right]$$

D.2.1.2 Modified Single Present Value (SPV*) formula

Application: to find P when the amount at the end of year t is expressed in base-year dollars (C_0) and the price escalation rate is known.

Formula (constant e):

$$P = C_o \times \left[\frac{1+e}{1+d}\right]^t$$

Example:
C_0 = \$1,000
e = .03
d = .05
t = 10

$$\$825 = \$1{,}000 \left[\frac{1+.03}{1+.05}\right]^{10}$$

Formula (variable e):

$$P = C_o \times \frac{\prod_{i=1}^{t}(1+e_i)}{(1+d)^t}$$

Example:
C_0 = \$1,000
e_1 = 1% (.01)
e_2 = 2% (.02)
e_3 = 3% (.03)
e_4 = 4% (.04)
e_5 = 5% (.05)
t = 5
d = 5% (.05)

$$\$908 = \$1{,}000 \times \frac{(1.01)(1.02)(1.03)(1.04)(1.05)}{(1+.05)^5}$$

D.2.2 Annually Recurring Amounts

When costs occur on an annual basis, whether constant or changing at a known rate, the present value of each annual cost over a given number of years can be calculated with a single equation using Uniform Present Value factors.

Note: In the formulas for annually recurring amounts shown in section D.2.2, the number of time periods (n) can only be set to integer values. For time periods with decimal fractions, the present value of the cost incurred during the fractional time period must be calculated separately and added to the present value of the costs incurred during the integer time period.

D.2.2.1 Uniform Present Value (UPV) formula and factor

Application: to find P when A is known and constant.

Formula:

$$P = A_o \times \left[\frac{(1+d)^n - 1}{d(1+d)^n}\right]$$

Example:
A_0 = \$1,000
d = 5% (.05)
n = 10

$$\$7{,}722 = \$1{,}000 \times \left[\frac{(1+05)^{10} - 1}{.05(1+.05)^{10}}\right]$$

D.2.2.2 Modified Uniform Present Value (UPV*) formulas and factors

Application: to find P when A is known but varies from time period to time period at a constant escalation rate (e) or at a changing escalation rate (e_i).

Formula (constant e):

$$P = A_o \times \left(\frac{1+e}{d-e}\right) \times \left[1 - \left(\frac{1+e}{1+d}\right)^n\right]$$

Example:
A_0 = \$1,000
d = 5% (.05)
e = 3% (.03)
n = 10

Formula (variable e):

$$P = A_o \times \sum_{t=1}^{n} \frac{\prod_{i=1}^{t}(1+e_i)}{(1+d)^t}$$

Example:
C_0 = \$1,000
e_1 = 1% (.01)
e_2 = 2% (.02)
e_3 = 3% (.03)
n = 3
d = 5% (.05)

$$\$2{,}813 = \$1{,}000 \times \left[\frac{(1.01)}{(1.05)} + \frac{(1.01)(1.02)}{(1.05)^2} + \frac{(1.01)(1.02)(1.03)}{(1.05)^3}\right]$$

D.3 FUTURE VALUE FORMULAS

Future value formulas are used to find the cost at some future point in time (t) of a good or service when the cost of that good or service at the base date, the price escalation rate, and the number of time periods (usually years) between the base date and the future date are known. Only one future value formula is presented here, the single compound amount formula.

D.3.1 Single Compound Amount Formula

Application: to find the future value at time t_2 (F_{t2}) of an amount paid at time t_1 (C_{t1}),

where $t_2 > t_1$.

Formula:

$$F_{t2} = C_{t1} \times (1+d)^{(t2-t1)}$$

Example:
C_5 = \$1,000
t_1 = 5
t_2 = 10
d = 5% (.05)

$$\$1,276 = \$1,000\ (1+.05)^{(10\ -\ 5)}$$

D.4 ANNUAL VALUE FORMULA

The Annual-Value formula is used to determine an equal payment per time period (usually years) which is equivalent to a one-time cost or a stream of costs incurred during the same time period, given the time value of money as reflected in the discount rate (d). The Uniform Capital Recovery factor can be used to calculate this annual value, given the present-value of a cost or of a stream of costs computed using the same discount rate.

Uniform Capital Recovery (UCR) formula
Application: to find A when P is known.

Formula:

$$A = P \times \left[\frac{d(1+d)^n}{(1+d)^n - 1}\right]$$

Example:
P = \$1,000
d = 5% (.05)
n = 10

$$\$130 = \$1,000 \times \left[\frac{.05(1+.05)^{10}}{(1+.05)^{10} - 1}\right]$$

Note: Any single cost or stream of uneven costs over a given time period can be annualized over that time period by first finding the present value of that cost or stream of costs and then applying the UCR formula. For a stream of equal costs occurring in each time period over a given study period, the annualized cost is identical to that periodic cost when the same discount rate and study period are used.

APPENDIX F

EVALUATING ENERGY SAVINGS

PERFORMANCE CONTRACTS

CONTENTS

Appendix F

EVALUATING ENERGY SAVINGS PERFORMANCE CONTRACTS

F.1 BACKGROUND

The National Energy Conservation Policy Act (NECPA) is the primary legislative authority directing federal agencies to improve energy management in their facilities and operations. The Energy Policy Act of 1992 (EPACT) amended NECPA to include additional provisions regarding energy management requirements, budget treatment for energy conservation measures, incentives for federal agencies, reporting requirements, new technology demonstrations, and agency surveys of energy-saving potential. Executive Order 12902 of March 8, 1994 mandates additional requirements for federal energy and water efficiency beyond the provisions of EPACT. These requirements include a 30 percent reduction in energy consumption in federal buildings by the year 2005 from the FY 1985 baseline, in Btu per gross square foot, and a 20 percent increase in energy efficiency in federal agency industrial facilities by 2005 compared to FY 1990.

To meet these ambitious requirements of federal energy management legislation, federal agencies can access four sources of financing to fund energy efficiency projects:

(1) Agency Capital Funds (Direct Appropriations)

(2) FEMP's Federal Energy Efficiency Fund

(3) Utility Demand Side Management Incentives

(4) Energy Savings Performance Contracts

This appendix provides a short overview of the economic requirements of Energy Savings Performance Contracts (ESPC), formerly known as "Shared Energy Savings" contracts. In addition, this appendix contains an example of the comparative economic evaluation of an ESPC project with a similar project using agency funding. The information in this appendix, other than this example, is based primarily on FEMP's Energy Savings Performance Contracting Guidance Manual, version 2.0 [15]. That manual should be consulted before attempting to establish or evaluate an ESPC.

In an ESPC, the Energy Service Company (ESCO) incurs all costs of implementing energy savings measures, including: performing the audit, designing the project, acquiring and installing the equipment, training personnel, and operating and maintaining equipment. In exchange, the ESCO receives a share of any energy cost savings directly resulting from implementation of energy conservation measures during the term of the contract. EPACT and the Executive Order strongly recommend this method of financing for energy efficiency projects. Specific provisions of EPACT provide that

- Agencies are allowed to enter into contracts for 25 years without funding of cancellation charges,

- Congress is notified 30 days before awarding contracts in excess of $750,000,

- Funds are available to cover ESPC payments in the first fiscal year,

- ESCOs incur costs of conservation measures for a share of the savings,

- Payments are to be made from the agency's utility and related operation and maintenance funds, and
- ESCOs guarantee savings to agencies.

F.2 ECONOMIC ANALYSIS REQUIREMENTS

In developing an ESPC, the government agency must conduct an economic viability analysis, including an economic analysis of the proposed project, an examination of issues that affect project viability, and a review of financing alternatives. The economic analysis should include

- current utility rates for the federal facility,
- a cost estimate for the retrofit measures, including the cost to the government of evaluating these measures,
- the energy consumption of the existing system(s), based on an assessment of actual operating conditions,
- the operating and maintenance (O&M) costs of the existing and new systems,
- an estimate of the annual energy consumption for the proposed systems, and
- an estimate of the annual energy savings, net of O&M cost differences between the existing and new systems.

Annual energy cost savings should include both energy consumption savings and power demand savings (if applicable), based on current, local, utility rates.

There are two "Rules of Thumb" for evaluating the economic viability of an ESPC:

Rule 1: The annual savings potential should be greater than $25,000 per year.

Rule 2: The ESPC project term is typically two times the "simple payback" of the entire project. The simple payback is the period of time it would take the government to recover its investment (from the anticipated annual savings) if the project were paid for with appropriated funds.

For the purpose of evaluating an ESPC, simple payback is computed by dividing the project cost by the annual savings at current prices. This simple payback does not include price escalation rates, a discount rate, or general inflation. The project term of two times the simple payback period allows the ESCO to recoup costs for capital equipment, cost of financing, labor, handling of hazardous material, maintenance, and profits, and the Government to realize its share of the savings. However, the project term is negotiable, depending on the Government's needs. For example, when dealing with sophisticated equipment, such as energy management and control systems, a highly trained ESCO may be desired to maintain the system over a longer period of time, so that the Government may want to consider a longer contract period.

There is no rule of thumb with regard to how the energy savings are shared between the ESCO and the Government. This is a matter of negotiation in setting up the contract.

To get the maximum benefit for a federal agency, retrofit measures with short and long term paybacks may be combined or "bundled" into a single ESPC contract. The purpose is to make short payback measures pay for needed measures with long-term paybacks. Even projects in different buildings can be bundled into a single ESPC.

Life-cycle cost analysis is not explicitly included in the requirements for developing and evaluating an energy savings performance contract. Since there is no initial investment on the part of the Government, an LCC analysis is not needed to demonstrate that the ESPC is economically justified. The ESCO may undertake an LCC analysis to evaluate its own investment in the project. In doing so it is under no obligation to follow the LCC methods and evaluation criteria required for federal investments under either 10 CRF 436 or OBM Circular A-94.

However, the federal agency should seek to determine the most advantageous method of financing the package of conservation measures proposed in the ESPC. The agency should consider financing alternatives, such as appropriated funds, the Federal Energy Efficiency Fund, utility demand-side management incentives, or some combination of these alternatives in developing a final plan. In doing so, the agency should compare the estimated Net Savings to the government from each alternative financing plan. This comparison should take into consideration any differences in the expected timing with which the different approaches could be implemented. For example, if the ESPC could be implemented immediately but the in-house funding would be delayed for several years, this difference in timing should be reflected in the comparative analysis. The Net Savings approach is outlined in section 6.1 of this handbook.

The following two case examples are provided to demonstrate how ESCO funding can be compared to agency funding for the same project. The first case is based on the assumption that the project will be implemented at the same time whether it is funded as an ESPC or paid for with agency funds. The second case is based on the assumption that the project can be implemented immediately if it is funded by an ESCO, but the project will be delayed by two years if the Government finances the project.

F.2.1 Example: Net Savings Computation for ESPC Versus Agency Funding of an Energy Conservation Retrofit Package in a Federal Facility

ESPC package proposed:	
Required investment:	$100,000
Annual energy savings:	$25,000 (at base-date energy prices)
Annual O&M cost:	$5,000 for existing system (at base-date prices), paid by Government $4,000 for new system (at base-date prices), to be paid by ESCO
ESPC contract duration:	8 years
Expected equipment life:	approximately 20 years
Shared savings plan:	90% of energy savings go to ESCO for 8 years, O&M costs paid; 10% of energy savings go to Government for 8 years, O&M costs avoided; after 8 years, all savings go to Government, plus O&M costs incurred
Escalation rates for analysis:	Energy: electricity, region 1, commercial, implicit in table F/Ba-1 in appendix F O&M: same as general inflation (0% differential escalation) DOE discount rate for energy-related projects (d) = 3% (real)

F.2.1.1 Case I. Immediate project implementation

Note: Evaluation of alternatives only needs to be made for the eight year contract life since the savings to the Government in all subsequent years will be the same in either case.

Net Savings with ESPC:

Initial Investment	0
PV energy savings: ($2,500, 8 years, UPV*= 7.00)	$17,500
PV O&M savings: ($5,000, 8 years, UPV = 7.02)	$35,100
Net Savings to Government	$52,600

Net Savings with agency funding:

Initial Investment	($100,000)
PV energy savings: ($25,000, 8 years, UPV*= 7.00)	$175,000
PV O&M savings: ($1,000, 8 years, UPV = 7.02)	$7,020
Net Savings to Government	$82,020

While the ESPC provides a present-value Net Savings to the Government of $52,600, the use of agency funding for the same project would generate a present-value Net Savings of $82,020. Thus, if agency funding is available, it is the more economic method of financing.

F.2.1.2 Case II. Two-year project implementation delay with agency funding

For the second case, assume that the ESPC can be implemented immediately but that agency funding is not currently available and project implementation would be delayed by two years if agency funding were to be used. Approximately $50,000 in potential energy savings will be foregone if the agency delays project implementation for those two years, although the agency share of those savings would be much smaller.

The Net Savings for each alternative can be compared over a 10-year period since the savings to the Government over years 11-20 will be the same in either case. However, in the case of the two-year delay in implementation, the package will still have two years of life left at the end of 20 years. This remaining life is better handled by assigning a residual value to the package than extending the study period to 22 years, since the latter would require a replacement of the retrofit package at the end of year 20 to force the same study period for both cases. (Net Savings for mutually exclusive project alternatives must be based on the same study period length.) In this example, the residual value at the end of 18 years of service is estimated, based on the straight-line depreciation method, to be 10 percent ($10,000) of its initial cost ((20-18)/20 = 10%). (There is no required method for estimating residual values.) The residual must be discounted to present value over the 20 year study period (SPV = .554 when d = 3 percent).

Net Savings over 10 years with ESPC:

Initial Investment	0
PV energy savings: ($2,500, years 1-8, UPV*= 7.00) + $25,000, years 9-10, UPV*=(8.53-7.00=1.53)	$55,750
PV O&M savings: ($5,000, years 1-8, UPV=7.02) $(1,000, years 9-10, UPV=(8.53-7.02=1.51)	36,610
Net Savings to Government	$92,360

Net Savings over 10 years with agency funding:

PV Initial Investment ($100,000, SPV (2 years)=0.943)	($94,300)
PV residual value at end of year 20 ($10,000, SPV (20 years)=0.554	5,540
PV energy savings: ($25,000, years 3-10, UPV*=(8.53-1.90=6.63)	165,750
PV O&M savings: ($1,000, years 3-10, UPV=(8.53-1.91=6.62)	6,620
Net Savings to Government	$83,610

In this second example, the Net Savings to the Government are greater by implementing the project immediately using an ESPC than by delaying implementation by two years and using agency funding.

GLOSSARY

Because the function of this handbook is to explain and help implement the FEMP LCC Rules, terminology and definitions used in the Rules are presented here. Definitions of additional economic terms used in this handbook are also provided. These terms are defined from the perspective of implementing the FEMP LCC Rules. Defined terms that appear in the definitions of other terms are capitalized.

Adjusted Internal Rate of Return (AIRR) — Annual yield from a project over the Study Period, taking into account reinvestment of interim returns.

Alternative Building System — The installation or modification of a building system intended primarily to reduce operating-related costs, including energy and/or water costs.

Annually Recurring Costs — Those costs which are incurred each year in an equal amount throughout the Study Period, or which change from year to year at a known rate.

Annual Value (Annual Worth) — The time-equivalent value of past, present, or future cash flows expressed as an Annually Recurring Uniform amount over the Study Period.

Annual Value (Annual Worth or Uniform Capital Recovery) Factor — A discount factor by which a present dollar amount may be multiplied to find its equivalent Annual Value, based on a given Discount Rate and a given period of time.

Base Case — The building system against which an Alternative Building System is compared.

Base Date — The beginning of the first year of the Study Period, generally the date on which the Life-Cycle-Cost analysis is conducted.

Base Year — The first year of the Study Period, generally the year in which the Life-Cycle-Cost Analysis is conducted.

Base-Date Price — The price of a good or service as of the Base Date.

Capital Investment Costs — Costs which are paid from capital funding accounts rather than from agency operating funds. For projects subject to the FEMP Rules, these include initial investment, capital replacements, and residual values.

Cash Flow — The stream of costs and savings (expressed for the purpose of this requirement in Constant Dollars) resulting from a project investment.

Compound Interest Factors or Formulas — See Discount Factors or Formulas.

Constant Dollars — Dollars of uniform purchasing power tied to a reference year (usually the Base Year) and exclusive of general price inflation or deflation.

Cost Effective — The condition in which an Alternative Building System saves more than it costs over the Study Period, where all Cash Flows are Discounted to their equivalent value at a common point in time.

Current Dollars — Dollars of nonuniform purchasing power, including general price inflation or deflation, in which actual prices are stated. (With zero inflation or deflation, current dollars are identical to constant dollars.)

Demand Charge — That portion of the charge for electric service based on fixed plant, equipment, and transmission costs associated with providing maximum required capacity.

Differential Cost — The difference in the costs of an Alternative Building System and the Base Case.

Differential Escalation Rate — See Real Escalation Rate

Discount Factor — A multiplicative number used to convert a Cash Flow occurring at a given point in time (usually in the future) to its equivalent value at a common point in time (usually the Base Date).

Discount Formula — An expression of a mathematical relationship which enables the conversion of dollars at a given point in time to their equivalent amount at some other point in time.

Discount Rate — The rate of interest, reflecting the investor's Time Value of Money (or opportunity cost), that is used in Discount Formulas or to select Discount Factors which in turn are used to convert ("discount") Cash Flows to a common time. *Real Discount Rates* reflect Time Value of Money apart from changes in the purchasing power of the dollar and are used to discount Constant Dollar Cash Flows; *Nominal Discount Rates* include changes in the purchasing power of the dollar and are used to discount Current Dollar Cash Flows.

Discounted Payback (DPB) Period — The time required for the cumulative savings from an investment to pay back the Investment Costs and other accrued costs, taking into account the Time Value of Money.

Discounting — A technique for converting Cash Flows occurring over time to time-equivalent values, at a common point in time, adjusting for the Time Value of Money.

Disposal Cost — See Residual Value

Economic Life — That period of time over which a Building or Building System is considered to be the lowest-cost alternative for satisfying a particular need.

Energy Conservation Measure — An installation or modification of an installation in a Building which is primarily intended to reduce energy consumption cost, or allow the use of a renewable energy source.

Energy Cost — The annual cost of fuel or energy used to operate a building or building system, as billed by the utility or supplier (including Demand Charges, if any). Energy Costs are incurred during the Service Period only. Energy consumed in the construction or installation of a new building or building system is not included in this cost.

Escalation Rate — The rate of change in price for a particular good or service (as contrasted with the Inflation Rate, which is for all goods and services). See Real Escalation Rate and Nominal Escalation Rate.

Federal Government — The U.S. Government.

Future Value — The time-equivalent value of past, present, or future Cash Flows expressed as of some future point in time.

Inflation — A rise in the general price level, i.e., the price level for all goods and services. (A negative change in the general price level is called "Deflation.")

Initial Investment Costs — The initial costs of design, engineering, purchase and installation, exclusive of "Sunk Costs," all of which are assumed to occur as a lump sum at the beginning of the Base Year or phased in during the Planning/Construction Period.

Internal Rate of Return — Annual yield from a project over the Study Period, i.e., the compound rate of interest which, when used to discount Cash Flows of an Alternative Building System, will result in zero Net Savings (Net Benefits).

Investment Costs — The Initial Investment Cost of a building or building system and capital Replacement Costs, less Residual Value, plus Disposal Cost, if any.

Life-Cycle Cost (LCC) — The total discounted dollar costs of owning, operating, maintaining, and disposing of a building or building system over the appropriate Study Period (see Life-Cycle Cost Analysis).

Life-Cycle Cost Analysis (LCCA) — A general approach to economic evaluation that encompasses several related economic evaluation measures, including Life-Cycle Cost (LCC), Net Benefits (NB) or Net Savings (NS), Savings-to-Investment Ratio (SIR), and Adjusted Internal Rate of Return (AIRR), all of which take into account all dollar costs related to owning, operating, maintaining, and disposing of a project over the appropriate Study Period.

Liquid Petroleum Gas (LPG) — Propane, butane, ethane, pentane, or natural gasoline.

Measures of Economic Evaluation — The various ways in which project cash flows can be combined and presented to describe a measure of project cost effectiveness. The measures used to evaluate FEMP projects are Life-Cycle Cost (LCC), Net Savings (NS), Savings-to-Investment Ratio (SIR), Adjusted Internal Rate of Return (AIRR). Discounted Payback (DPB) and Simple Payback (SPB) are measures of evaluation not fully consistent with the LCCA but are used as supplementary measures in some federal programs.

Modified Uniform Present Value (Worth) (UPV* or UPW*) Factor — A discount factor used to convert an annual amount, changing from year to year at a given escalation rate, to a time-equivalent Present Value. The FEMP UPV* Factor indicates a discount factor published in the Annual Supplement to Handbook 135 for use in computing present-value energy costs, based on energy price escalation rates provided for this purpose by DOE's Energy Information Administration.

Mutually Exclusive Projects — Projects where the acceptance of one precludes acceptance of the others. Examples are whether to use single-glazing, double glazing or triple-glazing for a window; or R11, R19, or R30 levels of insulation in an attic.

Net Savings (NS) or Net Benefits (NB) — Time-adjusted savings or benefits less time-adjusted differential costs taken over the Study Period, for an Alternative Building System relative to the Base Case.

Nominal Discount Rate — The rate of interest (market interest rate) reflecting the time value of money stemming from both inflation and the real earning power of money over time.

Nominal Escalation Rate — The projected annual rate of change in actual (market) prices for a particular good or service.

Operational Costs — See Operating, Maintenance, and Repair Costs

Operating, Maintenance, and Repair (OM&R) Costs — Non-investment costs related to the use of a building or building system, including energy and water costs.

Planning/Construction (P/C) Period — The period beginning with the Base Date and continuing up to the Service Date during which only Initial Investment Costs are incurred.

Present Value (Present Worth) — The time-equivalent value of past, present or future Cash Flows as of the beginning of the Base Year.

Present Value (Present Worth) Factor — A discount factor by which a future dollar amount may be multiplied to find its equivalent Present Value as of the Base Date. Single Present Value Factors are used to convert single future amounts to Present Values. Uniform Present Value Factors and Modified Present Value Factors are used to convert Annually Recurring amounts to Present Values.

Real Discount Rate — The rate of interest reflecting the portion of the time value of money attributable to the real earning power of money over time and not to general price inflation.

Real Escalation Rate — The difference between the rate of annual price change for a particular good or service and the rate of general Inflation.

Renewable Energy — Energy obtained from sources that are essentially inexhaustible (unlike, for instance, fossil fuels of which there is a limited supply). Renewable sources of energy include wind energy, geothermal energy, hydroelectric energy, photovoltaic and solar energy, biomass, and waste.

Replacement Costs — Capital costs incurred to replace the project during the Study Period. Sometimes referred to as Capital Replacement Costs. Replacement costs as used in this handbook do not include the cost of replacing system components that are paid out of current operating budgets; these are considered to be Operation-Related Costs.

Resale Value — See Residual Value

Residual Value — The estimated value, net of any Disposal Costs, of any building or building system removed or replaced during the Study Period, or remaining at the end of the Study Period, or recovered through resale or reuse at the end of the Study Period (also called Resale Value, Salvage Value, or Retention Value).

Retention Value — See Residual Value

Retrofit — The installation of an Alternative Building System into an existing building.

Risk Attitude — The willingness of decision makers to take chances or to gamble on investments of uncertain outcome. Risk attitudes are generally classified as *risk-averse, risk-neutral,* or *risk-taking*.

Risk Exposure — The probability of investing in a project whose economic outcome is less favorable than what is economically acceptable.

Salvage Value — See Residual Value

Savings-to-Investment Ratio (SIR) — A ratio of economic performance computed from a numerator of discounted energy and/or water savings, plus (less) savings (increases) in other operation-related costs, and a denominator of increased Initial Investment Costs plus (less) increased (decreased) Replacement Costs, net of Residual Value (all in present-value terms), for an Alternative Building System as compared with a Base Case.

Sensitivity Analysis — Testing the outcome of an evaluation to changes in the values of one or more system parameters from the initially assumed values.

Service Date — The point in time during the Study Period when a building or building system is put into use, and operation-related costs (including energy and water costs) begin to be incurred.

Service Period — The period of time starting with the Service Date and continuing through the end of the Study Period.

Simple Payback (SPB) Period — A measure of the length of time required for the cumulative savings from a project to recover its Initial Investment Cost and other accrued costs, without taking into account the Time Value of Money. SPB is usually measured from the Service Date of a project.

Single Present Value (Worth) (SPV or SPW) Factor — The discount factor used to convert single future benefit and cost amounts to Present Value.

Study Period — The length of the time period covered by the economic evaluation. This includes both the Planning/Construction Period and the Service Period.

Sunk Costs — Costs which have been incurred or committed to prior to the Life-Cycle Cost analysis. These costs should not be considered in making a current project decision.

Time-of-Use Rate — Charges for service (usually electricity) that vary from period to period, based on the cost of supplying the service during that period.

Time-Value of Money — The time-dependent value of money, reflecting the opportunity cost of capital to the investor during that time period. See Discount Rate.

Uniform Present Value (Worth) (UPV or UPW) Factor — The discount factor used to convert uniform annual values to a time-equivalent Present Value.

Useful Life — The period of time over which a Building or Building System continues to generate benefits or savings.

SYMBOLS AND ABBREVIATIONS

AIRR — Adjusted Internal Rate of Return

ASEAM — A Simplified Energy Analysis Method Computer Program

BLCC — The Building Life-Cycle Cost Computer Program

Btu — British Thermal Units

DoD — Department of Defense

DOE — Department of Energy

DPB — Discounted Payback

ESCO — Energy Service Company

ESCP — Energy Savings Performance Contract

FEMP — Federal Energy Management Program

HVAC — Heating, Ventilation and Air Conditioning

GJ — Gigajoule (10^9 joules)

kWh — Kilowatt Hours

LCC — Life-Cycle Costs or Life-Cycle Costing

MBtu — 10^6 x Btu

NS — Net Savings

OM&R — Operation, Maintenance, and (Routine) Repairs

OMB — Office of Management and Budget

PB — Payback

SIR — Savings-to-Investment Ratio

SPB — Simple Payback

SPV — Single Present Value (Factor)

TLCC — Total Life-Cycle Costs

UPV — Uniform Present Value (Factor)

UPV* — Modified Uniform Present Value (Factor)

REFERENCES

[1] Code of Federal Regulations, 10 CFR 436, Subpart A, *Federal Energy Management and Planning Programs; Life Cycle Cost Methodology and Procedures*, effective December 20, 1990.

[2] Petersen, S.R., Annual Supplement to NIST Handbook 135 and SP 709, *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis 1995*, NISTIR 85-3273-9, National Institute of Standards and Technology, Gaithersburg, October 1994 (revised annually).

[3] *ASTM Standards on Building Economics*, American Society for Testing and Materials, Third Edition, Philadelphia, PA, 1994.

[4] Petersen, S.R., *Present Worth Factors for Life-cycle Cost Studies in the Department of Defense (1995)*, NISTIR 4942-2, National Institute of Standards and Technology, Gaithersburg, MD, October 1994 (revised annually).

[5] Petersen, S.R., *BLCC, The NIST "Building Life-Cycle Cost" Program*, NISTIR 5185-2, National Institute of Standards and Technology, Gaithersburg, MD, January 1995.

[6] Petersen, S.R., *DISCOUNT--A Program for Discounting Computations in Life-Cycle Cost Analyses*, User's Guide and Reference Manual, NISTIR 4513, National Institute of Standards and Technology, Gaithersburg, MD, January 1991.

[7] Petersen, S.R., *ERATES: A Computer Program for Calculating Time-of-Use, Block, and Demand Charges for Electricity Usage*, User's Guide and Reference Manual, NISTIR 5186, National Institute of Standards and Technology, Gaithersburg, MD, July 1993.

[8] Office of Management and Budget (OMB) Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," Washington, DC, October 27, 1992.

[9] Bowen, B., Charette, R., and Marshall, H, *UNIFORMAT II--A Recommended Classification for Building Elements and Related Sitework*, NIST SP 841, National Institute of Standards and Technology, Gaithersburg, MD, August 1992.

[10] ASTM Standard E1557-93, *Classification for Building Elements and Related Sitework—UNIFORMAT II*, published in *ASTM Standards on Building Economics*.

[11] U.S. Department of Defense, "Memorandum of Agreement on Criteria/Standards for Economic Analyses/Life Cycle Costing for MILCON Design," Washington, DC. March 1994.

[12] Marshall, H. E., *Techniques for Treating Uncertainty and Risk in the Economic Evaluation of Building Investments*, National Institute of Standards and Technology Special Publication 757, Gaithersburg, MD, September 1988.

[13] "Uncertainty and Risk," Part II in the Audiovisual Series on Least-Cost Energy Decisions for Buildings, August 1992.

[14] Fireovid, J. A. and Fryer, L. R., *ASEAM 3.0, A Simplified Energy Analysis Method*, no publication number or place, April 1991. (Version 5.0 in review)

[15] Federal Energy Management Program, *Financing Federal Energy Efficiency Projects, How to Develop an Energy Savings Performance Contract*, version 2.0, U.S. Department of Energy, Washington, D.C., April 1995 (no document number). This document is also titled *Energy Savings Performance Contracting Guidance Manual*.

INDEX

☆ U.S. GOVERNMENT PRINTING OFFICE: 1996 - 408-819 - 814/50152