AFFORDABLE HOUSING ENERGY EFFICIENCY ALLIANCE

The Affordable Housing Energy Efficiency Handbook

A Guide on How to Incorporate Energy Efficiency into Affordable Housing: New Construction and Rehabilitation Projects

AHEEA is implemented by the Heschong Mahone Group, Inc.

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ACKNOWLEDGEMENTS

This handbook was made possible through funding provided by Southern California Edison as part of the Affordable Housing Energy Efficiency Alliance Program.

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TABLE OF CONTENTS

TABLE OF FIGURES

AFFORDABLE HOUSING ENERGY EFFICIENCY ALLIANCE

Chapter 1: Introduction

Chapter 1 addresses the importance of energy efficiency in affordable housing and the challenges affordable housing developers face.

INTRODUCTION

The energy burden on low-income households, as a proportion of income, is four times greater than for other American households.[1] Although energy costs are a large portion of a typical low-income family's budget, utility costs are an overlooked component of housing costs. The challenge is to understand that affordable housing can be made energy efficient and comfortable without causing cost over-runs and delays in construction. The Affordable Housing Energy Efficiency Handbook will demonstrate how to minimize first costs, risks, and delays through smart design concepts and processes and available funding sources. The end result will have a great impact on home affordability and tenant's ability to pay for housing costs as well as live in a more comfortable home.

The intent of the Affordable Housing Energy Efficiency Handbook is to:

- Encourage energy efficiency design in new construction as well as in acquisition/rehab projects
- Showcase the funding sources, programs, incentives, and assistance available to further lower investments in energy efficiency
- Overcome owner-developers perception that achieving large energy savings is usually too expensive, time consuming or difficult
- Demonstrate design concepts, processes, and practices that will help to minimize the costs of high performance buildings
- Highlight the non-energy benefits associated with high performance buildings
- Dispel the myth that cheaply built homes are affordable to operate in terms of utility costs
- Emphasize that energy efficiency lowers utility bills, thereby enhancing home affordability
- Stress that a home that just complies with Title 24 is the least efficient home you can legally build in California

Energy Efficiency Makes Homes More Affordable

"Inability to pay utilities is second only to inability to pay rent as a reason for homelessness."[2]

Affordable housing is not less expensive to live in merely because the first costs are minimized. The cost of housing includes not only the rent, but also utility costs. Higher utility expenses reduce affordability. Building "cheap" homes is not the same as making homes affordable to live in. Cheaply built homes invite callbacks, complaints and discomfort, and waste energy. Therefore, additional first costs to improve energy efficiency do not make housing less affordable.

Energy efficiency in affordable housing, more than any other building sector, makes a critical impact on the lives of tenants. According to the U.S. Department of Housing and Urban Development (HUD), "Utility Bills Burden the Poor and Can Cause Homelessness."[3]

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[1] National Energy Policy Report

[2] Karen Brown, Ex Dir, Colorado Energy Assistance Foundation. James Benfield, Ex Dir, Campaign for Home Energy Assistance. [as quoted on HUD's web site.]

[3] http://www.hud.gov/offices/cpd/library/energy/homelessness.cfm

Although the definition of "affordability" includes both rent and utilities, people do not usually consider of the impact of utility bills on low-income households. Utilities impose a disproportionate burden on the poor. While median income families spend an average of less than 4% of their income on energy, the average energy burden on Aid to Families with Dependent Children (AFDC) households is nearly seven times greater, at 26%.[1] For single, elderly, poor and disabled persons living on Social Security Income (SSI), the average energy burden is 19%of SSI. Figure 1 below summarizes the energy burden on low-income tenants.

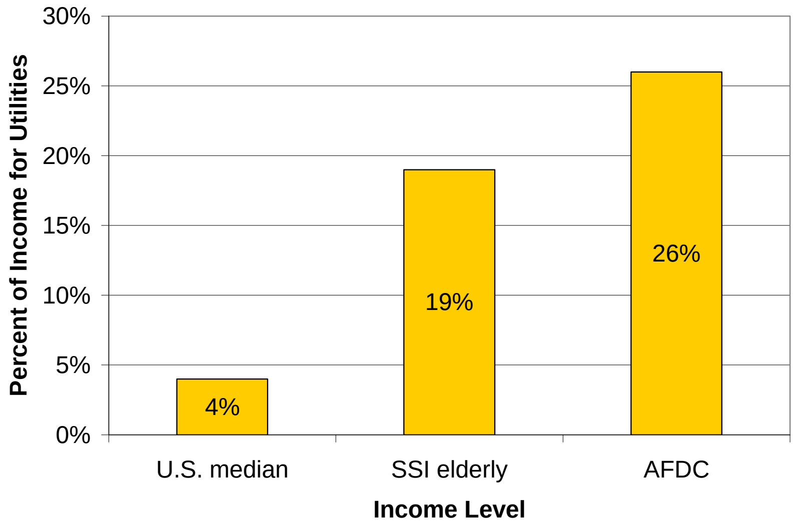

Figure 1: Impact of Energy Burden on Low-Income Families

Energy Efficiency: Beyond Making Homes More Affordable

Everyone can agree that we need to use less energy. The planet is running out of a finite supply of fossil fuels at the same time that global warming is threatening to change our climate into a destructive force that could change the world as we know it. Since buildings are responsible for over 40% of total energy consumption in the United States, part of the solution must involve making them much more efficient.[2]

As daunting as the task may seem, it will be accumulative changes in individual buildings over time that make the difference. Therefore each person involved in building design and construction has a role to play in finding solutions to the crisis our planet faces. With the recent surge of interest and activity around highly efficient, green buildings, accumulating experience allows them to be built on a reasonable budget and without delay. While there are added costs associated with some aspects of a more energy efficient design, there can also be savings to help offset those costs. When energy efficiency is evaluated on a life cycle cost basis, and the projected future costs of energy and building maintenance are also taken into consideration, the case for building energy efficient buildings becomes more and more compelling.

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[1] http://www.hud.gov/utilities/intercept.cfm?http://www.nliec.org/coldfacts.htm

2 McIlwain, J. (2006, July/August). Sorry Kermit, It's Easy Being Green. Multifamily Trends, pp.20-21.

Unique Challenges to and Solutions for Energy Efficient Affordable Housing

Energy efficiency is a key to making homes more affordable. There are, however, several challenges unique to affordable housing that owner-developers must overcome in order for energy efficiency to make economic sense. Issues such as who pays for and who benefits from the energy efficiency measures, which energy efficiency measures are most appropriate for certain occupancy types, and unpredictable end use schedules present a particular challenge when designing systems based on demand. Of course, the most significant challenge is the lack of funding common to most affordable housing projects – whether new or rehab. Below is summary of how these challenges can be overcome with good planning and early investment in energy efficiency.

Split Incentives

Affordable housing owner-developers lack the incentive to improve efficiency because they get no return on their investment due to split incentives, low and subsidized rents, and the inability to pass on the cost of upgrades on to the tenant. If there are common systems, such as central water heating, whereby the owner pays for the gas utilities, then investment in energy efficiency makes sense. However, when energy is individually metered, the investment instead awards the tenants with lower utility bills. This handbook intends to demonstrate how to overcome this barrier by minimizing the cost of high performance buildings through early and integrated design practices, utilizing ratepayer program incentives and other funding sources, and presenting case studies to show that lower utility costs make homes more affordable.

Occupancy Types and Use Patterns

Affordable housing owner-developers must also consider a myriad of occupancy types. Not only must the dwelling units be addressed, but also common areas and different occupancy types combined in mixed-use projects. A common solution to this challenge is to analyze each differing occupancy type separately: dwelling units, commercial/retail, common areas, etc. This brings the challenge of more sophisticated consideration of energy efficiency, based on how the spaces are used.

Energy use schedules in residential buildings are not as predictable as in commercial buildings. In an office building, for instance, one can assume a certain schedule for when the people are in the space working and when there is no one in the space. Affordable, senior, and supportive housing in particular lend themselves to unpredictable occupancy schedules which further complicate the prediction of energy uses. It is more difficult to predict when any given unit will be occupied, or when a particular device, such as an air conditioner, will be ON in any of the units. Similarly, within a given unit it is tough to predict how much energy the occupants will use – how often and how long they run the air conditioner, how often they use hot water etc. This handbook intends to provide strategies to overcome unpredictable energy uses and maximize energy efficiency in the project as a whole.

Lack of Funding

Whether building new or rehabilitating existing buildings, all affordable housing projects are cash strapped. First cost often takes precedence over long-term cost/savings considerations. This handbook intends to demonstrate that building "cheap" is not affordable, that energy efficiency costs can be minimized to the owner-developer, and that energy efficiency can impact tenants utility bills, thereby making the homes more affordable in the long run. This handbook will also provide information to address the issues of first cost and how to fund energy efficiency.

How to Use this Handbook

This handbook is organized to introduce you to the basic concepts of energy efficiency and integrated design, walk you through the various energy saving measures, and identify possible funding sources and assistance available to the affordable housing market.

Chapter 1: Introduction addresses the importance of energy efficiency in affordable housing and the challenges affordable housing developers face.

Chapter 2: Energy Efficiency Requirements, Design Concepts, and Practices explains the 2005 Title 24 Energy Standards and methods for compliance. The chapter also provides advice to developers on selecting an energy consultant and utilizing an integrated design process throughout project development.

Chapter 3: Energy Efficiency Measures and Multifamily Buildings provides an overview of individual measures and systems available for increased building energy efficiency. The measures are categorized in 4 sections: building envelope, HVAC, lighting, and appliances. This chapter is intended to educate builders, developers, engineers, consultants, and designers.

Chapter 4: Third-Party Verification – Home Energy Rating System discusses the role of the HERS rater and third-party verification of energy efficiency measure installation. The chapter describes how quality assurance provided by a HERS inspection can qualify a project for incentives, as well as reduce call backs to the builder, owner and building manager. Information on finding a HERS rater can also be found in this chapter.

Chapter 5: Maintenance and Operations stresses the important of maintaining buildings and systems to keep them operating efficiently and provides tips for ensuring that building managers and tenants know how equipment should be operated for highest efficiency. This chapter is geared toward developers and building managers.

Chapter 6: Funding Energy Efficiency suggests possible funding sources for energy efficiency in housing projects. The chapter also explains holistic cost modeling, a good tool for determining the lifecycle cost of a building or project.

Chapter 7: Housing Agencies' Role in Energy Efficiency explains the role of the housing agency in reducing energy consumption in affordable housing and encouraging owners and developers to consider more efficient systems. The chapter also explains energy efficiency-based utility allowance schedules, energy audits, and bulk purchasing options for ENERGY STAR appliances, all useful tools for affordable housing developers.

Chapter 8: Energy Efficiency Programs describes a number of incentive programs available to affordable housing developers for increased energy efficiency. Always check with your utility provider for information on current incentive programs. In addition, many permitting departments will fast track projects participating in energy efficiency programs or reaching a certain percentage above the Title 24 requirements.

Chapter 9: Case Studies provides real life examples of projects that have incorporated energy efficiency measures into their buildings. Both a new construction project and a rehabilitation project are illustrated, explaining the measures taken and the costs and benefits to the owner and tenants.

Chapter 10: Beyond Building for Energy Efficiency describes non-energy benefits of energy efficiency and suggests ways to build green outside the scope of energy efficiency, limiting negative impact on the environment. Designers and developers may benefit from Chapter 10.

Chapter 11: Resources provides an extensive list of resources available for gathering more information on all topics covered in this handbook.

The AHEEA handbook is meant to be used as a guide for energy efficiency in affordable housing. Though many codes and programs provide a set of rules, there are no official rules for achieving energy efficiency. Open-minded consideration and creativity in project design and measure selection is encouraged. As technologies progress and building and energy codes change, so should strategies for increasing energy efficiency.

AFFORDABLE HOUSING ENERGY EFFICIENCY ALLIANCE

Chapter 2:

Energy Efficiency Requirements, Design Concepts, and Practices

Chapter 2 explains the 2005 Title 24 Energy Standards and methods for compliance. The chapter also provides advice to developers on selecting an energy consultant and utilizing an integrated design process throughout project development.

ENERGY EFFICIENCY REQUIREMENTS, DESIGN CONCEPTS, AND PRACTICES

Designing an energy efficient building requires a team effort that involves the owner, developer, the design team and other consultants that work on various aspects of the buildings design. The simple truth is that most well designed buildings are not masterpieces developed in a flash of inspiration, but rather through an interactive process where the design team understands the owner and developers requirements and evaluates several options for building design and materials with an eye on the local weather, building energy efficiency, occupant comfort and owner/developer costs. The energy consultant is often involved in the process early, and plays a crucial role in developing the design and evaluating cost-effective options for building efficiency. The design is developed over several such interactions, which we refer to as the integrated design process.

With whole team commitment to energy efficiency and an integrated design process, energy efficient buildings can be built to cost less to operate, protect owners and tenants from future energy cost increases and improve the comfort of the inhabitants, and are recognized as more valuable by the market and financial institutions. We will explore the integrated design process later in this document, but first let us look at some of the basics of energy efficiency – what is thermal comfort, how to achieve this comfort in an efficient manner, and what are existing rules and regulations on energy efficiency.

Buildings, Energy and Comfort

Buildings are a very important part of our strategy to find comfort in a world with fluctuating climates that can often be extreme. However, despite highly variable climate conditions, many buildings are built with complete disregard for local conditions and instead rely on a “brute strength” approach to achieving human comfort through the use of energy-hogging mechanical systems to control heat, humidity and ventilation. While HVAC technology is advancing and the performance is improving, the increasing cost to install the systems and the future cost of the energy to run them should be of great concern.

Energy efficiency is first about building design based on climate and appropriate technology, and then about better performing equipment and systems. When a building is designed well to passively create comfortable conditions, the mechanical systems needed to condition it can be reduced in size and cost, sometimes even eliminated, and energy bills will be lower for the life of the building. If we add to that building inhabitants that are educated about how their building works and that actively participate in strategies to adapt to their local conditions, then well designed buildings could possibly “free run” for a good percentage of the year and only rely on mechanical systems for the most extreme conditions.

This concept commonly referred to as climate responsive design provides a baseline approach for minimizing the need for mechanical conditioning and ventilation. However, reducing the loads is only the necessary first step in achieving an energy efficient design. The mechanical systems that are put in place to meet this cooling/heating/ventilation load need to be efficient in order to use the minimum amount of energy needed to meet the requirements. While no standard or code specifies that the building be built in a climate responsive manner, there are assumptions built into the California Building Energy Efficiency Standards (Title 24, Part 6) for what minimum system efficiency should be for various building components by building type and climate zone.

California Building Energy Efficiency Standards: Title 24, Part 6

California's building efficiency standards (along with those for energy efficient appliances) have saved more than $56 billion in electricity and natural gas costs since 1978. It is estimated the standards will save an additional $23 billion by 2013.[1]

The Energy Efficiency Standards for Residential and Nonresidential Buildings were established in 1978 in response to a legislative mandate to reduce California's energy consumption. The standards are updated periodically to allow consideration and possible incorporation of new energy efficiency technologies and methods.[1]

While California's Building Code, Title 24, governs all aspects of building construction, Part 6 (Building Energy Efficiency Standards) mandates energy efficiency in new construction, additions, and alterations of buildings. The Energy Efficiency Standards establish mandatory minimum energy efficiency measures.

Once these minimum standards are met, the Standards allow the builder to choose either a performance or prescriptive path to 1) achieve compliance and 2) design and construct a building that maximizes energy performance. The prescriptive approach utilizes an established set of measures for each climate zone. The performance approach allows for greater flexibility in determining the measures and design concepts best suited for that particular building.

The Title 24, Part 6 (here forth referred to as Title 24) is divided into two separate code bases – one deals with low-rise residential buildings, and the other deals with non-residential buildings as well as high-rise residential buildings. Multifamily buildings are thus split between the two codes based on the number of floors. Buildings with three or less floors are governed by the residential code, while buildings that are four floors or higher are governed by the non-residential/high-rise residential code. When addressing building energy efficiency for multifamily buildings, it is important to note this difference.

2005 Title 24 Standards and Impacts on Multifamily Buildings

The Energy Commission adopted the 2005 Standards on November 5, 2003, and the Building Standards Commission adopted them on July 21, 2004. The 2005 Standards took effect on October 1, 2005 and include a number of significant updates that affect multifamily buildings.[2] In this section we will provide a brief overview of the code changes and how they will impact multifamily building design and construction.

In 2005 the most significant changes to the Title 24 standards include Time Dependent Valuation (TDV), greater emphasis on HERS measures (third-party verification), and new residential lighting mandatory measures.

Time Dependent Valuation (TDV)

Time Dependent Valuation (TDV) changes how energy is "valued" based on the time of day it is used. Previously, energy use estimates had a constant value whether the use was at night or day, summer or winter. TDV assigns high values for on-peak savings (summer afternoons) and a low value for off-peak savings (night-time). There is greater credit for peak energy saving measures over off-peak measures. For example:

- Higher Energy Efficiency Ratio (EER) air conditioners — EER gives an indication of demand (kW) needs. Typically air conditioners of 7.5 tons or less, have used the SEER rating for efficiency. SEER reflects average performance during the course of the cooling

[1] http://www.energy.ca.gov/title24/index.html

[2] http://www.energy.ca.gov/title24/2005standards/index.html

season, whereas EER better reflects performance during full load or peak conditions when the weather is the hottest.

- Lower Solar Heat Gain Coefficient (SHGC) glazing — SHGC measures how well glazing blocks heat from sunlight. The SHGC is the fraction of the heat from the sun that enters through the glass. SHGC is expressed as a number between 0 and 1. The lower the SHGC, the more solar heat is blocked.

Conversely, TDV gives greater penalties for building features such as

- West-facing glass — West-facing glass must be 5% or less of the total floor area for low-rise buildings, or less than 40% of the total wall area for high-rise buildings. Otherwise, other energy efficiency trade-offs are necessary.
- Oversized, unshaded windows/skylights — Exposed windows will result in higher solar gains in hot climates, and thus increased cooling energy use.

HERS Measures

The 2005 Standards place a greater emphasis on site verification performed by a certified Home Energy Rating System (HERS) Rater. The following measures require HERS verification:

- Quality Insulation Installation (QII) — QII is to prevent incorrectly installed insulation, such as being compressed or installed with gaps that result in an effectively lower R-value. A HERS verification will provide additional credit for proper installation.
- Maximum Cooling Capacity
- High EER Air-conditioning1 — A high EER must be verified by a HERS rater.
- Adequate Air Flow
- Air Handler Watt Draw
- Low Leakage “Tight” Ducts— Ducts that are designed, installed, and field tested with a Duct Blaster to confirm 6% (0f what?) or less leakage.
- Thermostatic Expansion Valve (TXV) and/or Refrigerant Charge Testing

Envelope Measures

The changes to envelope measures include:

- Glazing: The 2005 Title 24 code addresses window area allowances that were not realistic for multifamily buildings and seen by many as a loophole. The new requirements include:
- West-facing glass is limited to 5% of floor area in low rise buildings (the building is penalized if there is more than 5%). In high rise buildings, the window/wall ratio is limited to 40% for west facing windows and 40% for the building as a whole.
- Standard multifamily design is based upon actual glazing area instead of 16% or 20% (up to 20%) of floor area for low rise buildings, and instead of a percentage bin such as 30%-40% window/wall area ratio for high rise buildings.
- Revised fenestration U-factors to make them consistent with NFRC rating procedures
- Envelope U-factors: the effective R-value of an envelope assembly is de-rated under the 2005 Title 24 rules for “standard” insulation installation practices. This is to account for

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[1] EER= Energy Efficiency Ratio. SEER = Seasonal Energy Efficiency Ratio

the fact that often the insulation is not installed properly, and there are gaps in the insulation, or places where blown-in insulation does not settle uniformly.

- Additional changes for high rise buildings include:
- More insulation required in metal construction
- "Cool roofs" required for low slope roofs for the prescriptive approach

Central Domestic Hot Water Heating

The most significant change to water heating is that the base case for central water heating is central water heating and no longer individual water heaters. Individual water heaters (storage and tankless) will be the baseline for units with individual water heaters. This closes a loophole in the previous code whereby central water heaters were compared to individual water heaters, providing a "false" estimate of energy savings, since the minimum allowable efficiency of central water heaters is higher than the minimum allowable efficiency for individual water heater. Changes to water heating are summarized below:

- Central Domestic Hot Water base case is central DHW
- Distribution losses better accounted for in the Performance Approach through algorithms that take into account pipe lengths, locations and insulation
- Pipe insulation: hot water pipes (3/4" or greater) must be insulated all the way to the kitchen (prescriptive requirement)

HVAC

The 2005 code changes to HVAC requirements were designed to reduce peak load. HVAC code changes are listed below:

- A minimum SEER 13.0 is required for small air conditioners (less than 7.5 tons)
- Credit is given for high Energy Efficiency Ratio (EER), but requires HERS field verification.
- Increased duct insulation (except Climate Zones 6-8)
- Prescriptive duct testing in high rise buildings

Lighting

Lighting mandatory measures require that all general lighting fixtures either be fluorescent or have occupant sensors controlling them. In kitchens, the total wattage from installed fluorescent fixtures must equal or exceed that of the installed wattage from incandescent fixtures. Below is a detailed list of the lighting changes:

- High efficacy lighting or controls are required in bathrooms (cannot be traded with other rooms), garage, laundry room, and utility room.
- All other rooms require high efficacy lighting, or occupancy sensor (with manual on/auto off), or dimmer
- Kitchen lighting wattage must be calculated and least 50% of wattage must be high efficacy and operated by a separate switch
- Completed lighting forms (WS-5R) are required as documentation
- All recessed fixtures in thermal envelope must be ICAT —approved for zero-clearance insulation coverage, and must be air tight

Additional changes for high rise buildings include:

- Increased control requirements for mechanical and lighting systems
- Acceptance tests required for many automated mechanical and lighting controls (common areas or mixed use)

Title 24 Compliance and Energy Performance Modeling

All new homes built in California must meet a minimum level of energy efficiency as required by the Title 24 Building Energy Standards. These standards provide a choice of two methods to show compliance:

- Prescriptive Packages
- Performance Based Calculations using Computer Modeling Tools

Computer performance modeling is the preferred approach due to the flexibility and the ease of use of the approved programs. There are two CEC-approved compliance software tools widely used for modeling energy use in multifamily buildings:

- EnergyPro: www.energysoft.com
- MICROPAS: www.micropas.com

For more information on CEC approved compliance software, visit:
http://www.energy.ca.gov/title24/2005standards/2005_computer_prog_list.html

Modeling Options for Low Rise and High Rise Buildings

The Title 24 code treats low rise and high rise multifamily buildings separately. Low rise multifamily buildings must meet the residential code requirements entirely. However, high rise multifamily buildings must meet certain requirement from both the residential and non-residential codes as shown in Figure 2.

Building Type	Envelope	HVAC	Domestic Hot Water	Lighting
Low rise	Residential	Residential	Residential	Residential
High rise	Non-Residential	Non-Residential	Residential	Residential

Figure 2: Primary Difference between Low Rise and High Rise Multifamily

Both the residential and non-residential standards address space heating, space cooling, water heating and lighting. Low rise buildings can be modeled using either CEC-approved compliance software, EnergyPro or MICROPAS. High rise buildings can only be modeled using EnergyPro (for a list of compliance software, see Section entitled “Energy Modeling Software”). Differing requirements for low and high rise residential buildings have different implications for building design and equipment selection. Construction practices also differ in low rise versus high rise buildings.

Residential Title 24 requirements impact several types of construction, including:

- Single family residences
- Duplexes
- Multifamily residential buildings 3 stories or less
- Additions and alterations to existing buildings of any above listed building types

Non-residential Title 24 requirements impact several residential buildings types, including:

- High rise multifamily buildings 4 stories or greater in height
- Long-term care, dormitories, private garages, sheds, etc.

Modeling Unit-by-Unit versus Whole Building

Two approaches to modeling multifamily buildings are whole building and unit-by-unit. The difference between the two approaches is outlined below.

Whole Building Compliance

- Simplest approach to compliance, particularly for a project with one multifamily building or building occupancy type.
- Similar to analyzing single family residence
- Treats building as a whole and only models exterior envelope
- Applicable to both prescriptive and performance compliance paths

Unit-by-Unit Compliance

- Demonstrates each dwelling unit complies individually
- Each unique unit type determined by orientation, floor level and exterior envelope
- Fewer unique unit type models by running plan in all 4 cardinal orientations
- More simple than whole building approach if there are multiple buildings in the project
- Multiple building multifamily developments generally include a few basic building plans repeated in a variety of orientations or reversed (mirrored) configurations

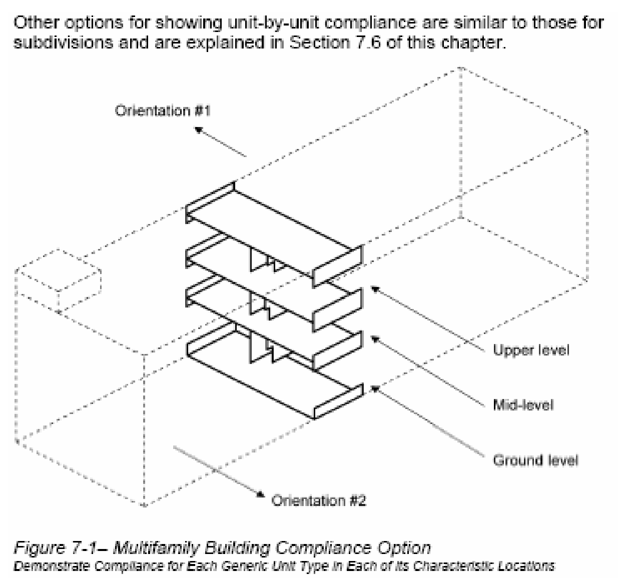

Figure 3: Unit-by-Unit Modeling Diagram[1]

[1] Source: 2005 Residential Compliance Manual, p7-9

Common Areas

In addition to hallways and lobbies, most multifamily projects contain common areas, which may include community rooms and laundry facilities. If the common area is equal to, or less than 10% of the total building square footage, it can be included in the residential model. If the area is greater than 10%, then the common areas must be modeled separately as non-residential.

When modeling mixed-use projects, different occupancy types must be modeled separately. Multifamily common areas of a mixed-use project also follow the 10% rule.

Modeling New Construction versus Alterations (Rehab)

The base case references for new construction and alterations (rehab) projects are different for compliance purposes:

- **New Construction:** Title 24 compliance is based on a comparison with Prescriptive Package "D" for low rise multifamily, and Table 143-B for high rise multifamily buildings.
- **Alterations (Rehab):** Title 24 compliance is based on a comparison with the existing building

Integrated Design Concepts

Integrated design is a team concept in that the building design is developed through close collaboration between the owner, developer, architect, mechanical engineer, electrical engineer, energy consultant and other specialized consultants that, together, make a building work. Integrated design involves making informed decisions based on quantifiable data while striving to achieve commonly agreed upon building performance and aesthetic goals. These decisions are best made through a regular schedule of team meetings when all team members get a chance to guide changes to the design. As we will explain later in this section, design charrettes are an excellent method for developing the design through the team approach. It is especially useful at critical design stages, which include the early design programming stage where most of the design priorities are set.

Figure 4 below is a diagram of the integrated design process and participation.

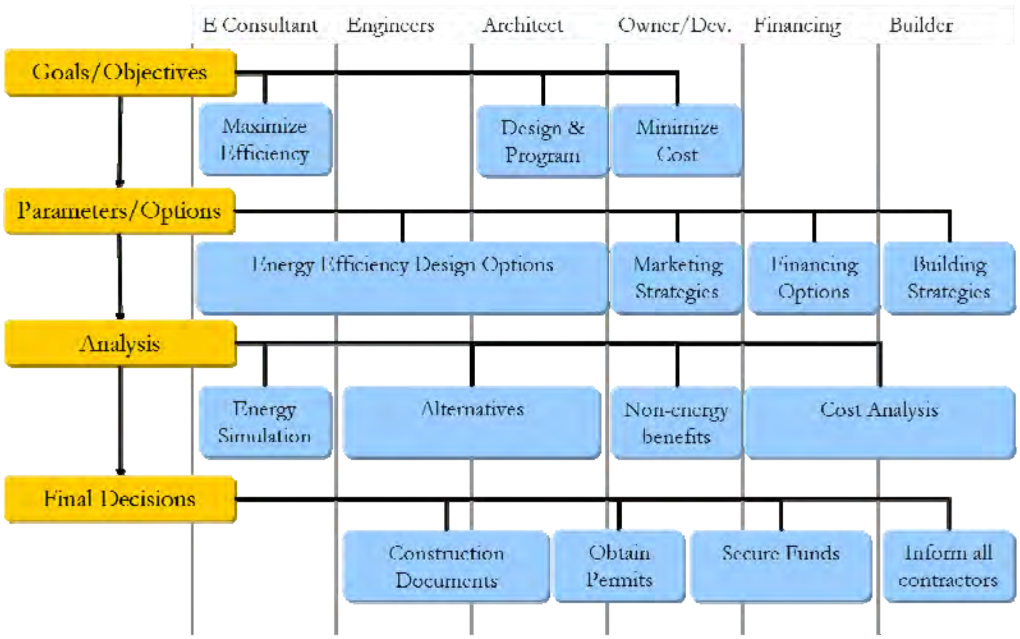

Figure 4: Integrated Design Process Flow Chart

At the heart of the integrated energy design concepts is the notion of the interconnectedness of the local climate and site conditions, building shape and orientation, the exposure and distribution of the windows and any shading controls, the relationship between daylighting and electric lighting, the efficiency of the envelope, the effects of thermal mass, and the type, sizing and efficiency of the mechanical equipment and systems. These are the elements that must be systematically evaluated early in the design process, and prioritized in order to set the design on path to achieve those goals. At every decision point in the design process, these parameters and priorities then guide decision making.

A good team will also need good tools in order to assist in the decision making process. These include cost-benefit analysis tools, energy efficiency analysis tools, such as building energy simulation programs, and documentation of results and decisions for future reference.

Building Energy Simulation

Interactions between the site and building parameters mentioned previously are quantifiable, physical processes, and there are many building energy simulation tools that can model the energy relationships of the whole building. In California, specialized software tools (discussed earlier in this chapter) are used to model buildings for compliance with Title 24 requirements. Some of this same software can also be used as a tool to model whole building performance.

Building energy simulation is an important tool available to the design team committed to designing a high efficiency building. It is not only a tool for energy analysis, it also has an important role to play in the economic analysis of a project and, when its output is displayed graphically, it plays an important role in communication between technical and non-technical members of the team. Building energy modeling is a specialized skill, and accuracy is essential when the results are the basis for major decisions, such as type and size of HVAC equipment and window area, location, shading and glazing performance. For these reasons, it is advisable to hire an experienced energy consultant and budget enough time and money to include the consultant in the design team meetings and for multiple building simulation runs during design development.

Start Energy Simulation Analysis Early

For the best results this process must be started early. It is even possible, and in fact desirable, to model a building in the conceptual design stage. Here accuracy is not the most important thing because the building design will go through many stages before a final design is completed. Instead, the value here is to establish the building's basic energy efficiency profile in its climate zone, and to examine the effects of a changing a few essential parameters such as orientation, window performance and insulation levels have on the HVAC sizing requirements.

Maximizing Individual Measure Efficiency versus Combination of Measures

By performing multiple building simulations runs with different combinations of measures, an indication of the sensitivity of particular measures in that building can be established. This kind of parametric analysis becomes useful in later stages of design because the design team as a whole will have a shared knowledge of where the most cost effective measures to achieve greater energy efficiency can be expected.

One of the things that building simulation software can accomplish, that would be almost impossible without the calculation power of a computer, is to accurately evaluate the effectiveness of multiple measures in combination and compare those results with alternate combinations as well as varying degrees of individual measures. For example, it is well known that in hot climates a significant amount of the cooling load enters the living space through the roof/attic/ceiling areas. One might think that by simply adding more and more insulation that the cooling load could be controlled to any desired level, but insulation is subject to the laws of diminishing returns. Building simulation models show that a combination of a radiant barrier with a comparatively lower level of insulation can often further reduce cooling loads and be a more cost effective solution for a particular climate zone than maximizing insulation alone.

It is important to remember that the goal of the integrated design process is not to use the 'most' efficient measure for any given building element, but rather to seek a combination of cost-effective and energy efficient measures that will achieve the energy efficiency goals. Economics is always a prime consideration when selecting and set of measures, and a good energy analysis is never complete without its companion cost analysis. Only by balancing these two elements – first costs and energy savings – can one achieve a combination of measures that will provide comfort to the occupants, low energy usage, and cost savings for the owner/developer. It is also important to remember that no two buildings are exactly the same, so each building will need its own customized set of measures that meet both the energy efficiency and cost benefit criterion. There is no magic bullet that works every time, everywhere. However, it is true that particular measures perform better in certain climates and building designs, and thus lend better to the measure combinations than other measures. We will explore that in the section of this handbook titled Energy Efficiency Measures and Multifamily Buildings.

Hiring an Energy Consultant

While an energy consultant is typically associated with ensuring that building designs meet the California's Title 24 Building Energy Standards, the energy consultant also plays a critical role in designing a high performance building.

The qualified energy consultant will:

- Help to achieve the client's goals of the most energy efficient structure
- Use the method of choice with an approved computer program and provide an energy compliance package for building department approval
- Know any local jurisdiction idiosyncrasies to assure that their Title 24 report will proceed smoothly through the plan check process
- Advise the client on a variety of matters such as upcoming changes in the energy standards; new energy saving equipment, appliances and devices; the latest information on new types of insulation, glazing and other building components

The process of choosing an energy consultant is very similar to selecting other professional services:

- *Experience* — Use an energy consultant with experience preparing code compliance calculations. Some designers do energy calculations as a sideline, preparing reports just once in a while. Although they may be capable of filling out the forms, it is doubtful as to whether they can provide cost-effective, energy efficiency options.
- *Certification* — The best qualification an energy consultant can probably have is to be certified. The California Association of Building Energy Consultants (CABEC), Certified Energy Analyst program requires demonstrated experience, a tested knowledge of the energy standards, and compliance to a code of ethics. For a list of Certified Energy Analysts visit website at www.CABEC.org and select Member and CEA Directory and search by CEA, or call CABEC at: 866-360-4002.

Energy Efficiency Design Charrettes – Talking Your Way into a Better Building

The integrated energy design process is not a rigid formula; rather it is a dynamic process that brings together owners, builders, designers, engineers and contractors to solve problems at the whole building level. To orchestrate this process it is advisable to designate one person as the integrated energy design coordinator. Often, it is advantageous to the process if that person is an outside specialty consultant with previous experience with these types of projects. An independent consultant can strike a balance between the competing interests of the other stakeholders and must be willing and able to challenge the design team at times if design decisions start to default to old assumptions and methods of working. This person's main job is to champion the ambitions and goals of the building, develop a spirit of cooperation amongst the design team members and to be on a constant lookout for opportunities to exploit any synergies that will advance the project. One method of achieving such synergies is through design charettes.

A design charrette is essentially a brainstorming session common in the design process of high performance projects buildings. It is an assembly of all people, skills, and authority involved in the design and building of a project from start to finish, for the purpose of synchronizing understanding of the project and project goals.

Focus on Energy

Through a design charette focused specifically on energy efficiency, all parties involved in the design and building process, from the beginning stages through completion, are able to contribute to and understand energy saving strategies for a particular project. In an energy efficiency design charette, the team works together to:

- Establish energy efficiency as a priority EARLY in the design process — The earlier in the design process the energy efficiency goals are established, the less costly they are to incorporate. Also, as a project progresses, the opportunities to insert additional efficiency measures decrease.
- Establish energy efficiency goals — It is essential that all parties involved understand and agree on the concepts and aim of the project. Otherwise, efficient measures may be cut due to misunderstanding or conflict of interest
- Develop strategies to accomplish goals — Having a plan to achieve your goals is as important as setting them. This plan will serve as the basis of your design and equipment specifications, as well as your Request for Bids specifications.
- Integrate design solutions — Avoid the checklist approach. The object is not to install the most energy saving measures, but a combination of measures that, when used together, yield cost effective energy savings for your unique project. Use the expertise of your energy consultant, architect, and mechanical engineers to identify integrated design solutions.

Building a Design Team

Assembling a committed team is critical to the success of energy efficient/high performance design. Not only should the team have knowledge and expertise or energy efficient design practices, but also is receptive and committed to carrying out the energy efficiency goals established through the charrette process. The design team should include the owner-developer, architect, energy consultant, mechanical engineer, contractors, purchasers, and construction superintendent.

Who Should Attend the Charrette?

All parties in any way involved in the design or building process are encouraged to attend the energy efficiency design charrette. At minimum, the design team, as defined above, should attend the charrette. Also, carefully consider who might influence the implementation of energy efficiency design plan. Any person who might contribute to, or even impede energy efficient design should also attend. Other key participants may include your marketing team (to understand the marketing value of energy efficiency) and your financing team. Utility or energy efficiency program representatives could contribute to the process of establishing energy efficiency goals.

Charrette Participant Preparation and Responsibilities

The most productive charrette results from all members bringing all possible knowledge and resources to the table. This requires some forethought and planning.

- Provide a meeting agenda and expectations for participants to research options and be prepared to present ideas
- Don't start cold – Do some homework in advance by having your energy consultant model several project-specific baselines or scenarios with various options to present at the meeting.
- Bring ideas and be prepared to provide recommendations

To ensure that there are few or no unanswered questions, and to help you establish your energy efficiency goals, do some research in advance of the meeting. Identify key participants to bring the following resources to the meeting:

- *Costs and Cost Analysis Tool* — Use a simple payback method or cost analysis to determine the least to most costly energy efficiency measures
- *Financing – Funding, TCAC, Tax Credits* — Research in advance the funding programs, and assistance that reward energy efficiency to factor into your cost analysis
- *Incentive Programs* — Research in advance the programs and incentive funding available for energy efficiency to factor into your cost analysis
- *Marketing Opportunities* — Identify how energy efficiency can help your project gain acclaim, funding opportunities, and a marketing edge
- Establish a low, medium, high cost alternatives matrix with corresponding funding, incentives, tax credits funding, and marketing opportunities
- Don't forget to factor in the non-energy benefits in your analysis. See the section entitled "Going Beyond Energy Efficiency: Non-Energy Benefits of Energy Efficiency in Affordable Housing."

Meeting Structure and Agenda

Initially, a charrette can be very structured, as all team participants are introduced to the different roles and aspects of the project. By following a charrette-like process, eventually this procedure evolves into common practice, and participants develop a sense of ownership, responsibility, and consensus on energy efficiency goals.

Below is a sample agenda for an energy efficiency design charrette:

- *Project Overview* — To ensure that all participants understand the scope of the project and its intentions, provide a detailed explanation of the project and its components.
- *Establish Energy Efficiency Design Goals* — The energy goals should be created collectively to make certain all team members are in general agreement and moving in the same direction. Energy efficiency goals might include:
    - Minimizing first cost while still achieving energy savings
    - Maximizing energy efficiency
    - Creating a "zero energy project" which includes on-site generation.

- *Energy Design Options* — Once the project goals have been set, specific energy design options can be identified and discussed. The greater part of the charrette is getting into these issues.

Energy Design Options can include:

Site Considerations	Climate Solar access Orientation with relation to the sun and wind
Building Envelope	Insulations Radiant barrier / Cool roof Attic venting Windows and glazing Shading of building and windows Thermal mass Infiltration / exfiltration
HVAC Equipment	Space heating Space cooling Distribution
Water Heating System	Central or individual Storage or tankless Distribution controls Location(s) Central laundry or in-unit
Lighting	Fixtures Controls
Appliances	Refrigerators Dishwashers Clothes Washers
Other issues	Operations and Maintenance Parking / Transportation Water efficiency

At the conclusion of the meeting, each person should understand his/her role in the project's progress and be in sync with the other team members in achieving the energy efficiency goals established during the charrette.

The Next Steps

Following the charrette discussion of project goals and possibilities for energy efficiency, final decisions can be made and implemented. The next steps are as follows:

1. Finalize energy calculations using tools such as EnergyPro
2. Develop specifications for energy efficiency measures
3. Transfer into schematic and construction documentation
4. Apply for funding and incentive programs

Additional Outcomes and Strategies

The success of a well-planned and efficient project may draw attention and set an expectation for future projects. Such examples further promote our efforts to increase health and efficiency in the natural and built environments. One of the great benefits of an energy efficiency design charrette is that ideas and principals discovered through the process can be carried into other projects. The process can be evaluated, improved upon, and recycled for energy efficiency and success in future projects. Following the design charrette process and next steps:

1. Translate into corporate design guidelines
2. Evaluate process
3. Evaluate the outcome (e.g., what did it save or cost?)
4. Modify the process and get good at it

Chapter 3:

Energy Efficiency Measures and Multifamily Buildings

Chapter 3 provides an overview of individual measures and systems available for increased building energy efficiency. The measures are categorized in 4 sections: building envelope, HVAC, lighting, and appliances. This chapter is intended to educate builders, developers, engineers, consultants, and designers.

ENERGY EFFICIENCY MEASURES AND MULTIFAMILY BUILDINGS

Whole building energy efficiency requires selecting the most cost-effective and energy efficient package of measures. Often that means choosing measures that are not "best" in their category. For example, a U-Factor of 0.2 and low SHGC window is not necessary in each building.

The list of measures below is not exhaustive, but represents some of the most commonly installed measures. The actual benefits of each measure are highly dependent on how they interact with other building elements. No one measure by itself will guarantee high energy savings.

Building Envelope

Building professionals call the outer layer of a building "the building envelope" because it envelopes the interior living space. It can refer to a wall, roof, floor, window or door, and is responsible for the most significant loads that affect building heating and cooling energy use. Through careful design of the building envelope we can keep out a large portion of the summer heat while allowing in some of the winter heat.

The overall energy and health performance at the building envelope level depends on a balance of measures and strategies discussed in this chapter

Building Orientation and Sunshades

Every building site comes with a unique set of climate conditions. The two most important influences on a site are the sun and the wind. The two most important building design elements that interact with them are building shape and orientation. The opportunity to create a building design that takes full advantage of this relationship only occurs once in a project—at the earliest stage of the design process.

It is possible to optimize the shape and orientation of a building for free heating, cooling and daylighting, not just during the extremes of summer and winter, but throughout the year. This kind of building design can yield the most cost effective energy savings because there are no material costs and no installation costs, just some extra design time, and the consequent savings accumulate over the lifetime of the building.

Each building surface will respond differently to climatic conditions depending on which direction it is facing, and what materials it is made of. In California, our climate is predominantly hot and dry, so it follows that buildings tend to be "cooling dominated". With good solar orientation (the long axis of the building facing within 20º of true South) and shading devices for windows (optimized for the particular latitude) this potential energy penalty can be converted into a benefit for the building as a whole. In cases where the building orientation is limited by the site, it is still possible to design the building shape to minimize the energy penalty for a less than ideal orientation.

Insulation

Each part of the building envelope has unique properties of heat transfer. Heat flows through the building materials and air between zones that have a temperature differential. This could be inside to outside, or between two areas that are at different temperatures, such as a home and a garage. The greater the temperature difference, the greater the heat flow from the hotter zone to the colder zone.

Insulation resists the flow of heat better than other regular building materials, such as brick, concrete or wood. In California, insulation is regulated by the California Standards for Insulating Materials, which ensures that insulation products perform to the manufacturer's published specifications. The energy performance specification is the R-value, a measure of a material's resistance to heat transfer. California's minimum standard is R-13 for walls and R-19 for ceilings in wood frame construction. The minimum R-values are higher in hotter climate zones, especially for high rise buildings. One of the most cost effective methods to achieve a Title 24 compliance credit is to install higher R-value insulation.

Quality of Installation

In all cases, except in the case of continuous insulation sheathing, the rated R-values of insulation products are nominal and other factors, such as the percentage of the wall taken up by framing members, and the quality of the installation, must be accounted for to calculate the effective R-value of a wall, floor or roof assembly as a whole. Investigations into the performance of buildings often show a significant gap between the specified level of insulation and the actual performance of particular envelope components. Building scientists have determined that many of these shortfalls are related to improper installation techniques.

The most common flaws that degrade thermal performance in insulation installations are:

- Insulation is not in contact with the air barrier, creating air pockets through which heat can transfer, bypassing the insulation.
- The insulation has voids or gaps, resulting in portions of the construction assembly that are not insulated.
- The insulation is compressed, creating a gap near the air barrier and/or reducing the thickness of the insulation.

When insulation is not in contact with the air barrier, which is generally the back of the drywall on an exterior envelope assembly, convective air movements in these small spaces allow additional heat transfer to occur, reducing overall energy performance.

In the new 2005 Standards these common problems of sub-standard installation of insulation are addressed with the Quality of Insulation Installation (QII) HERS measure for wood framed walls, ceilings and roof assemblies (floor assemblies are not included). A standard R-value calculation method is used for the effective R-value used in Title 24 compliance. If the insulation on a building is not to be inspected by a HERS rater, then this standard value is reduced by 13%. If the insulation is to be inspected by a HERS rater following the procedures of the QII HERS measure, then a Title 24 compliance credit is available which restores the effective R-value to the standard calculation value.

For Energy Star projects the threshold is raised higher with the mandatory Thermal Bypass Checklist (TBC) requirement. This complements the QII requirements by identifying the 16 areas where heat most commonly bypasses the insulation. Each of these 16 items must be checked and verified by a HERS rater in order for a building to meet the minimum requirements of an Energy Star home. The TBC/QII protocol, including the inspection requirements, ensures that our buildings are insulated per the design specification, further improving the value of this important energy efficiency measure.

Materials

There are many ways to insulate a building and a variety of materials that can be used. Figure 5 provides description for a number of insulation types and products. Though these products are often marked with their overall R-value, for they are listed here by R/inch for purpose of comparison.

Common Insulating Materials	Approx R/inch[1]	Comments
Blankets		Flexible batts or rolls made from mineral or natural fibers
Fiberglass	R-3	Most common application; may contain recycled content; the fine glass fibers may be hazardous, similar to asbestos; some brands may contain formaldehyde
Mineral wool	R-3	Also known as rock or slag wool; similar to fiberglass but has higher fire resistance
Cotton	R-3	Made from recycled cotton fibers; borate treated for fire and insect resistance; environmentally friendly
High Density Fiberglass	R-4	Also known as 'super-insulation' for its high performance, R-15 for 2x4 and R-21 for 2x6 walls
Blown-in (dry)		Loose fibers that are blown into building cavities or attics using special pneumatic equipment; good choice for retrofits.
Fiberglass	R-2.5	R-value reduces as it settles (more reduction than cellulose)
Cellulose	R-3.5	Made from recycled newspapers; borate treated for fire and insect resistance; may contain formaldehyde from ink; commonly used in attics; some R-value reduction as it settles
Spray Polyurethane Foam (SPF)	R-6	Available in aerosol cans for small scale filling of gaps; professional application required for large scale; no ozone depleting potential, some global warming potential
Sprayed-in (wet)		
Cellulose	R-3.2	Higher quality envelope than drywall; adhesive prevents settling and reduction in wall R-value over time; moisture must be carefully managed per manufacturers' instructions
Fiberglass	R-3.8	Also known as 'blown-in-blanket'; adhesive prevents settling and reduction in wall R-value over time
Cementitious	R-3.9	Made from minerals extracted from seawater; non-toxic, non-flammable
Foam board		Manufactured by blowing molten liquid or pellets into air spaces using a blowing agent; installed as continuous layer, eliminating thermal bridging
Polyisocyanurate	R-6	Closed-cell foam with very high thermal performance; no ozone depletion potential, negligible global warming potential;
Polyurethane	R-6	Closed-cell foam with very high thermal performance; no ozone depleting potential, but does have global warming potential
Expanded Polystyrene	R-4	Molded beads; higher water absorption than other foams; no ozone depleting potential, some global warming potential
Extruded Polystyrene	R-5	Also known as 'blueboard'; lowest moisture absorption of all foam boards; uses ozone depleting blowing agent
Insulating Concrete Forms	varies	Foam boards or blocks used as formwork for concrete; continuous insulation; remains permanent part of building structure; can speed construction, light weight.
Structural Insulated Panels (SIP)	varies	Foam board sandwiched between two structural skins; typically expanded polystyrene or polyisocyanurate foam board with oriented strand board skins.
Reflective Systems	varies	High reflectance, low emittance foil; typically aluminum foil with a variety of backings such as kraft paper, plastic film, polyethylene bubbles, or cardboard

Figure 5: Common Insulating Materials

[1] Exact R-value varies by density; check manufacturer's specification sheet and follow manufacturer's installation procedures.

Moisture control

Some moisture (30% relative humidity) is required in residential buildings for comfort, but uncontrolled moisture can cause structural damage and unhealthy living conditions (mold etc.). Moisture degrades the performance of insulation significantly as the insulating property of the commonly used blankets and batts comes from the air trapped between the fibers.

Moisture in the building envelope can be controlled by providing adequate drainage between the layers of the building envelope. The outermost layer of the envelope is exposed to rain and water from outside elements. It is critical that this layer should either be made of waterproof materials, such as vinyl shingles, or if it is made of materials that absorb moisture, such as stucco, to provide an air space and a continuous water barrier (with the joints taped) behind the exterior layer, to drain the water away from the framing members and the interior insulation.

Moisture problems can also occur in cathedral ceilings unless a continuous ventilation space between the top of the insulation and the bottom of the roof sheathing is maintained from one end of a bay to the other. In order to address this issue insulation manufacturers have created high density R-30 and R-38 fiberglass batts that fit into standard dimension 2 x 10 and 2 x 12 joist bays and leave one inch of vent space for free air flow.

Air Sealing — Reducing Infiltration

Infiltration is the unintentional exchange of conditioned air with unconditioned air through cracks and leaks in the building envelope. Loss of conditioned air and the subsequent need to condition the newly infiltrated air represents a significant loss of energy. Sealing these cracks and other leakage sources prevents this loss of energy, and also helps prevent moisture infiltration, making living spaces draft free and greatly improving comfort.

Many insulation materials do a poor job of resisting *air flow*, so must be contained by an air barrier on all six sides so to be effective. An air barrier can be any material that restricts air flow and must continuously enclose the insulation without any holes, cracks or gaps, and must be in full and continuous contact with the insulation. Typically, the air barrier will be the drywall on the inside of the exterior wall or the underside of the ceiling joists, or the floor sheathing. Continuous insulation sheathing can also act as an air barrier.

When using blown-in insulation in attics with eave vents, solid baffles must be installed to prevent “wind washing” of insulation and allow an unobstructed flow of ventilation air into the attic. Wind washing occurs when the air flow through the eave vent pushes the blown-in insulation away from the outside walls, reducing the effective R-value of the ceiling, and in some cases also causing moisture problems.

Radiant Barrier

In multifamily buildings, the summer sun can heat up an attic to reach temperatures up to 140ºF. This heat can radiate down into the dwelling units, increasing the temperature and causing air conditioning systems to work much harder and use more energy. A simple and cost effective solution to block the sun’s heat from penetrating the roof and heating up the attic is a radiant barrier. A radiant barrier can reduce attic temperatures by 30ºF and block up to 97% of radiant heat gain, saving energy and increasing comfort.[1] Additional energy savings are achieved in homes where the HVAC and ductwork are within an attic space with radiant barrier, because it reduces heat gain in this equipment.

A radiant barrier is a reflective layer of aluminum foil or plastic film, usually installed in the attic to reflect the sun’s heat and prevent it from penetrating into the living space. The essential

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[1] http://www.energyvideos.com/bldfaq.php?P=CAandA=5andS=rad

http://www.toolbase.org/Technology-Inventory/Roofs/radiant-barriers characteristic of radiant barriers is that they are high reflectance and low emittance materials. “Reflectance” indicates how much radiant heat will be reflected by the material. “Emittance” indicates how much radiant heat a substance will give off, or emit, at a certain temperature. Opaque materials with high reflectance will have low emittance[1]. A radiant barrier can have reflective surfaces on one or two sides. If a one-sided radiant barrier is installed it must face an air space to be effective.

Radiant barriers reflect the radiant heat from the sun and so are most effective in hotter climate zones and in low rise buildings. When incorporated in to a well thought out, energy efficient design (i.e. with a whole building approach) that can be documented through a building energy simulation program, air conditioners can be down-sized and significantly reduce first costs.

Two-sided radiant barriers can also provide some energy savings benefits during the winter when heat energy inside the house is radiating out towards the cold exterior. In this case, the radiant barrier reflects the heat back towards the interior and radiates very little to the outside. (There is some reduction in the desired solar gain through the roof in winter, the extent of which is being studied)

In both summer and winter, not only are there energy savings benefits due to the lower energy usage of the HVAC systems but there are also increased comfort benefits. Radiant barriers reduce the ceiling surface temperatures in summer and increase them in winter. This provides additional comfort to the occupant as radiant surface temperatures play a larger role than air temperature in the perception of thermal comfort.

Radiant Barrier Products

There are a variety of certified radiant barrier products available. For new construction, OSB (oriented strand board) roof sheathing that is pre-laminated with a radiant barrier foil is popular because there is no additional labor cost for installation. Flexible radiant barriers, with one or two layers of bubble-wrap type material covered on one or both sides with aluminum foil, are also common. This type of radiant barrier is also suitable for use in retrofit applications. Another variant popular in retrofit applications is a scrim-type material covered on both sides with aluminum foil. Once installed radiant barriers are virtually maintenance free. If they are installed in a location where they can accumulate dust, they simply need to be dusted to maintain best performance.

Title 24 Radiant Barrier Requirements

In California, radiant barriers are a prescriptive requirement in climate zones 2, 4 and 8 -15. This means that in these climate zones radiant barriers have been proven to be a cost-effective energy efficiency measure. It also means that when the performance method is used for Title 24 compliance, an energy penalty will be incurred in these climate zones if a radiant barrier is not installed. Another energy feature in the home will need to be installed that will provide an energy credit to cancel out this penalty.

Radiant barriers have increased in value as a Title 24 compliance strategy because the current energy code assigns higher value energy savings during peak demand. Peak demand is largely driven by air conditioning loads, and since radiant barriers are effective at reducing those loads, they contribute to peak load reduction, and therefore become more valuable.

Not all radiant barrier materials are the same and the best of radiant barriers will only perform well when installed as part of a whole insulation system design. Title 24 compliance credit is only available for radiant barriers with an emittance that is less than or equal to 0.05 (5%), and where they are installed as part of a whole system of complementary building energy components.

[1] For opaque materials, the sum of reflectivity and emissivity factors is 1.

There are several ways in which radiant barriers are allowed to be installed for Title 24 compliance credit:

- Draped over the truss/rafter (the top chords) before the upper roof decking is installed
- Spanning between the truss/rafters (top chords) and secured (stapled) to each side
- Secured (stapled) to the bottom surface of the truss/rafter (top chord)
- Attached (laminated) directly to the underside of the roof decking

In all of these methods the radiant barrier is installed face down to prevent the build up of dust on the radiant barrier surface which reduces performance over time. But radiant barriers must never be installed face down on top of attic insulation that has been laid on top of the ceiling, as this will eliminate the required air gap in front of the reflective side and the radiant barrier will no longer perform to its specification. Also, the radiant barrier shall be installed to cover all gable end walls and other vertical surfaces in the attic.

In each of these installation methods, special consideration must be given to the movement of air and moisture. When the radiant barrier is laminated directly to the underside of the roof sheathing it must be perforated to allow moisture/vapor transfer through the roof deck. In all other cases, an air space between the roof sheathing and the top surface of the radiant barrier must be created. When the radiant barrier is draped the air space must be a minimum of 1.5 inches at the center of the rafter/truss span. Otherwise, a minimum air space of 1 inch must be provided. At the bottom of the rafter/truss bay there must be a minimum gap of three inches between the radiant barrier and the insulation, and at the ridge a minimum gap of six inches measured horizontally must be maintained. These minimum gaps are required to allow the free (convective) flow of hot air up and out through the attic vents, 30% of which must be upper vents. The standard one square foot of vent area for each 150 square feet of attic floor area is also part of the set of requirements. Whenever possible, ridge vents or gable end vents should be installed for maximum energy performance. Enclosed rafter spaces, where the ceiling is applied directly to the underside of the rafter, must be individually ventilated at each end.

Glazing — Windows, Doors and Skylights

Windows, doors and skylights bring daylight into our homes, and daylight brings health and a sense of well-being. They also bring a connection to the outside world and the cycles of day and night, winter and summer. They do all this and at the same time protect us from the wind and rain, but also allow us to let in the fresh air, both warm and cool when the outside conditions are more comfortable than those indoors.

Historically, windows have been the weak link in the thermal envelope. Single pane windows, which are commonly found in multifamily apartment buildings at least 25 years old, have about the same insulating value as a sheet of metal. Most of the insulating value comes from the layer of air on either side of the glass. They are more like a hole in the wall than a thermal barrier and they can lose heat ten to twenty times faster than a well insulated wall. The introduction of dual-glazed windows, once the sealing issues were ironed out, was a great improvement, with the insulating value almost doubling.

Window Performance

But there is a lot more to improving window performance than just adding more glass. Some of the factors that affect window performance are:

- Type of material used for frame and sash
- Size of space between glazing layers
- Type of gas between glazing layers

- Type of spacer between glazing layers
- Type of coating(s) on glazing layers

All three types of heat transfer work in combination in a window, in varying degrees, and depending on the external conditions. They work together in complex ways that do not lend themselves to simple, individual measurements. To address this problem, and to provide an independent evaluation of whole window performance, the National Fenestration Ratings Council (NFRC) was created. The NFRC developed a window evaluation system based on three basic window properties:

- Insulation value (U-factor)
- Solar radiation control (Solar Heat Gain Co-efficient or SHGC)
- Visibility (Visible Transmittance or VT)

Insulation value is a measure of heat transfer that results from a difference in air temperatures between the outside and the inside. Solar radiation control is a measure of heat transfer that occurs from direct or indirect solar radiation that is independent of air temperature. Visibility is not a measure of energy performance but is an important consideration when selecting a window. The downside of reduced visibility (minimal in most instances) from window coatings must be balanced with the benefits of energy efficiency that result from them.

Window Selection

The U-factor and SHGC are the essential values that are input into Title 24 compliance software for compliance calculations. It is mandatory that either windows with values determined by the NFRC be used, or the California Energy Commission's default table values be used. The latter option is usually a last resort, due to a limited choice of low performance windows. An official NFRC window sticker is also mandatory so that the local building inspector can verify that the values used in the Title 24 calculations correspond to the actual values of the installed windows.

The U-factor and SHGC will have significantly different effects, depending on whether the building is in a heating or a cooling climate. In a predominantly heating climate, a reduced U-factor will have a relatively large effect on reducing heating energy, and in a cooling climate it will have a relatively small effect. Total energy, heating and cooling, will usually be reduced in both cases. In a predominantly cooling climate, reduced SHGC will have a relatively large effect on reducing cooling energy and in a heating climate it will have a relatively small effect. In some cases, total energy use may increase in the heating climate due to the loss of solar gain during the heating season.

These examples illustrate that window selection is not as simple as selecting a window with the "best", i.e. lowest, performance values. Each climate zone will have its own characteristic mix of heating and cooling days throughout the year, and the best option will vary accordingly. Similarly, each building design is unique, and even within a given climate, the proper window specs will depend on what the other loads on the building are and the efficiency of these systems. Sometimes choosing the "best" window may result in cooling energy savings, but increased heating energy, thus negating the net gain from such high-efficiency windows. Only computer simulation, either with a specialized window program like RESFEN or Window5, or on a whole house basis with Title 24 or other building simulation programs, can provide climate specific guidance as to the most cost-effective choice of window performance.

For an approximate guide, the Efficiency Windows Collaborative has performed computer runs on nine California cities and six different window types. These are available in their "Fact Sheet: Selecting Energy Efficient Windows in California", and can be downloaded at http://www.efficientwindows.org/factsheets/california.pdf. But, this guide is limited by such factors as a single window area to floor area ratio (15%), equal distribution on all four orientations and typical insulation and shading.

For a specific recommendation there is no substitute for a computer run that can take into account the specific thermal properties of the windows, their exact surface area and orientation, the specific climate zone that they occur in, and the dimensions and position of shading devices, including where the building self-shades. Ask the energy consultant performing the Title 24 calculations to assist in this analysis.

At the most sophisticated level and to achieve the maximum level of energy efficiency, a blend of windows with different thermal properties can be selected for specific locations and orientations on a building and optimum dimensions of shading devices can be calculated using sun angle calculators. This should only be attempted if someone on the project agrees to take responsibility for seeing the design all the way through to construction, as misplacement of windows during installation could cause this strategy to backfire.

In cooling climates, customized window performance design can pay off when combined with other high efficiency envelope components by reducing the cooling loads on the building to the extent that the air conditioning equipment can be downsized. Then the savings in equipment costs can help to pay for the extra performance of the windows and other envelope components.

Heating, Ventilating and Air Conditioning (HVAC) Equipment

Purchasing a heating and cooling system for new and existing multifamily homes represents a major cost decision for a project. More often than not, the owner needs to rely on professional expertise for guidance in that decision. Since the lifetime cost of running heating and cooling equipment can surpass the cost of the home itself, it pays to get the selection right the first time. It is helpful for the owner to understand what goes in to the proper selection of an HVAC system, and to know what questions to ask prospective designers or contractors to be able to select the best professional help available.

Improving energy efficiency with high efficiency equipment and distribution systems does not have to result in unacceptably higher first costs. When combined with efficient building envelope measures and an accurate building load calculation, mechanical equipment can be properly sized, and the resulting cost savings can help to pay for other energy efficiency measures.

The most typical systems found in multifamily buildings are:

- Heating and cooling (hotter climates, usually inland)
    - Split system air conditioner with a gas furnace (forced air)
    - Heat pump (through-the-wall or ducted)
    - Water-sourced heat pumps (high rise residential)
- Heating only (milder climates, usually coastal)
    - Gas furnace (wall or forced air)
    - Hydronic fan coil (forced air)

These systems can be made more energy efficient by:

- Improving equipment efficiency
- Correct sizing of air conditioners
- Proper duct system design and installation
- Reduced air handler fan power
- Adequate airflow over the indoor coil

All of the above energy efficiency measures are eligible for a Title 24 credit when a HERS Rater verifies the measure and/or tests the equipment. This ensures that the installed system matches the level of energy efficiency that is claimed in the Title 24 calculations and provides the owner with an assurance that the energy savings are going to be real.

Selecting the right system is often based on prior experience and first costs, and not a rational energy efficiency decision. Do not allow your project to fall into this default. Not all systems are equal energy users. Electric resistance heating and Packaged Terminal Air Conditioners (PTACs) are the least efficient equipment, while a heat pump or split system can be made highly efficient.

High Efficiency HVAC Equipment

The simplest approach to improving equipment efficiency is to choose Energy Star labeled equipment. Higher efficiencies can be attained by consulting online resources such as the Consortium for Energy Efficiency's (CEE) "Directory of ARI Verified Equipment" that groups equipment in efficiency tiers and includes two tiers above the Energy Star tier. Also useful is the "California Energy Commission Appliances Database" that lists equipment certified for use in the State of California and is in a simpler spreadsheet format

SEER versus EER Ratings

Although the federal standards look at the Seasonal Energy Efficiency Ratio (SEER) rating, in California (especially the hotter, inland regions) it is more important to select an air conditioner based on its Energy Efficiency Ratio (EER) rating. The testing conditions for the EER rating are much more like California's hot, dry climate than the SEER rating. It is a better measure of energy efficiency performance in our climate. The California Energy Commission recognizes this by rewarding high EER equipment with a much higher Title 24 credit than for high SEER equipment. This credit is only available when a HERS Rater verifies that the system consists of the properly matched components necessary to achieve the high EER rating.

Correctly Sizing an Air Conditioner

Air conditioners are often oversized if a "rule of thumb" or past experience is used to "ballpark" the equipment size. Oversizing is common because it can act as insurance against future customer complaints that the equipment cannot adequately cool or heat one or more rooms. Oversizing is, however, a costly mistake, both in the inflated first cost of equipment with unnecessary capacity and also in the extra cost to run the oversized equipment.

The efficiency of heating and cooling equipment is based on properly sized equipment. When HVAC equipment is oversized, there is a significant efficiency cost because the equipment is cycling on and off more often ("short cycling"). This "short cycling" increases wear and tear on the equipment, which reduces life expectancy and increases maintenance costs. In addition, equipment that short cycles has an oversized fan that blasts hot or cold air, on and off, creating uncomfortable drafty conditions and unnecessary noise. Conversely, right-sized systems provide even heating and cooling, and quiet operation. Properly sized equipment can reduce energy usage by as much as 35%.[1] The main benefits of right-sized HVAC systems are cost and energy savings. The bonus is the superior comfort that properly sized and designed systems can provide.

Rightsizing an air conditioner starts with an Air Conditioning Contractors of America (ACCA) Manual J, or an American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE) approved equivalent calculation. This calculation will accurately determine the space heating and cooling loads. These calculations are easily accomplished using computer software when the building characteristics are accurately input. The software will calculate how much

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[1] http://www.cee1.org/resid/rs-ac/rs-ac-main.php3

cooling and heating energy is needed to maintain the desired indoor temperature. The calculations take into account:

- Temperature differences between the outside conditions and the set point on the indoor thermostat
- Building orientation
- Heat resistance of walls, floors and roofs
- Heat resistance and heat emittance of windows and skylights
- Shading of windows and skylights
- Reflective surfaces, especially roofs
- Air tightness of the building
- Heat storage capacity of high mass components like concrete slabs and masonry walls

Once the maximum heating and cooling loads have been determined, the equipment is sized to meet those loads. These calculations are a mandatory requirement of Title 24.

Proper Duct Design and Installation

HVAC equipment efficiency is only part of the equation for an energy efficient HVAC system. No matter how efficient the equipment is, if the distribution system is not also well designed and operating properly, then the HVAC system as a whole will not be efficient. In fact, an air conditioner with a high SEER/EER connected to a leaky duct system can have a lower overall system efficiency than an air conditioner with a lower SEER/EER connected to a tightly sealed duct system.

Air distribution systems, e.g. a ducted system with a fan that blows warm or cool air through the ducts, are common because they are low cost and can perform double duty for heating and cooling (triple duty if used for outside air ventilation also). Unfortunately, these systems when poorly installed, and located outside of conditioned space, can lose over 30% of the energy consumed by the equipment that is conditioning the space.

Duct Design

The first step towards an efficient air distribution system is to include an ACCA Manual D duct design, or equivalent, as part of the construction documents. This will tell the HVAC installer where to install the supply and return registers and what sized ducts should be connected to them. It will also provide critical external static pressure information so that the air blower can be sized correctly. There is software available that can automatically calculate duct sizes and airflow requirements.

Require a duct design as part of the construction documents, including:

- Duct locations (attic, crawlspace, conditioned space etc.)
- Duct sizes (lengths and cross sectional areas)
- Supply and return grilles location (floor, ceiling, sidewall etc.)
- Supply and return grilles size
- Airflow at supply grilles (in cubic feet per minute, or CFM)

When the duct design process is started early enough, while there is still time to negotiate duct locations with the architect and the structural engineer, it is possible to locate ducts entirely within the conditioned space. This has proven to be one of the most cost effective of all duct efficiency strategies. It simply requires advance planning, detailing in the design stage and coordination between the trades during the installation stage. In multifamily construction, this strategy is best accomplished by locating the duct system within a central dropped ceiling (soffitted) area. The equipment is located in an adjoining closet or in the dropped ceiling itself. One of the most important details of this dropped ceiling approach is to maintain the soffitted area within the thermal and air barriers of the conditioned space. Containment of soffitted areas within the air barrier is often a required detail for fire protection purposes. Ducts in conditioned space can also be accomplished by running the ducting in the structural space between floors. This approach requires early consultation with the structural engineer because open web floor trusses will generally be a pre-requisite of this system.

Sealed and Tested Ducts

In California, untested duct systems leak around 20% to 25% for new homes and as much as 28% to 35% for existing homes, wasting energy and increasing the cost to the consumer. When ducts are located in unconditioned space (e.g. attic), duct leakage from supply and return ducts cause significant energy loss. The supply ducts leak conditioned (heated or cooled) air into unconditioned spaces. Conversely, and for similar reasons, return ducts suck unconditioned air from the unconditioned space. The situation for leaky return ducts is further complicated by the potential risk to the health of the inhabitant. The air that is sucked in from the attic, crawl space or other building cavities can be contaminated by dust, mold, chemicals and/or airborne pathogens from animals. It is therefore especially important to make sure that the return ducts are sealed.

Sealed ducts save energy and money, and improve indoor air quality. They also create a more comfortable living environment. A properly designed and sealed HVAC system can provide the right amount of heating and cooling to the spaces that need it and can prevent drafts throughout the home. Duct sealing is considered so important that it is assumed in the baseline Title 24 building model for every climate zone. Buildings that do not have sealed and tested ducts receive a penalty in Title 24 calculations. If a proposed building does not include sealing ducts, then other measures must be used to offset the penalty.

Heat Pumps

Air-source heat pumps with electric resistance backup are especially responsive to duct efficiency measures. If ducts are in conditioned space, or are well insulated and sealed, then loads on the equipment will be reduced and the amount of time that electric resistance is employed will be reduced. Electric resistance heating is the least efficient form of space heating so that any reduction in the amount of time that it is used will increase the overall efficiency of the system.

Additional Tips:

- Specify ducts in conditioned space whenever possible
- Include sealed and tested ducts as part of the air conditioning contractors scope of work
- Increase duct insulation beyond the baseline minimum (when ducts are outside of conditioned space)
- Consult your energy consultant for the most appropriate combination of measures for your project
- Hire a HERS Rater to verify the ducts have been sealed and tested correctly according to T24/HERS criteria

Ventilation

Ventilation differs from infiltration even though both result in an air exchange between the inside and the outside. Infiltration is leakage, while ventilation is the controlled exchange of inside and outside air to maintain indoor air quality and temperature/humidity.

It is important to note that there is a balance between energy savings and adequacy of indoor air quality. High ventilation rates will result in increased energy consumption due to the effort needed clean, heat/cool the larger quantity of outdoor air before it is supplied to the dwelling unit. On the other hand, having a very low ventilation rate (along with a tight envelope or low infiltration) may result in poor indoor air quality, commonly known as the 'sick building' syndrome.

There are three basic types of residential ventilation. Supply ventilation is the introduction of outside air. Exhaust ventilation is the removal of indoor air to the outside, such as in kitchens and fans. Balanced ventilation systems do both. It is important that the supply ventilation air spreads throughout the dwelling unit. It is also important to maintain pressure inside the house that is as close as possible to the outdoor air pressure. Unbalanced ventilation can cause too much air pressure or too less, leading to discomfort, unwanted airflows within and between dwelling units, and possibly structural damage in the long term.

Ventilation can be natural or mechanical. Natural ventilation utilizes pressure differential and temperature differential to achieve air exchange. It may require some occupant interaction – such as opening and closing windows, or it may utilize mechanically controlled openings. Mechanical ventilation utilizes fans to achieve "forced" air exchange. This is a more energy intensive process but must be weighed against indoor air quality concerns.

Domestic Hot Water

Tenants value hot water that is reliable and arrives quickly. Many hot water systems in multifamily buildings suffer from temperature fluctuations and from slow delivery times. These problems lead directly to tenant complaints and maintenance costs, as well as wasted energy and wasted water.

Basics

In multifamily buildings, domestic hot water (DHW) can be supplied either by a central system that serves many dwelling units, or by individual water heaters in each unit.

Both central and individual systems can be made compliant with Title 24—there are prescriptive standards for both types of system, and cost-effective, energy-efficient equipment is available for both types of system.

Central Systems

Central systems are usually the best option in multifamily buildings, for several reasons:

- One large heater or boiler is cheaper to purchase and install than many small ones, and increases the available space in each dwelling unit.
- Larger heaters or boilers are more energy-efficient than smaller ones
- Recirculation loops give tenants quick access to hot water at a constant temperature
- Maintenance is easier and more convenient
- Systems can be located in a basement or other location that minimizes the risk of water damage in the event of a leak

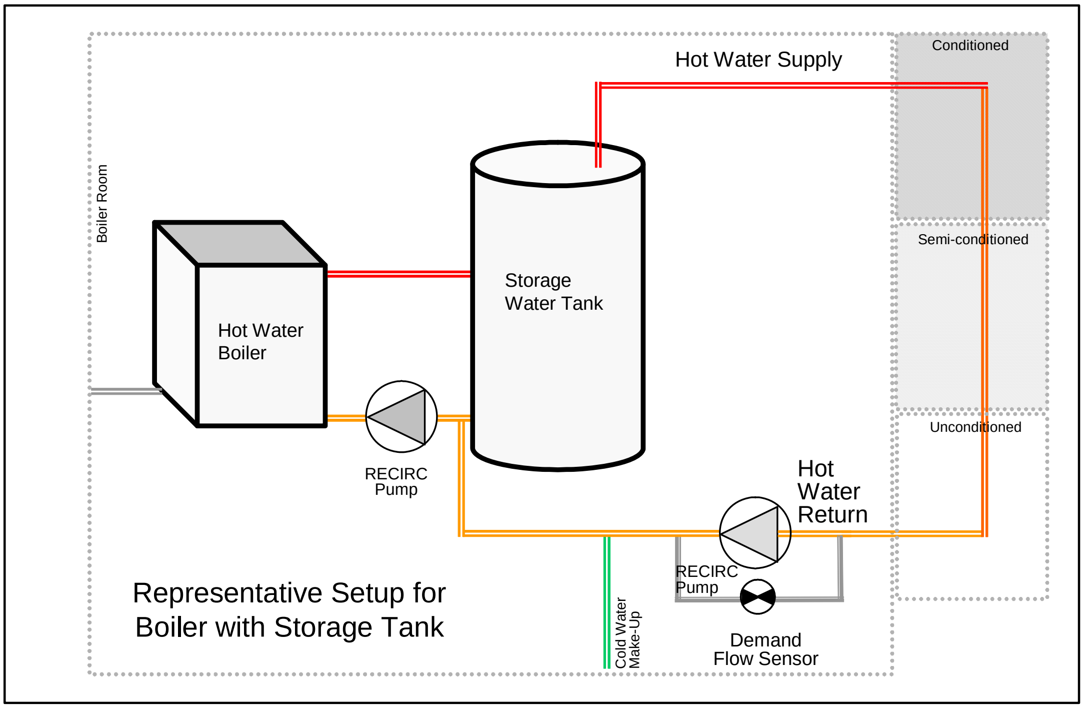


Figure 6: Representative Graphic of a Central DHW System Including Components

Recirculation Loops

Central systems take two forms—trunk-and-branch systems, and recirculation systems. Trunk-and-branch systems carry hot water from the source to each dwelling unit, along pipes that fan out through the building. Recirculation loop systems have one central, large-diameter insulated pipe that serves many units, and constantly circulates water from the storage tank. From this recirculation loop, small “runout” pipes typically 6-12’ in length tee off to supply each fixture.

In larger buildings, recirculation loops are typically used because they provide hot water to tenants more quickly than trunk and branch, because they are cheaper to install, and because they are more energy-efficient. This is for two main reasons:

- The total length of hot water pipe is reduced, so heat loss through the walls of the pipe is reduced
- Because cold water in the pipes does not need to be replaced with hot water each time there is demand, the peak load on the DHW system is reduced. This allows heaters or boilers to be reduced in size.

Optimizing the layout of recirculation loops can significantly reduce their cost and improve their performance. By planning the dwelling units so that faucets are close to the loop, the length of the loop as well as the length of the final delivery pipes can be reduced. The loop can pass vertically through two or three stories without incurring pressure balancing problems.

If trunk and branch is used (typically in smaller buildings), “parallel piping” can be used to reduce energy use. Parallel piping simply involves minimizing the length of pipe between the source and each end use (rather than minimizing the total length of pipe). Parallel piping requires more copper, and so has a higher initial cost.

Heater and Boilers

Central systems can be powered by heaters or by boilers. These two technologies function in slightly different ways, but the end result is the same, and either technology is suitable for most buildings.

Boilers usually provide a longer service life, and parts are more easily replaced. Since boilers allow the storage tank to be more fully insulated, they often have a lower standby heat loss than heaters do. Conversely, heaters are often cheaper than boilers, and in larger buildings many heaters can be used in parallel to provide a backup if one heater fails.

Solar

Solar water heating is a mature technology that is almost always cost-effective in sunny climates, and carries the additional benefit of reducing cooling load by shading the roof from hot summer sun. Solar systems are especially cost-effective for larger buildings.

A great variety of solar systems are available, and most can easily be integrated with a gas-fired central system so that peak loads are met even when there's no sun. Title 24 calculations can now include savings from solar systems, so those savings can be fully accounted.

Individual Water Heaters

Water heaters are available in two basic forms: with and without storage tanks. Storage tanks are used to meet peak demand (such as for showers in the morning) by providing a store of hot water. Tankless ("instantaneous") heaters must be able to meet this demand without the benefit of storage, and therefore have larger burners.

Tankless heaters currently have a higher initial cost, but have a number of advantages over storage water heaters:

- They occupy less space than storage heaters
- They do not require periodic cleaning of sediment that settles to the bottom of tanks
- They provide unlimited hot water
- Tankless heaters are more modular, so parts can be replaced more easily
- They typically have a higher energy factor (around 0.80 instead of 0.65), because the heater supplies water only when needed.

Things to Consider When Designing a System

There are several technologies and methods that can be used to improve the level of service, reliability, and efficiency of DHW systems in a cost-effective way. This handbook provides an introduction to the principles, and guidance on which options are likely to be best suited to multifamily buildings.

All Systems

This section describes technologies that can improve both central systems and individual systems.

Condensing versus Non-Condensing

Natural gas contains a certain amount of water. Conventional non-condensing heaters and boilers waste a lot of energy in converting this water into steam which is then allowed to escape with the flue gases. Condensing heater and boilers recapture this lost energy by cooling the flue gases to the point where the steam recondenses and gives up its energy. They can produce 20-30% more hot water for a given amount of natural gas.

Modern condensing heaters and boilers have a separate chamber in which the flue gases condense--this solves the reliability problems that plagued early condensing boilers. Condensing boilers are now required by law in many European countries, and are increasingly popular in the U.S.

Condensing heaters and boilers are especially efficient under part load, and part-load is the most common operating condition for DHW in multifamily buildings.

Check your local code to find out what type of draining is required for the condensate produced by condensing heaters and boilers.

Forced (or Induced) Venting versus Atmospheric Venting

More efficient heating and more reliable operation can be achieved by controlling the flow of air into and out of the combustion chamber. In "forced" or "induced" draft heaters, air is either pushed ("forced") or pulled ("induced") through the flue by a fan. These systems also reduce standby losses by reducing air flow through the flue.

Conventional heaters use "atmospheric ventilation", i.e. there is no fan and they allow the hot, buoyant flue gases to rise through a vertical chimney, which draws fresh air into the combustion chamber.

In many multifamily buildings, confined vertical space often means that vertical chimneys cannot be fitted, and so side venting is required. Side venting always requires a forced or induced draft because the short vertical chimney height does not create sufficient buoyancy to induce the required air flow rate.

Note that all condensing heater and boilers have forced or induced venting.

Pipe Insulation

Pipe insulation is a very low cost measure that provides hot water more quickly at a higher and more consistent temperature, and saves energy. A length of uninsulated pipe can result in a plug of cold water being carried into a dwelling unit, resulting in tenant complaints and long wait-times for hot water. It is therefore important to insulate the whole length of hot water piping in a building, whether it is served by a trunk-and-branch system or by a recirculation loop.

Title 24 sets out the required insulation levels (R-values) according to the diameter of the pipe. Adding thicker insulation beyond these levels will not usually improve performance significantly.

Drainwater Heat Recovery

Free heat can be recovered from hot water as it flows away down the drain. This heat can then be used to pre-heat cold water before it flows into a boiler, laundry facility or shower. Many drainwater heat recovery systems are made only of copper pipe, have no moving parts, and require no maintenance.

Simple "non-storage" drainwater heat recovery systems have a 3'-6' spiral copper heat exchanger that replaces a vertical section of the drain water pipe. As warm water flows down the pipe, incoming cold water flows up through the heat exchanger, so it is preheated before being used. If the drain water piping is designed so that several dwelling units feed into the same heat exchanger, this can be a cost-effective solution in multifamily buildings, and can be used to preheat cold water for showers or to preheat cold water entering the heater or boiler.

Drainwater heat recovery can also be effective in laundry facilities where many washing machines are being used simultaneously.

Additional energy can be saved by *storage* heat recovery systems, which store the hot waste water for a period of time and use a heat pump or heat exchanger to preheat the cold water entering a heater or boiler. These systems are effective in locations where a large amount of hot wastewater is generated, for instance multifamily buildings or laundries.

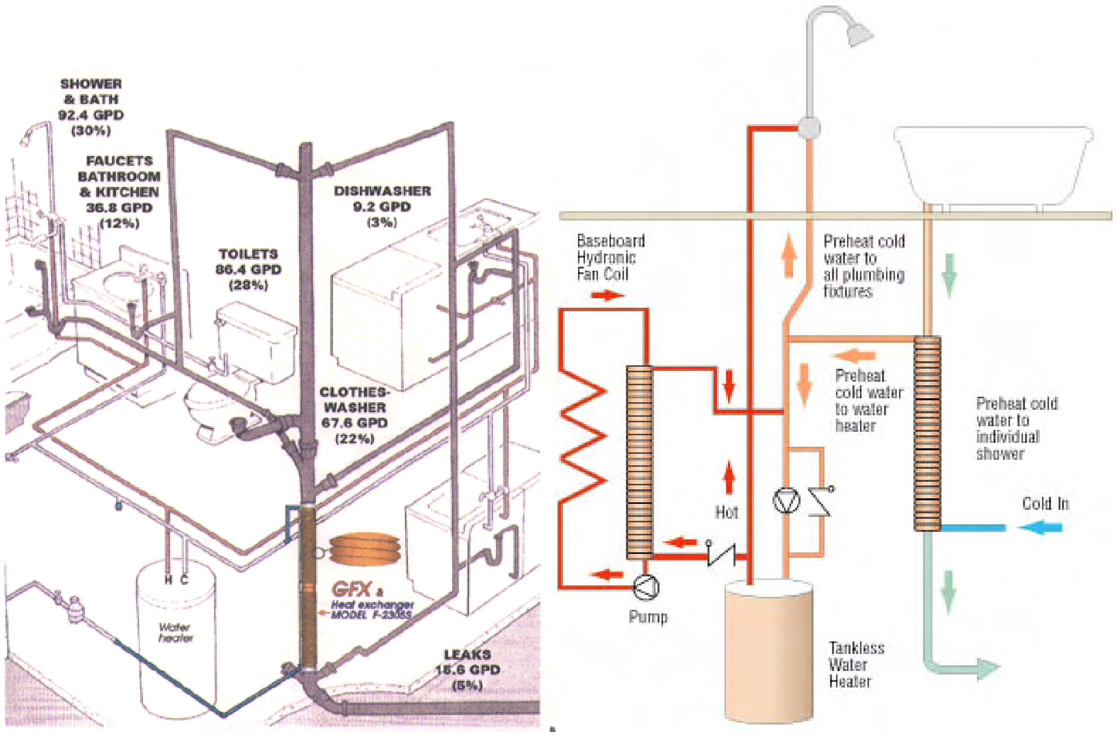


Figure 7: Diagram of Heat Recovery System for Pre-heating of Cold Water and Space Heating[1]

Heat Pump Water Heaters

Heat pump water heaters (HPWHs) function like air-conditioners—transferring heat from one place to another. They take heat from the air inside the dwelling unit and transfer it into the hot water storage tank. They are more than twice as efficient as conventional electric resistance heaters.

HPWHs provide an additional benefit in climates with long hot summers--they provide a significant amount of free cooling. Conversely, in the winter, the cool air they produce must be allowed to escape from the dwelling unit, otherwise heating costs would be increased. It is therefore best to use HPWHs only in the summer, or to have a suitable location such as a buffer space that can be ventilated separately from the rest of the dwelling unit.

In individual systems, HPWHs can be used to supplement a storage water heater, or can be the only source of hot water. If used as the only source of hot water, a larger storage tank may be required to meet peak demands, since HPWHs typically have a low output.

[1] http://gfxtechnology.com/install-400.gif, http://gfxtechnology.com/combi.html

As part of a central system, larger HPWHs can be used to provide a constant level of background water heating while also providing free cooling to common areas of the building. As a supplemental source of hot water, a HPWH may be run only during the summer when space cooling is required

Individual Systems

Heat Traps

Heat traps prevent hot water from the storage tank from leaking out along the supply pipes when there is no demand. They are simply loops of pipe that use the principle of convection to trap hot water in the top of the loop and reduce the flow. They are maintenance-free and do not wear out, and are always cost-effective.

Many storage water heaters come with heat traps already fitted, while others require the heat traps to be fitted when the heater is installed. Some heaters assume the presence of heat traps in their *energy factor* (EF) values, so check whether the heater comes with traps fitted. Note that they may be fitted inside the heater and may not be visible.

Most separate storage tanks (for use with boilers) require heat traps to be added at installation.

Central Systems

Sizing of Central Systems

Central systems must be able to meet the likely peak demand for hot water. This peak demand usually exceeds the heat output of the gas burner in the heater or boiler, so a storage tank is used to make up the difference at peak times.

Designers must therefore choose a combination of burner output and storage tank capacity to meet the predicted demand; guidance can be found in the ASHRAE Applications Manual. A system with a *low*-output burner and a *large* tank will behave much like an individual storage heater, whereas a system with a *high*-output burner and a *small* tank will behave more like a tankless heater.

Larger buildings typically have more predictable hot water demand than smaller buildings. This is because unpredictable demand is often caused by a handful of tenants who work unusual hours or whose behavior differs from other tenants. In a large building their influence is small in comparison to the total hot water demand, whereas in a small building they may greatly influence the overall demand profile.

Therefore, larger buildings don't need as much storage capacity as smaller buildings.

Recirculation Loop Controls

Recirculation loops don't need to run constantly to provide a high level of service to tenants. Constant recirculation wastes a lot of energy and increases maintenance costs for the pump and copper piping.

Title 24 prescribes controls that automatically switch off the recirculation pump during times when hot water is not required. This requirement can minimally be met by providing timeclock control of the recirculation pump, but additional controls can be added that save more energy, improve the level of service to tenants, and provide feedback to the building manager. Two common types of system are described below.

Both these systems can be fitted with remote telemetry that allows the system to report faults and energy performance to the building manager.

Demand Controls

The recirculation pump is controlled so that it only circulates water in the loop when there is demand from tenants *and* the loop water is below a threshold temperature. This minimizes the amount of time for which the pump is switched on, and also minimizes heat loss from water in the loop. These systems are especially effective in small buildings where there are likely to be long periods with no hot water demand.

Temperature Modulation Controls

The temperature of the water in the storage tank is modulated so that the temperature is high during periods of peak demand, but is set back to a lower temperature during periods of low demand (for instance, overnight). This type of system may be especially suited to the detection of faults such as leaks, crossover flows, and pump failure.

Point-of-Use Heaters

Instantaneous heaters at the point of use are a good solution in locations that have intermittent hot water use and are a long way from the central heater or boiler. A typical example is a bathroom in a common area of the building. Instantaneous heaters reduce the length of the recirculation loop or can remove the need for a separate hot water branch, thereby saving installation cost as well as energy.

Specifications

Energy performance specifications allow designers and purchasers to directly compare the energy performance of different products. Products that have higher efficiencies will usually have lower fuel costs.

Different energy performance specifications are used for water heaters than for boilers. This is because storage water heaters can be tested as a complete package, whereas central systems can mix and match components. Water heaters are typically described by an *energy factor* (EF) while boilers are described by *thermal efficiency* or by *annual fuel utilization efficiency* (AFUE).

It is *not* possible to directly compare EF values with thermal efficiency or AFUE values, because they are calculated using different test procedures. However, energy modeling software allows direct comparisons to be made, in terms of annual Btu consumption, for the purposes of code and program compliance modeling.

Both EF and AFUE are determined by U.S. Department of Energy test procedures and can be used in conjunction with local fuel costs to estimate the annual cost of operation.

Water Heaters

Energy Factor

The standard way of specifying the energy performance of a water heater (both storage heaters and tankless heaters) is the *energy factor* (EF). EF is a measure of efficiency for a typical pattern of annual use, and includes combustion efficiency, standby losses, and cycling losses. Title 24 uses EF to rate the efficiency of water heaters. Figure 8 shows the energy factors associated with several water heater types.

Water Heater Type	Storage	Instantaneous
Non-condensing, atmospheric draft	0.60-0.63	0.70-0.80
Non-condensing, forced draft, electronic ignition	0.64-0.65	0.75-0.85
Condensing, forced draft, electronic ignition	0.85-0.95*	Not available
Heat pump water heater	2-2.5	Not applicable

Figure 8: Energy Factor (EF) Ranges by Water Heater Type

First Hour Rating

First hour rating quantifies the peak demand that can be met by a water heater. It is calculated as the amount of hot water that the water heater can supply in the first 60 minutes of operation. It is a combination of how much water is stored in the water heater and how quickly it can reheat to the temperature set on the thermostat.

Boilers

For boilers, energy performance is usually specified by either the *thermal efficiency* or by the *annual fuel utilization efficiency* (AFUE). AFUE is similar to EF because it defines a typical pattern of use and measures the performance of the boiler over that cycle. *Thermal efficiency* measures only the efficiency of the boiler during steady-state operation. Title 24 requires a minimum 0.75 thermal efficiency for boilers, for prescriptive compliance (table 112F, 2005).

Some boiler manufacturers use alternative methods to measure efficiency. When comparing products, ensure that the same method is being used for both.

Boiler Type	AFUE
Non-condensing atmospheric draft	0.80-0.82
Non-condensing forced draft	0.82-0.86
Condensing, forced draft	0.92-0.98*

Figure 9: Thermal Efficiency (AFUE) by Boiler Type

* Thermal efficiency varies—condensing units are more efficient in low-temperature applications such as DHW.

Lighting

Residential Lighting and Title 24

As our residential buildings become more energy efficient the field of opportunities for further energy efficiency through changes in building standards begins to shrink. The "low hanging fruit" have all been picked and more effort, and sometimes complexity, is needed to squeeze out the additional savings. Residential lighting is somewhat of an exception in this regard with Title 24 only relatively recently requiring high efficacy lighting in kitchens and bathrooms.

With the latest changes in the 2005 Building Energy Efficiency the scope of the lighting requirements for residential buildings has been simplified and expanded. Now, all residential lighting is covered by the standards and outdoor lighting attached to the building has been added. In multifamily buildings, parking lots for eight or more vehicles are also included, and all common areas must have high efficacy lighting or be controlled by an occupant sensor. Furthermore, recessed lighting is now required to be certified as air-tight in addition to the existing requirement for contact with insulation.

All of the Title 24 lighting standards are mandatory measures. Unlike the standards for heating, cooling and water heating, there are no options for using the performance approach, and no opportunities for trade-offs with other measures. The standards regulate the quality of lighting, measured by its efficiency and quality of construction, but do not regulate the quantity of lighting.

The main effect of the standards is to encourage fluorescent lighting technology over traditional incandescent lighting. This is accomplished by setting a minimum requirement for the amount of light a fixture produces divided by the amount of electricity it consumes. Compact fluorescent lighting uses about one fourth the energy of an incandescent bulb, with the same light output, and lasts about 10 times longer. Although the standards do not rule out other technologies, like LED lighting, fluorescents is the most cost effective lighting technology that can currently meet the standards.

With the exception of kitchen lighting, there are also alternate ways to meet the standards by using certain controls, such as occupancy sensors and dimmers, in conjunction with incandescent lighting. The energy efficiency benefits of dimming incandescent lighting are not straightforward, since a bulb dimmed to 25% of its light output still uses half the energy, resulting in decreased efficiency when dimmed. One the other hand, the life expectancy of dimmed incandescent bulbs is greatly extended. CFLs do not lose efficiency when dimmed, which makes them a smart choice, but they must be carefully selected to match the dimming control. Occupancy sensors must be of the “manual-on/auto-off” type, where lighting must be manually turned on by a person and then automatically turned off when the space is vacant.

Residential Kitchens

Residential kitchen lighting accounts for 25% of total lighting costs in a typical California home, so is a prime target for improving energy efficiency. Multifamily housing in the affordable housing sector typically has linear fluorescent lighting in the kitchen. This is a well developed technology with a variety of reliable, energy efficient products to choose from. In other multifamily sectors, such as condominiums and townhomes, recessed lighting in kitchens is more typical. Traditionally, these have been incandescent fixtures, and the transition to CFL substitutes has been slow. In anticipation of the new standards, which require about 75% of the lighting in a kitchen to be high efficacy, the California Energy Commission, through its Public Interest Energy Research Program (PIER), commissioned a project to develop a low-cost, high-performance downlighting system for residential kitchens. The resulting Energy Star-rated system is far more cost effective than existing incandescent and CFL downlight alternatives, cuts energy use by 75% compared to incandescent downlighting, and provides superior illumination levels. The product is commercially available from several manufacturers.

ENERGY STAR® Appliances

ENERGY STAR® is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping us all save money and protect the environment through energy efficient products and practices. Energy Star qualified household appliances allow families to save money on energy bills and reduce greenhouse gas emissions, without sacrificing comfort and lifestyle. Results are already adding up. Americans, with the help of ENERGY STAR®, saved enough energy in 2005 alone to avoid greenhouse gas emissions equivalent to those from 23 million cars — all while saving $12 billion on their utility bills. For more information on ENERGY STAR® appliances, lighting, rebates, and specifications, visit www.energystar.gov.

Refrigerators

Refrigerators consume more energy than any other household appliance, using more than 16% of all electricity in a typical California home.[1] Replacing a refrigerator purchased before 1993 with new ENERGY STAR®, qualified refrigerator can cut refrigerator energy consumption by 50%, without sacrificing automatic ice makers and through-the-door ice dispensers. High efficiency compressors, superior insulation, and more accurate temperature and defrost mechanisms increase the performance of ENERGY STAR®, qualified refrigerators. Top freezer models generally yield an additional 7-13% energy savings over side by side models.

Additional ways to save energy with any refrigerator include positioning the refrigerator away from any heat source, such as a dishwasher or oven, and out of direct sunlight, and leaving space between the refrigerator and wall or cabinets to allow air to circulate around the condenser coils. Also make certain the refrigerator and freezer doors seal tightly. Set refrigerator temperature between 35 and 38 degrees Fahrenheit and the freezer temperature at 0 degrees.

Dishwashers

Heating the water for a dishwasher consumes 80 to 90% of the energy needed to run the dishwasher. To improve energy efficiency, reducing the amount of water used (the volume needing to be heated) is most effective. Replacing a dishwasher ten years old or older with an ENERGY STAR® qualified appliance can cut water use significantly.[2]

Clothes Washers

Replacing old clothes washers can reduce both energy and water bills. New ENERGY STAR® qualified clothes washers require 50% less energy for operation than new conventional models.[3] In addition to energy savings, ENERGY STAR® model clothes washers use 40% less water than standard washers and extract more water from the clothes in the spin cycle, which reduces clothes drying time and saves additional energy. Whether ENERGY STAR® or not, the Modified Energy Factor (MEF) listed on each clothes washer will indicate the amount of energy used throughout the washing process. The higher the MEF, the more efficient the washer is.

[1] http://www.consumerenergycenter.org/home/appliances/refrigerators.html

[2] http://www.energystar.gov/index.cfm?c=dishwash.pr_dishwashers

[3] http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers

Chapter 4:

Third-Party Verification – Home Energy Rating Services (HERS)

Chapter 4 discusses the role of the HERS rater and third-party verification of energy efficiency measure installation. The chapter describes how quality assurance provided by a HERS inspection can qualify a project for incentives, as well as reduce call backs to the builder, owner and building manager. Information on finding a HERS rater can also be found in this chapter.

THIRD-PARTY VERIFICATION – HOME ENERGY RATING SYSTEM (HERS)

Introduction to HERS Ratings

HERS ratings were established to measure the energy efficiency in residential buildings and to ensure compliance with Building Energy Standards addressed in Title 24 Part 6. Certain measures within the Standards require field verification to confirm proper installation of energy-efficient systems. HERS raters are certified by the California Energy Commission to conduct third-party inspections of measures for verification of system installation and quality assurance.

HERS Providers and Services

The California Certified Energy Rating and Testing Services (CalCERTS), California Building Performance Contractors Association (CBPCA), and the California Home Energy Efficiency Rating System (CHEERS) have been approved by the Commission as HERS providers to oversee HERS raters providing Title 24 field verification and diagnostic testing. HERS rater inspections may be required during several stages of construction.

- Pre-upgrade HERS inspections and reports allow raters to establish benchmarks from which improvements can be measured.
- Some installments, such as blown insulation, require a HERS rater be present to witness and verify proper installation.
- Final HERS inspections and reports are completed post-construction and confirm that all proposed installations have been adequately fulfilled. Until this field inspection has been completed, all stickers and information regarding appliance data and specifications must remain on installed units. In addition, a copy of the CF-6R for each dwelling unit will be required by the HERS rater. A CF-4R must be signed by the HERS rater and submitted to the building department to approve each dwelling unit for occupancy.

Once HERS field inspections have been conducted, the reports are uploaded onto a registry, for easy access and exchange of information. Often HERS raters double as or work in conjunction with Energy Consultants. Energy consultants can take the information from the HERS inspection report and enter it into a building energy model to analyze projected energy savings and suggest additional improvements.

The Value of a HERS Rating

Quality Assurance

Each HERS Rater is must attend training sessions and pass an exam to be eligible to conduct HERS inspections in each of the following areas: existing homes, new construction, and non-residential buildings. These trainings are provided by three California Energy Commission approved organizations. Once certified, HERS raters can reliably verify that energy efficient building materials and systems have been properly installed to meet expected efficiency levels, as well as verifying that the building meets or exceeds building energy standards. A HERS rater provides quality assurance, making sure the owner or tenant achieves expected energy savings.

Incentive and Rebate Programs

HERS inspection reports often validate eligibility and/or qualification of particular projects for incentive and rebate programs. In most cases, utility companies require field verification by a HERS rater for enrollment in these programs. The HERS rater may work in conjunction with an Energy Consultant to calculate energy savings and confirm that new construction or building improvements meet or exceed the required energy savings for program eligibility.

For more information on incentive and rebate programs you may be eligible for, please visit www.sce.com or www.fypower.com.

Finding a HERS Rater

The most efficient way to find a HERS rater is to go through one of three California Energy Commission approved providers.

- CalCERTS - California Certified Energy Rating and Testing Services

  https://www.calcerts.com

- CBPCA - California Building Performance Contractors Association

  http://www.cbpca.org/

- CHEERS - California Home Energy Efficiency Rating System

  http://www.cheers.org

Figure 10 below is a sample request for bid for HERS provider services.

COMPANY NAME

DATE

HERS Inspector Name	**California State**	**California Home Energy**
Street Address	**Contractors License**	**Efficiency Rating System**
City, State, Zip	**#**	**HERS #**

T-24 & Energy Star Testing & Verification Proposal
Builder:
Project:

Bldg Type	**Web Site Setup $100**	**Web Site Unit Fee $20**		**Ducts Conditioned $20**	**Space**	**TXV $20**	**E Star $180**	**Building Cost**	**Average Cost Per Unit**
D	3	288		42			42	$14,460.00	$50.21

If bid is awarded, all scheduling is the responsibility of the project superintendant.
We will give a Builder orientation to the project super on site as to the necessary flow of inspections to secure Utility Rebates $$.
It is the Buildrers responsibility to submit the project to the sponsoring Utility to be posted on the CHEERS Registry for the Rater to view and be named "Rater of record".

All related trades need to be aware of the credits taken to achieve Energy Star status.

Approved By: ____________ Date: ____________

Title: ____________

Total Project Cost, Invoice Amount = **$14,460.00**

Total Buildings =	**3**	**Total Project Average Per Building =**	**$4,820.00**
Total Units =	**288**	**Total Project Average Per Unit =**	**$50.21**

Figure 10: Sample HERS Bid

AFFORDABLE HOUSING ENERGY EFFICIENCY ALLIANCE

Chapter 5:

Maintenance and Operations

Chapter 5 stresses the important of maintaining buildings and systems to keep them operating efficiently and provides tips for ensuring that building managers and tenants know how equipment should be operated for highest efficiency. This chapter is geared toward developers and building managers.

MAINTENANCE AND OPERATIONS

Responsibility

The building operations and maintenance department of a development connects building, owner, and tenant through responsibility for both the safety and health of the residents and the financial and environmental performance of the building. The O&M department is essential in ensuring a building's energy efficiency through frequent cleaning and upkeep of buildings, grounds, and equipment. Regular testing and maintenance of energy-using systems will reduce the probability of breakdowns, air quality problems, and inefficiencies.

Education and Procedures

Education of O&M staff and tenants on the proper building and equipment operation is necessary to make sure the building functions as it was intended to and to realize a building's full energy saving potential.

Building Maintenance Staff

- Proper education, training, and policy implementation among maintenance staff will lengthen the life of building systems and increase building health.
- Tips for assuring buildings operate efficiently:
- Train O&M staff in the function, operation, and repair of each building service system
- Keep all manufacturers instructions and manuals in a location easily accessible to maintenance staff.
- Be sure O&M are in touch with residents and understand their daily needs
- Keep record log of all checks and procedures
- Offer feedback on building performance and hold maintenance staff accountable

Tenant Educational Measures

Some energy efficiency measures require tenant understanding to achieve best results. For example, programmable thermostats can greatly reduce energy use if programmed for the HVAC system to operate only when the conditioned space is occupied. The programmability of the thermostat is useless if the tenant does not understand how to operate it. Another more basic example is refrigerator temperature setting. If the tenant is able to manipulate refrigerator and freezer settings, being informed of appropriate temperatures for energy efficiency is important. If tenants do not understand the measures that have been taken to reduce energy consumption, they may not realize expected or potential savings.

Tips for educating tenants:

- Create informational videos with climate control instructions
- Give residents copies of service and warranty manuals
- Involve tenants in building maintenance

Specific Maintenance Measures for Building Energy Efficiency

Building Envelope

Maintaining the building envelope seal is as important as maintaining mechanical systems and will increase their effectiveness. Properly sized equipment will have to work overtime to compensate for cracks and gaps in the building envelope. To keep building envelopes well sealed, caulk any openings or cracks, repair holes, and replace cracked or broken windows. Also replace or repair weatherstripping around windows and doors, when the seal is no longer tight. Removal of window air conditioning units in winter and practical use of operational shades and awnings in warmer months will also reduce heat loss and heat gain in the building.

Heating and Cooling

Heating and cooling systems require additional attention as outdoor temperature and sun angles shift, and should therefore be adjusted seasonally. Be sure to turn off pilot lights in summer and to adjust thermostats in occupied areas to avoid unnecessary energy use. Check for duct leakage, lubricate equipment, balance steam distribution, and make certain vents and registers remain clean and unobstructed to ensure efficient operation. Keeping system parts, such as burners, filters, heat exchangers, boilers, coils and blowers, clean and free of build-up is also essential to the effectiveness of these systems. Regular attention will both reduce energy consumption and prolong equipment life. The maintenance of HVAC systems should be carried out in conjunction with repairs to the building envelope for maximum energy savings.

Domestic Hot Water

Domestic Hot Water systems require occasional cleaning and sealing to maintain efficiency. Regular maintenance should include repair of any leaks and insulation of exposed pipes. Also flush tanks, clean and adjust burners, and remove any buildup within the system. Lower water temperature to about 120 degrees and reduce water pressure to avoid excessive energy and water use.

Lighting

Maintain lighting efficiency by keeping fixtures clean and energy efficient bulbs on hand for replacement. Additionally, keeping walls clean and well painted brightens rooms and helps maintain lighting efficiency. Elimination of unnecessary lamps by removal, or partial use by timer, will also keep energy use to a minimum.

Other Measures

- Check temperature settings and door seals on refrigerators
- Reduce ventilation and exhausted air rates
- Calibrate meters to check accuracy

For more information on building operation and maintenance tips and procedures, please visit http://www.hud.gov/offices/pih/programs/ph/phecc/O&M.cfm

AFFORDABLE HOUSING ENERGY
EFFICIENCY ALLIANCE

Chapter 6:

Funding Energy Efficiency

Chapter 6 suggests possible funding sources for energy efficiency in housing projects. The chapter also explains holistic cost modeling, a good tool for determining the lifecycle cost of a building or project.

FUNDING ENERGY EFFICIENCY

In addition to utility/ratepayer-funded incentive and design assistance programs, many affordable housing funding sources encourage energy efficiency in their financing mechanisms. Whether it be a reward or a minimum requirement, public funding is shifting toward energy efficiency through loans and incentives; grants or seed money; and state-specific programs that fund energy efficiency. A summary of such financing mechanisms is below.

Tax Credit Allocation Committee (TCAC) Energy Efficiency Requirements

The Tax Credit Allocation Committee (TCAC) funding encourages and rewards projects that incorporate energy efficiency by requiring minimum energy efficiency construction standards, awarding competitive points for energy efficiency, and will consider a basis boost for projects that incorporate on-site generation.

In California, the demand for housing tax credit has recently exceeded the supply by approximately two to one (2:1). This means many good, worthwhile projects are unable to be awarded credit. It also means a rather elaborate set of legal and regulatory rules for determining what projects are awarded credit has been established. State and federal law require at least 10% of the annual credit be awarded to projects that materially involve nonprofits. State law also requires 20% of the annual credit be awarded to projects located in rural areas of the state, and 2% of the credit be set-aside for “Small Development” projects of 20 or fewer units. Additionally, to assure geographic distribution of the tax credit, a certain percentage of credit is awarded each year to projects located in twelve geographic regions of the state.

Public policies encouraging smart growth principles, energy efficiencies, and the like are part of California’s housing tax credit program. In its competitive scoring system, points are awarded for a variety of items, ranging from serving lower income tenants, to achieving energy efficiencies, to the degree that the project will contribute to revitalization efforts in the area in which it is located.[1]

Scoring Points

For projects applying for TCAC funds, minimum construction standards require that the applicants provide a statement of their intent to utilize ENERGY STAR® qualified appliances, including but not limited to, refrigerators, dishwashers, and clothes washers shall be installed when such appliances are provided within Low-Income Units and/or in on-site community facilities unless waived by the Executive Director

Further, applicants may receive competitive points for the following:

- Sustainable building methods. (Maximum 8 points)
- A new construction or adaptive reuse project that exceeds Title 24 by at least 10%. For a rehabilitation project not subject to Title 24, that reduces energy use on a per square foot basis by 25%, as calculated using a methodology approved by the California Energy Commission. (4 points).
- For rehabilitation projects not subject to Title 24 requirements, use of fluorescent light fixtures for at least 75% of light fixtures, or comparable energy lighting for the project’s total lighting (including community rooms and any common space) throughout the compliance period. (2 points)

[1] http://www.treasurer.ca.gov/CTCAC/program.pdf

- Use of Energy Star rated ceiling fans in all bedrooms and living rooms; or use of a whole house fan; or use of an economizer cycle on mechanically cooled HVAC systems (2 points)
- Use of water-saving fixtures or flow restrictors in the kitchen (2gpm or less) and bathrooms (1.5 gpm or less). (1 point)
- Use of at least one high efficiency toilet (1.3 gpf) or dual-flush toilet per unit. (2 points)
- Use of material for all cabinets, countertops and shelving that is free of added formaldehyde or fully sealed on all six sides by laminates and/or a low-VOC primer or sealant (150 g/l or less). (1 point)
- Use of no-VOC interior paint (5 g/l or less). (1 point)
- Use of CRI Green-label, low-VOC carpeting and pad and low-VOC adhesives 25 g/l or less. (1 point)
- Use of bathroom fans in all bathrooms that exhaust to the outdoors and are equipped with a humidistat sensor or timer. (2 points)
- Use of formaldehyde-free insulation. (1 point)
- Use of at least one of the following recycled materials at the designated levels: a) cast-inplace concrete (20% flyash); b) carpet (25%); c) road base, fill or landscape amendments (30%). (1 point)
- Design the project to retain, infiltrate and/or treat on-site the first one-half inch of rainfall in a 24-hour period. (1 point)
- Include in the project specifications a Construction Indoor Air Quality Management plan that requires the following: a) protection of construction materials from water damage during construction; b) capping of ducts during construction; c) cleaning of ducts upon completion of construction; and d) for rehabilitation projects, implementation of a dust control plan that prevents particulates from migrating into occupied areas. (2 points)

Threshold Basis Increase

The TCAC Executive Director, in his/her sole discretion, may permit a further increase in basis limits to a maximum of 5%, where distributive energy technologies such as microturbines and/or renewable energy sources such as solar will be implemented. To obtain this increase, an applicant must submit evidence of the cost of the system and the operating cost savings to be created through the use of the technology, throughout the time of the compliance period.

Other Funding Sources

- Seek out local/national foundations that offer funding or assistance for energy efficiency and/or green building.
- Participate in utility, California Energy Commission (CEC), or other rate-payer funded programs that provide incentives and/or design or technical assistance. These programs serving SCE customers are outlined in the section titled “Energy Efficiency Programs.”
- Research the availability of funding, programs and assistance from agencies including the U.S Department of Energy, Environmental Protection Agency, and the Department of Housing and Urban Development.
- Many housing authorities either require or award points for energy efficiency in their Notice of Funding Availability (NOFA).

- Energy Efficiency-Based Utility Allowance (EEBUA) schedules — If your governing housing authority has not already adopted an Energy Efficiency-Based Utility Allowance schedule, encourage them to do so. An EEBUA provides a lower utility allowance for projects that are energy efficient, thereby increasing the amount of rent that can be collected without increasing the total housing burden to the tenant. Details of an EEBUA are described in the section: "Assistance to Housing Authorities."
- Redevelopment Agencies — Check to see if your local redevelopment agency offers funding or points for energy efficiency.

Lifecycle Costs versus First Cost

The financial benefits of using energy efficiency building strategies are best articulated through life cycle costs analysis. While first costs in some, but not all, cases exceed those of conventional construction, the life cycle cost of an energy efficient building is, in most examples, much lower than that of a conventional building. The costs of construction, operation, and maintenance are all considered in life cycle analysis to determine which approach is most economical in the long run. Generally the energy savings in an efficient building will offset any upfront costs of construction or installation.

Quantitative Costs

Quantitative costs are associated directly with monetary values. Within this category, costs can be separated into first costs (capital costs), and lifecycle costs accrued over the life of the building. Both must be considered when determining which energy efficiency measures are cost effective.

First/Capital Costs

The first step in analyzing lifecycle costs is to consider the upfront costs of the building project. These costs include, but are not limited to:

- Site acquisition
- Design/Architect
- Project management
- Construction
- Labor
- Materials
- Equipment
- Contigencies
- Costs of financing
- Commissioning and turnover
- Rebates/Incentives (subtracted from costs)

Life cycle costs

The next step is to examine the future expenditures the building will require. These costs should be significantly lower for an efficient building.

Operation Cost

- Labor
- Energy
- Water

Maintenance

- Labor
- Materials
- Equipment

Replacement

- Redesign
- Labor
- Materials
- Equipment
- Contingencies
- Financing

Tenant/Occupancy Considerations

- Productivity improvement rate
- Salary costs
- Time on market
- Capitalization rate
- Average lease rate
- Tenant retention

Calculating Overall Cost

Life cycle cost (LCC) can be calculated with the following formula:

LCC = C + O + M + R + T – S

Where:

C = Capital/first costs of the project

O = Operational costs, such as energy (present value)

M = Maintenance costs (present value)

R = Replacement costs (present value)

T = Tenant/Occupancy Considerations (present value)

S = Salvage value of systems/materials at end of life cycle period (present value)

It is important that the present value, with consideration of inflation, etc, is calculated for each cost. This makes costs time dependent and will yield more accurate estimates, particularly when comparing alternatives. To calculate present value, use the following formulas:

For one time costs **PV = A(1/(1+d)^t)**

For reoccurring costs **PV = A((((1+d)^t)-1)/(d((1+d)^t)))**

Where:

PV = Present Value

A = Amount of Cost

d = Real Discount Rate (interest rate, generally 2%)

t = time (in years)

Figure 11 is a spreadsheet example of how lifecycle cost can be calculated. The costs entered here are hypothetical and not an accurate representation of true costs.

Year	Costs				Present Worth Factor	(Sum of Costs x Present Worth Factor) Present Worth of Cummulative Costs
	First Costs/ Replacement Costs	Operational Costs	Maintenance Costs	Tenant/ Occupant Consideration		
2007	$963,000.00	$105,000.00	$21,000.00	$21,745.00	0.98	$1,088,530.10
2008		$107,625.00	$25,640.00	$22,289.00	0.96	$149,331.84
2009		$110,316.00	$25,430.00	$22,846.00	0.94	$149,076.48
2010		$113,074.00	$28,453.33	$23,394.33	0.92	$151,727.93
2011		$115,900.00	$30,668.33	$23,944.83	0.90	$153,461.85
2012		$118,557.70	$32,883.33	$24,495.33	0.88	$154,824.00
2013		$121,282.60	$35,098.33	$25,045.83	0.86	$156,027.02
2014		$124,007.50	$37,313.33	$25,596.33	0.84	$157,010.42
2015		$126,732.40	$39,528.33	$26,146.83	0.82	$157,774.20
2016		$129,457.30	$41,743.33	$26,697.33	0.80	$158,318.37
2017	$57,000.00	$132,182.20	$43,958.33	$27,247.83	0.78	$203,102.93
2018		$134,907.10	$46,173.33	$27,798.33	0.76	$158,747.86
2019		$137,632.00	$48,388.33	$28,348.83	0.74	$158,633.18
2020		$140,356.90	$50,603.33	$28,899.33	0.72	$158,298.89
2021		$143,081.80	$52,818.33	$29,449.83	0.70	$157,744.98
2022		$145,806.70	$55,033.33	$30,000.33	0.68	$156,971.45
2023		$148,531.60	$57,248.33	$30,550.83	0.66	$155,978.31
2024		$151,256.50	$59,463.33	$31,101.33	0.64	$154,765.55
2025		$153,981.40	$61,678.33	$31,651.83	0.62	$153,333.17
2026	$34,000.00	$156,706.30	$63,893.33	$32,202.33	0.60	$172,081.18
2027		$159,431.20	$66,108.33	$32,752.83	0.58	$149,809.57
2028		$162,156.10	$68,323.33	$33,303.33	0.56	$147,718.35
2029		$164,881.00	$70,538.33	$33,853.83	0.54	$145,407.51
2030		$167,605.90	$72,753.33	$34,404.33	0.52	$142,877.05
2031		$170,330.80	$74,968.33	$34,954.83	0.50	$140,126.98
2032		$173,055.70	$77,183.33	$35,505.33	0.48	$137,157.30
2033		$175,780.60	$79,398.33	$36,055.83	0.46	$133,967.99
2034		$178,505.50	$81,613.33	$36,606.33	0.44	$130,559.07
2035	$62,000.00	$181,230.40	$83,828.33	$37,156.83	0.42	$152,970.54
2036		$183,955.30	$86,043.33	$37,707.33	0.40	$123,082.39
2037		$186,680.20	$88,258.33	$38,257.83	0.38	$119,014.62
Cost over 30 years	$1,116,000.00	$4,520,007.70	$1,706,033.33	$930,010.33		$5,628,431.09
Salvage Value					–	
Total Life Cycle Cost						$5,628,431.09

Figure 11: Lifecycle Cost Analysis Spreadsheet

Qualitative Costs – Holistic Cost Modeling

Beyond items that can easily be translated to a monetary value, there are other costs affecting the owner, occupant, and planet that deserve acknowledgement. Qualitative costs, both internal and external, can affect lifestyle, economics, and the natural aesthetics of our planet. While many of these costs are indirect, they do have value and will shape the future of societies and our planet. Please also consider the following:

Internal – immediate costs

- Quality of life
- Health
- Relationship with community
- Environmental image

External – born by society as a whole

- Global warming
- Ozone depletion
- Deforestation
- Resource degradation
- Ecosystem degradation
- Species/biodiversity loss
- Air and water pollution

Chapter 7:

Housing Authorities Role in Energy Efficiency

Chapter 7 explains the role of the housing agency in reducing energy consumption in affordable housing and encouraging owners and developers to consider more efficient systems. The chapter also explains energy efficiency-based utility allowance schedules, energy audits, and bulk purchasing options for ENERGY STAR appliances, all useful tools for affordable housing developers.

HOUSING AGENCIES' ROLE IN ENERGY EFFICIENCY

Housing Authorities

Housing authorities play a key role in promoting energy efficiency in affordable housing. Housing authorities develop and govern utility allowances and can encourage energy efficiency by offering an Energy Efficiency-Based Utility Allowance (EEBUA) schedule. Through the AHEEA program, housing authorities that serve projects in SCE's service territory can qualify for assistance in developing, adopting, and implementing an EEBUA through July 31, 2008.

The concept of an EEBUA is described below along with a hypothetical case study illustrating the financial impact an EEBUA can have on a project's cash flow.

Energy Efficiency-Based Utility Allowance Schedule

One policy that many PHAs are adopting in California, Energy Efficiency-Based Utility Allowance schedules (EEBUA), corrects a long-standing, split-incentive problem by bringing utility allowances more in line with utility costs for projects that are energy efficient: new construction projects that are 15% above the energy code, and rehab projects with a 20% improvement over existing conditions. The rationale for this schedule is that developers who build energy efficient affordable housing (or owners who improve the efficiency of existing properties), to reduce utility costs to the tenants, should be allowed to reap some (not all) of the economic benefit of their investments. When there is only one utility allowance schedule applied to all properties, efficient or not, owners and developers have no incentive to invest in improvements. A lower utility allowance, resulting in slightly higher rents, allows the owner to receive a portion of the money that the utility company would otherwise have collected – without increasing the tenants' total housing burden (rent plus utilities). Further, the model that is used to calculate the lowered (energy efficiency-based) utility allowance ensures that the tenant also saves. EEBUA thus provides a long-term mechanism to provide a pay-back for investments in energy efficiency. To ensure proper use of the EEBUA, housing authorities rely on a home energy rater (HERS) to verify that a project meets the policy's energy efficiency requirements. This program strives to foster good relationships between HERS raters, property owners, and housing authorities.

Establishing Rent and Utilities for Affordable Housing Projects

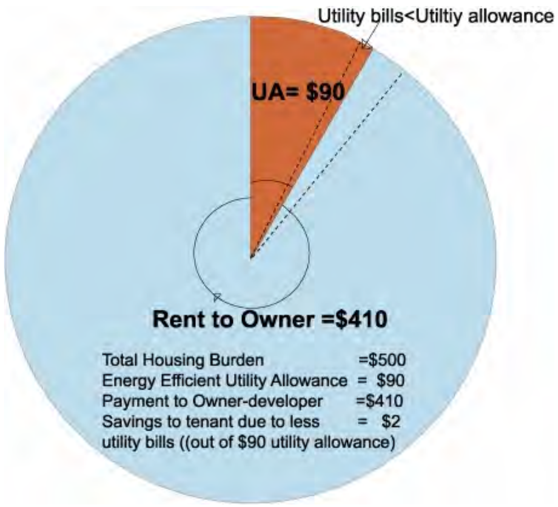
Housing authorities cap housing burden of tenants at 30% of income. The housing burden is rent plus utilities. The utility allowance is based on average billing information or an engineering analysis. Total rent is the housing burden less utilities:

Housing Burden – Utilities = Rent

Standard Utility Allowances (SUA) overestimate utility costs for efficient projects, and artificially decreases rents.

Figure 12 below shows the concept and impact of an Energy Efficiency-Based Utility Allowance on (1) housing costs to the tenant, (2) rent to the developer, and (3) utility costs. Note that the total housing burden (rent and actual utility costs) is no higher with the energy efficient unit. In the chart, the SUA (and the actual utility costs for the inefficient unit) was $100; the section within the dotted lines represents the reduction in utility COSTS that the tenant pays. The blue area between the dotted line and the EEBUA "slice" represents the reduction in utility allowance from the SUA to the EEBUA, and is what the developer gets in increased rent. The $2 difference between these (the "mini-slice within the larger EEBUA slice) is savings for the tenant.

The Impact of an Energy Efficiency-Based Utility Allowance



*Owner’s rent increases $10/mo and tenant’s **net** utility costs decrease $2/mo without changing total calculated housing burden.*

With a Standard Utility Allowance	
Total Housing Burden	$500/mo
Utility Allowance	$100/mo
Developer Rent	$400/mo
Tenant Utility Costs	$100/mo
With an Energy Efficiency-Based Utility Allowance	
Total Housing Burden	$500/mo
Utility Allowance	$ 90/mo
Developer Rent	$410/mo
Tenant Utility Costs	$ 88/mo

Figure 12: Impact of an Energy Efficiency-Base Utility Allowance Schedule

Example of the Impact of an Energy Efficiency-Based Utility Allowance on Increased Cash Flow for the Owner-Developer

The following is a case study to illustrate the impact that an Energy Efficiency-Based Utility Allowance schedule would have on a hypothetical new construction project. We use a project with 40 two-bedroom units and 12 three-bedroom units. Some of the assumptions (e.g, rents, allowable housing burdens for tenants, “other” laundry income associated with the property, etc.) were drawn from a 53-unit apartment complex in Southern California called, "Vista Verde Apartments." All but one of the units was designed to be affordable to low and very low-income families (41%-47% of median area income). The exception is the manager’s apartment. Figure 13 shows what the rents and income figures would have been had an Energy Efficiency-Based Utility Allowance schedule been in place and utilized for this project. Figure 13 also shows the difference between the rental incomes using the two schedules. Notice that the developer receives an additional $4,426 in rents per year without increasing the tenants’ total housing burden.

Unit Type	Number of Units	Monthly Housing Cost	Monthly Utility Allowance	Monthly Net Rent	Yearly Gross All Units	Total Rent Per Year
Standard Schedule						
2-BR	40	$543	$101	$442	$212,367	$274,637
3-BR	12	$543	$111	$432	$62,270	
Energy Efficiency-Based New Construction Schedule						
2-BR	40	$543	$94	$449	$215,727	$279,063
3-BR	12	$543	$104	$440	$63,336	
Annual Increased Rental Income Due to Energy Efficiency-Based Utility Allowance						**$4,426**

Figure 13: EEBUA Hypothetical Project Rental Income

Figure 13 shows the fifteen year annual net income for our hypothetical project, both with the Standard Utility Allowance schedule and with the Energy Efficiency-Based Utility Allowance schedule. The top half of the table shows the income and expense estimates from the actual application for the project proposed to the local PHA. The bottom half shows what the income and expenses would have been with an EEBUA, given the following assumptions:

- $5000 additional first costs (52 units X $96/unit) for efficiency upgrades
- Rents from the Figure 13 above
- Repayment (to the lender) of the additional $5000 over the life of the 15-year mortgage
- No additional "other" income or additional operating expense (e.g., the laundry facilities are assumed to be unchanged)

Note that in both sections of the table, years 8-12 are present in the calculations but collapsed (not shown) in the presentation, since they add little additional information. The most notable lesson of the table is that even with a larger debt service payment (more than enough to cover the additional cost of measures even without a utility program incentive), the residual cash is significantly larger. The cumulative residual cash by the 7th year is about $28,477 and $68,419 after 15 years. The developer is able to make more return on his/her investment while the tenants' total housing burden is also slightly decreased.

Mortgage Amount	$963,000	Rental Income (Tier 1)	$274,637			Other Income	$4,800
Upgrade Cost	$5,000	Rental Income (Tier 2)	$279,063			Operating Expense	$105,000
Mortgage Rate	4.50%	Vacancy Rate	5.00%	Expenses	3.50%	Rent and other Rates	2.50%

Standard Schedule										
Year	1	2	3	4	5	6	7	13	14	15
Rental Income	$274,637	$281,503	$288,541	$295,754	$303,148	$310,727	$318,495	$369,356	$378,590	$388,055
Other Income	$4,800	$4,920	$5,043	$5,169	$5,298	$5,431	$5,567	$6,455	$6,617	$6,782
Gross Income	$279,437	$286,423	$293,584	$300,923	$308,446	$316,157	$324,061	$375,812	$385,207	$394,837
Vacancy	$13,972	$14,321	$14,679	$15,046	$15,422	$15,808	$16,203	$18,791	$19,260	$19,742
Effective Gross Income	$265,465	$272,102	$278,904	$285,877	$293,024	$300,350	$307,858	$357,021	$365,947	$375,095
Operating Expense	$105,000	$107,625	$110,316	$113,074	$115,900	$118,798	$121,768	$141,213	$144,744	$148,362
Net Operating Income	$160,465	$164,477	$168,589	$172,804	$177,124	$181,552	$186,090	$215,808	$221,203	$226,733
Debt Service	$89,669	$89,669	$89,669	$89,669	$89,669	$89,669	$89,669	$89,669	$89,669	$89,669
Residual Cash	$70,797	$74,808	$78,920	$83,135	$87,455	$91,883	$96,422	$126,139	$131,535	$137,065
Cumulative Residual	$70,797	$145,605	$224,525	$307,660	$395,115	$486,998	$583,420	$1,263,823	$1,395,357	**$1,532,422**
Energy Efficiency-Based New Construction Schedule										
Year	1	2	3	4	5	6	7	13	14	15
Rental Income	$279,063	$286,040	$293,191	$300,521	$308,034	$315,735	$323,628	$375,309	$384,692	$394,309
Other Income	$4,800	$4,920	$5,043	$5,169	$5,298	$5,431	$5,567	$6,455	$6,617	$6,782
Gross Income	$283,863	$290,960	$298,234	$305,690	$313,332	$321,165	$329,194	$381,765	$391,309	$401,091
Vacancy	$14,193	$14,548	$14,912	$15,284	$15,667	$16,058	$16,460	$19,088	$19,565	$20,055
Effective Gross Income	$269,670	$276,412	$283,322	$290,405	$297,665	$305,107	$312,735	$362,676	$371,743	$381,037
Operating Expense	$105,000	$107,625	$110,316	$113,074	$115,900	$118,798	$121,768	$141,213	$144,744	$148,362
Net Operating Income	$164,670	$168,787	$173,007	$177,332	$181,765	$186,309	$190,967	$221,463	$227,000	$232,675
Debt Service	$90,134	$90,134	$90,134	$90,134	$90,134	$90,134	$90,134	$90,134	$90,134	$90,134
Residual Cash	$74,536	$78,653	$82,872	$87,198	$91,631	$96,175	$100,833	$131,329	$136,865	$142,540
Cumulative Residual	$74,536	$153,189	$236,061	$323,259	$414,890	$511,065	$611,897	$1,321,435	$1,458,300	**$1,600,841**
Yearly Difference	**$3,739**	**$7,584**	**$11,536**	**$15,599**	**$19,775**	**$24,066**	**$28,477**	**$57,612**	**$62,943**	**$68,419**

Figure 14: EEBUA Income and Expense Comparison

An essential element of this policy is reliable third-party verification of efficiency improvement before the PHA grants the lower utility allowance. In the long run, this means new markets for HERS raters, a market-based incentive for developers to recoup investments in energy efficiency, more comfortable and affordable housing for low-income tenants, and energy savings for a large portion of the state's housing stock that is often neglected.

U.S. Department of Housing and Urban Development

Although the definition of "affordability" includes both rent and utilities, people do not usually think of the impact of utility bills on low-income households. Utilities impose a disproportionate burden on the poor. For single, elderly poor and disabled persons living on Social Security Income (SSI), the average energy burden was 19 percent of SSI. In selected States—Delaware, Illinois, and Vermont—it was nearly 25 percent.

For Aid to Families with Dependent Children (AFDC), the energy burden was, on average, seven times greater than for families at median income. AFDC families paid an average of 26 percent of their income toward energy, while median income families spent an average of less than 4 percent of their income on energy.[1]

Income Level	Percent of Income for Utilities
U.S. median	4 percent
SSI elderly	19 percent
SSI (DE, IL, VT)	25 percent
AFDC	26 percent

Figure 15: Percent Income Spent on Utilities

To address energy efficiency and to help lower utility bills, HUD has adopted energy initiatives, policies and how federal government wide energy policies affect HUD programs and assistance. Below is a summary of HUD's plans and programs.

HUD Energy Action Plan 2007-2008

In April 2005, Deputy Secretary Bernardi directed HUD's Energy Task Force to begin work on a plan to extend HUD's Energy Action Plan for an additional two years. The Phase II Energy Action Plan is built on the foundation established by HUD's initial Energy Action Plan. Secretary Alphonso Jackson, while serving as HUD's Deputy Secretary, approved the initial phase of HUD's Energy Action Plan in April 2002.

Departmental Task Force

A Department-wide Energy Task Force, established by Secretary Jackson in July 2001, prepared the Energy Action Plan. The Task Force is responsible for overseeing and coordinating implementation of the Energy Action Plan. The Energy Task Force is co-chaired by the Offices of Policy Development and Research (PDandR) and Community Planning and Development (CPD), and includes the Offices of Housing, Public and Indian Housing, Field Policy and Management, and Healthy Homes and Lead Hazard Control. In June 2004, Task Force membership was broadened to include Regional Energy Coordinators designated by each Regional Office.

Phase I Achievement

Phase I of the Energy Action Plan contained 21 actions. Deputy Secretary Bernardi directed HUD's program offices to fully implement the Energy Action Plan by the end of Fiscal Year 2005 – and that has largely been accomplished. The Phase I Energy Action Plan was substantially implemented in Fiscal Year 2005. For the first time, actions promoting energy efficiency were included in HUD's Annual Performance Plan (APP) as well as in HUD's Management Plan. Every Field Office also included energy in their Field Office Management Plan.

[1] http://www.hud.gov/offices/cpd/library/energy/homelessness.cfm

Phase II Plan

The Phase II Energy Action Plan identifies actions that HUD will take to expand energy efficiency, during FY 2006 and FY 2007. It addresses several recent developments:

- *Post-Katrina energy prices.* As a result of Hurricanes Katrina and Rita (as well as other factors), the cost of oil and natural gas is significantly higher than last year. Even before Katrina and Rita, the Energy Information Agency projected that natural gas and heating oil costs would increase substantially. As of January, 2006, the EIA projected that the average family would see an increase in 2005-06 winter heating costs of 41% for natural gas and 24% for heating oil, or an average of $257 per family.

- *National Energy Policy Act of 2005.* The Energy Policy Act of 2005, passed by Congress in August 2005, includes several measures related to public housing, and requires HUD to develop an integrated strategy for energy efficiency in public and assisted housing. Subtitle D of the Act includes several HUD-related provisions, mostly affecting public housing. Section 506 Congress also enacted tax provisions that include a residential tax credit for energy efficiency in both new and existing homes.

- *Partnerships for Home Energy Efficiency*. In July, 2005 Secretary Jackson joined with Department of Energy Secretary Samuel Bodman and EPA Administrator Steven Johnson to announce the formation of a Partnership for Home Energy Efficiency. This three-agency partnership addresses the current high cost of energy as it affects the 110 million existing homes in the United States – both market rate and subsidized. The partnership will assist homeowners, renters and multifamily property owners to save at least 10 percent on their energy bills by the year 2010.

Vision for the Future

Overall Goal:

Reduce energy use in HUD's inventory of public and assisted housing and in HUD- financed housing by at least 5 percent

Public Housing

- Housing Authorities adopt Energy Star as the standard for purchasing appliances and equipment

- Newly-built HOPE VI projects have an energy performance rating equivalent to the Energy Star New Homes standard.

Community Planning and Development

- CDBG grantees adopt energy efficiency guidelines for housing rehabilitation incorporating Energy Star product and construction standards

- HOME grantees adopt energy efficiency guidelines for new construction or substantial rehabilitation incorporating Energy Star product and construction standards

FHA Single Family

- FHA increases consumer awareness of Energy Efficient Mortgages (EEMs) and the Streamlined (k) Limited Repair program

- FHA-approved Housing Counseling Agencies provide counseling and information on opportunities for residential energy efficiency

FHA Multifamily

- Assisted multifamily properties are operated and maintained in an energy efficient manner
- Section 202/811 projects meet or exceed Energy Star building energy performance standards

Newly-insured multifamily properties achieve energy efficiency performance levels equivalent to the 2003 IECC or Energy Star

PHASE II Objectives

The Phase II Energy Action Plan contains 25 actions designed to accomplish the following five objectives:

- Strengthen partnerships with federal agencies and local communities to promote Energy Star and energy efficiency in the residential sector
- Strengthen incentives or implement statutory requirements for energy efficiency through HUD programs
- Provide training, technical assistance or information on energy efficiency to homeowners, renters and property owners
- Establish measures to track progress in reducing energy consumption and ensure accountability
- Support further research and technology development

Phase II Energy Action Plan – Summary of Actions

Department-Wide

- Provide incentives for energy efficiency through HUD's competitive grant programs
- Include energy efficiency performance measures in the Annual Performance Plan
- Expand the use of Energy Star products and standards through the HUD-DOE-EPA partnerships
- Provide training or information for organizations building or rehabilitating affordable housing
- Establish energy partnerships to support HUD energy efficiency actions

Community Planning and Development

- Encourage adoption and reporting of Energy Star in HOME- and CDBG-funded projects
- Identify opportunities and assist with feasibility analysis for Combined Heat and Power Public And Indian Housing
- Base equipment purchases in public housing on Energy Star appliance or construction standards
- Build HOPE VI developments to a high level of energy efficiency
- Improve tracking and monitoring of energy efficiency in public housing
- Streamline energy performance contracting
- Promote energy conservation in federally-assisted housing on Indian Lands

Housing – Single Family

- Feature the Energy Efficient Mortgage as a priority loan product
- Provide training on how FHA single family programs can be used to promote energy efficiency
- Continue improved tracking, and evaluate performance of, Energy Efficient Mortgages

Housing – Multifamily

- Promote energy efficiency in multifamily assisted housing
- Continue HUD-DOE multifamily weatherization partnerships
- Encourage use of Energy star New Home standards in Section 202-811
- Develop possible incentives for energy efficiency through multifamily insurance programs
- Develop asset management strategies and guidance for existing multifamily properties
- Support energy efficiency training for multifamily managers and maintenance staff

Housing – Manufactured Homes

- Implement recommendations of the Industry Consensus Committee for HUD-Code Homes

Field Policy and Management

- Partner with local groups, HUD program offices and other agencies to educate HUD customers

Policy Development and Research

- Conduct energy-related policy analysis and research to support Departmental actions
- Evaluate opportunities for energy efficiency in Section 8 (utility allowances).

Office of Healthy Homes and Lead Hazard Control

- Finalize computerized assessment tool for integrated environmental and energy retrofits

Promoting Energy Efficiency in HUD Assisted Properties

Each year HUD expends over $4 billion on energy expenses. These costs currently represent over 10 percent of HUD's annual budget and appropriations and projected increases in utility costs will put additional stress on an already constrained Federal budget.

To stem rising energy costs, Region 9's Office of Multifamily Housing is undertaking an important partnership to facilitate energy efficiency improvements and reduce energy consumption in HUD-subsidized properties.

This article provides an overview of some of the key components and operational details of HUD's Multifamily Energy Efficiency Pilot initiative.

HUD Multifamily Energy Efficiency Pilot Initiative

The objective of the Multifamily Energy Efficiency Initiative is to provide energy audit and technical assistance to subsidized multifamily properties through partnerships with energy efficiency program providers to effect investment in cost effective energy efficiency measures in conjunction with ongoing FHA transactions.

Investments in energy efficiency improvements as part of planned refinancing transactions can significantly lower operating costs and, in the case of supportive housing, enable housing sponsors to enhance services to residents. Such improvements can also improve indoor environmental quality and increase resident comfort and affordability and, potentially, the viability and marketability of the project, which are important aspects that are examined in refinancing deals.

The pilot program will begin in June 2006 and initially target the FHA transactions involving: (i) requests for long-term Section 8 contract renewal and project refinancing; or (ii) refinancing requests from Section 202 project sponsors. HUD anticipates that up to 40 transactions with candidate projects will be processed annually Other HUD subsidized projects can be considered on a case-by-base basis.

Long-Term Section 8 Contract Renewals

The long-term renewal of housing assistance contracts and utility assistance payments represents a 20-year resource commitment by HUD. To encourage energy efficiency and reduce energy consumption in HUD subsidized buildings over this investment period, project sponsors requesting long-term renewal of Section 8 housing assisting contracts are requested to undertake a project energy audit and incorporate cost-effective energy efficiency measures in the project refinancing and project reserve for replacement plans.

Section 202 Refinancing

Many projects developed under HUD's 2020 program were constructed between 20 and 30 years ago with up to 40 year fixed rate mortgages carrying steep interest rates. These projects are now experiencing maturing building systems and physical dilapidation at the same time that their resident population is aging and in need of services not originally provided as part of an independent living facility. These properties are also increasing in value due to steep increases in the value of land. FHA preservation efforts permit properties to refinance 202 mortgages using FHA mortgage insurance. Energy audits will be made available to project sponsors to assist in identifying cost effective energy efficiency improvements that can be reasonably included in refinancing plans with improvements called for in Physical Condition and Needs Assessments.

HUD believes that these transactions have the necessary financing capacity and contract administration processes in place to accomplish energy retrofits capable of reducing energy consumption by 20 percent or more.

Operational Details of Multifamily Energy Efficiency Pilot Program

***Step 1*: Project Selection.** In conjunction with the Office of Multifamily Housing's *Pre-application Review Process* HUD will make an initial desk assessment of targeted multifamily projects to determine whether they are appropriate candidates for the pilot program. The assessment should consider:

- Whether the project completed an energy audit in the last 3 years and if so whether the recommended improvements were included in the project's capital plan
- General property conditions, inclusive of building age, and whether appliances and heating and cooling systems have been replaced in the last 7 years

- Project energy and water costs, including those paid by tenants, relative to other multifamily projects and whether the project has request budget adjustments because due to rising utility rates
- Whether the project sponsor is interested in incorporating energy efficiency measures as part of requested or pending FHA refinancing transactions

***Step 2*: Audit Referral.** HUD is partnering with the Pacific Gas and Electric Company (PGE) and other energy efficiency program providers to effect investments in energy efficiency measures by facilitating energy assessments of HUD assisted projects during 2006. During 2006, PGE agreed to provide up to 20 energy audits for projects selected by HUD. Similar commitments have been discussed with LADWP, Nevada Power, the Arizona Energy Office, and energy service providers funded from State public good funds.

Once a project is determined to be an appropriate candidate for the energy efficiency pilot, the project sponsor will receive contact information for energy audit providers participating in this initiative. Project sponsors may request and schedule an energy audit with a participating energy audit providers or alternatively may elect to contract for their own energy auditing services.

***Step 3*: Audit Scheduling.** Projects sponsors are responsible for making arrangements with the energy audit providers to schedule the audit.

***Step 4*: Energy Efficiency Recommendations.** Energy audit providers will provide the project sponsor and HUD with a copy of the energy audit.

Additional technical support may be available to project sponsors from energy efficiency program providers to assist in developing project energy efficiency investment strategies and plans, providing specifications for energy efficiency products and equipment, and identifying energy rebates and incentives. During 2006 HUD is working with the Heshong Mahone Group, Navigant Consulting, and Strategic Energy Innovations to assist housing sponsors in accessing energy efficiency services and financial incentives.

***Step 5*: Linking Energy To Project Plans.** AEC reviews on all projects now recommend the use of energy saving devices and measures including Energy Star standards and appliances. Owners are asked to explore energy saving devices and methods in their final plans and specifications. The prioritized list of energy efficiency measures provided by the energy audit will be a useful tool for AEC reviewers to conduct effective and systematic reviews of energy improvements.

Project sponsor are asked to include cost effective energy efficiency measures in the project's refinancing plan along with improvements identified in the *Physical Condition and Needs Assessment*. Energy efficiency measures not funded through refinancing should be addressed in project operations and *Reserve for Replacement Schedules*.

Recommended Energy Investment Criteria

What Energy Investments to Include in Capital Plans

The goal of the Multifamily Energy Efficiency Pilot program is to produce economic savings for the project sponsor and assisted households through cost-effective energy efficiency investments.

Typically an energy investment plan is created after an energy audit identifies areas for potential improvement. A project's investment strategy should reflect the financial criteria that the sponsor's organization usually applies to capital expenditures. Typically, this entails targeting investments that produce energy savings or cash flows large enough to pay back investments within a specified time frame.

Depending on the improvements recommended by the energy audit, energy investments can be made through operations, replacement reserves, of financing transactions. For this initiative, HUD requests project sponsors seeking long-term renewal of Section 8 housing assisting contracts to include cost-effective energy investments with pay-back periods of 5 year or less as part of project's refinancing transactions or alternatively in conjunction with project operating or reserve for replacement plans. Energy Audits will list cost effective energy efficiency measures by payback period, which takes account of estimated reductions to energy consumption, the added cost of energy efficiency improvements, and energy rates.

Frequently, short payback measures can be combined with longer payback measures (10 years or more) in order to increase the number of measures that can be cost-effectively included in a project. Projects that combine short- and long-term paybacks are recommended to avoid "cream-skimming" (implementing only those measures that are highly cost effective and have quick paybacks) at the expense of other worthwhile measures.

Cost effective measures with longer payback periods should also be included in the investment plan if the existing equipment is nearing the end of its useful life or the equipment has had a catastrophic failure. In such cases, the equipment will require a replacement whether or not the energy audit determines that the measure has a payback period fitting the sponsor's investment criteria. Furthermore, the energy analysis for such items should consider the installed costs (i.e., first cost) as sunk.

Reserve for Replacement Plan - Energy Efficiency Schedule.

Measures not included in project refinancing plan should be addressed as part of project operations or included in project's the 10-year *Reserves for Replacement plan*, unless the measures are not cost effective. Accordingly, the reserve analysis should reflect identified energy efficiency needs.

The Energy Efficiency Schedule should be presented independently from other reserve schedules for ease of tracking. The Energy Efficiency schedule should be reviewed every 5-years to ensure that investments in energy efficiency measures are made on schedule and the properties continue to make cost effective operational improvements to lower project and household energy consumption. Minimally, this may require energy walk through assessments, which can be performed by site managers.

Other Factors Influencing Energy Investment Decision

Some factors related to building heating, air conditioning, and lighting system design are not considered as part of typical energy audits. Examples include avoided costs, such as reductions to maintenance costs resulting from replacing existing equipment with more reliable, durable, and energy efficient equipment. Additionally, intangible benefits such as the comfort of residents and ancillary societal benefits (e.g., reduced carbon emissions, improved indoor air quality) can result from reduced energy use. Project sponsors may include avoided costs and other benefits in the analysis if such costs and benefits can be properly documented.

ENERGYSTAR® Online Bulk Purchasing Initiative

In 2005, ENERGY STAR® saved 150 billion kilowatt hours (kWh),

or 4 percent of total 2005 electricity demand and about $12 billion on utility bills. In addition, ENERGY STAR helped avoid 28,000 megawatts (MW) of peak power, equivalent to the generation capacity of more than 50 new power plants.

ENERGY STAR has become the trusted national symbol for energy efficiency. ENERGY STAR labeled products must meet strict energy efficiency criteria set by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA). Because they use less energy, these products reduce energy costs and help protect the environment by causing fewer harmful emissions from power plants.

EPA reports that by using ENERGY STAR labeled products, households can reduce their energy use and save up to 30 percent, or $450 annually on average, on their utility bills (currently averaging around $1,500 per year).

ENERGY STAR qualified products have been widely used in market rate housing but because of first cost considerations the purchase of ENERGY STAR products have not been fully incorporated into affordable housing developments and property management strategies.

In recent years, the cost differential between ENERGY STAR labeled appliances and less energy efficient appliances has significantly decreased. The simple payback period or time needed to recoup the added cost for ENERGY STAR appliances from energy savings is now less than 5 years for most products. And because these products are more reliable and durable than other appliances, from a life cycle perspective the purchase of ENERGY STAR products can be very cost effective and increase in value as energy and labor costs increase.

ENERGY STAR Bulk Purchasing

To mitigate remaining costs differences and assist affordable housing sponsors gain access to the widest possible range of ENERGY STAR products, DOE and the U.S. Department of Housing and Urban Development (HUD) have collaborated on the development of a web-based tool to simplify the process for obtaining ENERGY STAR product price information and, if desired, initiating purchases of ENERGY STAR products.

The ENERGY STAR Bulk Purchasing Tool provides affordable housing sponsors with on-line access to manufacturers and suppliers of ENERGY STAR products. The manufacturers and suppliers participating in this initiative recognize the potential market for ENERGY STAR within the affordable housing sector and pursuant to agreements with DOE participating manufacturers and suppliers of ENERGY STAR products have agreed to offer bulk purchase pricing. Moreover because the number of participating manufacturers and suppliers of ENERGY STAR products is not restricted, the quotes provided will be competitive.

In short, the ENERGY STAR Bulk Purchasing Tool offers public housing authorities, affordable housing sponsors, and other public and community-based organizations with a one-stop site to access a broad possible menu of ENERGY STAR products and equipment at competitive bulk purchase pricing. Use of the web-based on-line program does not require special software; only access to the internet.

The ENERGY STAR Bulk Purchasing Tool is accessible at: www.bulkpurchase.net. The web site is user-friendly and easy to navigate.

Overview of the Online Bulk Purchase Process

- Purchasers choose an ENERGY STAR product type.
- Purchasers complete and submit the product-specific questionnaire.
- Participating ENERGY STAR partner suppliers will be notified via email.
- Suppliers will have the opportunity to respond to Purchaser requests.
- Purchasers are notified via email when a partner responds to a request. All subsequent responses will be posted on this web site without email notification. All dialogues are confidential.
- Purchasers log into this Web site and check Supplier responses.

- Purchasers decide whether or not to follow up with any of the ENERGY STAR Supplier responses.

For a simple set of instructions on how to use the ENERGY STAR Bulk Purchasing Tool send an e-mail request to Wayne Waite, Regional Energy Representative, at Wayne_W._Waite@hud.gov.

A Look at the Efficiency of ENERGY STAR Products

- ENERGY STAR qualified refrigerator models use at least 15% less energy than required by current federal standards and 40% less energy than the conventional models sold in 2001.
- ENERGY STAR compact fluorescent bulbs use 70% less energy than "old-fashioned" incandescent bulbs and they often last 10 times longer. If you replace an existing 60-watt incandescent bulb with a 15-watt compact fluorescent, you will save $33 in energy costs for just that bulb over its lifetime.
- ENERGY STAR rated clothes washers use 50% less energy than conventional washers. They also use less water per load and one-third less detergent. Compared to a model manufactured before 1994, an ENERGY STAR qualified clothes washer can save up to $110 per year on your utility bills.
- ENERGY STAR qualified central air conditioners have a higher seasonal efficiency rating (SEER) than standard models, which makes them about 25% more efficient and will reduce cooling bills by 20%.
- ENERGY STAR qualified furnaces have an annual fuel utilization efficiency (AFUE) rating of 90% or greater, making them about 15% more efficient than standard models.

Figure 16: A Look at the Efficiency of ENERGY STAR Products

Demystifying Multifamily Energy Audits

How Energy Audits Can Help Housing Sponsors and Managers

An important principle of energy efficiency is that you should know how much energy you are consuming and why before your carry out a energy efficiency retrofits. This axiom is especially important when housing sponsors are contemplating investments in energy efficiency appliances, equipment, or other building measures with the expectation of reducing operating costs.

Energy audits should be undertaken in all cases where the housing sponsor is seeking to maximize the rate or return on investment or where energy improvements are financed in whole or in part from future energy savings. Furthermore, energy audits are considered an essential component for financial transactions involving existing subsidized housing units to ensue that property and household energy costs remain affordable.

This article describes what is involved in a typical energy audit and reviews how housing sponsors can use information from energy audits to develop energy efficiency plans.

What Is An Energy Audit?

Energy audits evaluate building systems and characteristics that affect energy consumption (building envelop, heating and cooling, hot water, appliances, and lighting) and assess the potential for improving energy efficiency and the relative merits of available energy measures.

Having a energy audit and using the results in coordination with physical needs assessments supports integrated planning of capital investments, operating improvements, and maintenance cost reductions.

Energy audits typically involve three steps.

- *Data Collection and Property Inspection.* An energy audit identifies how energy is used in a facility. Data is collected on energy use and costs and a physical inspection of the property and energy-related equipment is performed. The physical inspection reviews equipment conditions, past maintenance schedules, remaining useful life, and system performance. Physical inspection may also consider indicators of performance issues such as leaking or foiled heat exchangers, high humidity, poor space temperature control, and comfort concerns.

- *Analysis of Utility Costs.* The energy audit analyzes utility costs of the existing property. Utility data is trended and benchmarked against similar properties with like heating and cooling requirements, and used to provide estimates of energy savings that may be gained by implementing cost effective conservation measures.

- *Energy Efficiency Measures*. The energy audit provides a prioritized list of recommended *cost-effective* energy efficiency improvements to reduce energy costs. Cost-effective energy efficiency improvements are energy measures whose estimated energy savings exceed the installed cost of the energy measure over the measure's useful life. Recommendations are based on engineering and economic analysis and consider factors such as operating hours, equipment efficiency, and building and occupant energy demand characteristics. Costs are generally developed through industry norms or available historical project information.

There are several ways to estimate the cost effectiveness of an energy efficiency measures. One method commonly used in energy audits for determining cost effectiveness is calculating the Simple Payback of energy efficiency measure. To calculate simple payback the total first cost of the improvement is divided by the first-year energy cost savings produced by the improvement. This method yields the number of years required for the improvement to pay for itself. Simple payback analysis provides a relatively easy way to examine the overall costs and savings potentials for a variety of project alternatives. The simple payback analysis allows project sponsors to set priorities based on measures that represent the greatest return on investment and can also help sponsors select appropriate financing options.

Products of an Energy Audit

The audit report will list energy efficiency measures in rank order based on the measure's simple payback period. In the case of simple improvements such as replacing old fluorescent lights with newer, more efficient systems, or insulating hot water distribution piping, the payback period can be a few years or less. Major improvements such as replacing an older boiler or installing new, energy-efficient windows can take much longer. Measures with lower payback periods generally produce higher rates of return on investment.

Minimally, the report produced from the Energy Audits should provide the following information to the project sponsor:

- Current energy usage and costs (KwH, Therms, utility cost)
- Prioritized list of recommended energy efficiency improvements

- Installed cost estimates for recommended energy efficiency measures
- Expected useful life of recommended energy measures
- Annual energy saving estimates (consumption and cost reductions)
- Simple payback period in years for each recommended measures

Figure 17 below provides a sample chart of the output typically produced from an energy audit completed for the *Energy Action* program in 2004.

Sample Energy Audit Summary Report: City Apartments

Year Built:	1980
Number of Units:	74
Space Heating:	Electric – resistant Cols – Convection
Water Heating:	Gas – DHW Only – Recirc – Internal Storage
A/C:	Electric – Expansion Coils – Terminal Coils
Envelop:	Masonry – Single Pane – Tar and gravel - Medium

Affected System	Recommendation	kWh Savings	Thm Savings	Annual Savings	Life Cycle Savings	Cost	Rebate	Pre-Rebate Payback	Post-Rebate Payback
PRIORITY ENERGY EFFICIENCY MEASURES									
Air Conditioning	Install new high efficiency terminal air conditioners – Replace on fail	2030	0	$308	$4,620	$120	$120	0.4	0.0
Service Hot Water	Install tank insulation on service hot water heaters.	0	209	$178	$1,780	$300	$300	1.7	0.0
Lighting	Replace incandescent light bulbs with compact fluorescent lights (CFLs).	6643	0	$1,007	$8,055	$762	$263	0.8	0.5
Misc.	Install occupancy sensor to control vending machine.	1156	0	$175	$1,750	$229	$90	1.3	0.8
Service Hot Water	Install thermostatic control to reduce operation of domestic hot water recirculation pump.	1597	60	$293	$2,932	$350	$88	1.2	0.9
HVAC	Install weather stripping around the wall/window packaged units.	732	0	$111	$1,110	$225	$56	2.0	1.5
Lighting	Install occupancy sensors.	199	0	$30	$300	$96	$17	3.2	2.7
Lighting	Replace T-12 fluorescent tubes and magnetic ballasts with new T-8 tubes and electronic ballasts.	7333	0	$1,112	$17,785	$3,485	$500	3.1	2.7
Targeted High Priority Measures		**19,691**	**269**	**$3,214**	**$38,332**	**$5,567**	**$1,433**	**1.7**	**1.3**
Lighting	Replace existing exit signs with high efficiency LED exit signs.	1813	0	$275	$4,389	$1,495	$500	5.4	3.6
Service Hot Water	Install new pipe insulation to bare hot water pipes.	0	62	$52	$786	$279	$57	5.4	4.2
Air Conditioning	Install new high efficiency terminal air conditioners.	503	0	$76	$1,140	$500	$100	6.6	5.3
Laundry	Install horizontal axis washing machines.	140	81	$117	$1,351	$1,200	$0	10.3	10.3
Subtotal:		**22,146**	**412**	**$3,743**	**$46,008**	**$9,041**	**$2,090**	**6.7**	**5.4**

Figure 17: Example Energy Audit[1] Examining the Audit

7

[1] Source: Audit summary from actual energy audit performed by GRID Alternatives www.gridalternatives.org

AFFORDABLE HOUSING ENERGY EFFICIENCY ALLIANCE

The energy improvements in the sample audit will cost $6,950.69; ($9,041 in energy improvement costs - $2,090 in projected rebates), and the property would incur an estimated $46,008 in the form of higher energy bills over the next 10 to 15 years if City Apartments did not implement these recommendations. In short, the energy audit shows that it costs far more in the long run to do nothing than it does to purchase new equipment and upgrade the performance of the property.

Figure 18 below shows the difference between the cost of energy efficient equipment (after applying rebates) and the value of the energy that equipment will save over time.

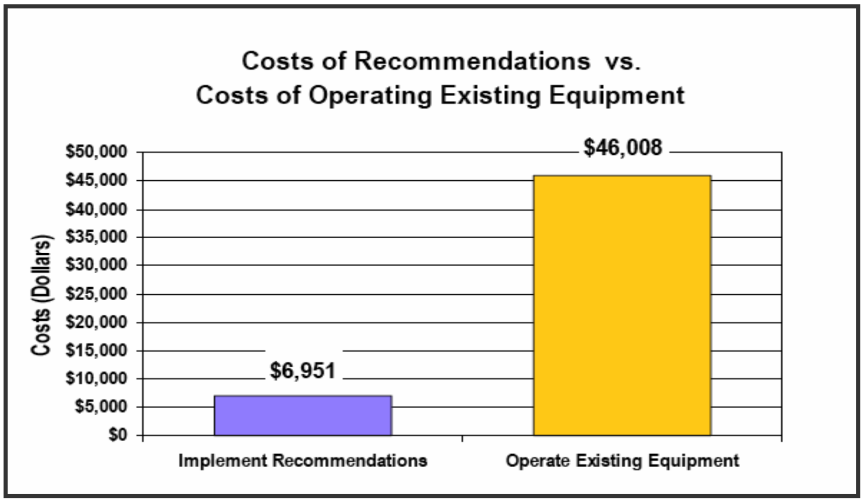


Figure 18: Cost of Energy Efficient Equipment versus Operating Existing Equipment

Cumulative Energy Savings Over Useful Life

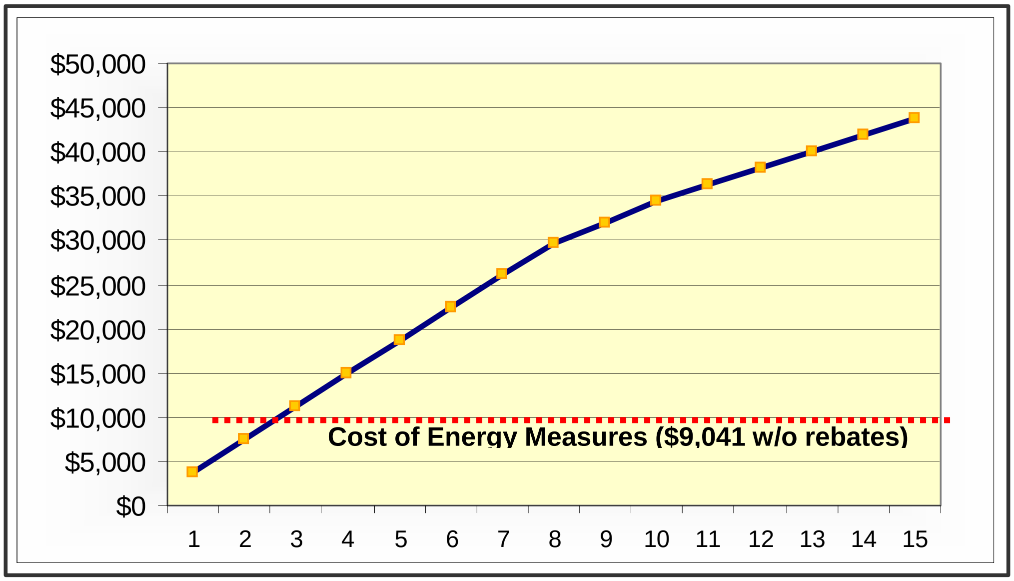


Figure 19: Cost of Energy Measures

AFFORDABLE HOUSING ENERGY EFFICIENCY ALLIANCE

Chapter 8:

Energy Efficiency Programs

Chapter 8 describes a number of incentive programs available to affordable housing developers for increased energy efficiency. Always check with your utility provider for information on current incentive programs. In addition, many permitting departments will fast track projects participating in energy efficiency programs or reaching a certain percentage above the Title 24 requirements.

ENERGY EFFICIENCY PROGRAMS

A key strategy in incorporating energy efficiency into projects, policies, and practices is to take advantage of the many programs that are funded by ratepayers and governed by the California Public Utilities Commission (CPUC). These programs provide incentives, rebates, information, and assistance to a wide range of markets – from consumers purchasing appliances at local home centers, to commercial new construction, agricultural processes, and affordable housing owners and developers.

Whether you are an affordable housing owner, developer, housing authority, lender or redevelopment agency, there are public service energy efficiency programs geared to help you with the important work of improving energy efficiency in affordable housing. Listed below are a few of these programs. Some are geared toward new construction, some toward rehab projects, and others offer free design services to affordable housing.

Affordable Housing Energy Efficiency Alliance

The Affordable Housing Energy Efficiency Alliance (AHEEA) helps the affordable housing market incorporate energy efficiency into projects, programs, funding, and policies. This innovative program serves as an energy efficiency clearinghouse to provide cost-free training and information to affordable housing owner-developers, housing authorities, redevelopment agencies, and support services agencies.

Energy Efficiency Program Coordination

The program serves as a clearinghouse of energy efficiency programs offered throughout the region. Representatives can assist you in locating a program to suit your needs whether it is to obtain financial incentives and design assistance for new construction or rehab, or to find low-income programs and services for your tenants.

Training

In AHEEA training sessions, participants can learn about:

- Cost-effective design and construction of new multifamily buildings and rehabilitation of existing buildings to maximize energy efficiency, reduce operating costs, and improve comfort.
- Funding sources and financing models that help to offset the costs of energy efficiency improvements
  - Energy efficiency programs applicable to affordable housing
  - Energy standards and how they apply to multifamily buildings
  - Energy Efficiency-Based Utility Allowance (EEBUA) schedules
  - Resources – where to get additional help

Design Assistance/Energy Efficiency Design Charrettes

Project specific technical assistance is available to help the design team in identifying cost effective energy efficiency measures. The program also offers facilitation of energy efficiency design charrettes or workshops (discussed further in the Chapter 2 section titled *Energy Efficiency Design Charrettes – Talking Your Way into a Better Building*).

Energy Efficiency-Based Utility Allowance Schedules (EEBUA)

EEBUA is a lower utility allowance for energy efficient projects to help payback investments in energy efficiency. The program offers assistance to housing authorities and agencies with an Energy Efficiency-Based Utility Allowance (EEBUA) schedule. For more information about EEBUA schedules, please refer to the section titled Energy Efficiency-Based Utility Allowance Schedule.

Newsletter

The newsletter provides up-to-date information on energy efficiency topics such as funding sources, technologies, training, and case studies.

Case Studies

- Case studies provide real life examples of new construction and rehab projects' energy efficiency goals, costs, and savings
- Case studies also reflect the impact of an Energy Efficiency-Based Utility Allowance schedule on a project's financing

AHEEA program funding is limited and participation is available on a first-come, first served basis until July 31, 2008 or until funds are expended, whichever is first. For more information, or to request these free services, please contact Julieann Summerford at 619-917-5690 or summerford@h-m-g.com, or visit www.h-m-g.com/multifamily.

Designed for Comfort

Designed for Comfort (DfC) is a public program that promotes energy efficiency in affordable multifamily and supportive housing. The DfC program is offered to existing properties within Southern California Gas Company and Southern California Edison Company service territories. Rehabilitated projects that are designed to perform 20% more efficiently than existing conditions may qualify for program incentives and design assistance.

DfC emphasizes increased comfort and energy efficiency by offering an integrated analysis of your building with measure upgrades, such as:

- High performance windows
- Energy-efficient water heating
- Improved wall and ceiling insulation
- High efficiency space heating and cooling equipment

In addition to cash incentives for these upgrades, each participating project unit of receives an EnergySmart Pak consisting of energy efficient lighting and water saving devices, further enhancing energy and water savings.

Benefits to Owners/Developers

DfC offers many resources for owner/developers of qualified affordable multifamily and supportive rehabilitation projects:

- Assistance and training to help the design team analyze the most cost-effective options for energy efficiency upgrades
- Support with locating readily available, proven energy-efficient equipment and materials

- Cash incentives upon successful installation and verification of qualified upgrades
- Cash incentives to help offset the cost of the energy consultant team and HERS raters
- Public recognition — participating projects may be showcased as examples of cost-effective investments in energy efficiency and comfort

HERS Raters

Home Energy Rating Systems (HERS) Raters are required to inspect and verify the energy efficiency measures before and after installation and submit a verification certificate. This certificate is sufficient to demonstrate that the project meets elevated energy efficiency standards and qualifies for public funding.

Energy Consultants

Energy consultants are to provide compliance documentation showing that the measure upgrades are designed to perform at least 20% more energy efficient than existing conditions.

Incentive Description	Incentive Amount
Small project (3-8 units): Owner Incentive	Up to $1,500 per unit
Large project (9 units or more): Owner Incentive	Up to $700 per unit
Supportive Housing: Owner Incentive	Up to $500 per unit
HERS Rater Incentive	$50 per unit ($6,000 per project cap)
Energy Consultant Incentive	$40 per unit ($5,000 per project cap)

Figure 20: Designed for Comfort Incentives

Funding is limited and participation is available on a first-come, first-served basis until December 31, 2008 or funds are expended, whichever occurs first. To sign up or obtain more information, call Designed for Comfort toll-free number today: (866) 352-7457

California New Homes Program (CANHP)

Southern California Edison's California New Homes Program (CANHP) facilitates energy-efficient design and construction in multifamily housing through design assistance and cash incentives.

CANHP offers many resources to qualified multifamily new construction projects including:

- Design Assistance to help achieve energy efficiency
- Financial Incentives to help pay for energy efficiency
- Program Coordination with the ENERGY STAR® For Homes Program

CANHP offers two options:

- Performance Path – incentives for buildings that exceed Title 24 by at least 15%

  Low rise: performance-based for buildings with 1-3 stories

  High rise: performance-based for buildings with 4 or more stories

- Prescriptive Path – incentives for individual measures

  ENERGY STAR® Appliances and Lighting

  Quality Insulation Installation and Tight Duct Testing

Performance Path Incentive Description	Incentive Amount	Requirements
Developer Incentive (15% above T-24)	$150 / unit coastal regions $200 / unit inland regions	Climate Zones 1-7 Climate Zones 8-16
Developer Incentive (20% above T-24)	N/A coastal regions $275 / unit inland regions	Climate Zones 1-7 Climate Zones 8-16
Energy Consultant Incentive	$40 / unit	max $5,000 per consultant (2007 only)

Figure 21: CANHP Performance Path Incentives

Prescriptive Path Incentive Description	Incentive Amount	Requirements
ENERGY STAR® Dishwashers	$30 / unit	EF 0.65 or higher
ENERGY STAR® Clothes Washers	$35 / unit	MEF 1.8 or higher; WF 7.5 or lower
ENERGY STAR® Refrigerators	$50 / unit	Must exceed current federal standards by 20%; Not all ENERGY STAR® models qualify
Hardwired High Efficicacy Interior Lighting Fixtures w/ Controls	$10 / fixture	$50 per unit ($6,000 per project cap)
Quality Insulation Installation (QII)	$50 / unit	For prescriptive path only
Verified Ducting System (Tight Ducts)	$75 / system	For prescriptive path only

Figure 22: CANHP Prescriptive Incentives

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To be eligible for the CANHP program projects must:

- Be new multifamily residential construction (3 or more attached units)
- Be served by Southern California Edison
- Exceed 2005 Title-24 standards by at least 15% (to be eligible for the Performance Path)

Incentives are limited and available on a first-come, first-served basis. To sign up or to obtain a complete list of program requirements and product specifications, call the CANHP Program today: (626) 633-3120.

Housing Energy Partnership

Housing Energy Partnership (HEP) is a new partnership that provides innovative energy services for small- and medium-sized affordable housing providers within the Southern California Edison service territory. HEP provides FREE comprehensive energy services for groups (or aggregations) of housing providers that are interested in reducing energy costs. In addition to helping organize aggregations, the suite of services includes:

- Investment-grade audits
- Engineering review
- Finance strategies
- Administrative oversight
- Construction and procurement support
- Bulk purchasing
- Measurement and verification
- Assistance with Edison programs/ resources

Often, owners or managers of less than 500 units cannot access the financing needed for major energy retrofits. By aggregating units among multiple owners, HEP provides access to financial strategies, such as energy performance contracts, and allows owners to benefit from bulk purchasing or other asset pooling strategies.

For example, there may be five multifamily housing providers that want to bring energy and cost savings to their properties. If each provider has 250 units, once aggregated through the Housing Energy Program, these individual housing providers have the benefits afforded to larger organizations. With 1250 units total in the aggregation, the providers are now able to attract energy services companies, bulk purchasing opportunities, and other energy programs unavailable to organizations with less than 1000 units. Ultimately, this could mean new high efficiency HVAC, lighting, refrigerators, insulation, etc. at significantly reduced or even zero upfront cost!

The key to the program is the aggregation of providers into pools of 500 units or more to leverage combined assets for projects or obtain services from an energy services company, which would bring independent financing and installation of measures. Figure 23 illustrates the basic steps of the program.

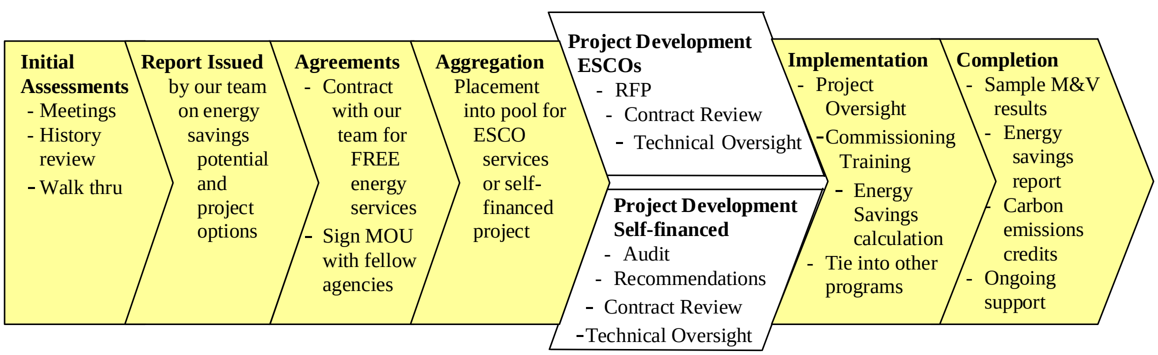

Figure 23: HEP Program Steps

For participating customers, the Housing Energy Program (HEP) provides FREE technical assistance, including audits, project and engineering oversight, training, bulk purchasing and contractor assistance. Contact HEP at aggregation@seiinc.org or (888) 403-2002.

Rebuild America[1]

Rebuild America is a network of community-based partnerships across the nation that are committed to saving energy, improving building performance, easing air pollution through reduced energy demand, and enhancing the quality of life through energy efficiency and renewable energy technologies.

Rebuild America was created by the U.S. Department of Energy in 1994. Since then, the program has served as a mechanism for revitalization and job creation in many U.S. communities. Rebuild America now resides in DOE's Building Technologies Program and is currently being reinvented.

Rebuild America is working in your state and community to connect people, resources, ideas and practices for energy solutions to community needs. Using an integrated systems approach to Schools, Housing, Public and Commercial Buildings, Factories, Vehicles and Electricity Transmission Systems, Rebuild America is helping to:

- Increase the number of high performance buildings
- Implement energy efficiency and renewable energy improvements
- Provide technical assistance tools, resources and services

What Are Partnerships Doing

As a Rebuild America partnership, community members actively decide what is done to improve their community and how it is done. With help from Rebuild America, communities:

- Choose buildings to improve
- Select project team
- Set goals
- Identify technologies and practices to apply
- Determine financing
- Make improvements
- Report findings and results

What Technical Services Are Available in 2006

Through the Rebuild America program, the Department of Energy is making a limited amount of technical assistance available to State Energy Offices and Rebuild America customers. A variety of projects will be considered including those in the following areas:

- Pre-project planning
- Project definition
- Design phase/building evaluation
- Contracts and financing
- Technologies and system design
- Building commissioning

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[1] http://www.eere.energy.gov/buildings/program_areas/rebuild.html

- Facilities management

Discover innovative ideas and answers to your questions on improving energy efficiency, Rebuild America goes beyond energy efficiency in buildings to address community energy needs in many sectors including transportation, power generation and distribution, air quality, business retention, and economic revitalization.

Building America[1]

Building America is a private/public partnership sponsored by the U.S. Department of Energy that conducts research to find energy-efficient solutions for new and existing housing that can be implemented on a production basis.

Building America conducts systems engineering research to do the following:

- Produce homes on a community scale that use on average 30% to 90% less energy
- Integrate onsite power systems leading to "zero-energy" (ZEH) homes that will ultimately produce as much energy as they use by 2020 (PDF 852 KB)
- Help home builders reduce construction time and waste
- Improve builder productivity
- Provide new product opportunities to manufacturers and suppliers
- Implement innovative energy- and material-saving technologies.

By using a systems engineering approach to home building, Building America unites segments of the building industry that traditionally work independently of one another. It forms teams of architects, engineers, builders, equipment manufacturers, material suppliers, community planners, mortgage lenders, and contractor trades. Currently, there are five Building America teams who have worked with over 549 different industry partners.

Throughout the design and construction process, research participants in Building America projects evaluate the interaction between the building site, envelope, mechanical systems, and energy-use factors. In many uses, cost tradeoffs allow the teams to incorporate energy-saving strategies at no extra cost. Building America research participants agree to:

- Provide all construction materials and labor for research projects
- Evaluate their design, business, and construction practices
- Identify cost savings
- Re-invest cost savings in improved energy performance and product quality
- Extend their efforts from discussion of possibilities to development of solutions
- Use a design, test, redesign, and retest process to resolve technical barriers

The research conducted by Building America teams increases the quality and performance of today's homes and provides valuable information for homes of the future. By supporting industry-driven systems engineering research, the Building America Program provides the feedback required to develop critical "next generation" building systems.

The long-term goal of the Building America program is to develop cost-effective systems for homes that can produce as much energy as they use—a zero energy home.

Building America Homes Have a Number of Advantages

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[1] http://www.eere.energy.gov/buildings/building_america/about.html#zeh

- Improved comfort—an energy-efficient building envelope reduces temperature fluctuations
- Reliability—BA homes can be designed to continue functioning even during blackouts
- Security—a home that produces energy protects its owner from fluctuations in energy prices
- Environmental sustainability—a BA home saves energy and reduces pollution.

Building America Homes Optimize a Variety of Features

- Climate-specific design
- Passive solar heating and cooling
- Natural daylighting
- Energy-efficient construction
- Energy-efficient appliances and lighting
- Solar thermal and solar electric systems

PATH[1]

The Partnership for Advancing Technology in Housing (PATH) is a public/private sector initiative that seeks to expand the development and utilization of new technologies in order to make American homes stronger, safer, more durable and more energy efficient. The program is managed by HUD's Office of Policy Development and Research. In support of the interagency Partnerships for Home Energy Efficiency, significant PATH resources are being committed to promoting energy efficiency in existing homes.

The Roadmap for Energy Efficiency

The key to PATH involvement in energy efficiency in existing homes is the PATH Roadmap for Energy Efficiency in Existing Homes. While other PATH roadmaps address technology innovations in new homes, the Roadmap for Energy Efficiency targets existing housing and existing technologies. There is a wealth of off-the-shelf products that can reduce energy use, sometimes substantially. Progress will in large measure be the result of strengthening systems for marketing, installing, and financing energy upgrades, whether or not the underlying technologies are new. A key focus of the Roadmap is to provide homeowners with credible, reliable information about energy efficiency in their homes, and to develop tools for the remodeling industry that will increase their effectiveness in incorporating energy efficiency in existing remodeling activities.

PATH and the Partnerships for Home Energy Efficiency

In support of the Partnerships for Home Energy Efficiency, HUD is committing PATH resources to implement the following initiatives identified in the Roadmap:

[1] http://www.energysavers.gov/pdfs/path_fs.pdf

Develop guidelines or protocols for energy-efficient remodeling. In partnership with the remodeling industry, HUD is initiating a multi-year project aimed at developing voluntary guidelines for energy-efficient remodeling. Beginning in September 2005, the project will develop protocols for assessing the energy efficiency of an existing home and identifying energy upgrades that provide maximum economic return to the homeowner over time. The protocols will provide guidance to remodeling and trade contractors and homeowners, and help ensure that dollars invested in energy upgrades result in maximum savings. Users will be able to identify and evaluate potential energy improvements, either as stand-alone projects that can improve comfort and reduce energy bills, or in conjunction with other work (such as room additions, bathroom or kitchen remodeling). The protocols would provide a consistent, high-quality approach that can be used by those who work in the remodeling and rehabilitation industry and can significantly impact energy efficiency decision-making by property owners.

The protocols will be developed with significant input from remodelers, energy specialists, consumers, and existing home performance practitioners. The initial protocols are expected to be available for testing in September 2006.

Contractor credentialing and certification. In partnership with the U.S. Environmental Protection Agency (EPA) and Department of Energy (DOE), HUD is supporting the development of an industry-recognized contractor certification or credentialing program for energy efficiency. A strong, effective certification program that ensures the competency and integrity of remodelers and trade contractors is fundamental to countering negative perceptions of the industry. Certification also will be a strong motivator for remodelers and trade contractors, providing a way to differentiate themselves as energy-efficient solutions providers. Accordingly, “a strong, effective certification program that includes training, testing, and periodic review is required.” This work is being carried out by the Building Performance Institute, based in Albany, NY.

- *A building typology approach to retrofits of existing homes.* This fall HUD will issue a Request for Proposals to develop and pilot a standard retrofit package for specific housing types in particular local markets. Services to be provided will include developing a methodology for selecting four housing types to be tested during the project; developing specifications for implementing energy retrofits in these housing types and for measuring performance of completed retrofits; and piloting the application of these specifications in the four locations where these housing types predominate. (See HUD’s Small Business Forecast at www.hud.gov).

- *Field testing and demonstrations*. PATH will continue to support field testing of energy-efficient remodeling of existing homes. PATH has supported field testing of a range of energy-efficient equipment in existing homes, including, for example, installing ducts in conditioned spaces in Albertville, Alabama; a water-cooled air-conditioning system and tankless hot water heater in Florida; and comprehensive energy retrofits in Henderson, Nevada, and Ithaca, New York. PATH has also supported demonstration projects for energy efficiency in existing homes (primarily in Habitat for Humanity projects).

- *Low-E storm windows and additional RandD*. PATH is also supporting cooperative research into energy-efficient technologies that have application to existing homes. One such effort is the development of low-E storm windows in partnership with DOE. PATH also is supporting with DOE more advanced research into high-performing, electrochromic windows.

For More Information

Please see the Partnerships for Home Energy Efficiency website at www.energysavers.gov and visit the PATH web site at www.pathnet.org.

AFFORDABLE HOUSING ENERGY EFFICIENCY ALLIANCE

Chapter 9:

Case Studies

Chapter 9 provides real life examples of projects that have incorporated energy efficiency measures into their buildings. Both a new construction project and a rehabilitation project are illustrated, explaining the measures taken and the costs and benefits to the owner and tenants.

CASE STUDIES

In many cases, a project can achieve energy efficiency goals with zero or very little net costs. Early and integrated design, TCAC funding, and incentives from ratepayer funded utility programs prove that energy efficiency does not always cost more. Below are two case studies, one for new construction and one for a rehab project, which demonstrate how to improve efficiency for the least cost.

Case Study of a New Construction Multifamily Project

Project name: Vista Hermosa Apartments

Owner: Cabrillo Economic Development Corporation

Location: Santa Paula, California

Climate Zone: 9

Architect: Brady Roark, Architect

Energy Consultant: Bob Blossom, Architect

The Vista Hermosa Apartment Project is one of many housing projects that benefited from the Energy Star new construction incentives program funded by the CPUC in Southern California Edison service territory.

Figure 24: Vista Hermosa Building Elevation

This affordable housing project, owned by Cabrillo Economic Development Corporation is a 6 building, 24-unit project in Santa Paula. The project energy consultant worked with HMG on multiple iterations of the calculations, bringing the project from an average of 9.2% with negative electric energy savings up to an average of 25.61% above the California Building Energy Code – the Title 24 compliance. All 6 buildings of the project exceed Title 24 by 21.45% to 38.4% with a project weighted average of 25.61%. The incentives program paid $150 per dwelling unit for the incremental costs involved in installing high performance measures over standard measures that they would have installed had they not participated in this program.

Figure 25 summarizes the measures that the project team has started with (Base Case) and the measures that they installed after design assistance from the energy consultant and the incentives program team (proposed case).

Component	Base Case	Proposed Case
Ceiling / Attic	Wood truss, R-30	R-30 + Radiant Barrier
Wall	Wood frame, 2x4, R-11	Wood frame, 2x4, R-13
Floor	Wood frame raised floor	Wood frame raised floor
Fenestration	Dual pane low-E, vinyl frame	Dual pane low-E vinyl frame
Space Heating	Forced Air Furnace	Forced Air Furnace
Space Cooling	Room heat pump(10 SEER)	Split system heat pump(12-14 SEER)
Water Heating	Storage type individual water heater (0.54 EF)	Instantaneous gas water heater (82 AFUE)

Figure 25: Base Case and Proposed Measures

Figure 26 below summarizes the cost of installing the high performance measures (up charge), the annual savings (to the owner or tenant, depending on who pays the electric or gas bills) resulting from the upgrade measures, and the payback period. The net cost of upgrading the measures was $10,800, including the incentive amount offered by the Energy Star program. These upgraded measures will result in an annual savings of $4,165, with an average payback period of 2.6 years. The owner will benefit with a quick payback on his investment and lower maintenance of his buildings, and the tenants benefit from a more comfortable home and lower utility bills.

Upgrade	Up charge	1 Yr. Savings	Payback (Yrs)
Radiant Barrier	$1,200	$1,702	4.2
12-14 SEER A/C	$6,000		
Instantaneous W/H	$7,200	$2,463	2.9
Energy Star Rebate	($3,600)	n/a	n/a
Net Cost	$10,800	$4,165	2.6

Figure 26: Cost of Upgrade and Payback Period

Case Study of an Existing Multifamily Project

Project name: Los Angeles Eco-Village

Owner: Cooperative Resources and Services Project (CRSP)

Location: Los Angeles, California

The Los Angeles Eco-Village is one of many projects throughout the state of California that have received funding and design assistance through the Designed for Comfort program.

“This project has brought us in closer alignment with our ecological values and has sure made a difference in our comfort,” states Lois Arkin, Executive Director of CRSP.

Figure 27: View of the Two Upgraded Buildings of LA Eco-Village[1]

The Los Angeles Eco-Village Intentional Community (LAEV-IC) is located in an urban Los Angeles neighborhood. In addition to energy efficiency, this project has incorporated many green features into the two 1920s apartment buildings like sustainable building materials, water conservation, permaculture style gardens and orchards, and recycling and composting. The two properties consist of a 40-unit building of mostly studio units, about 400 square feet in size; and an adjacent eight unit building with one- and two-bedroom units that are 800 to 1,000 square feet.

Energy Efficiency Upgrades: LA Eco-Village participated in DfC and was able to upgrade from single pane French doors to dual pane glass doors, attic insulation from R-0 to R-30 and installed new demand controls for the existing domestic water heater. These upgrades improved energy efficiency by more than 30% for the entire project.

The total cost of these upgrades was approximately $32,100. The **DfC** incentives provided 100% of the funding for these upgrades. The upgrades resulted in the combined annual cost savings for tenants and owners of $4,700 in electric bills and $3, 900 in gas bills. These upgrades result in more comfortable homes for the tenants. For both the property owner and the self-managing residents, this means fewer complaints, reduced maintenance costs, and greater pride in their properties. Figure 28 and Figure 28 below show the cost of installing the measures and the resulting cost savings.

Measures	**Cost**
Insulation	$9,630
Demand controls for central boiler	$1,816
Dual pane glass doors	$20,645
Total Cost	**$32,091**
Incentives through DfC	**$32,091**
Net Costs	**$0**

Figure 28: Cost of Upgrades for LA Eco-Village Project

Cost Savings	
Electric cost savings/year	$4,700
Gas cost savings/year	$3,900
Total energy efficiency improvement after rehab	30%

Figure 29: Estimated Annual Cost Savings for LA Eco-Village Rehab Project

[1] Photo Credit: CRSP

AFFORDABLE HOUSING ENERGY EFFICIENCY ALLIANCE

Chapter 10:

Beyond Building for Energy Efficiency

Chapter 10 describes non-energy benefits of energy efficiency and suggests ways to build green outside the scope of energy efficiency, limiting negative impact on the environment. Designers and developers may benefit from Chapter 10.

BEYOND BUILDING FOR ENERGY EFFICIENCY

Non-Energy Benefits of Energy Efficiency in Affordable Housing

Energy efficiency not only provides direct energy savings and lower energy bills, it also provides non-energy related benefits such as:

- *Greater Marketability for Market-Rate Housing* — Market-rate multifamily builders can differentiate themselves in the market by offering and marketing their homes as energy efficient, whether by participating in a utility new homes program or meeting the ENERGY STAR labeling requirements. Building energy efficient homes distinguishes builders as leaders in energy-efficient construction and environmental stewardship, providing valuable peer and public recognition that translates into market advantage because consumers are increasingly concerned about energy efficiency and the environment. According to a National Association of Home Builders (NAHB) survey, energy efficiency is one of the top three priorities for the multifamily homebuyer. Respondents to the survey said they were willing to pay a median of $5,000 upfront in the purchase price of their next home to save $1,000 every year in utility costs.
- *Greater Opportunity for Increased Revenue* — Energy efficiency features can help to increase revenue as the projected energy and utility cost savings may allow a homebuyer to purchase additional upgrades thereby increasing builder profit.
- *Greater Affordability* — The cost of housing includes both rent and utilities. On average, middle-income households spend about 5%, low-income households spend about 20%, and retired elderly on SSI households spend about 25% of its monthly income on utilities. Simply put, energy efficiency saves energy, lowers utility bills, and enhances home affordability.
- *Increased Comfort and Enhanced Customer Satisfaction* — A comfortable home reduces customer complaints and callbacks and improves customer satisfaction. Energy efficiency features make homes more comfortable. High performance heating and cooling equipment helps to provide consistent temperatures, balance humidity, create proper airflow, improve indoor air quality, and run more quietly. High performance windows conduct less heat and reduce drafts to help keep the home's temperature more consistent. High performance windows help to reduce fading of carpet, floors, furniture, and drapes as well as reduce unwanted outside noise.
- *Lower maintenance* — Energy efficient products are associated with higher performance and lower maintenance. High performance products are
- *Quality Construction* — Energy efficiency implies quality and high performance. Because many of the features included in an energy efficient home require a third-party inspection, such as Quality Insulation Installation, builders, tenants, and homeowners, can be confident that the energy efficiency measures are installed properly
- *Energy Efficiency Programs* – Utility funded programs offer cash incentives to builders who successfully install qualified energy efficiency upgrades. These programs aim to help offset the incremental costs of improving energy efficiency as well as to help offset the cost of the builder's energy consultant team and HERS rater who conducts the third-party verification to ensure quality.
- *Energy Efficiency Resources* – Utility funded programs also offer design assistance and training (workshops and one-on-one expert consultation) to help design team analyze the most cost-effective options for energy efficiency upgrades.

- *Energy Star® Partnership Marketing Benefits* – As ENERGY STAR partners, builders can use EPA-produced marketing resources and technical resources at no cost. Some examples include: ENERGY STAR Logos, Partner Locator listing, which links customers to ENERGY STAR partners, Consumer Brochures, Fact Sheets, and Sales Toolkit, Outreach Partnership, Awards and Recognition. For more information on these benefits, visit www.energystar.gov/homes.
- *Energy Efficiency Analysis and Verification* – Utility funded programs help to offset the costs of the energy analysis and verification of energy efficiency performance documentation and verification to demonstrate to various public agencies that your building meets elevated energy efficiency standards and qualify your project for public funding (such as Tax Credit Allocation Committee (TCAC) or for Energy Efficiency-Based Utility Allowance (EEBUA) schedules.
- *Public, Peer, Industry Recognition* – Energy efficient projects may be showcased as examples of cost-effective investments in energy efficiency, comfort and durability through various venues such as utility program participant case studies, local building industry (affordable and market rate) association awards, Flex Your Power, and Energy Star® recognition and awards.
- *Reducing Greenhouse Gas Emissions* – The residential sector was responsible for 18% of US greenhouse gas emissions in 2005.[1] Of that 18%, 100% of CO2 emissions were energy related. Reducing energy use in buildings is a logical step towards reducing greenhouse gas emissions and curbing global climate change.

Tenant Assistance Programs

Energy efficiency in and of itself is a goal. Lower utility bills, however, can have a greater impact on low income tenants. Owner-developers can take it one step further by encouraging their tenants to further conserve energy in their homes and lowering their utility bills by taking advantage of SCE's programs that assist income qualified tenants in lowering their energy bills. For further information and application forms for the following programs, please visit http://www.sce.com/RebatesandSavings/LowIncome.

Energy Management Assistance (EMA) Program

The Energy Management Assistance (EMA) program helps income-qualified households conserve energy and reduce their electricity costs. SCE pays all the costs of purchasing and installing energy-efficient appliances and equipment, which are free to eligible customers.

Three Stages of the EMA Program:

The three stages of the EMA program are carried out by respected community service agencies and building contractors under SCE's supervision.

- *Outreach and Assessment* – Finding out if a customer is eligible for the Program, and checking the customer's home to be sure it is feasible to install specific measures.

    All customers must provide proof of income.

    Homeowners must provide proof of ownership.

    Renters must obtain the owner's written permission.

[1] http://www.nahb.org/generic.aspx?genericContentID=75563

- *Service delivery* – Installing appliances and other measures. The California Public Utilities Commission requires installers to meet or exceed existing codes and regulations, and follow accepted building practices.
- *Inspections* – Inspecting customer homes after service delivery to be sure the measures will work properly and that the contractor has performed well. If it is not up to standard, the contractor has to repair or redo the installation at no cost to the customer.

Cooling and Appliance Measures

A qualified customer who has a working refrigerated air conditioning unit may receive one of the following:

- In climate zones 10-15, a replacement energy-efficient window or wall air conditioner (unit must be 15 years old)
- In climate zones 10-16, an energy-efficient evaporative cooler (also called a "swamp cooler")
- In climate zones 14-15, replacement energy-efficient central air conditioning

A qualified customer who has a working electric refrigerator that was manufactured before 1993 and at least 10 cubic feet in size may receive a free replacement that will use much less energy than the old model. SCE also takes the old appliance away for proper disposal and recycling at no charge to the customer.

Note: All replacement refrigerators meet ENERGYSTAR® standards. SCE installs white freezer-top models without extra features such as icemakers. Replacement size depends on the size of the old unit.

Other EMA Measures

- Compact fluorescent light bulbs (CFLs), which use up to 70% less energy than ordinary incandescent bulbs and last 7 to 8 times longer. Replacement outdoor fixtures with CFLs may also be provided.
- Free Weatherization services, where SCE makes repairs and improvements that help keep a home warm in winter and cool in summer.

Note: Customers with natural gas space heating should contact their local gas provider for weatherization services.

Qualifications for EMA Program Measures:

- Meet the income qualifications outlined in section
- Receive electric service through a residential electric meter in SCE's service territory
- Have an SCE service account, or be sub-metered under a master-meter SCE account.

Measures are available to both homeowners and renters. Renters must obtain the homeowner's permission. Customers may only receive EMA services once every ten (10) years. If you have further questions, or wish to apply for EMA services, please call **1-800-736-4777**.

CARE Rate Discount Program

The CARE Program offers income-qualified customers a 20% discount off their monthly bills, whether the utility account is in the tenant's name or the owner/manager's. Enrolled customers are also exempt from the 2001 rate increases ordered by the California Public Utilities

Commission. To qualify, customers must meet program income guidelines, later outlined in this chapter.

This program is funded by California utility customers and administered by Southern California Edison under the auspices of the California Public Utilities Commission. If you have questions about the CARE Rate Discount Program or wish to apply, please call **1-800-447-6620**.

Family Electric Rate Assistance (FERA)

The FERA Program offers a discounted rate on the monthly bill to income qualified customers that exceed their baseline usage by 30%-100%. To qualify, there must be a minimum of 3 or more permanent residents in the household and the total household income must fall within the program guidelines.

Call **1-800-798-5723** for further inquiries or to enroll in the program.

Income Guidelines for EMA, CARE and FERA

The California Public Utilities Commission (CPUC) sets guidelines, updated every year, for the annual household income that qualifies customers for EMA, CARE and FERA program services. These guidelines are based on federal and state government standards. Customers can enroll in the EMA Program and/or the CARE Program if the combined gross annual income of all household members is equal to or less than the amounts shown in Figure 30.

EMA / CARE / FERA Programs		
Maximum Household Income		
Number of Persons in Household	**Total Combined Annual Income**	
	EMA / CARE	**FERA**
1-2	up to $29,300	Not eligible
3	up to $34,400	$33,601 - $42,000
4	up to $41,500	$40,501 - $50,600
5	up to $48,600	$47,401 - $59,200
6	up to $55,700	$54,301 - $67,800
each additional person	$7,100	$6,900 - $8,600

Figure 30: Financial Assistance for Utility Bills

Green Building

Beyond energy efficiency, there are a number of ways to preserve our resources while increasing comfort and lifestyle. Green buildings, by definition, reduce or eliminate negative impacts on the environment and the heath of building occupants. Through green design we can increase comfort today, while planning for the future of our planet and the built environment. "Green Building" is a process for creating buildings and supporting infrastructure that minimize the use of resources, reduce harmful effects on the environment, and create healthier environments for people

Incorporating green building features in affordable housing should be an important consideration. Dollar savings help low-income families the most as utility costs are known to be approximately

25% of the expenses after rent. Most senior housing and special needs housing fall under the affordable housing category. Green features are all the more important in these sensitive groups where comfort and health both are important issues. Formaldehyde, volatile organic compounds (VOCs), mold and other indoor pollutants can impact children's nervous and respiratory systems and be a trigger for asthma. We can do economic development with respect for people and the environment and do it economically.

Green buildings can produce economic and quality-of-life benefits for tenants, improve the financial bottom line for property owners, and generate economic and environmental benefits for the local, regional, and world community. There are several reasons why green building practices have not been widely applied to affordable housing. The biggest obstacle in both the conventional and affordable housing market is the prevailing emphasis on keeping upfront construction costs as low as possible. This issue is particularly acute in the affordable housing industry, which tends to focus entirely on getting low-income people into the homes, and not on the long-term costs of living in them.

This is when local, utility incentive programs and other state and federal tax credit programs built for affordable housing help in offsetting some of the costs associated with greening of affordable housing. These programs assist owners and developers in design, implementation of green features through financial incentives and tax credits.

The Challenge – Breaking the Negative Stereotypes of Green Building

There are two very common myths associated with green building. The first is that it costs more to go green than build conventionally. In some instances, the upfront costs of construction and installation are slightly higher. The reality, however, is that lower energy bills and lower maintenance and replacement costs make up for any capital costs beyond those of standard construction. In addition, rebate and incentive programs offer additional funds to recover your money even more quickly.

The second myth is that green buildings do not offer the comfort and luxury of conventional buildings. The opposite is usually true. Green design is about fulfilling tenant needs in the most efficient manner. Sustainable buildings provide a healthier, more comfortable environment for occupants than conventional design through improved air quality, reduction of toxic elements, maintenance reduction, and more. Green building is as much about aesthetic qualities as it is about reducing the use of nonrenewable resources and demands lifestyle improvements rather than sacrifices.

Common Issues in Green Design

The issues of green design are infinite and cannot be defined in this short chapter. Some ideas on how to design sustainably are discussed briefly in the text below. For the best solution, consider what:

- Is best for the occupant
- Is best for the environment
- Is best for the community
- Is most profitable
- Squanders the fewest resources
- Is lasting

The Benefits of Building Green

As building standards grow increasingly green, the choice to go greener today may prevent the need for renovation in years to come. Some additional benefits to building green for various players are:

- *Tenants* — reduced utility bills, improved health and safety, improved indoor air quality, improved comfort
- *Property owners* — minimized life-cycle cost of building operation, liability and maintenance
- *Local and regional community* — reduced demand on infrastructure for energy, water, waste water, and solid waste disposal; improved interactions between government and the building industry; improved building safety; reduced strain on the local environment; strengthened local economy, and improved quality of life
- *Building Professionals* — Market differentiation by building green, reduced construction defect liability, and improved quality of construction
- *Global environment* — reduced resource consumption and pollution of all types

Green Features

The five broad areas of green building features are as follows:

- *Site* — site selection, bike storage, building orientation, landscaping, storm water management, construction recycling.
- *Water Efficiency* — efficient toilets and appliances, efficient irrigation, reclaimed/recycled water.
- *Energy/Atmosphere* — energy efficient envelope, systems, lighting and appliances, renewable energy, no HCFCs.
- *Materials/Resources* — efficient building systems, reused, recycled-content, and rapidly renewable materials.
- *Indoor Environmental Quality* — avoid or eliminate VOCs, formaldehyde, and mold, natural ventilation, daylighting, thermal comfort, views, acoustics

Rating Systems

Currently, there are a number of green building rating systems and guidelines that provide ratings for green buildings. Of these, the most widely recognized program is the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification. Other programs include Green Globes, administered by the Green Building Initiative, and the Federal Sustainable Buildings Principles. Local initiatives, such as Green Points, have also been developed to offer builders, homeowners and municipalities a tool to assess how environmentally friendly or green a home is, and to transform the built environment to sustainability by providing the building industry with consistent, credible standards for what constitutes a green building.

Most green building certification systems rate the "greenness" of buildings by awarding points for clearly-defined, environmentally preferable construction, design, and systems. These attributes include a range of factors in addition to energy efficiency. These rating systems are by nature flexible — they provide only general guidelines for a building's development team across multiple categories. These major green certification programs currently allow builders flexibility to meet the green threshold by accumulating a minimum number of points from any of the various categories.

For investors interested in developing or purchasing green properties, an understanding of the scoring and methodology underlying the various rating systems, along with costs and paperwork associated with the scoring systems is especially important when gauging the green qualities of any certified green property.

Important Things to Consider

Cost Analysis

The cost of building sustainably should not be excluded from the efficiency equation. Economic sustainability on all scales should also be considered. The general understanding is that additional upfront costs will be recovered through reduced utility bills, lower maintenance, etc, however, this is not always the case. Be sure to weigh all factors, environmental, social, and economic to find the best overall solution for your project.

First Cost

Some aspects of design have little or no first cost including site orientation and window and overhang placement. Other sustainable systems that may cost more in the design phase, such as an insulated shell, can be offset by the reduced cost of a smaller mechanical system. This concept is known as "right sizing" of infrastructure and mechanical systems. Material costs can be reduced during the construction phase by dimensional planning—a strategy to design for minimizing framing needs, carpet etc.

Life-Cycle Cost Method

A long-term ownership supports a life cycle approach. Projects that are typically owned and operated by the same organization for 15-55 years justifies medium to long payback periods. Sustainable buildings can be assessed as cost-effective through the life-cycle cost method, a way of assessing total building cost over time. It consists of:

- Initial costs (design and construction).
- Operating costs (energy, water/sewage, waste, recycling, and other utilities).
- Maintenance, repair, and replacement costs.
- Other environmental or social costs/benefits (impacts on transportation, solid waste, water, energy, infrastructure, worker productivity, outdoor air emissions, etc).

Rehabilitation versus New Construction

In many cases it is more efficient to rehabilitate and add on to an existing building rather than tear it down to build something entirely new. With rehabilitation demolition costs are reduced, less material needs to be relocated to the landfill, and less material needs to be brought to the site for new construction.

In addition to resource and cost savings, there are other incentives for rehabilitation. For example, older buildings often exceed the building envelope allowed in current new construction building codes. In the most common example, the existing building extends into a side, front, or rear setback. When a building is renovated and added onto, the level nonconformity cannot be increased, but existing nonconformities may remain. In this case, the existing portion of the building may remain within the setback, but any additions or new construction must recognize the setbacks laid out in the building code.

Furthermore, the preservation of existing buildings aids in conserving the community culture and thus aids in social and cultural sustainability. Rehabilitation can help communities retain identities.

If it is necessary to tear down a building, salvage materials and reuse them in a new construction project, or donate them to company that specializes in the recycling of used building materials.

Sustainable Design Charrette

While the primary reason to embark on an integrated energy design process is to design a more energy efficient building that will reduce the utility bills of owners and occupants, and help meet California's peak load reduction goals, the process itself will often create many additional opportunities to benefit the project as a whole. In fact, the integrated energy design process on some projects might just be one part of a much larger whole building design process that is seeking, for example, recognition from a green and sustainable building rating system like the US Green Building Council's LEED for Homes program. But, even when a project has more limited goals there are often many opportunities to benefit the project simply through increased cooperation and communication between design team members. For example, when there is early communication and cooperation between the structural engineer and the mechanical engineer opportunities like placing the ducting systems within conditioned space become viable options whereas if they were working independently the opportunity might be lost. And sometimes the solution to a problem for one discipline can become an opportunity for another discipline to save energy at the same time. So, for example, when a project is required to soundproof walls due to noisy street conditions, some solutions, like high mass walls can have knock on energy efficiency benefits when the energy consultant and the structural engineer also get involved in an integrated design solution. Early involvement of general and specialty contractors in the design phase, even if limited, can also save time and money by giving valuable feedback on issues such as constructability, serviceability, operations and maintenance costs, and relative costs of various options under consideration. It is this kind of coordination between the design team members that prevents time being wasted on dead end solutions and allows for more time to be spent on a better designed building that is not only more energy efficient but more aesthetically pleasing, more comfortable, and healthier—all factors that promote a higher quality of life for the inhabitants.

Photovoltaics

The Tax Credit Allocation Committee (TCAC) has offered to increase the threshold basis boost up to 5% for installing on-site generation. Many affordable housing developers are considering photovoltaics (PV). Some programs, including the California Energy Commission (CEC) Emerging Renewables Program, offer higher rebates and other incentives to affordable housing developers. Below is a summary of Solar/PV programs.

New Solar Homes Partnership[1]

At the direction of Governor Schwarzenegger, the California Solar Initiative was approved by the California Public Utilities Commission (CPUC) on January 12, 2006. The initiative creates a $2.8 billion ten-year program to put solar on a million roofs in the state.

This program changes the way the state's renewable energy incentives and rebates will be managed. The CPUC will oversee a program to provide incentives for existing residential customers and for all non-residential customers.

[1] http://www.gosolarcalifornia.ca.gov/nshp/index.html

The California Energy Commission will manage a 10-year, $350 million program to encourage solar in new home construction, known as the New Solar Homes Partnership (NSHP).

The Energy Commission will work with builders and developers to incorporate high levels of energy efficiency and high-performing solar systems to help create a self-sustaining solar market where home buyers demand energy efficient, solar homes. The NSHP will specifically target single family, low-income, and multi-family housing markets.

During 2006, Californians interested in taking advantage of solar incentives should contact the following:

- For residential and small business customers planning to install solar systems under 30 kilowatts, visit the Energy Commission's http://www.consumerenergycenter.org/erprebate/
- For individual systems 30 kilowatts or larger, contact your local electric or gas utility about their "self-generation" program.

To be eligible for the Southern California Edison (SCE) Self Generation Incentive Program (SGIP), your business or organization must be an SCE customer installing eligible renewable or energy-efficient self generation equipment to serve electric load on a site served by SCE.

Persons or businesses that provide or install self-generation equipment for qualifying SCE customers under SGIP may apply for the incentive on behalf of their client SCE customers.

The California Energy Commission's Renewable Energy Buydown Program provides similar incentives for renewable self generation units under 30 kW.

Solar for New Affordable Housing[1]

Affordable housing developers face different processes in the purchase and installation of PV systems for their projects. To encourage affordable housing developers to include PV in their developments, the California Energy Commission will accommodate their needs by providing a 25 percent higher rebate, not to exceed 75% of the total system cost, if affordable housing applicants meet several specific criteria.

Eligible projects include single- and multi-family developments where at least 20 percent of the project units are reserved for very low-, lower-, or moderate-income households for a period of at least 45 years. Single-family applicants should refer to the New Solar Homes Partnership to determine which category they belong in for the project in progress and understand the reservation timeframe and the documentation required for NSHP funding. Multi-family projects of all sizes are eligible for a 36-month reservation period and must satisfy the requirements in Section A. The PV systems in multi-family projects must serve only the project units reserved for extremely low, very low, lower, or moderate income households and the manager's unit. The PV systems may serve common areas in a multi-family project only where all of the project's units are reserved for extremely low, very low, lower or moderate income households.

Single-family developments are subject to the reservation periods, documentation, and progress requirements specified in Section A or B, depending on which category (Section A or B) the development falls within.

To receive the higher rebate, affordable housing applicants must also satisfy the requirements below:

[1] http://www.gosolarcalifornia.ca.gov/nshp/affordable.html

Regulatory Agreement

The affordable housing project must be undertaken pursuant to section 50052.5, 50053 or 50199.4 of the Health and Safety Code, or other affordable housing law. Applicants must demonstrate this by providing documentation that identifies the statutory basis under which the project was undertaken. In addition, the applicant must provide a copy of the regulatory agreement or approval for the project's development that identifies 1) the project, 2) the number of residential units in the project subject to the affordability requirements, and 3) the applicable affordability requirements for these residential units. The regulatory agreement or approval must expressly limit residency in the affordable residential units to persons with extremely low, very low, lower or moderate income persons as defined by the Health and Safety Code section 50052.5, 50053, 50199.4, or regulations adopted by the California Department of Housing and Community Development.

Individual Meter Requirement

Each residential unit (single-family home, multi-family unit, etc.) for which a system is being installed must have an individual electric utility meter. Applicants must provide documentation from the electric utility confirming service and meter number.

Energy Efficiency

To participate in the NSHP, the homes must also be highly energy efficient. Documentation showing energy savings for each residential unit of at least 15 percent of the combined space heating, space cooling and water heating energy compared to the 2005 Building Energy Efficiency Standards is required for Tier I and at least 35 percent of the combined space heating, space cooling and water heating energy and 40 percent of the air conditioning energy is required for Tier II. Also, documentation must show that all permanently installed lighting is high efficacy except in dining rooms and closets smaller than 70 square feet and that all appliances provided by the builder are Energy Star labeled. When systems are installed to serve the energy needs of a project's common areas, the entire affordable housing project must be at least 20 percent more energy efficient than the current standards specified in the 2005 Building Energy Efficiency Standards. Applicants must provide the energy efficiency calculations performed by an individual who is a Certified Energy Plans Examiner by the California Association of Building Energy Consultants (CABEC). For a list of Certified Energy Plans Examiners, visit the Energy Commission's Web site at: www.energy.ca.gov/efficiency/cabec_roster.htm

Where to Send Applications

The complete reservation application and all supporting documentation must be submitted together.

Information sent in after the initial application may be matched to the application; however, this cannot be guaranteed. Information provided in the application and supporting documentation must be consistent throughout. Applicants should check to ensure all names and addresses are the same throughout all documentation or else provide an explanation. Failure to do so may result in delays or application rejection. If the reservation package is missing required forms, or has omissions or discrepancies, the applicant will be notified that the application has been rejected. Any new application will be subject to the program requirements and funding availability at the time of the new submission.

The complete reservation application must be delivered by FAX to (916) 653-2543 or by mail to:

NSHP Reservation Request
California Energy Commission
1516 - 9th Street, MS-45
Sacramento, CA 95814-5512

If the application is mailed close to a scheduled rebate level decline, it must be postmarked no later than the last day before the decline to be considered for the higher rebate level. No funding will be reserved if an application is incomplete or illegible, has conflicting information or does not otherwise comply with the program requirements. An application will be approved for a reservation based on the date it is deemed complete and not the date it was first submitted. The rebate level and other program criteria applicable on the date the application is deemed complete will apply. Applicants are strongly encouraged to keep copies of all applications and supporting documentation submitted to the Energy Commission.

Because the available rebate amount changes during the term of the program, the Energy Commission recommends that applicants not start construction on participating homes and system installations until they receive a confirmation indicating the amount of funding that has been approved for their reservation. The applicant can track the status of the application at [www.gosolarcalifornia.ca.gov]

California Energy Commission's Emerging Renewables Program[1]

The Emerging Renewables Program provides rebates to consumers who install qualifying renewable energy systems on their property. Your financial incentive may vary according to the system size, technology, and installation method. Affordable housing projects may qualify for an extra 25 percent rebate above the standard rebate, not to exceed 75 percent of the system cost based on meeting additional eligibility criteria.

Funding for the Renewable Energy Program is collected from the ratepayers of four investor-owned utilities in California to support existing, new, and emerging renewable electricity generation technologies.

Technology Type	Size Category	Rebate Offered*
Photovoltaic (Solar cells)**	Less than 30 kilowatts	$2.60 per watt
Solar Thermal Electric Fuel Cells using a renewable fuel***	Less than 30 kilowatts	$3.00 per watt
Wind	First 7.5 kilowatts	$2.50 per watt
	Increments between 7.5 kW and 30 kW	$1.50 per watt

* Rebates for owner installed systems are discounted by 15 percent.

** Applicants may choose to receive incentive payments based on actual system performance instead of rebates.

*** Fuel cells that operate on non-renewable fuels and are used in combined heat and power applications may be eligible for rebates at a later date when funds from other sources, such as the Self-Generation Incentive Program, are no longer available.

Figure 31: Rebates Available for Emerging Renewable Systems[2]

[1] http://www.consumerenergycenter.org/erprebate/program.html

[2] Effective July 1, 2006

CPUC Self-Generation Incentive Program[1]

The PUC's Self-Generation Incentive Program (SGIP) is a statewide program developed to provide incentives for the installation of certain renewable and clean generation. The SGIP provides rebates for systems sized up to 5 MW. Generation technologies involved in the SGIP include photovoltaic (solar) systems, microturbines, fuel cells, and wind turbines.

Incentives vary by technology and fuel type. By utilizing incentives from the PUC, the average cost for a 50 kW photovoltaic system drops from $450,000 to $300,000. For program statistics, evaluation reports, and information on how to apply for incentives, please contact the program administrator for your utility.

[1] http://www.cpuc.ca.gov/static/energy/electric/051005_sgip.htm

Chapter 11:

Resources

Chapter 11 provides an extensive list of resources available for gathering more information on all topics covered in this handbook.

RESOURCES

Residential Energy Efficiency Programs

California Energy Efficiency Programs

www.californiaenergyefficiency.com
Listing of different energy-efficiency programs administered by the four major IOUs in California.

US EPA Energy Star® Program

www.energystar.gov
ENERGY STAR®, a government-backed program helping businesses and individuals protect the environment through superior energy efficiency.

- **Energy Star® Homes Program**

  www.energystar.gov/homes

- **New ENERGY STAR® Homes Guidelines effective July 1, 2006**

  http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.homes_guidelns09

- Listing of **Energy Star® New Homes Partners** in California

  http://www.energystar.gov/index.cfm?fuseaction=new_homes_partners.showHomesResultsandpartner_type_id=SHBands_code=CA

- **Resources for Energy Star Partners**

  http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_partner_resources

- **Energy Star Heating and Cooling – for Residential Buildings**

  http://www.energystar.gov/index.cfm?c=heat_cool.pr_hvac

Pacific Gas and Electric Energy Efficiency and Rebate Program

www.pge.com/res/rebates

- **The PGandE Multifamily Energy Efficiency Rebate Program**

  www.pge.com/003_save_energy/003a_res/multi_family.shtml

- **Other Financial Assistance Programs**

  (http://www.pge.com/res/financial_assistance/

- **The Pacific Energy Center (http://www.pge.com/pec/)** –hosts educational programs and provides design tools, advice, and support in creating energy efficient buildings and comfortable indoor environments.

- **Info for Builders**

  http://www.pge.com/res/energy_tools_resources/efficient_new_homes/info_for_builders/

11

CARE - California Alternate Rates for Energy (PGandE)

www.pge.com/res/financial_assistance/care/index.html

Southern California Edison Residential Rebates and Savings

www.sce.com/RebatesandSavings/Residential

- **SCE Multifamily Energy Efficiency Rebate Program**

  http://www.sce.com/RebatesandSavings/Residential/Multi-FamilyEfficiency/

- **SCE Energy Centers Workshops**

  http://www.sce.com/RebatesandSavings/EnergyCenters/workshops.htm

Southern California Gas Residential Rebate Program

www.socalgas.com/residential/savemoney

- **SCG Multifamily Rebate Program**

  http://www.socalgas.com/residential/contractors/

LIHEAP – Low-Income Home Energy Assistance Program

www.csd.ca.gov/LIHEAP.html

- **LIHEAP Clearinghouse for California**

  http://www.ncat.org/liheap/profiles/California.htm

Flex Your Power

www.fypower.com
A California's statewide energy efficiency marketing and outreach campaign. It is a partnership of California's utilities, residents, businesses, institutions, government agencies and nonprofit organizations working to save energy.

Government Organizations

USA Environmental Protection Agency (EPA)

www.epa.gov

- **Links for New Homes**

  http://www.energystar.gov/index.cfm?c=new_homes.hm_index

- **Home Renovations**

  http://www.energystar.gov/index.cfm?c=home_improvement.hm_improvement_index

- **Products**

  http://www.energystar.gov/index.cfm?fuseaction=find_a_product

- **Information for Home Builders, Lenders, and Raters**

  http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.pt_bldr

- **US EPA Ozone Depletion Glossary**

  http://www.epa.gov/ozone/defns.html

US Dept. of Energy (DOE) Rebuild America

www.rebuild.org
Organization providing energy-efficiency solutions for production housing.

- **US DOE Energy Efficiency and Renewable Energy** (US DOE EERE) - Fact sheets of different energy-efficiency measures related to home, business and transportation.

  www.energy.gov/efficiency/index.html/

- **Insulation Factsheet**

  www.ornl.gov/roofs+walls/insulation/ins_01.html

- **Zipcode Insulation Calculator**

  http://www.ornl.gov/~roofs/Zip/ZipHome.html

US Housing and Urban Development (HUD)

www.hud.gov
Contains energy-related housing policy news. Also discusses the role that energy-efficiency plays in housing programs.

- **On Energy**

  www.hud.gov/offices/cpd/energyenviron/energy/index.cfm

- **Listing of HUD resources**

  www.hudclips.org/cgi/index.cgi

- **US HUD Multifamily Clearinghouse**

  http://www.hud.gov/offices/hsg/mfh/hc/mfhc.cfm

California Energy Commission (CEC)

www.energy.ca.gov
California's energy policy and planning agency.

- **Title 24 Code**

  http://www.energy.ca.gov/title24/index.html

- **List of approved Computer Programs for T24 Compliance Analysis**

  http://www.energy.ca.gov/efficiency/computer_prog_list.html

- **Consumer Energy Center**

  http://www.consumerenergycenter.org/index.swf

- **Cool Roofs**

  http://www.fypower.org/res/tools/products_results.html?id=100123)

- **Appliance Database**

  http://38.144.192.166/efficiency/appliances/index.html

- **Residential Products Guides** - Information on energy efficient products and equipment: appliances, envelope, heating and cooling, lighting, and water efficiency.

  http://www.fypower.org/res/tools/products.html

- **CEC Online Training Videos** - Educational online videos on energy-efficiency in homes, commercial buildings and schools

  www.consumerenergycenter.org/videos/

California Public Utilities Commission (CPUC)

www.cpuc.ca.gov

- List of all CPUC-funded **Energy Efficiency Programs**

  http://www.californiaenergyefficiency.com/

- **Hot Topics – Energy Proceedings** - Energy Related News Proceedings within the CPUC

  http://www.fypower.org/res/tools/products.html)

- Full text of the bill mandating a **new rate structure** for California's investor-owned utilities.

  http://www.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/7185.htm

California Housing and Community Development

www.hcd.ca.gov
Government agency in charge of policy planning to improve the affordable housing market in California.

Energy Efficiency and Multifamily Resources

American Council for an Energy-Efficient Economy

11 www.aceee.org
A nonprofit organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection.

- **The Top-rated, Energy-Efficient Appliances:** including refrigerators, dishwashers, clothes washers, room air conditioners, central air conditioners, heat pumps, water heaters, furnaces, gas boilers and oil boilers

  http://aceee.org/consumerguide/index.htm

Alliance to Save Energy

www.ase.org
A non-profit coalition of business, government, environmental and consumer leaders supporting energy efficiency resources and advocating energy-efficiency policies.

- **Resources for Home Builders**

  http://www.ase.org/section/_audience/eprofessionals/builders

- **Factsheets**

http://www.ase.org/section/_audience/policymakers/policyfacts

American Solar Energy Society (ASES)

www.ases.org
A national membership organization whose mission is to attain a sustainable U.S. energy economy. ASES strives to accelerate the development and use of solar and other renewable energy resources through advocacy, education, research and collaboration among professionals, policy-makers and the public.

California's Energy Resource Centers

www.energyefficiencycenter.com

California Multifamily Collaborative

www.seiinc.org/multifamilyconsortium
An organization of volunteers working to connect people with energy efficiency issues in multifamily housing

Consortium for Energy Efficiency

www.cee1.org/home.html
Contains information on energy-efficient products for residential, commercial and industrial applications.

- **The Residential section** The CEE established **Efficiency Specifications and Factsheets for Residential Appliances**

  http://www.cee1.org/resid/resid-main.php3

Enercom's Energy Depot

www.energydepot.com

- **The Energy Library**

  http://www.energydepot.com/epcorcom/library/library.asp

EnergyGuy

www.theenergyguy.com
Guide to selecting an energy professional and lots of energy efficiency information, including a calculation tool for cost/benefit analysis of solar water heating.

Florida Solar Energy Center (FSEC)

www.fsec.ucf.edu

A series of notes that are useful in gaining a basic understanding of the science and issues related to renewable energy and energy efficiency.

- **Energy Notes**

  http://www.fsec.ucf.edu/Pubs/energynotes/index.htm

- **Design Notes**

http://www.fsec.ucf.edu/Pubs/designnotes/index.htm

- **Fact Sheets**

  http://www.fsec.ucf.edu/Pubs/factsheets/index.htm

- **Home Designs**

  http://www.fsec.ucf.edu/Pubs/homedesigns/index.htm

Global Green USA

www.globalgreen.org
Fosters a global value shift toward a sustainable and secure world through education, advocacy, partnerships, and programs. Global Green USA website provides case studies, publications and information on energy-efficiency measures.

Housing California

www.housingca.org
A statewide coalition of over 1,000 regional and local housing advocates, nonprofit developers and homelessness service organizations

IBACOS

www.ibacos.com
Organization sponsored by the more efficient homes.

Iris Communications

www.irisinc.com

- **Green Building Source**

  http://oikos.com/

- **Iris Catalog** of energy efficient products

  http://oikos.com/catalog/

Lawrence Berkeley National Laboratory (LBNL)

www.lbl.gov

- Internet-based **Home Energy Saver** calculator, designed to help consumers identify the best ways to save energy in their homes, and find the resources to make the savings happen

  http://hes.lbl.gov/

Rocky Mountain Institute (RMI)

www.rmi.org

- **RMI Home Energy Brief #2, Lighting**

  http://www.rmi.org/images/other/Energy/E04-12_HEB2Lighting.pdf

- **RMI Home Energy Brief #3, Space Cooling**

  http://www.rmi.org/images/other/Energy/E04-13_HEB3SpaceCool.pdf

- **RMI Home Energy Brief #4, Space Heating**

  http://www.rmi.org/images/other/Energy/E04-14_HEB4SpaceHeat.pdf

- **RMI Home Energy Brief #5, Water Heating**

  http://www.rmi.org/images/other/Energy/E04-15_HEB5WaterHeat.pdf

- **RMI Home Energy Brief #6, Cleaning Appliances**

  http://www.rmi.org/images/other/Energy/E04-16_HEB6CleaningApps.pdf

- **RMI Home Energy Brief #7, Electronics**

  http://www.rmi.org/images/other/Energy/E04-17_HEB7Electronics.pdf

- **RMI Home Energy Brief #8, Kitchen Appliances**

  http://www.rmi.org/images/other/Energy/E04-18_HEB8KitchenApps.pdf

- **RMI Home Energy Brief #9, Whole System Design**

  http://www.rmi.org/images/other/Energy/E04-19_HEB9WholeSystem.pdf

National Resources Defense Council (NRDC)

www.nrdc.org

- **Affordable Green Housing**

  http://www.nrdc.org/cities/building/fhousing.asp

- **Green Communities** - An initiative of Enterprise in partnership with the NRDC to build environmentally healthy homes for low-income families.

  http://www.greencommunitiesonline.org/

- **San Francisco Green Communities**

  http://www.greencommunitiesonline.org/San-Francisco/

Partnership for Advancing Technology in Housing (PATH)

www.pathnet.org
Promotes innovation in housing technologies.

Rebuild America

www.rebuild.org/index.asp
General information on how energy affects different industries.

US Green Building Council (USGBC)

www.usgbc.org
Information on energy-efficiency resources and the LEED (Leadership in Energy and Environmental Design) certification process.

Building and Energy Efficiency News

Home Energy Magazine
www.homeenergy.org

- **Training Programs in California**

  http://www.homeenergy.org/contrainingguide/index.html#california

Articles:

- **A Review of the Most Efficient Boilers**

  http://homeenergy.org/archive/hem.dis.anl.gov/eehem/95/950909.html

- **A Review of the Benefits of Radiant Barriers in Attics**

  http://homeenergy.org/archive/hem.dis.anl.gov/eehem/92/920704.html

- **Fuel Use in Multifamily Buildings**

  http://homeenergy.org/archive/hem.dis.anl.gov/eehem/99/991112.html

- **New Guidelines for Multifamily Water Heating**

  http://homeenergy.org/archive/hem.dis.anl.gov/eehem/96/960713.html

- **Allocation of Energy Costs**

  http://homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990714.html

- **Green Products for Multifamily Rehab**

  http://homeenergy.org/archive/hem.dis.anl.gov/eehem/00/001114.html

Housing Zone
www.housingzone.com/weeklynews.asp
Provides up-to-date news on the multi-family housing industry, including green building-related news.

Building Raters and Rating Systems

California Association of Building Energy Consultants
www.cabec.org
Association of energy consultants doing Title 24 compliance calculations and energy-efficiency consulting.

CalCERTS
www.calcerts.com
HERS Providers for Title 24 Compliance and ENERGY STAR® Qualified New Residential Construction

- **The CalCERTS Rater Directory**

  https://www.calcerts.com/rater_locator.cfm\

California Home Energy Efficiency Rating System, Inc. (CHEERS)

www.cheers.org
A California Statewide non-profit organization dedicated to promoting energy efficiency

- **Find a CHEERS Associated Company, Rater, or Analyst**

  http://www.cheers.org/ratersearch/default.htm

Cool Roof Rating Council

www.coolroofs.org
An independent organization which has established a system for providing radiative property data on roof surfaces that may improve the energy efficiency of buildings while positively impacting the environment.

National Fenestration Rating Council

www.nfrc.org
A non-profit, public/private organization created by the window, door and skylight industry providing ratings on window, door and skylight products.

Gabel Dodd/Energy Soft LLC

www.energysoft.com
Provider of the EnergyPro Residential and Non-residential **Title 24** compliance software.

MicroPas

www.micropas.com
Residential Title 24 energy compliance software.

Integrated Building Design

- **RMI Home Energy Brief #9, Whole System Design**

  http://www.rmi.org/images/other/Energy/E04-19_HEB9WholeSystem.pdf

Building Physics

- **EDR Design for Your Climate**

  http://www.energydesignresources.com/resource/27/

Building Envelope

General

- **The Building Envelopes Program at Oak Ridge National Laboratory (ORNL)**

  http://www.ornl.gov/sci/roofs+walls/

- **Sun Angle Calculator**

  www.geocities.com/senol_gulgonul/sun/

- **US EPA Ozone Depletion Glossary**

http://www.epa.gov/ozone/defns.html

- **RMI Home Energy Brief #1, Building Envelope**

  http://www.rmi.org/images/other/Energy/E04-11_HEB1Building.pdf

Insulation

- **DOE's Insulation Fact sheet**

  www.ornl.gov/roofs+walls/insulation/ins_01.html

- **DOE's Zip code Insulation Calculator**

  http://www.ornl.gov/~roofs/Zip/ZipHome.html

- **CIMA – Cellulose Insulation Manufacturers Association**

  www.cellolose.org

- **NAIMA – North American Insulation Manufacturers Association**

  www.naima.org

- **PIMA – Polyisocyanurate Insulation Manufacturers Association**

  www.polyiso.org

- **RIMA - Reflective Insulation Manufacturers Association**

  http://www.rima.net/

- **Structural Insulated Panel Association (SIPA)**

  www.sips.org

- **Insulating Concrete Forms Association (ICFA)**

  www.forms.org

Radiant Barrier

- **CEC Energy Videos: Installing Radiant Barrier Sheathing**

  http://www.energyvideos.com/bldvid.php?P=CAandA=5andS=rad

- **RIMA - Reflective Insulation Manufacturers Association**

  http://www.rima.net/

- **Radiant Barriers: A Question and Answer Primer**

  http://www.fsec.ucf.edu/Pubs/EnergyNotes/en-15.htm

- **EERE Consumer's Guide: Radiant Barriers**

  http://www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/my topic=11680

- **Radiant Barrier Fact Sheet**

  www.ornl.gov/roofs+walls/radiant

Cool Roofs

- **Cool Roof Rating Council -** An independent organization which has established a system for providing radiative property data on roof surfaces that may improve the energy efficiency of buildings while positively impacting the environment.

  www.coolroofs.org

- **Consumer Energy Center Cool Roof Site**

  www.consumerenergycenter.org/coolroof/

Windows

- **The Efficient Windows Collaborative**

  http://www.efficientwindows.org/

- **Fact Sheet: Selecting Energy Efficient Windows in California**

  http://www.efficientwindows.org/factsheets/california.pdf

- **RESFEN**

  http://windows.lbl.gov/software/resfen/resfen.html

- **Certified Products Directory Search: Doors and Windows**

  http://cpd.nfrc.org/pubsearch/psMain.asp

Passive Solar

- **Passive Solar Design – Thermal Mass**

  www.txses.org/epsea/mass.html

Heating Ventilation and Air Conditioning (HVAC)

General

- **Energy Star Heating and Cooling**

  http://www.energystar.gov/index.cfm?c=heat_cool.pr_hvac

- **US EPA Ozone Depletion Glossary**

  http://www.epa.gov/ozone/defns.html

- **Air-Conditioning and Refrigeration Institute (ARI)**

  www.ari.org

- **Directory of ARI Verified Equipment**

  www.ceehvacdirectory.org

- **Air Conditioning Contractors of America (ACCA)**

  www.acca.org

  Note: Manuals J: Residential Load Calculation. Manual D: Residential Duct Design, Manual S: Residential Equipment Selection

- **Institute of Heating and Air Conditioning Industries (IHACI)** www.ihaci.org

- **American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)**

  www.ashrae.org

- **Rocky Mountain Institute Home Energy Brief #3, Space Cooling**

  http://www.rmi.org/images/other/Energy/E04-13_HEB3SpaceCool.pdf

- **Rocky Mountain Institute Home Energy Brief #4, Space Heating**

  http://www.rmi.org/images/other/Energy/E04-14_HEB4SpaceHeat.pdf

Residential Central Air Conditioning and Heat Pumps

- **Thermal Energy Storage (TES): PGandE Pacific Energy Center study of TES systems**

  www.pge.com/003_save_energy/003c_edu_train/pec/info_resource/pdf/THRMSTOR.PDF

Room Air Conditioners

- **CEE Super Efficient Room Air Conditioners (SEHA)**

  http://www.cee1.org/resid/seha/rm-ac/rm-ac-main.php3

Domestic Hot Water (DHW)

- **Rocky Mountain Institute Home Energy Brief #5, Water Heating**

  http://www.rmi.org/images/other/Energy/E04-15_HEB5WaterHeat.pdf

- **California Energy Commission's database of water heaters**

  www.energy.ca.gov/appliances/appliance

- **The Energy Guy**

  www.theenergyguy.com/Links_HeatCoolProducts.html#WaterHeating

- **Energy Solutions Center**

  http://www.energysolutionscenter.org/

- **ToolBase Services**

  http://www.toolbase.org

- **American Council for an Energy-Efficient Economy (ACEEE)**

  http://www.sceee.org/consumerguide/topwater.htm

Appliances

- **California Energy Commission Certified Equipment Directory**

  http://www.energy.ca.gov/appliances/appliance

- **Super Efficient Home Appliances Initiative from CEE:**

  http://www.cee1.org/resid/seha/seha-main.php3

- **Rocky Mountain Institute Home Energy Brief #6, Cleaning Appliances** http://www.rmi.org/images/other/Energy/E04-16_HEB6CleaningApps.pdf

- **Rocky Mountain Institute Home Energy Brief #7, Electronics**
  http://www.rmi.org/images/other/Energy/E04-17_HEB7Electronics.pdf
- **Rocky Mountain Institute Home Energy Brief #8, Kitchen Appliances**
  http://www.rmi.org/images/other/Energy/E04-18_HEB8KitchenApps.pdf

Lighting

- **CFL Downlights for Residential Kitchens**
  http://cltc.ucdavis.edu/projects/current-projects/testing-current-projects
- **Dimmable Compact Fluorescent Lighting, WSU Energy Efficiency Fact Sheet**
  www.energy.wsu.edu/documents/building/light/compact_fluor.pdf
- **The Energy Star Kitchen Lighting System (KLS) project**
  http://cltc.ucdavis.edu/projects/references/residential-kitchen-downlights/cec-tb-5.pdf
- **Residential Lighting Initiative**
  http://www.cee1.org/resid/seha/seha-main.php3
- **Rocky Mountain Institute Home Energy Brief #2, Lighting**
  http://www.rmi.org/images/other/Energy/E04-12_HEB2Lighting.pdf

Commissioning

Building Commissioning Association

www.bcxa.org

Finance

Online Feasibility Calculator

www.rebuild.org/lawson/Calculators.asp
Tool for calculating cost effectiveness of energy-efficiency measures.

Energy-Efficient Mortgages

www.pueblo.gsa.gov/cic_text/housing/energy_mort/energy-mortgage.htm
Home buyers looking to buy energy-efficient homes can take advantage of mortgages with more favorable loan terms.

Second-Tier Utility Allowance Schedule

www.harivco.org/EnergyEfficient.htm
Alternative utility allowance schedule utilized by the Riverside Housing Authority for affordable multifamily housing that is 15% moreefficient than required by Title 24.

California Housing Finance Agency (CalHFA)

www.calhfa.ca.gov/multifamily/financing/index.htm

US DOE Building Technologies Program

www.eere.energy.gov/buildings/info/multifamily/finance.html
Tips on planning and financing an energy-efficient development.

EnergyWi$e Construction Funding Directory

www.fundinggreenbuildings.com/
Directory listing donor sources for green buildings.

Lifecycle Cost Analysis

- **Energy Design Resources**

  http://www.energydesignresources.com/resource/131

- **U.S. Department of Energy**

  http://www.eere.energy.gov/femp/information/download_blcc.html

Renewable Energy

Net Metering

www.awea.org/faq/netbdef.html
Metering system to allow consumers to sell electricity generated on-site back to the grid.

Photovoltaic Cells

www.energymatters.org/PVFacts.html

Solar and Wind Financial Incentives

www.californiasolarcenter.org/incentives.htm
Different tax credits available for on-site power generation using solar and wind power.

Case Studies

Brookview Senior Housing

www.designedforcomfort.com/Downloads/PDF/brookview.pdf
102-unit affordable housing retrofit project with cost-effective upgrades, while achieving 40% energy performance improvement over original building design.

20th Street Apartments

www.cyane.com/case%20studies/20THST.pdf
34-unit multifamily rehabilitation project using green materials and efficient building technologies.