

The Energy Efficiency Loading Order

In what order should I pursue energy efficiency upgrades? How do I get the most bang for my buck?

There are many reasons property owners retrofit their buildings. Retrofits are sometimes tied to appliance repairs or replacements, or are needed to address structural damage, health, safety, or comfort issues. Energy is not often the motivating factor behind retrofits; however, with some forethought and planning, incorporating energy efficiency improvements into all types of retrofits can result in increased property value, and health and safety improvement, in addition to lower energy and water bills. Incorporating energy efficiency into existing retrofits can produce disappointing results if cost effectiveness, interactive effects, and careful analysis and design are not considered when designing the retrofit. Energy professionals are trained to understand these building science concepts, and can provide valuable design support and recommendations. Building science includes the study of how energy features in a building impact and interact with each other. For instance, if space heaters are in need of replacement, if building air leakage, insulation, duct leakage, and thermostats are first corrected, smaller high performance heating units can replace the existing space heaters.

Each building is unique, and your building's age, condition and renovation history need to be considered when determining energy efficiency improvements. Whether you are planning renovations or equipment replacements, or are pursuing energy efficiency upgrades by themselves, consider the following "energy efficiency loading order." It is almost always more cost effective to reduce the need for energy first by maintaining and improving existing equipment, followed by replacement of equipment with high performance models, when they reach the end of their useful life. Renewable energy generation systems (solar hot water and solar energy [PV] systems) should be considered last, after all cost effective means of reducing the energy use are installed first. This approach optimizes cost effectiveness, maximizes energy savings and comfort, and often results in the need for smaller appliances and systems. The loading order detailed below includes general recommendations. Consult an energy efficiency expert for specific recommendations to address your building's needs.

1. Building Envelope (walls, ceiling, floors)

A. Seal the Building Envelope First: Reduce Infiltration and Drafts

Air leakage, or infiltration, is movement of air through cracks and leaks in the building walls, ceilings and floors (known as the building envelope). Sealing cracks and leaks reduces the load on heating and cooling systems, helps prevent moisture from collecting in and damaging walls, and

makes the living spaces more comfortable by reducing drafts. Insulation does not stop air movement, so if you are considering increasing the insulation levels, always seal the building envelope at the same time for a significant increase in energy savings with minimal additional cost. Common air sealing techniques include caulking and weather-stripping around doors, windows, plumbing fixtures, and ceiling fixtures, and installing foam gaskets behind electric outlets and switch plates. To learn more about building air sealing [click here](#).

B. Add Insulation to Restrict the Flow of Heat and Cold

Properly installed insulation minimizes heat flow through the envelope, keeping the building comfortable and reducing the need for heating and cooling. The most common insulation material in residential buildings is fiberglass batts (blankets) and blown-in fiberglass or cellulose (shredded newspaper) insulation, which is blown into building cavities or attics. Insulation is measured by the material's resistance (R-value) to heat transfer, so a higher R-value will provide more insulating value. However, as described above, the benefits of insulation are reduced by air leakage through the walls. Improving the insulation **and** sealing air leaks at the same time is most cost-effective way to reduce energy waste and make the most of your retrofit dollars. As improper installation decreases the performance of the insulation, it is important to have the installation installed correctly. Roof and attic insulation are among the less expensive and more convenient measures to install, and can be some of the most impactful for lowering energy bills in low-rise buildings. [Click here](#) for more information on building insulation.

C. Select the Right Glazing: Windows, Doors and Skylights

Windows can be one of the building's most attractive features, and can contribute to undesirable heat loss in winter and heat gain in summer. As part of the building envelope, the most cost effective measures to improve window performance include caulking around windows to reduce infiltration and drafts, and replacing seals and stops. Proper use of curtains can reduce the need for heating/cooling: open curtains during the winter days to warm the interior and close them at night to protect against cold drafts; in summer close south-and west-facing curtains during the day to reduce the need for the air conditioning. Window replacements are usually expensive and can take many years to pay off in energy savings. However, if your building has single pane windows (common in multifamily buildings over 25 years old), after increasing insulation levels and reducing air leakage, consider window replacement with double-pane, high performance glass and low-e coatings to reduce summer heat gain. Window upgrades can provide many non-energy benefits as well, such as improved functionality, increased security, reduced noise, reduced condensation and increased aesthetics. For more information about the types of window and door products, [click here](#).

2. Hot Water, Dishwashers, Clothes Washers

Water heating is the largest energy use in the average multifamily building, at 40% of total energy use. Below are many low- and no-cost ways to reduce energy (and water) use associated with water heating,

followed by options of increasing expense. Best options will vary, depending upon equipment age and condition.

A. No- and Low-Cost Water Saving Measures

If there is no immediate need to replace water heaters, insulate existing tanks with blanket-type insulation wraps, insulate exposed water pipes (hot and cold) with pipe insulation, and install aerating and low flow faucets and showerheads. These measures save both energy and water. [Check here](#) for current programs and kits for tenants spaces from a California utility company.

B. Replacements

Equipment that is regularly maintained and calibrated in accordance with manufacturer specifications will last longer and run more efficiently. But if the water heaters are at or near the end of their useful life, select more efficient units that will be most appropriate for your needs. While a more energy efficient water heater may cost more initially, energy savings will continue during the life of the appliance, typically 10 to 15 years. Look for the ENERGY STAR and EnergyGuide labels when selecting new units. If you need to replace new dishwashers or clothes washers, consider buying ENERGY STAR models for these as well, to save energy and water. Current rebate information can be found [here](#).

C. Solar Water Heaters

Solar water heaters are more cost effective if existing water heaters use electricity, or if you have an un-shaded south and west facing locations for solar panels. However, solar water heaters have longer payback periods than other options above, which should be explored first. Solar water heaters offset the use of electricity or natural gas, and reduce greenhouse gas emissions associated with burning natural gas. Again, look for the ENERGY STAR label, and for systems certified by the Solar Rating and Certification Corporation ([SRCC](#)).

3. Space Heating

Space heating is second largest energy use in multifamily buildings, averaging 22%. When combined with the water heater, they can account for over 60 % of a multifamily building's total energy use.

A. Maintenance

Properly maintaining heating equipment can save money and increase comfort. Change filters on recommended schedules, and make sure registers are kept clean and are not blocked by furniture, carpeting or drapes. Equipment that is regularly maintained and calibrated in accordance with manufacturer specifications will last longer and run more efficiently.

B. Programmable Thermostats

You can save an estimated 10% a year on heating and or cooling by programming thermostats to turn units off when not needed. Programmable thermostats can store multiple daily settings (wake up, leave, return home, bedtime), and some can be programmed differently every day of the week. Set programmable thermostats as low as is needed for winter comfort, and as high as comfortable in summer to reduce energy costs. Match occupant schedules so systems do not run all night, or when the spaces are vacant. A five minute movie on selecting and setting programmable thermostats can be found [here](#).

C. Air Ducts

Ducts, used in some buildings, deliver heated or cooled air from furnaces or air conditioning systems to tenant or common spaces. Ducts are made of sheet metal, fiberglass, or flexible materials. Ducts that are leaky or poorly insulated can add hundreds of dollars a year to heating and cooling bills, and can also draw unconditioned, dusty, or moldy air into the air supply entering tenant or common spaces. [Sealing and insulating ducts](#) is usually very cost effective but should be done by a professional. Ducts should be sealed at the supply, return, joints, and at registers using mastic, butyl tape, or foil tapes (not duct tape). Insulation, or duct wrap, can be added to existing ducts, and should be at least R-6. If ducts are being installed for the first time, or are in need of replacement, select ducts insulated to at least R-8. A duct sealing informational brochure can be found [here](#).

D. Replacements

When space heaters are at or near the end of their useful life, replace them with high performing models. Units with high Annual Fuel Utilization Efficiency (AFUE) ratings will save energy and perform better. ENERGY STAR models exceed the minimum (78% rating) and rebates may be available to help offset higher costs. When replacing exhaust fans, consider high-efficiency low-noise models. Click [here](#) for ENERGY STAR tips about saving on heating costs.

4. Lighting (11% of total energy use)

Switching to energy efficient lighting is one of the fastest ways to noticeably cut your energy bills, and will provide the most savings in fixtures that are used the most. Timers and motion sensors (compatible with the energy-efficient bulbs you want to use) can be installed in infrequently used spaces such as bathrooms and closets, to save even more money by reducing the amount of time the lights are on when not needed. Use natural daylighting when heat gain will not increase air conditioning use. Compact fluorescent lamps

(CFLs) with electronic ballasts use about one-fourth the energy of standard incandescent bulbs (but contain a small amount of mercury, and must be recycled). They can be used in desk lamps, ceiling fixtures, and outdoor porch and flood lights. LED lights use about 20 to 25% of the energy of traditional bulbs and perform better in cooler locations. They come in screw-in bulbs, desk lamps, kitchen under-cabinet lighting, outdoor flood and other lights. For best results, match the bulb with the location and lumens (brightness of the bulb) needed, and look to [ENERGY STAR](#) for more information about lighting products and options.

5. Refrigerators, Computers, and Other Appliances

Appliances (refrigerators, computers, stoves, televisions, DVD players, toasters, video game systems, etc.) account for about 17% of energy costs, with refrigerators, computers, and cooking at the top of the list. There are two costs associated with appliances: the price tag to purchase, and the ongoing cost of use it during its lifetime. When shopping for new appliances consider both costs. Look for ENERGY STAR and EnergyGuide labels, as they usually substantially exceed minimum state or federal standards. Efficient models will save energy and water which benefits tenants, building owners and the environment. Even with ENERGY STAR labeling and “sleep” or “eco” mode, turn off and unplug computers, TVs, DVD players, phone chargers, and video game systems when not in use to avoid what are known as “phantom loads.” For current information about appliance rebates, [click here](#).

6. Central and Room Air Conditioning

Air conditioning, although only 2% of energy use in multifamily buildings, impacts California’s statewide energy system reliability. Air conditioning that is needed only for a few of the hottest days each year, requires that special “peaking” power plants are brought online, at a very high cost, to meet the increased electricity demand. Over-sized, older, less efficient cooling equipment, underutilized programmable thermostats, and leaky ducts result in wasted energy and more stress on the State’s energy system. Reducing air conditioning energy use benefits all Californians and our environment as well. Consider using interior fans instead of or in addition to air conditioners to spread the cooled air through the space. See 3.B above, about proper use of programmable thermostats, and 3.C. about the importance of repairing and insulating ductwork. Finally, equipment that is regularly maintained and calibrated in accordance with manufacturer specifications will last longer and run more efficiently. For long term savings when replacing cooling equipment, select units with high Season Energy Efficiency Ratio (SEER). The minimum SEER required in California is 13, and ENERGY STAR models will have 14.5 SEER. Appliance rebate information can be found [here](#), and ENERGY STAR tips on saving cooling costs can be found [here](#).