9 Steps Towards Green

Introducing Sustainability to
Affordable Housing on a Limited Budget

LISC

Green Development Center

Introduction

The purpose of this guide is to familiarize property managers and other affordable housing professionals with very basic, inexpensive green retrofits from which nearly all buildings can benefit. Green retrofits are a growing and important form of investment in affordable housing. Much of the nation's affordable housing stock is older and uses energy and water less efficiently than market-rate housing. It also frequently suffers from poor ventilation and other health and safety issues. Upgrading these homes holds the potential for billions of dollars in utility savings, an increased quality of life for low-income Americans, and expanded economic opportunity.[1]

However, with the limited capital reserves available for affordable housing, it is especially important to prioritize expenditures in order of return on investment. Many green technologies, which are undoubtedly an important part of the built environment of the future, are more capital-intensive and pay off over a longer period of time than others. While ideally these technologies will be ultimately incorporated into existing affordable housing, in the near future, the economic choice is to target those with a higher ratio of annual benefits to cost.

These benefits can be measured in terms of dollars saved, environmental resources preserved, or benefits to the community. The ultimate selection of retrofits will depend on current usage patterns of the property, the financial resources available for upgrades, the expertise of available retrofit professionals, tenant preferences, and local goals for sustainability.

Please Note:

This guide is not intended to provide individuals with all the knowledge necessary to carry out the following building improvements themselves. There are a myriad of health and safety concerns such as carbon monoxide, natural gas, mold, mildew, radon, asbestos, and other substances that can be aggravated by attempting to improve a building without the proper knowledge. Even tasks that seem simple can involve unseen dangers. One should consult qualified professionals prior to performing any work outlined in this document, and anyone performing the work should have the proper skills and experience.

Costs and payback periods, where provided, are very general. This is due to substantial variations in climate, building attributes, occupant behavior, labor, material, and energy prices, and other factors. For example, electricity prices in the U.S. range from 7.29 ¢/kWh in North Dakota to 27.79 ¢/kWh in Hawaii.[2] Variations such as these dramatically affect costs and payback periods and can alter the estimates given here severalfold. The costs and payback periods here attempt to provide a national average based on a middle-of-the-road scenario.

This guide is intended to complement two of LISC's other green affordable housing resources, *Green Rehabilitation of Multifamily Rental Properties: A Resource Guide* and *Getting Started With Green Preservation.* These documents contain more detailed information on various aspects of greening multifamily buildings and an overview on how to develop plans for deeper, more thorough retrofits. They can be downloaded at http://www.lisc.org/content/publications/detail/7383 and at http://www.lisc.org/content/publications/detail/8298. Also of value are the presentations from LISC's 2009 Greening Affordable Housing Conference, which can be downloaded at http://www.lisc.org/content/publications/detail/17645.

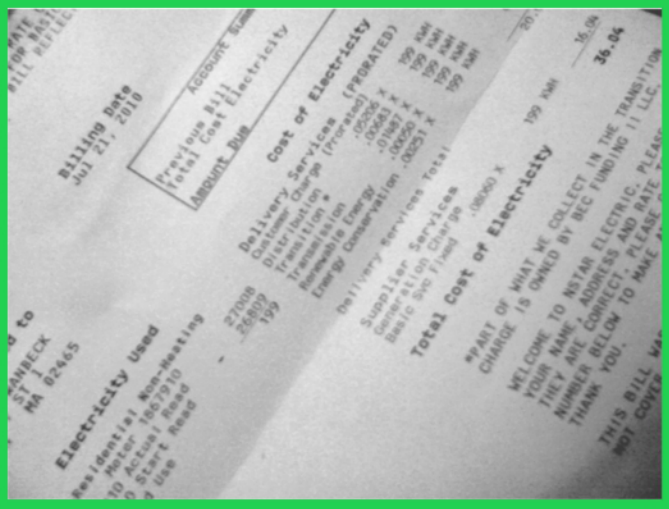
Step 1: Prepare

Gather Bills

Utility use records are very helpful for directing limited resources more efficiently. By comparing tenant vs. common areas, fuel vs. electricity vs. water consumption, and one building in a portfolio vs. another, the largest bills in the largest buildings can be attacked first. Collecting individual unit's bills can be done through fun events such as giveaways, and is an excellent opportunity to initially reach out to residents regarding your green intentions.

Use an Energy Management Tool

This comparative process is made easier by entering your building's data into an energy management tool such as the EPA's Portfolio Manager (http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager) or the New Ecology Inc.'s WeGoWise (http://wegowise.com/). Doing so makes it quicker and easier to understand the property or portfolio's energy and water use on a square-foot basis, compare it with national averages, and track it over time. It is also a valuable tool for tenant education, making it easy to generate informative graphs to share with residents.



Think of the Building as a System

Many of the following summaries illustrate the interconnectedness of all a buildings' components. When one piece fails or underperforms, it affects the performance of all others. For example, replacing incandescent bulbs with CFLs will result in less heat generated by lighting – which will reduce cooling costs in the summer but increase heating bills in the winter. Another example is the fact that airsealing will reduce heating and cooling loads, but can trap moisture and vapors, and therefore requires planning for proper air quality control. As you learn more about green building practices, keep in mind that understanding these balanced relationships is the key to planning for a thorough green upgrade of a property.[3]

Step 2: Perform a Lighting System Retrofit

Replace Incandescent Bulbs with CFLs

Compact Fluorescent Lamps can both save energy and reduce a property's maintenance burden. They are designed to screw into existing sockets to replace incandescent bulbs. Their higher cost is offset by the fact that they use up to 75% less electricity for the same lighting output, and last 6 to 15 times as long, which saves money on both replacement bulbs and labor. Outdoor fixtures may require special bulbs.[4]

Applicability: All housing types. Payback fastest in areas with high electricity costs.
Cost: $3.40 to replace a 100 watt incandescent bulb.
Payback: As little as 3 months.[5]

Replace Incandescent Exit Signs with LEDs

Because exit signs are always on, they represent an opportunity for saving much energy. New exit signs with Light Emitting Diode (LED) illumination use a fraction of the energy, and last many times longer than incandescent signs.[6]

Applicability: Multifamily housing. Payback fastest in areas with high electricity costs.
Cost: $40 each, plus labor.
Payback: Less than 1 year to 4 years.[7]

Replace T12 Bulbs With T8s

Older fluorescent fixtures still have larger, 40-watt "T12" lamps, which can be replaced by thinner, 32-watt "T8" bulbs for energy savings. The existing fixture will require some rewiring and upgraded parts to accept a T8 lamp. In areas with high electricity costs, savings will equal about $4-5 per year per lamp. Newer "Super T8" bulbs, T5 bulbs, and LED-strip lights are yet more efficient options.

Applicability: Multifamily housing. Payback fastest in areas with high electricity costs.

Use Low-Mercury Lamps

All fluorescent lamps contain a small amount of mercury. Some manufacturers, however, offer products with a much lower amount. Mercury content is not typically publicized and one must therefore require vendors to disclose it. When disposing of old lamps, avoid breaking them and take them to a hazardous household waste disposal center. If they are temporarily stored, make sure that they are stored in a contained area so that if they break, the mercury will not be washed away with rainwater.[8]

Equip Lights with Sensors

Occupancy sensors can generate savings of 20-60% where installed.[9] Ideal for building common areas, the sensors will switch lights on only when the space is being used. Outdoor lights can be connected to daylight sensors, rather than timers, ensuring that they remain extinguished while the sun shines. Make sure the lenses of outdoor sensors are cleaned according to manufacturer's recommendations.

Applicability: Multifamily housing. Payback fastest in areas with high electricity costs.

See Also:

- Energy Efficiency Sustainability Primer (Available at the LISC Green Development Center Intranet Page).
- Lighting Systems, page 29 in Bay Area LISC and Built It Green's Green Rehabilitation of Multifamily Rental Properties: A Resource Guide. (http://www.lisc.org/content/publications/detail/7383).

Low Flow Faucets

Low-flow plumbing fixtures save on water bills and reduce the amount of scarce, potable water that is removed from the ecosystem. Energy savings also occur, because less hot water is used. Most modern faucets have aerators, devices that break up the flow of water and limit the total use. If existing kitchen faucet aerators use over 1.5 gallons per minute (gpm), or bathroom faucets use over 0.5, they should be replaced with low-flow aerators. Pre-1992 faucets may have no aerator, in which case a total replacement of the fixture may be considered.

Applicability: Most effective in bathrooms with pre-1992 fixtures.
Cost: $1 each.
Payback: Less than 1 year.

Step 3: Upgrade the Plumbing Fixtures

Low Flow Showerheads

Showerheads should use 1.75 gpm or less. A variety of showerheads are available that incorporate aerating features to achieve lower flow rates. "Laminar flow" is another technology that achieves a low-flow, without aerating. This reduces steam and moisture, which is helpful in humid climates and bathrooms with minimal ventilation. The flow rate from existing showerheads can be measured to determine whether an upgrade is warranted. Because showerheads are an item of particular importance to the daily comfort of building

occupants, managers should take care to select models that perform at an acceptable level, as required by tenants.

Applicability: Most effective in bathrooms with pre-1992 fixtures.
Cost: $10-20 each.[10]
Payback: Less than 1 year - 2 years.

Toilet Upgrades

Old toilets use about 3.5 gallons per flush (gpf), far exceeding today's maximum of 1.6 gpf. Replacement with a new 1.28 gpf toilet is ideal (consult the Maximum Performance Testing Report (http://www.cuwcc.org/MaPTesting.aspx) for toilet performance and pricing). However, older models can also be retrofitted at little expense. This is done by inspecting each toilet for leaks, adjusting or replacing any malfunctioning components as necessary, and then adding a new, adjustable flapper that will control the amount of water left in a tank after a flush.[11]

See Also:

- EPA WaterSense Program (http://www.epa.gov/watersense/).
- HUD's "Retrofitting Apartment Buildings To Conserve Water: A Guide for Managers, Engineers, and Contractors" (http://www.huduser.org/portal/publications/destech/retrofitting.html).
- Plumbing Systems, Fixtures, and Fittings, page 53 in Bay Area LISC and Built It Green's "Green Rehabilitation of Multifamily Rental Properties: A Resource Guide" (http://www.lisc.org/content/publications/detail/7383).

Step 4: Tune-Up the Hot Water System

Reduce Water Heater Temperature Setting

Many hot water heaters are set to an excessively high temperature. Energy is wasted when heat escapes through the walls of the storage tank.120°F is an adequate temperature setting for most households. Water heaters that do not have a numerical dial can be adjusted by measuring the temperature at tenants' taps with a thermometer. Adjusting the temperature setting on the heater will save about 3-5% of water heating costs per 10°F reduction.[12]

Lowering the hot water setting also improves tenant comfort and safety. Scalding accidents can occur within seconds at excessively high water temperatures.[13] However, managers of multifamily properties should take care to ensure that water does not fall below any minimum temperatures at tenants' fixtures required by local housing laws. Also, properties with occupants who have suppressed immune systems should keep their water stored at 140°F.[14,15]

Applicability: All housing types and locations.
Cost: None.
Payback: Immediate.

Insulate Hot Water System

Heat lost through the walls of older water heaters with no or minimal built-in insulation can be reduced by 25-40% by adding an inexpensive insulating blanket. Take care to consider, however, that gas powered heaters necessitate care to avoid creating a fire hazard or interfering with venting. Also, some electric water heaters' warranties may be voided by the application of a blanket; follow the manufacturer's recommendations. Pipes, particularly

those running through unconditioned spaces, should also be insulated.

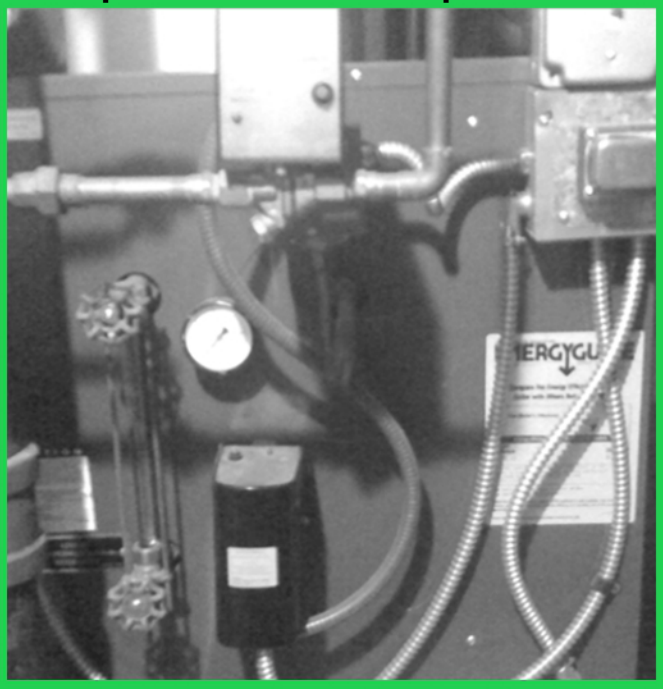
Applicability: Older, electric water heaters, particularly those located in unconditioned spaces.
Cost: $10-$20 single family, $40-$60 multifamily.
Payback: 1 year or less, if the existing water heater is sufficiently inefficient.

Repair Leaking Pipes
Pipes that are leaking into a wall cavity can damage insulation, rust or rot the building structure, and create an environment for mold to grow. Any hot water lost is also a waste of energy. Any signs of leakage should be investigated and repaired.

Maintenance
Flushing the water heater tank can remove sediment and scale that impede efficiency. A professional technician can also test the unit for carbon monoxide spillage, flame rollout, and gas leaks that may pose a hazard to tenants.

See Also:
• DOE's Water Heater Page on EnergySavers.gov (http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12760).
• Water Heating Efficiency, pages 32-33 in Bay Area LISC and Built It Green's Green Rehabilitation of Multifamily Rental Properties: A Resource Guide (http://www.lisc.org/content/publications/detail/7383).

Step 5: Tune-Up the HVAC System



Furnace and Air Conditioner Maintenance
Both multifamily and single family heating and cooling systems can dramatically improve efficiency and interior air quality through maintenance by a qualified technician.

Duct Sealing and Insulation
Ducts that pass through unconditioned spaces must be insulated, or will lose a great deal of energy before they ever reach the conditioned space. These areas should be insulated with rigid fiber board or fiberglass. Air leakage in ducts is also a major area for energy loss, and can be solved with duct mastic. Before any air sealing is done, however, a qualified professional should test for interior air quality hazards in the building to ensure that eliminating air leaks is safe.

Applicability: Units with central air conditioning and / or forced air heating.

Thermostatic Radiator Valves
In older buildings using a central hydronic heating system, boilers tend to send heat throughout the entire building at once, overheating some areas. This can be fixed by installing thermostatic radiator valves on individual radiators, allowing for local control. After a tenant adjusts these valves, the radiator will close off when the temperature of the room rises above the setting.

Applicability: Older buildings in cold climates, with hydronic heating systems.
Cost: $20 each.
Payback: 1-5 years.[16]

Foil Backing Behind Radiators

The backside of radiators heats up the wall, which in turn radiates energy to the outdoors. An inexpensive piece of radiant barrier insulation can be installed behind radiators to redirect this energy back towards the tenant space. This can be a piece of foil-faced cardboard.[17]

Applicability: Older buildings in cold climates, with hydronic heating systems.

Install Ceiling Fans

Air movement is one of the determinants of occupant comfort. Ceiling fans can greatly reduce tenant dependence on air conditioning. They also have the effect of maintaining air circulation, beneficial to interior air quality. It is fairly easy to replace an existing ceiling light fixture with a ceiling fan-light.

Air Conditioner Covers

Provide tenants with covers for through-wall air conditioners to block air leakage during the winter. This will stop both airflow and conductive heat from escaping through the unit. Both fabric and rigid foam versions are available; generally, the rigid foam versions have a higher R-value but are more costly and may require more time and planning from management.

See Also:

- Energy Efficiency Sustainability Primer (Available at the LISC Green Development Center Intranet Page).
- Heating and Cooling, pages 34-38 in Bay Area LISC and Built It Green's "Green Rehabilitation of Multifamily Rental Properties: A Resource Guide" (http://www.lisc.org/content/publications/detail/7383).

Step 6: Take Steps to Improve the Indoor Air Quality

CO and Gas Leak Testing

Natural gas and liquid propane are unhealthy to breath and can explode in concentrated quantities. A gas leak is also a waste of fuel. Carbon monoxide (CO) causes health problems that range from mild headaches and nausea to death, depending on concentrations. It is a byproduct of heating oil and natural gas combustion that occurs in furnaces, boilers, water heaters, ovens, stoves, and dryers. These devices can all be tested to ensure that they are burning cleanly and thus not producing excessive amounts of CO, and that air pressure differences are such that the CO is traveling directly through the flue and out of the house. Overall levels of CO in the interior can also be tested. This testing will occur during a proper energy audit, as discussed later in this document.

Inspect for Any Signs of Moisture

Moisture can come from a variety of sources including exterior weather, soil, leaking pipes, showers, and cooking. A moist environment can aggravate mold, mildew, and dust mites. It can also damage insulation and structural materials. The property should be inspected for any signs of moisture such as mildew, condensation, peeling paint, and rot. If any are found, the source must be traced and then dealt with appropriately, rather than simply dealing with the symptoms.

Exhaust Fans

All bathrooms and kitchens should be vented to the exterior, in order to control moisture and minimize the potential for carbon monoxide and gas leak dangers. Inspect the ducting, if accessible, to make sure it is continuous, sealed, goes to a proper termination clear through the shell of the building, and does not terminate in the attic, basement, or crawlspace. Installers should use Energy Star qualified fans - which use 70% less energy than standard fans – as well as ensure that the fan is not too loud.[18] Bathroom fans should use controls that automatically vent moisture. These include humidistats (moisture sensors), timers connected to lightswitches, or simply the installation of a continuously

running fan.[19] Intermittent bathroom fans should exhaust a minimum of 50 CFM (cubic feet per minute). The minimum is 20 CFM if the fan runs continuously. Kitchen exhaust fans should exhaust a minimum of 100 CFM intermittent, or, preferably, 25 continuous. All exhaust fans should be tested to determine if adequate air is actually flowing through them. Any existing ventilation systems should also be cleaned, sealed, and balanced.[20]

Low-VOC Paint

Any new coats of paint that are applied in the course of a retrofit should be low in Volatile Organic Compounds (VOCs). VOCs are emitted gasses found in a variety of building materials, including most kinds of paint. There are thousands of different of compounds, which produce a variety of health effects including ear, nose, and throat irritation, worsening of asthma symptoms, and possibly cancer over long periods of exposure.[21] Low-VOC paints are now widely available in a large assortment of colors and will provide a healthier environment for occupants.

See Also:

- IAQ Sustainability Primer (Available at the LISC Green Development Center Intranet Page).
- Heating and Cooling, pages 34-38 in Bay Area LISC and Built It Green's Green Rehabilitation of Multifamily Rental Properties: A Resource Guide. (http://www.lisc.org/content/publications/detail/7383).
- EPA's IAQ Page (http://www.epa.gov/iaq/index.html).
- Wall and Ceiling Finishes, and Bathroom Improvements, pages 43 and 52 in Bay Area LISC and Built It Green's Green Rehabilitation of Multifamily Rental Properties: A Resource Guide.

Step 7: Plan for Future Operations and Maintenance

Purchase Green Cleaning Products

Cleaning products can harm the health of residents and staff, particularly through eye, skin, and respiratory irritation. They can also be hazardous to the environment when disposed of, often overloading water with nitrogen and phosphorous.[22] Select products that are certified by the Environmental Choice or Green Seal programs, or are otherwise low in VOCs and other harmful substances. Staff should also follow standard procedures for cleaning, keeping good hygiene, storing products, managing spills, and disposing of products.[23]

Plan for Future Capital Investments to Use Green Materials

Many green retrofit investments are impractical because they would require the removal of existing valuable components, or may be too costly to undertake at present. However, managers can plan to incorporate these features in future, more thorough renovations. For example, when a new roof is required managers can make sure to use durable, environmentally sound materials that meet the Energy Star requirements for cool roofs. Cool roofs are those that reflect the sun's rays and thus reduce cooling loads and the urban heat island effect. New windows should be energy efficient models. Toilets and appliances should be high-efficiency models. New siding, flooring, carpeting, cabinetry, paint, paving, and just about any other type of material, can all be specified to meet their own green standards which address a variety of environmental issues. Otherwise, replacements done without this forethought will miss valuable opportunities to introduce green qualities.

One can also ensure that any services performed for the building are undertaken with a green approach. If a capital needs assessment (CNA) is planned, it should be a green CNA. This is a more synergistic approach that will take into account operating costs, identify fundamental design flaws, and make recommendations as to how to green the property. A traditional CNA, on the other hand, focuses only on physical deterioration that must be repaired in order to return the building to it's original condition, regardless of how fundamentally flawed and inefficient the original design may be.[24]

Perform Retrocommissioning

Retrocommissioning is a process of improving the functioning of an existing building's equipment and systems. In addition to testing the building's performance and implementing improvements, the retrocommissioning process also ensures that owners and staff receive training on how to maintain these improvements.[25] Retrocommissioning works to ensure that simple errors do not negate the expected energy savings from retrofit investments, reducing risk to owners and lenders. This activity often occurs in conjunction with, and subsequent to, an energy audit.

Applicability: Multifamily housing.
Cost: $0.30/ft^2
Payback: 1-2 years.[26]

Place all Manuals in One Binder

Simple lack of awareness of building system maintenance is often the cause of subpar performance. Consolidating operations manuals assists maintenance staff in keeping up with the manufacturers' maintenance schedules and other recommendations. If not covered during retrocommissioning, consider holding a staff training session on new green system operation.

See Also:

- LISC's "Green Operations and Maintenance: Toolkit and Buyer's Guide" (http://www.lisc.org/content/publications/detail/8209).
- EPA's "IAQ Building Education and Assessment Model" (http://www.epa.gov/iaq/largebldgs/i-beam/index.html).
- California Commissioning Collaborative's "California Commissioning Guide: Existing Buildings" (http://www.documents.dgs.ca.gov/green/commissionguideexisting.pdf).

Step 8: Get an Energy Audit, Followed by Airsealing and Insulation

Energy Audit

An energy audit is a relatively inexpensive procedure that will pay for itself. In addition, utilities often have programs that either pay for audits in full or subsidize the cost. It is wise to have an audit done prior to any airsealing or insulation. The reasons for this are twofold:

Blower Door Test, Performed During Energy Audit

Firstly, airsealing is a powerful means of reducing a building's energy use, but one must take care to ensure that it does not negatively impact occupant health and safety. Buildings require a certain quantity of fresh air ventilation over a given period of time. In an old building, much of this ventilation may be occurring through the very air leaks that airsealers attempt to close. Pollutants such as carbon monoxide and mold, which may have been flushed out by a building's leakiness, can build up to hazardous levels after airsealing is done. It is therefore important to have a qualified professional inspect the building for potential hazards before performing any airsealing, and to test the building afterwards for adequate airflow. This is a quantity measured in cubic feet per minute (CFM) and referred to as the Minimum Ventilation Guideline (MVG) or Base Airflow Standard (BAS).

Secondly, it is simply too easy to waste limited funds by installing insulation in suboptimal locations, or by installing it improperly. For example, attics and ducts should only be insulated after all pathways of air leakage have been sealed. Otherwise, the insulation's effectiveness will be reduced, possibly to the

Spray-foam Insulation

point of uselessness. An energy audit will also determine the added insulation necessary to achieve the proper R value for a building's climate, taking into account the existing insulation and other building materials. Auditors will also be familiar with standards regarding proper moisture control and other health and safety measures that must be included in any airsealing or insulation activities.

Airsealing

The most effective places to airseal are generally at the tops and bottoms of buildings. This is due to a phenomenon called the "stack effect" in which air is drawn upwards through a building due to the fact that hot air rises. In attic areas, plumbing and electrical penetrations, soffits, wall top plates, chimney bypasses and ducts are some of the most effective places to seal. At the bottom of the structure, similar penetrations are also valuable sealing opportunities, as is the frequently overlooked rim joist. Also look for leaks anywhere two separate building materials come together, such as overhangs, corners, bays, and bulkheads.[27] Loose window sashes should be cleaned and weatherstripped.

Insulation

Common insulating opportunities include attic spaces and hatches, knee walls, band joists, floors above unheated garages, overhangs, basements, and crawlspaces. Blow-in insulation types such as cellulose and rockwool are excellent for retrofits because they can be installed with minimal damage to existing finishes and fill in tight, oddly shaped spaces. Both are largely composed of recycled materials, and are superior to fiberglass batt insulation due to these properties.[28] Spray-foam insulation provides a high R-value per inch and fills in small gaps, which is beneficial when there is limited space in the wall cavity. Some forms also provide an air and vapor barrier. Most types are flammable, however, and require encapsulation in a fire-rated material. Spray-foam is also more expensive than cellulose or fiberglass. Other insulation types, such as cotton fiber, can also be considered for their high recycled content. Any insulation used should be free of added formaldehyde.

Insulation Installer with Blower Machine and Various Insulation Types

See Also:

- Weatherization Sustainability Primer (Available at the LISC Green Development Center Intranet Page).
- Krigger, John. "Residential Energy: Cost Savings and Comfort for Existing Buildings."
- Building Performance Institute Website (http://www.bpi.org/).

Step 9: Tenant Education

Organize a Tenant Education Meeting

Prior to developing a scope of work, meet with tenants to discuss expectations and concerns regarding the retrofit process. Where possible, use existing tenant organizations to promote this event. When there is no tenant organization, try to build on any relationships with tenants that you have. Promote the event as a practical discussion regarding construction work that will be happening in the building. Keep in mind that tenant education is very building-specific and community-specific.

Discuss Utility Use Patterns with Residents

Reach out to tenants and show utility use with graphs generated from an energy management tool, comparing their actual use with a standard. A visual representation makes a more persuasive statement, and will help to prioritize conservation efforts. Explain basic steps such as turning off computers at night, using fans rather than air conditioning when possible, operating thermostatic controls, removing window air conditioner units in the winter (plan ahead for storage, and provide insulating covers), and buying Energy Star products. Link these measures with a sense of empowerment and the ability to be wise with one's own finances, taking advantage of opportunities that most people miss.

Ensure Tenants Have Operational Knowledge

After the retrofit work is completed, provide tenants with written materials on the correct usage, maintenance, and replacement of the new features. These materials, as well as all manuals for equipment controlled by tenants, should be compiled in one binder. Also schedule a walk-through of the residence in order to ensure understanding and answer any questions. Connect this operational knowledge with the conservation of resources that it is intended to advance.

Promote Green Cleaning

Explain the importance to family health of avoiding the introduction of high-VOC products into the home, and encourage tenants to use products certified by the Environmental Choice or Green Seal programs. These products are now a widely available choice.

Introduce Tenants to the Recycling Program

Make the impact of recycling "real" by putting it in easily comprehensible terms – such as "the energy from recycling a glass jar saves enough energy to power a computer for 25 minutes."[29] Share with tenants the actual amount of CO2 emissions saved. Where applicable, link the program with benefits to the community through improvements in air quality resulting from the reduction in waste transfer stations and incinerators.

Achieving Sustainability

Green retrofits of affordable housing encompass all three pillars of sustainability – Environmental, Economic, and Social. The preceding improvements have the capacity to reduce environmental deterioration, improve the financial situation of property owners and household budgets alike, and preserve affordable housing while improving the daily life of its residents. Because less than 2% of residential buildings are replaced annually,[30] we can expect currently existent housing to remain an important part of our built environment for many years. Achieving sustainability must therefore incorporate the renewal of this resource as a core strategy. The scale of the task dictates that physical advancement must be incremental but persistent, starting small and building imperceptibly into profound change. In a way, the first steps on this journey are the most important. The need to enact these basic measures is a great opportunity for professionals involved in affordable housing management to take part in solutions of global importance.

Endnotes

[1] Abramowitz, David. *Green Affordable Housing: Within Our Reach.* Center for American Progress. December, 2008. <http://www.americanprogress.org/issues/2008/12/pdf/green_housing.pdf> Accessed July 29, 2010.
[2] U.S. Energy Information Administration, *State Energy Profiles.* <http://tonto.eia.doe.gov/state/state_energy_rankings.cfm?keyid=18&orderid=1> Accessed June 17, 2010.
[3] Building Performance Institute, *Your house is a system* <http://www.bpi.org/homeowners_benefits.aspx> Accessed July 6, 2010.
[4] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Energy Savers: Compact Fluorescent Lamps.* <http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12050> Accessed June 14, 2010.
[5] Bay Area LISC and Built It Green, *Green Rehabilitation of Multifamily Rental Properties: A Resource Guide.* 29.
[6] ENERGY STAR Program, *Save Energy, Money, and Prevent Pollution with Light-Emitting Diode (LED) Exit Signs.*<http://www.energystar.gov/ia/business/small_business/led_exitsigns_techsheet.pdf> Accessed June 14, 2010.
[7] Bay Area LISC and Built It Green,. 29.
[8] Green Building in Alameda County, *Builder's Guide to Reuse and Recycling.* 30. <http://stopwaste.org/docs/buildersguide-05.pdf> Accessed June 23, 2010.
[9] Thorne, Jennifer and Steve Nadel. *Commercial Lighting Retrofits: A Briefing Report for Program Implementers.* American Council for an Energy-Efficient Economy. Washington, D.C. April, 2003. <http://www.aceee.org/pubs/a032full.pdf> Accessed June 14, 2010.
[10] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Energy Savers: Reduce Hot Water Use for Energy Savings.* <http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13050> Accessed June 16, 2010.
[11] U.S. Department of Housing and Urban Development, *Retrofitting Apartment Buildings to Conserve Water.*10-11. <http://www.huduser.org/portal/publications/destech/retrofitting.html> Accessed June 21, 2010.
[12] American Council for an Energy-Efficient Economy, *Consumer Guide to Home Energy Savings: Condensed Online Version.* <http://www.aceee.org/consumerguide/waterheating.htm> Accessed June 11, 2010.
[13] Consumer Product Safety Alert, *Document 5098: Tap Water Scalds.* <http://www.cpsc.gov/cpscpub/pubs/5098.pdf> Accessed June 11, 2010.
[14] ASHRAE, *Standard 12-2000: Minimizing the Risk of Legionellosis Associated with Building Water Systems.* 4. <http://www.e-nergias.com/www/tecnicos/2005/ashrae_12.pdf> Accessed June 28, 2010.
[15] OSHA, *Technical Manual.* Chapter 3 Section 7: Legionnaire's Disease. <http://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_7.html> Accessed July 7, 2010.
[16] NYSERDA report 95-14, "Thermostatic Radiator Valve (TRV) Demonstration Project," 1545-EED-BES 91, September 1995, may be obtained from the National Technical Information Service at www.ntis.gov/search/index.aspx by searching for PB96-198163. Accessed June 11, 2010.
[17] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Energy Savers: Heat Distribution Systems..* <http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12580>
[18] ENERGY STAR Program, *Fans, Ventilating For Consumers.* <http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=VF> Accessed June 18, 2010.
[19] Bay Area LISC and Built It Green, 52.
[20] Community Preservation Corporation, *Ten Common Sense Upgrades for Multifamily Buildings.* 2. <http://www.communityp.com/docs/Ten_Common_Sense_Upgrades.pdf> Accessed June 28, 2010.
[21] Minnesota Department of Health, *Volatile Organic Compounds (VOCS) In Your Home.* <http://www.health.state.mn.us/divs/eh/indoorair/voc/index.htm> Accessed June 18, 2010.
[22] Environmental Protection Agency, *Greening Your Purchase of Cleaning Products: A Guide to Federal Purchasers.* <http://www.epa.gov/epp/pubs/cleaning.htm> Accessed June 21, 2010.
[23] U.S. Green Building Council, *LEED for Existing Buildings: Operations and Maintenance.* 62. September, 2008. <https://www.usgbc.org/ShowFile.aspx?DocumentID=3617> Accessed June 21, 2010.
[24] Vermeer, Kimberly, and LISC, *Getting Started with Green Preservation.* 14-15. <http://www.lisc.org/content/publications/detail/8298>.
[25] California Commissioning Collaborative, *California Commissioning Guide: Existing Buildings.* <http://www.documents.dgs.ca.gov/green/commissionguideexisting.pdf> 2006. 4. Accessed June 16, 2010.
[26] Mills, Evan. *Building Commissioning.* Lawrence Berkeley National Laboratory, July 21, 2009. <http://cx.lbl.gov/documents/2009-assessment/LBNL-Cx-Cost-Benefit.pdf> Accessed June 16, 2010.
[27] Building Performance Institute, *Technical Standards for Certified Shell Specialists.* 6. <http://cbpca.org/documents/Shell_Standards.pdf> Accessed June 17, 2010.
[28] Bay Area LISC and Built It Green, 19.
[29] Montana Department of Environmental Quality *Recycling Glass in Montana*, <http://deq.mt.gov/recycle/Glass/default.mcpx> Accessed July 6, 2010.
[30] Memorandum of Understanding Between the U.S. Department of Energy and the U.S. Department of Housing and Urban Development Regarding Building Energy Programs and Energy Efficient Mortgages. Signed by Secretaries Chu and Donovan. January 13, 2010. 2. <http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/ns/hud_doe_mou.pdf> Accessed July 29, 2010.

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