



Shades of Green

A green building guide
for YouthBuild associates



YouthBuild

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CHAPTER 1

Design, Layout and Infrastructure**Green Design Teams and the Integrated Design Process**

Integrated design is also known as whole building design or integrated project delivery, and emphasizes good interaction and coordination between building disciplines and building elements. The process aims to bring together all people with a stake in the building—such as financiers, designers, future occupants, developers, and sub-contractors.



The group should work to design a building in which all components blend to provide space that is comfortable, functional, efficient and beautiful – a difficult task without a thoughtful team! YouthBuild programs should make sure to include YouthBuild students, neighbors, community representatives, and the electric and gas utility in your community in your home design team.

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Integrated design should begin with pre-design and continue through project completion. By coordinating plans before specifications are made, members of a Green Design Team can come up with creative ways to maximize efficiency and impact and use low-cost green techniques. For example, if the ductwork is not done by the same people planning the wall systems, and the two parties do not coordinate with one another, the ductwork might not be installed in the conditioned space of the house (such as the ceiling above hallways) to save energy. If the team includes all stakeholders, and considers all building systems from the start, it can anticipate hard choices, reducing undesirable tradeoffs and increasing positive synergies (where one action leads to multiple benefits).

The integrated design process can be applied to both rehabilitation and new construction. Although a rehab job may limit the green building techniques that can be implemented (because of cost or structural issues), many green techniques can be adapted in even the most restrictive, basic remodeling jobs with creative, team approaches to solutions. Involving the whole team of stakeholders from the beginning is the best way to build green solutions into a rehab or new construction job in an efficient and cost-effective manner.

Implementing Integrated Design

The integrated design process includes the early definition of specific building performance objectives, such as “this home will use no more than 900 kWh per month on an annualized basis.” These building performance objectives could be included in a project vision statement, and should clearly drive programming efforts. These objectives should also be integrated into all project narrative documents, building specs and contracts. Establishing specific levels of annual energy and water use is just one example of a building performance objective that would require cross-disciplinary planning to succeed.

- Designate a coordinator of the integrated design process. This person will probably be the YouthBuild director or construction manager and will be the scheduler and facilitator of meetings and of communication between subcontractors, developers, and community members. The coordinator will also ensure that youth are included in the design process.
- Allow for additional costs, including the time necessary for team meetings or the hiring of a professional consultant to provide education and assistance.
- Choose members of local or national green building organizations (see the [YouthBuild Green Pages](#) for listings) when selecting architects, designers, and developers.
- Clearly communicate to all subcontractors that the building process requires teamwork and working with youth; include this requirement in all conversations and in contracts.
- Establish a performance-based bonus structure to reward team members (engineers, plumbers, interior designers, electricians, etc.) for the extra effort involved and to encourage team cooperation and innovation, particularly with larger developments.
- Choose the building rating system you are going to use (such as Energy Star, LEED for Homes, or one designed for your local climate by your local green building program) to help decide on a course of action and receive verifiable recognition of your green home by a professional organization.
- Host a design charrette, a form of brainstorming that creatively engages all stakeholders. If time is not available for a four-day charrette, shorter processes or variations can be used, such as focused project team meetings, brainstorming sessions such as community visioning events, and intensive workshops in which specific community members and experts are brought together to design the home(s) or the neighborhood.
- Define the green building goals cooperatively and choose ones that can be reached and are appropriate to the project and community. If registering the project with a home rating system, use the rating system checklist to help identify feasible goals and become acquainted with the rating measures.
- Distribute a written statement of those goals once they are identified. Require personal signatures from team members to commit them to these goals.
- Hold a meeting with all stakeholders and team members to get initial commitments and feedback.

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- Simulate interactions among building systems; use computer modeling tools such as AutoDesk® Revit or Bentley® BIM, or simpler software such as Chief Architect Home Edition, to get a feel for design and materials needs. This will help, particularly with larger developments.
- Systems that should be analyzed together include:
 - windows and envelope systems with mechanical systems,
 - gutters, drainage, foundations, flatwork and landscape,
 - framing and mechanical systems, and
 - windows, ventilation, and lighting (electrical and mechanical).
- Include a life-cycle cost analysis (calculating the cost of a system or product over its entire life span) of options in your planning. These analyses serve as good research projects for team members and students. Refer to the resources section of this chapter for more information.
- Monitor progress and hold team meetings as needed. Give awards and accolades at key targets in the project. Establish a pattern of meetings for members of the integrated project team throughout the various design phases and during construction to do real work or make specific decisions. Waive the meeting if there is no business at hand. The frequency of these meetings should not interfere with the team's ability to get things done. Try to identify concrete tasks that the group can accomplish beyond simply "checking in."
- Celebrate its conclusion with press coverage. Invite your local government officials to tour the home and speak at a ribbon-cutting event. Don't forget to invite existing and potential project funders!

Charrette

A design charrette is a collaborative planning process that harnesses the talents and energies of all interested parties to create and support a feasible plan.

A Charrette is usually:

- A group process that lasts for approximately three-to-four consecutive days
- An open process that includes all interested parties
- A collaborative process involving all disciplines in a series of short feedback loops
- A process that produces a feasible plan. A generalist, holistic approach

A formal Charrette is **not**:

- A one-day workshop
- A multi-day marathon meeting involving everyone all the time
- A plan authored by a select few that will affect many
- A “visioning session” that stops short of implementation



Cobb County YouthBuild's Green Design Team

Benefits of Integrated Design

- Including team members from the beginning allows them to feel more invested in the building process.
- Coordination fosters a closer working relationship between stakeholders (agency, funder, architect, developer, managers, staff, students, community, and homeowner) that will strengthen the critical partnerships you worked hard to secure.
- By taking the time to design a building from a whole-system approach at the beginning of the project, green improvements are likely to be less expensive and more effective.
- Investing time for this up front makes many more things affordable and easier as you go forward. It takes extra time and energy, but it will pay off in the end.
- In cases where a YouthBuild program does not make the design and specification decisions for a building project, integrated design can help to persuade the project developer to include more green features and techniques by identifying the “low hanging fruit” and no- to low-cost items, and by communicating the benefits of green building.

Challenges of Integrated Design

- Coordinating multiple schedules and changing traditional work patterns can be difficult.
- YouthBuild programs may not have much control over their construction projects, even if they attempt to organize an integrated team, such as where there are partnerships with Habitat for Humanity or a housing authority, or other projects where YouthBuild is not the owner or developer.

Case Study

Charrette in Atlanta Gives Opportunity for Learning and Collaboration

The Cobb County YouthBuild collaborative design charrette is an example of how to provide YouthBuild participants with hands-on opportunities to learn about sustainable building practices. With a small budget surplus, the Atlanta office of the American Institute of Architects' (AIA) Committee on the Environment (COTE) sponsored a community charrette in partnership with the YouthBuild at Cobb County Housing, the Southface Energy Institute, and the Community Housing Resource Center. The result was a four-day program: a two-day interactive workshop with the purpose of exposing YouthBuild students



to sustainable building practices, and a two-day charrette with the students assuming the role of architects designing a house for a future YouthBuild construction site. Because of the charrette's success, Atlanta AIA decided to fund an annual charrette with Cobb County YouthBuild.

Day One: YouthBuild Cobb County students toured the facilities at the Southface Energy Institute. Students toured the Earth Craft House, a building that highlights a broad range of sustainable design and building practices. Two professionals spoke to the students. Jeff Christian, from the Oak Ridge National Laboratory, informed the group about the concept of zero energy and its integration into Habitat for Humanity homes across the country. Zero energy reduces utility costs for Habitat owners by utilizing solar energy and energy-efficient building materials. Joe Martin from AIA-COTE spoke to the students about The Rural Studio, an architectural training program out of Auburn University where architectural students design and build structures alongside residents in rural Alabama. Including this material was a way of introducing the broader issue of sustainable development and showing YouthBuild Cobb County students the kind of work that student architects do while learning their profession.

Day Two: After an overview of the charrette process, students were divided into four teams of eight students; each team worked with two architects. The teams were asked to come up with a design for one of four possible housing models. One group was assigned to work on a single-family home. The second group was asked to design a loft-style condominium arrangement. A third was given the task of working on an attached multifamily unit. The fourth group designed a hybrid unit, combining characteristics of single family, loft, and multifamily.

Day Three: The student teams went to an empty lot where Cobb Housing was going to build. Asked to envision what the building might look like, each team took photographs of the site, posted this information and reviewed the concepts of passive solar heating and cooling in sustainable design.

Day Four: The students developed models and scaled drawings and presented their completed designs to each other. While no new buildings were constructed as a result of the charrette, students incorporated sustainable materials and building practices into their design ideas and gave each other constructive feedback.

Several students left encouraged and excited about pursuing careers in architecture and design. “We also changed the way Cobb County Housing handled debris at construction sites. We initially had many locations for debris. We found that it was more sustainable to consolidate these into one location for debris. We have since adopted this practice,” says Lance Wise, Executive Director at Cobb County YouthBuild.

To get more information about design charrettes and partnerships, contact Lance Wise at (770) 429-4400 x8 or lwise@cobbhousinginc.org.

Construction Plans and Specifications

The Cobb County YouthBuild collaborative design charrette is an example of how to provide YouthBuild participants with hands-on opportunities to learn about sustainable building practices. With a small budget surplus, the Atlanta office of the American Institute of Architects’ (AIA) Committee on the Environment (COTE) sponsored a community charrette in partnership with the YouthBuild at Cobb County Housing, the Southface Energy Institute, and the Community Housing Resource Center. The result was a four-day program: a two-day interactive workshop with the purpose of exposing YouthBuild students



Nueva Esperanza YouthBuild Holyoke’s Green Design Team

As you read through this manual you will notice that many items require **preconstruction planning**. This planning phase bridges the process of developing a green integrated design and actually breaking ground, allowing the Green Design Team to carefully map the actual details,

work plans and expenses of the initial construction or rehab job. The Green Design Team can accommodate changes to the original plan that may come up, deliberately gathering everyone involved and scheduling time to integrate new designs, technologies, or techniques into your practice.

The Green Design Team should review the entire portfolio of green building options for each building phase. Use this guide and other resources to decide each course of action, paying attention to how systems will interact. After making these preconstruction decisions, the team will be ready to draw up formal construction plans and specifications with subcontractors who are ideally already members of the Green Design Team.

Plans and specifications should include:

- A detailed mechanical plan (see the Plumbing, Electrical, and Mechanical section for details)
- A landscaping plan for protecting and restoring existing native plants and the site's wildlife habitats (see the Landscaping section for details), and
- Flashing for windows, doors, roof, deck, and chimney.

General Design Principles and Considerations

Below are a few general design considerations and techniques that go a long way to save on energy for heating and cooling. Several of the following points are explained in more detail elsewhere in this guide:

- If possible, orient the longest side of the house to face south, to maximize natural heating, lighting, and cooling (see the Building Design section for details).
- Two-bedroom homes should be designed at a maximum size of 1,250 sq. ft., with a maximum 250 sq. ft. for each additional bedroom.
- Use material dimensions when determining building dimensions to reduce material cuts and the resulting waste.
- Choose building materials that require no additional finishing.
- Choose building materials that are precut, preassembled or panelized— such as walls, roofs, or even entire home systems.
- Design a covered or shaded outdoor area or porch to be 100 sq. ft. minimum.
- Design a covered entry—such as an awning or porch—to prevent water intrusion.
- Prepare and protect existing trees for construction and avoid the trees' root systems.
- Design shared driveways and parking, and use shared trenches and tunnels for utilities.
- Ensure that the home meets American with Disabilities Act (ADA) standards for accessibility.
- Design a space for household recycling and equip new owners with recycling bins and instructions.
- Space and water heating equipment should go in a separate closet with an outside air source.
- Choose direct-vent, sealed-combustion fireplaces or include no fireplaces at all.

Building Design

Good passive design uses natural heat from the sun and natural nighttime cooling to keep the home at a comfortable temperature year-round.

Passive designs can be implemented with little or no extra cost. Even basic measures can significantly reduce the need for expensive mechanical heating and cooling. Your first goal should be to lower energy bills. However, know that with a much larger investment, it is possible to build *zero energy* homes—homes designed to use zero net energy from the utility grid—in every climate that require no mechanical heating and cooling as a result of good siting, excellent design, renewable energy use, and superb insulation.

Passive solar design integrates a combination of building features to reduce or even eliminate the need for mechanical cooling and heating and daytime artificial lighting. *Passive* refers to the fact that there are no mechanical parts associated with any of these techniques.

FAST FACT

True South is not the same as magnetic south at most locations. Because of the earth's magnetic field, a compass reading of south varies as much as 22° in some parts of the country. This difference is called magnetic declination, and is measured in degrees. You can find True South with a compass if you know your local declination, or by the solar noon or north star method.

It is important to find out the hours and *direction* from which the building will receive unobstructed sunshine and wind throughout the year. The position of the sun, and therefore the amount and direction of sunlight, can be determined once you find true south on your building site. It is also important to understand the climate of your building site, specifically the number of days above and below 65°F during an average year. This information will help determine the building's heating and cooling needs—passive or mechanical.


The orientation of the building with respect to solar and wind patterns, nearby buildings and other things blocking the sun, and vegetation must be carefully planned to maximize and manage southern exposure for natural heating, lighting, and cooling to work well. The following sections describe window selection, natural heating, cooling, and lighting design.

Windows

The placement, size, and specifications of windows greatly influence the energy efficiency of a building. New window technologies such as selective coatings can make it easier to balance windows' heat gain and heat loss properties without overheating the space. This balance is very specific to your local climate and site characteristics.

In hot climates, the strategy for windows is to admit light while rejecting heat. Design large north windows to take in cooler, diffuse north light. Minimize window height on the south side (strip windows work well), and shade the windows from direct sunlight when the sun is high in the south sky.

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In cooler climates, effective strategies include installing smaller windows on the north side and large windows on the south side to maximize solar gain during the winter. South-facing windows will also require shading in the summer to block direct solar gain. 

FAST FACT

Solar gain is a measure of heat from the sun; the amount of heat produced in a building by solar radiation, e.g., through windows or transparent walls.

When selecting windows, start by looking at two important specifications: the U-value and the solar heat gain coefficient. U-value is the rate of heat transmission (lower is better). The Solar Heat Gain Coefficient (SHGC) measures how well a window blocks heat from sunlight. The SHGC is the fraction of the heat from the sun that enters through a window. SHGC is expressed as a number between 0 and 1. The lower a window's SHGC, the less solar heat it transmits. Also consider visible light transmittance (higher is better). Low-E windows use technology that reduces the amount of energy loss through windows by inhibiting the transmission of radiant heat while allowing more visible light to pass through.

Most window manufacturers offer an array of optional heat-reflecting coatings that block heat gain but allow penetration of natural light. Windows that receive large amounts of direct or reflected sunlight are good candidates for window coatings. This is a great choice for west-facing windows.

FAST FACT

Low-emissivity (Low-E) coatings on glazing or glass control heat transfer through windows with insulated glazing.

For more information:

http://www.energysavers.gov/your_home/windows_doors_skylights/index.cfm/mytopic=13430Implementation of Window Selection and Placement

- A general rule is to install fewer windows on the west and east sides to avoid the glare of morning and afternoon sun.
- Use double-glazed windows and avoid metal frames, regardless of climate. Single-paned windows lose up to 25 percent of the energy used to heat and cool a home because they are not insulated.
- If building in consistently hot climates, use glass with a moderate solar heat gain coefficient. Be sure to shade south-facing windows from summer sun (see Shading).
- For climates with both heating and cooling concerns, use glass with a moderate solar heat gain coefficient. Design for heat in summer with plenty of shading. Plants and trees that shade in the summer and not in the winter (such as deciduous trees and trellises) are a good choice.
- If building in consistently cold climates, use glass with low U-value and high solar heat gain coefficient.

- Use **Energy Star-rated windows** for your local climate or for a climate-specific window property recommendation and pricing tools, contact the Efficient Windows Collaborative:

EWC/Alliance to Save Energy
1200 18th Street NW, Suite 900
Washington, D.C. 20036
(202) 857-0666
<http://www.ase.org>
<http://www.efficientwindows.org>

FAST FACT

75 percent of YouthBuild programs surveyed in 2005 use Energy Star-rated windows. In 2009, that percentage rose to 83 percent.

- Use a computer simulation tool such as **RESFEN** to compare window options by customizing calculations with heating and cooling costs for your area, utility costs, and housing design.
- Windows manufactured with Low-E coatings typically cost about 10%–15% more than regular windows, but they reduce energy loss by as much as 30%–50%. Many manufacturers are beginning to include Low-E as their standard at no extra cost. Installing efficient windows in new construction is both cheaper and more effective for energy savings than replacing windows later.

Benefits of Window Selection and Placement


- From an energy standpoint, a window is basically a hole in the wall. Choosing insulating, reflective windows (double glazed, reflective film, solar screens), and good caulking can help “close the hole.”
- Avoiding windows on the east and west, where there will be direct sunlight, and carefully placing windows relative to overhang (shade in summer, sunlight in winter; see box to the right) will help dramatically.

Challenges of Window Selection and Placement

- If you are using a wooden frame for your window, a moderate insulator (R1 per inch), requires some maintenance (stain or paint) to prevent rot from moisture build-up.
- Over the course of many years aluminum will oxidize leaving a dull-pitted appearance. If not well insulated with a thermal break, it is very cold to the touch in winter and hot in summer.
- Low-E windows are a more cost-effective strategy in colder climates.

Natural Cooling

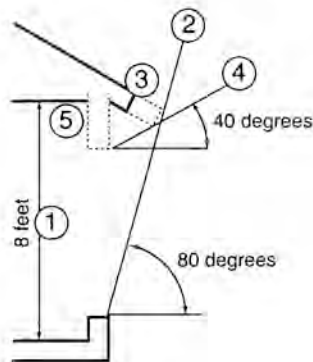
The use of outdoor air to cool a home without the need for mechanical cooling is especially effective when used in combination with shading, operable windows, and proper insulation. Cross ventilation captures breezes and directs them through the home, while upper-story windows allow naturally rising warm air to escape. Open layouts allow unrestricted air flow.

Common shading techniques include using trees and shrubs, trellises, overhangs, awnings, shade screens, window coatings, and interior shades. 

Window awnings and roof overhangs work like visors on baseball caps by blocking high-angle sunlight. On buildings, awnings can typically cover individual windows while overhangs cover sections of outside walls. Both sources of shade are most effective on the south side of the building. Some awnings stay in a fixed position, others can be rolled up in the winter to allow low-angle sun to enter the building.

Screens used for shading are often called sun screens, shade cloths, or solar screens. These screens are made from aluminum or plastic and are lightweight, durable, and easy to install. Unlike insect screens, shade screens are especially made to block a certain amount of the sun's energy, usually between 50 and 90 percent of the energy striking the outside of the window.

SIZE SOUTH-FACING OVERHANGS TO PROPERLY SHADE WINDOWS



OVERHANG SIZING RULES:

1. Draw the wall to be shaded to scale.
2. Draw the summer sun angle upward from the bottom of the glazing.
3. Draw the overhang until it intersects the summer sun angle line.
4. Draw the line at the winter sun angle from the bottom edge of the overhang to the wall.
5. Use a solid wall above the line where the winter sun hits. The portion of the wall below that line should be glazed.

Source: U.S. DOE Office of Building Technology

Interior window shades such as roller shades, blinds, and drapes can reduce heat gain. However, interior shades don't block sunlight as well as exterior shades or awnings. Interior shades work in three ways: 1) They reflect sunlight back out the window before it can significantly turn into room heat, 2) They block the movement of hot air from the area around the window into the room, 3) They insulate the room from the hot surfaces of the window glass and frame.

Living areas on the west and southwest walls can be buffered from hot or cold outside air by closets, a garage, and other non-living spaces, that is, rooms that are not heated or can get too hot or too cold without affecting occupant comfort. Do the same on the north walls in cold climates to buffer for winter winds. Place the highest priority on the surfaces that receive the most summer heat; that's usually the east and west sides of the building.

In many climates, the right combination of natural methods can lead to energy savings that range anywhere from 10 to 50 percent. At the very least, natural cooling allows you to install smaller cooling equipment that will run fewer hours and consume less energy.

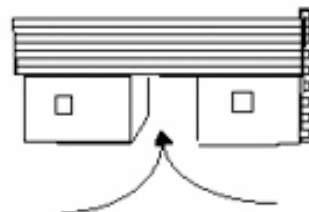
Implementation of Natural Cooling

Ventilation

- Open floor plans with a center hall aligned with the direction of prevailing summer breezes with windows and doors with screens placed at either end will channel fresh, cool air through the building. In southern regions houses and porches face the prevailing breeze and have a center door or hallway. Air from the sides of the house is funneled through the house out the back door. This configuration can create a significant breeze.
- Install stack ventilation and, where possible, install an operable cupola, clerestory, or wind-chimney.

Trees and Shrubs

- Your site plan should preserve as many existing trees as possible. Plan to plant new trees immediately after construction. Deciduous trees are best for south yards. The closer a tree is to the building, the more hours of shade it will give. Trees should be planted between 20 and 40 feet from the building to provide good shade and to prevent roots from damaging the foundation.
- Shrubs usually cost less, reach mature size more quickly, and require less space than sapling trees. Shrubs can also shade walls and windows without blocking roof-mounted solar panels as trees can do.



The classic Texas "dog trot" house was a good example of a no-cost cooling design. The large open breezeway separating the two main portions of the house channeled the prevailing winds to load cooling in the mornings and flushed heat in the evenings.

- In addition to the shading, trees provide a cooling bonus. To keep themselves cool, trees pump water from the ground into their leaves. As this water evaporates from the surface of the leaves, it cools the tree and its surrounding area.
- When their leaves fall in the winter, many deciduous trees allow solar heat to reach the building. Evergreens can work well for north and northwest yards, where you will want to block cold winter winds and won't have many windows to benefit from solar gain or daylighting.

Trellises

- Trellises are permanent structures that shade parts of the outside of a building. Clinging vines growing over the trellis add more shade and the cooling effect that comes from water evaporation. A special trellis to shade air conditioners and heat pumps improve the equipment's performance. Be sure not to restrict airflow to the equipment.
- Fast-growing vines create shade quickly. Deciduous vines, such as grape and wisteria, lose their leaves in winter, allowing the sun's heat to strike the building. Trellises and climbing plants are a design solution that is attractive and flexible.

Shade Screens

- Put shade screens only on windows exposed to direct sunlight. The term "shading coefficient" listed on shade screens describes the amount of heat that penetrates the screen (lower numbers mean less heat gets through). While you can see through a shade screen, the view is somewhat obscured.

FAST FACT

There can be up to a 16-degree temperature difference between the shaded and unshaded sides of a building.

- To give you the most benefit, interior shades should have a light-colored surface on the side that faces the window, fit tightly to prevent air movement into the room, be made of an insulating material, and cover the whole window.

Natural Heating

Materials used to store heat can be installed on or in south-facing walls and rooms to collect the sun's heat during the day; the heat will then be radiated out into the living area at night. Such materials include concrete, masonry, wallboard, and water tanks. This technique is best suited for cooler climates or places where the temperature drops dramatically at night (at higher elevations, for example).

Sunrooms



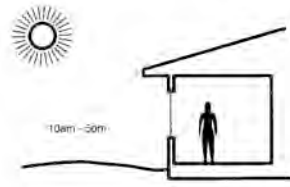
South-facing sun rooms are often added on as a way to retrofit a home to take advantage of the sun's heat and light. It is also possible to use a sunroom to help ventilate the rest of the house. Lower vents connected from the sunroom to the interior rooms draw air through the living space; the air is then released through the upper vents along the top of the sunroom.

Trombe wall

A trombe wall consists of an 8- 16" thick masonry exterior wall coated with a dark, heat-absorbing material and covered by a single or double layer of glass placed from about 3/4" to 6" away. Heat from the sun is stored in the air space between the glass and dark material, and conducted slowly to the interior of the building through the masonry. Trombe walls may also sit deeper in the sunroom while still having the ability to receive direct sunlight.

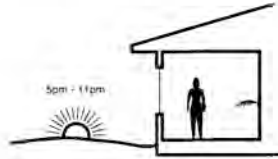
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THERMAL MASS IN THE HEATING SEASON



10:00 am to 5:00 pm

Sunlight enters south-facing windows and strikes the thermal mass inside the home. The sunlight is converted to heat energy, which heats both the air and thermal mass materials. On most sunny days, solar heat maintains comfort during the mid-morning to late afternoon periods.



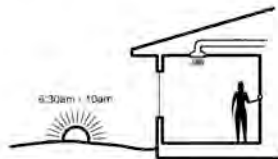
5:00 pm to 11:00 pm

As the sun sets, it stops supplying heat to the home. However, a substantial amount of heat has been stored in the thermal mass. These materials release the heat slowly into the passive solar rooms, keeping them comfortable on most winter evenings. If temperatures fall below the comfort level, supplemental heat is needed.



11:00 pm to 6:30 am

The home owner sets the thermostat back at night, so only minimal back-up heating is needed. Energy-efficient features in the home minimize heat losses to the outside.



6:30 am to 10:00 am

The cool early morning hours are the toughest for passive solar heating systems to provide comfort. The thermal mass has usually given up most of its heat, and the sun has not risen enough to begin heating the home. During this period, the home owner may have to rely on supplemental heat. Energy-efficient features in the home minimize the need for supplemental heating.

Source: U.S. DOE Office of Building Technology

Implementation of Natural Heating

- Use uncovered concrete, tile, brick, stone, or masonry floors—carpet or other floor coverings inhibit heat absorption and transfer.
- Use finished concrete or tiled floors.
- Apply durable insulated exterior finish systems to concrete or block walls that are exposed to the interior.
- Use double gypsum board throughout the building.
- Use water storage containers.

Natural Lighting

Also referred to as daylighting, natural lighting is achieved by sizing and placing windows and shading to provide just enough sunlight to reduce or eliminate the need for daytime electrical lights. Windows can be most effective and cooling if they allow daylight very high into a space.

As discussed earlier, the natural properties of glass allow sunlight in, yet also trap heat. If the building requires natural lighting and cool spaces, apply a coating that will screen out ultraviolet and infrared light. Pick glazing criteria carefully and design window size and location to efficiently light the room for the task. More window space does not necessarily mean more light. Too much window space can easily require more heating and cooling energy than the desired lighting energy savings. There is a subtle interplay of costs and benefits that must be calculated to get to the intended goals of energy savings and comfort.

There are a variety of windows and daylighting features available, such as standard vertical windows, clerestories, skylights, solar tubes, cupolas, and monitors.

Implementation of Natural Lighting

- Employ an open floor plan to allow more sun inside. Use light-colored wall and ceiling paint to reflect the sunlight around the room, getting more use out of it.
- A day-lit room requires, as a general rule, at least five percent of the room floor area in glazing window area.
- Use a low-E coating to minimize glare while offering appropriate heat gain or loss.
- Skylights are usually trouble because of unwanted seasonal overheating, heat loss, and leaks. Try the newer “light pipes” if you can afford them.

Benefits of Natural Heating, Cooling, and Lighting

- Incorporating passive solar designs can reduce heating bills from 10 to 50 percent, a saving accrued from reduced HVAC unit sizes, installation, operation, and maintenance costs.
- Families living in your homes enjoy improved comfort, indoor air quality and environmental health.
- Several studies have shown that schools that use natural lighting have less student absenteeism, higher test scores and an average of 10 percent higher grades in all subjects.
- Natural systems reduce greenhouse gas emissions from mechanical heating, cooling, ventilation, and lighting.
- Buildings that use natural light have brighter, inspiring interiors and are more in tune with local climate and nature.
- Circulating outside air using natural cooling techniques is healthier for occupants than mechanical cooling.

Challenges of Natural Heating, Cooling, and Lighting

- The cost of adding passive solar design to a home is highly variable depending on the site, size of house, and chosen techniques.
- The site may contain slopes and outcropping, or the orientation may need to conform to city or developer specifications.
- Solar access may be blocked by a nearby building or other obstruction.
- Additional planning is needed to implement natural designs, and planning must start at the design phase.
- A limited number of choices are available to those doing rehab of existing structures.
- Natural cooling can be difficult in areas where outdoor humidity is high.



Link and Learn

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CHAPTER 2

Lot Selection

Most YouthBuild programs have little choice in lot selection, since often, our construction sites are determined by construction partners or municipal housing authorities. If your program does have the ability to choose the site, avoid choosing undeveloped sites. Instead, use a previously developed site or a re-zoned residential area. This will reduce environmental impacts on the land. It may also utilize existing infrastructure – water, gas and electric lines, roads and sewer or storm drainage systems – that would cost the municipality, county or developer significant extra fees to construct.



By both choosing a smaller site and constructing a smaller home, you can minimize the amount (and cost) of building materials required for the project. Good design is important for smaller structures, and can mitigate the smaller footprint with more functional space. Also important is maximizing living spaces outside the home, such as the addition of patio and deck space, natural clearings, or other outdoor rooms (sunrooms). This can result in the need for less indoor square footage that needs to be constructed, then heated and cooled. A prospective building site should be examined for existing tree groupings, landforms, or structures that will help create pleasant, usable outdoor spaces.

Implementation of Environmentally Responsible Site Selection:

- Renovate (reuse, recycle) abandoned buildings
- Reuse quality items from existing structures, including lumber, doors, molding, lighting fixtures, conduit, pipe, etc. If items are still usable but not needed in your home design, donate the materials to a local building supply resale store
- Avoid ecologically sensitive areas (including wetlands, prime farmland or rare habitats) that have been identified as such through site footprinting or third-party assessment
- Choose an infill site
- Choose a restored brownfield recognized by the Environmental Protection Agency (EPA) that is inspected and zoned for residential use
- Check availability of a sufficient, rechargeable water source
- Choose a lot size of less than 5,750 sq. ft.
- Choose a lot with good access to public transportation, bike paths, and businesses, preferably within walking distance to common services – schools, public transit lines, or work places.

- Choose a lot with good access to renewable energy sources (solar, wind, geothermal, or biomass)
- Construct more than one unit per lot (duplex, garage apartment, granny flat)
- If soil or water testing is done on the property ask if you can have your students watch and learn.

FAST FACT

Contact and share information on site selection and development within the YouthBuild system. Several YouthBuild programs have experience in constructing homes on a redeveloped greyfield or brownfield, namely:

- YouthBuild Louisville (Ky.)
- YouthBuild Holyoke (Mass.)
- HRDE-Mon YouthBuild (W. Va.)
- Housing Authority of the City of High Point (N.C.)
- Yuma Private Industry Council, Inc. (Ariz.)

Brownfield Remediation



Brownfield remediation is a viable option for YouthBuild programs if the program can access public funding to support the redevelopment, and if the program has experience in successfully converting brownfields for residential uses. About 15 percent of the YouthBuild program respondents surveyed in 2005 confirmed that they have developed on brownfields or grayfields. In 2009, 14 percent of YouthBuild programs that responded to a second survey developed a brownfield and 4.5 percent offered their students job training related to brownfield remediation.


You can check the status of the land from any of the following:

1. Environmental Protection Agency records
2. Comprehensive plan (often conducted by a municipal government planning department)
3. Previous owner records (such as insurance maps, and land surveys)
4. Utility records
5. Set of site plans

If you are given an opportunity to build on an EPA-recognized brownfield, you will need to clean it and rid it of any pollutants. A site remediation plan can include:

- Pump and treat
- Bioreactors
- Land farming
- In-situ remediation

Benefits of Environmentally Responsible Site Selection

- Building on a previously developed site avoids the disruption of natural habitats and sensitive ecosystems.
- Renovating a building or reusing historic materials from one can preserve the cultural heritage of community, limit urban sprawl, and yield lower infrastructure costs.
- The deconstruction of abandoned buildings on the property can yield valuable savings by reducing the need to purchase new building materials.
- Brownfield remediation significantly improves the health of the land, leaving it in better condition than before construction.
- Brownfield remediation can be supported by government grants. 

Challenges of Environmentally Responsible Site Selection

- Reusing lots can be costly in time and funds. One scenario would be to have the donor, public agency, or authority do any demolition and remediation or prep of the property. Many cities and codes require that the builder relocate any displaced tenants at their expense.
- It is important to receive an official or stamped set of environmental drawings on an infill property, which gives the builder a clean bill of health for the lot.
- If you have to take down a building and have no prior experience doing so, you should consult with an expert on deconstruction (instead demolition and landfill) before beginning the project.
- Brownfield remediation is a specialized field of expertise that requires certification and proper training approved by EPA.



Link and Learn

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CHAPTER 3

Low-Impact Lot Development

Low-impact lot development highlights the importance of protecting the natural environment in and around your lot—including wetlands, agricultural areas, rivers, and trees—by minimizing land disturbance, preserving open space, practicing erosion control, incorporating natural systems into design, and developing effective storm water maintenance systems. Low-impact lot development must minimize environmental intrusion during on-site construction as well as during occupancy.



The approaches to lot development in this chapter include storm water management; bioretention; habitat protection; and implementing a plan for reducing, reusing, and recycling previous buildings and materials. These steps can protect the environment *and* save you money.

Storm Water Management

Using storm water management in the construction of a home results in less harm to streams, wildlife, and wetlands than traditional methods do. Less soil is washed into drains and water systems, reducing silt build-up in nearby streams and wetlands, and reducing pollution that enters the water system from street and building run-off. Rainwater can better infiltrate into the ground to recharge drinking water supplies, streams and wetlands. The site will be greener and more attractive with open spaces.

Implementation of Storm Water Management

- **Assess and Understand the Site:** Assess the site's topography, soils, vegetation, and natural drainages. Divide the area that can be developed from the area that must be protected. Install buffers and barriers during construction to prevent erosion and water run-off; restore the surface of the entire site when construction is complete to maximize permeable surfaces and slow running water.
- **Protect Your Building from Water Leakage:** The site you select for your building must provide adequate drainage on all four sides of the home. Whether building a new home or rehabbing, grade surfaces around the home at a minimum slope of 5% so runoff flows away from foundations. Where lot lines, walls, slopes and other physical barriers prohibit a grade of 5 percent, drains and swales must be provided to ensure drainage away from the structure. In areas where surface water must flow near a building, you can cap the ground next to the foundation with concrete or clay to seal out moisture. French drains, and foundation waterproofing are other ways to protect the building from capillary seepage. (See Shades of Green Weatherization Tool Bench sheets on moisture management for more information.) Be sure that your roof has properly installed gutters and downspouts to release

water onto a surface such as a paved driveway. You can also connect downspouts to solid plastic pipe that will carry water down slope away from your building to a storm drain ditch. Because leaves can clog gutters and downspouts, clear gutters regularly and inspect them to ensure your roof runoff system is working properly.

- **Protect Native Vegetation and Soils:** Set aside a portion of the site's native vegetation and areas with soils that have high infiltration capacity. If left alone, these natural areas provide excellent storm water management systems.
- **Minimize and Manage Storm Water at the Source:** Minimize areas of impervious surfaces such as roads, rooftops, and parking areas by designing shorter, narrower roads; using various permeable pavements; and installing rainwater catchment systems (see Roofing section). Manage remaining runoff by disconnecting the impervious surfaces from one another, and directing runoff to bioretention areas (or rain gardens), amended soils, native vegetation, or other types of infiltration areas. This can greatly reduce the need for pipes and other water conveyance infrastructure, like ditches.

Bioretention

Also known as a bioswale, swale, or rain garden, a bioretention basin is a storm water management approach that creates a natural water filtration and treatment area—a porous soil covered with a thin layer of mulch and vegetation.

Implementation of Bioretention



A stand of various grasses, shrubs, and small trees is established to promote evapotranspiration (loss of water from the soil both by evaporation and by transpiration from plants) maintain soil porosity, encourage biological activity, and promote uptake of some pollutants carried in the rainwater. Runoff from an impervious, nonabsorbent area such as a parking lot is directed into the bioretention basin using curbs and earthen berms twelve to eighteen inches high. The water in the basin then slowly infiltrates the mulch or soil environment, or is taken up by the plants thus providing natural treatment to remove contaminants.

When installed correctly, the rain garden allows storm water from the house and driveway to flow into its interior, saturating the soil. Over a day or so, the water is taken up by the plants, or slowly percolates through the garden to become groundwater. There is no standing water or “swamp” smell, and the foundation of the home is protected.

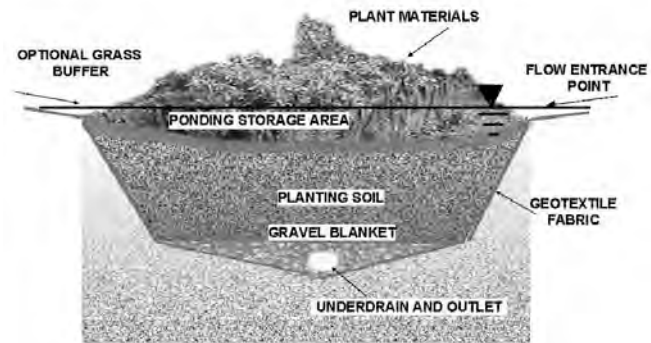


Use plants that are native to the area for all rain gardens. These plants will do a better job of quickly absorbing storm water, and will be more resilient to temperature fluctuations and drought.

CASE STUDY

Bog Garden in the Pacific Northwest

A homeowner in the city of Shoreline installed a bog garden to direct storm water flows away from the foundation of his house. The bog garden uses wetland vegetation to collect roof runoff for a 1/4-acre residential property. The homeowner backfilled a lined retention pond (12' long by 8' wide by 3' deep) with three-way garden mix, coconut husk fiber, and peat moss. He then planted more than 30 species of native and nonnative (to the Pacific Northwest) wetland plants.



The structure of a bog garden.

SOURCE: Prince George's County, Maryland, Dept. of Natural Resources

As the garden functions, there is no standing water, but the soils are saturated much of the time. Unlike many similar systems, this one promotes evaporation and transpiration; the impermeable liner allows excess water to flow into a constructed dry streambed.

Results

The bog garden is an aesthetically pleasing, affordable garden that provides an effective visual barrier to the street. The installation reduced impermeable lawn surface while directing water away from the house foundation. Very little excess flow discharges from the bog garden, and what does flow out quickly infiltrates within a few feet of its point of discharge. The bog garden serves as a model for other residential homeowners.

Source: University of Maryland, Department of Civil & Environmental Engineering
<http://www.ence.umd.edu/~apdavis/Bioret.htm>

Habitat Protection

Implementation of Habitat Protection

- Minimize slope disturbance by limiting or eliminating development on steep slopes (slopes greater than or equal to 25 percent).
- Align roads and paths along natural topography lines.
- Complete a natural resources inventory and include it in the site plan.
- Create construction “no disturbance” zones using fencing or flagging to protect vegetation and sensitive areas from construction vehicles, material storage, and washout.
- Maintain wildlife habitat.
- Protect aquatic ecosystems by washing forms and equipment in areas where runoff will not contaminate waterways.
- Reduce soil compaction from construction equipment by laying mulch, chipped wood, or plywood sheets.

- Avoid turf grass and use native grasses.
- Provide basic training in tree and other natural resource protection to the onsite supervisor.
- Improve the soil with organic amendments and mulch.
- Avoid the use of chemical fertilizers and pesticides.

Reduce, Reuse, and Recycle Plan

A reduce, reuse, and recycle plan is much more than waste management. In addition to managing waste through responsible disposal and recycling when possible, such a plan includes reducing the amount of materials you purchase and choosing used or recycled-content materials. Demolition and deconstruction should be carefully planned for waste reduction and reuse of materials that remain in good condition. Nearly half of waste sent to landfills is construction waste. Having a reuse and recycling plan from the beginning of the process can dramatically lower these numbers. Involve students in discussing the social and environmental value of recycling. Encourage them through math exercises and recycling contests.

FAST FACT

43 of the 60 YouthBuild programs (72%) surveyed in 2005 found reusing scrap building materials to be effective. In 2009, 46 of the 62 programs (74%) that answered the question indicated that they use recycled-content building materials; and 40% use locally-grown and manufactured materials which are made from renewable resources like soy-based insulation and sustainably-grown wood products.

Implementation of Reducing, Reusing and Recycling

- Develop and implement a construction and demolition waste management plan and post it at the job site.
- Determine a plan for who will remove and obtain salvaged materials.
- Dedicate and provide onsite bins and space to facilitate the sorting and reuse of scrap building materials.
- Disassemble existing buildings instead of demolishing them.
- Reuse salvaged materials.
- Use precut or preassembled building systems or methods.
- Use locally available indigenous material.
- Use a life-cycle assessment tool to compare the environmental affects of reusing materials.
- Use recycled content building materials.
- Conduct onsite recycling effort, use grinder and apply materials onsite, thus reducing transportation-related costs.
- Return unused construction material to vendors for credit.
- Sell or deliver waste materials to recycling sites.



- Use building materials that require no additional finishing resources to complete application on-site.
- Design the building using increments of known material sizes to minimize cutting of plywood, lumber, and other materials.
- Research recycling guidelines and waste managers in your community and design an applicable recycling area for occupants.

Benefits of Low-Impact Lot Development

- Communities designed to maximize open space and preserve mature vegetation are highly marketable and command higher lot prices.
- Reducing runoff from impervious surfaces such as blacktop and concrete can reduce or eliminate the need for storm water ponds in larger developments.
- Implementing a storm-water management plan on a building site will also help protect the building from water damage and minimize maintenance associated with moisture issues.
- Low-impact lot development can help save money on building supply purchases.
- Low-tech, decentralized bioretention areas are inexpensive to design, install, and maintain and less costly than conventional stormwater technologies that treat runoff at the end of the pipe.
- Bioretention areas remove pollutants through filtration, microbes, and uptake by plants. Contact with soil and roots provide water quality treatment that is better than conventional infiltration structures.
- Bioretention areas increase groundwater recharge as compared to a conventional “pipe and pond” approach. They can help reduce stress on watersheds that experience severe low flows due to impervious coverage.
- Bioretention areas enhance the landscape in a variety of ways: they improve the appearance of developed sites, provide wind breaks, absorb noise, provide wildlife habitat, and reduce the urban heat island effect.

Challenges of Low-Impact Lot Development

- There are maintenance issues associated with stormwater management systems. A low-impact development system may have different types of maintenance requirements than a conventional system.
- Low-impact development can have higher upfront costs, such as engineering more complex plans, but the long-term savings “outpace” the increased costs.

FAST FACT

Commonly available recycled content materials: rubble, insulation, rebar, steel, concrete, and pressed wood.



Link and Learn

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CHAPTER 4

Foundations and Moisture Management

One of the most significant components of a building is its foundation. Providing a quality foundation is often the most expensive consideration in constructing a new home.

Foundations are integral to overall home performance. They help control water penetration and dampness, reduce heat loss, and minimize unwanted air flow. Paying attention to details when constructing the foundation will help prevent moisture buildup, mold, and mildew.



Please take a look at the Shades of Green Tool Bench resources:

- [Basements and Foundations: Guidelines for Moisture Control](#)
- [Unconditioned Basements: Venting and Insulation](#)
- [Conditioned Basements and Foundations: Insulation and Air Sealing](#)

Techniques for Moisture Management and Environmental Performance

The following construction practices can help minimize water problems as well as improve energy performance and minimize resource use:

- Use insulated shallow foundations in northern climates; consider pier and beam foundations instead of slab on grade.
- Insulate the foundation before backfilling.
- Install enhanced foundation waterproofing such as sub-slab drainage systems or sump pumps.
- Use non-asphalt-based damp proofing.
- Reuse form boards and metal forms.
- Use aluminum forms.
- Install non-vented crawlspaces and insulate crawlspace areas.
- Install proper vapor retardant under slab or in crawl space floor.
- Avoid using expansive soils around the foundation. Instead, replace soil with a backfill material that does not expand when wet (for example, recycled aggregate in concrete.)

Perimeter Footing Drain

- Install perimeter or footing drain system of perforated pipe below the level of the basement slab on the inside and outside of foundation. This type of drain system is also known as a French drain.
- Wrap pipe with filter fabric and surround with clean gravel or crushed stone.

Direct Surface Water Away From House

To keep surface water from soaking in around the foundation, all roof runoff must be directed away from the house. This means putting effective gutters all around the building and sloping the final grade away from the foundation at least 5 inches in the first 10 feet. (That's ½" of slope per linear foot.) To protect the footing from subterranean water, it must bear on at least 4 inches of a non frost-susceptible material such as washed gravel or rock. Check with local code offices to determine the requirements in your area.

French Drains

A French drain is a drainage system that consists of a trench dug into the ground through and out of an area with poor drainage. The trench is filled with a porous material—usually gravel, crushed stone, or slag—along with a perforated PVC plastic pipe to collect and channel unwanted ground water. It is better to install the drain during construction, rather than later, to avoid problems digging around utilities, porches, and other obstacles. French drains will clog over time, so they need to be cleaned periodically.

Types of Foundation Materials


We will discuss the following four different types of foundation materials, how to implement them, as well as the benefits and challenges.

1. Poured Concrete
2. Preserved Wood Foundation (PWF)
3. Insulated Concrete Forms (ICFs)
4. Frost Protected Shallow Foundations (FPSF)

Poured Concrete

A foundation needs to last the lifetime of a home. It is important to pay attention to the details that ensure the poured concrete will remain dry and crack free. A sturdy footing and a vapor-proofed, reinforced-concrete pad sitting on a bed of compacted crushed stone is fundamental for a durable foundation. Adding insulation is crucial for frost impacted areas. Poured concrete foundations are effective and can be completed in a few days. Poured concrete can also be purchased with fly ash premixed in, or you can add your own fly ash on site.

Implementation of Poured Concrete

- Selecting a poured concrete basement requires diverting surface water away from the house and limiting water seepage by installing a perimeter drain. This is especially important for all basement footings sloped to allow for daylighting, drywells, or sump pits. 
- Carefully estimate the amount of concrete required to avoid waste.

SHADES OF GREEN

- Fly ash cement is generally available in two standard colors; coloring agents can also be added at the job site. Fly ash can be used sparingly as an admixture or in large amounts to replace Portland cement. Casa Verde Builders in Austin, Texas, uses 40 percent content fly ash in all its concrete.
- Manufacturers are developing specialty cements, which should be widely available soon, that can be formulated to produce various set times, cold weather resistances, strengths and strength gains, depending on the job.

Benefits of Fly Ash Concrete

- Some manufacturer's proprietary fly ash cement is considered a non-shrink material with advantages in workability, water retention, and strength.
- Because fly ash mixes with less water, it is less likely to crack.
- Fly ash has low embodied energy and is an industrial by-product.
- Fly ash concrete is currently cost-competitive with Portland cement concrete.
- Because fly ash is made of spherical tiny glass beads it is lighter than Portland cement.
- Because fly ash cement requires less water than Portland cement, it is easier to use in cold weather and withstands chemical absorption.
- Fly ash can be substituted for traditional raw aggregate materials such as shale, clay, or sand.

Challenges of Fly Ash Concrete

- Fly ash comes from various operations in different regions, so its mineral makeup may vary among manufacturers.
- Fly ash may not be available in your area.
- There are some concerns about freeze-thaw performance and a tendency of mixes made with fly ash to leave a powdery substance on the surface. This "efflorescence" happens especially when fly ash is used as a complete replacement for Portland cement.
- If concrete contains too much fly ash, it become impervious and will not form a bond with tile and stone adhesive mortars

FAST FACT

Fly ash is a fine, glass-like powder recovered from gases created by coal-fired electric power generation. U.S. power plants produce millions of tons of fly ash annually; this fly ash is sent to landfills.

Fly ash is an inexpensive replacement for cement used in concrete. It improves the strength, segregation, and ease of pumping of the concrete. Fly ash is also used as an ingredient in brick, block, paving, and structural fills.

Preserved Wood Foundation (PWF)

Preserved wood with batt insulation can be used to construct foundation walls. The preserved wood is soaked in a salt solution and pressure-treated, making it less vulnerable to water and more adaptable to outdoor usage. A vapor and water barrier must be installed at the interface between the soil and the wood because the wood will absorb water, which can cause mold and insect invasion. The R-value for a 4 ft. preserved-wood wall is around R-19 if 2x4 construction is used with a full-depth fiberglass batt. Permanent wood foundations must be preservative-treated in accordance with American Wood-Preservers' Association (AWPA) Standard C22, "Lumber and Plywood for Permanent Wood Foundations - Preservative Treatment by Pressure Processes."

Implementation of Preserved Wood Foundation

A PWF is not simply an exchange of treated wood for concrete. It requires a building system that keeps water away from the foundation through a bed of gravel and free draining soil. A treated wood floor system will eliminate the need for concrete foundation work, allowing construction to proceed regardless of weather and utilizing the same wood framing construction crew. PWF enclosing habitable space must be protected by a 6 millimeter polyethylene moisture barrier. It must be applied to the plywood by embedment into vertical beads of sealant or into uniformly applied damp proofing. Use of appropriate vapor barriers, including a sump pump or drain piping is recommended, depending on soil or weather conditions.

Benefits of Preserved Wood Foundations

- PWFs are dry, comfortable, easy to finish, and more economical to convert to fully livable space than masonry foundations.
- PWFs are easily insulated and finished, which reduces foundation heat loss by up to 50 percent without the added expense of extra studding or furring.
- Unlike concrete or block, a PWF does not allow moisture or dampness to pass through the foundation walls, virtually eliminating the cold, damp, and musty basement feeling and maximizing comfortable living space.
- A PWF can easily be plumbed and wired just like the rest of a house.
- The PWF is approved by the 2000 International Residential Code (IRC) which specifies fasteners, wood treatment, and gravel or crushed stone footings and often refers to American Wood Preservers Association (AWPA) standards. Check with local code offices to determine the requirements in your area.
- When building a PWF, you can reduce building costs by as much as \$10 per square foot.
- A preserved wood system would be a good choice for a house in a rural area because wood is lightweight and easier to transport, store, and use than ready-mix concrete.

Challenges of Preserved Wood Foundation

- In the event of a hurricane, a tornado, or flooding, a wood basement is unlikely to perform as well as concrete blocks or other foundations.
- The walls have little thermal mass, and since the exterior soil is often moist, the relative humidity near the wall will often be 100 percent, even if water is not present.
- Structural problems resulting from soil pressure on the foundation walls can occur. Any evidence of movement or failure of the structure requires a specialist in PWFs.

Insulated Concrete Forms (ICF)

Insulated Concrete Forms (ICF) are constructed from expanded polystyrene (like white foam coolers) and stacked like building blocks to form the exterior walls of a home; the forms are reinforced with steel and filled with concrete to complete the foundation or build walls. The forms interlock and fasten to each other to provide seamless “foundation to rafter” insulated, reinforced concrete walls. Window and door openings of any size are possible. ICFs provide a lasting building envelope, designed to withstand high wind, fire, the elements, and the test of time.

Implementation of Insulated Concreted Forms

Basement waterproofing materials for windows and doors for an ICF basement need to be ordered with wider jamb extensions to accommodate the increased wall thickness. The level of manufacturer support, including training, on-site and technical support, and marketing materials will vary between manufacturers. In practice, it's not difficult to stack ICFs into walls, although bracing and leveling before the pour are critical. Cuts in the forms can make the concrete pour more shaky; avoid cutting corner blocks, use plenty of bracing, and secure large joints with scraps of plywood.

Benefits of Insulated Concrete Forms



- ICF construction is compatible with all home designs.
- ICF walls benefit from concrete's inherent structural qualities, particularly important in regions affected by severe weather.
- The combination of a continuous concrete wall and the integral interior and exterior insulation provides superb energy efficiency and lower utility bills.
- ICFs energy efficiency translates into even, consistent temperatures throughout the home. Outdoor pollutants can be kept to a minimum.
- With several inches of concrete sandwiched by foam insulation, ICF homes are typically quieter than conventionally built homes.
- ICFs save money, conserve resources, and use recycled materials.
- ICFs are not subject to rot and result in a better insulated foundation.

Challenges of Insulated Concrete Forms

ICF homes may cost up to 10 percent more to build, depending on the manufacturer, shipping costs, and other factors impacting local building costs. Lower heating and cooling loads will offset the increased up-front construction costs with lowered requirements for HVAC equipment and long-term utility savings.

Frost-Protected Shallow Foundations (FPSF)

A Frost-Protected Shallow Foundation protects against frost damage without the need for excavating below the frost line. An FPSF has insulation placed strategically around the outside of a foundation to direct heat loss from the building toward the foundation, and to use the earth's natural geothermal energy.

Implementation of Frost-Protected Shallow Foundation

To install frost-protection properly, the builder must apply one layer of insulation to the outside face of the foundation, while a second layer of insulation extends horizontally away from it. The rigid foam traps any heat that the ground absorbs from the building, keeping soil temperatures around the footing above freezing. The building's heating system can be safely turned off for up to three weeks in the winter because thermal lag in the concrete will maintain the soil temperature above freezing.

Benefits of Frost-Protected Shallow Foundation

- Homeowners experience effective energy savings because FPSFs use geo-thermal heat to maintain sub-slab soil temperatures above freezing.
- FPSFs reduce construction, labor, and material costs and are an affordable method in building a comfortable and insulated foundation with less excavation required.
- FPSFs can be constructed using conventional materials, such as rigid expanded or extruded polystyrene foam, which is readily available.
- FPSFs have insulated footings that can keep the soil above freezing even in the coldest weather.

Challenges of Frost-Protected Shallow Foundation

- In some areas it may be difficult to acquire permit approval.
- An FPSF is only cost-effective if the frost line is 30 inches deep or deeper.
- If you have a walkout basement and the grade comes down the sides of the house, you must plan for and install dampproofing where required.
- You will need to train subcontractors about the importance of frost-protected insulation.

CASE STUDY

Green and Red Construction in Guadalupe, Arizona

In this small town with a population of just over 5,000 people, YouthBuild Guadalupe has constructed more than 100 new, Energy Star rated affordable homes in partnership with the City of Guadalupe and Habitat for Humanity. This new construction has greatly improved the housing stock, while respecting designs that celebrate the local culture – all while delivering energy efficiency.

Red Construction—A Culturally Conscious Design

The new home designs incorporated the input of citizens from three community forums. To reflect Southwestern culture, YouthBuild members skinned log trees (referred to as “Vegas”) for the supportive roof structure. A courtyard area was designed to perform as an outdoor family gathering space. The community requested buildings that serve multiple generations, and the design group responded by creating a “casita” for rental income or a mother-in-law apartment—a small house with its own bathroom and kitchenette. The larger, main home was also constructed to structurally support a second story for an additional two bedrooms, to accommodate a growing family. The design also includes cut-outs, or enclaves in the wall system, to place statues or other items.

Green Construction—An Environmentally Conscious Design

The house is designed as a passive solar building, using orientation and layout to maximize the benefits and reduce problems of its desert climate. The courtyard, in addition to making sense culturally, was designed to help cool the rest of the house. The home wraps around the courtyard on three sides forming a C-shape. A fountain cools the space, which in turn, along with the shading from indigenous plants, cools the house. The courtyard also features an outdoor cooking area because traditional Native and Hispanic cooking is done outdoors to help keep the house cooler.

The roof is enclosed with a mirror seal—a nontoxic white, reflective, elastomeric flat roofing system that replaces the usual rubber or petroleum based products.. Most roofs are made of toxic materials and require special handling and training, but the non-toxic white reflective roof can be installed safely by Guadalupe youth. The roof reflects the sun light, so that it keeps the house cooler, another solar energy-efficient design.

Because the weather is hot and dry, Guadalupe YouthBuild can use evaporative coolers instead of traditional refrigerant air conditioning. The central AC is a water cooled air chiller that uses no Freon, so it helps prevent prevents ozone layer depletion. The exhaust air from the evaporative cooler is only 80° (Freon air conditioning exhaust is well over 100°) and as a result, the construction crews funnel the exhaust into the courtyard to keep it even cooler.

For a watering system, three cistern water tanks will collect 4,000 gallons a year of rainwater from the roof for landscaping.

SHADES OF GREEN

Another green element is a Flex-Crete block locally produced on the Navajo reservation in Page, Arizona. The Flex-Crete product is a fiber-reinforced aerated concrete product that uses large volumes of fly ash. Fly ash is abundant where coal is burned for electricity production. The ash is combined with concrete, fiber, and aluminum chloride. This particular block gives a high “R” value, which measures insulation quality. Traditional building insulation quality is measured at R-19, and the Flex-Crete product provides up to an R-40 value. It is soundproof, fireproof, and termite-resistant. For more information, visit www.flex-crete.com.

Even the deconstruction material taken from the original home was reused. For example, the original concrete foundation was broken up and the larger pieces used as pavers throughout the courtyard. They also used the old plywood from the old carport for the new carport.

Contact Jennifer Drury for advice on green and culturally-conscious building designs:
<mailto:jdrury@guadalupeaz.org>.



Link and Learn

Shades of Green Tool Bench: Basements and Foundations:

<http://www.ybshadesofgreen.org/files/helper-pdf/Basements-MoistureControl-050210-v8.pdf>

Shades of Green Tool Bench: Conditioned Basements and Foundations:

<http://www.ybshadesofgreen.org/files/helper-pdf/ConditionedBasements-050310-v7.pdf>

Shades of Green Tool Bench: Unconditioned Basements: Venting and Insulation:

<http://www.ybshadesofgreen.org/files/helper-pdf/UnconditionedBasements-050310-v7.pdf>

RSMeans, *Green Building: Project Planning & Cost Estimating*, (Contributing Authors, 2002)

Raised Floor Living; Rediscover the Raised Floor Home:

<http://www.raisedfloorliving.com/homepage.asp>

Toolbase Tech Spec on Frost-Protected Shallow Foundations from the Partnership for Advanced Technology in Housing (PATH):

http://www.toolbase.org/pdf/techinv/fpsf_techspec.pdf

Overview of Insulated Concrete Forms from Green Building Advisor:

<http://www.greenbuildingadvisor.com/green-basics/insulated-concrete-forms>

Inspectapedia's types of building foundation damage:

<http://www.inspectapedia.com/structure/FoundationOccur.htm>

Home Energy Magazine's comparison of foundations and basement walls:

<http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990311.html>

CHAPTER 5


Insulation

The building envelope comprises all heated and cooled parts of a building, including the walls, roof, and foundation. By properly insulating your building envelope, you can control the flow of air in and out of the home, which will have a tremendous impact on heat loss, cooling needs, moisture control, and air quality.

Insulation is an important factor in the success of a building envelope, but is not the controlling one. In a building envelope, there are several components that work together, and how they are assembled is the key to lowering energy use and maintaining healthy indoor air quality.



Source: American Youth Works

The building envelope should be designed to manage the migration of three factors simultaneously—moisture, air, and temperature. Remember to consider the climate and location of the building as it relates to humidity and temperature. 

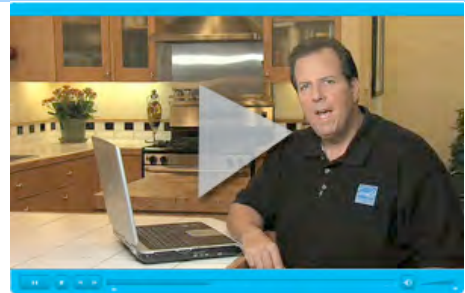
General Implementation

- Install a good drainage plane on the exterior of the home, such as a building paper or house wrap in a lapped or shingle style to provide good drainage. This drainage plane must have an air space provided by furring strips or Home Slicker between it and the siding.
- Use raised heel trusses “energy heels.”
- Consider installing an insulated conditioned crawlspace as one strategy for control of temperature, moisture, and indoor air quality. (Not recommended if moisture is a problem in your area.)
- Use treated wood that does not contain chromium or arsenic.

AT HOME WITH ENERGY STAR VIDEO

The At Home with ENERGY STAR video podcast shows homeowners first-hand how they can make simple energy-efficient improvements around the house.

[> VIEW THE VIDEO](#)



Signs of Insulation Problems

In the winter:

- Walls and floors feel cold to touch
- High heating costs
- Uneven heating levels within building
- Mold growing on walls

In the summer:

- Uncomfortably hot inside air
- High cooling costs
- Mold growing in basement

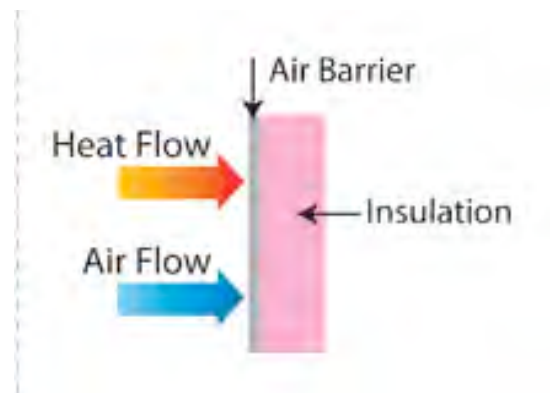
Source: Canadian Mortgage and Housing Corp

Air Barriers

Outside walls, foundation and attic openings, openings in exterior walls for doors, windows, pipes, wiring, and cable – ALL openings -- must include a very good air barrier. Neither fiberglass nor cellulose will stop air flow through the wall assembly, so all penetrations in the exterior sheathing—including joints in the sheets of sheathing—must be sealed with caulk or foam prior to installing insulation. An open-cell expanding foam such as Icynene provides the air barrier as well as good thermal resistance. (House wrap is not an air barrier, but a drainage plane).

An *air barrier* is any material that restricts the flow of air through a construction assembly. In wall assemblies, the exterior air barrier is typically a combination of sheathing and either building paper, house wrap, or rigid board insulation.

The interior air barrier is often an interior finish, like gypsum board. A *thermal barrier* restricts or slows the flow of heat. This is typically accomplished through different insulation materials (e.g., fiberglass, rock wool, cellulose, polystyrene, polyurethane, vermiculite) and applications (batts, blown-in, spray foam, rigid board, and granules).



Installing Insulation

Insulation is crucial to controlling home energy use and comfort. But insulation alone won't do the job – it must be properly installed with an accompanying air barrier (wrap, caulk, foam or other sealant).

To be fully effective, insulation must be aligned with a contiguous air barrier. Insulation works because it incorporates air pockets that resist the flow or slow the conduction of heat. This resistance to heat flow is measured by the R-value of the material. However, most insulation (with the exception of spray foam and rigid foam board) does NOT stop air flow. Thus, for



Holes are drilled into the exterior to blow insulation into the walls.

most insulation to be effective, a separate air barrier or skin is needed to stop the flow of air. For the air barrier itself to be effective, it must be contiguous and continuous across the entire building envelope, with all holes and cracks fully sealed, and it must be perfectly aligned with the insulation

DO-IT-YOURSELF GUIDE TO SEALING & INSULATION WITH ENERGY STAR

Sealing and Insulating are often the most cost-effective ways to make a home more comfortable and energy efficient — and you can do it yourself with guidance from ENERGY STAR.

[> LEARN MORE](#)



Implementation

Following are some guidelines and best practices for insulation implementation:

- Examine insulation materials for their affect on human health and the environment.
- Use total-fill insulation such as blown cellulose, BIBS, sprayed foam, or SIP panels that tend to provide better performance. With regard to spray foams, the open-cell foams are highly preferred to closed-cell polyurethane foams. Open-cell foams allow moisture to migrate through the wall as needed, but control air flow completely. The air-sealing step is eliminated.
- Icynene foam lends itself well to being installed along the attic roof line, as opposed to the ceiling. This provides an unvented, semiconditioned attic space, which is excellent for duct work and mechanical system performance.
- Utilize continuous insulation on exterior wall.

SHADES OF GREEN

- Use total fill insulation such as blown cellulose, BIBS, and sprayed foam.
- Use sill sealer between foundations and sill plate.
- Caulk bottom plate of exterior walls.
- If building a basement, insulate between floor joists with unfaced batts supported by wire or metal rods.
- Fill insulation cavities entirely, leaving no gaps where convection currents can form.
- Install continuous insulation on exterior walls with cathedral ceilings.
- Use treated wood that does not contain chromium or arsenic.
- Seek an independent inspection of insulation.

FAST FACT

Instead of continuous framing extending from the garage to conditioned spaces, terminate framing at the boundary wall to the conditioned space so end-blocking can be installed.

THE THERMAL BYPASS CHECKLIST

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. It must be completed by a certified home energy rater in order for a home to be qualified as ENERGY STAR.

> [DOWNLOAD THE CHECKLIST PDF](#)



Vapor Barrier Placement by Geographical Location

In most cold climates, vapor barriers should be placed on the interior (warm-in winter) side of walls. However the map shows that in some colder climates, the vapor barrier should be omitted, while in hot and humid climates, such as along the Gulf coast and in Florida, the vapor barrier should be placed on the exterior of the wall.



Perm Ratings of Different Materials (Ratings of 1 or less qualifies as a vapor barrier)

| | |
|--|------------|
| Asphalt-coated paper backing on insulation | 0.40 |
| Polyethylene plastic (6 mil) | 0.06 |
| Plywood with exterior glue | 0.70 |
| Plastic-coated insulated foam sheathing | 0.4 to 1.2 |
| Aluminum foil (.35 mil) | 0.05 |
| Vapor barrier paint or primer | 0.45 |
| Drywall (unpainted) | 50 |
| Drywall (painted – latex paint) | 2-3 |

Used with permission of the Department of Energy

Home Energy Audits

A home energy audit is often the first step in making your home more efficient. An audit can help you assess how much energy your home uses and evaluate what measures you can take to improve efficiency. But remember, audits alone don't save energy. You need to implement the recommended improvements. ENERGY STAR provides extensive information about home improvement projects to enhance energy efficiency, lower utility bills, and increase comfort.

You can perform a simple energy audit yourself, or have a [professional energy auditor](#) perform a more thorough audit.

Do-It-Yourself Audits

If you have five minutes and your last 12 months of utility bills, use the ENERGY STAR Home Energy Yardstick to compare your home's energy efficiency to similar homes across the country and get recommendations for energy-saving home improvements from ENERGY STAR. You will also need to enter some basic information about your home (such as zip code, age, square footage, and number of occupants). If you don't have your bills, contact your utility for a 12-month summary.

What You Need to Know to Get Started:

Collect this information first, then go to the site and conduct your audit!

- Your energy use and costs for the last year: You'll need your last 12 months of utility bills OR a 12-month summary statement from your utility company.
- Energy sources for your home: natural gas, electricity, fuel oil, propane and/or kerosene?
- The square footage of your home.



[> Get Started with the Home Energy Yardstick](#)

Types of Insulation

Loose-fill Insulation

Loose-fill cellulose insulation goes into finished walls and is blown into place. When used in walls, it is best when wet because the loose-fill wall insulation could settle. Wet-blown insulation offers great insulating qualities and can be trimmed by hand on walls before installing drywall. In attics, be sure to use baffles to keep the material away from soffit vents. Also, do not cover recessed light fixtures unless the fixtures are certified to accept insulation. Fiberglass, mineral wool (recycled steel slag), and newspaper are all different types of loose-fill cellulose insulation that are treated with boron-based chemicals to make it fire retardant. Cellulose-insulation has R-value of R-3.8 per inch.



Blankets or Batts of Insulation

Blankets or batts of insulation are usually fiberglass, mineral wool, or recycled cotton. They can be fitted between studs in unfinished walls or between joists and beams and for all unfinished walls. Fiberglass insulation has R-values R-2.2 to 4.0 per inch.



Rigid board insulation

Exterior rigid insulation wall sheathing can be used to provide a complete thermal break at all wall framing. This includes expanded polystyrene, extruded polystyrene. Polymer insulation has R-values typically R-6.0 to 7.4 per inch. Be sure that the rigid board you choose does not have chlorofluorocarbons (CFCs). Expanded polystyrene usually does not have CFCs. Rigid board may require certified installers, depending upon your local jurisdiction.



SOURCE: Energy Star Thermal Checklist

Rigid plastic board insulations generally have a higher R- value than batts and therefore require less basement space and a thinner supporting framework. They are also less prone to moisture damage than batts. However, they are more expensive and must have a fire-resistant covering.

Benefits of High Performance Building Insulation

- Homeowners can avoid using heating and cooling systems longer, instead using natural ventilation.
- Smaller HVAC equipment can be purchased.
- Spaces are more comfortable.
- Homes can feel comfortable using up to 50 percent less energy for heating and cooling.
- Less heating and cooling means fewer greenhouse gas emissions are produced from fossil fuels.
- High-performance insulation lasts longer, is fire-resistant, and reduces maintenance costs
- By not using fiberglass, the health risks associated with inhaling fiberglass are reduced or eliminated.

CASE STUDY:

Cobb Housing YouthBuild Reducing Mechanical System Loads by 50 percent

Cobb Housing YouthBuild found that by properly and completely insulating a home with an open cell expanding foam such as Icynene, a home that would have required a 4-ton cooling system can now perform well with a 2-ton.



A cost-benefit analysis determined that the best insulation for a typical 1500 square foot home in Georgia using cellulose in the walls and an Icynene insulated roofline resulted in savings on a downsized cooling system for Cobb Housing, monthly savings to the homeowner, and reduced health hazards to the youth (fiberglass is very unhealthy to work with).

For a copy of this analysis contact [Joseph Martin, Assoc. AIA, LEED AP](#)



Link and Learn

Get Started with the Home Energy Yardstick:

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

www.buildingscience.com

www.earthcrafthouse.org

Energy Star's Improve Energy Efficiency with Advanced Wall Insulation Techniques:

www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/BuilderGuide2A4.pdf

www.eere.energy.gov/EE/buildings_envelope

For building-envelope design resources:

www.energydesignresources.com/category/buildingenvelope/

Minnesota Office of Environmental Assistance:

www.moea.state.mn.us/greenbuilding/products.cfm

RSMeans, *Green Building: Project Planning & Cost Estimating* (Contributing Authors, 2002)

Rocky Mountain Institute's Home Energy Briefs:

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

Greenbuilding Guidelines for New Home Construction; Chapter 6 Summary of Greenbuilding:

www.sfenvironment.com/aboutus/innovative/greenbldg/tools/newhome_8.pdf

For definitions and considerations for insulation:

www.greenbuilder.com/sourcebook/Insulation.HTML#CELLULOSE

Johnston, David and Kim Master, LEED AP. *Green Remodeling, Changing the World One Room at a Time*. New Society Publishers

CHAPTER 6

Floor Framing and Subfloor

When using a green approach to building a framing and subfloor system, the material choice is critical. There are several approaches that can ensure that the floor frame will be durable yet healthy for the environment and the occupants.

Green flooring choices generally do not require any changes to the home's design. You may simply substitute the better, more durable, environmentally efficient material for the conventional material during your installation process.



Some areas now specify metal framing to meet building codes. When possible, use green materials as suggested for non-metal components. Steel studs are a good green choice as well for vertical applications.

Implementation of Green Floor Framing and Subfloor Installation

- Avoid using dimensional lumber greater than 2" x 10" for floor framing.
- Use oriented strand board (OSB) for subfloor and sheathing.
- Use urea-formaldehyde-free material.
- Avoid use of underlayment.
- Substitute solid sawn lumber with engineered lumber.
- Use certified wood (Forest Stewardship Council (FSC) certified is commonly available and trustworthy) for framing.
- Use wood I-joists for floors and ceilings.
- Use finger-jointed, engineered, or steel studs for vertical applications.
- Use reclaimed lumber from demolition.
- Use web floor trusses.
- Design energy heels on roof trusses 6" or more.
- Use micro-lam beams and micro-lam I-beam floor joists.
- Ensure that all wood is at least 12" above soil.
- Use low-VOC finishes and adhesives.
- Use a moisture barrier under a concrete slab floor.
- Consider using insulation under a concrete slab to provide thermal mass.
- Add up to 35% fly ash to the concrete mix.

FAST FACT

Oriented Strand Board (OSB), is a panel product made by gluing and high-temperature pressing layers of thin wood chips, with each layer oriented at a right angle to adjacent layers. When used as subfloor material it is strong, rigid, and impact-resistant for underlayment, carpet, or tile. Traditional plywood uses prime, big logs from new growth as opposed to OSB that uses waste products.

Source: <http://www.osbguide.com/hconstruction.html>

Low-VOC

VOCs (volatile organic compounds) are airborne gases like formaldehyde and acetone contained in solvents such as paints and adhesives that are released as the material dries (off-gassing). Exposure to these gases is associated in scientific studies with respiratory, allergic, or immune effects in infants or children among other health concerns.

The EPA's definition of "low" is based not on an indoor health standard but on an outdoor environmental standard. "Low-VOC" implies less than 250 grams of VOCs per liter for latex paint, and less than 380 grams per liter for oil-based. These levels are far higher than those recommended by many environmental and health experts.

To find a paint's VOC content, look at the label or the material safety data sheet.

Source: http://www.utne.com/pub/2006_136/promo/12178-1.html

Benefits of Green Floor Framing and Subfloor Installation

- Guarantees long-term availability of precious woods.
- Using low- or no-VOC paints and coatings reduces pollutants in the indoor environment.
- OSB reduces the need for large diameter old-growth trees, is as strong as plywood sheet material, and is less expensive.
- OSB reduces air leakage relative to frame construction, is energy-efficient, provides excellent soundproofing, is erected quickly, and saves wood by eliminating much of the conventional framing lumber.
- OSB uses recycled content materials, is straighter and stronger than solid sawn studs, and eliminates crooked walls, thereby reducing material waste.
- Fly ash increases the strength and durability of the concrete and reduces the amount of cement needed.
- Concrete slab flooring will not twist, warp or split, is stronger than 2x10s or 2x12s, and can span greater distances.



Link and Learn

Green Remodeling Illustrations can be found in chapter 5 at:

<http://www.stopwaste.org/docs/remodeler-c5.pdf>

Johnston, David and Kim Master, LEED AP. *Green Remodeling, Changing the World One Room at a Time*. New Society Publishers

Wikipedia, Oriented Strand Board:

http://en.wikipedia.org/wiki/Oriented_strand_board

Wikipedia, Volatile Organic Compound:

http://en.wikipedia.org/wiki/Volatile_organic_compound

Pagés Ruiz, Fernando. Ecohome Magazine, Jan-Feb 2010. *Greening the Shell: How plywood and OSB stack up in the search for sustainable sheathing*.

GreenBuildingAdvisor.com. Interior Walls and Floor Framing Affect a Home's Livability:

<http://www.greenbuildingadvisor.com/green-basics/interior-walls-and-floor-framing>

CHAPTER 7

Exterior Wall Systems

Building an energy efficient, environmentally sound wall system is an opportunity to use resources efficiently. “Green” walls also create healthier buildings that improve human health and comfort and provide cost savings. There are many alternatives to traditional stick framing techniques; some of which are described here. This section also covers an integrated approach to all components of a home’s wall system.



Advanced Framing Techniques

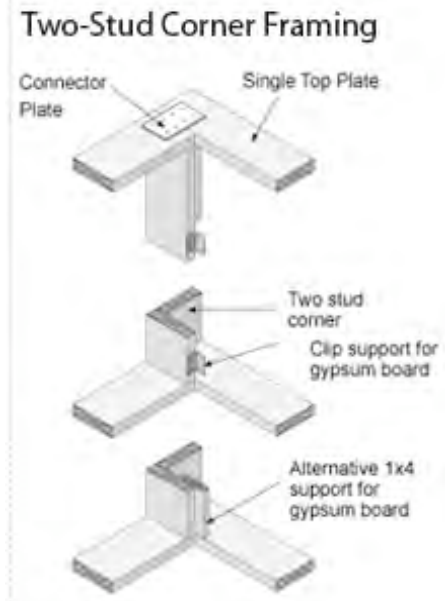
Optimum Value Engineering (OVE) simply means “construction designs that use less wood and natural resources, but deliver equal or superior strength and quality.” OVE is also sometimes called “Advanced Framing Design,” because the techniques of OVE apply primarily to stick framing in residential construction. OVE home designs use efficient construction techniques to create corners, boxes, reinforcing supports and other joists or framing with a minimum of wood. These techniques were created by the [National Association of Home Builders \(NAHB\)](#).



Two-stud corner framing. Used with permission of the Nebraska Energy Office

Common techniques include utilizing two-stud corner framing with inexpensive drywall clips, increasing floor joists and rafter spacing to 24", eliminating headers in non-loadbearing walls, increasing stud spacing from 16" to 24", and using single top plates with in-line framing to transfer loads directly.

One commonly used and easy to implement advanced framing technique is to use 2 x 6" studs, 24" on center to frame the exterior walls. This results in multiple benefits. Using fewer studs allows your crew to assemble the walls more quickly. Because there are fewer studs, there is less thermal bridging; the wall cavities allow itself has more space for insulation and can be made more energy efficient.

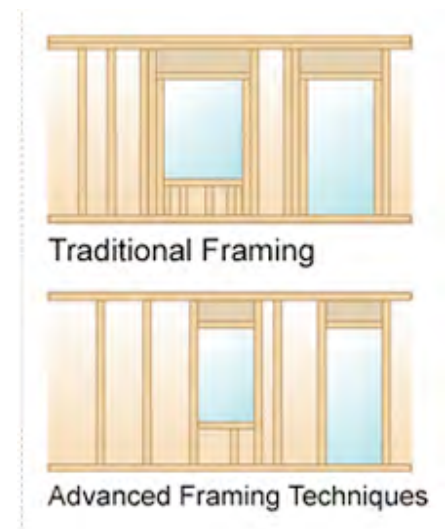


Courtesy of BuildingScience.com

Implementation of Advanced Framing Techniques

Check with local codes before implementing.

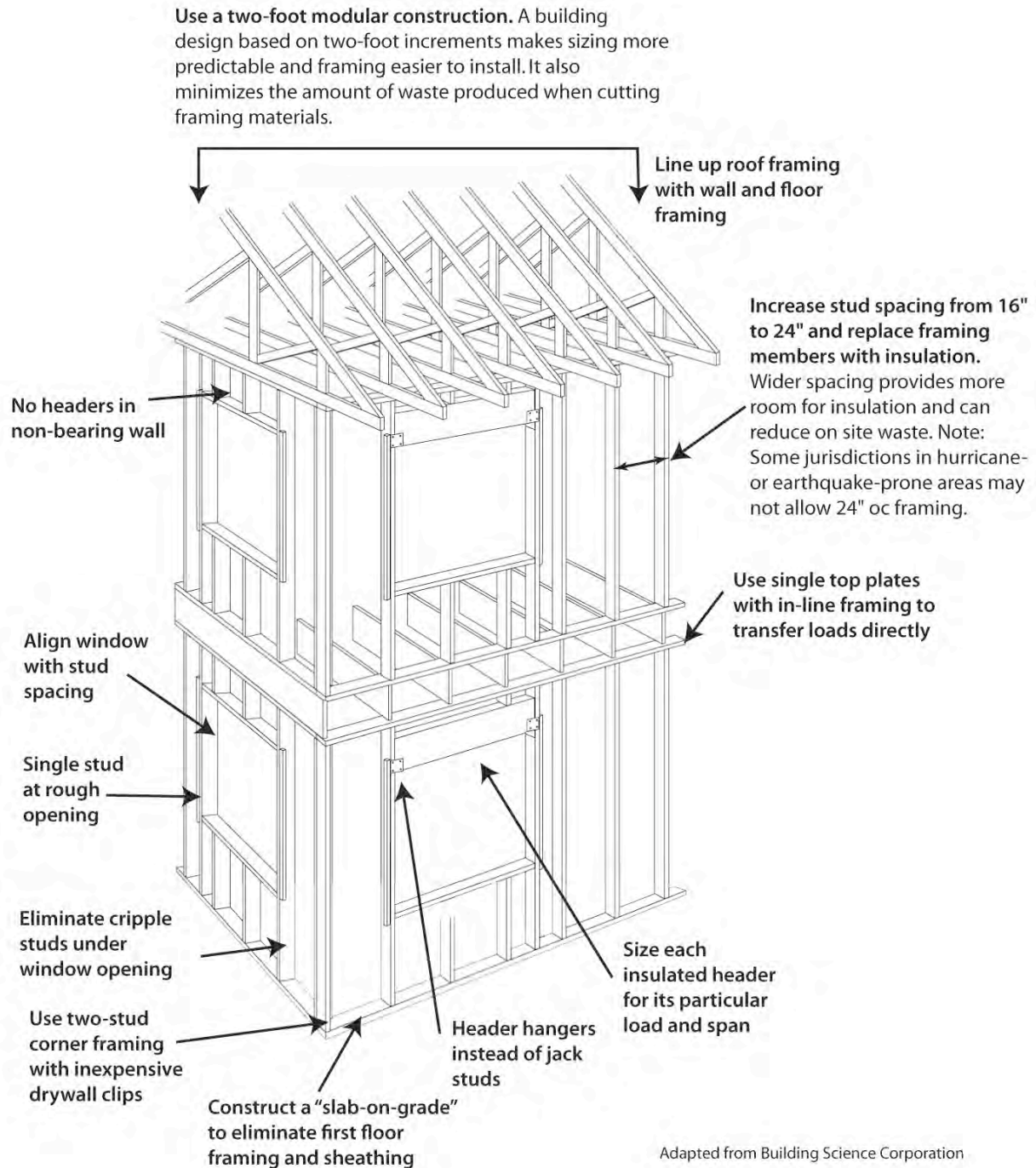
- Use FSC-certified wood
- Use dimensional lumber no larger than 2 x 6"
- 19.2" and 24" on-center framing, floor systems and bearing walls
- 24" on-center framing, roof systems
- 24" on-center interior partitions
- Single top plate walls
- Right-size headers or insulated (box) headers, where required
- Eliminate headers in non-bearing walls
- Doubling the rim joist in lieu of header (2 x 6" or deeper wall framing)
- Finger-jointed studs on 24" centers
- Ladders at perpendicular wall intersections
- Two-stud corner framing
- Use wood framing treated with Borate for a minimum of 3' above the foundation, or sand diatomaceous earth or mechanical termite barrier in known problem areas
- Check moisture content of wood before enclosing both sides



Advanced Framing Techniques can save 23-30% on lumber, reduce labor and scraps.

Basic Advanced Framing Techniques

For more discussion about this diagram download the [Advanced Framing tool](#).



SOURCE: Department of Energy's Building America Program. www.buildingamerica.gov

Benefits of Advanced Framing Techniques

- Save lumber (25–30 percent).
- Reduce labor.
- Reduce scrap.
- Reduce drywall cracking and simplify air sealing.
- Adopt techniques incrementally.
- Improve energy efficiency (3–5 percent per year) by allowing better insulation and minimizing the thermal effect of studs, improve buildings thermal performance.

Challenges of Advanced Framing Techniques

- More up-front planning is needed to implement; planning must start at design.
- Framers will need training on this technique.
- May be difficult to get subcontractors on board.
- May be difficult to clear some techniques with local jurisdictions.



Link and Learn

Builder News; Building Online: The Building Industry's Web Design and Marketing Agency:
www.buildernewsmag.com

Building Science:
www.buildingscience.com

NAHB (National Association of Home Builders) *Model Green Home Building Guidelines*;
Version 1.0 2004:
www.nahbrc.org/greenguidelines

Building American, DOE, *Optimum Value Engineering Best Practices*, (September 2002):
www.ibacos.com/pubs/OptimumValueEngineering.pdf

Member Manual: Version 1.5; Teacher Addition; Casa Verde Builders, American YouthWorks;
2003

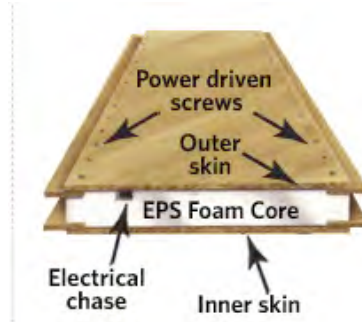
Green Business: Green Building. Efficiency Wood Use in Residential Construction:
www.nrdc.org/cities/building/rwoodus.asp

Johnston, David and Kim Master, LEED AP. *Green Remodeling, Changing the World One Room at a Time*. New Society Publishers:
www.amazon.com

Reduce Lumber Use and Still Maintain Structural Integrity:
www.toolbase.org/Technology-Inventory/Whole-House-Systems/advance-framing-techniques

Structural Insulated Panels (SIP)

Structural Insulated Panels are a widely used alternative construction material for homes. SIPs are panels made from a thick layer of foam (polystyrene or polyurethane) sandwiched between two layers of oriented strand board (OSB), plywood, or fiber cement. As an alternative to the foam core, SIPs are available with a core of agricultural fibers (such as wheat straw) that provides similar thermal and structural performance. The result is an engineered panel that provides structural framing, insulation, and exterior sheathing in a solid, one-piece component.



Panel manufacturers now use continuous lamination machines, which automate forming and cutting according to dimensions downloaded from digital floor plans. The panels will arrive pre-cut, and can be rapidly assembled by students without extensive training. Using SIPs will allow you to quickly construct an exterior building envelope that is strong, airtight, and energy efficient.

Some manufacturers now offer special variations in SIP products, such as a high-end panel made with an injected polyurethane core, and vertical joint connectors featuring eccentric cam locks that draw the panels tightly together and assure proper alignment. Manufacturers can also produce curved walls or other customized architectural features.

SIPs in Practice

For a 2,500 square foot home, one custom homebuilder in Arkansas (Stitt Energy Systems) estimates an additional \$5,000 to \$8,000 for materials. *Labor savings are substantial however, and can tip the economic scales in favor of SIPs.* For example, in areas of the country with high labor rates, installation costs for SIPs can be lower than conventional wall systems.

SIPs have:

- Manufactured wall panels 4' to 24' wide and 8' or 9' high, made in standard thicknesses of 4 1/2" to 6 1/2".
- Thicknesses of up to 12" for roof panels where greater R-value is needed.
- A core material of thicker panels usually corresponds to standard lumber dimensions, so board stock may be used for splines and plates. Panel lengths can vary to accommodate higher ceilings or roof spans up to 24'.



Structural Insulation Panels (SIPs)
Source: [Energy Star Thermal Bypass Checklist](#)



Implementation of Structural Insulated Panels (SIPs)

- Send your plans to an SIP manufacturer so it can produce a customized panel layout and working drawings.
- Have a structural engineer certify the design.
- Have the foundation in place before panels are delivered.
- If possible, use a forklift or have at least four people on site to unload the truck.
- Assembly can usually be done in one to two days.
- Use aerosol foam, gaskets, or other caulking materials for sealing SIPs.
- Bond the foam core to the stiff outer skins to create a web-and-flange structural strength (along the same principal as an I-beam) across the length and breadth of the panel. Insulation capacity is another advantage of SIPs.
- The foam core is typically held back from the edge to allow the panel to accept 2 x 4 top and bottom plates. Alternatively, placing header sections between full-length wall panels may create rough openings for doors.
- Window openings can be made in a similar fashion with the addition of a base panel. Dimensional lumber usually frames out rough openings.
- For wider openings, headers with greater load bearing capacity may be needed. Insulated headers using sandwiched foam have been specially designed to work in conjunction with SIPs.
- Properly seal joints.
- Consult a structural engineer to specify required headers and connections.

Benefits of Structural Insulated Panels

- With the capacity to handle axial, bending, racking, and shear loads, properly designed and assembled SIPs not only replace conventional framing, but will withstand high wind and great seismic forces.
- SIPs provide better overall air tightness than conventionally framed walls.
- SIPs panel systems offer a dense, uniform, and continuous air barrier with few thermal bridges, and no opportunity for internal convection.
- SIPs generally have higher R-values than similarly sized framed walls, improving thermal performance.
- Operational energy costs are typically low.
- Labor time is reduced due to ease of installation.
- Uses at least 50 percent less framing lumber.
- Requires less room at building site (less site disturbance).
- SIPs contribute less construction waste to landfills due to their customized sizing.



Structural Insulated Panel section.
Courtesy of
www.consumerenergycenter.org

Challenges of Structural Insulated Panels

- If the inhabitants wish to remodel, they may have to hire a design professional.
- Producing and engineering the SIPs may increase initial costs.
- Panels usually cost more than stick frames do.

CASE STUDY

YouthBuild AmeriCorps Rebuilds Gulfport, Mississippi, with SIPs

In the fall of 2005, YouthBuild USA and the YouthBuild movement of hundreds of local programs across the nation pledged to build upon their experience, infrastructure, and dedication to help respond to the economic and social disaster wrought by Hurricane Katrina. Through this dedication and the support of The Home Depot and the Corporation for National and Community Service, the YouthBuild AmeriCorps Katrina Rebuilding Project was born.



This project has engaged 385 YouthBuild AmeriCorps graduates and students who have used the construction skills and community service they learned from their programs to build 140 units of housing in North Gulfport, Mississippi, a predominately low-income community that was destroyed by the hurricane. A special AmeriCorps program of 35 YouthBuild graduates has been in Gulfport for one year, dedicating their full time to restoring this devastated community; they have been joined by rotating crews of 35 to 45 current AmeriCorps members approximately every month from YouthBuild programs nationwide.

What makes this project an exciting step forward in the trend towards building green in YouthBuild is the opportunity it presents to not only offer affordable housing to the people of Gulfport, but also to offer environmentally conscious housing while educating YouthBuild graduates and students on green building applications and materials.

The use of the SIPs played a pivotal role in enabling the YouthBuild AmeriCorps Katrina Rebuilding Project to construct homes that were at once sound, affordable, and green. ThermaSAVE is a pre-assembled structural insulated panel made of expanded polystyrene and concrete, and eliminates the need for conventional wood framing and insulation. The environmental benefits are: it is nonhazardous (versus fiberglass insulation); it reduces construction waste (compared to traditional wood framed construction); it is a terrific insulator and substantially reduces energy consumption from heating and cooling; and it is highly resistant to mold, pests (such as termites), and fire and natural disasters—SIPs are structurally sound to survive severe storms, hurricanes, and earthquakes—and therefore minimizes additional resources needed for repair and reconstruction. SIPs can be used to construct foundation or basement wall, even below grade; floors spanning up to 16 feet between supports, load-bearing walls up to four stories. Lastly, many SIPs, such as ThermaSave, are certified by the International Code Council (ICC).

To learn more about the YouthBuild AmeriCorps Katrina Rebuilding Project and its application of ThermaSAVE and other green building materials, contact Tony Frazier at tfrazier@youthbuild.org.



Link and Learn

Benefits of SIPs:

www.ibpanels.com/benefits.php

The Engineered Wood Association:

www.apawood.org

Structural Insulated Panel Association:

www.sips.org

Technology Inventory: Accelerating Awareness of Housing Innovations:

www.toolbase.org

Path “Partnerships for Advancing Technology in Housing”:

www.toolbase.org/techinv/techspecs/sips.pdf

Insulated Concrete Forms (ICF)

Insulated concrete forms (ICF) are constructed from expanded polystyrene and stacked like building blocks to form the exterior walls. The forms are reinforced with steel and filled with concrete. The forms interlock and fasten one to the other to provide seamless “foundation to rafter” fully insulated, reinforced concrete walls. Window and door openings of any size are possible.



*Every ICF-constructed home saves approximately 8.5 trees.
Courtesy of www.energystar.gov*

Insulated concrete forms provide a lasting building envelope, and are designed to withstand high wind, fire, the elements, and the test of time.

Basement waterproofing materials for an ICF basement may need to be different (i.e., water-based moisture barriers need to be used, because petroleum-based tar would melt the exterior foam on the ICF form). Windows and doors would need to be ordered with wider jamb extensions to accommodate the increased wall thickness. Another major factor in the discussion to use ICFs is the level of manufacturer support available, including training, on-site and telephone technical support, and marketing materials.



Benefits of Insulated Concrete Forms

- Some ICF systems boast up to 75 percent energy savings over conventional systems.
- ICF construction is compatible with all home designs.
- ICF walls benefit from concrete’s inherent structural qualities, which is particularly important in regions affected by severe weather.
- The combination of a continuous concrete wall plus the integral interior and exterior insulation provides superb energy efficiency and lower utility bills.
- Outdoor pollutants can be kept to a minimum due to decreased air infiltration.
- With several inches of concrete sandwiched by foam insulation, ICF homes are typically quieter than neighboring homes built conventionally.

Challenges of Insulated Concrete Forms

- ICF homes may cost up to 10 percent more to build, depending on the manufacturer, shipping costs, and other factors. However, lower utility bills will offset the increased up front construction costs.

Adobe

Adobe, an ancient, energy efficient building technique, is a mixture of dirt or clay that has been moistened with water and baked or left to dry in a desired shape, like a brick. Often, builders add chopped straw or other fibers to the wet clay before shaping it, to add structural strength. Adobe can be shaped into uniform blocks that can be stacked like bricks to form walls, but it can also be simply piled up over time to create a structure.



Those who build in wetter climates often choose to make Adobe using either rammed earth or pressed block, which require little curing time. Today, builders use several tactics to keep moisture from affecting adobe earth walls, including adding cement stabilizers. Adobe construction, in combination with good passive solar design, makes for an effective energy-saving solution in cold, wet, hot, and dry climates.

Implementation of Adobe

Building with adobe is a whole-building approach, so if your program is interested, there are several things to consider:

- Determining site logistics
- Identifying and preparing the soil, stabilization
- Identifying foundation and subfloor needs
- Choosing a wall system
- Identifying door and window bucks, attachments
- Designing electrical systems—bond beams and roofing systems



An adobe brickyard



If your program is interested in integrating adobe into your construction, visit www2.itu.edu.tr/~isikb/Tech1.htm for a step-by-step approach, and contact your nearest green building organization for professional referrals.

Benefits of Adobe

- Indoor air quality in earthen construction is very healthy.
- Adobe is a good thermal mass material, holding in warm and cool air well.
- The mass of the adobe walls will absorb heat and radiate it back out into the house at night.
- When using high-mass walls, insulation, and a large south solar aperture, you can cut energy use in January by 60 percent or more.
- High-mass earth walls also cut cooling costs in hot desert locales.
- Earth walls allow you to buy smaller heating and cooling units.

Challenges of Adobe

- Adobe construction is labor and detail intensive.
- When adobe is used as an exterior plaster it will need to be either stabilized or re-plastered on a regular basis.
- Adobe does not insulate very well, so walls made of adobe need some means of providing insulation to maintain comfort in the building.
- A custom-built adobe house will cost about \$45–\$65 and up per square foot.



Link and Learn

HomeownerNet; *The Adobe House*, (La Casa Adobe):

www.homeownernet.com/articles/adobe.html

Your Portal to Adobe Homes, Rammed Earth Homes, Green Building, Pressed Block, Adobe Houses, and Passive Solar Homes:

www.adobebuilder.com/index.html

GreenBuilding.com *Building Today for Tomorrow*:

www.greenhomebuilding.com/adobe.htm

CHAPTER 8

Roofing

Green roof framing techniques are similar to those discussed in advanced framing, with a focus on reducing waste, reducing the amount of virgin wood used, and choosing wood products that have been certified for being sustainably harvested, such as FSC-certified products. Advanced roof framing techniques include the use of wood trusses and engineered lumber.

Designing and installing a “green” roofing system requires skills in architecture, construction, roofing and energy auditing; these roofs have so many benefits that a “Green Roof Professional” certification in green roofing has recently been created. For more information, go to:

<http://www.greenroofs.org/index.php/eduprogram>



In addition to more environmentally responsible wood framing techniques, Structural Insulated Panels also represent a greener option for builders. SIPs consist of an insulating foam core sandwiched between an inner and outer face, typically made of oriented strand board (OSB). They combine structural framing, insulation, and sheathing in a single product for use in roofs, walls, or floors. (See also Exterior Wall Systems).

Remember that the roof system is also part of the building envelope. Proper insulation, ventilation and control of air leakage is essential to meeting green building goals. There are several approaches to include in your roofing system to ensure a durable, energy-efficient roof.

Even in mild climates the sun’s heat can cause extreme temperatures in the enclosed attic space, which can push heat into the living space through the roof. Two approaches to reduce heat gain and its resulting energy use include adding insulation underneath the roof and installing a reflective roof such as aluminum or a roof radiant barrier to reflect heat.

Installing a rainwater catchment system is another roofing technique that helps offset water use by collecting and using rainwater for landscaping, car washing, or other uses.



Wood Trusses and Engineered Lumber


Wood trusses are structural frames that rely on a triangular arrangement of webs and chords to transfer loads to reaction points. They have a high strength-to-weight ratio, and have longer life spans than conventional frames. Wood trusses also offer more flexibility in floor plan layouts and a broad range of shapes and sizes to choose from.



The light frame wood trusses are prefabricated by pressing galvanized steel truss plates into wood members that are pre-cut and assembled in a jig. Trusses are manufactured from 2x4s or 2x6s, so they can be made from smaller trees than the ones needed for dimensional rafters, which are usually 2x10s or 2x12s.

Engineered lumber comes in various forms, including I-joists and laminated veneer lumber (LVL), both of which can be used for rafters. Because I-joists combine oriented strand board (OSB) webs with 2x3 flanges, they make good use of small trees and wood chips. Like plywood, LVL rafters are assembled from layers of veneer and glue. Because LVLs can be ordered in almost any length, they are particularly useful for buildings that have long spans.

Implementation of Green Roof Framing

- Use engineered roof trusses to save on dimensional lumber or use alternate roof structures with SIPs, steel, or laminated veneer lumber.
- Truss heels are necessary to avoid compressing or squishing the insulation. [Compressing insulation causes a loss of insulation value, and should be avoided.] Truss heels are blocks built on the truss ends that raise the truss 4–8" above the top plate. Raised heel trusses or “energy heels” normally sit directly on a 2 x 4 or 2 x 6 top plate. This makes a little triangle in the attic at the eaves. When insulation is installed in the attic, it needs to be pushed to the farthest edges and into corners. The house exterior walls are where insulation is needed most.
- Avoid using dimensional lumber larger than 2 x 10".
- Insert continuous ridge and soffit vents.
- Insulate and weather strip attic access doors.
- The **International Residential Code** includes requirements for roof ventilation in Section R806. 

Benefits of Green Roof Framing

- Wood trusses provide an economical framing solution.
- Wood trusses enhance wood’s environmental advantage by optimizing wood use for each application.
- The environmental impact of wood trusses is lower in regards to air and water toxicity, resource use, and embodied energy, compared to light-gauge steel and insulated concrete forms.

Challenges of Green Roof Framing

- Local inspectors may not be familiar with untraditional methods or materials, and may be resistant to them.

Aluminum or Galvanized Metal Roofs

One roofing material which is lightweight and resists rust and corrosion is aluminum. Aluminum roofs not only provide premium protection, they are also great for the environment.



The Casa Verde YouthBuild program uses galvanized metal roof systems, a second type of metal roof. These roofs reflect heat and have less mass to store the heat they do collect. When combined with a ridge-and-soffit venting system, they reduce the attic temperature by 20–30 degrees on hot summer days. These roofs will last 30–40 years with little or no maintenance.

Implementation of Alternative Roofing Systems


- Use metal material (aluminum or galvanized metal) for roof or alternative roof structure-SIPs (see SIP section under wall systems), steel, or laminated veneer lumber (LVL).
- Use photovoltaic-integrated roofing panels or photovoltaic shingles.
- Avoid black roofs, such as EPDM (rubber), asphalt, and modified bitumen.
- Use a non-petroleum, water-based reflective coating on your roof.
- Install ice flashing at roofs edge and a drip edge at eave and gable, if needed.

FAST FACT

Roofing Shingles: According to the Bureau of Cedar Shakes and Shingles, three full-grown trees are destroyed for the average shake roof. One study has shown that composition shingles buried in landfills will take over 300 years to decompose. By using aluminum roofing shingles, your project can avoid contributing to the growing problem of land-fills because aluminum is completely recyclable and often begins with a high recycled content. Also, because aluminum is more malleable, it can be formed into more intricate and detailed product designs, which provide strength and beauty to a roof.

Source: <http://www.zappone.com>

Benefits of Alternative Roofing Systems

- Installation of reflective metal roofing can save the home up to 40 percent in summer cooling energy costs while *highly emissive* metal roofs can reduce urban air temperatures by as much as 12° F. Combined, these benefits mean less money, less dependence on energy resources and less general air pollution. 

Challenges of Alternative Roofing Systems

- An aluminum or galvanized metal can initially cost more than conventional asphalt shingles.
- The heat reflective (home cooling) benefit of aluminum roofs will diminish over time unless steps are taken at the outset, such as the application of a clear sealant that retains the metal's reflective qualities.

Radiant Roof Barriers

Radiant roof barriers are made of a thin sheet or coating of highly reflective material applied to one or both sides of a number of substrate materials. Substrates include kraft paper, plastic films, cardboard, plywood sheathing, and air infiltration barrier material. Radiant barriers reduce heat transfer by thermal radiation across the air space between the roof deck and the attic floor.

Implementation of Radiant Roof Barriers

There are several configurations possible:

- Install under tile roofing with shiny side up.
- Lay the radiant barrier directly on top of existing attic insulation, with shiny side up.
- Attach the radiant barrier to bottom surfaces of the attic truss chords or rafter framing.
- In homes roofed with wood shakes, drape the radiant barrier with shiny side down over the tops of rafters before the roof deck is applied.
- Attach the radiant barrier directly to the underside of the roof deck.
- For single-ply membrane roofs, separate the rigid insulation from the roofing membrane so that the insulation can be reused.

Benefits of Radiant Roof Barriers

- Radiant barriers installed within the attic or under roofing materials can reduce cooling costs as much as 5 percent, reduce heat island affect, and prolong the life of the roof by lowering the roof temperature.
- White, reflective roofs with no barrier can reflect 80 percent of the sun's heat, which reduces the radiant heat that can travel through the roofing and be absorbed in the attic or house interior.

Challenges of Radiant Roof Barriers

- Without proper attic ventilation, radiant barriers can cause moisture-related problems, especially if used in combination with wood shakes or installed incorrectly.

Rainwater Catchment Systems

A rainwater catchment system, attached to the roof, can also help the homeowner utilize rainwater as a valuable water resource. Homeowners anywhere can benefit from rain water catchment, but especially in arid and desert climates. Metal roofs, such as aluminum, lend themselves very well to this technique.

Implementation of Rainwater Catchment Systems

- **Collection Area:** This is generally the roof of the house. The roofing material should be one that does not leach heavy metals or petrochemicals.
- **Conveyance System:** Add gutters or pipes that deliver rainwater falling on the rooftop to cisterns, rain barrels with overflow systems, or other storage vessels. Construct drainpipes and roof surfaces with chemically inert materials such as wood, plastic, aluminum, or fiberglass.
- **Storage Facilities:** A storage tank or cistern should be constructed of an inert material such as reinforced concrete, fiberglass, or stainless steel. The storage system can be built as part of the building or as a separate unit.
- The catchments' surfaces should be made of a nontoxic material. If using paint then use nontoxic paint (no lead, chromium, or zinc-based paints).

Benefits of Rainwater Catchment Systems

- Rainwater catchments are inexpensive and flexible systems that are easy to reconfigure, expand, or relocate.
- These systems will reduce the homeowner's water bill.
- Using less water will reduce the amount of energy used and the pollution caused by pumping water from its source to the house.

Challenges of Rainwater Catchment Systems

- Rainwater catchments may not meet local building code requirements for primary water source for new construction.
- Local code will dictate what uses are allowable in your area for rainwater other than for irrigation.
- Requires a good-sized roof.
- Gutters require constant maintenance and cleaning.

CASE STUDY

Casa Verde Builders Design and Construct Green Homes Using Galvanized Steel Roofs

Casa Verde Builders is a program of American YouthWorks, a nonprofit corporation in Austin, Texas, that has been providing alternative educational services to young people for more than 25 years.

Since 1993, Casa Verde Builders has been building single-family, energy efficient sustainable houses in East Austin—providing homes for families who might otherwise never have the opportunity to own one. These homes are built by AmeriCorps Volunteers, young people between the ages of 17–25 who work for minimum wage and receive an educational award at the end of their year of service.

Green Building Collaboration

In 1992, the City of Austin's Green Building Program needed a builder to build a model energy- and resource- efficient home. After several months of discussions with various community groups, a partnership formed among the Green Building Program, Austin Habitat for Humanity, and American YouthWorks. The Green Building Program provided technical support for the project. Habitat for Humanity provided the lot for the project, sold the finished home to one of the families on its waiting list, and provided volunteer labor for some phases of the project. The American Institute for Learning set up the program with staff and students from their alternative school to build the home. Within a few months a floor plan was developed, funds and materials for construction promised, and two staff members and eight students selected for the project. Construction began on August 13, 1993. Since this auspicious but modest start, the young people and staff of Casa Verde Builders have built over 100 quality, energy-efficient, affordable homes for low-income families. Families have new homes; the neighborhood has dramatically lower crime with the increase in home owners; and hundreds of young people have pride in their accomplishments that will last a lifetime. In 2005 one of their homes won a national Gold Medal award from NAHB, the National Association of Home Builders.

Reduced Energy Consumption

The City of Austin has been tracking utility costs for a sampling of the Casa Verde homes and comparing them with other comparable homes in Austin since 1994. On average, Casa Verde homes use 30-50 percent less electricity, and 10 percent less natural gas than other similar homes in Austin.

Roofing Design and Construction

The roofing design and construction of the home is particularly significant in green design. To avoid heat buildup in the attic, Casa Verde uses galvanized metal roofs. These roofs reflect heat and have less mass to store the heat they do collect. When combined with a ridge-and-soffit venting system, they reduce attic temperatures by 20–30 degrees on hot summer days. These roofs will last 30–40 years with little or no maintenance. To prevent the heat that does build up in the attics from penetrating into the conditioned spaces, Casa Verde installs an R-30, 10-inch layer of blown cellulose insulation above the ceiling. In addition to the thermal benefits that reduce the operating costs of the homes, these roofs are made of steel, the most recycled material commonly used in construction. The primary material in the cellulose insulation is

SHADES OF GREEN

recycled newsprint, again reducing the need to use virgin raw materials in the construction process. To complete the thermal package, Casa Verde installs a 14 SEER air-conditioning unit with a high-efficiency gas furnace. Casa Verde installs ceiling fans in all major rooms and a whole-house fan for use in mild weather. Finally, most of the rooms are designed to have windows on at least two walls to provide cross ventilation.

For more information, contact: Dick Pierce, CEO, American YouthWorks:(512) 236-6100;
<mailto:dpierce@americanyouthworks.org>;
<http://www.americanyouthworks.org/cvb/greenconstruction/frontpage.htm>



Link and Learn

Source Book of Alternative Technologies for Freshwater Augmentation in Latin America and the Caribbean; Part B Technology Profiles:

<http://www.oas.org/dsd/publications/Unit/oea59e/ch10.htm>

MRA Investment Grade Roofing online:

<http://www.metalroofing.com/v2/content/news/benefits4.cfm>

Green Building Case Study Casa Verde Builders online:

http://www.austinenergy.com/Energy_Efficiency/Programs/Green_Building/Resources/Case_Studies/index.htm

Johnston, David and Kim Master, LEED AP. *Green Remodeling, Changing the World One Room at a Time*. New Society Publishers

Peck, Steven W. *Award-Winning Green Roof Designs: Green Roofs for Healthy Cities*, Schiffer Publishing, and sourced through <http://www.greenroofs.org/>

Radiant Barriers: A summary from NAHB Research Center's "Tool base" series:

<http://www.toolbase.org/Technology-Inventory/Interior-Partitions-Ceilings/radiant-barriers>

Cool Roofs: Research and Materials, from Lawrence Berkeley Lab, US Department of Energy:

<http://eetd.lbl.gov/coolroofs/>

CHAPTER 9

Interior Walls and Trims

Drywall provides a huge time- and weight-saving product, compared to the plaster walls that were prevalent in the United States prior to World War II. With 30 billion to 40 billion square feet of drywall produced each year, however, drywall (which requires baking to cure) uses a significant amount of energy (roughly 1% of US annual energy consumption) and creates a huge carbon footprint.



Alternative interior wall systems can be made from agricultural waste such as straw. Some products contain as much as 100 percent agricultural waste product, are fire resistant, avoid toxic binders, and do not require structural studs.

If using gypsum board, look for drywall or gypsum with recycled content that is locally available. The gypsum board scraps should be separated on the job site and recycled as part of your recycling plan. If you do not recycle all of your gypsum board content, it can be ground up and used for soil amendment (as long as the gypsum scraps do not contain toxic paints or remnants of wall coverings). Alternatives to gypsum board include straw bale, adobe, and cobb. New, non-heat dried drywall products are also becoming available (EcoRock, which uses 80% fly ash and a very low-carbon finishing process, or DensArmor), but as of Spring 2010 have not entered production scale due to the slowdown in new construction. Keep looking for these greener products.

Note: Sheetrock® is a trade name for gypsum wall board, or drywall. “Greenboard” is a drywall product with water-resistant paper coatings, not a “green” environmentally preferred type of drywall.

Implementation of Green Interior Walls and Trim


- Install 24" off-center studs.
- Install finger-jointed studs or high-recycled content metal studs.
- Use straw panel walls, such as strammit panels.
- As alternative, low energy density drywall becomes available, price and consider installing it in your homes.
- Use certified wood trim.
- Use finger-jointed trim.
- Utilize a wood interior panel system.

Wood Interior Panel System

The wood paneling system is designed for interior finishes. Each panel has a hardwood veneer bonded to an engineered wood substrate such as medium-density fiberboard (MDF) or wheatstraw board.

Wood paneling can reduce the cost when compared to custom millwork by as much as two-thirds.

The paneling system is used exactly like any hardwood paneling in interior finish applications. It is a pre-cut system where pre-machined stiles, rails, and panel pieces are assembled and installed with minimal cutting and sanding. This allows the appearance of custom-built paneling at significantly lower cost of materials and labor. Panels and rails can be stacked to create full wall-paneling options.

MDF is made from highly refined wood fibers combined with a binding agent and pressed into a composite wood product that is uniform and dimensionally stable. Unfortunately, MDF has a high formaldehyde content, and you should therefore seal all edges and the material itself to minimize off-gassing. 

Wheatboard is made with discarded wheat straw from farming operations. The straw material is processed into substrate panels that have excellent stability and strength. Wheatboard panels usually cost \$10–\$35 per square foot.

Benefits of Wood Interior Panel Systems

- Wood interior panel systems help extend scarce hardwood resources and use recycled materials.
- Panel systems use less wood and recycled material, and *they cost much less* than a similar product using actual wood.
- These products are made of compressed straw and recycled manufactured wood products, and use significantly less wood than authentic wood wall décor.
- Wood panels hold up as long or longer than other actual wood decor due to their treatment and manufacture. They can usually be cleaned with conventional cleaning agents, and are rather strong for their cost as well.



Link and Learn

Minnesota Building Materials Database- A Tool for Selecting Sustainable Materials:

<http://www.buildingmaterials.umn.edu/>

Austin Energy Green Building Program: Casa Verde Builders Case Study:

<http://www.austinenergy.com/Energy%20Efficiency/Programs/Green%20Building/Resources/Case%20Studies/index.htm>

BobVila.com: *The Energy Wise House: Building with Insulated Concrete Forms:*

http://www.bobvila.com/HowTo_Library/EnergyWise_House_Building_with_Insulated_Concrete_Forms-New_Walls-A1627.html

Johnston, David and Kim Master, LEED AP. *Green Remodeling, Changing the World One Room at a Time*. New Society Publishers

California State Guide to Recycled content drywall:

<http://www.calrecycle.ca.gov/RCP/ProdByType.asp?ProductTypeID=134&QRY=&CATID=257>

EcoRock:

<http://www.seriousmaterials.com/html/ecorock.html>

US Green Building Council's "Green Home Guide" site:

<http://greenhomeguide.com/>

CHAPTER 10

Exterior Finishes

Protecting the home from the elements—whether it's extreme cold, heat, or moisture—is a vital part of visual appeal, environmental considerations, and energy savings.



Vinyl Siding

Vinyl was once thought to be the best choice, but now there are differing opinions. Vinyl siding is a low-maintenance material, and some manufacturers may add a small amount of post-industrial scrap. However, vinyl siding is also made from polyvinyl chloride (PVC). Many environmental groups disapprove of the use of PVC because of the danger of its by-product — dioxin — which is created during the manufacture, use, and combustion of PVC. Dioxins include some of the most toxic chemicals known to science. (For more information about PVC, see the resources section.) Fiber cement and metal are better options for the environment and human health.

Solid-sawn Wood

Using solid-sawn wood with natural weather resistance (like cedar or redwood) puts some strain on harvested forests (true green building wouldn't use any cedar or redwood, unless it was reclaimed—most certification programs require no use). One way to compromise is to use these natural materials only on the front of the home, and side the rest with a man-made product that closely resembles the natural material, such as one that contains wood fibers, or virgin or recycled materials.

Plastic

There are currently over 20 products in the market consisting of plastic or plastic-wood composites. Plastic lumber is made from 100 percent recycled plastic, #2 HDPE and polyethylene plastic milk jugs and soap bottles. Plastic-wood composites are a combination of plastic and wood fibers or sawdust. These materials are a long-lasting exterior weather-, insect-, and chemical-resistant wood lumber replacement for nonstructural applications.

Alternatives

Alternative sidings include stucco, cement board, metal siding, recycled wood, polystyrene-concrete mixes, and other eco-friendly alternatives.

Implementation of Green Exterior Finishes

- Use untreated wood or wood that has been safely treated and does not contain chromium or arsenic for decking and sill plates. Consider using alkaline copper quat (ACQ) treated lumber when necessary. Do NOT use pressure-treated lumber (wood that has been soaked in chromated copper arsenate (CCA), and pressured to drive the chemicals into the wood fibers).
- Use earth-based plaster.
- Use alternative siding materials such as:
 - Mineral or cement fiberboard (also referred to as fiber cement and cement board).
 - A recycled material or an environmentally friendly, engineered product.
 - Wood products such as sidewall shingles, or OSB siding. (Remember to utilize certified wood, low-VOC coatings, and non-exotic species. Avoid virgin, old-growth tree products.)
 - Hardboard like masonite or ABTco Stucco.
 - Fiber/cement composites like MaxiPlank® or James Hardie® products.
 - Polymer products like Nailite®, vinyl products like Wolverine®.
- Use locally produced block or brick.
- Use cement-based, integral colored stucco system.
- Design “moisture-forgiving” walls and roof details that repel rain and can dry out.
- Finish with light-color exterior finishes and high-reflecting roof covering. [See also: the “Roofing” section of Shades of Green. “Cool Roof” systems are a new addition, and successfully reflect unwanted heat from the home interior.]

Benefits of Green Exterior Finishes



- Using recycled content materials is more durable and reduces demand for old-growth timbers.
- Using safely treated wood reduces exposure to chromium and arsenic.
- Cement-fiber will not burn, cup, swell, or shrink.
- Alternative siding will last longer, can be fire resistant, and can reduce maintenance costs.
- Choosing not to use vinyl siding means fewer toxins eventually being released into the environment, where they make their way into our bodies, causing health risks.
- Cedar shingles require less maintenance than wood clapboard.

Challenges of Green Exterior Finishes

- Cultured stone and brick can be extremely expensive, and other alternative materials can be more expensive than vinyl.
- Synthetic stucco will look authentic, but may not offer the same durability.
- Wood products have the least impact on human health but if not grown and processed sustainably can contribute to deforestation.



Link and Learn

Sustainable Building Sourcebook, Chapter 4 Materials; Austin Energy GreenBuilding Program:
<http://www.austinenergy.com/EnergyEfficiency/Programs/GreenBuilding/Sourcebook/engineeredSidingAndTrim.htm>

U.S. Green Building Council PVC Task Group's Assessment of Technical Basis for a PVC Related Materials Credit in LEED:

http://www.usgbc.org/Docs/LEED_tsac/USGBC_TSAC_PVC_Draft_Report_12-17-04..pdf

EPA's Persistent Bioaccumulative and Toxic (PBT) Chemical Program:

<http://www.epa.gov/pbt/pubs/dioxins.htm>

Center for Health, Environment and Justice's PVC-Free Schools Campaign Fact-Sheets:

<http://www.besafenet.com/pvc/about.htm>

EJNet.org's Dioxin Homepage:

<http://www.ejnet.org/dioxin/>

Persistent Organic Pollutants (POPs) Campaign. Indigenous Environmental Network:

<http://www.ienearth.org/pops.html>

Marin County Community Development Agency:

http://www.co.marin.ca.us/depts/CD/Forms/Remodeling_Green_Building_Residential_Design_Guidelines_Certification_Form.pdf

Build Smarter with Alternative Materials:

<http://www.build-smarter.com>

Johnston, David and Kim Master, LEED AP. *Green Remodeling, Changing the World One Room at a Time*. New Society Publishers

CHAPTER 11

Plumbing, Electrical, and Mechanical

The systems and appliances installed in a home can dramatically affect the amount of energy that the building will consume over its lifetime. There are several approaches and products that can be used to ensure the most energy efficient home. Energy efficiency standards for air conditioners, heat pumps, and residential unit packages have been raised in many locations, and many organizations have developed efficiency rating systems.



HVAC (Heating, Ventilating and Air Conditioning)

Choices concerning the heating and cooling systems of a home provide multiple opportunities for energy conservation. When these functions are designed well, the cost reduction in maintenance expenses will benefit the homeowners continuously throughout the lifetime of their home, while protecting the environment in the process. Here are some ways to address this key concern:

- Start with easy tasks like installing ceiling fans, programmable humidistats, and a high-efficiency particulate air (HEPA) filter.
- Choose a reputable HVAC installer that you trust; or consult with a green-building program near you (see the YouthBuild Green Pages for listings).
- Install 12 SEER or higher air-conditioning units over 1.5 tons with non-CFC/HCFC cooling refrigerant. This is now required by code in some states.
- Install outside air mechanical ventilation system or an energy recovery ventilator.
- Be sure to get a system air-flow test and blower-door test to find any unwanted air leaks and to test caulking in walls, windows, and doors.

[> LEARN MORE ABOUT BLOWER DOOR TESTS](#)

IMPROVE PERFORMANCE

When is it time to replace heating and cooling equipment to improve performance?

[> Read this list of telltale signs.](#)

Preprogrammable Thermostats

Properly using a programmable thermostat in your home is one of the easiest ways you can save energy, money, and help fight global warming. An ENERGY STAR qualified programmable thermostat helps make it easy for you to save by offering four pre-programmed settings to regulate your home's temperature in both summer and winter — when you are asleep or away.

The average household spends more than \$2,200 a year on energy bills — nearly half of which goes to heating and cooling. Homeowners can save about \$180 a year by properly setting their programmable thermostats and maintaining those settings. The pre-programmed settings that come with ENERGY STAR qualified programmable thermostats are intended to deliver savings without sacrificing comfort.

Simple Steps to Energy Savings with Programmable Thermostats

Achieve significant energy and money savings that are possible through the proper use of your programmable thermostat.

1. Choose the right programmable thermostat — There are three types of programmable thermostats designed to best fit your daily schedule
2. Properly install the thermostat — Here's what you need to know about proper and safe installation of your programmable thermostat, as well as when you should call a certified HVAC contractor to handle the installation for you.

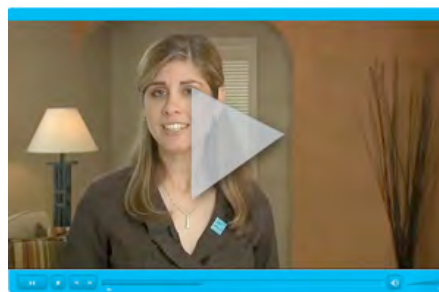
[> WATCH A VIDEO ON HOW TO INSTALL](#)
3. Properly set and use your thermostat
4. Save with your manual thermostat — If you choose to keep your manual thermostat, there are recommendations to help you save, too.

[> LEARN MORE](#)

AT HOME WITH ENERGY STAR VIDEO

Learn how to properly use your ENERGY STAR qualified programmable thermostat to save energy, money, and help fight global warming.

[> WATCH THE VIDEO](#)



Plumbing

When installing and working with plumbing systems, there are many areas where the conscious employment of specific practices and best materials can have a big impact on energy costs. Consider how these ideas could work for your project:



- Keep water supply lines out of exterior walls.
- Install anti-scald valves in showers and tubs.
- Use tankless (gas) hot water heater —whole house—DOE Std. 10CFR430.
[> DOWNLOAD THE USING TANKLESS WATER HEATERS TOOL](#)
- Install water heater within 20 feet of fixtures and appliances.
- Use an on-demand hot-water recirculation system—not one that is continuous or on a timer.
- Use hot water pipes with minimum of one inch of insulation.
- Cold water pipes should have a minimum of one-half inch of insulation in unconditioned space.
- Use a heat trap on cold and hot water lines to and from heater if not integral to heater.

Electrical

Making changes to a home electrical system can make a huge difference in energy usage and monthly cost. Using solar power systems, Energy Star qualified appliances, or something as simple as CFL light bulbs all contribute to a greener environment.



- Provide homeowner with information on “Green Choice” power options.
- Each ton of cooling from air-conditioning units should cover a minimum of 550–600 square foot of space. For more specific sizing, use Manual J or Manual ANSI/ACCA Manual D.
- Install CFL light bulbs. CFLs need a little more energy when they are first turned on, but once the electricity starts moving, use about 75 percent less energy than incandescent bulbs.
[> LEARN MORE ABOUT CFLs](#)

Benefits of Green Electrical

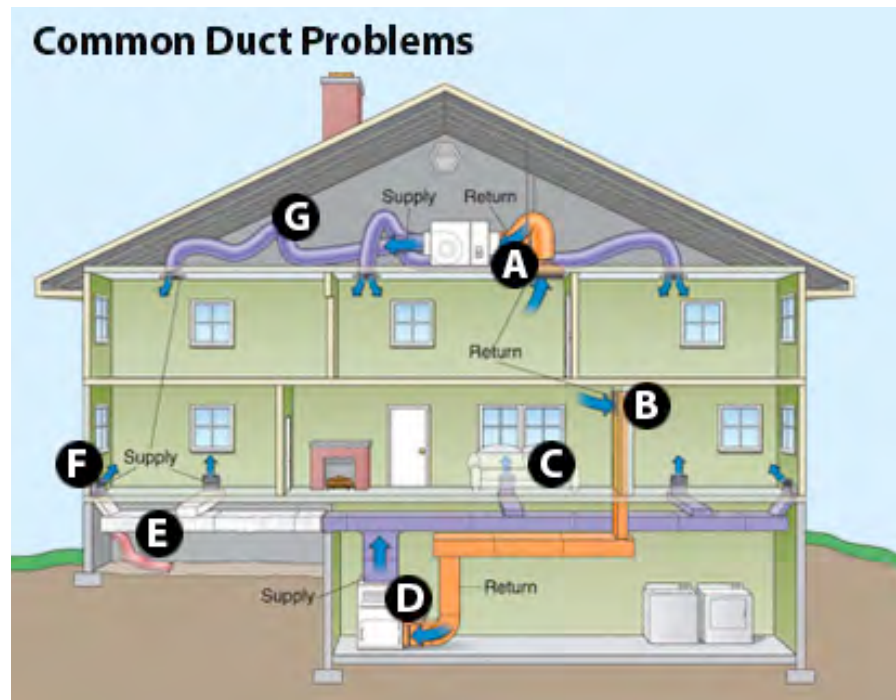
In many climates, air conditioning is the biggest item in the power bill. An oversized air-conditioning unit may cycle on and off every 15 minutes—this does not allow the unit to get to optimum efficiency (similar to driving around in first or second gear!), and can thus increase your electrical costs. Efficient air-conditioning units are designed to run from 30 minutes to several hours.

Challenges of Green Electrical

- Getting your HVAC contractor to believe in what was discussed above and specify the proper unit.
- Enlisting the help.

Ductwork

Your home's ducts move heated and cooled air to the living areas to make you feel comfortable. But in a typical house, 20 percent of the air that moves through the duct system is lost due to leaks, holes, and poor connections. The illustration below shows many common duct problems, such as:



- A Leaky duct connections
- B Leaky return ducts
- C Furniture blocking registers
- D Leaks at furnace and air filter slot and duct tape failures
- E Fallen duct insulation
- F Leaky supply ducts
- G Kinks in ductwork restricting airflow

Following are some duct installation best practices:

- Duct size, design, and installation should be done per ANSI/ACCA Manual D or local equivalent.
- The main HVAC trunk should be made of sheet metal and flex-duct take-offs should not be greater than 10 feet.
- Ninety-degree angles in ducts should have turning vanes.
- Duct connections should be sealed with mastic-hardcast or UL181 foil tape (not duct tape).
- Ducts, plenums, and trunks should be insulated if they cannot be installed in a conditioned space.
- Install air balancing dampers that are accessible.
- Ensure that pressure is balanced for all bedrooms.
- Eighty percent of ductwork should be located within thermal envelope and conditioned space, never in exterior walls.



Duct connections should be sealed with mastic-hardcast or UL181 foil tape, not duct tape.

- Use return ducts or transfer grilles in each room.
- Complete a direct duct-pressure test with an optimal leakage of less than 10 percent.
- Mask duct outlets during construction and vacuum before running to protect indoor air quality.

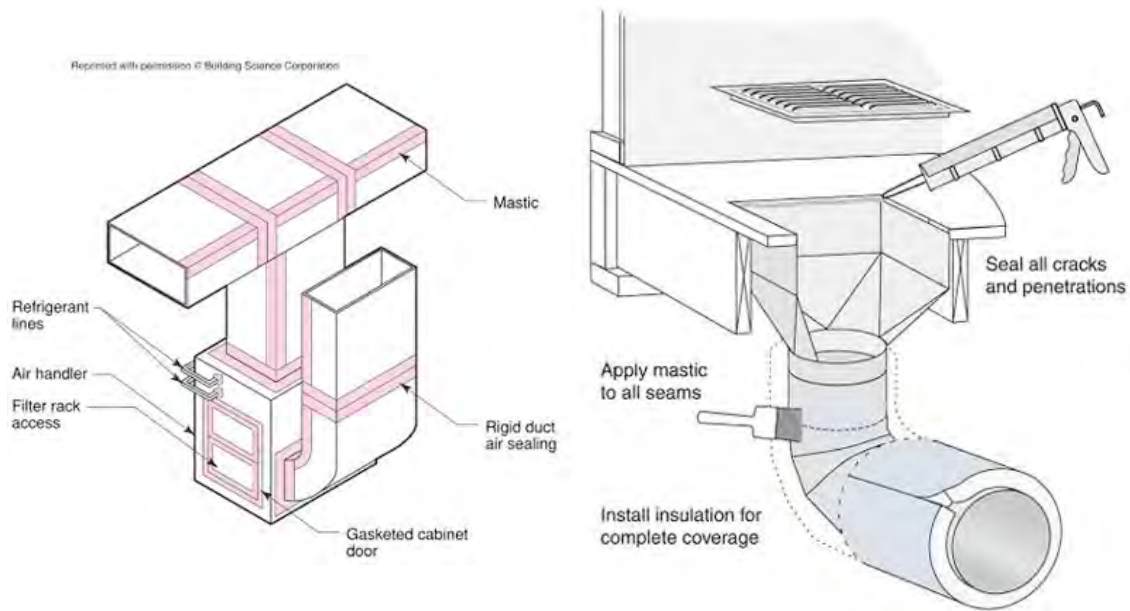
Benefits of Energy-Efficient Ductwork

- Reduces energy costs by 30–40 percent per year and improves comfort level.
- The most efficient systems on the market are up to 70 percent more efficient than the current average.
- Homeowners can qualify for a cash rebate from the local utility or be able to purchase a system with no payments or interest for up to one year in certain areas.
- Cleaning all ducts before occupancy increases comfort and reduces air-conditioner use.
- Installing an attic ventilation system reduces electricity usage and moves large volumes of air to achieve comfort at higher temperatures without air conditioning.
- Installing a greater efficiency gas furnace reduces air emissions, costs less to operate, and saves natural resources.

Behind the walls of an ENERGY STAR qualified home...

Tightly-sealed and well-insulated ducts keep you more comfortable and increase the energy efficiency of your home. Sealing also helps improve indoor air quality by reducing the risk of dust, moisture, pollen, pests, and noise from entering the ducts and circulating throughout your home.

Examples of Tightly Sealed Ducts



Reprinted with permission © Building Science Corporation

> For more information, download the [Energy Star Duct sealing brochure](#).

[[link to DuctSealingBrochure04.pdf](#)]

Solar Hot Water Heating Systems

Solar water collectors can provide up to 80 percent of a house's hot water (and even more depending on the climate and location of the home), and save the United States millions of barrels of oil every year by reducing the need for conventional heating.

The basic technology of solar water heating is very simple. Sunlight strikes the roof system and heats an “absorber” surface within a “solar collector” or an actual storage tank. Either a heat-transfer fluid or the potable water (to be used) flows through tubes attached to the absorber and picks up its heat. Systems with a heat-transfer-fluid loop include a heat exchanger that then heats the potable water. The heated water is stored in a conventional water heater tank until needed or in a separate preheat tank. If additional heat is needed, it is provided by the conventional water heating system.

As for size and installation, there is no “one size fits all” solar water-heating system. The size of the collector will depend on where the house is built and how much hot water is required. It is possible to build a solar water heating system using an experienced installer or system supplier. Installing the system on a roof will require an analysis of the design load of the roof and the weight of the equipment. It is best to go with a solar heating system that carries an OG300 rating by the Solar Rating and Certification Corporation in order to qualify for available tax credits.



*For solar hot water systems, flat-plate solar collectors are typically installed facing south on a rooftop.
Photo courtesy of www.nrel.gov.*

FAST FACT

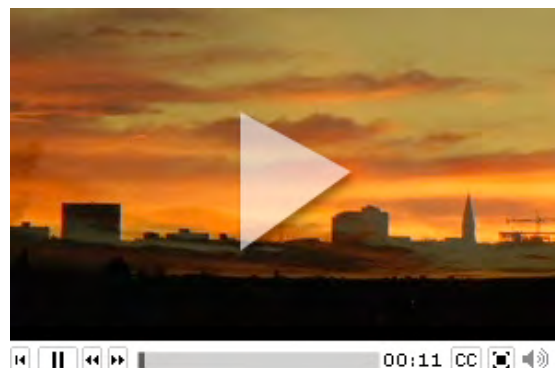
Read “[A Consumer's Guide: Heat Your Water With the Sun](#)” from the U.S. Department of Energy.

WHAT IS SOLAR POWER?

Solar radiation is a general term for the electromagnetic radiation emitted by the sun. We can capture and convert solar radiation into useful forms of energy, such as heat and electricity, using a variety of technologies. The technical feasibility and economical operation of these technologies at a specific location depends on the available solar radiation or solar resource.

Watch a video about the Center for Photovoltaics and the research they are doing.

> WATCH THE VIDEO



Types of Solar Heating Systems

Direct System. This system uses a pump to circulate potable water from the water storage tank through one or more collectors and back into the tank. The pump is regulated by an electronic controller or an appliance timer.

Indirect System. In this system, a heat exchanger heats a fluid that circulates in tubes through the water storage tank, transferring the heat from the fluid to the potable water.

Thermosiphon. A thermosiphon solar water-heating system has a tank mounted above the collector. As the collector heats the water, it rises to the storage tank, while heavier cold water sinks down to the collector.

Draindown System. In cold climates, this system prevents water from freezing in the collector by using electric valves that automatically drain the water from the collector when the temperature drops to freezing.



The Economics of Installing Solar Water Heating System

Solar water heating systems usually cost more to purchase and install than conventional water heating systems. However, a solar water heater can usually save you money in the long run.

How much money you save depends on the following:

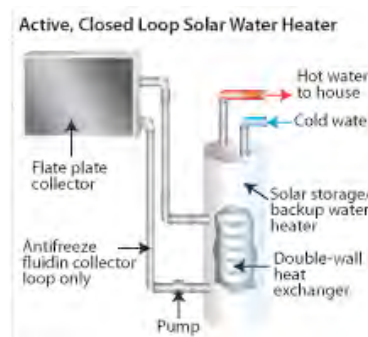


- The amount of hot water you use
- Your system's performance
- Your geographic location and solar resource
- Available financing and incentives
- The cost of conventional fuels (natural gas, oil, and electricity)
- The cost of the fuel you use for your backup water heating system, if you have one.

Solar Energy Collectors

There are three types of collectors useful for residential homes:

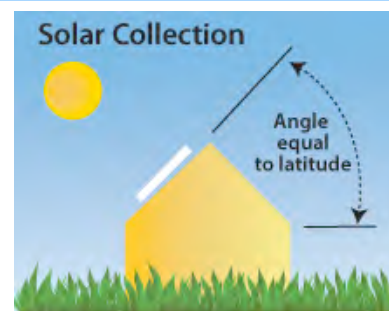
- **Flat Plate Collector.** This popular collector uses a rectangular box with a transparent cover attached to the roof. There are small tubes in the box that have fluid (either water or an antifreeze solution) running through. The tubes are attached to a storage plate and as heat builds up in the collector, it goes through the tubes and as the fluid goes through tubes it is heated. The fluid is then stored in a storage tank.
- **Integral Collector-Storage System.** Also known as ICS or batch system, this features one or more black tanks or tubes in an insulated, glazed box. Cold water first passes through the solar collector, which preheats the water. The water then continues on to the conventional backup water heater, providing a reliable source of hot water. They should be installed only in mild-freeze climates because the outdoor pipes could freeze in severe, cold weather.
- **Evacuated-tube Solar Collector.** This features parallel rows of transparent glass tubes. Each tube contains a glass outer tube and metal absorber tube attached to a fin. The fin's coating absorbs solar energy but inhibits radiative heat loss. These collectors are used more frequently for U.S. commercial applications.



HOW TO EVALUATE YOUR SITE FOR SOLAR WATER HEATING

Before you buy and install a solar water heating system, you need to first consider your site's solar resource. Your local solar system supplier or installer can perform a solar site analysis. You will also need to purchase some additional equipment (called "balance-of-system" to safely transmit electricity to your loads and comply with your power-provider's requirements.

> [LEARN MORE ABOUT SOLAR SITE ANALYSIS](#)



Implementation of Solar Hot-Water Heating Systems

- **Review applicable building codes.** Chapter 23 of the International Residential Code briefly covers solar systems. It states that solar systems and storage units must be listed with an approved testing agency, and heat transfer fluids cannot be flammable.
- **Eliminate unnecessary water heating loads.** Maximize the home's energy efficiency and reduce water heating demand before implementing solar strategies by installing efficient shower heads, setting the water temperature lower, and other measures.
- **Take advantage of solar energy during the design process.** Maximize a home's use of solar energy with good siting and architectural features, which add little or nothing to the cost of the house.

Contact an appropriate subcontractor to decide the appropriate solar water heating system for the site.

Benefits of Solar Hot Water Heating Systems

- For the amount of money and energy saved, solar water heating doesn't involve a large investment for each household—from \$3000 to \$6000 is typical.
- The technology can cut the average family's energy costs to heat water by 20 to 40 percent (as much as 90 percent in some southwestern regions).
- Check for current available tax rebates for installing solar heating systems.

Challenges of Solar Hot Water Heating Systems

- They can add additional construction cost and time.
- A third-party inspection may be required.
- They will require some attention and maintenance by the homeowner, and therefore require a degree of homeowner education.

Installing and Maintaining the System

The proper installation of solar water heaters depends on many factors. These factors include solar resource, climate, local building code requirements, and safety issues; therefore, it's best to have a qualified, solar thermal systems contractor install your system.

After installation, properly maintaining your system will keep it running smoothly. Passive systems don't require much maintenance. For active systems, discuss the maintenance requirements with your system provider, and consult the system's owner's manual. Plumbing and other conventional water heating components require the same maintenance as conventional systems. Glazing may need to be cleaned in dry climates where rainwater doesn't provide a natural rinse.

Regular maintenance on simple systems can be as infrequent as every 3–5 years, preferably by a solar contractor. Systems with electrical components usually require a replacement part after or two after 10 years.

[> LEARN MORE ABOUT SOLAR HEATING SYSTEM MAINTENANCE AND REPAIR](#)

Grid-tied Renewable Energy Electric Systems

A grid-connected power system allows a home to get part or all of its electric power from renewable sources, and reduces demand on existing coal, oil, gas, hydroelectric, and nuclear generating plants. New laws called “net metering” allow electricity consumers to connect battery-less PV energy systems to the utility grid. When a renewable energy system is generating more power than it is using, the excess feeds back into the grid, resulting in a reduction in the utility bill. The electric meter spins backward, “banking energy” as a credit for future use.



Renewable energy use for electrical generation is an area of construction that YouthBuild programs have typically avoided. The installation and maintenance of these systems is not especially difficult or complicated, but should be learned from a professional and installed by a commercial installer. A qualified installer will help design and build a system that not only meets the needs of the project, but meets the National Electrical Code and functions safely.

Renewable energy use should only be considered once a program has had success in building energy-efficient homes. When sizing a renewable energy system, even the smallest amount of wasted electricity can result in huge cost differences as solar electric panels are added to systems in series, meaning that depending upon the wiring, you may have to add two or more panels to the system even if your electric load would only require one additional panel. The high initial cost of renewable energy electric systems require a builder to reduce the electric loads as much as possible. The biggest electric loads in residential homes are refrigerators, washers and dryers, and appliances that produce heat such as irons and coffee pots.

Implementation of Grid-tied Renewable Energy Electric Systems

- Contact the local utility company to see if they will allow a connection of a solar system to their electrical grid.
- If the utility company will allow the connection of a PV system to their grid, the next question to ask is if they will buy the energy back at the retail or wholesale rate.
- Identify a qualified renewable energy installer. You can find an installer in the Off-Grid Living Web site under the Resources section.

Benefits of Grid-tied Renewable Energy Electric Systems

- Allow inhabitants to lower electric bills and have access to a very reliable source of power.
- Grid-tied renewable energy systems will lower electric bills, and, as electricity costs increase, the payback time for a system decreases.
- Renewable energy systems immediately contribute to a cleaner planet.
- Homeowners can access numerous rebates through the federal government and various state and local programs. (See the *YouthBuild Green Pages* for listings.)
- Builders can access numerous incentives through the federal government, various state and local programs, and private sources of funding.

Challenges of Grid-tied Renewable Energy Electric Systems

- Initial costs will vary greatly depending upon the size of the system and amount of labor costs.
- Homeowners need to learn proper maintenance of system, particularly if there is a battery bank.

CASE STUDY

YouthBuild Brockton uses Energy Star Ratings to Build Affordable and Sustainable Homes

Since 2001, YouthBuild Brockton, Massachusetts, has built five Energy Star-rated homes and is currently working on one unit in partnership with Habitat for Humanity and a seventh unit in partnership with the Boston Housing Authority. John Bengel, executive director of the Brockton program, emphasizes that the importance of the Energy Star Program is two-fold: The program promotes energy-efficiency and environmental responsibility in construction, and it provides affordability for the homeowner.



Old Colony Y YouthBuild Brockton celebrates as a first-time homeowner is handed the keys to a four-star Energy Star-rated home built by the program

According to the U.S. Environmental Protection Agency Energy Star Web site, “homes that earn the Energy Star must meet guidelines for energy efficiency set by the U.S. Environmental Protection Agency. Energy Star-qualified homes are at least 15 percent more energy efficient than homes built to the 2006 International Energy Conservation Code (IECC).” The Environmental Protection Agency (EPA) reports building homes that use substantially less energy for heating, cooling, and water heating can reduce maintenance costs \$200–400 annually. The Energy Star program measures efficiency for the entire home, not just retail appliances. Features that are also rated include increased insulation, tight building construction and ducts, and energy-efficient window and building envelope.

Bengel reports that using Energy Star-rated insulation and appliances increased construction costs only 2 to 4 percent. The Energy Star program does have an application fee that can be waived. After house plans and specifications are complete with Energy Star features, the EPA representatives evaluate the plans to assign an Energy Star rating and consult the construction team to implement improvements on the submitted plans. Bengel describes the application process as supportive and fairly easy to implement. Besides producing efficient, affordable homes, builders can apply for rebates based on their level of energy efficiency. Bengel says that, with a 92 percent rating for the YouthBuild constructed homes, the rebate program covered nearly half of the costs of the appliances by using efficient forced hot-air furnaces, more insulation, and installing Energy Star-rated appliances and lighting.

“The Energy Star program promotes homeownership by creating homes that are less expensive to operate,” says John Bengel.

For more information, contact Mark Showan (mshowan@oldcoloniymca.org), program director at YouthBuild Brockton.

> Find out more about the Energy Star program and associated rebates within your state

Link and Learn

PowerHouse's Choosing Energy Smart Appliances web page:

<http://www.powerhousetv.com/Building/Planning/007726>

Seasonal Energy Efficiency Rating:

<http://www.furnacecompare.com/faq/definitions/seer.html>

Frequently Asked questions about duct sealing:

http://energystar.custhelp.com/cgi-bin/energystar.cfg/php/enduser/std_alp.php?p_sid=_k3feshi&p_lva=&p_li=&p_accessibility=0&p_page=1&p_cv=&p_pv=1.329&p_prods=329&p_cats=&p_hidden_prods=&prod_lvl1=329&p_search_text=&p_new_search=1

Off Grid Living Online-this site lists renewable energy installers for different regions:

www.off-grid-living.com/

Popular Mechanics Solar Water Heating Roundup:

http://www.popularmechanics.com/home_journal/home_improvement/2270791.html

US Department of Energy Efficiency and Renewable Energy's Solar Hot Water web page:

http://www.eere.energy.gov/de/solar_hotwater.html

Solar Energy International:

<http://www.solarenergy.org/>

Johnston, David and Kim Master, LEED AP. *Green Remodeling, Changing the World One Room at a Time*. New Society Publishers

CHAPTER 12

Porches, Stairs, Ramps


Porches, stairs, and ramps should also use environmentally responsible products. There are several types of wood-polymer decking that can be used on the outside of the home. These products are made from wood waste and recycled plastic grocery bags, milk jugs, and other materials. Trex® is a well-known brand, but there are other brands on the market as well. Fiberon® is a product approved for use on wheelchair ramps due to the texture of its surface. Other quality brands include Timbertech® and Weyerhaeuser®. They rarely splinter or crack so they are very kid- and barefoot-friendly.



Like many “green” choices, there are pros and cons to alternative decking materials. Not all composite deck materials use recycled plastic or waste wood fibers. Make sure you are using only alternative decking materials that use recycled content. New PVC vinyl alternative decking is especially harmful, since burning PVC creates dioxin – one of the most toxic substances on earth.

Also, alternative wood products may cost up to 3 times as much as treated lumber. Because these materials do not need stain or paint to maintain, stay cooler to the touch and resist warping and splintering, they are easier and less expensive to maintain than wood structures.


Implementation

- Locate the porch on the south side for maximum sunlight.
- Create a covered or shaded area or porch of a minimum of 100 square feet.
- Install covered entry-awning or porch-awning to prevent water intrusion.
- Use alternative materials such as wood polymer products, recycled plastic, masonry, concrete, or other recycled content composite materials such as Choice Dek® for porch, stairs, ramps, and patios. 

Benefits of Using Alternative Materials


- Wood polymer products require substantially less maintenance than wood products.
- Wood polymer products will not splinter, crack or warp.
- Constructed from reclaimed plastics and hardwoods, wood polymer products can be cut, fastened, sanded, and painted easily.
- They are naturally UV-resistant.
- They are slip-resistant, wet or dry.
- They remain undamaged by rot or termites.
- Wood polymer products are comparably priced with premium decking lumber but in the long run will save you money on maintenance, replacements and sealants.

Challenges of Using Alternative Materials

- The higher initial costs may not be affordable without minimizing the size of the structure to bring the cost down, purchasing in bulk, or finding a good deal. 
- Trex® can begin to look like wet newspaper after a few months.

Alternative Deck Supply Companies

This list does not constitute an endorsement or recommendation by the DOL TA Collaborative, U.S. Department of Labor, or YouthBuild USA.

- BamDeck™: 100% Bamboo decking. Manufacturer: CaliBamboo, (888) 788-2254:
<http://www.calibamboo.com/bamboodecking.html?gclid=CPTfIjIqRKECFQ8Uswod9UmBGQ>
- LockDry® Decking: Waterproof aluminum decking. Manufacturer: FSI Home Products, Inc., (888) 739-6172:
<http://www.lockdry.com/?gclid=CN-gn7iRrKECFR0IswoDeUicFQ>
- ChoiceDek®: A composite of 50 percent waste cedar fibers and 50 percent recycled plastic. Manufacturer: A.E.R.T., Junction, TX, (800) 951-5117:
<http://www.choicedek.com>
- Trex®: A composite of 50 percent waste wood and 50 percent recycled plastic. Manufacturer: Trex, (800) BUY-TREX:
<http://www.trex.com/decking/default.aspx?gclid=CJiB5-WOrKECFYd-5QodpQz4FA>
- TimberTech®: A composite of 50 percent waste wood, 20 percent sawdust, and 30 percent virgin polyethylene. Tongue and groove, planks or “TimberTopper” deck covers available. Manufacturer: Crane Plastics, (800) 307-7780: 
<http://www.timbertech.com>
- American Plastic Lumber, Inc.: 100% recycled plastic lumber products including Durawood and Trimax. (877) 677-7701:
<http://www.american-plasticlumber.com/decks.html>



Link and Learn

Healthy Building Network, a coalition of builders and environmental organizations that first raised the issue of arsenic in treated lumber, and spurred alternatives:

<http://www.healthybuilding.net/about/index.html>

Bobvila.com: Composite Deck Installation video:

<http://video.bobvila.com/m/21320271/composite-deck-installation.htm>

Low-Maintenance Decking Review:

<http://www.decks.com/article10.aspx>

The Future is Strong for Composite Decking from Residential Design and Build, January 2009:

[http://www.rdbmagazine.com/print/Residential-Design-and-Build/The-Future-is-Strong-for-Composite-Decking-/1\\$2749](http://www.rdbmagazine.com/print/Residential-Design-and-Build/The-Future-is-Strong-for-Composite-Decking-/1$2749)

McGraw Hill Construction Network Sweets Green Collection:

<http://www.construction.com/Sweets/GreenManufacturers/>

Deck Lumber Alternatives: A Factsheet from Austin Energy's Green Building Program

<http://www.austinenergy.com/Energy%20Efficiency/Programs/Green%20Building/Sourcebook/outdoorDeckingMaterials.htm>

Building A Deck- Expert Advice from Start to Finish, Taunton Press, 2002.

Also from Taunton Press, *Green from the Ground Up: Sustainable, Healthy, and Energy-Efficient Home Construction*. David Johnston and Scott Gibson, 2008. See Chapter 12: Siding and Decking

The Green Good Life from The Independent Weekly, January 29, 2003:

<http://www.indyweek.com/gyrobase/Content?oid=oid%3A18946>

CHAPTER 13

Finishing the Home Interior

Energy efficient appliances and HVAC systems, and non-toxic paints and sealants for walls, woodwork, floors and cabinets are important “finishing elements” for your homes, ensuring healthy, durable, comfortable and low-cost conditions for the families that own the homes.

The finishes inside the home should have low toxicity to protect indoor air quality. Energy-efficient appliances and HVAC products are an important part of meeting green building objectives and balancing integrated systems. Recycled products in woodwork, countertops, and other durable structures should be used whenever possible to conserve natural resources.



Energy-Efficient and Water-Efficient Appliances

Installing energy-efficient appliances will reduce home utility bills and operating costs over the lifetime of the home. The sum of the purchase price and the energy cost of running an appliance over its lifetime are called its lifetime cost. Lifetime costs of energy-efficient appliances are generally much lower than the cost of an average model.

There can be a significant difference in the energy consumption of major appliances like refrigerators, dishwashers, room air conditioners and water heaters. EnergyGuide labels, found on all major appliances, can help you with your selection. The most efficient appliances are those that use the least amount of electricity and water to get a job done. Certain features of an appliance, such as the amount of flow allowed by a faucet or shower head, can also tell you a lot about its efficiency.



FAST FACT

Energy Star-qualified appliances use 10 to 50 percent less energy and water than standard models. The Energy Star labeled appliance may cost a little more upfront (or not!) but the money saved on utility bills can more than make up the difference. You may also qualify for a federal or state tax credit or a utility rebate if you purchase Energy Star-labeled products.

Implementation

- Install ceiling fans in main rooms and bedrooms to reduce air conditioning use.
- Install front-loading clothes washers, which can bring a 50 percent savings in both energy and water use.
- Install fluorescent and compact fluorescent bulbs, or the Energy Star advanced lighting package. Consider LED lighting for ambient lighting situations.
- Install programmable thermostats.
- Install top-freezer model refrigerators, which outperform side-by-side models, or choose the most efficient partial automatic or manual defrost models.
- For outdoor lights, use photo cell, motion-detected, or solar-powered lighting; prevent up-lighting pollution; and use timed or automatic light switches.
- Install water-efficient shower heads, ideally those with a flow of less than 2.5 gallons per minute (gpm).
- Install faucets and aerators with flows less than 2.2 gpm.
- Install toilets with less than 1.6 gallons per flushes (gpf), or power-assist and dual-flush toilets.
- Install dishwashers that use less than 7 gallons of water per load.

FAST FACT

Energy Star offers product comparisons, energy savings calculators and 'bulk purchase' calculator links on its web site. YouthBuild programs may save by buying multiple Energy Star labeled appliances and other products for new or rehab construction projects.

Paint and Adhesives

All oil and many latex-based paints contain organic solvents that disperse and bind other paint components. These volatile organic compounds (VOC) are known to have bad effects on human health, and there is evidence that VOCs from paint contribute to ground-level smog. In response to such concerns, more governmental agencies are acting to limit the VOC levels in house paints and other common products.

Carpeting and wall paper may use adhesives to bind fibers or install to surfaces. Many of these adhesives are also irritating to lungs and skin. Look for natural fibers in carpeting, and low-VOC adhesives in rubber backing or carpet binding, in wall paper and laminate or stick-down flooring materials. [See "Floor Finishes" below.]

Implementation

- Use low- or non-VOC paints and adhesives (do not exceed 100 grams per liter VOC).
- Avoid paints containing heavy metals and other health hazards.
- Use low-VOC wallpaper.
- Use recycled paint and paint primer with a minimum of 50% postconsumer content. There are two types of recycled-content paint: reprocessed and re-blended.
- Provide good ventilation to ensure a minimum of exposed soft surfaces during installation.
- Take care to buy the right amount of paint in order to save money and prevent waste.

Floor Finishes


Whether you are finishing floors with carpet, tile, wood, or other material, there are ways to lessen the environmental and human health impacts of the manufacture, installation, and use of floor finishes.

Implementation

Design the building to use the structural floor as the finished floor to avoid the use of floor finishes altogether.


- Choose carpets that have high recycled content and are recyclable.
- Specify carpet tile instead of broadloom so that 100 percent of the carpet does not have to be removed when only 20 percent of it shows wear.
- Find carpet tile with low toxicity. For example, look for carpets made of recycled plastic.
- Use natural-fiber carpets such as sea grass carpet or wool.
- Carpet underlayment should have recycled content and provide both insulation value (R-12) and sound barrier properties.
- Avoid solvent-based floor finishes that can cause air quality problems, and use alternatives such as water-based urethane finishes for wood floors.
- Choose durable flooring, avoid vinyl products, and choose alternatives such as cork, natural linoleum, recycled-content rubber, or chlorine-free polymer resin tile.
- With wood flooring, find locally or regionally grown and processed products if possible. Avoid exotic tropical woods (which are shipped long distances, burning fuel) or virgin timber or endangered woods. Look for FSC (Forest Stewardship Council) seal of safely harvested wood products. Alternatives such as bamboo and cork are a strong and rapidly renewable substitute.
- When using ceramic tile, find products that have recycled content such as glass.
- Substitute particleboard with formaldehyde-free materials for new, finished wood flooring.
- Use exterior grade plywood for interior uses.
- Seal all exposed particleboard or medium-density fiberboard (MDF).
- Use no adhesives on finish flooring, or choose a non-VOC adhesive.
- Look for Green Label or Green Label Plus certified carpets and adhesive products as they have been tested to meet strict indoor air quality standards by the Carpet and Rug Institute.

Cabinetry

Most conventional cabinets are made of hardwood, plywood, laminated or painted particle board, or medium-density fiberboard—all of which off-gas formaldehyde and other noxious or toxic gasses from the use of urea formaldehyde glue. Solvent-based adhesives used to attach a wood grain or veneer may also off-gas toxic fumes. 



Implementation

- Use water-based exterior coatings.
- Use interior cabinet materials that have no added formaldehydes, such as Medite II, medium-density fiberboard, solid wood, metal, wheatboard, or glass. Look for the KCMA ESP label. 

FAST FACT

Formaldehyde is a colorless strong-smelling gas widely used in the manufacture of building materials and household products. Its most common use is as a glue resin in pressed wood products. At high levels, formaldehyde can cause acute health effects: It has caused cancer in lab animals and may cause cancer in humans.

Benefits of Using Green Finishing Touches

- Many states offer rebates for purchasing energy-efficient appliances.
- Many states offer income-tax credit or elimination of state sales tax for purchase of high-efficiency appliances.
- Since burning oil or gas in the furnace creates CO² directly, choosing a more efficient furnace will reduce this pollutant from the home by about one ton per year.
- New energy-efficient furnaces will save about 800 kWh per year – or up to 10% of your annual home energy bill.
- Inhabitants can save about \$65 per year through reduced electric bills by using energy-efficient models of clothes washers alone – and up to 20% of the total home energy bill by using only Energy Star labeled major home appliances.
- Zero- or low-VOC paints and adhesives improve indoor air quality, reduce smog, and are healthier for installers and occupants.
- Sealing particleboard assures the long-term availability of wood resources while protecting ancient, old-growth forests.
- Using finger-jointed trim uses material more effectively, saves money and resources, and is straighter and more stable than conventional clear wood.

Challenges of Using Green Finishes

- More efficient or less toxic products may have a higher initial purchase price than conventional ones. Energy savings and health benefits usually repay these upfront costs within four years.



Link and Learn

Energy Star:

<http://www.energystar.gov>

RSMeans, *Green Building: Project Planning & Cost Estimating* (Contributing Authors, 2002)

Spiegel, Ross & Dru Meadows, *Green Building Materials- A Guide to Product Selection and Specification*. John Wiley & Sons, Inc.

Energy Builder:

<http://www.energybuilder.com/greenhome-basics.htm>

Sustainable Building Products and Materials, Minnesota Office of Environmental Assistance:

<http://www.moea.state.mn.us/greenbuilding/products.cfm>

Johnston, David and Kim Master, LEED AP. *Green Remodeling, Changing the World One Room at a Time*. New Society Publishers

Green California, Environmentally Preferable Purchasing Best Practices Manual:

<http://www.green.ca.gov/EPP/Introduction/default.htm>

IAP Fact Sheet, *Formaldehyde*:

http://www.nsc.org/news_resources/Resources/Documents/Formaldehyde.pdf

Forest Stewardship Council: <http://www.fsc.org/buy-fsc-products.html> and the FSC product database of certified wood products: <http://info.fsc.org/>

Kitchen Cabinet Manufacturer's Association (KCMA) Environmental Stewardship Program:

<http://www.greencabinetsource.org/index.cfm?fuseaction=Defining.welcome>

The Carpet and Rug Institute (CRI)'s Green Label and Green Label Plus Program:

<http://www.carpet-rug.org/commercial-customers/green-building-and-the-environment/green-label-plus/>

CHAPTER 14

Concrete Flatwork

Decorative concrete flatwork can be used as an affordable alternative to brick or flagstone and can be used for driveways, sidewalks and patios. Concrete is generally considered an environmentally friendly product because it is usually locally available, very durable, and Concrete's negative environmental impacts are primarily its large contribution to greenhouse gas emissions, both from the chemical process of production and from the burning of fuel during production (high temperatures are required in the manufacture of concrete). The cement industry produces 5% of global man-made CO₂ emissions.



Another concern to address when designing flatwork is the potential for runoff.

Costs

Concrete's initial costs can be higher than other materials, but its lifecycle costs are much lower than competing materials due to lower maintenance costs. This means that the families living in your homes will save money down the road.

Pervious Surfaces

When installing exterior flatwork, consider using pervious surfaces – concrete that is designed to let water flow through instead of running off. Pervious (also called permeable) surfaces handle stormwater runoff, reduce erosion, are lighter weight and can help filter water. Permeable driveways are durable, and can support normal heavy vehicle loads. They can also help manage rain water from adjacent roof and road surfaces.




Implementation of Green Flatwork Practices


- If using concrete, add fly ash, a commonly used coal combustion product, for a total fly ash content of at least 30-0 percent.
- Use Eco-Crete, or other pervious concrete, for paths, sidewalks, and driveways.
- Use natural crushed stone, gravel, open paving blocks or pervious pavers, or Eco-Crete in lieu of cement. If using pervious pavers, experiment with either poured or pre-formed in interlocking pavers for extra durability.
- Minimize the surface area of flatwork as much as possible to avoid contributing to rainwater runoff if not using pervious materials.

- Use local materials.
- Use light-colored or natural-colored materials.

Benefits of Green Flatwork Practices

- Fly ash added to concrete results in a stronger product, disposes of the otherwise toxic material safely by containing it, and lowers the product's carbon footprint by displacing a percentage of the high energy demanding concrete.
- Concrete stands up to natural disasters, wind-driven rain, moisture damage, and vermin. Less replacement means reduced resource requirements.
- Using light- or natural-colored material helps reduce the heat island affect. 
- Concrete is commonly recycled in urban areas into fill and road base material at the end of service life. Materials are usually extracted and manufactured locally.

Challenges of Green Flatwork Practices

- Initial costs may be higher for concrete alternatives.
- The manufacture of concrete results in significant greenhouse gas emissions.
- Installing pervious concrete flatwork in freeze-thaw climates requires attention to avoiding and limiting saturation during freezing months through the initial careful design of the subbase and other drainage factors. Consult the National Ready Mixed Concrete Association (NRMCA 2004) guidelines for using pervious concrete in areas prone to freeze-thaw conditions.
- The availability of fly ash is inconsistent regionally and locally. 



Link and Learn

RMC Research Foundation, National Ready Mixed Concrete Association, *Ready Mixed Concrete Industry LEED Reference Guide* (2010):

[http://www.rmc-foundation.org/images/RMCREF LEED Guide Revised 01-10.pdf](http://www.rmc-foundation.org/images/RMCREF_LEED_Guide_Revised_01-10.pdf)

Portland Cement Association, Concrete Technology:

http://www.cement.org/tech/cct_con_design_pervious_hydro.asp

Portland Cement Association, *Solar Reflectance of Concrete*:

http://www.cement.org/tech/cct_con_design_solar_reflectance.asp

University of Florida *Field Guide to Low Impact Development*:

http://buildgreen.ufl.edu/Fact_sheet_Permeable_Surfaces.pdf

Sustainable Sources, with both fly-ash concrete:

<http://flyash.sustainablesources.com/> and pervious surfaces:

<http://perviouspaving.sustainablesources.com/>

Concrete from Wikipedia:

http://en.wikipedia.org/wiki/Concrete#Environmental_concerns

Headwaters Resource Tech Bulletin, *Fly Ash in Colored Concrete*:

<http://www.flyash.com/flyashenvironment.asp>

CHAPTER 15


Sustainable Landscaping

The landscaping surrounding a home can protect and preserve ecosystems as well as add beauty and grace to the structure. “Landscaping” encompasses both hardscape (walls, sidewalks, stone work) and softscape (trees, shrubs, flowering areas, lawn). Thinking about the natural community surrounding the construction site will enable you to integrate sustainable landscaping approaches throughout the construction process.





Create protection zones before construction begins to protect soil from becoming compacted by machinery and foot traffic, and to preserve large sections of plants, not just individual trees, will be beneficial. This can be achieved by placing protection barriers beyond tree-drip lines and by not parking vehicles or equipment, or storing heavy materials, within the root zone of trees. All staging areas should be located away from trees. This is a functional measure – the ground around a home should be porous enough to support planting and also absorb rain and stormwater drainage from the roof of the house. Preventing soil erosion from stormwater during construction is required in many building code regulations.

Where you place trees is also important. Too close and root systems may damage the foundation and underground plumbing. Too far from the house, or in the wrong direction, and you lose the cooling value of shade during hot summer months. For instance, if evergreens are placed on the north side of a building and deciduous trees on the south side, the trees help to break cold prevailing winds in winter while letting sun in on the south; in summer, leafy shade is welcome. In addition, a dense hedge or tree planted on the west side of a house can provide shade and deflect westerly winds in the winter. In contrast, a loose-foliage tree planted on the east side of a house allows some protection from the sun in summer but lets in winter sun.

Always use native plants in new plantings. Native plants will survive local growing conditions better, and tend to use less water than non-native plants. 

Consult the resources below for more specific ideas in your region.

Implementation of Sustainable Landscaping

- Create a plant protection zone.
- Protect trees by fencing during construction at the drip line.
- Shade west and east sides of house with trees or trellises on at least 50 percent of wall area.
- Trunks and stems of plants and trees should be a minimum of 36 inches from the foundation.
- Retain existing trees and vegetation (50 percent of vegetation retained in pervious area).
- Avoid trenching within the drip line of any mature tree.
- Move existing plants rather than cutting down existing plants. (This helps save money on plant purchases.)
- Use landscaping plants that are native (instead of ornamental turf grass), and from the city's approved list. These native plants (for example, native fescue grass) will often be less  expensive and will require less or no watering.
- Use water-wise plants such as coreopsis, yarrow, verbena, ceanothus, buddleia, lavender, rosemary, and Russian sage, which need little supplemental water to survive.
- Use a low-volume irrigation system if necessary, such as a drip-soak system, not a spray one, and time it to come on at night, when less water will evaporate from the sun.
- Use edible plants in place of non-edible landscaping (for example, geographically appropriate fruit trees).
- Harvest plants by inviting plant-rescue groups to harvest plants prior to site clearing.
- Mulch all beds (all open soil) with a minimum of two inches of plant-based mulch.
- Planting beds should have at least 6 inches of good topsoil (a proper mix of sand, clay, organic material).
- Provide a backyard compost bin.
- Use terracing, retaining walls, and swales to reduce long-term erosion and allow more water to soak in.
- Minimize the amount of lawn needed, as lawns require extra maintenance and use  unnecessary fossil fuel mowers. One to two thousand square feet of lawn, or less, is adequate.

Benefits of Sustainable Landscaping

- Replacing turf grass with native plants can save water, help avoid the need for fertilizer, and save money.
- Using native plants will reduce yard maintenance.
- Shade trees can reduce ambient air temperature by 15 degrees.
- Planting shade trees will cut down cooling costs.

Challenges of Sustainable Landscaping

- Having an agreed-to plan before the final grading is done.
- Providing a modest amount in the budget for landscaping.



Link and Learn

Many resources are connected to university systems with histories as land-grant institutions; or to the federal resources available through USDA. Here are a few:

Sustainable Landscaping Council (based in Florida):

<http://www.sustainablelandscapecouncil.com/>

Sustainable Landscaping Handbook (Delaware):

<http://ag.udel.edu/udbg/sl/main/sustain.landscape.01-27-09.pdf>

California emphasizes reducing construction site waste and conserving and protecting water. This site includes many useful links to other landscaping themes, such as composting and irrigation systems:

<http://www.calrecycle.ca.gov/organics/Landscaping/>

Green landscaping case studies in a variety of geographic areas, with many building types. Visit often for new examples:

<http://www.sustainablesites.org/cases/>

EPA maintains several useful green landscaping links:

<http://www.epa.gov/greenacres/> and <http://www.epa.gov/greenkit/landscap.htm>

Information from the EPA on Integrated Pest Management (IPM) practices, which reduce pesticides and encourage healthy insect and wildlife populations, can be found at:

<http://www.epa.gov/agriculture/tipm.html>

RSMeans, Green Building. *Project Planning and Cost Estimate* (Contributing Authors, 2002)

Recycle Works: A program of San Mateo County:

http://recycleworks.dev.ikorb.com/greenbuilding/sus_plantings.html

Environmental Assistance, *Building an Eco-home*:

http://www.recycleworks.org/greenbuilding/sus_landscape.html

CHAPTER 16

Deconstruction

CASE STUDY: ReSOURCE Vermont

Integrating Green Building, Job Training and Social Enterprise

In 2001, ReCycle North (currently known as ReSOURCE) in Burlington, Vermont identified a serious problem that was also a unique opportunity. After completing a reuse pilot project, ReCycle North began a Building Material Reuse enterprise (called ReBUILD) to address the 25 to 40 percent of the U.S. waste stream that is construction and demolition debris. The enterprise operated by salvaging old building waste and feeding it through a three-step cycle of programs – Deconstruction Service, Building Material Center Retail Store and Waste Not Products.

In 2004 the YouthBuild program joined ReCycle North to serve 16- to 24-year-old youth who have dropped out of high school and are in need of a comprehensive development and job training opportunity. Youth are trained in construction skills while building affordable housing, and working alongside ReCycle North's Deconstruction Service. Adding YouthBuild as a training component complimented the cycle of deconstruction, recycling and reuse with education and construction.

In 2009 ReCycle North rebranded and changed the organization name to ReSOURCE in order to extend the organization's impact, to change more lives, to provide relief, to retrain, rebuild, repair, and restore.



VELCO project before deconstruction



VELCO project during deconstruction

Why Deconstruction?



Christine Beling from the Environmental Protective Agency explains, "Construction activities, including demolition, consume a significant amount of natural resources, over-burden landfills and contribute to greenhouse gas emissions. According to the Waste Management Division of the Vermont Department of Conservation, waste from new construction, renovation and

SHADES OF GREEN

demolition projects generate 90,000 tons of . . . waste each year – more than 20 percent of Vermont's annual trash – even though much of this material is still a valuable resource." An average home (approximately 2,000 square feet), when demolished, can produce about 10,000 cubic feet of landfill debris. By retrieving materials such as tile, hardwood flooring, molding, doors, windows, cabinets, plywood, light fixtures, wiring, piping, scrap metal, bricks, plumbing fixtures, insulation and lumber, 60-90 percent of building waste is diverted from landfills.

The process of systematic deconstructing of homes and buildings, rather than the traditional method of demolishing these structures, not only reduces the waste sent to landfills but also harvests reusable building materials to reduce the destruction of natural resources. Even the unusable clean wood does not go to waste and is delivered to the Burlington Electric power plant for burning. Metal no longer suitable for construction is recycled for other uses. Reusing the energy invested in these materials reduces the pollution caused by both producing *new* materials and *disposing* of used materials. Aside from the important environmental benefits of deconstruction, homeowners and contractors can also profit and receive tax-deduction credits. The amount of the credit is determined by the value of reusable (and thus resalable) goods that are salvaged from the project.



VELCO project after deconstruction was finished



Deconstruction in action

Lastly, deconstruction creates jobs and training opportunities. Demolition, which is often a job for one man and a machine, now becomes a project for a team of trained workers. In the case of ReSOURCE, the program has two YouthBuild graduates currently employed in deconstruction and gives the current YouthBuild students a chance to serve on a professional

construction crew and gain valuable experience in a growing field. Students working on a deconstruction crew can see what goes into building a house in a few days, something that would normally take months on a construction site. In addition to protecting the environment and generating jobs, the deconstruction process places a role in relieving poverty by both making these materials available at a low cost in the Building Material Retail Store, as well as using the materials that would otherwise not be available to build and refurbish low-income housing.

ReSOURCE's Three-Step Cycle of Services

After the first step of ReBUILD's deconstruction services, salvaged materials are brought to the **Building Material Center Retail Store** for resale in the second step of the cycle of services. The store is open to the public and low-income individuals as well as nonprofit organizations are able to get the materials for free through the ReLIEF Essential Goods Program. This store also offers education and training opportunities to unemployed or under-employed individuals and internship opportunities for YouthBuild students giving these youth opportunities to gain experience in additional areas outside of construction such as office management, retail and maintenance.


Step three is an enterprise called **Waste-Not-Products**. The program also utilizes materials that have outlived their original purpose. ReBUILD's Waste-Not-Products are creative household items made from salvaged materials. By training YouthBuild students in carpentry and woodworking skills, the program has created: birdhouses, tables, benches, furniture, cutting boards, picture frames, and mirrors made from unserviceable windows, flooring or lumber which are then sold to generate valuable revenue that will be reinvested into programming.



Building Material Center Retail Store and some of the salvaged materials

Key Challenges and Successes

One of the biggest challenges faced by the ReSOURCE Deconstruction Program, according to executive director, Tom Longstreth, has been marketing the service to the community and convincing potential customers of the value of the service when it is often faster to go with the demolition method. However, ReSOURCE has worked hard to keep the deconstruction costs

competitive with the often high disposal rates of the “crunch and dump” excavator demolition. In 2009 alone, ReSOURCE completed 15 full deconstructions (removal of the entire structure down to the foundation) including 2 camps, 2 houses, 3 interstate rest stops and 10 other buildings. ReBUILD deconstruction is also available to do a “soft-strip” project. The crew will come in and carefully dismantle kitchens, bathrooms, and other pieces of a building so that these materials can be reused. 

Another huge success of the program has been their ability to incorporate YouthBuild alumni as both crew members and leaders. The current crew includes three YouthBuild graduates. Sherman Plumley, a current deconstruction foreman, graduated from YouthBuild in 1999 and has been working in the deconstruction program for the past 7 years. He estimates having deconstructed at least 100 structures. Not only has deconstruction aligned with Sherman’s interests and skills, but, as he explains, through his deconstruction job, he has “been able to grow as an individual. I’ve been able to see a lot of great places, been all over Vermont and New England. And so it’s been good to just . . . be able to enjoy the environment that I’m helping keep up . . . and it’s fun to get my aggression out and destroy things occasionally.” Simultaneously, he feels his job allows him to positively give back to the community that gave so much to him as a troubled youth.

Community Response

Despite being ranked year after year as the “greenest” state by *Forbes* magazine. Tom Longstreth also points out that “Vermont is also known for Yankee thrift. Thus, we run into a lot of people who are reluctant to pay for our service and sometimes instead go to a local volunteer fire department that will sometimes burn a structure for fire fighter training purposes.”

However, there are organizations such as Vermont Electric Power Company (VELCO) that are very responsive to the idea of environmentally friendly business and the green economy. VELCO recently hired the deconstruction team to dismantle a house and garage that had served as one of their field offices. They chose deconstruction over traditional demolition as a cost effective means to help reduce the company’s carbon footprint and provide a benefit to the community. Carl Holzschuh, spokesperson for VELCO explained, “As part of our commitment to reduce waste and provide community leadership, VELCO reached out to ReCycle North for ideas on how to creatively “unbuild” this building . . . Deconstruction is a more environmentally conscious and charitable approach to traditional demolition.”

VELCO is not alone, as individual community members also understand the value of this approach. Bob Bombardier was faced with a difficult decision when the barn built by his parents in 1949 had become more of liability than an asset. Bob reached out to ReBUILD’s deconstruction crew to discuss carefully dismantling the barn not only in an effort to retrieve usable lumber, but also to salvage pieces of his family history. The entire project went so well that Bob says, “I would do it again; the crew was timely, professional and did a good job.” Bob generously donated much of the material recovered from the barn, but he has since been able to put up a small barn/garage using many of the materials from his original barn. These are just two of the many stories behind the work of ReBUILD.



Bombardier barn project

With an emphasis on community outreach, high quality, good customer service and environmental stewardship the ReBUILD deconstruction program and ReSOURCE as a whole organization is continuing to fulfill its three-part mission of environmental protection through reuse of materials, job training for those in transition and poverty relief by providing materials to those in need. ReSOURCE has also demonstrated how YouthBuild can be integrated into a social enterprise and how this integration can have benefits for students, staff, the organization and the entire community.

To learn more about developing a similar collaborative in your region, contact the Building Material Reuse Association (BMRA) by visiting <http://www.bmra.org/> or contact Tom Longstreth at (802) 658-4143.