Weatherization and Energy

New Jersey's climate requires homes to perform efficiently in both hot and cold temperatures. Homeowners can use high-efficiency appliances and HVAC equipment, passive solar techniques, proper ventilation, air sealing, and durable roofs to ensure high performance and diminish the home's total energy consumption. The result will be a reduction in space heating, cooling and water heating requirements. These strategies promote overall building energy efficiency and durability throughout the year.

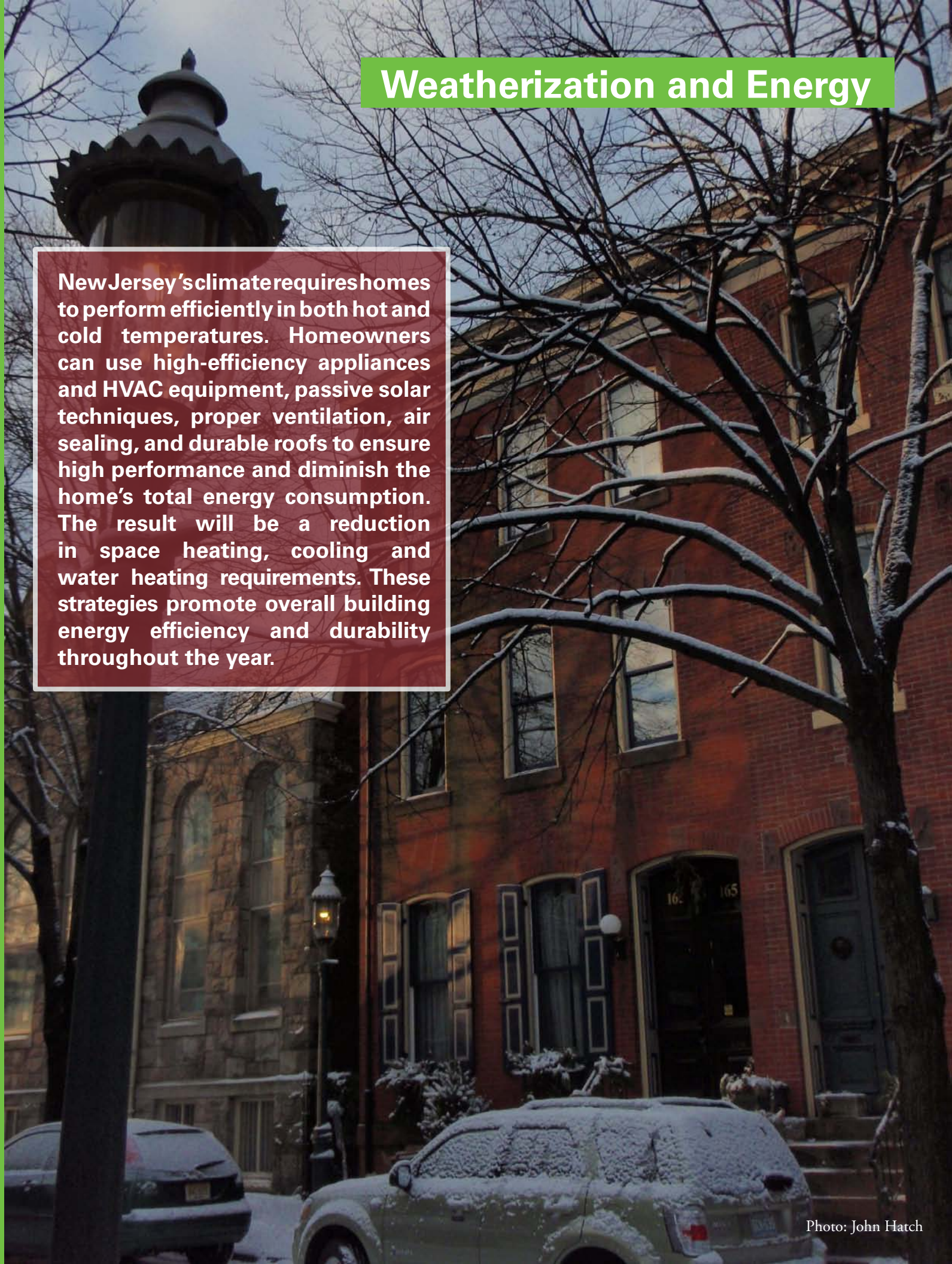


Photo: John Hatch

Weatherization and Energy

How to Use the Guidelines

Health and Safety

- HS1 - Nuisance and Toxic Dust Control
- HS2 - Cautious Materials -Asbestos and Lead
- HS3 - Mold
- HS4- Radon

Green Home Maintenance and Housekeeping

Building Envelope

- Conduct a Home Performance Audit and diagnostic tests **[IDP2/EA51-54]**
- Install or upgrade insulation **[EA49]**
- Air seal to reduce infiltration **[IDP55]**
- Weatherstrip doors and windows **[EA58]**
- Upgrade or replace existing windows **[EA56/59]**
- Provide moisture management strategies **[IDP24]**
- Use appropriate window glazing **[EA60]**
- Upgrade existing exterior door **[EA57]**
- Install window shading system **[EA62]**
- Install a durable wall cladding **[MR119]**
- Provide a durable and reflective roof **[MR120]**

HVAC

- Follow standards for mechanical design **[EA63]**
- Provide controls and zoning for HVAC **[EA64]**
- Use ceiling fans for natural ventilation **[EA65]**
- Install programmable thermostats **[EA67]**
- Select high-efficiency HVAC equipment **[EA66]**
- Conduct duct tightness test **[EA68]**
- Maintain HVAC systems **[EA69]**
- Seal and insulate HVAC system **[EA70]**
- Make sure ductwork is clean **[EA71]**

Lighting and Electrical

- Provide daylighting **[EA83]**
- Provide appropriate lighting **[EA84]**
- Install energy-efficient lighting **[EA85]**
- Provide appropriate indoor lighting controls **[EA90]**

Plumbing

- Insulate water heater **[EA80]**
- Insulate hot water pipes **[EA81]**
- Reconfigure plumbing for efficiency **[EA77]**
- Utilize solar water heating **[EA101]**

Equipment

- Select high-efficiency clothes washer **[EA92]**
- Select an energy-efficient refrigerator **[EA93]**
- Choose an energy-efficient dishwasher **[EA94]**
- Install energy-efficient cooking appliances **[EA95]**
- Select energy-efficient office equipment **[EA99]**
- Consider on-site renewable energy **[EA102]**

Case Studies

Green Products and Services

Glossary of Terms

How to Use the Guidelines

Organization of the Guidelines

The Guidelines are organized into chapters by major project type: Kitchen, Bath and Living Spaces, Finished Basement and Major Addition, Weatherization and Energy, and Outdoor Living and Landscaping.

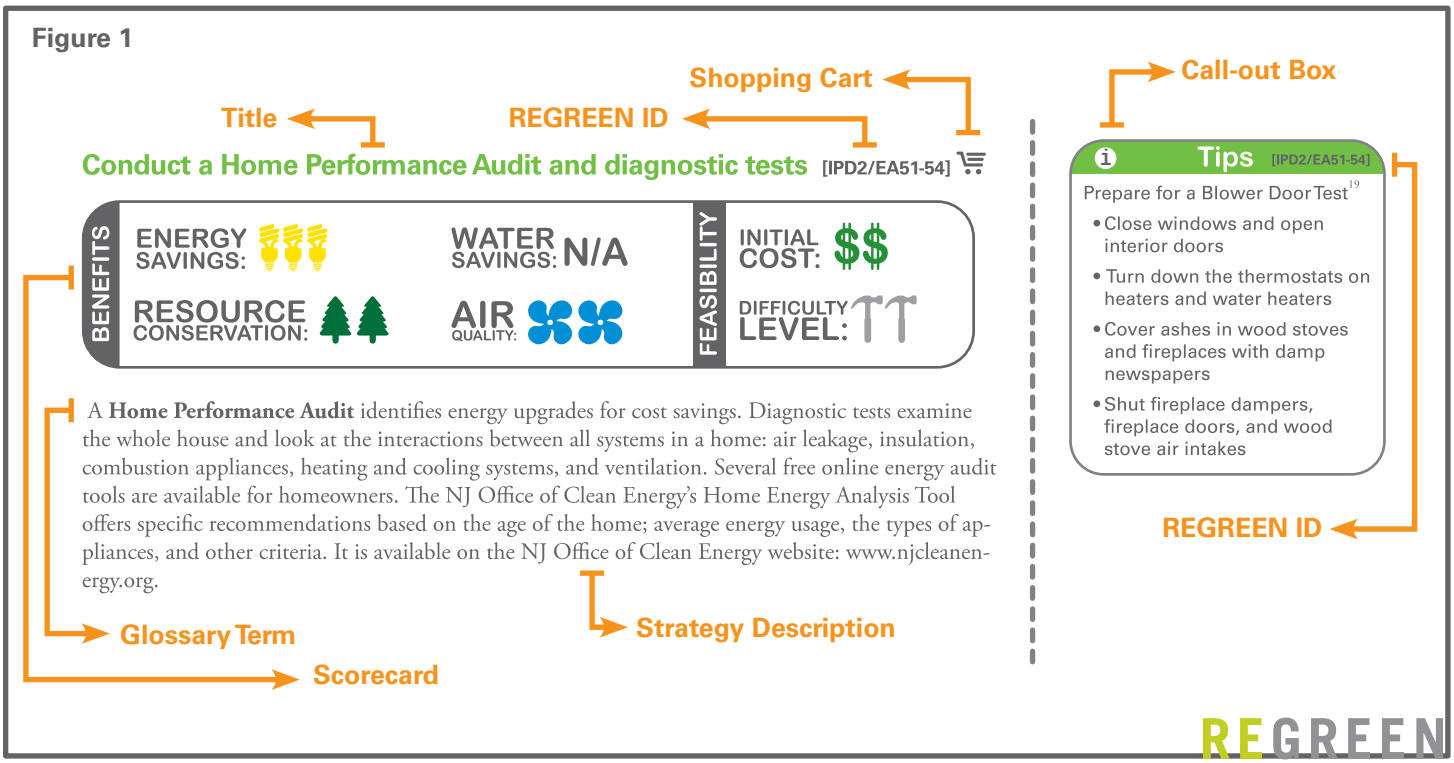
Each chapter includes the following:

- How to Use the Guidelines
- Health and Safety
- Green Home Maintenance and Housekeeping
- Best Practice Strategies
- Resources and References
- Case Studies
- Green Products and Services
- Glossary of Terms

Getting the Most from the Strategy Write-ups

The Guidelines provide information on best practice strategies for each project type. These strategy write-ups are organized by building system and follow the order of the 2008 REGREEN Residential Remodeling Guidelines (i.e., IDP2), which are incorporated with permission. **Figure 1** describes the information available.

Figure 1



Title and REGREEN Strategy ID – The strategies in the REGREEN Residential Remodeling Guidelines 2008 inspired most of the strategies in these Guidelines. Where appropriate, the strategy references the related REGREEN strategy ID.

Shopping Cart – The cart denotes entries in the Green Product and Service Guide located in the back of each project chapter.

Strategy Description – This write-up provides an overview of each strategy and its environmental benefits.

Glossary Term – Acronyms and green building terms are highlighted in bold and defined in a glossary at the back of each chapter.

Call-out Boxes - The call–out boxes in **Figure 2** highlight information of special importance. These include the following types of information:

- Tips - useful hints or practical facts for accomplishing a strategy
- Incentive - sources of financial assistance
- New Jersey Bio-Region - New Jersey has 5 bio-regions, each with unique elements and environmental features to consider when remodeling
- Building Age - a home's age can inform needed repairs and call out special circumstances
- Caution - on occasion, there are hazards associated, so items are called out for safety reasons

Hazard Symbol - Symbols were developed to advise users of certain health and safety threats related to specific strategies. The symbols, which appear below, reference the guidance on Health and Safety located at the beginning of each section.

HS1 – Nuisance and Toxic Dust Control HS1

HS2 – Hazardous Materials - Asbestos & Lead HS2

HS3 – Mold HS3

HS4 – Radon HS4

Web Link - When viewing this document electronically, the websites will hyperlink, however, occasionally website links change. In most cases, the site provides a seamless link to the new address. If this is not the case, users may need to copy and paste the link into the browser address bar. At the time of publication the hyperlinks in this report were all functional.

Scorecard - The scorecard, **Figure 3**, provides a snapshot of the environmental benefits, initial costs, and difficulty levels associated with a particular strategy. Both qualitative and quantitative information was used to assign scores to each strategy.

Figure 3

Conduct a Home Performance Audit and diagnostic tests [IPD2/EA51-54]

It is divided into two parts: 1) Benefits and 2) Feasibility.

Graphic icons were developed for each impact category.

BENEFIT Key

1 icon = low benefit, 2 icons = medium benefit, 3 icons = high benefit

FEASIBILITY Key

$ low initial cost, $$ medium initial cost, $$$ high initial cost

T low difficulty level, TT medium difficulty level, TTT high difficulty

The icons above have been developed to graphically describe the ratings that follow.

BENEFITS

Energy Savings

To help meet its greenhouse gas reduction responsibility, in 2007 New Jersey passed **carbon dioxide** (CO_2) reduction goals, i.e., achieve 1990 emission levels by 2020, followed by a further reduction of emissions to 80 percent below 2006 levels by 2050. The state has also established renewable energy and energy efficiency targets. Green remodeling strategies utilize renewable energy sources such as solar, geothermal, and wind to net a lower CO_2 footprint.

Figure 2

Tips [EA49]

Use the U.S. Department of Energy's Zip-Code Insulation Program to determine how much insulation to add and where to achieve the recommended insulation levels for maximum energy efficiency www.ornl.gov/~roofs/Zip/ZipHome.html

Incentive [EA49]

Federal tax credits may be available for added insulation to walls, ceilings, or other part of the **building envelope**. See the Tax Incentive Assistance Project: www.energytaxincentives.org/general/legislative.php.

NJ Bio-Region [EA49]

In colder climates, adding extra insulation is more cost effective than installing a **radiant barrier.**[26]

Building Age [EA49]

Insulation in older homes will have settled and at best be dusty or dirty so new attic insulation is typically installed on top of old insulation.

Caution [EA49]

Vermiculite Insulation was used in attics until it was discovered that vermiculite ores from some sources have naturally occurring **asbestos** in trace amounts. This type of insulation is only a health concern when someone comes into contact with it; while it is contained, it is not determined to be a health risk. If a remodeling or renovation project involves removal of this type of insulation, certified professionals will be needed to safely remove or contain the material. For more information, see **EPA** website: www.EPA.gov/asbestos/pubs/verm.html

Water Savings

Water conservation reduces water use both inside and outside the home. Within the home this may include low-flow fixtures. Outside the home this may refer to using **native plants** that have lower water requirements or rain barrels to collect rainwater for reuse on the lawn and garden. Water management includes providing proper moisture control at footings, slab perimeter, and foundation walls as well as using porous paving materials to encourage stormwater recharge for reduced runoff.

Air Quality

Americans spend up to 90 percent of their time indoors where air quality can be more polluted than outdoors. Pollutants range from allergens such as mold, mildew, fungus, and dust mites to toxins, such as asbestos, and volatile organic compounds like formaldehyde and benzene found in building materials and a number of household items including pressed-wood furniture, computer ink, carpeting, and conventional household cleaners and cosmetics.

Resource Conservation

Resource conservation means using materials that are durable and easy to maintain with low embodied energy (the energy used in resource extraction, manufacturing, shipping). These come from renewable sources or are produced from waste, recycled materials, or salvaged from other uses. Avoiding building materials that deplete natural resources, such as old-growth timber, and materials made from toxic or hazardous substances improves nature's ability to provide goods and services.

FEASIBILITY

$ Initial Cost

Cost is always a consideration for remodeling projects. Evaluating the cost of a recommended green remodeling strategy provides homeowners with a better sense of the relative costs and benefits of each recommended measure.

Costs come in two forms, so it is important to consider both in assessing feasibility. The first reflects initial costs of the strategy compared to conventional practices. A second consideration to make is the pay-back period or life-cycle cost. The pay-back costs are less obvious and are often project specific, but they can have significant environmental and economic value that factor into the overall cost. For more information on average costs, savings, and payback periods of typical energy efficiency improvements, see the Energy Efficient Rehab Advisor at (www.rehabadvisor.pathnet.org/). For customized results, have an energy professional conduct a thorough energy audit of your home.

$ Less than $500

$$ $500-$5,000

$$$ Greater than $5,000

Difficulty Level

Time is money and expertise is gained over time. Some people may consider a Home Performance Audit strategy in the 'medium' category because although relatively straightforwardto act on, it requires experts with custom equipment to prepare an accurate assessment. Implementing the findings from a Home Performance Audit becomes a 'high' difficulty category as space heating and cooling systems, ventilation, water heating, appliances, climate and even site factors need to be integrated to assure desired energy improvements across 'ALL loads' and to avoid negative unintended consequences. It is expected that 'high' difficulty strategies may also be dangerous for the basic homeowner to undertake.

T Easy to Do It Yourself (DIY) - little previous knowledge necessary

TT Task for an Experienced DIYer or Professional - may require additional effort and higher learning curve than conventional strategy it replaces

TTT Task for an Expert/Certified Professional - high learning curve; new technique; requires specific green knowledge

Notes: [1] U.S. Environmental Protection Agency 2008. Healthy Buildings, Healthy People: A Vision for the 21st Century

Health and Safety

Green remodeling poses hazards typical of many other home renovation or remodeling projects because of the age of the homes (given that they are more likely to contain older and use more hazardous materials) and the incentive for green remodeling to replace older or damaged building systems.

New Jersey homeowners considering green remodeling should anticipate potential emissions of hazardous air contaminants during removal of old building materials. The risks associated with improper removal of materials containing **asbestos**, lead, mold or even fiberglass insulation are minimized by understanding and following the steps listed here prior to initiating work. For complex situations, consider hiring professionals.

General hazard recognition and risk reduction information for the following potential renovation-related risks are contained in this section:

HS1 – Nuisance and Toxic Dust Control

HS2 – Hazardous Materials - Asbestos & Lead

HS3 – Mold

HS4 – Radon

HS1 – Nuisance and Toxic Dust Control

Construction projects involving demolition of existing sheetrock, plaster, wood, brick or concrete products in ceilings, walls or floors of a home will release dust as these materials are ripped, sanded, ground, pulverized or crushed. Control of dust emissions during the pouring of solids or from transferring of small particles is controlled in industrial facilities. Homeowners planning renovation projects should also consider steps to minimize the release and maximize control of dust in the environment. These nuisance dusts, when released from the point of origin into the air of the home, tend to remain suspended in the air for very long periods of time, and as such, will be transported with air currents caused by open doors, cracks around and beneath doorways, forced air heating and cooling ductwork, and even by the air currents caused by persons walking in and out of dusty areas, to other areas of the home. At a minimum, allowing the uncontrolled release of nuisance dusts from any demolition project, as well as those created from sawing, sanding, or grinding of newly constructed materials (e.g., sheetrock, spackling, wood dust etc.) presents unnecessary and difficult dust cleanup demands for affected living spaces. At their worst, susceptible occupants of homes where uncontrolled nuisance dusts are allowed to escape into adjacent living spaces may temporarily experience eye, nose, or throat irritation. Asthmatics may experience adverse respiratory distress when exposed to high levels of nuisance dust particles.

There are several simple steps to minimize potential hazards of nuisance dust during remodeling.

1. Remove unnecessary porous and non-porous materials (e.g., draperies, bedding, upholstered furniture, children's toys, clothing, etc.) from the project area.
2. Seal the project area from the remainder of the home using polyethylene sheeting at doorways and at inlets to any forced air supply or **return registers** within the project space.
3. Consider installing **HEPA filtered air scrubbers** in the project area and discharging the exhaust air through an adjacent window using a tight fitting flexible duct through a sealed window opening (consider surrounding security requirements). Use a lightweight section of facial tissue at the doorways to confirm that air pressure is moving from the clean adjacent living space and into the project area (not the other direction) so that air leaks from the clean home into the dirty renovation area. This will reduce any potential for dusts from the renovation area to enter the adjacent areas of the home.
4. Periodically during the work session and after every work session, **HEPA vacuum** the renovation area following renovations to remove accumulated surface dust, without re-suspending it into the air.

HS2 – Hazardous Materials - Asbestos & Lead

When removing old building materials, know that they contain hazardous materials, which while intact present little to zero risk to occupants, but when removing can create airborne emissions and increase health and safety risks. This is especially true of **asbestos** and lead, and, possibly to a lesser extent, fiberglass. Removal of **asbestos**, lead or fiberglass needs to be planned and conducted with care to minimize exposures to airborne dust from these materials.

Asbestos

Asbestos is a mineral that has been mined in the U.S. since the early 1900's. Its superior heat resistance properties, combined with its lightweight, high-tensile strength, and non-corrosive qualities, made it an ideal building material for buildings constructed between 1940 and the late 1980's. **Asbestos** was banned as a building material in the U.S. after scientists concluded studies linking long-term occupational exposures to damaging respiratory health including asbestosis (scarring of the lung), lung cancer, and mesothelioma (cancer of the lining of the lung). Because intact **asbestos** presents no increased health risk, there is no requirement for removing it from existing homes. However, when it is disrupted, pulverized or suspended in air, the potential for inhalation of **asbestos** fibers increases risks of exposure. While health effects develop only after decades of long-term occupational or environmental exposure, homeowners should take particular care to prevent unintentional release of **asbestos** into the air of their homes during green remodeling efforts so that children and others are not exposed.

Asbestos is commonly found in older homes (constructed between 1940 and the late 1980's) in the following building materials:

- Pipe and boiler insulation
- Sprayed on fireproofing insulation
- Acoustical tiles and wall coverings
- Floor tiles
- Roof shingles
- Siding shingles

There is no requirement that homeowners remove **asbestos**-containing materials from homes. However, if removal is part of a green building remodeling project, material should be tested by a New Jersey licensed **asbestos** control monitor, and if determined to contain **asbestos**, be removed by a New Jersey licensed **asbestos** contractor. The number of the state program to contact for assistance in identifying qualified personnel to assist homeowners to safely address any possible **asbestos** concerns is (609) 292-7837.[5] General information about asbestos and its proper management and disposal can be found at the Department of Health website: www.state.nj.us/health/iep/asbestos.shtml and the Department of Environmental website: www.nj.gov/dep/dshw/rrtp/asbestos.htm.

Lead

Lead was in residential paints prior to 1978. It was banned after that time due to the significant health affects to children inhaling or consuming dusts from lead-based paints. Because of the hazards posed by dusts and chips of lead-painted surfaces, any remodeling or renovation which impacts painted surfaces of homes constructed prior to 1978 needs to be inspected by a New Jersey licensed lead inspector. If lead paint is identified, it should be safely removed by a state of New Jersey licensed contractor. They can safely remove lead-based paint and conduct follow-up surface lead testing to confirm that the removal was successful. Information on lead-based paint and qualifications for lead inspectors and contractors can be found at: www.state.NJ.us/health/iep/documents/pb_advisory_bulletin.pdf.

Contact the New Jersey Department of Health and Senior Services at (609) 292-7837 with any questions.

Fiberglass

Fiberglass insulation is a manufactured glass-wool-like material used as an insulation and sound absorption material in homes, schools, automobiles and consumer products since the 1970's. Fiberglass insulation can be safely installed if handled properly; any prolonged skin, eye or respiratory contact with fiberglass can cause temporary irritation. During renovation, wear loose fitting clothing and gloves to reduce skin contact, eye glasses or goggles to reduce eye exposure, and N95 disposable respirators (available from any home improvement store) if high levels of fiberglass dust are expected during removal or installation. More information on fiberglass safety precautions and handling recommendations can be found at the American Lung Association website at: www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=35439
or call the American Lung Association in New Jersey at (908) 687-9340.

HS3 – Mold

Mold contamination of building materials is not limited to older homes. Homes of any age can develop mold if moisture from leaky pipes, roofs, foundations, accumulates in the presence of dust, wood, paper or other **cellulose**-containing materials at normal room temperatures or high relative humidity (76 percent) for as little as 48 hours. Standing moisture around building materials such as wallboard, carpets, insulation, wood or other **cellulose** containing materials can cause mold. Many mold spores are known human allergens and produce toxins which may cause irritation or central nervous system effects. Because of vast differences in susceptibility, or if individual health impacts related to elevated mold spore exposure are of concern, consult a trained and experienced occupational/environmental health physician.

In addition to the above, mold damage can occur if flooding from faucets, showers, toilets (above the trap), is not completely dried within 48 hours of the incident. Floods from dirty water sources such as washing machines, dishwashers or sewers may contain high levels of bacteria, viruses, and protozoa which, along with potential mold growth, present additional risks.

If **mold amplification sites** occur, remove the affected material using methods that prevents unintentional dispersal of mold spores and the source of moisture intrusion. The U.S. **Environmental Protection Agency** indicates that small areas of mold growth (less than 10 square feet) can be cleaned or removed by homeowners themselves using precautions to prevent exposure and reduce spread of spores to adjacent areas. When mold contaminated areas exceed 10 square feet, special precautions including erecting containment barriers and the use of specialized **HEPA vacuum** devices should be used by trained professionals. When mold contamination occurs in excess of 100 square feet, professionals need to clean using full containment of the area (see www.epa.gov/mold/moldguide.html).

If mold growth from dirty water floods occurs, take special precautions to prevent skin, eye, oral and inhalation contact, and hire trained professionals to clean up in accordance with U.S. **EPA**: www.epa.gov/iaq/flood/index.html and IICRC S500 guidelines

Homeowners should anticipate that the amount of mold contamination shown on the outside of a piece of drywall or paneling may be less than the amount that will be exposed when wall cavities are opened up. If there is any doubt, consider hiring a professional Certified Industrial Hygienist (CIH) to evaluate the extent of damage before attempting to remove contaminated building materials yourself.

HS4 – Radon

Radon is a radioactive gas that comes from the natural decay of uranium in the ground. It is odorless, tasteless and invisible, and can only be detected through specialized tests. **Radon** enters homes through openings such as cracks and joints in the foundation, sump pits and openings around pipes. The home traps radon inside and it can build up to high levels.

Radon is the second leading cause of lung cancer in the United States, resulting in 15,000 to 22,000 deaths annually. It is the leading cause of lung cancer for non-smokers.

Radon concentrations can vary from house to house. The radon concentration in a home depends on a number of factors, including the amount of uranium present in the soil, the permeability of the soil, the number of openings in the foundation and air pressure differentials. Any home can have a **radon** problem, regardless of whether it is old or new, well sealed or drafty, or with or without a basement.

The New Jersey Department of Environmental Protection recommends radon testing for all homes in New Jersey. If the **radon** concentration is 4 pCi/L or higher, a **radon** mitigation system is recommended. There is no safe level of **radon** since lung cancer can result from very low exposures to **radon**, however, the risk decreases as the **radon** concentration decreases. f the **radon** concentration is less than 4 pCi/L, a mitigation company can be consulted to determine whether the **radon** level can be brought down still further. **Radon** levels have been brought to less than 1 pCi/L in sixty percent of the homes mitigated in New Jersey. Mitigation systems can also help reduce the potential for accumulation of volatile organic compounds that may be released from soil water vapor in areas where ground water contamination is an issue.

Radon test kits are commercially available at most home improvement stores, however, test conditions and locations may make data interpretation difficult or inaccurate. Carefully follow the kit directions to ensure proper use and confidence in the results. The New Jersey Department of Environmental Protection has issued licensing requirements for **radon** testing firms, and has a list of qualified professionals to perform **radon** testing and mitigation, see www.njradon.org.

Appendix

HS1= NUISANCE AND TOXIC DUST CONTROL

Fly ash Properties

www.austinenergy.com/energypercent20Efficiency/Programs/Greenpercent20Building/Sourcebook/flyashConcrete.htm

www.oikos.com/library/betterconcrete/index.html

HS2= HAZARDOUS MATERIALS - LEAD AND ASBESTOS

N.J. Department of Health Indoor Environments Program

www.state.NJ.us/health/iep/index.shtml

Agency for Toxic Substances and Disease Registry, New Jersey

www.atsdr.cdc.gov/Asbestos/sites/national_map/fact_sheets/trentonnj.html

N.J. Department of Environmental Protection, Guidelines for Disposal of Asbestos Containing Materials

www.state.NJ.us/dep/dshw/rrtp/Asbestos.htm

U.S. EPA Asbestos Caution Regulations adopted in New Jersey

www.EPA.gov/r02earth/ahera/ahera.htm

N.J. Department of Community Affairs Lead Testing and Abatement

www.state.NJ.us/dca/codes/code_services/xls/clc.shtml

New Jersey (NJ) Department of Health and Senior Services

http://www.state.nj.us/health/

Lead in Paint, Dust, and Soil (USEPA)

http://www.epa.gov/lead/

The Leadsafe NJ Program (NJDCA)

http://www.state.nj.us/dca/dcr/leadsafe/

HS3 = MOLD

USEPA Guide to Mold in Your Home

www.EPA.gov/mold/moldguide.html

USEPA Flood Clean-up Guidelines

www.EPA.gov/iaq/flood/index.html

N.J. Department of Health and Senior Services Indoor Environments Program

www.state.NJ.us/health/iep/index.shtml

HS4 = RADON

N.J. Radon Soil Gas Map

www.EPA.gov/radon/zonemap/newjersey.htm

N.J. Department of Environmental Protection Radon tiers by County

www.state.NJ.us/dep//rpp/radon/radonin.htm

N.J. Radon Levels

www.NJradon.info/NJ_counties.html

N.J. Radon Testing Guidelines

www.NJ.gov/dep/rpp/radon/radontes.htm

Green Home Maintenance and Housekeeping

Introduction

Your home is one of the biggest investments of your life. Can 'going green' protect your investment and make it safer, more enjoyable and save you money? Yes.

This guide to Green Home Maintenance and Housekeeping practices will improve the health, comfort and environment for your family, and save you money, most directly by reducing your utility bills. The guide's focus on 'Energy' savings, improvements to 'Indoor Air Quality', effective and efficient 'Household Waste Management' and conserving 'Water' all add measurable benefits to you and high return on your investment. Routine checks and repairs will ensure your home's appearance and proper function. By following these recommendations, you will also prevent more expensive damage from occurring.

Weatherization and Energy

You can save energy and money at home by making small changes and following some easy, practical solutions/tips

1. Easy energy saving kitchen tips.
   - Air dry dishes instead of using the dishwasher's drying cycle.
   - Recommended temperatures for the refrigerator are 37°F to 40 °F for the fresh food compartment and 0° to 5°F. for the freezer compartment.
   - Cover liquids and wrap foods stored in the refrigerator. Uncovered food release moisture and make the compressor work harder.
   - Instead of preheating and using a stove's larger oven, consider using a pressure cooker, slow cooker or a microwave; for small meals use the toaster oven rather than your large stove/ oven.
   - Use a covered kettle or pan to boil water.
   - Match the size of the pan to the heating element.
   - Keep range-top burners and reflectors clean; they will reflect the heat better and save energy.
   - In natural gas appliances, look for blue flames; yellow flames indicate the gas is burning inefficiently and an adjustment may be needed. Consult the manufacturer or your local provider.

   Note: Homes with combustion appliances should install **carbon monoxid**e **(CO)** alarms to prevent accidental death by **carbon monoxide** poisoning. For more information, see the U.S. Environmental Protection Agency, "Indoor Air Quality Carbon Monoxide Fact Sheet" available at www.epa.gov/iaq/co.html

2. Laundry tips
   - The biggest energy and cost savings comes from alternatives to the dryer. Air dry your clothes on clothes lines or drying racks.
   - Wash your clothes in cold water using cold-water detergents whenever possible.
   - Wash and dry full loads. If you are washing a small load, use the appropriate water-level setting.
   - Wash and dry towels and heavier cottons in a separate load from lighter-weight clothes.
   - Don't over-dry your clothes. If your machine has a moisture sensor, use it.
   - Clean the lint filter in the dryer after every load to improve air circulation.
   - Use the cool-down cycle to allow the clothes to finish drying with the residual heat in the dryer.
   - Periodically inspect your dryer vent to ensure it is not blocked.

3. Optimize energy usage in your home
   - Lower the thermostat on your hot water heater to 120°F.
   - Drain a quart of water from your hot water tank every three months to remove sediment that impedes heat transfer and lowers the efficiency of your hot water heater. Follow the manufacturer's advice.
   - Plug home electronics into power strips; turn the powers strips off when the equipment is not in use.

- Turn off your computer and monitor when not in use.
- Replace all bulbs in your home with **Compact Fluorescent Lamps** (**CFLs**).

4. Check your home insulation and prevent air leaks.
   - Air seal the attic floor joists wherever wires, heating ducts, or plumbing pipes come through; caulk or foam the top plate of the partitions below the attic floor. Install gaskets and 4 inches of rigid foam insulation on top of the attic access panel or access door.
   - Air seal the band joists in the basement using 2 inch rigid foam and foam-in-a-can.
   - Add additional insulation if the home is built before 1980, or to achieve an insulation **R-value** of R-38 to R-50. (Air seal first.)
   - Prevent air leaks when the fireplace is not in use. Keep the fire **damper** tightly closed and use inflatable chimney balloons that fit beneath the fireplace flue.
   - Use kitchen exhaust fan covers that keep air from leaking in when the exhaust fan is not in use.

5. Maximize the efficiency of your **HVAC** system
   - Set the thermostat as low as is comfortable in the winter and as high as is comfortable in the summer. Typically, thermostats are set between 65°F and 70°F for heating and 72°F and 78°F for cooling.
   - Using a 2-inch paint brush, apply duct mastic to all accessible duct work joints or holes.
   - Clean or replace filters on furnaces once a month or as is needed.
   - Remove the register covers and caulk the duct work in the wall, floor and ceiling to prevent conditioned air from being lost in the wall or ceiling cavity. This is especially important in the ceilings directly below the attic.
   - Clean warm-air registers, baseboard heaters, and radiators as needed; make sure they are not blocked by furniture, carpeting or drapes.
   - Bleed trapped air from hot-water radiators once or twice a season; call a professional if required.
   - Place heat resistant radiator reflectors between exterior walls and the radiators.
   - Minor duct repairs are easy to make, but it is best to get a qualified professional for insulating, sealing or repairing any ducts.
   - For summer cooling, install a whole house fan to pull cool air through the house and exhaust warm air through the attic.
   - Avoid placing lamps or TV sets near your air-conditioning thermostat.
   - Keep the air conditioning unit in the shade and not in the sun.
   - Add plantings to shade air conditioning elements in sunny locations. Leave sufficient space so air flow is not obstructed and access is available in the event of a need for service.

6. Your home's energy performance can be improved by improving the performance of the windows.
   - Lower the amount of gas or electricity used to heat and cool your home. In summer, open windows at night to let in cool air and close both windows and shades during the day to keep out heat. During winter, do the opposite. Open shades in the morning to capture sunlight and close them at night to retain the heat.
   - Install exterior or interior **storm windows**.
   - Repair and **weatherize** windows.
   - When installing new windows, consider **double-glazed, low-E** windows with high performance glass.

Conduct a Home Performance Audit and diagnostic tests [IPD2/EA51-54]

BENEFITS: ENERGY SAVINGS: ★★★ | WATER SAVINGS: N/A | RESOURCE CONSERVATION: ▲▲ | AIR QUALITY: ❋❋
FEASIBILITY: INITIAL COST: $ | DIFFICULTY LEVEL: TT

A **Home Performance Audit** identifies energy upgrades for cost savings. Diagnostic tests examine the whole house and look at the interactions between all systems in a home: air leakage, insulation, combustion appliances, heating and cooling systems, and ventilation. Several free online energy audit tools are available for homeowners. The NJ Office of Clean Energy's Home Energy Analysis Tool offers specific recommendations based on the age of the home, average energy usage, the types of appliances, and other criteria. It is available on the NJ Office of Clean Energy website (www.njcleanenergy.org).

Certified professionals can conduct a more comprehensive **Home Performance Audit**. This often includes a combination of visual inspections and diagnostics tests to identify opportunities to repair or upgrade aspects of the building envelope or mechanical systems. The following strategies are common elements of a more comprehensive **Home Performance Audit**:

- **Blower Door Test** – **Blower door tests** help determine a home's airtightness. Proper airtightness is important for reducing energy use and drafts due to air leaks, avoiding moisture problems, and regulating indoor air quality. It is important that auditors use a calibrated blower door, which allows them to test airtightness before and after recommended changes have been implemented, and to verify that the work completed solved the problems.
- **Thermographic inspections** - **Thermographic inspections** or **infrared scanning** uses specially designed infrared video or still cameras to make images (called thermograms) that show surface heat variations. **Thermograms** help determine whether and where a home needs insulation. Because wet insulation conducts heat faster than dry insulation, **thermographic** scans can also detect roof leaks and other moisture problems.
- **Thermal Bypass Inspection (TBI)** – The **Energy Star® Thermal Bypass Inspection (TBI)**, and a corresponding checklist, is designed to check for missing or incorrectly installed insulation and sealing of penetrations and air gaps. It is most commonly performed for new construction and major renovations. Reducing thermal bypass, or the movement of heat around or through insulation, is important as they can lead to comfort issues as well as higher utility bills. For more information, see the **Energy Star® Thermal Bypass Checklist**: www.energystar.gov/index.cfm?c=bldrs_lenders_raters.thermal_bypass_checklist

The NJ Office of Clean Energy Home Performance with Energy Star Program (www.njcleanenergy.com/) provides reduced fee home energy audits and a listing of certified energy auditors on its website.

Tips [IPD2/EA51-54]

Prepare for a Blower Door Test[1]

- Close windows and open interior doors
- Turn down the thermostats on heaters and water heaters
- Cover ashes in wood stoves and fireplaces with damp newspapers
- Shut fireplace dampers, fireplace doors, and wood stove air intakes

Incentive [IPD2]

New Jersey's Clean Energy Program (NJCEP) offers low-price Home Performance Audits and other incentives.

www.njcleanenergy.com/residential/home/home

The Database of States Incentives for Renewables and Efficiency (DSIRE) provides information on state, local, utility, and federal incentives and policies that promote renewable energy and energy efficiency.

www.dsireusa.org/

Install or upgrade insulation HS2 [EA49]

BENEFITS: ENERGY SAVINGS: ★★★ | WATER SAVINGS: 💧 | RESOURCE CONSERVATION: ▲▲ | AIR QUALITY: ❋❋
FEASIBILITY: INITIAL COST: $$ | DIFFICULTY LEVEL: T

Insulation slows down the heat flow through a home's building envelope - the walls, attic, roof and basement. In the winter, insulation slows heat loss and helps prevent moisture buildup. During summer months, it reduces heat gain and helps keep a home cool.

Insulation is rated according to its **R-Value**, or its ability to resist heat flow, with a high **R-Value** being a greater resistance. Adding insulation with a higher **R-Value** can cut heating and cooling costs anywhere from 15 to 45 percent, depending on factors such as the original amount of insulation in the home, house size, air leaks and personal energy use and living habits.[2]

Tips [EA49]

Use the U.S. Department of Energy's Zip-Code Insulation Program to determine how much insulation to add and where.

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

Incentive [EA49]

Federal tax credits may be available for added insulation to walls, ceilings, or other part of the **building envelope**. See the Tax Incentive Assistance Project: www.energytaxincentives.org/general/legislative.php.

NJ Bio-Region [EA49]

In colder climates, adding extra insulation is more cost-effective than installing a radiant barrier.[6]

Building Age [EA49]

Insulation in older homes will have settled and at best be dusty or dirty so new attic insulation is typically installed on top of old insulation.

Caution [EA49]

Vermiculite Insulation was used until it was discovered that vermiculite ores from some sources have naturally occurring **asbestos** in trace amounts. This type of insulation is only a health concern when someone comes into contact with it; while it is contained, it is not determined to be a health risk. If a remodeling or renovation project involves removal of this type of insulation, certified professionals will be needed to safely remove or contain the material. For more information, see **EPA** website www.EPA.gov/asbestos/pubs/verm.html

Certified energy auditors conduct an insulation check as part of a comprehensive home performance audit. They can determine the **R-Value** of the home's current insulation and measure air leakage. They then can recommend where air sealing and insulation should be added.

Thorough air sealing should be done before insulating. Insulation alone does not protect against air leakage; moist air can damage the insulation and reduce its effectiveness. Adding insulation before air sealing may make some air leaks difficult to access. Avoid **thermal bridging** by installing a layer of continuous insulating **sheathing** over frames or joists.

The general rule-of-thumb is to install insulation on any surface separating a heated space from an unheated space; walls, ceilings, attics, floors and ducts should be well-insulated. One of the best places to begin installing or upgrading insulation is in the attic as a significant amount of heat can be transferred through the roof. Installing attic insulation is also a relatively easy job for do-it-yourselfers.

There are four basic types of insulation:[3]

- **Batts** and blankets—**Batts** and blankets are made from mineral fibers, such as fiberglass and rock wool, and typically have a value of R-3 per inch. They are available in widths suited to standard spacings of wall studs and attic or floor joists; 2x4 walls can hold R-13 or R-15 batts and 2x6 walls can have R-19 or R-21 products. Use this type of insulation below floors, above ceilings, and within walls. **Batts** and blankets can be installed by homeowners or professionals.
- **Loose-fill insulation**—**Loose-fill insulation** is often made from fiberglass, rock wool, or cellulose in the form of loose fibers or fiber pellets and typically has a value of R-3 to R-4 per inch. This type of insulation works best in places where it is difficult to install other types of insulation such as building cavities and attics. Loose-fill insulation is usually blown in by professional installers.
- **Rigid insulation board**— **Rigid insulation board** is often made from fiberglass, polystyrene, or polyurethane and typically has a value of R-4 to R-8 per inch. Use this type of insulation on basement walls and as perimeter insulation at concrete slab edges, and in cathedral ceilings. For interior applications it must be covered with 1/2-inch **gypsum board** or other building-code approved material for fire safety. For exterior applications, cover with weather-proof facing.
- **Spray foam**—**Spray foam insulation** comes in two forms: **open-cell** and **closed-cell**. The **closed-cell** foams typically have a higher **R-value** (R-7 to R-8 per inch) than **open-cell** foam (R-5.6 to R-8 per inch). Most foam insulation products have a higher **R-value** per inch than fiberglass **batt** insulation.[4] This type of insulation provides both insulation and an air barrier, and is suited well for filling small spaces — such as window jambs, small stud bays, **rim joist** areas, and for sealing around electrical boxes and other penetrations. **Spray foam insulation** should be applied by professional installers using special equipment to meter, mix, and spray the foam into place. Most foam materials can now be used with foaming agents that don't use **chlorofluorocarbons** (**CFCs**) or **hydrochlorofluorocarbons** (**HCFCs**), which are harmful to the earth's ozone layer.[5]

Air seal to reduce infiltration [IDP55]

Tips [IDP55]

Use a re-useable dispenser gun to seal the harder to reach spots and increase your resource conservation.

Caution [IDP55]

To assure combustion safety, New Jersey building code requires that foam insulation be covered by a non-combustible material such as **gypsum board**.

It is advisable to test for **carbon monoxide** before air sealing efforts.

Air infiltration or leakage may contribute to as much as 30 percent of a home's heating and cooling costs.[7] The most common sources of air infiltration are the attic, crawl space, or basement, and around windows, doors, and chimneys. Other sources include **plumbing chases**, electrical outlets, attic accesses, dropped ceilings and leaky ducts.

Reduce air leakage as much as possible before adding insulation and provide controlled ventilation as needed. First, identify air leaks in the home (see Conduct a Home Performance Audit and diagnostic tests [IDP2, EA51-EA54] above). A good rule of thumb is to seal the high and low air leaks first. Start by plugging holes and leaks in the attic and basement, then move to the exterior wall, and look for smaller leaks around doors, windows and electrical switches and outlets. Use

caulk to seal openings up to ¼ inch such as cracks and gaps between window frames and siding. For larger gaps, add a backing material before caulking or use a **spray foam** sealant. After all the larger air leaks have been sealed, **weather-strip** doors and windows.

Weatherstrip doors and windows [EA58]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:	WATER SAVINGS:		INITIAL COST:	$
RESOURCE CONSERVATION:	AIR QUALITY:		DIFFICULTY LEVEL:	TT

When replacing doors or windows is not feasible, consider **weatherstripping. Weatherstripping** stops drafts coming into the home from under or around doors and windows; on newer windows and doors it is fairly easy. On average, doors have more gaps and larger cracks than even loose-fitting windows.

Weatherstripping kits for doors are readily available at local hardware stores, but finding replacement **weatherstripping** that matches the old can be a challenge. Steel or custom door kits may be harder to find. Check with the manufacturer in these cases. Typical **weatherstripping** kits include two side strips, a top strip, and fasteners. Consider a **door sweep** if the floor, carpet or rug is below the bottom of the door frame. The cost of materials will pay for themselves in energy savings within one year, saving about 10 percent on heating and **cooling loads.**

Proper sealing means **weatherstripping** the entire door jamb in one continuous strip on both sides. For air sealing windows, apply **weatherstripping** between the sash and the frame. In both cases make sure that the **weatherstripping** is the right thickness so as to not impair the ability of doors or windows to open and close.

Double-hung windows are trickier than **casement windows** to **weatherstrip**, requiring two types of **weatherstripping**. The type of **weatherstripping** needed depends on the type of window and the situation. Angled or V-shape spring-type **weatherstripping** is nailed to the frame and bottom sash to seal **double-hung windows**. Pliable **weatherstripping** is sponge-like and installed in the channels and sash of wood **casement windows**. Compressible felt strips are not as durable at these other options but good for use with warped windows or for windows that are not often opened.

Upgrade or replace existing windows HS2 [EA56/59]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:	WATER SAVINGS:		INITIAL COST:	$$$
RESOURCE CONSERVATION:	AIR QUALITY:	N/A	DIFFICULTY LEVEL:	TT

Determining whether the home's windows need to be updated or replaced starts with a **Home Performance Audit** (see strategy IDP2/EA51-54), which will reveal if some or all of the windows leak. Visual inspection may also reveal window problems. Are any of the windows cracked? Do they open to allow fresh air to enter? Are there any windows without **storm windows**?

Upgrade or replace **single-pane** with **double-pane windows** with low-E or spectrally-selective glass to save 10 to 25 percent per year on heating.[8] To help offset the up-front cost, check for incentives from federal tax credits and through state and local utilities. If window replacement is not in the budget and old **single-pane windows** are in good condition, install **storm windows** in the winter months. Upgrading the sash alone can also save money. **Storm windows** can reduce heat loss through the windows by 25 percent to 50 percent. **Storm windows** also protect against impacts from rain, ice and snow. Bear in mind that good windows installed badly will not achieve expected savings, so see the link in the resources section for tips on "How to Hire an Expert Installer." Finally, windows that are properly sealed and caulked prevent leakage of air in and out of the house and provide a protective barrier from water and noise. (For more information, see Weatherization and Energy: **Weatherstrip** doors and windows [EA58]).

Tips [EA58]

Before purchasing **weatherstripping** materials, make sure the draft is not caused by loose hinge screws; if it is, glue wood plugs using **low-VOC** glue in the holes and re-drive the screws.

Ensure the door shuts and latches before completely nailing in the **weatherstripping**.

To prevent binding, plane the top with the door still in place and always move the plane toward the center of the door to avoid splintering off the edges.

Building Age [EA58]

Older windows, especially double-hung windows, are difficult to **weatherstrip**. If they're in bad shape, consider replacement windows; see related window strategies.

Caution [EA58]

Weatherstripping can dramatically change the pressure of the home and may cause **backdrafting** from an gas water heater that previously had no drafting issues. As part of a whole-house systems approach to home performance, make use of pre- and post-diagnostics to evaluate and confirm building performance changes.

Tips [EA56]

- Add shrink-wrap plastic sheeting over windows you rarely open in the winter.
- Install tight-fitting, insulating window shades on windows that feel drafty after **weatherizing**.
- In the winter, close curtains and shades at night and open them during the day. In the summer, close curtains on south and west windows during the day.

Incentive [EA56/59]

Fed Tax credit info:
www.aceee.org/energy/national/

NJ Bio-Region [EA56/59]

Energy Star®'s criteria for residential windows (as well as doors and skylights) are tailored to four Climate Zones nationally, two of which, 4 and 5, are defined by **Energy Star®** for New Jersey www.efficientwindows.org/factsheets/Newpercent20Jersey.pdf

To find the Climate Zone for a specific zip code, consult the **Energy Star®** Climate Zone Finder www.energystar.gov/index.cfm?fuseaction=windows_doors.search_climate

Building Age [EA56]

A historic wood window, properly maintained and fitted with a **storm window**, can be just as energy-efficient as a new window. For more tips on green historic windows, see www.preservationnation.org/issues/sustainability/additional-resources/July2008WindowsTipSheet.pdf

Caution [IPD24]

Moisture leads to mold and can significantly degrade indoor air quality.

NJ Bio-Region [EA60]

Salt air and moisture wear down window **glazing**.

Building Age [EA60]

Older homes with **single paned** glass may be able to be re-glazed.

Provide moisture management strategies HS1 [IDP24]

BENEFITS: ENERGY SAVINGS: | WATER SAVINGS: | RESOURCE CONSERVATION: | AIR QUALITY:
FEASIBILITY: INITIAL COST: $$ | DIFFICULTY LEVEL: TT

A dry house is a more durable house and therefore extends the value of the home, a precious resource. The cost and complexity of moisture management strategies depends on what steps will be undertaken. Consider the costs of not properly managing moisture in terms of the durability of the structure of the building and to a home's indoor air quality, as mold can quickly reach toxic levels.

The **building envelope** plays a key role in the total performance of the building, so most moisture management strategies focus here. Several strategies keep the **building envelope** drier. Roof overhangs and overall sealing of any roof and wall penetrations are major examples. Incorporate a **house-wrap** or weather barrier when replacing the exterior **cladding** such as upgrading the house siding. Create a drainage plane, such as **house-wrap** with texture placed under siding, to allow hidden wet spaces to dry more quickly.

The integrity of the **building envelope** can be challenged by moisture in any state: 1) liquid in the form of rainwater penetration, 2) solid such as ice and snow, and 3) vapor, such as relative humidity. If these conditions are not managed properly, they can lead to decay of the home, creating permanently wet conditions that also affect indoor air quality. [See additional window, wall and foundation strategies in this section to understand how to best manage moisture.]

Use appropriate window glazing [EA60]

BENEFITS: ENERGY SAVINGS: | WATER SAVINGS: | RESOURCE CONSERVATION: | AIR QUALITY:
FEASIBILITY: INITIAL COST: $$ | DIFFICULTY LEVEL: TT

Correctly designed **glazing** systems reduce energy usage and enhance natural daylighting in the home. Optimizing window **glazing** is a **passive solar design** that considers the orientation of the sun and adjusts window **glazing** accordingly. **Glazing** is measured by its **Solar Heat Gain Coefficient (SHGC)**. The **SHGC** gauges the amount of solar heat energy transmitted through the window **glazing**. Higher heat energy - indicated by a high **SHGC** - is desirable for south-facing windows in northern climates. Design east and west windows with a lower **SHGC** to keep the heat gain down in summer. To best balance the temperature of the **building envelope**, **glazing** as part of a whole window design assures that all issues are factored in for optimal comfort and energy savings. **SHGC** is considered with a window's **R-Value** rating to assure optimal window performance.

Window performance also depends on the connection to the adjacent envelope elements so these need to be properly water-managed. A **glazing** system has high resistance to water vapor transport but must be integrated with the **building envelope**'s rainwater management design as framing design and construction techniques also impact water intrusion.

When replacing windows, select units with features that improve energy performance. These features include double or triple **glazing**, warm-edge spacers, gas filling between the panes (argon, krypton or a mixture of both), and a variety of coatings on the glass including **low-emissivity** (**low-E**) coatings. All of these features improve the **U-factor** by reducing the heat loss through the window.

Upgrade existing exterior door [EA57]

BENEFITS
ENERGY SAVINGS:
WATER SAVINGS:
RESOURCE CONSERVATION:
AIR QUALITY: N/A
FEASIBILITY
INITIAL COST: $
DIFFICULTY LEVEL: T

An exterior door that is old, improperly installed, or not well-sealed can contribute significantly to energy losses in a home. If the home has older doors or if installing a new door can be included as part of a larger home improvement project, replacing them will result in lower heating and cooling costs. Adding a storm door can be a good investment if a home's existing door is old but still in good condition, however, adding a storm door to a newer, insulated door is not generally worth the expense since it won't save much more energy. When selecting a door for energy efficiency, consider its **energy performance rating** and look for the **Energy Star®** and **National Fenestration Rating Council** labels. Check for federal tax credits and state and local incentives for qualifying doors.

Install window shading system [EA62]

BENEFITS
ENERGY SAVINGS:
WATER SAVINGS: N/A
RESOURCE CONSERVATION: N/A
AIR QUALITY: N/A
FEASIBILITY
INITIAL COST: $$
DIFFICULTY LEVEL: TT

Roughly 40 percent of the unwanted heat build-up in the home comes in through windows. High performance windows can partly compensate for poor orientation and/or poorly placed windows (See Use appropriate window glazing EA60 above). However, shading devices can supplement the benefits of high-tech windows and add an extra layer of protection against the sun. Shading on south and west facing windows helps reduce heat gain in the summer. In the winter, when the sun is lower in the sky, windows permit sunlight to pass through the window to warm the interior. **Deciduous trees** on the southeast, south and southwest areas of the home can provide considerable shade and natural cooling during summer months. These same trees will lose their leaves during the winter months, allowing sunlight to heat homes during the day. Although both exterior and interior shades can control heat gain, exterior shading devices - such as roof overhangs, **awnings**, **louvers**, shutters, and **solar screens** - are most effective since they block sunlight before it enters the windows.

Roof overhangs can help keep unwanted summer midday sun from heating a home, and can protect the home from rain and potential moisture damage. The drawbacks of overhangs are that they are difficult to add unless the remodel includes plans for work on the roof, and there is no way to retract them. While there is not a universally accepted method for calculating sizes for overhangs, the U.S. Department of Energy offers the following general guidelines for moderate climates:

- Moderate climates: below 6,000 heating degree days (HDD) (at base 65°F [18°C]) and below 2,600 cooling degree days (CDD) (at base 75°F [22°C]) (HDD and CDD data is available from local weather services.)
- Locate shadow line at window sill using the June 21 (summer solstice) sun angle.
- Sustainable by Design offers the following shareware design tools for calculating solar angles and designing window overhangs: www.susdesign.com/tools

Awnings are often made of fabric or metal and can be stationary or retractable. A light-colored **awning** also reflects sunlight. To take advantage of the desirable winter heat gain, homeowners should remove **awnings** for winter storage or buy retractable ones.

Louvers operate like exterior mini-blinds. They can have vertical or horizontal slats to control the level of light entering a home and, depending on the design, can be adjusted from either inside or outside of the house.

Shutters are moveable wooden or metal coverings that, when closed, keep sunlight out. They can be either solid or slatted, with fixed or adjustable slats. Rolling shutters have a series of horizontal slats that run down along a track.

Solar screens look like standard window screens, except they block light and cut glare.

Incentive [EA57]

Rebates and Tax Credits for Windows, Doors, and Skylights:

www.energystar.gov/index.cfm?c=windows_doors.pr_taxcredits

Building Age [EA57]

Older homes may require or desire custom doors to fit with the structure and original architecture. Consider a locally hand built door made from salvaged wood.

Tips [EA62]

If a home is oriented more than 30° off true south, the effectiveness of an overhang, as with any solar feature, begins to decrease significantly

NJ Bio-Region [EA62]

Sunny areas with less natural shade can benefit from **awnings** in the summer. In the cold winter months, however, **awnings** should be removed and stored.

Building Age [MR119]

If upgrading the **cladding** of an older home consider low-maintenance materials such as fiber siding that need to be painted 25 percent less often than wood.

Caution [MR119]

Older homes may have **cladding** in place that contains lead paint and **asbestos**.[9] **Asbestos** used in "cement form" releases particles if the siding is cut.

Tips [MR120]

According to studies by the Oak Ridge National Laboratory, lightly colored, more reflective roofing can save up to 40 percent in summer cooling energy costs while highly emissive roofs can reduce urban air temperatures by as much as 12 ° F.

NJ Bio-Region [MR120]

According to the Cool Metal Roof Coalition, a highly reflective and highly emissive painted or granular coated metal roof is optimal for reducing energy consumption where annual cooling loads dominate (Florida) while an unpainted metal roof is more desirable because of its low infrared emittance in colder climates where heating degree days dominate (New Jersey).

Building Age [MR120]

The normal life of a roof today is 35-50 years, depending upon the maintenance of the roof. Signs that it's time to replace the roof:

1) roof leaks 2) missing, torn or curled shingles 3) poor condition of interior walls touching the roof (moisture marks, loss of paint)

Install a durable wall cladding [MR119]

BENEFITS: ENERGY SAVINGS: | WATER SAVINGS: | RESOURCE CONSERVATION: | AIR QUALITY:
FEASIBILITY: INITIAL COST: $$$ | DIFFICULTY LEVEL: TTT

A durable wall **cladding** should be part of the home's moisture management strategy. Proper installation of **cladding** requires a layered approach with an air space or **rainscreen** behind the siding so this area can dry out while also fully sealing the **building envelope**. Newer versions of **house-wrap** have textured surfaces that create a drainage plane to move water more readily behind the **cladding** and out to the wall assembly.

Siding properly installed over a **rainscreen** requires less frequent painting or staining than when installed directly over **sheathing**, reducing the need for refinishing. Factory pre-primed claddings are also highly efficient. Noncombustible siding, such as **fiber cement**, adds fire protection and often is required by building codes. This must be layered with fire-resistant screening in the air space behind the **cladding** to be effective.

Provide a durable and reflective roof [MR120]

BENEFITS: ENERGY SAVINGS: | WATER SAVINGS: | RESOURCE CONSERVATION: | AIR QUALITY: N/A
FEASIBILITY: INITIAL COST: $$ | DIFFICULTY LEVEL: TTT

Roofs are the home's first layer of defense against the elements: temperature fluctuations, **UV** light, rainstorms, snow and ice, and high winds. Roofing, especially dark colored roofing, can be a source of significant unwanted heat gain. Discarded roofing material, such as asphalt shingles, is also a major source of Construction and Demolition (C&D) waste.

If adding a new roof as part of an addition or replacing an existing roof, consider environmentally friendly alternatives to conventional asphalt roofing shingles such as clay, concrete, slate tile, **cool metal roofing**, fiber-cement composite roofing, **recycled content** plastic/rubber shingles, or a green or **vegetated roof** (made with living plants). In general, light colored roofs offer a greener alternative to dark roofing materials since they reflect rather than absorb heat. Consider a cool metal or reflective roof with material certified by USEPA **Energy Star**® Reflective Roof Program. Also, look to install a highly durable, **50-year roof**. Keep in mind that light colored shingles often make for a longer lasting roof since they experience less contraction and expansion than darker ones.

Cool metal roofing can achieve solar reflectance of over 70 percent, which means that less heat is transferred into the home. It also means a reduction in the **urban heat island effect** (the local warming due to dark-colored surfaces and buildings). Infrared emittance -- the amount of absorbed solar radiation that is re-emitted from the roof to the sky -- varies with the surface finish. For example, the emittance of painted or granular-coated metal roofing is higher than unpainted metal roofing and can be as high as 90 percent. Select cool metal roofs qualify as **USEPA Energy Star**® Roofing Products.

Follow standards for mechanical design [EA63]

BENEFITS: ENERGY SAVINGS: | WATER SAVINGS: | RESOURCE CONSERVATION: | AIR QUALITY:
FEASIBILITY: INITIAL COST: $$ | DIFFICULTY LEVEL: TT

The Air Conditioning Contractors of America (ACCA) developed standards to size heating, ventilating and air conditioning systems (**HVAC**s) to assure maximum comfort and energy efficiency.

The ACCA also provides software that calculates **heating and cooling loads**. Use these calculations both before and after **HVAC** installation to assure effectiveness. Request **load calculations** from contractors to validate the overall size and design proposed. Addressing **building envelope** issues at the design phase can reduce the load and resulting size requirement of the home's **HVAC** systems.

The **ACCA Manual J - Residential Load Calculation** accurately estimates heating and air conditioning loads. **Manual S – Residential Heating and Cooling Equipment Selection** recommends optimal heating and cooling equipment to meet loads as identified from **Manual J** results. Use the **Manual S** calculation to assure proper sizing based on the square footage and the home's heat loss during cold weather and heat gains during warm weather. **Over-sizing** and improper design are major issues in **HVAC** installation and design. **Over-sizing** can compound the cause of indoor climate issues such as inconsistent temperatures from one room to another. Calibration of the **sensible (or dry) cooling load** and the **latent (or wet) cooling load** assures interactions with windows or people will be accounted for in the design.

Manual D – Residential Duct Systems provides tools for proper duct sizing and is used in conjunction with **Manual J** and **S** calculations. Correct sizing is essential to maximizing **HVAC** energy efficiency. A system that is too big used with a smaller duct system creates improper air flow and raises the utility bill. Proper duct design assures even air flow to each conditioned space within the home. Similar to the issues faced with an improperly or oversized **HVAC** unit, improper duct system design can lead to increased energy bills and a lack of comfort in the home due to an imbalance of heating or cooling in the conditioned spaces. Additional duct design attributes include well-insulated and sealed ducts that are best placed within conditioned space and with a minimum number of turns. Placement of the duct system is also essential to assure energy efficiency, promote proper functioning of the entire unit, and reduce future maintenance requirements.

Provide controls and zoning for HVAC [EA64]

The heating, ventilating and air conditioning (**HVAC**) system distributes air through the home via the **ducting system**. Assuring proper distribution across defined zones or areas of the home is another key design element and should be considered with sizing to assure an efficient system. This is especially true in determining **optimal load calculations** and appropriate air flow for each room. **Zoning** more effectively directs heating and cooling from a single **HVAC** system to multiple areas of the home than multiple **HVAC** units and avoids the added expense that comes with them.

Proper **zoning** controls optimal comfort and efficiency. A **zone controller** connects multiple thermostats to the single **HVAC** system and allows for cooling customization, such as focusing the cooler air in occupied spaces at optimal times. **Zoning** increases overall thermal comfort of a home and is particularly useful in larger houses that are poorly conditioned, such as single-zone two-story houses with a generally warmer second floor.

Use ceiling fans for natural ventilation [EA65]

Since people can tolerate higher temperatures when air is in motion, use ceiling fans in conjunction with an air conditioning system in occupied rooms. This reduces air conditioning use,thus saving electricity and money. In the summer, run ceiling fans in a counterclockwise motion. Ceiling fans can be used in the winter in a clockwise motion at low speeds to bring warm air back down into the occupied space.

Caution [MR120]

If a roof is to be used to collect potable water, its material should not capture or hold contaminants (such as asphalt or fiberglass with a textured surface), and it should not leach contaminants into the water, as can be the case with copper and certain other materials.

Tips [EA63]

It is more efficient for a smaller unit to run for longer time than a larger unit to operate with shorter cycles. This can be likened to fuel usage differences between highway and local driving.

NJ Bio-Region [EA63]

Correct sizing matters, particularly in areas of high humidity such as shore locations where the air conditioning unit pulls substantial moisture out of the air.

Caution [EA63]

An improperly sized system can lead to indoor air quality issues, including mold. Combustion safety is a primary consideration requiring testing during **HVAC** design or modifications; a change in the home's air pressure can result in **backdrafting** of combustion units, putting dangerous gases into the home. Test before and after remodeling with the **Blower Door Test**.

Building Age [EA64]

This strategy does not apply to older homes with boilers and hot water steam heat. Retrofitting **zoning** into older homes or into any existing installation is a challenge and could prove to be very costly; consider options and benefits of doing so versus effort and costs before proceeding.

Tips [EA65]

Turn ceiling fans off when rooms are unoccupied.

Open both sections of **double-hung windows** to allow cool air in the lower window and warmer air to escape upper windows.

Consider a solar powered attic or **whole house fan** for additional energy savings.

NJ Bio-Region [EA65]

Shore locations can save cooling costs by leveraging natural shore breezes from ocean-facing windows.

Building Age [EA65]

Older homes pose challenges to designing optimal mechanical cooling, so consider ventilation options before installing air conditioning. Many older homes have cross ventilation systems built into their original design, as they were built before air conditioning became commonplace.

Caution [EA65]

Fresh air is essential for indoor air quality and combustion safety, but energy-efficient homes may minimize air flows including fresh air. **Energy Star®** homes require a controlled mechanical vent to assure air exchanges such as a programmable bathroom fan.

Tips [EA67]

Before purchasing, check the compatibility of the thermostat with the respective **HVAC** system. Make sure the thermostat selected operates via battery versus obtaining some power from the 24V AC **HVAC** lines.

Incentive [EA66]

N.J. Clean Energy Program offers rebates for properly sized and installed high-efficiency systems www.njcleanenergy.com

Also, consider a whole house fan to avoid air conditioner usage and expense. Generally a whole house fan is used at night and turned off during the day. It moves cooler nighttime air into the house through open windows and exhausts warm air through the attic.

Another way to cool the home is with **transoms** in window and door designs. Designing for convection directs cool air to enter the home on the lower floors (such as through the basement) and expels warm air through upstairs windows.

Strategic location of plants and landscaping can cool (and clean) the air before it enters the home. Finally, **awnings** and blinds provide additional passive cooling options.

Install programmable thermostats [EA67]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:	WATER SAVINGS: N/A		INITIAL COST:	
RESOURCE CONSERVATION: N/A	AIR QUALITY: N/A		DIFFICULTY LEVEL:	

Programmable thermostats save energy and money by allowing homeowners to set temperatures based on occupancy and to schedule setting changes. This uses heating and cooling only when needed. **Programmable thermostats** are especially useful if the house is empty during the work week and only fully occupied on weekends. Pre-programming and proper use of a programmable thermostat saves energy costs by minimizing heating or cooling of an empty house.

Select high-efficiency HVAC equipment [EA66]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:	WATER SAVINGS:		INITIAL COST:	
RESOURCE CONSERVATION:	AIR QUALITY:		DIFFICULTY LEVEL:	

Heating is the largest energy expense in most homes, accounting for 35-50 percent of annual energy bills in northern climates. Save money by reducing heating energy usage while also reducing the home's contribution to environmental problems by upgrading to **Energy Star®** rated heating equipment as determined by the **Annual Fuel Utilization Efficiency** (**AFUE**) rating for oil and gas furnaces and boilers (and other measures as applicable to heat pumps). **Energy Star®** rebates apply for **Energy Star®** rated equipment.

The American Council for an Energy-Efficient Economy cites several considerations for assessing when it is time to replace the furnace.[10] In particular, gas furnaces or boilers that are older than 20 years are good candidates for replacement with a high-efficiency model with the guidance of an **Energy Star®** certified heating contractor and heat-**load calculations** that the contractor provides. If it is time to replace the furnace, installing a ground-source **heat pump** could be an option depending on the extent of the remodeling effort; see the Ridgewood historical remodel case study at the end of this chapter for a **heat pump** upgrade in practice.

The efficiency of central air conditioning systems is rated by a **Seasonal Energy Efficiency Ratio** (**SEER**). **SEER** ratings range from 14 to 23; a higher **SEER** rating means a more efficient unit. **Energy Star®**-qualified central air conditioners have a **SEER** rating of greater than or equal to 14 and are significantly more efficient than standard models; as such, **Energy Star®** models provide for more cost savings over the life of the unit. Newer units in general have incorporated significant advances to increase efficiency. **Energy Star®** models also require a minimum **Energy Efficiency Ratio (EER)** of greater than or equal to 12 for **split systems**, and of greater than or equal to 11 for single-package models. While higher efficiency units often cost more initially they save on operating costs over their lifetime.[11] A high-efficiency unit must also be designed, installed, and maintained properly to reap efficiency benefits (see [EA63]).

An effective pleated filter also contributes to savings on heating/cooling and helps prevent the introduction of pollutants into the living space. Radial pleated filter designs such as a 'MERV 8' provides optimal dust holding capacity, especially as compared with standard rigid fiberglass filters

that provide little resistance against dust or bio contaminates. Keeping the filter clean is an essential component of **HVAC** maintenance.

Conduct duct tightness test [EA68]

Similar to a pressure test of a plumbing system, a **Duct Blaster Test** gauges the tightness of the ductwork. It uses a fan combined with a pressure gauge to pressurize the duct system and measure air leakage of the ductwork. The test is often performed along with a **Blower Door Test** as part of a **Home Performance Audit** to find leaks. It should be performed before and after related work to properly identify and target areas for action and to assure resolution of desired upgrades and energy and operating cost savings.

Caution [EA68]

Ducts that don't work properly can create serious, life threatening **carbon monoxide** (**CO**) problems in the home. Install a **CO** monitor to alert you to harmful **CO** levels if you have a fuel-burning furnace, stove or other appliance, or an attached garage.

www.eere.energy.gov/consumer/tips/ducts.html

Maintain HVAC systems [EA69]

Heating, Ventilating, and Air Conditioning (**HVAC**) systems can be **commissioned** or tested to ensure systems are operating as the manufacturers intended, e.g., **refrigerant** adequately charged, airtight ducts, proper room-by-room pressure and proper airflow.

HVAC systems must be properly balanced to ensure even distribution of air and need to be inspected, tested, and tuned up after installation. **Zoning** and other controls should also be tested to make sure they are functioning properly. To confirm functioning, have all aspects of the **HVAC** system **commissioned**. **Commissioning** provides documented confirmation that the **HVAC** systems are working as intended.

Commissioning systematically investigates, analyzes, and optimizes the performance of **HVAC** systems to improve their operation; maintenance ensures continued performance over time. Regular maintenance ensures that the energy efficiency upgrades remain at optimal levels as designed and are meeting the homeowner's current needs.

To protect an investment in an **HVAC** upgrade and assure its efficiency over time, **HVAC** equipment should be tuned up annually and filters should be cleaned or be replaced on a regular basis. **Energy Star®** recommends tending to filters every 30 days during peak heating or cooling season. The wrong amount of **refrigerant** in air conditioners can also impact the functioning of the cooling unit. Proper maintenance extends the life of the **HVAC** system, extending the resource value of the system.

To assure regular maintenance, homeowners should consider setting up an **HVAC** maintenance contract for "tune-up" of your **HVAC** system before heating and cooling seasons to protect performance. A maintenance contract can pay for itself in energy savings and ensures that your **HVAC** contractor will schedule tune-ups even if you forget.

Tips [EA69]

Hire a trained technician to verify installation and operational requirements. **Energy Star®** has collaborated with the **EPA** to provide documented standards for assuring proper installation and verification of **HVAC** systems.

www.energystar.gov/ia/home_improvement/PHEE_InstallationAC_final.pdf

Caution [EA69]

Improperly balanced systems can depressurize the house, allowing **radon** and other hazardous **soil gases** to enter the home.

The **commissioning** process should check for **refrigerant** leaks that can emit **refrigerant** gasses into the air.

Seal and insulate HVAC system [EA70]

A house can lose over 30 percent of its heating and cooling capacity from improperly sealed ducts, especially if the ducts are located in unconditioned spaces.[12] In the winter, hot air leaks into

Tips [EA70]

The contractor should be able to confirm the sealing work with a **Duct Blaster Test** performed before and after duct sealing.

Caution [EA70]

Pressure imbalances due to duct leakage can force moisture laden air into **building envelopes** and lead to moisture problems.

unconditioned spaces and causes the furnace to work harder. In the summer, hot attic air can leak in and increase the load on the air conditioner. A perfectly sealed operative duct system would have the same amount of air entering the return **grille** and leaving the supply registers, creating neutral air pressure. In contrast, leaky **supply ducts** create negative pressure that pulls outside air into the building. On the return side, leaks cause a suction that pulls air into the ducts, forcing more air into the home and creating a positive pressure that also overtaxes the **HVAC** system.

Seal all ducting with low-**VOC duct mastic**. The **Energy Star® Thermal By Pass Checklist** recommends the use of mastic, not tape, to seal ducts. Results have shown that using tape to seal ducts is ineffective as tape often frays and curls away degrading the seal. If any ductwork is in less desirable condition, or in uninsulated areas, additional insulation most likely will be required. A qualified professional can help insulate and repair ducts.

Tips [EA71]

Check references and licenses to locate a duct cleaning provider and make sure they are a certified member of the **NADCA**. Air duct cleaning companies must meet requirements to become a **NADCA** Member including having certified Air System Cleaning Specialists (ASCS) on staff.

Caution [EA71]

HVAC components can become contaminated with particles of dust, pollen or mold that can be released into the home's living space cause allergic reactions.

The homeowner should inquire about the use of **biocides** or chemical treatments in the duct cleaning process to make sure a service provider would not intend to use them.

Older **duct systems** should be inspected before cleaning to be sure that there are no **asbestos**-containing materials.

Make sure ductwork is clean [EA71]

Duct cleaning refers to the cleaning of heating and cooling system components in forced air systems, including the supply and return-air ducts, registers, grilles, **diffusers**, **heat exchangers**, **heating and cooling coils**, **drain pans**, fan motor, fan housing, and the air handling unit. While clean ducts help maintain healthy indoor air quality, unless done properly, cleaning ducts can cause more indoor air problems.

If a visual inspect reveals infestation, mold or extreme debris problems, duct cleaning may be necessary. If so, be sure the service provider cleans all components of the system to avoid any recontamination that may require more serious cleaning needs. Be sure the service provider is qualified by the **National Air Duct Cleaners Association (NADCA)**. A certified service provider uses specialized tools to dislodge dirt and other debris in ducts and vacuums them out with a high-powered vacuum cleaner. Different types of ducts require different cleaning methods; sheet metal ducts with external insulation are the easiest to clean. A **Duct Blaster Test** should also be performed when cleaning ducts to gauge the tightness of the ductwork. Finally, be sure to cover duct registers and openings during renovation or remodeling.

Provide daylighting HS1 [EA83]

Sunlight is a natural way to reduce energy use during the daytime hours. Homes that only require artificial lighting at night and on darker days save more electricity and are more aesthetically pleasing than ones that do not.

Windows and skylights are obvious sources of daylight, but balance daylight access with appropriate **glazing** and shading techniques. Poorly designed window or skylight layouts can increase summer **cooling loads** significantly. **Awnings**, **louvers**, and shutters can block direct sunlight and allow indirect sunlight into the building. Conversely, a well-designed scheme reduces **heating loads** significantly in the colder months. In the northern hemisphere, south facing windows receive the most sunlight over the course of the day. For these windows, properly sized overhangs will shade the window from direct summer heat but will allow the lower winter sunlight to filter through.

An alternative to window skylights is **solar tubes**. The flexible cylinders of the **solar tubes** draw sunlight from the roof into a ceiling fixture resembling a standard lighting fixture. They are useful in smaller interior rooms without space for a traditional skylight, such as a bathroom. Translucent panel skylight systems are another means of allowing sunlight in without producing glare and minimizing heat transfer.

Provide appropriate lighting [EA84]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:	WATER SAVINGS: N/A		INITIAL COST: $$	
RESOURCE CONSERVATION:	AIR QUALITY: N/A		DIFFICULTY LEVEL: TT	

Lighting consumes almost 15 percent of a household's electricity use.[13] Provide an appropriate mix of color-correct **ambient** and task lighting to improve both the quality and quantity of lighting used in the home.

Two ways of determining which lighting is appropriate for a particular use are its **color temperature** and its **Color Rendering Index (CRI)**.

Color temperature defines the color and warmth or coolness of a light source. **Color temperature** is measured in degrees **Kelvin (K)**. High **Kelvin** temperatures (3600–5500 **K**) are considered "cool" and low color temperatures (2700–3000 **K**) are considered "warm." Task lighting calls for cool light that produces a higher contrast than warm light and is better for visual tasks. Warm light is recommended for living spaces. A **color temperature** of 2700–3600 **K** is generally recommended for most indoor general and task lighting applications.

The **Color Rendering Index (CRI)** is a 1-100 scale that measures how colors appear under different light sources. A light source with a **CRI** of 80 or higher is considered acceptable for most indoor residential applications.

Install energy-efficient lighting [EA85]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:	WATER SAVINGS: N/A		INITIAL COST: $	
RESOURCE CONSERVATION: N/A	AIR QUALITY: N/A		DIFFICULTY LEVEL: T	

Traditional incandescent bulbs will be phased out by 2012. The technological improvements in **compact fluorescent lighting (CFLs)** over the past decade have made for a smooth transition. **CFLs** are inexpensive, last ten times as long as traditional bulbs, and use a fraction of the electricity. They also fit into standard light fixtures, allowing for their widespread use with minimal up-front cost.

Light-emitting diodes (LEDs), currently used in a variety of applications, potentially could find their way into more traditional lighting applications. Highly efficient, durable, and non-toxic, **LEDs** currently cost too much to warrant their widespread use. However, rapid advances in **LED** technology continue to push **LED** lighting to more practical uses.

Wherever possible, replace incandescent bulbs with greener alternatives. It is a simple and affordable way to significantly reduce home energy use.

Provide appropriate indoor lighting controls [EA90]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:	WATER SAVINGS: N/A		INITIAL COST: $$	
RESOURCE CONSERVATION: N/A	AIR QUALITY: N/A		DIFFICULTY LEVEL: TT	

Lighting represents about 15 percent of household electricity usage and about 10 percent of household energy expenses. Newer lighting technologies, extensively used in commercial buildings, are now available for home use. These technologies can reduce lighting energy use in your home by over 50 percent.[14]

Lighting controls such as dimmers, timers, and motion detectors reduce light usage by synchronizing lighting directly with living patterns. Motion detectors switch the light on when someone walks

Tips [EA84]

The U.S. Department of Energy offers the following energy-efficient lighting design tips:

- Remember that more light is not necessarily better. Human visual performance depends on light quality as well as quantity.
- Match the amount and quality of light to the performed function.
- Install **task lights**, such as desk lamps, where needed and reduce **ambient light** elsewhere.
- Use energy-efficient lighting components (i.e., **CFLs**, **LEDs**), controls, and systems.
- Maximize the use of daylighting.

Caution [EA85]

Fluorescent bulbs and lamps are considered hazardous waste and should be disposed of properly. If a bulb breaks avoid direct contact with skin. Burned out or broken fluorescent lamps should be brought to a facility that recycles them. Check with the County's Solid Waste and Recycling Department or type in your zipcode at www.Earth911.com to find out where you can recycle miscellaneous items such as **CFLs**.

Tips [EA85]

Not all **CFLs** are dimmable, so be sure to check before purchasing for a dimmable fixture.

into a room, while light sensitive detection adjusts indoor lighting based on the changing levels of outdoor light.

High-tech lighting controls, including whole house systems that offer tie-ins to computer and security systems as well as outdoor lighting, are most effective in new construction that can be hardwired with low-voltage wiring.

Caution [EA80]

Do not block air flow beneath a gas-fired natural draft water heater. Do not cover the burner access or the flue collar. Leave about 2" of exposed area around the flue collar. Don't use a regular blanket or insulation not designed to be used specifically with a water heater. Follow manufacturer's instructions for insulation.

Insulate water heater [EA80]

New water heaters have added interior layers of insulation that improve their energy consumption. Older water heaters are the third largest energy expense in the home, accounting for about 13 percent of the utility bill.[15] Insulate free-standing water heater storage units for quick and inexpensive improvements in energy efficiency. Heat is lost because the temperature inside a water heater is significantly higher than the temperature of the room, especially when the water heater's location is unconditioned. **Water heater blankets** and kits are available from local hardware stores and **weatherization** supply companies.

Tips [EA81]

The first six to eight feet of pipe from the water heater are the most important to insulate. Assure a snug fit around the pipes especially the elbows and angles; tight-fitting insulation is always more effective. Also Insulate cold-water pipes in areas with high summertime humidity to prevent condensation of moisture on the pipes and the associated sweating or dripping which degrades the durability of the piping.

Insulate hot water pipes [EA81]

Hot water pipes usually run through unheated areas of the home, so insulating them is important to prevent heat loss and help the water heater run efficiently. Insulated hot water pipes reduce water usage by increasing the amount of time that hot water stays hot thereby reducing the need to run tepid water through the faucet. Requiring less energy to heat water also reduces water heating bills.

Insulating hot water pipes on accessible pipes is an easy task. Pre-formed foam pipe insulation sleeves (available at local hardware stores) can be cut to fit snugly and snap in place on the pipes. Use a durable pipe insulation material that can withstand high temperatures over time. Cover slits and joints with vinyl duct tape to provide additional insulation.

Building Age [EA81]

Older homes should also consider covering cold water pipes especially those in unheated areas of the home to prevent freezing.

If the hot water pipes are buried into the slabs consider re-plumbing as part of a whole house performance plan.

Utilize solar water heating [EA101]

Solar water heating is cited as the most cost-effective renewable energy system for residential applications. Payback periods related to solar water heating differ depending on the cost of energy for heating water. In areas where electricity is used for water heating, the payback periods are shorter than for areas that use natural gas for water heating.[16] Installing a solar water heater is a proven solution to reducing the home's carbon footprint. Conventional electric water heaters produce about eight tons of CO_2 annually and gas water heaters about two tons of CO_2 annually.[17]

Solar water heating can be used for domestic hot water, pool heating, and space heating needs and is in use by over a million homes in the United States.[18] There are many types of solar water heaters. Evacuated tube solar hot water system can provide 90 percent–100 percent of domestic hot water needs.[19] Appropriate design and climate considerations are key in the consideration of any solar

project. Care must be taken to guard against freezing of the collector and piping, and evacuated tubes for solar hot water can overheat and break if the power went out on a sunny day.

Reconfigure plumbing for efficiency HS3 [EA77]

BENEFITS
ENERGY SAVINGS:
WATER SAVINGS:
RESOURCE CONSERVATION:
AIR QUALITY: N/A
FEASIBILITY
INITIAL COST: $$
DIFFICULTY LEVEL: TTT

Heating the water in your house accounts for about 11 percent of your annual energy costs. One can save water and energy by redesigning plumbing efficiently. Advancements in piping materials and plumbing systems cut installation and material costs, conserve water, and save energy. **Cross-linked polyethylene (PEX)** piping materials have quickly earned a reputation as a durable replacement for copper because they are:[20]

- Flexible – allowing for fewer joints and an easier (and quicker) installation
- Durable - capable of withstanding extreme temperatures and highly resistant to chemicals
- Consumer friendly – quieter than traditional piping materials and offered in color-coded **PEX** tubing for simple identification of cold and hot water lines.
- Energy-efficient – reduces heat loss from water in the pipe because it is a better thermal insulator than copper
- Water efficient – right-sizing capability allows for quicker hot water delivery

PEX also lends itself to **home-run** or parallel pipe configurations in which hot and cold pipes originate at a manifold and service individual fixtures with dedicated supply lines. **Home-Run** systems can be installed more quickly (because of flexible piping) than more rigid and conventional "tree" type plumbing systems. The dedicated supply lines from the manifold to the fixture – particularly in the hot water supply lines – are often smaller in diameter for a **Home-Run** system, so less water goes down the drain while waiting for hot water at the fixture. Finally, **Home-Run** systems operate much like an electrical system breaker box, allowing homeowners to easily turn off the water for repairs or maintenance.

Select a high-efficiency clothes washer [EA92]

BENEFITS
ENERGY SAVINGS:
WATER SAVINGS:
RESOURCE CONSERVATION:
AIR QUALITY: N/A
FEASIBILITY
INITIAL COST: $$
DIFFICULTY LEVEL: T

Clothes washers are responsible for about 22 percent of household water consumption or about 13,000 gallons of water each year.[21] Today's energy-efficient washers reduce water use and energy bills.

Replace a clothes washer when 1) a repair will cost more than half the price of a comparably equipped new appliance, and 2) a washer is more than seven years old. If you are in the market for a new clothes washer consider the following:[22]

- In selecting a washer load capacity, consider the household's largest routine load – larger capacity means fewer loads, saving time and energy
- Front-loaders use less energy and water, are usually gentler on clothes, and have faster spin speeds that drain more water out of laundry than regular top-loaders do thus shortening drying times and energy use
- Look for washers with the **Energy Star® label**

Front-loading washers are more expensive than top-loading washers, but in New Jersey rebates are available for units that meet Tier 3 **Energy Star®** standards which require a **Modified Energy Factor (MEF)** of 2.2 or higher and a maximum **Water Factor (WF)** of 4.4. There is no certification

Tips [EA92]

Consumer Report's Washer Tips:

1. Keep wash temperatures low. Reserve hot water for very special stains, like oil, that respond best to hot water, or for allergy-proofing bed linens. Also consider cold water detergents.
2. Wash full loads.
3. Use your washer's fastest spin speed. The more water your washer extracts from clothing at the end of the cycle, the less energy your dryer will need to dry the clothes

Incentive [EA92]

New Jersey **Energy Star®** Rebates
www.njcleanenergy.com/

Tips [EA93]

Find out how much your old refrigerator is costing you: www.energystar.gov/index.cfm?fuseaction=refrig.calculator

If you have an older unit with coils on its back side, vacuuming it once a year will help maintain optimal efficiency. Be sure to unplug the appliance before you do so.

Check the refrigerator door's **gasket** seal by closing the door on a dollar bill. Replace it if the bill falls out or can be easily removed without opening the door. Keep door gaskets clean of mold and mildew with mild detergent and water, not bleach.

Caution [EA93]

Household refrigerators and freezers manufactured before 1995 typically contain **chloro-fluorocarbon** (**CFC**) refrigerants - ozone-depleting substances (ODS) that are also potent greenhouse gases. The U.S. **EPA** provides guidance on the safe disposal of refrigerated household appliances. www.EPA.gov/ozone/title6/608/disposal/household.html

Caution [EA94]

Most dishwasher detergents contain **phosphates** that may harm the environment by promoting algae growth. Consumer Reports has information on eco-friendly brands that clean well without using **phosphates**.

Caution [EA95]

When installing a gas range or oven, make sure to properly vent the area since you are introducing combustible gas into your home.

for dryers, but a unit with a moisture sensor that turns off automatically when clothes are dry saves money and energy.

Select an energy-efficient refrigerator [EA93]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:		WATER SAVINGS: N/A	INITIAL COST:	$$
RESOURCE CONSERVATION:		AIR QUALITY: N/A	DIFFICULTY LEVEL:	

Refrigerators consume more electricity than any major kitchen appliance. Energy efficient refrigerators like **Energy Star**® models are about 40 percent more efficient than refrigerators built before 2001, and 50 percent more efficient than those built before 1993. If an existing refrigerator is more than 10 years old, consider upgrading to a refrigerator that meets or exceed **Energy Star**® standards as a new refrigerator with an **Energy Star**® label uses at least 20 percent less energy than one required by current federal standards.

Size, options and freezer compartment configurations affect energy use. A larger unit may be **Energy Star**®certified, but a smaller unit may still use less energy, so choose the smallest refrigerator that appropriately meets household needs. Features (such as water dispensers) use energy, so fewer features mean both greater energy efficiency and a lower likelihood of repairs. Top freezer models are generally more energy efficient than side-by-side models. Leave room around the unit for proper air flow around the cooling coils to ensure peak efficiency. Maintaining the unit is also important.

Choose an energy-efficient dishwasher [EA94]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:		WATER SAVINGS:	INITIAL COST:	$$
RESOURCE CONSERVATION:		AIR QUALITY: N/A	DIFFICULTY LEVEL:	

Most dishwasher energy use goes toward heating water, however, today's high-efficiency dishwashers use as little as three gallons of water thanks to sensors, high-efficiency pumps, and improved filtration. The expected life of a dishwasher is 9-12 years, and the payback period for a new dishwasher is long, but studies suggest it is more sensible to replace a dishwasher that is more than six years old rather than pay for repairs. Look for dishwashers the carry the **Energy Star**® label, which are over 40 percent more energy-efficient than the minimum government standards.

Install energy-efficient cooking appliances [EA95]

BENEFITS			FEASIBILITY	
ENERGY SAVINGS:		WATER SAVINGS:	INITIAL COST:	$
RESOURCE CONSERVATION:		AIR QUALITY:	DIFFICULTY LEVEL:	

Cooking itself does not contribute significantly to overall home energy use, but preheating does, making it sensible to invest in an energy-efficient model. When shopping for new cooking appliances or remodeling the kitchen, consider making a fuel switch since running gas pipes, vents, and electrical connections will influence the layout of the kitchen. Consider cooking preferences and local gas and electric rates. If another appliance such as a furnace, clothes dryer, or water heater is also on a switch list, take this into consideration when you look at placement and installation costs.

In general, electric ranges and ovens are more efficient than gas units. The most efficient ovens are convection ovens that cook by circulating hot air around the food, using only one-third as much energy to operate as conventional ovens. They produce further savings through reduced cooking times because the food is more evenly exposed to heat. Among electric ranges, induction models may cost more but they are also the most efficient.

In terms of gas units, look for electronic or thermal igniters instead of standing pilot lights. For smaller meals, consider using a microwave oven or a toaster oven that require less energy than a large oven. Self-cleaning gas or electric ovens are more efficient because they have more insulation than non-self cleaning models.

Select energy-efficient office equipment [EA99]

BENEFITS
ENERGY SAVINGS:
WATER SAVINGS: N/A
RESOURCE CONSERVATION:
AIR QUALITY:
FEASIBILITY
INITIAL COST: $
DIFFICULTY LEVEL:

Today there are about 18 million home-based business owners and 24 million telecommuters.[23] Working from home eliminates commute times and transportation-related emissions, but it contributes to higher electricity bills to power office equipment and lighting. In fact, small electronic devices alone account for 16 percent of an average home's energy bill. Office equipment that has earned the **Energy Star®** label uses less energy to perform regular tasks and automatically enter a low-power mode when not in use, thereby reducing **phantom loads**. Up to 75 percent of the electricity these units consume occurs while these devices are turned off.[24] When buying new office equipment, consider both the standby and the operating power consumption.

Energy Star® ratings are available for computers, monitors, printers, scanners, copiers, fax machines, multi-function devices (machines that combine printing, scanning, and faxing), lighting, cordless phones, answering machines, audio equipment, and room air conditioners.

Tips [EA99]

Energy-saving features, such as sleep mode, can be deactivated by users; homeowners should not disable energy conservation features.

Consider on-site renewable energy [EA102]

BENEFITS
ENERGY SAVINGS:
WATER SAVINGS: N/A
RESOURCE CONSERVATION:
AIR QUALITY: N/A
FEASIBILITY
INITIAL COST: $$$
DIFFICULTY LEVEL:

Ongoing advances in solar and geothermal technologies coupled with broader government financial incentives have made on-site renewable energy increasingly more feasible for the homeowner. Providing some or all of the home's energy from on-site renewable sources is an excellent way to not only significantly reduce utility bills, but also decrease one's reliance on and consumption of traditional fossil fuel energy sources.

Due to the increasing number of incentives for solar equipment, a homeowner can install a **photovoltaic** array with smaller up-front costs and a quicker payback period. New Jersey maintains a **Solar Renewable Energy Certificate** program that allows participants to receive sellable credits for the energy that they produce; each time a system generates 1000 kWh of electricity, a **SREC** credit is issued to the program participant.[25] Also, all equipment related to solar energy—including **passive solar** equipment—is eligible for sales tax exemption in the state.[26]

Another option for on-site energy production is the implementation of a solar water heating system. Solar water heaters can be either passive or active; passive systems are generally less expensive but not as efficient as active ones.[27] In New Jersey, a solar water heater would need to be used in conjunction with a traditional water heating system for cloudy days and winter months.

Geothermal technologies take advantage of relatively constant underground temperatures by pumping cooler air in the summer and warmer air in the winter to the surface. One of the more common applications of geothermal technology for homeowners is **ground source heat pumps** (**GSHPs**). Properly designed and installed **GSHPs** can provide efficient, clean, and renewable heating and cooling for homes. The U.S. Department of Energy calculates a payback period for individual geothermal systems of five to ten years from decreased energy costs.[28] The Resources section contains a link to the International Ground Source Heat Pump Association's website, which maintains a database of accredited geothermal heat pump installers.

Tips [EA102]

Use NREL's PVWatts™ calculator to determine the potential energy production and cost savings of installing a PV array.

www.nrel.gov/rredc/pvwatts/

Incentive [EA102]

Many of the federal incentives have been expanded through the February 2009 American Recovery and Reinvestment Act (the "stimulus package"). This includes a rebate for 30 percent of the cost of qualifying photovoltaic arrays, solar water heaters, and **GSHPs**.

Building Envelope

Conduct a Home Performance Audit and diagnostic tests [IPD2, EA51-54]

Resources:

New Jersey Clean Energy Program – Home Performance with Energy Star®

www.njcleanenergy.com/residential/home/home

Home Energy Analysis – Free Online Tool

www.njcleanenergy.com/residential/tools-and-resources/home-energy-analysis/home-energy-analysis

U.S. Department of Energy: Do-It–Yourself Home Energy Audit

www.eere.energy.gov/consumer/your_home/energy_audits/index.cfm/mytopic=11170

USEPA Energy Star® Home Energy Yardstick

www.EnergyStar.gov

Alliance to Save Energy Home Energy Checkup and Audit

www.ase.org

U.S. Department of Energy: Detecting Air Leaks

www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11250

New Jersey Office of Clean Energy, Rebates and Promotions

www.njcleanenergy.com/main/rebates-and-promotions/rebates-and-promotions

USEPA Energy Star®, Thermal Bypass Inspection Checklist

www.EnergyStar.gov/ia/partners/bldrs_lenders_raters/downloads/Thermal_Bypass_Inspection_Checklist.pdf

Affordable Housing Design Advisor - Thermal Bypass Checklist (video tutorial)

www.designadvisor.org/

References:

[1] **U.S. Department of Energy: Blower Door Tests**

www.energysavers.gov

Install or upgrade insulation [EA49]

Resources:

USEPA - Current Best Practices for Vermiculite Attic Insulation - May 2003

www.EPA.gov/Asbestos/pubs/insulation.html#What

U.S. Department of Energy: Insulation

www.eere.energy.gov/consumer/tips/insulation.html

USEPA Energy Star® Program

www.EnergyStar.gov

Energy Trust of Oregon, Home Energy Solutions, Weatherization Specification Manual Attic Insulation

www.energytrust.org/TA/hes/weatherization/attic.html#at37

U.S. Department of Energy: Seal Air Leaks and Save Money, Fact Sheet

www.eere.energy.gov/buildings/publications/pdfs/building_america/26446.pdf

U.S. Department of Energy: Radiant Barriers

www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11680

USEPA Energy Star®, Guide to Do It Yourself Sealing and Insulating

www.EnergyStar.gov/ia/partners/publications/pubdocs/DIY_Guide_May_2008.pdf

References:

[2] **Iowa Energy Center. 2009. Home Tightening, Insulation and Ventilation. Home Series Booklets**

www.energy.iastate.edu/homeseries/downloads/HomeSeries1.pdf

[3] **U.S. Department of Energy. 2008. Insulation Fact Sheet**

www.ornl.gov/sci/roofs+walls/insulation/ins_02.html

[4] **Toolbase Services: Alternative Insulation Materials**

www.toolbase.org/Technology-Inventory/walls/sprayed-foam-insulation

[5] **U.S. Department of Energy: Sprayed-Foam and Foamed-In-Place Insulation**

www.energysavers.gov/your_home/insulation_airsealing/index.cfm/mytopic=11700

[6] **U.S. Department of Energy: Radiant Barriers**

www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11680

Air seal to reduce infiltration [IDP55]

Resources:

The Family Handyman: Insulate Basement Rim Joists

www.rd.com/familyhandyman/content/57548/

USEPA Energy Star® Methodology for Estimated Energy Savings from Cost-Effective Air Sealing and Insulating

www.EnergyStar.gov/index.cfm?c=home_sealing.hm_improvement_methodology

Oikos, Rim Joists

www.oikos.com/library/airsealing/rim_joists.html

The Best Way to Insulate a Rim Joist, Stop Energy Losses With A Spray-Foam Kit, Isaac Savage

www.taunton.com/finehomebuilding/PDF/Free/021189072.pdf

U.S. Department of Energy: Insulation and Air Sealing

www.energysavers.gov/your_home/insulation_airsealing/index.cfm/mytopic=11220

USEPA EnergyStar. 2008. A Do-It-Yourself Guide to Sealing and Insulating with Energy Star®

www.energystar.gov/index.cfm?c=diy.diy_index

Iowa Energy Center. 2009. Home Tightening, Insulation and Ventilation. Home Series Booklets

www.energy.iastate.edu/homeseries/downloads/HomeSeries1.pdf

References:

[7] **Partnership for Advancing Technology in Housing (PATH). 2008. Energy Efficient Rehab Advisor – Air Sealing**

www.rehabadvisor.pathnet.org/sp.asp?id=9715

Weatherstrip doors and windows [EA58]

Resources:

Weatherstripping a wooden door

www.rd.com/18170/article18170.html

Lowe's How To: Weatherstripping Windows and Doors:

www.lowes.com/lowes/lkn?action=howTo&p=Improve/Weatherstripping.html

Home Tips: Options for Weatherstripping Windows

www.hometips.com/content/**weatherstrip**_intro.html

How to install Weatherstripping

home.howstuffworks.com/how-to-apply-weatherstripping2.htm

Applying permanent weatherstripping

www.easy2diy.com/cm/easy/diy_ht_3d_index.asp?page_id=35758373

U.S. Department of Energy: Weatherstripping

www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11280

Upgrade or replace existing windows [EA56/59]

Resources:

Building Science.com

www.buildingscience.com/bsc

Efficient Windows Collaborative. Fact Sheet: Selecting Energy-efficient Windows in New Jersey

www.efficientwindows.org/factsheets/Newpercent20Jersey.pdf

American Council for an Energy-efficient Economy: ACEEE Consumer Resources

www.aceee.org/Consumer/index.htm

Build Wisely: Moisture Proof Barrier

www.buildwisely.com/moisture-proof-barrier.html

U.S. Department of Energy Energy Efficiency and Renewable Energy Windows

www.eere.energy.gov/consumer/tips/windows.html

www.eere.energy.gov/consumer/your_home/windows_doors_skylights/index.cfm/mytopic=13310

GBlist: Environmental windows

www.ibiblio.org/london/renewable-energy/mailarchives/greenbuilding2/msg01067.html

Home Energy Magazine Online September/October 1997, Creating Windows of Energy-Saving Opportunity

www.homeenergy.org/archive/hem.dis.anl.gov/eehem/97/970908.html

The National Fenestration Rating Council (NFRC), Fenestration Facts

www.NFRC.org/fenestrationfacts.aspx

Lowe's, Curing Indoor Condensation Problems

www.lowes.com/lowes/lkn?action=howTo&p=Repair/IndrConden.html

References:

[8] **Journal of Light Construction June 2008, A Close Look at Common Energy Claims, Martin Holladay as seen on**

www.ecohomemagazine.com/energy-efficient-design/a-close-look-at-common-energy-claims.aspx

Provide moisture management strategies [IDP24]

Resources:

Sustainability of the Building Envelope, Rob Bolin, PE

Syska Hennessy Group May 2008

www.wbdg.org/resources/env_sustainability.php

The Energy & Environmental Building Association

www.eeba.org/index.html

Building Science Consulting, Read This Before Your Design, Build or Renovate

www.buildingscienceconsulting.com/resources/mold/Read_This_Before_You_Design_Build_or_Renovate.pdf

Build Wisely, Moisture Proof Barrier

www.buildwisely.com/moisture-proof-barrier.html

Use appropriate window glazing [EA60]

Resources:

Building Science

www.buildingscience.com/bsc/

Efficient Windows Collaborative

www.efficientwindows.org/index.cfm

American Council for an Energy-efficient Economy: ACEEE Consumer Resources

www.aceee.org/Consumer/index.htm

Build Wisely: Moisture Proof Barrier

www.buildwisely.com/moisture-proof-barrier.html

Architecture Week, Glazing for Daylight by Gregg D. Ander, FAIA

www.architectureweek.com/2004/0211/building_1-1.html

Whole Building Design Guide, Windows and Glazing by Gregg D. Ander, FAIA

www.wbdg.org/resources/windows.php

How to Glaze Old Windows - Step By Step Guide

www.diythisnthat.com/2008/08/05/glazing-old-windows-step-by-step-guide/

The Natural Handyman, Window Glazing and Glass Replacement

www.naturalhandyman.com/iip/infwindows/infgla.html

U.S. Department of Energy: Windows

www.eere.energy.gov/consumer/tips/windows.html

www.eere.energy.gov/consumer/your_home/windows_doors_skylights/index.cfm/mytopic=13310

GBlist: Environmental windows

www.ibiblio.org/london/renewable-energy/mailarchives/greenbuilding2/msg01067.html

The National Fenestration Rating Council (NFRC), Fenestration Facts

www.NFRC.org/fenestrationfacts.aspx

Upgrade existing exterior door [EA57]

Resources:

The sustainable entrance

www.entrepreneur.com/tradejournals/article/181772176_2.html

Day Light and Natural Air Flow

www.smgreen.org/Content/envelope/envairflow.html

National Fenestration Rating Council

www.NFRC.org/

Better Homes, Installing Door Hinges and Locksets

www.bhg.com/home-improvement/exteriors/doors/installing-door-hinges-and-locksets/

Install window shading system [EA62]

Resources:

Lawrence Berkeley National Laboratory: Shading Strategy

www.windows.lbl.gov/daylighting/designguide/section5.pdf

PATH Tech Set 4: Energy-Efficient Lighting

www.pathnet.org/sp.asp?id=16574

Consumerenergycenter.org, Windows, Shades Awnings

www.consumerenergycenter.org/home/windows/shades_**awnings**.html

U.S. Department of Energy: Landscape Shading

www.eere.energy.gov/consumer/your_home/landscaping/index.cfm/mytopic=11940

Install a durable wall cladding [MR119]

Resources:

Wall cladding

www.buildinggreen.com

Toolbase Services: Tech Set 2 - Durable Building Envelope

www.toolbase.org

References:

[9] **Lead paint was banned in 1978, but houses painted prior to that date have paint with a high lead content.**

Provide a durable and reflective roof [MR120]

Resources:

USEPA – Cool Roofs

www.EPA.gov/heatisland/mitigation/coolroofs.htm

Heat Island Group: Lawrence Berkeley National Laboratory

www.eetd.lbl.gov/heatisland/

USEPA Energy Star®: Reflective Roof Products

www.EnergyStar.gov/index.cfm?c=roof_prods.pr_roof_products

The Cool Metal Roofing Coalition

www.coolmetalroofing.org/index.htm

HVAC

Follow standards for mechanical design [EA63]

Resources:

Air Conditioning Contractors of America (ACCA)

www.acca.org/

HVAC Calculations

www.hvacloadcalculations.com/

USEPA Energy Star®/ACCA Quality Installation Standards

www.acca.org/quality/

The Engineering Toolbox - Cooling Loads

www.engineeringtoolbox.com/latent-sensible-cooling-load-d_245.html

Provide controls and zoning for HVAC [EA64]

Resources:

U.S. Department of Energy: Thermostats and Control Systems

www.eere.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12720

California Energy Commission Consumer Energy Center, Central HVAC

www.consumerenergycenter.org/home/heating_cooling/heating_cooling.html

HVAC Control Tutorial by Jeff Fisher

www.hometech.com/learn/HVAC.html#zoned

U.S. Department of Energy, Best Practices Guide for Residential HVAC retrofits

http://ducts.lbl.gov/HVACRetrofitguide.html

U.S. Department of Energy: Space Heating and Cooling

www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12300

Use ceiling fans for natural ventilation [EA65]

Resources:

U.S. Department of Energy: Ventilation

www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12351

Forget AC! Cool Your Home Naturally by Carol Venolia and Kelly Lerner, Mother Earth News Homes: Guide to Affordable and Sustainable Building, Spring 2008.

www.MotherEarthNews.com

U.S. Department of Energy: Summer Energy Savers

www.energy.gov/4242.htm

Rocky Mountain Institute - Home Cooling

www.rmi.org/sitepages/pid208.php

USEPA Energy Star®

www.EnergyStar.gov/index.cfm?c=ceiling_fans.pr_ceiling_fans

Select high-efficiency HVAC equipment [EA66]

Resources:

California Energy Commission Consumer Energy Center, Central HVAC

www.consumerenergycenter.org/home/heating_cooling/heating_cooling.html

USEPA Energy Star®: Heat & Cool Efficiently

www.EnergyStar.gov/index.cfm?c=heat_cool.pr_**HVAC**

USEPA Energy Star® Guide to Energy-efficient Heating and Cooling

www.EnergyStar.gov/ia/products/heat_cool/GUIDE_2COLOR.pdf

The Consortium for Energy Efficiency (CEE) and the Air-Conditioning and Refrigeration Institute (ARI) online database

www.ceedirectory.org/ceedirectory/pages/cee/ceeDirectoryMain.aspx

References:

[10] **American Council for an Energy-Efficient Economy**

www.aceee.org/consumerguide/heating.htm

[11] **Change for the Better with Energy Star®, Stewardship for the Earth**

www.EnergyStar.gov/ia/business/small_business/EnergyStarCongregationsHandout.pdf

Install programmable thermostats [EA67]

Resources:

Toolbase Services: Programmable Thermostats

www.toolbase.org/TechInventory/TechDetails.aspx?ContentDetailID=801&BucketID=6&CategoryID=6

USEPA Energy Star®: Programmable Thermostats

www.EnergyStar.gov/index.cfm?c=thermostats.pr_thermostats

U.S. Department of Energy: Thermostats and Control Systems

www.eeregov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12720

HVAC Control Tutorial by Jeff Fisher

www.hometech.com/learn/HVAC.html#zoned

Conduct duct tightness test [EA68]

Resources:

U.S. Department of Energy: Ducts

www.eere.energy.gov/consumer/tips/ducts.html

Southface Energy Institute - Blower Door and Duct Blaster Testing

www.southface.org/web/resources&services/publications/factsheets/22blowdoor.pdf

Why Test Ducts by Jim Fleming

www.energyrater.biz/Why_test.htm

U.S. Department of Energy - Best Practices Guide for Residential HVAC retrofits

http://ducts.lbl.gov/HVACRetrofitguide.html

Maintain HVAC systems [EA69]

Resources:

Whole Building Design Guide: Plan the Commissioning Process

www.wbdg.org/project/plan_comm_process.php

USEPA Energy Star®, Quality Installation for HVAC

www.EnergyStar.gov/ia/home_improvement/PHEE_InstallationAC_final.pdf

Seal and insulate HVAC system [EA70]

Resources:

USEPA Energy Star® Thermal Bypass Inspection Checklist

www.EnergyStar.gov/ia/partners/bldrs_lenders_raters/downloads/Thermal_Bypass_Inspection_Checklist.pdf

U.S. Department of Energy: Best Practices Guide for residential HVAC retrofits

www.ducts.lbl.gov/HVACRetrofitguide.html

Why Test Ducts by Jim Fleming

www.energyrater.biz/Why_test.htm

U.S. Department of Energy: Insulation and Ducts

www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11500

References:

[12] **U.S. Department of Energy: Insulation and Ducts**

www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11500

Make sure ductwork is clean [EA71]

Resources:

USEPA: Should You Have Your Ducting Cleaned?

www.EPA.gov/iaq/pubs/airduct.html#whatpercent20ispercent20airpercent20ductpercent20cleaning

National Air Duct Cleaners Association

www.nadca.com/

Make sure ductwork is clean [EA71]

Resources:

USEPA, Should You Have your Ducting Cleaned

www.EPA.gov/iaq/pubs/airduct.html#whatpercent20ispercent20airpercent20ductpercent20cleaning

NADCA Code of Ethics

www.nadca.com/consumerinformation/codeofethics.aspx

Lighting and Electrical

Provide daylighting [EA83]

Resources:

U.S. Department of Energy: Window Overhangs

www.eere.energy.gov/consumer/your_home/windows_doors_skylights/index.cfm/mytopic=13570

Southface: Passive Solar Design

www.southface.org/web/resources&services/publications/technical_bulletins/PSD-Passivesolarpercent2000-790.pdf

Low Impact Living - Install Solar Tube Lighting

www.lowimpactliving.com/blog/2008/01/14/how-to-install-solar-tube-light/

Provide appropriate lighting [EA84]

Resources:

New Jersey Clean Energy Program - Energy Efficiency Store for New Jersey Residents

www.energyfederation.org/njcleanenergy/default.php

Rensselaer Polytechnic Institute- Lighting Research Center

www.lrc.rpi.edu/

References:

[13] **U.S. Department of Energy: A Consumer's Guide: Lighting**

www.eere.energy.gov/consumer/your_home/lighting_daylighting/index.cfm/mytopic=11980

Install energy-efficient lighting [EA85]

Resources:

USEPA Energy Star® - Light Bulbs and Fixtures

www.EnergyStar.gov/index.cfm?c=lighting.pr_lighting

USEPA, Mercury – Spills, Disposal and Site Cleanup

www.EPA.gov/mercury/spills/index.htm

Toolbase Services: LED Lighting

www.toolbase.org/Technology-Inventory/Electrical-Electronics/white-LED-lighting

Provide appropriate indoor lighting controls [EA90]

Resources:

Whole Building Design Guide - Electric Lighting Controls by David Nelson, AIA, 05-14-2008

www.wbdg.org/resources/electriclighting.php

Green Living Ideas - Energy Saving Light Control Systems

www.greenlivingideas.com/lighting/energy-saving-light-control-systems.html

U.S.Department of Energy: Lighting

www.eere.energy.gov/consumer/tips/lighting.html

References:

[14] **U.S. Department of Energy: Lighting**

www.eere.energy.gov/consumer/tips/lighting.html

Plumbing

Insulate water heater [EA80]

Resources:

Lowe's Making Your Home More Energy-Efficient

www.lowes.com/lowes/lkn?action=howTo&p=Improve/HomeEnergyEfficient.html#1

U.S. Department of Energy Energy Efficiency and Renewable Energy, Water Heating

www.eere.energy.gov/consumer/tips/water_heating.html

Wrapping the water heater video in English and Spanish

www.pnm.com/customers/wx.htm

Charles and Hudson, How to Insulate Your Hot Water Tank by Murray Anderson

www.charlesandhudson.com/article?PLUCKarticleId=732a4e15-27b1-39a3-dd03-02c458b44ae4&PLUCKtitle=How_to_Insulate_Your_Hot_Water_Tank&PLUCKmediaType=Text&PLUCKauthor=Murraypercent20Anderson&PLUCKwhichPage=articlePage

References:

[15] **U.S. Department of Energy Energy Efficiency and Renewable Energy, Water Heating**

www.eere.energy.gov/consumer/tips/water_heating.html

Insulate water hot water pipes [EA81]

Resources:

Lowe's Making Your Home More Energy-Efficient

www.lowes.com/lowes/lkn?action=howTo&p=Improve/HomeEnergyEfficient.html#1

U.S. Department of Energy: Water Heating

www.eere.energy.gov/consumer/tips/water_heating.html

Utilize Solar Water Heating [EA101]

Resources:

Solar Site Assessment tool

www.howto.altenergystore.com/Articles-not-yet-activated/Tools-for-a-Successful-Solar-Electric-Install/a90/

New Jersey Office of Clean Energy

www.njcleanenergy.com/renewable-energy

Southface Institute, Using the Sun to Heat Water

www.southface.org/web/resources&services/publications/factsheets/residential_solar_water111804.pdf

U.S. Department of Energy: Consumer's Guide to Renewable Energy and Energy Efficiency

www.eere.energy.gov/consumer/

Toolbase Services: Solar Water Heaters

www.toolbase.org/Technology-Inventory/Plumbing/solar-water-heaters

References:

[16] **Toolbase, Solar Water Heaters**

www.toolbase.org/Technology-Inventory/Plumbing/solar-water-heaters

[17] **West, Larry Benefits of Solar Water Heaters**

environment.about.com/od/renewableenergy/a/solar_water_hea.htm

[18] **Southface Institute, Using the Sun to Heat Water**

www.southface.org/web/resources&services/publications/factsheets/residential_solar_water111804.pdf

[19] **U.S. Department of Energy: Consumer's Guide to Renewable Energy and Energy Efficiency"**

www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=12870

Reconfigure plumbing for efficiency [EA77]

Resources:

Toolbase Services: Resource Efficient Plumbing

www.toolbase.org

HGTVPRO- Home Run Plumbing - www.hgtvpro.com

PEX Information - www.pexinfo.com

References:

[20] **James Lyons. 2009. Promising Plumbing. BUILDER. January 2009**

www.builderonline.com

Equipment

Select high-efficiency clothes washer [EA92]

Resources:

Consortium for Energy Efficiency

www.cee1.org

USEPA Energy Star®

www.EnergyStar.gov

References:

[21] **American Water Works Association Research Foundation**

www.awwa.org/

[22] **Consumer Reports, Greener Choices**

www.greenerchoices.org/

Select an energy-efficient refrigerator [EA93]

Resources:

Consortium for Energy Efficiency: Refrigerators

www.cee1.org/resid/seha/refrig/refrig-main.php3

USEPA Energy Star® - Refrigerators

www.EnergyStar.gov/index.cfm?c=refrig.pr_refrigerators

N.J. State Website – Information on Energy Star® Appliances

www.state.New Jersey.us/globalwarming/help/

Choose an energy-efficient dishwasher [EA94]

Resources:

USEPA Energy Star® - Dishwashers

www.EnergyStar.gov/

Consortium for Energy Efficiency : Home Appliances

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

Install energy-efficient cooking appliances [EA95]

Resources:

Consumer Guide to Home Energy Savings: Cooking

www.aceee.org/consumerguide/cooking.htm

Select energy-efficient office equipment [EA99]

Resources:

American County for an Energy Efficient Economy: Consumer Guide to Home Energy Savings

www.aceee.org/consumerguide/electronics.htm

USEPA Energy Star®: Home Electronics

www.energystar.gov

References:

[23] **Alliance to Save Energy**

www.ase.org/

[24] **U.S. Department of Energy: Home Office and Home Electronics**

www.eere.energy.gov/consumer/tips/home_office.html

Consider on-site renewable energy

Resources:

National Renewable Energy Laboratory: PV Watts™

www.nrel.gov/rredc/pvwatts/

U.S Department of Energy., Database of State Incentives for Renewables & Efficiency (DSIRE): New Jersey

www.dsireusa.org/incentives/index.cfm?re=1&ee=1&spv=0&st=0&srp=1&state=New Jersey

N.J. Solar Renewable Energy Credit Program

www.njcleanenergy.com/renewable-energy/programs/solar-renewable-energy-certificates-**srec**/new-jersey-solar-renewable-energy

USEPA Energy Star®: Federal Tax Credits for Energy Efficiency

www.energystar.gov/index.cfm?c=products.pr_tax_credits

U.S. Deparment of Energy: Solar Water Heaters."

www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12850

U.S. Deparment of Energy: Geothermal Heat Pumps

www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12640

International Ground Source Heat Pump Association

www.igshpa.okstate.edu/

References:

[25] **New Jersey Solar Renewable Energy Certificate Program**

www.njcleanenergy.com/renewable-energy/programs/solar-renewable-energy-certificates-**srec**/new-jersey-solar-renewable-energy

[26] **DSIRE: New Jersey Solar Energy Sales Tax Exemption**

www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ01F&re=1&ee=**1**

[27] **U.S. Deparment of Energy: Solar Water Heaters**

www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12850

[28] **U.S. Department of Energy: Geothermal Heat Pumps**

www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12640

Case Study

Location of Project: Yardley, Pa
Homeowners: Parkland Properties, LP, Thomas G Wells, Member
Interior Designer: Emily **K**. Buehrle, EKB Designs
General Contractor: Thomas G Wells Construction, L.L.C.
Area Affected: 3200 sq feet

Overview and Scope

This two-stage home renovation increases energy efficiency, improves indoor air quality, and utilizes sustainable building products. The first stage was a remodel of the kitchen, increasing its size from 123 square feet to 180 square feet. The second stage began with a comprehensive Energy Audit of the **building envelope** followed by remediation of air **infiltration** and insulation deficiencies, replacement of the existing oil furnace with a **heat pump**, and a post-remediation Energy Audit. The overall goal of the contractor was to make the interior space comfortable and visually appealing while ensuring easy maintenance and energy efficiency.

Design Approach

The house is a rental property that the owners intend to rent well into the foreseeable future. This will enable monitoring of energy consumption and equipment durability over an extended period. The contractor saw this as an opportunity to try out various sustainable building products and energy efficiency strategies. He looked at the products needed for the project (i.e., new counter tops) and evaluated various sustainable options that fit the criteria. He also used this opportunity to evaluate the feasibility of various energy upgrades, such as air sealing and insulating knee walls in crawl spaces. The interior designer, Emily Buehrle, has a strong background in space planning and sustainable building products. She assisted the homeowners to meet their goals of interior features, colors, and textures that would resonate with the home's future occupants.

Team and Process

Tom Wells and his crew did the majority of the framing, finishing, window installation, cabinetry installation, and painting, while various other parts of the project were subcontracted. Tom was the leader in designing the green aspects of this project, relying on input from Wes Carver Electrical Contractors and Rob Taurino of JA Smith Heating and Air Conditioning. Ted Inoue was invaluable as the energy auditor and system evaluator.

Finance

The total cost of the renovations without the standard contractor mark-up was approximately $81,000. This overall cost did not seem out of proportion to other traditional kitchen remodeling projects done by the contractor. For this project, budgeting generally came secondary to the project goals; more importantly, the team wanted to demonstrate the value of techniques and products of which the average contractor and homeowner may not be aware. These included bamboo cabinetry, recycled glass countertops, **low-VOC** paints, spray foam insulation, and a **heat pump** to replace the oil furnace. The roof needed to be replaced unexpectedly due to leaky skylights; an asphalt roof was chosen instead of a metal roof for budget reasons. After the work was performed, the entire interior of the house was repainted.

First cost savings were not achieved by utilizing the green products, but are realized when factoring in the reduced energy consumption costs, increased comfort level, and otential increase in resale value of the house. The contractor also benefited from increased focus on his company by potential clients interested in green remodeling.

Lessons and Trade-offs

The major surprise came during the Energy Audit, which highlighted the many parts of the house that had air **infiltration** and insulation issues. The contractor believes that making the house as "tight" as possible is the most important aspect of the green remodel. The biggest trade-offs came from the unexpected roof replacement.

"The kitchen remodel is the most appealing and dramatic change to the house, but I am personally most excited about the energy efficiency package we installed. We are looking forward to monitoring the energy usage per square foot to see how it compares to homes of similar size."

- Tom Wells

List of Green Strategies

Energy Conservation

- Replaced old windows with **low-E** windows
- Removed trim from the windows and installed minimal expanding foam in the gap around the windows
- Replaced oil furnace with high-efficiency **heat pump**
- Installed spray foam insulation in open walls and ceilings in the kitchen, crawl space, the basement band joist, and part of the roof **sheathing**
- Installed dense pack **cellulose** in the exterior walls and attic
- Installed **fiberglass batts** covered with rigid foam board in second floor knee walls
- Caulked the baseboards to the hard wood floor
- Replaced the light bulbs with **CFLs** in the bedrooms
- Installed **CFL** recessed lights and high-efficiency light fixtures with insulated boxes in the kitchen, dining room, and family room
- Installed **LED** under-cabinet lighting
- Put mastic on the **HVAC** ductwork seams

Water Conservation

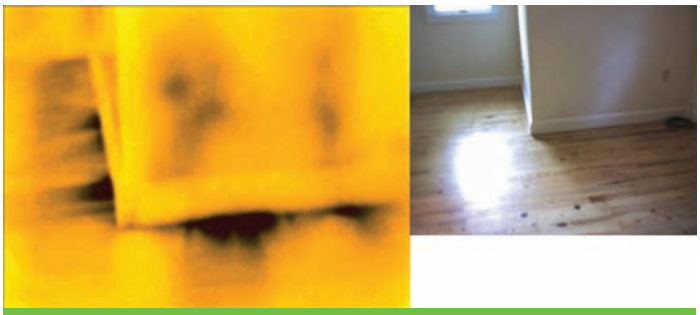
- Installed low-flow showerheads
- Utilized a kitchen faucet with a filtered water option

Indoor Air Quality

- Used **low-VOC** interior wall paints
- Used waterborne hardwood floor finishes

Sustainable Materials

- Installed recycled glass countertops and bamboo cabinetry with no added **formaldehyde** in the kitchen
- Installed a natural linoleum kitchen floor
- Used natural earth plaster and cork sustainable flooring in the mudroom
- Installed 50-year fiberglass architectural roof shingles



Infrared Image Visible Light

The bright yellow shows the hotter warm floor and insulation. The darker spots reveal the leaks from under the baseboard and the loss of heat through the studs.

Rear of home

Remodeled Kitchen

Case Study

Location of Project: Mill Hill Historic District, Trenton, New Jersey

Homeowners: John Hatch, David Henderson

Architect: W. David Henderson, R.A., HHG Development, LLC; John D. S. Hatch, AIA; Clarke Caton Hintz

General Contractor: Atlantis Historic Properties

Area Affected: 3,000 sq. ft.

Overview and Scope

The project is the major renovation of an 1887 row house in Trenton's Mill Hill Historic District. When purchased, the house had been vacant for a number of years and was in need of major rehabilitation, including structural repairs, window replacement, all new systems (electrical, plumbing, and **HVAC**), repairs to damaged walls, replacement of roof, and installation of insulation.

Design Approach

In keeping with their commitment to green practices the design team decided to implement as many sustainable strategies as possible while still preserving and restoring the historic character of the house. Since the house is located in a designated local, state, and national historic district, the local historic preservation commission reviewed certain work. This included the exterior windows and the installation of the solar panels. The new windows have insulated glass and are very efficient, but match the original arched windows quite closely. The Landmarks Commission approved them. Since the solar panels are located on a roof not visible from the street, the installation was also not an issue.

Team and Process

The homeowners and the designers are one and the same, so that relationship was easy to manage. Making this project as green as possible meant reaching out to various contractors and suppliers to get ideas and products for how to improve the efficiency and sustainability of the house.

Finance

Based on prior utility bills and estimated usage, the house is at least 25 percent more efficient so energy costs are significantly lower. In addition, the solar panels provide 75 percent of the electricity that is typically used. When more power is produced than used, it is sold back to PSE&G. Most of the electrical bills are only $5! In addition, the homeowner received various green power incentives through the state and federal governments, which also helped to reduce up-front costs. This has made the payback for the solar panels very quick.

Since the house needed such major renovations, it was a question of choosing the most energy- and water-efficient items throughout the remodeling process. These may have cost slightly more than the alternatives, but were considered in the financing for the overall project.

Lessons and Trade-offs

The project team and homeowner were surprised at the affordability of the green strategies. If they had to do it all over again, they would go even further with the sustainable and energy-efficient strategies, even if they cost more. In the future, the payback will only get shorter!

"Making projects energy and water efficient while using sustainably produced products is only getting easier with time. In addition, it's getting more and more cost effective. While people don't normally associate historic preservation with sustainable design, reusing existing structures is actually one of the most sustainable actions that anyone can take. There is a tremendous amount of energy and carbon stored in the historic building's structure, energy that would be wasted if the building were demolished and rebuilt. The greenest home is the one that's already built!"

- John D. S. Hatch

Before remodel

After remodel

List of Green Strategies

Energy Conservation

- Installed photovoltaics provide more than 75 percent of the electrical requirements
- Installed high-efficiency **heat pump**: 17 **SEER**
- Purchased new combination washer and condensing dryer that utilizes a closed system to remove moisture from clothes, saving energy and eliminating the need for outside venting
- Utilized **Energy Star®** appliances
- Installed R15 insulation added to most walls, R30 to roof; as the original walls and roof had no insulation
- Replaced all light bulbs, inside and out, with color corrected **compact fluorescent**
- Installed solar powered attic fan keeps air flowing in the attic to reduce condensation, heat build-up and energy costs
- Replaced or restored most of the original windows with historically accurate windows with insulated glass and low-air **infiltration**

Water Conservation

- Used ultra low flow toilets: 1 gallon per flush

Sustainable Materials

- Utilized reuse of most interior materials. Wood floors and plaster walls were kept wherever possible. Reused two claw foot tubs; wood moldings were either kept in place, or, if reconfiguring the space, were removed and reused
- Use materials that are historically appropriate (wood windows and doors, for instance) and are also sustainable

Roof-top solar panels

Solar powered attic fan

Before remodel

After remodel

Case Study

Location of Project: Princeton, New Jersey
Homeowners: Janet Black
Energy Auditor: GreenStreet Energies
General Contractor: GreenStreet Construction
Area Affected: 2,000 sq. ft.

Overview and Scope

This **weatherization** and energy upgrade to a two-story, late 19th/early 20th century colonial-style home included a comprehensive **Home Performance Audit** and implementation of energy-efficient recommendations by GreenStreet Energies, a home performance consulting service of GreenStreet Construction. An audit checklist and thermal-imaging scans were used to reveal leaks and sources of air **infiltration** and energy loss in the home. The tests revealed opportunities to add insulation and to seal up drafty areas around the windows and doors with weather stripping. **Spray polyurethane** foam was added under the first floor in between the basement ceiling beams, where no insulation or subfloor existed. GreenStreet also installed **storm doors**, **storm windows**, and **door sweeps**.

Design Approach

The homeowner, Janet Black, was introduced to GreenStreet Construction while attending a presentation they made at Design Within Reach, an interior design store located in Princeton, New Jersey. She approached GreenStreet and expressed her interests in greening her home. Working with the homeowner, GreenStreet carried out the Energy Audit and upgrades.

Team and Process

GreenStreet Energies provided a detailed Energy Audit report and recommended upgrades to correct the deficiencies that the audit uncovered. They subsequently were hired to perform all the energy work except for the installation of the spray foam insulation, which was performed by an insulation company. The whole project was completed in less than two months.

Finance

The total cost for the **Home Performance Audit** including energy work was about $5000, with an estimated payback period of three to four years. The project was completed very recently so the homeowner currently is waiting to see how the energy bills will be affected. The homeowner plans to reinvest her energy savings into future energy upgrades such as installing **storm windows** on the remaining second floor windows.

Lessons and Trade-offs

The antique floor had gaps between the floorboards, without any subfloor underneath. This presented a problem as the **spray polyurethane** foam could possibly foam up out of the basement into the living area. GreenStreet fixed the problem by doing a little prep work from the basement side to seal up most of the larger gaps so that the expanding foam insulation didn't come up through the floor.

"Every home is different. This brings a need for a collaborative between GreenStreet and the client in order to take full advantage of all the tools and information available to produce exactly what the client is looking for.

In the case of Janet Black's home, we found a situation unfortunately common in older houses - a beautiful antique floor with small gaps in between the floorboards was the only thing separating her first floor living space from her 40-45 degree basement. We realized that assumptions cannot be made about previous construction, whether it is as obvious and visible as this situation or something hidden deep within the construction of the house."

- Rees Keck, GreenStreet Energies

Added insulation in basement (before barrier)*

List of Green Strategies

Energy Conservation

- Installed spray foam insulation in areas lacking insulation, such as the basement ceiling*
- Added **storm windows** and weather stripping to all doors and windows to reduce air leakage
- Added **storm doors** and **door sweeps** to reduce drafts around existing entrances

Indoor Air Quality

- Installed **formaldehyde-free spray foam insulation***
- Used only non-toxic caulking and weather stripping materials

Resource Conservation

- Added **storm windows** and doors instead of replacing existing windows and doors, increasing their durability by adding a layer of protection from the elements

*Spray foam materials installed in walls or ceilings may present a fire hazard unless protected by an approved, fire-resistant thermal barrier with a finish rating of not less than 15 minutes as required by building codes. Rim joists/header areas in accordance with the IRC and IBC may not require additional protection. Foam plastic must also be protected against ignition by code-approved materials in attics and crawl spaces. See relevant Building Codes and www.iccsafe.org for more information.

Spray foam insulation in basement (before thermal barrier is added)*

Storm door installed to provide added protection

Case Study

Location of Project: Trenton, New Jersey

Developer: Isles Inc. and Tara Construction Management Corp.

Architect: Frank Russo, Shapiro Petrauskas Gelber

Contractor: Omega Corporation

Green Design Consultants: Lyle Rawlings, Advanced Solar Products, Inc. and Andy Shapiro, Vermont Energy Investment Corporation

Area Affected: 2 semi-detached, 1700 sq. ft. units

Overview and Scope

In an area of Trenton, New Jersey where many of the dwellings are vacant or in disrepair, the 22 semi-detached units of the Bellevue Court project have newly renovated interiors restoring façades to their original grandeur. Part of the larger project, the dwellings at 233-235 Bellevue Court have green technologies behind their traditional brick façades.

Spearheaded by the City of Trenton and developed by Isles Inc. and Tara Construction Management Corp, these two "**microload**" homes are projected to use 60 percent less energy than a code compliant home and 30 percent less energy than their **Energy Star**® neighbors.

Design Approach

The two 1700 square foot units have three bedrooms and two and one half baths. Sustainable and recycled materials were incorporated throughout the homes. To help provide exceptional air quality in these airtight homes, mechanical ventilation is provided using a **heat recovery ventilator** (**HRV**). The exhaust vents from each bathroom and kitchen are ducted to the **HRV** while fresh air from the **HRV** feeds into the return **plenum** of the furnace.

The real benefit in these houses is the dramatic reduction of their heating and **cooling loads** and the ability of these homes to meet a substantial part of those loads with renewable energy. Heating and cooling losses were reduced through the **building envelope** with highly insulated walls and windows and air sealing. Custom designed overhangs on the south wall of the "microload" homes block the high summer sun and allow for **passive solar heating** during the winter. The window glass was selected to allow solar heat to enter in winter. As a passive cooling strategy, a skylight with a manually operated crank was placed over the central stair to allow for warm inside air to move up and out of the house in summer. This also provides daylight in the area.

A 2.5 kW **photovoltaic** array on the roof is projected to offset close to 70 percent of the electric loads in the house. The system will be net metered, allowing unneeded solar-produced electricity to be sold back to the utility.

Team and Process

Responding to a need for affordable housing and eager to save the architecturally unique homes on Bellevue Court, the City of Trenton committed to bringing back the block. Isles Inc, and Tara Construction Management Corp were selected as the nonprofit/for-profit partnership for the project.

Finance

For the entire 22-unit Bellevue project, the development costs (including property acquisition, construction, professional services, developer's fees, and other costs) totaled $4.2 million. The units were donated by the City of Trenton, along with a $1 million grant. Additional funding for the project was provided through state and federal grant money.

Lessons and Trade-offs

Looking strictly at the energy usage of the two solar homes, the buildings are performing less efficiently than modeled. A few observations reveal interesting lessons.

Homeowner consumption is a major factor in the energy efficiency equation. Both of the owners are using electric heaters on the first floor, both have 240 kWh/year freezers in the basement and both have multiple televisions and other electronics with significant plug loads. One homeowner is utilizing an electric fireplace for heat that is placed near the home's thermostat. In addition, one of the homeowners always has shades drawn on the south facade, which was designed for direct solar gain "sun tempering." According to the homeowner, this primarily is for security and privacy reasons.

Also, a number of systems and certain features where not properly installed or balanced. Finally, the **PV** system on one home is being shaded by an adjacent home, creating less than optimum conditions for electric generation. These situations confirm the need for residential **commissioning**, particularly for complex integrated technologies found in high performance homes.

"Cellulose insulation was a change from the construction contractor's normal practices, but they were sold on the acoustic performance of the product. "When you close the outside door in these houses, it's like being in a sound-proof room."

- Omega Corporation

List of Green Strategies

Energy Conservation

- Installed highly efficient insulation in walls and ceilings
- Chose fiberglass frame double glazed **low-E** windows
- Carefully sealed all rough openings and basement ceilings
- Installed high-efficiency **HVAC** and water heating equipment
- Installed **Energy Star®** appliances throughout
- Installed a 2.5 kW rooftop **photovoltaic** array to provide a portion of the building's electricity needs

Water Conservation

- Installed dual-flush low water use toilets, low-flow showerheads, and low-flow faucets
- Created a **rainwater collection** system for gardening
- Planted drought-proof native plantings and grasses

Indoor Air Quality

- Used zero and **low-VOC** paints, caulks, finishes, and adhesives
- Purchased **formaldehyde-free** plywood kitchen cabinets
- Utilized a track-off mat system at the entryway
- Installed wood flooring and ceramic tile instead of carpeting
- Properly vented all occupied rooms
- Provided exhaust for all high-moisture areas

Sustainable Materials

- Reused and recycled many materials during construction
- Reused brick from the site for pervious paving
- Utilized **recycled content** plastic/wood lumber for porches and decks

Before | After

Ducts sealed with mastic

Dining room hardwood floors

Green Products and Services

Introduction

The purpose of the Green Products and Services is to help homeowners navigate the market with some helpful tips on what to look for when shopping for a particular green home remodeling project. The Guide is organized by building system and lists the general products and services that pertain to remodeling tasks within that system. It includes features and applicable certifications to look for, as well as web links to more information on that product or service. Each item in the Guide also refers to the related REGREEN strategy IDs.

Please note that the New Jersey Green Home Remodeling Guidelines Version 1.0 do not endorse any particular brand or company. It is not the function of the Green Product and Service Guide to direct the consumer to a specific product, but rather to provide a resource to seek out an appropriate manufacturer or service provider to handle remodeling needs.

With the ever-increasing number of green products and services coming into the home remodeling market, finding the appropriate ones can be a challenge. Some manufacturers market products as "green" when in reality they are only marginally better for the environment or whose green features are neutralized by other aspects of their manufacturing or composition. This phenomenon is referred to as "greenwashing" and calls on consumers to seek out references and ensure the true extent of green value.

Product Certification Programs

That being said, there are several leading green product standards and certification programs that can help consumers identify products that meet predefined green criteria. The leading green product standards and programs include:

- Energy Star® - identifies efficient products that reliably deliver energy savings and environmental benefits
- WaterSense – identifies high performing, water efficient products and practices
- Cradle to Cradle - certifies products based on lifecycle of materials used to construct a product and the overall lifecycle of the product
- GreenGuard® Certification Program - certifies products and processes for their low chemical emissions and low toxicity
- Green Seal® - certifies products and practices for their low toxicity and overall environmental impact
- GreenSpec Directory - a published resource on environmentally preferable products
- Forest Stewardship Council (FSC)- certifies wood products coming from forests managed to meet social economic and ecological needs
- Sustainable Forestry Initiative (SFI) - certifies wood products coming from well-managed forests and responsible procurement practices
- National Fenestration Rating Council® (NFRC) - a non-profit organization that administers the only uniform, independent rating and labeling system for the energy performance of windows, doors, skylights, and attachment products

For more information on various certification programs currently in use by architects and designers see:

- the ecolibrary™matrix - www.thegreenstandard.org/documents/GGNC09_EcoLibCert.pdf
- Gaia Product Profile developed by The Green Standard™ - www.thegreenstandard.org/gaia.html

Two other reputable sources for green products and services are:

- Green Building Advisor that lists products from the GreenSpec Guide to Residential Building Materials www.greenbuildingadvisor.com/
- National Association of Home Builders (NAHB) Research Center - www.nahbrc.org/manufacturer/greenapproved/index.aspx

Product Standards for GreenSpec[1]

1. Products Made with Salvaged, Recycled, or Agricultural Waste Content
   a. Salvaged products
   b. Products with **post-consumer recycled content**
   c. Products with **pre-consumer recycled content**
   d. Products made with agricultural crop waste material

2. Products That Conserve Natural Resources
   a. Products that reduce material use
   b. Products with exceptional durability or low maintenance requirements
   c. Certified wood products
   d. Rapidly renewable products

3. Products That Avoid Toxic or Other Emissions
   a. Natural or minimally processed products
   b. Alternatives to ozone-depleting substances
   c Alternatives to hazardous products
   d. Products that reduce or eliminate pesticide treatments
   e. Products that reduce stormwater pollution
   f. Products that reduce impacts from construction or demolition activities
   g. Products that reduce pollution or waste from operations

4. Products That Save Energy or Water
   a. Building components that reduce heating and cooling loads
   b. Equipment that conserves energy and manages loads
   c. Renewable energy and fuel cell equipment
   d. Fixtures and equipment that conserve water

5. Products That Contribute to a Safe, Healthy Built Environment
   a. Products that do not release significant pollutants into the building
   b. Products that block the introduction, development, or spread of indoor contaminants
   c. Products that remove indoor pollutants
   d. Products that warn occupants of health hazards in the building
   e. Products that improve light quality
   f. Products that help noise control
   g. Products that enhance community well-being

Sources

[1] The online GreenSpec® Directory lists product descriptions for over 2,000 environmentally preferable products at www.buildinggreen.com

Alex Wilson."Building Materials: What Makes a Product Green?" EBN Volume 9, Issue 1 (revised January, 2006) www.buildinggreen.com/auth/article.cfm?fileName=090101a.xml

Weatherization and Energy

General

Product	Features	Certifications	Product Directory/Service Resources	REGREEN ID
Home Performance Audit	Save up to 30 percent on energy costs, increase the comfort, safety, and durability of your home. Contact N.J. Office of Clean Energy to find certified contractors.		N.J. Office of Clean Energy - Call 1-866-NJSMART or visit www.njcleanenergy.com/residential/programs/home-performance-energy-star/home-performance-energy-star-r N.J. Office of Clean Energy List of Certified Contractors www.njcleanenergy.com/misc/residential/certified-contractors	IDP2
Awnings	Purchase an awning or screen shade to install over your deck or patio to block direct sunlight and rain and save energy. Some units are retractable manually or mechanically.		Professional Awning Manufacturers Association www.awninginfo.com/ Awnings Today www.awningstoday.com/ LBL Shading Strategy www.windows.lbl.gov/daylighting/designguide/section5.pdf FSEC Window Orientation and Shading www.fsec.ucf.edu/en/consumer/buildings/homes/windows/ Awnings in Residential Buildings: The Impact on Energy Use and Peak Demand www.awninginfo.org/images/stories/documents/pdf/energystudy22007.pdf	EA62
Native plants, species, and trees	Plant native plants and trees to provide shade and reduce watering needs.		New Jersey Agricultural Experiment Station, Rutgers University www.njaes.rutgers.edu/ If Plants Could Talk – A Gardening Television Series, Rutgers University www.ifplantscouldtalk.rutgers.edu/ Conserving Energy with Landscaping www.ext.vt.edu/pubs/envirohort/426-712/426-712.html	EA62
Roofing	Install a "cool roof" with highly reflective material such as lightly colored shingles and/ or metal. Metal roofing materials are highly reflective, durable, recyclable, usually composed of recycled materials, and resist against harsh weather and fire.		USEPA Energy Star®: Reflective Roof Products www.energystar.gov/index.cfm?c=roof_prods.pr_roof_products Metal Roofing Alliance www.metalroofing.com/ USEPA – Heat Island Effect www.epa.gov/hiri/mitigation/coolroofs.htm	MR120

Product	Features	Certifications	Product Directory/Service Resources	REGREEN ID
Spray foam insulation	Consider spray foam insulation such as open-cell foam which allows vapor to pass through and is R-4 per inch, and closed-cell foam which slows the passing of vapor and is R-6 to R-7. Look for products that are flame retardant, formaldehyde-free, contain no VOCs, and use a non-ozone depleting blower agent.		Taunton - The Best Way to Insulate a Rim Joist" by Isaac Savage www.taunton.com/finehomebuilding/PDF/Free/021189072.pdf U.S. Department of Energy- Insulation Fact Sheet www.ornl.gov/sci/roofs+walls/insulation/ins_08.html Air Seal and Insulate with Energy Star® www.energystar.gov/index.cfm?c=home_sealing.hm_improvement_sealing	IDP55
Windows	Several types of window glazing are gas filled, heat-absorbing tint, insulated (double-glazed, triple-glazed), low emissivity (low-E) coatings, reflective coatings, and spectrally selective coatings. Select Windows that are Low-E have U-factor of less than 0.36, and a Solar Heat Gain Coefficient (SHGC) of less than 0.39.	ENERGY STAR; NFRC National Fenestration Rating Council	National Fenestration Rating Council www.nfrc.org/ U.S. Department of Energy –A Consumer's Guide to Energy Efficiency and Renewable Energy: Types of Window Glazing or Glass www.eere.energy.gov/consumer/your_home/windows_doors_skylights/index.cfm/mytopic=13390 Efficient Windows Collaborative www.efficientwindows.org USEPA Energy Star® – High Performance Windows www.energystar.gov/ia/new_homes/features/HighPerformanceWindows1-17-01.pdf	EA60/56/59
HVAC				
Air conditioning system	Select an Air Conditioning System that meets or exceeds Energy Star® standards. Choose a model with a Seasonal Energy Efficiency Ratio (SEER) of at least 14 for ductless mini-split or central air conditioning.	ENERGY STAR	New Jersey Clean Energy Program www.njcleanenergy.com The Consortium for Energy Efficiency (CEE) and the Air-Conditioning and Refrigeration Institute (ARI) online database www.ceedirectory.org American Council for an Energy-Efficient Economy - Consumer Resources www.aceee.org/Consumer/index.htm HARDI Architect, Builder & Remodeler Good Practice Guide www.hardinet.org/pdf/GdPractGuide2.pdf	EA66
Duct mastic/ sealant	Seal ducts with products that have low to zero VOCs. Choose products that are Energy Star® and GreenGuard certified.	ENERGY STAR; GREENGUARD	USEPA Energy Star® www.energystar.gov/ GreenGuard www.greenguard.org/	EA68

Product	Features	Certifications	Product Directory/Service Resources	REGREEN ID
Fan: attic	Install an attic fan that meets or exceeds Energy Star® standards. Choose models with features including self flash, curb mount, and gable mount for pitched or flat roof applications. Installation flexibility allows for the retrofitting of the base assembly of any 12" turbine fan if need be.		Energy Star® www.energystar.gov BuildingGreen.com www.Buildinggreen.com Home Ventilating Institute - Home Ventilation & Indoor Air Quality Guide www.hvi.org/resourcelibrary/publications.html	EA65
Fan: bathroom	Install a bathroom fan to reduce moisture in the bathroom that can cause mold. Select models with a built-in Energy Star® light fixture that are programmable, produce low noise (0.5 to 1.5 sones), and can have a high CFM (Cubic Feet per Minute).		USEPA Energy Star® www.energystar.gov/ Home Ventilating Institute - Home Ventilation & Indoor Air Quality Guide www.hvi.org/resourcelibrary/publications.html	EA65/IEQ166/ IEQ167IEQ172
Fan: ceiling	Install ceiling fans that meet or exceed Energy Star® standards. Choose a model that has both clockwise and counter clockwise motion. Run fans using solar power.		USEPA Energy Star® www.energystar.gov/ Home Ventilating Institute - Home Ventilation & Indoor Air Quality Guide www.hvi.org/resourcelibrary/publications.html	EA65
Programmable thermostat	Install a programmable thermostat that meets or exceeds Energy Star® standards. The model should be compatible with your system and have features including battery operation and indicator, settings options that allow for vacation overrides and weekends, an energy monitor, and filter change indicator.		Energy Star® on Programmable Thermostats www.energystar.gov/index.cfm?c=thermostats.pr_thermostats ToolBase Service: Programmable Thermostats www.toolbase.org U.S. Department of Energy: Thermostats and Control Systems www.eeregov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12720	EA67

Weatherization and Energy

Lighting and Electrical

Product	Features	Certifications	Product Directory/Service Resources	REGREEN ID
Compact Fluorescent Lamp (CFL)	Select compact fluorescent lamps (CFLs) that use less energy, last longer, and contain less mercury than incandescent lamps. Choose lamps with a Color Rendering Index (CRI) of at least 80. For ambient lighting, select a lamp that produces 2700-3000K and a warm or yellowish hue. Task lighting requires lamps that produce 3600-5500K and a bluish or cool hue.		USEPA Energy Star® Compact Fluorescent Light Bulbs www.energystar.gov/index.cfm?c=cfls.pr_cfls United States Department of Energy – Lighting Principles and Terms www.eere.energy.gov/consumer/your_home/lighting_daylighting/index.cfm/mytopic=11990 General Electric Lighting. 1997-2009. Color Rendering www.gelighting.com/na/business_lighting/education_resources/learn_about_light/color_rendering.htm Rensselaer Polytechnic Institute: Lighting Research Center www.lrc.rpi.edu/	EA84
Light-Emitting Diode (LED) light fixture	Select LED light fixtures that use less energy, produce less heat, and are more durable than incandescent and even fluorescent lamps. Some products come with features such as dimming and motion sensors.		USEPA Energy Star®: Residential LED Lighting www.energystar.gov/index.cfm?c=ssl.pr_residential	EA84
Plumbing				
Piping	Use PEX (or cross-linked polyethylene) tubing as a plumbing substitute for copper or rigid plastic piping. Look for products made of non-halogenated plastics that contain no heavy metals or brominated flame retardants.		PEX Information www.pexinfo.com PEX Piping- PATH Case Study www.pathnet.org/si.asp?id=2584 Hot Water Delivery – Systems and Construction Practice www.awwa.org/waterwiser/references/pdfs/RES_HW_Klein_G_Hot_Water_Delivery_Systems_and_Constructi.pdf Toolbase Services: Resource Efficient Plumbing www.toolbase.org	EA77
Water Heater	Consider purchasing an On Demand Water Heating Systems or "flash" or "tankless" water heater.		GreenandSave: On Demand Water Heater www.greenandsave.com/utility_savings/gas/demand_water_heater.html Consumer Reports: Tankless Water Heaters www.consumerreports.org/cro/appliances/heating-cooling-and-air/water-heaters/tankless-water-heaters/overview/tankless-water-heaters-ov.htm	EA77

Weatherization and Energy

Equipment

Product	Features	Certifications	Product Directory/Service Resources	REGREEN ID
Cooking Appliances	Purchase Energy Star® – rated cooking appliances.		American Council for an Energy-Efficient Economy: Cooking www.aceee.org/consumerguide/cooking.html USEPA Energy Star® www.energystar.gov	EA95
Dishwasher	Select a dishwasher that meets or exceeds Energy Star® standards		USEPA Energy Star®: Dishwashers www.energystar.gov/ia/partners/manuf_res/downloads/Dishwasher_ConsumerBrochure.pdf GreenerChoices: Dishwashers www.greenerchoices.org/ratings.cfm?product=dishwasher Consortium for Energy Efficiency: Dishwashers www.cee1.org/resid/seha/dishw/dishw-main.php3 Consumer Reports: Dishwashers www.consumerreports.org/cro/appliances/kitchen-appliances/dishwashers/index.htm?resultPageIndex=1&resultIndex=1&searchTerm=dishwashers	EA94
Office equipment	Select office equipment that meets or exceeds Energy Star® standards. Look for products that can go into sleep mode when not in use to reduce phantom loads.		USEPA Energy Star®: Office Equipment www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductCategory&pcw_code=OEF Consumer Reports-Greener Choices www.Greenerchoices.org Consumer Guide to Home Energy Savings, 9th Edition, American Council for an Energy-Efficient Economy, 2007 www.aceee.org Consumer Reports www.consumerreports.org	EA99
Range hood	Choose a range hood with an Energy Star® rated fan that uses less energy and is quiet. Kitchen ventilation systems remove moisture and VOCs that are produced from cooking.		USEPA Energy Star®: Ventilating Fans www.energystar.gov/index.cfm?c=vent_fans.pr_vent_fans	EA95

Product	Features	Certifications	Product Directory/Service Resources	REGREEN ID
Refrigerator	Select an energy-efficient refrigerator that meets or exceeds Energy Star® standards. Top-freezer models are the most efficient followed by bottom-freezer models, while side-by-side models are the least efficient.		USEPA Energy Star®: Refrigerators www.energystar.gov/index.cfm?c=refrig.pr_refrigerators Consumer Reports-Greener Choices: Refrigerators www.greenerchoices.org/ratings.cfm?product=fridge	EA93
Washing machine	Select a high-efficiency, front-loading washing machine that meets or exceeds Energy Star® standards. Rebates are available for selected models.		GreenerChoices: Washers www.greenerchoices.org/ratings.cfm?product=washer USEPA Energy Star®: Clothes Washers www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers New Jersey Energy Star® Rebates www.njcleanenergy.com/residential/programs/energy-star-product-rebates/new-jersey-energy-star-product-rebates Consortium for Energy Efficiency: FAQs for Washing Machines www.cee1.org/resid/seha/prod-list-faq.php3	EA92

50-year roof 50 year roofs are built with durable materials such as fiber-cement that enable them to last up to 50 years.

The Air Conditioning Contractors of America's (ACCA) Manual S Manual S provides information on selecting the appropriate heating and cooling equipment of a home based on the calculations derived from the formulas in Manual J.

The Air Conditioning Contractors of America's (ACCA) Manual D Manual D is a guide to designing residential duct systems

The Air Conditioning Contractors of America's (ACCA) Manual J Manual J describes how to calculate the heating and cooling loads of a home.

ambient lighting Ambient lighting uses "warm" lighting sources with a color temperature between 2700-3000K that are more flattering to skin tones and clothing, recommended for living spaces.

asbestos Asbestos is the name given to a number of naturally occurring, fibrous silicate minerals mined for their useful properties such as thermal insulation, chemical and thermal stability, and high tensile strength. Asbestos is commonly used as an acoustic insulator, and in thermal insulation, fire proofing and other building materials. Many products in use today contain asbestos.

awning An awning is a constructed frame covered in a fabric that extends from an existing structure (usually the side of a house) to provide protection from the sun and rain.

backdrafting Backdrafting refers to the process in which a home becomes depressurized from air escaping to the outside and is replaced with air entering from the exterior that may contain combustion products including carbon monoxide.

baffles Baffles are devices used to control movement of light, fluids, wind, and other forces.

biocide Biocides are chemicals used to destroy living organisms. They are typically selective and can be used agriculturally as pesticides or in other industries to control the infestation and growth of unwanted organisms.

Blower Door Test The Blower Door Test measures the leakiness of the house or its air infiltration and helps a homeowner prioritize problem areas. This test uses pressure differences created by air flow via a calibrated fan that mounts on the frame of an existing door and pulls air out of the house, lowering the inside air pressure. As higher pressure outside air travels in through unsealed cracks and openings, tools like a smoke pencil can detect these air leaks as part of a visual inspection process.

borate Borates are boron-containing, naturally-occurring minerals. Common commercial applications of borates include wood treatment, detergent additive, and plant fertilizer.

building envelope The building envelope of a structure separates its interior from the exterior.

carbon dioxide (CO_2) Carbon Dioxide (CO_2) is a gas byproduct of the burning of fossil fuels and other forms of combustion.

carbon monoxide (CO) Carbon Monoxide is a toxic gas byproduct of combustion that is both odorless and colorless. Sources of its production include wood stoves, fireplaces, gas stoves, and furnaces among others.

casement windows Casement windows are hinged and open like doors with a crank.

cellulose Cellulose fibers from recycled newsprint can be applied as a form of insulation that is flame, mold, and pest resistant, provides thermal and sound insulation, and resists settling.

cellulose insulation Cellulose fibers from recycled newsprint can be applied as a form of insulation that is flame, mold, and pest resistant, provides thermal and sound insulation, and resists settling.

CFC sealant Chlorofluorocarbon (CFC) sealants and other CFC products cause ozone depletion.

chase Chases are grooves cut into walls to receive pipes, cables, or ducts.

cladding Wall cladding is a nonstructural material used as the exterior covering for the walls of a building.

Color Rendering Index (CRI) The Color Rendering Index (CRI) is a 1-100 scale that measures how colors appear under different light sources. A light source with a CRI of 80 or higher is considered acceptable for most indoor residential applications.

color temperature Color Temperature defines the color and warmness or coolness of a light source. Color temperature is measured in Kelvin (K) temperature. Contrary to what is expected, higher Kelvin temperatures (3600–5500 K) are considered cool and lower color temperatures (2700–3000 K) are considered warm.

- A color temperature of 2700–3600 K is generally recommended for indoor general and task lighting.
- Task lighting calls for cool light that produces a higher contrastand is better for visual tasks.
- Warm light is more flattering to skin tones and clothing and is recommended for living spaces.

combustion Combustion is the chemical process of the release of gasses in the process of burning a fuel.

combustion appliances Combustion appliances refers to appliances such as stoves, water heaters, and clothes dryers that burn fuels. It is important to make sure that these appliances work correctly and are properly ventilated to prevent carbon monoxide, a byproduct of combustion, from entering the home.

commissioning Commissioning ensures that a home's mechanical systems have met their design intent, operate and interact optimally.

Compact Fluorescent Lights (CFLs) Compact fluorescent lights are the miniature fluorescent lights that can screw into standard light fixtures that conventionally use incandescent bulbs. CFLs are more energy-efficient and durable than incandescent bulbs.

cool metal roofing Cool metal roofing is made from metals such as copper that is used to reflect sunlight and reduce the amount of heat that is transferred into a building.

cooling load Cooling load refers to the amount of heat that is to be removed from a space by a cooling system.

cross-linked polyethylene (PEX) Cross-linked polyethylene is a plastic often used for water supply piping that is flexible, resistant to scale and chlorine, doesn't corrode, is faster to install, and has fewer connections and fittings than does metal piping or rigid plastic piping such as PVC, CPVC, and ABS.

damper Dampers are adjustable plates located in the flue of a fireplace that prevent heat from escaping when it is not in use.

deciduous trees Deciduous trees are species that shed their leaves for part of the year.

diffuser Diffusers are circular, square or rectangular air distribution outlets which are usually located in the ceiling. They are comprised of deflecting blades which discharge supply air in various directions. Diffusers are designed to mix the conditioned air entering the space with the air already contained in the space.

disposable respirators Disposable respirators or filtering facepieces can be made of cloth or paper and are designed to clean the air as you breathe it to prevent you from inhaling irritating substances.

door sweep Door sweeps are hardware that attach to the bottom of a door to reduce draft.

double-hung window(s) Double-hung windows have two vertically sliding sashes, each closing a different part of the window.

double-pane window(s) Double-pane windows consist of two pieces of glass separated by an air space. The air space allows for less heat transfer between the interior and the exterior of the home reducing heating and cooling loads.

drain pans Drain pans provide a basin to catch any fluids leaking from a piece of equipment such as a clothes washer.

Duct Blaster Test A Duct Blaster Test utilizes a fan and a pressure gauge to measure the amount of air escaping from the ductwork of a home by pressurizing the system.

duct cleaning Refers to the cleaning of heating and cooling system components in forced air systems, including the supply and return-air ducts, registers, grilles, diffusers, heat exchangers, heating and cooling coils, drain pans, fan motor, fan housing, and the air handling unit.

duct mastic Duct mastic is a sealant used to reduce air leakage in duct systems. Its flexibility enables it to contract and expand.

duct squeezing Duct squeezing refers to the use of under-sized ducts in an HVAC system in tight spaces that accelerates the air flow creating excessive noise and increases the system's operating costs.

ducting system Ducting systems are networks of ducts or formed sheet metal that direct the flow of air from central HVAC units.

energy performance rating Energy performance ratings indicate the potential for heat transfer and sunlight transmittance of windows, doors, and skylights.

Energy Star® for Homes Typically 20-30 percent more efficient than standard homes, Energy Star qualified homes must meet certain criterion including energy saving features.

Energy Star® Thermal Bypass Checklist (TBC) The Energy Star® Thermal Bypass Checklist consists of guidelines for a home inspection that may reveal any opportunities for energy efficiency improvements.

Extruded Polystyrene (XPS) Extruded polystyrene is a plastic foam insulating material that is resistant to moisture, rot, mold, and corrosion.

fiber cement Fiber cement siding is composed of sand, cement, and cellulose that make it more durable than wood, is termite- and water-resistant, and non-combustible.

fiber-cement composite roofing Fiber-cement composite roofing is made of sand, cement, wood fiber and clay. It is recyclable, fire-proof, and durable, lasting up to 50 years.

flame spread rating Flame spread ratings (FSRs) are used to evaluate the surface burning characteristics of building materials including ignition temperature, smoke toxicity, and flame-spread. Building materials are compared to the FSR scale where inorganic reinforced cement board is 0 and red oak is 100.

flashing Any piece of material, usually metal or plastic, installed to prevent water from penetrating the structure.

foam sheathing Foam sheathing includes expanded polystyrene (EPS), Extruded Polystyrene (XPS), and Polyisocyanurate (PIR). These foam insulation materials are used for applications such as controlling heat flow, airflow, rain penetration, water vapor flow, and condensation.

formaldehyde Formaldehyde is a chemical compound used in products including paper towels, photographic film, glues, and inks among others. It is important to avoid products containing formaldehyde whenever possible as they off-gas potentially hazardous pollutants.

formaldehyde-free Formaldehyde-free products don't contain any formaldehyde. Formaldehyde is a chemical that off-gasses creating air pollution and should be avoided whenever possible.

glazing Window glazings are compounds applied to glass to reduce the amount of heat transfer between the interior and the exterior of a building and/or the ultra-violet (UV) light passing that passes through it.

grille Grilles are vent covers that are normally used on air return ducts. Grilles do not have a pre-attached damper. Louver assemblies can be used with grilles so that the grilles can be used on forced air ducts and still provide airflow control.

gypsum Gypsum is a mineral found in sedimentary rock formations in a crystalline form known as calcium sulfate dihydrate. It is typically used in gypsum board that consists of a non-combustible core.

gypsum board Gypsum board or drywall is used in various paneling applications that consists of a paper-faced non-combustible gypsum core.

hard wire Hard wiring refers to the use of cables or electric wire to connect electronic components.

heat exchanger(s) Commonly used in space heating, refrigeration, air conditioning, and other applications, heat exchangers are devices built for efficient heat transfer from one medium to another.

heat pump system Heat pumps use electricity to move heat from a cool space into a warm, making the cool space cooler and the warm space warmer. During the heating season, heat pumps move heat from the cool outdoors into your warm house; during the cooling season, heat pumps move heat from your cool house into the warm outdoors. Because they move heat rather than generate heat, heat pumps can provide up to 4 times the amount of energy they consume.

heating and cooling coils The heating and cooling coils of an appliance or piece of machinery converts electricity into heat energy.

heating load Heating load refers to the amount of heat it takes to maintain the temperature of an indoor space.

Heating, Ventilation, and Air Conditioning (HVAC) Systems Heating, Ventilating, and Air Conditioning systems process and supply air through ductwork helping to regulate humidity and temperature in buildings to provide safe and healthy conditions.

HEPA filtered air scrubbers High efficiency particulate air or HEPA air filters are a type of high-efficiency air filter that remove at least 99.97% of airborne particles down to a size of 0.3 micrometers (μm) in diameter.

HEPA vacuum High efficiency particulate air or HEPA filters are a type of high-efficiency air filter that remove at least 99.97% of airborne particles 0.3 micrometers (μm) in diameter. HEPA filter used in vacuum cleaners trap the fine particles (such as pollen and dust mite feces) which trigger allergy and asthma symptoms.

high-density fiberglass batts High-density fiberglass batts are insulation with higher R-values (a measure of resistance to heat flow) than other fiberglass batts. These materials are considered to be less irritating and don't require a chemical binder for securing.

high-recycled-content Products of high-recycled content are made mostly with materials that have already been used.

Home Energy Analysis A Home Energy Analysis considers possible measures that can be taken to improve a home's energy efficiency based on certain criteria.

Home Performance Audit Home Performance Audits are conducted to assess the energy efficiency of a home and evaluate possible energy saving measures.

home-run piping system Home-run or manifold plumbing systems utilize both PEX piping and a manifold. The system is characterized by direct lines from the manifold to any fixtures that reduce the amount of water needed and provides hot water faster.

house wrap House wrap, typically made of polyethylene, is a breathable material used to prevent moisture and wind from entering the home.

IICRC S500 Guidelines The Institute of Inspection, Cleaning and Restoration is an independent, non-profit certification body that sets and promotes standards for the inspection, cleaning and restoration service industry. These guidelines provide specific practical standards for water damage restoration.

infiltration Infiltration is the process by which water seeps through the ground where it may reach a water body or an aquifer.

infrared Infrared radiation is electromagnetic radiation of wavelengths approximately between 0.75 and 1000 mm.

infrared camera Infrared cameras are used to detect thermal variations and may be used in conducting energy efficiency analyses.

infrared imaging Infrared imaging detects thermal variations and may be used in conducting energy efficiency analyses.

Kelvin (K) Kelvin is a universally accepted base unit used to measure temperature. One degree in Celsius is equivalent to one degree in Kelvin. Water freezes at zero degrees Celsius, which is approximately 273.16 Kelvin.

latent cooling load The latent cooling load of an HVAC system is the amount of heat energy produced by moisture from indoor and outdoor sources that needs to be removed from a home in order to maintain a constant temperature.

Light-Emitting Diode (LED) Light-Emitting Diodes are electronic light sources that use less energy than incandescent bulbs or compact fluorescent lamps.

load calculations Load calculations are formulas used to derive the heating, cooling, or electrical loads of a system.

louver(s) Louvers are vertical slats on a window, blind, or shutter that are angled in such away to allow in light and air while providing a shield from rain, direct sunlight, and noise.

low-E Low-E or Low-Emissivity glazings are metal or metal oxide coatings applied to windows to reduce heat flow.

low-VOC Low-VOC products contain smaller amounts of volatile organic compounds (VOCs) that can offgas chemicals and cause air pollution.

manometer Manometers are instruments used to measure pressure.

Microload home The New Jersey Clean Energy Program defines "microload" as a "customized high performance level at or approaching Net-Zero Energy." While a regular home built to code would receive a Home Energy Rating System (HERS) score of 100; a Microload home would be built to use 50% less energy and would receive a HERS score of 45 or less. Microload homes are eligible for incentives under Tier 3 of the New Jersey Energy Star Home Program.

Modified Energy Factor (MEF) is a combination of Energy Factor and Remaining Moisture Content (RMC). MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many cubic feet of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency.

moisture meter Moisture meters are devices used to measure the amount of water in a given substance that help determine if it is ready to use.

mold amplification sites Mold amplification sites are locations where mold has built up over time. Typical sites of indoor mold buildup are damp cellulosic materials (e.g., wallboard paper, wallpaper, carpet backing, damp papers); debris in ventilation ducts, in carpets, or in mattresses or upholstered furniture; poorly maintained humidifiers; insulation on which organic film has accumulated; constantly humid painted, caulked or plastic surfaces (e.g., windowsills, shower stalls, cold air return vents); and potted plant soils.

National Air Duct Cleaners Association (NADCA) The National Air Duct Cleaners Association (NADCA) was formed in 1989 as a non-profit association of companies engaged in the cleaning of HVAC systems. Its mission is to promote source removal as the only acceptable method of cleaning and to establish industry standards for the association.

National Fenestration Rating Council (NFRC) The National Fenestration Rating Council (NFRC) is a non-profit organization that administers the only uniform, independent rating and labeling system for the energy performance of windows, doors, skylights, and attachment products.

natural ventilation Natural ventilation systems utilize pressure differences caused by wind or the buoyancy effect (created by differences in temperature or humidity) to circulate fresh air through buildings.

non-CFC sealant Non-CFC sealants do not contain the ozone depleting chemicals chlorofluorocarbons (CFCs).

non-combustible Non-combustible materials are incapable of burning.

optimal load calculations The optimal load of an HVAC system can be calculated to determine the amount of energy required for it to operate the most efficiently.

out-gas/off-gas Out gassing or off-gassing is the evaporation of chemical materials that may be hazardous.

over-sizing Over-sized ducting of HVAC systems may lead reduced indoor air quality and an imbalance of air flow distribution.

Pascal The Pascal is the standard unit of the measure of pressure equal to one Newton/square meter.

passive solar Passive solar home design considers the materials and arrangements of windows, walls, and floors to utilize solar energy for heating in the winter and reduce solar heat gain in the summer.

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petroleum-based Petroleum-based products are made from the raw natural resource petroleum, such as oil and natural gas.

phantom load The phantom load refers to the electricity being used by an appliance when it is turned off but still plugged into an outlet.

phenol formaldehyde Phenol Formaldehyde (PF) is commonly used in polymer resins as a safer alternative in pressed-wood materials, off-gassing less formaldehyde than products that use Urea Formaldehyde (UF).

plenum Plenums are boxes made of sheet metal that connect to the outlet of an air handler or furnace where to which other ductwork can attach

plumbing chase A hollow wall area accommodating piping used for drain waste or vent in plumbing systems.

polyisocyanurate Polyisocyanurate is a plastic consisting of closed-cell foam that contains a low-conductivity gas (usually hydrofluorocarbons or HCFC) in its cells. It has a high thermal resistance and is used as insulation that is available as a liquid, sprayed foam, or foam board.

polystyrene Polystyrene is a plastic foam that comes in extruded or expanded forms that are used in various building applications for their insulating properties.

post-consumer recycled content Post-consumer recycled products consist of materials that were previously used by consumers.

pre-primed Pre-primed materials are already prepared with a primer allowing for the application of other products, oftentimes paint.

programmable thermostat Programmable thermostats are devices used to control a home's heating/cooling system that can be set to turn off when no one is home and then back on when the home will be occupied to reduce the cooling load.

R-Value The R-value of a material indicates its resistance to heat transfer.

radiant barrier Radiant barriers are installed in homes to reduce summer heat gain and winter heat loss, and hence to reduce home heating and cooling energy useage. All radiant barriers have at least one reflective (or low emissivity) surface, usually a sheet or coating of aluminum.

rainscreen Rainscreens are used to reduce the exposure of exterior walls to precipitation preventing moisture intrusion and the decay of materials. Every rainscreen consists of vented or porous cladding, an air cavity, a drainage layer on support wall, and a rigid, water-resistant, airtight support wall.

reconstituted wood fiber Reconstituted wood fiber materials use chipped or stranded small-diameter trees as their wood source. This material is then bound together into forms suitable for use in construction.

recycled content Products with recycled content are made from materials that have already been used in another product.

recycled paper cellulose Recycled paper cellulose is an environmentally-friendly insulation alternative made of waste paper.

refrigerant A refrigerant is a compound used in a heat cycle that undergoes a phase change from a gas to a liquid and back used in refrigerators/freezers, air conditioners, and other appliances.

refrigerant charge Refrigerant charge refers to the quantity of refrigerant in a refrigerant system.

return air duct registers Registers are vent covers that are typically used on forced air ducts. They have a pre-attached damper or set of louvers to help control airflow.

return duct Return ducts prevent the pressurization of closed rooms from supply air by allowing air to flow black to the central return grille.

return grille Return grilles are grates used to cover the ends of return ducts.

rim joist Rim joists are the boards that cap the ends of the floor system.

roof overhangs Roof overhangs are an element of passive solar home design used to shade buildings that may be adjustable, removable, or fixed.

R-Value The R-value of a material indicates its resistance to heat transfer. A higher R-value is better than a low R-value.

sash Window sashes consist of the moving section(s) of a window.

Seasonal Energy Efficiency Ratio (SEER) The seasonal energy efficiency ratio measures the efficiency of a central cooling system over an entire season by comparing the number of BTUs produced to watt-hours consumed.

sensible cooling load The sensible cooling load of a home refers to heat gain from the collective impact of conduction, convection, the exterior, people, and appliances.

sheathing Sheathing refers to a building material that is used to cover exterior wall framing or roof trusses.

shutters Shutters are moveable wooden or metal coverings that, when closed, keep sunlight out. They can be either solid or slatted, with fixed or adjustable slats. Rolling shutters have a series of horizontal slats that run down along a track.

single-package models Single-package model HVAC systems have all of their components, including evaporators, cooling coils, compressors, and condensers, contained within one unit.

single-pane window Single-paned windows have only one piece of glass separating the interior and exterior of a home. Double-pane windows are considered to be much more energy-efficient.

six-sided containment Six-Sided Containment refers to the insulating of all six sides of frame wall cavities in unconditioned, concealed spaces.

smoke pencil Smoke pencils detect air pressure differences between two spaces by emitting smoke that leaks through any cracks or openings.

soffit vent(s) Soffit vents are applied to the underside of a construction element and are perforated for intake ventilation.

Solar Heat Gain Coefficient (SHGC) The Solar Heat Gain Coefficient is the fraction of incidental solar radiation admitted through a window.

Solar Renewable Energy Certificate (SREC) SREC stands for Solar Renewable Energy Certificate and is a tradable certificate that represents all the clean energy benefits of electricity generated from a solar electric system. Each time a solar electric system generates 1000 kWh (1 MWh) of electricity, an SREC is issued which can then be sold or traded separately from the power.

solar screen(s) Solar screens are mounted to the exterior of windows to reduce sunlight transmittance and prevent heat transfer.

solar tube(s) Solar tubes consist of a clear dome that collects sunlight into a highly polished and reflective tube that reflects the light down to a diffuser on the ceiling. They are sufficient to light a small room, hallway, or staircase.

solar water heating Solar water heaters or domestic hot water systems utilize storage tanks and solar collectors to provide hot water for a home, saving both energy and money.

split systems Split HVAC systems have their components, including evaporators, cooling coils, compressors, and condensers, located inside and outside of a building.

spray polyurethane Spray polyurethane foam (SPF) is a plastic insulation that expands after being installed as a liquid.

stack ventilation Passive stack ventilation are devices known for extracting warm air from the upper regions of a room or building, with incoming air being admitted via inlets lower down in the room or building. In winter, such incoming air will need to be heated for the comfort of occupants and this is wasteful.

storm door Storm doors consisting of a combination of glass and screens can be used to increase the energy efficiency of an exterior doorway.

storm window Storm windows are pieces of glass or plastic mounted to the interior or exterior of an existing window that serve to reduce the amount of airflow in and out of a home, reducing heating and cooling loads.

supply air duct registers Registers are vent covers that are typically used on forced air ducts. They have a pre-attached damper or set of louvers to help control airflow.

supply duct(s) Supply ducts made of formed sheet metal deliver air to interior spaces from an HVAC system.

supply register Registers are vent covers that are typically used on forced air ducts. They have a pre-attached damper or set of louvers to help control airflow.

task lighting Task lighting, often described as “cool” lighting, produces higher contrasts that are better for seeing. Task lighting sources emit temperatures between 3600-5500K.

thermal bridging Thermal bridging occurs when high thermal conductivity materials such as steel and concrete create pathways that bypass thermal insulation resulting in heat loss.

Thermal Bypass Checklist (TBC) The Thermal Bypass Checklist is a comprehensive list of building details where thermal bypass, or the movement of heat around or through insulation, frequently

occurs due to missing air barriers or gaps between the air barrier and insulation.

thermal bypass inspection The Energy Star® Thermal Bypass Checklist is a comprehensive visual inspection of building details where thermal bypass, or the movement of heat around or through insulation, frequently occurs due to missing air barriers or gaps between the air barriers and the insulation.

transom Transoms are the windows above doors that serve to allow in sunlight and release warm air.

U-Factor The U-factor of a window assembly indicates its rate of heat loss.

Ultraviolet (UV) light Ultra-violet light (UV) is defined as electromagnetic radiation in the spectral region between 180 and 400 nanometers. Prolonged exposure to UV light can result in sunburns, skin cancer, and the fading of certain materials.

unconditioned spaces Unconditioned or unfinished spaces including attics and crawlspaces can provide a variety of energy saving opportunities.

urban heat island effect The heat island effect occurs in urban areas where impermeable roof and pavement temperatures increase during the summer, elevating the air temperature. The increase in air temperature generates a greater demand in energy consumption for cooling systems and promotes the development of smog due to the concentration of air pollutants in urbanized areas. Also, runoff from these heated surfaces reaches waterways where it can increase the water temperature affecting the ecosystem.

U.S. Green Building Council's Leadership in Energy and Environmental Design for Homes (LEED-H) certification LEED for Homes is a rating system that encourages the building of green homes that use less energy, water and natural resources, create less waste, are healthier and more comfortable.

vermiculite insulation Vermiculite is a naturally-occurring mineral, favored for its absorbant, lightweight, fire-resistant, odorless characteristics. Pre-1990 vermiculite insulation products are likely to contain some traces of asbestos associated with the mine where the vermiculite was collected.

Volatile Organic Compounds (VOCs) Volatile Organic Compounds are off-gassed from certain solid or liquid products and may cause negative health effects when inhaled

wall cladding A wall cladding is a nonstructural material used as the exterior covering for the walls of a building.

warm-edge spacer Warm-edge spacers are used to separate panes of glass in insulated windows and conduct less heat than standard aluminum spacers.

warp Warping is the distortion or bending of wood due to moisture.

Water Factor (WF) Water factor is the number of gallons needed for each cubic foot of laundry. A lower number indicates lower consumption and more efficient use of water.

water heater blanket Water heater blankets are used to insulate water heaters with R-values less than 24.

weatherization Weatherization involves procedures that protect a building from the elements.

weatherstripping Weatherstripping is the sealing of cracks or holes around windows, doors and other openings exposed to the exterior of a building with caulk, foam, rubber strips, or other materials that can be used to reduce airflow between the interior and the exterior.

whole house fan Whole house fans located on attic floors ventilate warm air from interior spaces to the outside while depressurizing the home to draw in cool air from open windows.

window glazing Window glazings are compounds applied to glass to reduce the amount of heat transfer between the interior and the exterior of a building and/or the ultra-violet (UV) light passing that passes through it.

wind-washing Wind-washing refers to the movement of air caused by wind entering through building enclosures, usually at the corners and roof eaves, that can have a major impact on its thermal efficiency and moisture control.

zone controller A zone controller connects multiple thermostats to a single HVAC system.

zoning HVAC zoning strategically divides a building into zones where each has its own thermostat for independent temperature control.