The Guide to Green Building

Four (4) Continuing Education Hours

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The Guide to Green Building

LEARNING OBJECTIVES

Upon completion of this course the student will be able to:

1. Learn what means to build "Green" and the many benefits it offers
2. Explain the attributes of various materials and building products used for Green building
3. Understand a comprehensive list of design & building considerations to be examined during a home build.
4. Discuss the numerous materials & processes which can be applied during a Green building project
5. Review a comprehensive green building checklist to easily identify areas to apply Green Building principles

Introduction

Green buildings are healthier, more environmentally sound, and more economical. You will find you can make a real impact without sacrificing quality or breaking the bank. In fact, the principles behind green building promote just the opposite: quality design, pleasing aesthetics, functionality, comfort, and well-being.

ENVIRONMENTAL IMPACT OF BUILDINGS

- 65.2% of total U.S. electricity consumption
- 30% of total U.S. greenhouse gas emissions
- 136 million tons of construction and demolition waste in the U.S. (approx. 2.8 lbs/person/day)
- 12% of potable water in the U.S.
- 40% (3 billion tons annually) of worldwide raw materials use

In addition to making an impact on the environment (see inset), buildings can also have an impact on the health of occupants. Also, indoor air quality can be 2 to 50 times worse than outdoors and that 87% of an average American's time is spent indoors-- making indoor air quality a very real concern.

Finally, a green building can easily reduce monthly utility bills by as much as 25% or more. Many of the energy saving practices also make the home healthier and more comfortable at the same time.

GREEN BUILDING ATTRIBUTES

Many attributes describe healthy and environmentally sound materials and building practices that should be considered when designing and building a home. When selecting products, look for products that use these terms to describe themselves, but be careful to make sure the claims are credible.

Biodegradable/ Compostable

Biodegradable products have the ability to break down, safely and relatively quickly, by biological means, into the raw materials of nature and disappear into the environment. Be aware that sending biodegradable products to the landfill defeats the purpose. Solid biodegradable products can often be composted. Compostable materials are solid biodegradable materials that break down in the process of composting. Composting is a process dedicated to breaking down organic materials into rich soil called compost.

Durable

Durable materials are environmentally sound because they have to be thrown away and replaced

less often. They also reduce life cycle costs by reducing maintenance and replacement costs.

Energy Efficient

Almost anything that burns natural gas or is plugged in has an efficiency rating. Look for the most energy efficient model in everything from appliances and furnaces to light bulbs and televisions. Also, insulation and low-E, dual paned windows increase home energy efficiency by reducing demand on air conditioners and furnaces. The Energy Star® label used on many products is a good indication that it is more efficient than the standard model.

Formaldehyde-free

Insulation, particleboard, medium density fiberboard, or cabinets and furniture made from these materials can contain the toxin formaldehyde. Look for formaldehyde-free materials.

FSC Certified

The Forest Stewardship Council (FSC) certifies managed forests to ensure they are less destructive to forest ecosystems. Selecting lumber or wood products made with wood from FSC certified forests will help ensure healthier forests.

Local

In addition to environmental impacts from the creation of building materials, transportation of materials from great distances has a negative impact on the environment. Buying materials that are produced locally can minimize this impact.

Low/ No VOC

Volatile organic compounds (VOCs) are found in paints, sealants, adhesives, and some carpets. VOCs are toxic to humans and contribute to smog. Look for low or no VOC versions of these materials.

Non-toxic

Materials may contain toxins that are dangerous to human health. Most materials are relatively benign, but some materials, such as CCA-treated lumber, contain dangerous toxins.

Post-Industrial/ Post-Consumer

Recycled materials can have either post-industrial or post-consumer recycled material or a combination of both. Post-industrial recycled material is a waste product from an industrial process. Post-consumer recycled content is material that was recovered from the urban waste stream such as used paper and soda cans. Recovering post-consumer materials is more difficult to achieve and more likely to reduce landfill waste than post-industrial waste and, therefore, often favored when selecting recycled content materials.

Recycled/ Recyclable

Many common materials can be selected with or without recycled content. Recycled content products mean that the material used has been kept out of our landfills and has reduced the extraction of precious and limited natural resources. Examples of materials that can contain recycled content are concrete, tile, steel, and carpet. As important as having recycled content is whether a material can be diverted from the landfill (recycled) at the end of its useful life.

Resource Efficient

Products or measures that reduce the amount of natural resources used are good for the environment. Bare concrete floors don't require additional flooring material. Water-efficient fixtures and irrigation conserve water. Engineered lumber products use a high percentage of the trees harvested for the purpose.

Renewable

Renewable means that we can potentially replace all that we use within a short time without depleting the source. Anything mined from the earth (including metals and oil) or any wood taken from old-growth clear cuts are not renewable. Rapidly renewable materials are often defined as those that are planted or harvested within a ten-year cycle. Bamboo, straw, bio-based resins, and natural fiber carpets are among the materials that are rapidly renewable. Renewable energy is generated from fossil fuel-free sources such as solar, wind, and geothermal.

Salvaged

Reusing materials means that new materials do not have to be harvested or extracted from the earth. Salvaging materials during the demolition of an old home saves them for someone else to re-use.

Sustainable

A sustainable product is one that can be produced today without impacting the ability to produce the same product in the future. Therefore,

sustainable products should be produced and transported using renewable materials and renewable energy sources. In reality, the term "sustainable" is used rather loosely to describe products that rarely meet this definition.

Water Efficient

Water efficient faucets, toilets, appliances and showers can save a surprising amount of water each month. Low water landscapes and efficient irrigation systems can drastically reduce water used in the yard.

DESIGN CONSIDERATIONS:

The following describes the green building objectives for each given building stage or element of a new home or building. The objectives should be kept in mind as guiding principles when making design decisions and selecting materials and equipment. Below the objectives are some common materials and measures that can contribute to a greener home. The list is not comprehensive, but highlights some of the more commonly or easily achieved measures.

Construction and Demolition Waste

Objectives: Increase reuse of used building materials and reduce the amount of virgin building materials unnecessarily wasted or sent to the landfill.

Material/ Measure	Description
Salvage useful materials	During demolition, identify and salvage building materials that can be reused. Reduce waste by diverting cabinetry, windows, doors, fixtures, wood floors, dimensional lumber, etc. from landfills. Avoid removing existing trees and plants.
Divert construction and demolition waste from landfill	Place windows strategically to enable cooling by natural ventilation while also admitting daylight and enabling wintertime passive solar heating.

Building Orientation

Objectives: Building orientation is one of the most effective ways to improve home energy performance and it costs nothing. Orient home and place windows to enable natural daylighting, summertime shading, wintertime passive heating, and natural ventilation. These effects decrease the need for electric lighting, save energy used for heating and cooling the home, and create a more comfortable indoor environment.

Material/ Measure	Description
Orient along east-west axis	Long axis should face east-west to maximize passive solar effects.
Window placement	Place windows strategically to enable cooling by natural ventilation while also admitting daylight and enabling wintertime passive solar heating.

Lighting

Objectives: Improve the energy efficiency of household lighting.

Material/ Measure	Description
Natural daylighting	The more natural light in the home during the day the less lights need to be turned on, saving electricity and enhancing indoor light quality. Strive for indirect light to reduce glare.
IC Can lights	When using can lights in the top-floor ceiling select "Insulation Compatible" (IC) model. Non-IC can lights require insulation to be a certain distance from cans creating significant breaks in insulation.
Light Emitting Diode bulbs	LED lights reduce energy usage significantly over incandescent and CFL bulbs and last significantly longer.
Compact fluorescent bulbs	Compact fluorescent bulbs are direct replacements for standard incandescent bulbs but use 75% less energy and last up to 13 times longer. Look for low mercury bulbs.

Heating and Cooling

Objectives: Maintain a healthy and comfortable home while reducing the energy used for heating and cooling.

Material/ Measure	Description
Natural ventilation	Homes designed to take advantage of this will enjoy lower energy bills. Operable skylights can enhance natural cooling by allowing rising hot air to escape.
Window shading	Install shades, plant trees or orient windows to block direct sunlight from windows in summertime in order to keep indoor temperatures down--reducing the need for air conditioning.
Passive solar heating	Orient home and windows to admit solar radiation to passively heat the home without using your furnace.
Thermal mass	Thermal mass (often in the form of concrete walls and tile floors) can mitigate fluctuations in indoor temperature reducing the need for mechanical heating and cooling.
Air filters and sealed air ducts	Well-installed ducts (straight with taped seams) will reduce leakage of conditioned air and decrease possibility of harboring mold. A HEPA filter will efficiently remove particulates from the air.
Insulation	Use greater than minimum required amount of insulation in walls and ceiling. Upgrading to R-19 insulation in walls and R-30 in ceilings will result in a well-insulated home.
Efficient furnace	Look for a heating system with a high efficiency rating: AFUE > 90% (or HSPF > 8). Look for the Energy Star® label.
Efficient A/C system	Install an Energy Star® high-efficiency air conditioning system (SEER > 12).
Hydronic radiant heating	Hydronic radiant heating is more comfortable, does not blow allergy-inducing particles into the air, and can be more energy efficient than conventional forced air units.
Other ventilation	Install whole-house fan, ceiling fans, and attic ventilation to reduce need for air conditioning.

Appliances

Objectives: Select high-quality appliances that are more energy efficient.

Material/ Measure	Description
Energy Star Appliances	All major brands have Energy Star options that reduce energy usage over comparable models while providing equal or superior performance.
Horizontal-axis clothes washer	Horizontal axis washers are more effective at cleaning, gentler on clothes, use 40% less water, 50% less energy, and leave clothes drier requiring less time and energy to dry clothes. Most H-axis washers are also Energy Star rated.

Plumbing/ Domestic Hot Water

Objectives: Improve energy efficiency of water heating, improve water quality, and reduce indoor water consumption.

Material/ Measure	Description
Water efficient fixtures/ toilets	Low-flow faucets and showerheads also reduce the amount of energy used for heating water.
Insulate water heater and hot water pipes	Reduce energy wasted through heat loss.
Heat Traps	Install heat traps on storage hot water tanks to prevent cold water flowing back into storage tank.
High-efficiency hot water heater	Install an energy efficient water heater with Energy Factor (EF) > 0.6. Consider a tankless hot water heater. Tankless water heaters are very effective, have an EF of 0.8 or better and take up less valuable space.
Dual-flush toilets	Dual flush toilets reduce water use by allowing users to choose a full or half flush depending on the need.
Water filters	Water filters remove chlorine, soften water, and improve flavor of water.
Solar Hot Water	Pre-plumb or install solar hot water heater. This can reduce or eliminate the need to use a gas or electric hot water heater.
Graywater system	Water from faucets, showers and washing machines, not contaminated by human waste, can be filtered and used to irrigate landscaping.

Building Shell

Objectives: Increase use of renewable, recycled, and sustainable materials while constructing an energy efficient and durable building shell.

Material/ Measure	Description
Weather stripping	Weather stripping in either new construction or retrofit is the most cost-effective means of reducing heating and cooling costs.
Durable, environmentally preferable exterior siding	Select a durable siding. If using wood shingles or other wood siding, look for FSC certified wood or use hardboard instead. Otherwise, consider fiber-cement siding for its durability and termite resistance. Vinyl siding is not considered a good environmental choice.
Entry doors with certified lumber or with Energy Star® label	When selecting solid wood doors, look for doors made with FSC certified wood. Otherwise, look for doors that are Energy Star® rated.
Alternative or more sustainable framing	Use recycled light gauge steel framing, FSC Certified lumber, or engineered/ finger jointed studs for framing. Insulated concrete forms and structural insulated panels are other energy efficient and less lumber-intensive means of construction. Oriented Strand Board (OSB) for exterior sheathing and subfloor is more environmentally responsible than plywood. If using plywood, specify FSC-certified plywood.
Energy efficient windows made with environmentally preferable materials	Use low-e dual paned windows for their superior energy performance. Look for the Energy Star label. Select FSC certified wood or recycled aluminum with thermal breaks for window frames. Higher first costs can be offset by smaller mechanical systems and lower heating and cooling costs.
Foundation/ Slab	Use high fly-ash content in concrete for foundation and slab. Fly ash is material that would otherwise be landfilled, it displaces virgin materials normally used in the concrete and reduces the greenhouse gas emissions caused by concrete when it cures.
Roof/ Radiant Barrier	Select light colored "cool roof" materials to reflect heat of the sun-- reducing heat island effect and keeping indoors cooler and reducing the need for air conditioning. Install a radiant barrier in your attic to reduce indoor temperatures and the need for air conditioning.

Interior and Finishes

Objectives: select low VOC contents, formaldehyde-free, and more sustainable materials

Material/ Measure	Description
Interior wall framing	Use light gauge steel framing with recycled content or FSC-certified lumber to frame interior walls.
Low- or no-VOC paints and finishes	Use paints and finishes with low or no volatile organic compounds to improve indoor air quality.
Entry doors with certified lumber or with Energy Star label	If using solid wood, select cabinets made from FSC certified lumber. Otherwise use cabinets made from particleboard/ MDF with low or no formaldehyde content to improve indoor air quality. Cabinets finished in the factory will cure under controlled conditions and will reduce off-gassing of VOCs in your home.
Recycled content tile	If selecting tile for countertops and bathrooms, look for recycled content. Glass or traditional ceramic tiles are available with recycled content.
Recycling Center	During design, designate space for placing recycling receptacles

Flooring

Objectives: Select flooring materials that are nontoxic, renewable, and/or recycled/recyclable.

Material/ Measure	Description
Certified/ Salvaged Wood	Select FSC Certified wood from sustainably managed forests or wood that has been salvaged.
Concrete floor	Bare concrete floors are durable, healthy, and eliminate the need for additional flooring materials. They can be stained or polished for a

	beautiful finish. Concrete floors provide good thermal mass.
Renewable floor coverings	Bamboo is a rapidly renewable alternative to hardwood floors. Palm wood flooring comes from plantation grown trees. Cork and natural linoleum are also renewable floor coverings. Use low VOC adhesives during installation.
Natural fiber carpet	Select carpet with natural fibers such as wool, sisal, jute, sea grass, coir, etc. These natural fibers are renewable.
Recyclable/ recycled carpet	Select carpet that has recycled content or has been designed for easy recycling.
Low-VOC carpet	Select carpet with the CRI Green label indicating it meets strict indoor air quality restrictions.
Recycled content tile	If selecting tile flooring, look for tiles with recycled content. Glass or traditional ceramic tiles are avail- able with recycled content.

Landscape/ Hardscape

Objectives: Create a well-designed hardscape and landscape that reduces the amount of water used for irrigation and the amount of run-off that ultimately carries garage, oil, and other debris into the local water areas. (i.e. ponds, lakes, rivers).

Material/ Measure	Description
Dry wells	Dry wells or infiltration basins capture rainwater and help much of it to filter into the ground instead of running off into the street and out to the bay.
Permeable/ alternative Paving	Permeable paving systems will allow rainwater to penetrate the soil rather than running off into the street. This decreases the amount of polluted storm water reaching the local water run-offs and replenished the local aquifer.
Xeriscape	A xeriscape is a landscape designed with native or adapted plants that requires no irrigation after plants are established.
Native/ Drought Tolerant plants	Native plants and drought tolerant plants reduce the amount of water that is required for irrigation. Native landscaping provides habitat for native birds and butterflies.
Weather-based irrigation controls	Automatic irrigation controls with smart features can moderate irrigation levels based on weather and season saving significant amounts of water.
Drip irrigation	Drip irrigation reduces wasteful overspray and evaporation and can deliver low flow rates for low-water plants.
Rainwater storage	Rainwater can be captured from the roof and used later for landscape irrigation.

Outdoor Decks

Objectives: Make decks from certified wood or products that substitute for wood and treated lumber that does not contain highly toxic substance

Material/ Measure	Description
Decking	Use composite lumber made of 100% recycled plastic or of plastic/wood composite for decking material. If you must use wood for the deck, select FSC certified wood.
Treated lumber	Treated lumber is often used in landscapes and as supports for decking. Traditional CCA lumber is being phased out because of its toxicity and is being replaced by less-harmful ACQ treated lumber. Also, look for composite lumber options such as Polywood.

Solar Electricity

Objectives: use solar electricity (a.k.a photovoltaic) panels to reduce the amount of electricity purchased from the power company. Solar electric panels convert sunlight directly into electricity. Displacing electricity generated by burning fossil fuels at distant power plants, with local, non-polluting solar power.

Material/ Measure	Description
Solar Electric Panels	Solar panels are most often installed on rooftops. They can either come in roof-mounted panels or building integrated systems that are a relatively seamless part of the roof. Qualified solar installers will evaluate

	whether solar will work on your rooftop.

Furnishings

Objectives: Look for furnishings made with natural fibers or recycled content. Purchase furnishings made with FSC-certified wood or formaldehyde-free wood products. Avoid synthetic foams that contain fire retardants, called PBDEs, that may cause cancer and disrupt endocrine system.

DETAILED MEASURES

The following describes many green building materials and techniques that can be used by contractors when building a home. It is intended to assist owners or their contractors with green building design and construction measures that may be incorporated into their project.

A: SITE

1. Recycle Job Site Construction and Demolition Waste

- **Description:** Construction waste generally consists of wood, drywall, metals, concrete, dirt and cardboard – materials that can be reused or recycled if prepared properly.
- **Application:** Identify the types and quantities of materials generated at the job site and recycle at least 60% of the construction and demolition (C&D) debris. Contact local recycling facilities and haulers to identify terms and conditions required for recycling materials. Separating waste at the site is the most effective way to ensure high recycling rates. Allocate space for recycling bins and containers.
- **Benefit:** Recycling reduces pressure on landfills, saves money by reducing tipping fees, and provides raw materials for future building products.

2. Donate Unused Materials

- **Description:** Unused or salvaged materials such as surplus wood, windows, doors and other uninstalled materials can be donated to organizations such as Habitat for Humanity.
- **Applications:** Materials should be clean and in good condition.
- **Benefit:** Donating unused materials reduces landfill deposits and helps local charitable organizations. Donations may be tax deductible. Refer to the Resource List for local organizations.

3. Protect Native Soil

- **Description:** Typically, a building site is cleared of vegetation and the topsoil is removed. After building, sod is laid on subsoil, beginning a cycle of high water and chemical dependency. Ideally, construction is coordinated with a landscape professional to protect the soil, which is a valuable, living resource.
- **Applications:** Design for minimum building & hardscape footprints and little or no grading. Retain native vegetation. Delineate and limit the construction footprint; restrict heavy equipment that compacts soil, including cars, to areas that will be paved or built over. When grading is unavoidable, identify areas to be paved as a place to store native topsoil during construction. Amend soil with compost and re-spread topsoil after construction.
- **Benefits:** Preserving native soils, along with nurturing the health of disturbed soils, can significantly reduce storm runoff, reduce fertilizer and pesticide requirements, improve water quality and conserve irrigation water.

4. Minimize Disruption of Existing Plants and Trees

- **Description:** Through careful planning and construction practices, valuable trees and plants can be preserved and incorporated into new developments and neighborhoods.
- **Applications:** Complete a landscape survey to determine the feasibility of preserving or relocating mature trees and shrubs. Fence trees and shrubs for protection from equipment.

- **Benefits:** Preserving existing, mature landscape features helps prevent soil erosion, maintains existing sources of natural cooling (e.g. shade from a mature tree), diverts waste from landfills, and adds a unique character to the community.

5. Implement Construction Site Stormwater Practices

- **Description:** Stormwater runoff is part of a natural hydrologic process. However, land development and construction activities can significantly alter natural drainage patterns and pollute stormwater runoff.
- **Applications:** Identify all storm drains located near the construction site, and make sure all subcontractors are aware of their locations to prevent pollutants from entering them. Protect all storm drain inlets using filter fabric cloth to prevent sediments from entering the storm drainage system during construction activities. Keep materials out of the rain, and prevent runoff pollution at the source. Store hazardous waste in drums and covered bins and contract a company to dispose of it properly.
- **Benefits:** Properly managing water on site saves money in avoided engineering costs downstream. Keeping pollutants out of the storm drains minimizes erosion and water pollution and protects the local water areas.

6. Protect Water Quality with Landscape Design Features

- **Description:** Designing landscapes to allow irrigation and stormwater to soak into the soil recharges groundwater systems, and filters out pollutants.
- **Application:** Use permeable paving, which allows water to percolate into the soil, for walkways, patios, and driveways. Install like conventional pavers. Minimize roadway width and avoid contiguous impermeable surfaces. Design infiltration basins and berms.
- **Benefit:** Allowing stormwater percolation reduces the volume of polluted water that flows into rivers or the Bay, while replenishing soil moisture and local aquifers. Additional benefits include reduction in irrigation requirements, non-source pollution as well as lower risk of flooding.

7. Design Resource-Efficient Landscapes and Gardens

- **Description:** Conventional landscapes have high inputs of water and chemicals and are often over-planted or planted without regard for climate and soil conditions. This results in excess water and fuel consumption, water pollution and waste generation.
- **Application:** Specify plants that are appropriate for the climate and soil; select slow-growing, drought tolerant, native plants. Design with perennials instead of annuals; choose and site trees to reduce building heating and cooling energy. Give plants plenty of room to mature, reducing the need for pruning. Avoid invasive species and hedges that require constant shearing. Limit turf to the smallest area that will meet recreational needs. Recycle yard trimmings by grasscycling, mulching and composting.
- **Benefit:** Sustainable landscape techniques are in harmony with the local environment and help conserve water, reduce use of chemicals, create healthier soil and plants, and increase bio-diversity in landscape areas. Resource:

8. Reuse Materials or Use Recycled Content Materials for Landscape Areas

- **Description:** Plastic or composite lumber makes a very durable landscape edging, broken concrete can make a very attractive retaining wall or path, and ground glass cullet can be used for walkways. Recycled tire rubber “mulch” is available as a durable low-maintenance ground cover to retard weed growth.
- **Application:** Use salvaged or recycled content materials for hardscapes (patios,

decks, walkways and driveways) and other landscape structures. 25 25 B

- **Benefit:** The durability of plastic or composite lumber is greater than wood as they do not rot, crack or splinter. Salvaging or buying recycled content landscaping products conserves natural resources and strengthens markets for recycled materials.

9. Install High-Efficiency Irrigation Systems

- **Description:** New irrigation technologies apply water to the soil at the plant root zones at the rate the soil can absorb it, significantly reducing water waste from overspray.
- **Application:** Install low-flow drip, sub-surface drip, or low-flow sprinklers in place of standard sprinkler systems for all landscape applications. Base watering levels on moisture sensors or weather based controllers. Use captured rainwater. Group plants by water requirements.
- **Benefit:** High-efficiency irrigation systems dramatically reduce landscape water use, and are critical to preventing disease & minimizing weed growth.

10. Provide for On-Site Water Catchment / Retention

- **Description:** Rainwater is channeled through gutters and downspouts to an aboveground cistern or underground gravel dry well. Stored water is used for landscape irrigation.
- **Application:** Install wherever there is guttered roof runoff and room for the cistern.
- **Benefit:** Water catchment reduces the need to use drinking water for irrigation of lawns and gardens.

B: FOUNDATION

1. Incorporate Fly ash (recycled material) in Concrete

- **Description**: Fly ash is a by-product of coal burning power plants and can be an inexpensive substitute for a portion of Portland cement used in concrete.
- **Application**: Typically, 15%-50% of cement can be replaced with fly ash in residential concrete mixes.
- **Benefit**: Fly ash increases the strength and durability of the concrete. Cement use is a leading industrial source of carbon dioxide (greenhouse gas) emissions. Using fly ash reduces the amount of cement needed, thereby decreasing the overall environmental impacts of cement production.

2. Reuse Form Boards

- **Description**: Form boards are often 2x10 or larger solid sawn lumber typically cut from old-growth trees.
- **Application**: Forms are used whenever concrete is poured. By carefully removing and separating the forms, they can be reused several times. Special forms are available that are designed for re-use. Form boards can also be used as structural members if they are recovered from the form carefully.
- **Benefit**: Reuse of forms saves money and conserves resources. Solid sawn lumber is becoming increasingly expensive and scarce.

3. Use Aluminum Forms

- **Description**: Aluminum forms come in all sizes and shapes and produce a smooth finished surface on the concrete. They can be used repeatedly.
- **Application**: Aluminum forms can be used in most Applications to replace wood forms.
- **Benefit**: Because they can be reused many times, aluminum forms reduce wood use and, despite higher initial cost, pay for themselves quickly.

4. Use Recycled Content Aggregate

- **Description**: Recycled aggregate consists mainly of crushed concrete and crushed asphalt pavement. Most of the recycled

material is used as base material for road products.

- **Application**: Use recycled aggregate for applications where Class 2 base rock is specified.
- **Benefit**: Even though a large percentage of asphalt and concrete are recycled, there is still some that end up in landfills. Using recycled instead of virgin materials saves money, natural resources and energy.

5. Insulate Foundation / Slab Before Backfill

- **Description**: All foundations, including slab floors, can be insulated to minimize heat loss.
- **Application**: Insulate foundation with extruded polystyrene insulation of at least R-4 (1" or greater).
- **Benefit**: Insulating the foundation minimizes heat loss from the floors and basement, reduces energy loss and, therefore, reduces utility bills.

6. Install Rigid Foam, Insulated Concrete Forms (ICFs)

- **Description**: Rigid foam forming systems hold concrete in place during curing and remain in place afterwards to serve as thermal insulation for concrete walls.
- **Application**: Use rigid foam forming systems wherever an insulated foundation is desirable.
- **Benefit**: Unlike untreated lumber, ICFs are not subject to rot and result in a better insulated foundation.

C: STRUCTURAL FRAME

1. Substitute Solid Sawn Lumber with Engineered Lumber

- **Description**: Solid sawn lumber in sizes of 2x10 or greater typically comes from old-growth forests. Engineered lumber products, on the other hand, come from small-diameter and fast growing plantation trees. These products include glulams, laminated veneer lumber, wood I-joists, oriented strand board, parallel strand lumber, and other manufactured wood fiber structural materials.
- **Application**: A. Floor Joist 2x10 and larger lumber are typically used for floor and ceiling joists and some seismic Applications. Large size lumber can be replaced with engineered lumber in most applications unless required by seismic codes. B. Non-Load Bearing Header Solid sawn 4x6 are often used for headers when smaller dimension lumber would suffice, such as double 2x6, unless solid 4x6 are required by seismic codes. 27 27 C. Structural Headers and Beams Engineered lumber should be used whenever structural members are required. They substitute for 4x12 in most interior Applications such as the structural framing of floors, walls and roofs.
- **Benefit**: Reducing demand for large dimensional lumber decreases pressure to cut down old-growth forests. Engineered lumber uses wood fiber more efficiently than conventional lumber, resulting in stronger and higher quality homes.

2. Use Forest Stewardship Council (FSC) Certified Wood for Framing

- **Description**: FSC certification assures that the forest from which the wood is produced is managed in a sustainable and socially responsible manner.
- **Application**: Use FSC wood where solid wood framing is required.
- **Benefit**: FSC certification guarantees that forests are managed in a way that will assure the long-term availability of precious woods while protecting old growth forests.

3. Use Wood I-joists for Floors and Ceilings

- **Description**: Wood I-joists are engineered to use only the wood fiber necessary for the structural function required. They typically use oriented strand board (OSB) for the web and either laminated veneer lumber or solid sawn lumber for the chords (top and bottom pieces).

- **Application**: Replace solid sawn lumber with wood I-joists for floor and ceiling joists. Often they can be used at 19.2" centers to save material.
- **Benefit**: Wood I-joists use 50% less wood fiber to perform the same structural function as similar sized solid sawn lumber and will never twist, warp or split. They are stronger and lighter than 2x10 or 2x12 and can span greater distances.

4. Use Steel Interior Web Trusses

- **Description**: Steel web trusses use wood or laminated veneer lumber top and bottom chords that are connected by steel webbing for structural integrity.
- **Application**: Use primarily for long-span floor joists.
- **Benefit**: Web trusses eliminate waste since they are made to order. They reduce the pressure on old growth forests by replacing 2x10s and 2x12s traditionally used for floor joists.

5. Use Oriented Strand Board (OSB) for Subfloor and Sheathing

- **Description**: OSB is manufactured from fast growing farm trees. OSB comes in sheets and is used for sheathing and subfloors.
- **Application**: Use OSB as an alternative to plywood for sheathing or subfloors.
- **Benefit**: OSB is as strong as traditional plywood sheet material and is less expensive. OSB reduces the need for large diameter old-growth trees required for plywood. Some OSB uses lower formaldehyde content adhesives that contribute to healthier indoor air quality.

6. Use Alternatives to Standard Wood Studs

- **Description**: Use engineered studs and finger-jointed studs.
- **Application**: Finger-jointed and engineered studs may be used wherever conventional studs are typically used, in vertical Applications. Engineered studs are particularly appropriate for tall cathedral wall Applications.
- **Benefit**: Engineered studs and finger-jointed studs are straighter than conventional studs. They save wood by using smaller pieces of lumber.

7. Use Recycled-Content Steel Studs for Interior Framing

- **Description**: Steel studs can be either stand-alone or provide a "c" channel over wood studs. Steel often contains 75% or higher recycled content. New products are beginning to penetrate the market that have the same thermal properties as wood making them a better choice for exterior walls.
- **Application**: For use in non-insulated interior walls. Use only thermally advanced light gauge steel studs in exterior walls.
- **Benefit**: Steel reduces the need for wood and provides strong interior walls.

8. Use Structural Insulated Panels (SIPs) for Walls and Roof

- **Description**: SIPs are high-performance, load-bearing sheets that consist of a core of foam insulation with OSB on either side. SIPS can be used for floors, walls and roofs in residential buildings.
- **Application**: Use SIPs for structural exterior walls and roofs in place of stick framing. SIPs can be designed to meet seismic Zone 4 requirements. Note: It's important to seal the joints well, to avoid water penetration.
- **Benefit**: SIPs are more energy-efficient, provide excellent soundproofing and reduce infiltration relative to frame construction. They can be erected quickly, allowing for faster construction. They save wood by eliminating much of the conventional framing lumber.

9. Use Reclaimed Lumber

- **Description**: High quality dimensional lumber in long lengths can often be salvaged from old buildings that are being deconstructed or salvaged.

- **Application**: Use reclaimed lumber for non-structural Applications, in place of new material.
- **Benefit**: Reclaimed lumber from deconstructed buildings reduces resource consumption and landfill deposits. Reclaimed lumber is often of higher quality than new lumber.

10. Use OVE Framing Techniques

- **Description**: Optimum Value Engineering (OVE) framing minimizes the amount of wood while maximizing the amount of insulation.
- **Application**: Studs can be spaced at 19.2" or 24" centers to reduce the number of framing members used and provide ample space for insulation.
- **Benefits**: Spacing 2x6" studs at 24" on center will provide a perfect fit for batt insulation with greater R values that those made for 2x4 walls, use less lumber, and be structurally sound.

D: EXTERIOR FINISH

1. Use Sustainable Decking Materials

A. Recycled Content Decking

- **Description**: There are two types of recycled content decking: plastic lumber and composite lumber. Recycled plastic lumber contains only recycled plastic resins, while composite lumber is made by combining recycled wood fiber and recycled plastic resins.
- **Application**: Use recycled content decking in all non-structural deck applications. Both products can be used in place of old-growth redwood, cedar and pressure treated pine. These products accept screws and nails, and cut like wood. Follow manufacturer recommendations closely regarding the amount of expansion that will occur when using plastic lumber.
- **Benefit**: The durability of these materials is greater than wood. They will not rot, crack or splinter, do not require staining and are not treated with potentially toxic chemicals. Using recycled content decking also reduces pressure on old-growth forests.

B. Forest Stewardship Council (FSC) Certified Wood Decking

- **Description**: Certified, sustainably harvested lumber comes from forests managed in an environmentally and socially responsible manner.
- **Application**: Use FSC Certified lumber for all exterior decking **Application**s or as structural deck members in conjunction with recycled content decking.
- **Benefit**: FSC certification guarantees that forests are managed in a way that will assure the long-term availability of precious woods while preserving old growth forests.

2. Use Treated Wood That Does Not Contain Chromium or Arsenic for Decking and Sill Plates

- **Description**: Alkaline Copper Quatenary (ACQ) is an alternative treated wood that does not contain chromium – a heavy metal – and arsenic, which are detrimental to human health.
- **Application**: Use non-chromium/arsenic treated wood for any **Application** that specifies treated lumber including decking, fencing, sill plates, and site furnishings. Use appropriate precaution when working with and disposing of treated lumber.
- **Benefit**: ACQ uses copper as its main component, and is a better alternative to lumber treated with chromium and arsenic, particularly for children who play on or near decks.

3. Install House Wrap under Siding

- **Description**: House wrap protects the sheathing from moisture and allows vapor from inside to escape.
- **Application**: Install house wrap according to manufacturer's specifications over all sheathing before exterior finish is installed. To provide an effective drainage plane for water, it needs to be lapped and edges should be taped with

manufacturer's tape. Special products have been developed for wrapping window and door openings and for stucco Applications.

- **Benefit**: House wrap provides a continuous drainage plane that diverts water away from openings and protects the home from mold. It can also help reduce moisture build up in stud cavities by allowing water vapor to migrate through the material.

4. Use Alternative Siding Materials

A. Use Recycled Content Siding

- **Description**: Recycled content siding is often called hardboard. Hardboard includes varying amounts of recycled content materials and looks and performs like wood siding.
- **Application**: Use hardboard where wood siding is installed.
- **Benefit**: Siding that has been manufactured with recycled wood fiber will not crack, split or warp and holds paint longer than solid wood siding, therefore reducing maintenance costs and resources.

B. Use Fiber-Cement Exterior Siding

- **Description**: Fiber-cement siding is composed of cement, sand and cellulose fibers. It is usually textured to look like wood siding or stucco finish.
- **Application**: Fiber-cement siding can be cut with a carbide or diamond-tipped saw blade, snapper shears or with a guillotine cutter. Dust protection and control are required when cutting with a circular saw.
- **Benefit**: Fiber-cement siding is more durable than wood, termite resistant, non-combustible and warranted to last 50 years. Using fiber-cement siding reduces the demand for old-growth redwood or cedar siding. It may also reduce homeowner's insurance rates due to fire resistance.

E: PLUMBING

1. Insulate Hot and Cold Water Pipes and install heat traps

- **Description**: Insulating water pipes reduces heat loss or gain in the pipes while the water is standing.
- **Application**: Insulate hot water pipes in all runs through unconditioned spaces: basements, crawl spaces, attics, etc. Heat traps are installed on hot water heaters to prevent cold water from flowing back into the hot water heater.
- **Benefit**: Insulated pipes and heat traps save energy and water. The water does not need to run as long to get hot water to a distant faucet, thereby reducing hot water heating costs.

2. Install Flow Reducers in Faucets and Showers

- **Description**: Flow reducers fit into the aerator at the tip of the faucet and reduce the rate of water flow through the faucet. Low-flow showerheads replace standard showerheads.
- **Application**: Specify low-flow water conservation devices:
  - Kitchen faucets 2.0 gpm
  - Bathroom faucets 1.5 gpm
  - Showerheads 2.5 gpm

  Limit showerheads to one fixture per shower
- **Benefit**: Flow reducers can cut water usage of faucets and showers by as much as 40% with little noticeable effect.

3. Install Ultra-Low-Flush or Dual Flush Toilets

- **Description**: New high-efficiency toilets use 1.6 gpf (gallons per flush) or less. Some manufacturers offer dual flush toilets that allow for half flushes (.8gpf) when a full flush is not needed
- **Application**: Ensure the model actually uses no more than 1.6 gpf and performs well.

- **Benefit**: Ultra-Low-Flush toilets reduce the amount of water usage.

4. **Install Chlorine Filter on Showerheads**
    - **Description**: Water filters on showerheads reduce chemicals and particulates from the water stream.
    - **Application**: Install the water filter between the pipe and the existing showerhead.
    - **Benefit**: Chlorine is absorbed 6 times faster through the skin than through the digestive system. It has been shown that chlorine absorption can have adverse health effects on some people and especially children.
5. **Install Tankless Water Heater**
    - **Description**: Tankless water heaters (flash or on-demand heaters) heat water as needed rather than having a tank in which hot water is stored. Their capacity to provide hot water is virtually unlimited.
    - **Application**: Install tankless water heater as close to the point of use as possible. The device should have a variable-set thermostat and be appropriately sized. Gas tankless water heaters typically have more capacity than electric tankless heaters.
    - **Benefit**: Conventional water heaters lose 15% of their energy through standing tank losses, whereas tankless heaters use energy only for immediate hot water needs. Tankless water heaters often are quicker and more reliable.
6. **Install a Graywater System**
    - **Description**: Graywater is wastewater from sinks, showers and washing machines that is not contaminated by human waste.
    - **Application**: Graywater plumbing separates the waste pipes from sinks, showers, and washing machines from the toilet waste. Graywater drains are run to a holding tank similar to a septic tank, which, in turn, is used to water plants, lawns and gardens. Check with the building department for requirements.
    - **Benefit**: Graywater utilization cuts down on the use of potable water for outside irrigation and lawn watering. It is essentially recycling water at home.
7. **Install Water Filtration Units at Faucets**
    - **Description**: Water filtration units can be installed at individual faucets or for the whole house. They reduce chlorine and many other chemicals, particulates and microorganisms.
    - **Application**: Whole house filters are for drinking water and plumbing (not for hose bibs or toilets). Install filtration system between the cold-water line and the main drinking water faucets in the house.
    - **Benefit**: Agricultural run-off, chemical leaching and microorganisms increasingly contaminate public water systems across the country. House filtration systems reduce the health threat of these contaminants.
8. **Install On-Demand Hot Water Circulation Pump**
    - **Description**: An on-demand hot water circulation pump can send hot water to fixtures in seconds; without wasting water while waiting for it to get hot. It uses a pump to rapidly move water from a water heater to fixtures. It stops when water reaches a pre-set temperature.
    - **Application**: Install the pump at the furthest faucet from the water heater. Only one pump is needed to supply hot water to any fixture and can easily be installed.
    - **Benefit**: Both water and energy are saved since water doesn't have to be wasted until it reaches the correct temperature for use. Hot water arrives to the fixture 5 times faster than on average.

F: ELECTRICAL

1. Install Light Emitting Diode Bulbs (LED), Compact Fluorescent Light Bulbs (CFLs) And Standard Fluorescent Bulbs to Replace Incandescents

- **Description**: LEDs & CFLs screw in like conventional bulbs but consume up to one-fourth of the electricity used by incandescent bulbs to produce an equivalent amount of light.
- **Application**: Install LEDs & CFLs in place of standard incandescent bulbs. CFLs are not recommended for fixtures that are turned on and off many times per day, i.e. a busy bathroom. Choose a bulb that is one-fourth the wattage of the incandescent bulb. Install fixtures that are designed for standard fluorescent bulbs.
- **Benefit**: LEDs, compact and standard fluorescent bulbs are a profitable investment, saving several times their purchase price through reduced electricity bills and fewer replacement bulbs because they last at least eight times longer.

2. Install Insulation-Compatible (IC) Recessed Lighting Fixtures for Compact Fluorescent Lamps

- **Description**: Conventional recessed fixtures allow heat to be exhausted into the attic space. Air-tight IC fixtures are sealed, allowing insulation to be blown on top to keep the heat in.
- **Application**s: Use air-tight IC fixtures in soffits and under insulated spaces.
- **Benefit**s: Typical recessed fixtures lose heat as well as allow hot attic air to infiltrate into the house in summer months. Air-tight IC fixtures dramatically reduce the amount of heat loss/gain through these openings.

3. Install Lighting Controls

- **Description**: Lighting controls use dimmers, sensors and timers to turn lights off in unused areas or during times when lighting is not needed.
- **Application**: Install lighting controls either at specific locations or as a whole house system. Lighting controls are especially applicable for exterior uses. Dimmable CFLs are available at a premium.

Benefit: Lighting controls reduce energy use by having the lights on for shorter periods of time.

4. Install High-Efficiency Ceiling Fans

- **Description**: Ceiling fans improve interior comfort by circulating cold and warm air. They can be adjusted to either draw warm air upward during summer months or push it downward during the winter.
- **Application**: Preferable locations are bedrooms and living rooms where occupants spend time. Ceiling fans must be supported adequately between ceiling joists.
- **Benefit**: Ceiling fans can reduce the need for air conditioning and heating.

G. APPLIANCES

1. Install ENERGY STAR® Appliances

Description: ENERGY STAR ® appliances use water and energy more efficiently.

Application: Select ENERGY STAR ® appliances.

Benefit: Energy Star appliances perform as well or better than other models but use significantly less energy.

2. Install Horizontal Axis Washing Machine

- **Description**: Horizontal axis machines load from the front, spinning clothes in and out of the water to tumble them clean.
- **Application**: Select ENERGY STAR® horizontal axis washing machines.
- **Benefit**: Horizontal axis machines save resources by using less water and energy. They use up to 40% less water and 50% less energy than conventional top loading washers, translating into lower energy and water bills for the resident.

Manufacturers claim that there is less wear and tear on clothes compared to the traditional agitator (top loading) machines.

H. INSULATION

1. Upgrade Wall and Ceiling Insulation to Exceed Title 24 Requirements

- **Description**: Insulation in exterior walls and ceilings can reduce the demand for air conditioning and heating and make homes more comfortable.
- **Application**: Insulate walls and ceilings to exceed Title 24 Standards: Increase wall insulation from R-13 to R-19. Increase ceiling insulation from R-19 to R-30.
- **Benefit**: Increased wall and ceiling insulation improves comfort, decreases heating and cooling requirements, saves money, and makes the home quieter.

2. Install Recycled Content, Formaldehyde-Free Fiberglass Insulation or Cotton Batt Insulation

- **Description**: Many fiberglass insulation products include recycled glass, formaldehyde-free binders, non-asphalt adhesives or colored dyes. Cotton Batt insulation uses recycled denim cutoffs from blue jeans, is very effective and has no formaldehyde and is safe for installers.
- **Application**: When using fiberglass insulation, specify recycled content and no formaldehyde. Both can be used for any typical insulation installation.
- **Benefit**: Formaldehyde-free insulation reduces indoor air quality problems. Recycled content removes material from the waste stream and decreases burden from extraction of natural resources. 3

3. Use Cellulose Insulation

A. Walls

- **Description**: Cellulose is a highly effective insulation made out of recycled newspaper. Damp-blown spray cellulose wall insulation is mixed with low toxic binders to adhere to stud and joist cavity surfaces.
- **Application**: This installation is appropriate for new construction. Avoid damp-blown cellulose during wet months and install drywall only after testing for 25% (maximum) moisture content. Use boric acid treatment only; avoid ammonium sulfate treated cellulose insulation.
- **Benefit**: Spray insulation completely fills cavities and penetrations, thus reducing air infiltration. The binder in the insulation also reduces the air movement within wall cavities, reducing moisture intrusion and flame spread. Using cellulose insulation makes the home quieter, more comfortable and reduces energy use by 20-40%.

B. Ceilings

- **Description**: Dry-blown or loose-fill cellulose is treated with borates for fire and insect resistance. Cellulose does not contain formaldehyde, which is common in many fiberglass insulations.
- **Application**: Spread cellulose over ceiling joists or blow into tight cavities to increase ceiling R-value. It is important to maintain attic or ceiling ventilation pathways, especially in cathedral ceiling Applications. Avoid excessive blown-in cellulose behind netting as it may make it difficult to achieve flat walls and ceilings with drywall. Best to use 5/8" drywall only over dryblown cellulose insulation. Use boric acid treatment only, avoid ammonium sulfate treated cellulose.
- **Benefit**: Cellulose insulation is formaldehyde-free, provides up to 22-55% higher fire resistance, manufactured with recycled materials. It also reduces air leakage and contributes to a more comfortable and energy efficient home.

4. Use Advanced Infiltration Reduction Practices

Description: Expandable foam and caulk are used to prevent infiltration where wood connections are made or framing is drilled to provide for plumbing and electrical runs.

Application: These methods are especially important when fiberglass insulation is installed, since fiberglass does little to reduce infiltration. Seal holes between floors and between stud cavities around wire runs. Caulk top and bottom plates on all floors.

Benefit: Reduction in infiltration increases comfort and reduces energy bills.

I. WINDOWS

1. Install Energy-Efficient Windows

Windows play a big role in the energy efficiency of homes. In the summer, they can allow unwanted heat into the house, and in the winter, windows can account for as much as 25% of the heat loss. When selecting windows, look for models with the following energy saving features:

A. Double-Paned Windows

- **Description**: Double glazing insulates almost twice as well as single glazing.
- **Application**: Install double-paned windows whenever possible.
- **Benefit**: High quality double-paned windows make the whole house quieter and more comfortable during all seasons, while saving energy and money.

B. Low-Emissivity (Low-E) Windows

- **Description**: Low-E coatings, virtually unnoticeable to the eye, are installed inside the air space of a double-paned window. The low-E coatings help prevent heat from escaping through the glass in winter and block heat from entering the home during summer.
- **Application**: Use low-E, double-paned windows.
- **Benefit**: Low–E windows reflect heat, making the home more comfortable in cold weather and on hot summer days. The cost premium for low-E glass typically pays for itself in a few years. Low-E, double-paned glass coating increases glass R-value to 3 compared to R-1 for single-glazed windows.

2. Low-Conductivity Frames

- **Description**: Most window frames and sashes are made of wood, vinyl, fiberglass or aluminum. Wood, vinyl and fiberglass generally insulate better than aluminum frames. Thermally broken anodized aluminum frames are a great choice for durability and thermal insulation. Due to life-cycle impacts, vinyl is not a preferred material.
- **Application**: Consider specifying wood windows or thermally broken aluminum windows.
- **Benefit**: Wood windows create greater comfort and better energy efficiency and are an environmentally preferable material.

3. High performance window films

- **Description**: Tints, reflective coatings, and spectrally selective coatings can be applied to windows in either new construction or retrofit Applications. There are special coatings that can cut heat gain, reduce UV radiation, and provide shade.
- **Application**: Specify films that have the qualities you desire. Films can be applied to windows prior to or after installation.
- **Benefit**: Films can cut glare, reduce cooling loads, slow heat loss through windows, and reduce the fading caused by UV rays.

J. HVAC

1. Use Duct Mastic on all Duct Joints

- **Description**: Leaks in the joints between ductwork allow conditioned air to escape into attics and basements. Duct tape loses its effectiveness in 3-5 years. Mastic maintains the seal for decades.
- **Application**: Install mastic at every duct joint and around the bends in elbows. It is important for all ducts to be sealed.
- **Benefit**: Leaky air ducts can cause negative pressure in the house which can allow carbon monoxide from gas water heaters and furnaces into the home. Well-

sealed ductwork also keeps the house more comfortable.

2. **Install Ductwork within Conditioned Space**
    - **Description**: Ducts in exterior walls, attics and in uninsulated spaces lose a significant amount of heated or cooled air capacity.
    - **Application**: All ductwork for heating or cooling should be run through conditioned space inside the insulated envelope. Duct runs require chases to be designed into the home from the beginning.
    - **Benefit**: Locating ducts in the conditioned space significantly reduces energy loss and improves occupant comfort.
3. **Vent Range Hood to the Outside**
    - **Description**: Steam, gases, smoke and other combustion byproducts (such as unburned hydrocarbons) can result from cooking. Stovetop range hoods expel these by-products to the outside.
    - **Application**: Range hoods are particularly important for gas stoves and can be installed where stoves are adjacent to exterior walls.
    - **Benefit**: Range hoods improve indoor air quality, prevent overheating and excess moisture build-up.
4. **Clean all Ducts Before Occupancy**
    - **Description**: Debris and dust from construction can cause allergic reactions in occupants.
    - **Application**: Clean or vacuum all ductwork before occupancy to eliminate dust. Clean ducts before carpet is laid and finishes are applied. Reduce dust build-up by temporarily blocking registers at time of duct installation.
    - **Benefit**: Children are especially sensitive to micro particulates like drywall dust. Cleaning and vacuuming ductwork reduces dust around the house after occupancy.
5. **Install Attic Ventilation Systems**
    - **Description**: Soffit and eave ventilation and gable/ continuous ridge ventilation exhausts excess heat and moisture from attic spaces by natural convection.
    - **Application**: Install equal amounts of ventilation between the soffits/eaves and the gables/ridges. The code requirement of 1 square foot of net free area of venting for every 150 square feet of attic floor area should be doubled. Keep insulation from blocking the soffit vents.
    - **Benefit**: Attics can reach 140º-160º F on a hot summer day. That heat migrates into the house, exchanging air with the living space. Eave and soffit venting and continuous ridge venting increases comfort, reduces air-conditioning costs and reduces problems associated with excess attic moisture.
6. **Install Whole House Fan**
    - **Description**: Whole house fans can cool a house without using an air conditioner by bringing in large volumes of fresh air at night.
    - **Application**: The fan must be mounted in a hallway ceiling on the top floor. An insulated, airtight seal is necessary to prevent air leakage in winter. Fans should be sized to produce between 4-5 air changes per hour and should have two speeds: low speed for continuous ventilation and high speed. Keep a window open at night to avoid backdrafting of carbon monoxide in gas appliance flues.
    - **Benefit**: An average whole house fan uses one-tenth the electricity of an air conditioning unit. Moving large volumes of air can achieve indoor comfort at higher temperatures without air conditioning.
7. **Install Sealed Combustion Furnaces and Hot Water Heaters**
    - **Description**: Sealed combustion furnaces and water heaters duct fresh air directly into a sealed jacket around the combustion chamber eliminating the use of house air for combustion.

- **Application**: Install in place of conventional furnaces or hot water heaters.
- **Benefit**: Natural gas furnaces and hot water heaters use indoor air for combustion. When a negative pressure situation is created in the home by exhaust fans, dryers or leaky ducts, carbon monoxide can be pulled into the house from the combustion chamber. Sealed furnaces and hot water heaters eliminate that condition, thereby improving indoor air quality and reducing the danger of carbon monoxide contamination.

8. Install Greater than 12 SEER Air Conditioning with a Thermostatic Expansion Valve (TXV)

- **Description**: Air conditioning equipment is one of the greatest loads on power grids. SEER (Seasonal Energy Efficiency Ratio) measures cooling system efficiency at low temperatures while EER (Energy Efficiency Ratio) is a high temperature performance rating. The higher the SEER/EER number the less power is required to provide comfort. This assures that the air conditioning system operates at high efficiency during the full range of summer temperatures. TXV is a refrigerant regulation device that can help ensure that the air conditioning system operates at maximum efficiency over a wide range of conditions.
- **Application**: Higher SEER air conditioning units are installed like any other AC equipment. Some AC equipment comes with a factory installed TXV and others accept a TXV that can be bolted on. Zoned AC systems allow 2 to 4 zones to be conditioned at different temperatures so only the spaces being used are cooled. These require thermostats in each zone.
- **Benefit**: High SEER units save money and energy and reduce peak load problems for utilities. High EER systems not only save money and energy but offer more cooling when you need it most, on very hot days. Installing air conditioning systems with a TXV lowers utility bills and saves energy.

9. Install Air Conditioning with Non-HCFC Refrigerants

- **Description**: R-22 is an HCFC refrigerant used in residential heating and cooling systems. R–22 contains chlorine which is an ozone-destroying chemical. In 2010, under the Clean Air Act, HVAC manufacturers can no longer produce new air conditioners using R-22.
- **Application**: Some new AC units already use the alternative to R-22 refrigerant, R-410A, such as the trade brand Puron. Additional care should be taken when handling refrigerants, always select a reputable dealer who employs service technicians that have achieved Environmental Protection Agency (EPA) certification to handle refrigerants.
- **Benefit**: Using alternatives to HCFC refrigerants eliminates depletion of the ozone layer in case of leakage during replacement.

10. Install 90% AFUE (Annual Fuel Utilization Efficiency) or Greater Furnace

- **Description**: High efficiency furnaces convert gas to heat with greater efficiency.
- **Application**: Install high efficiency furnace in place of conventional furnace. Installing the proper size of furnace for the home is just as important as its efficiency. Check with your local utility company for rebate information.
- **Benefit**: A properly sized, high-efficiency furnace costs less to operate. It saves natural resources, reduces air emissions and contributes to a cleaner environment.

11. Eliminate Wood Burning Fireplaces

- **Description**: The burning of wood in fireplaces is a major source of air pollution during the winter months, generating up to one-third of the particulate matter on cold evenings.

- **Application**: Install EPA certified wood stoves, fireplace inserts, pellet stoves or natural gas units. These units should have outside combustion air vented directly into the insert or unit.
- **Benefit**: The amount of pollutant particulate matter will be reduced significantly compared to that of a standard wood burning fireplace.

12. Install Zoned, Hydronic, Radiant Heating

- **Description**: Hydronic heating forces hot water through radiators located in different areas or zones throughout the house. It is typically installed as baseboards or in floors.
- **Application**: Use hydronic, radiant heating instead of forced air heating. The system must be designed before construction starts.
- **Benefit**: Hydronic heating is more comfortable and saves energy by heating only the zone that requires heat and does not blow dust into the air like traditional forced-air units.

13. Install High-Efficiency Particulate Air (HEPA) Filter

- **Description**: HEPA filters remove over 90% of dust and particulates from the air.
- **Application**: HEPA filters are installed in the return air stream at the air handler, which should be sized to handle the reduced air pressure caused by the filter. Some units have an air conditioning setting for the fan that will handle the retrofit filter.
- **Benefit**: The EPA has identified microparticulates as a leading cause of respiratory discomfort. By removing these particles, the HEPA filter makes the living space healthier.

14. Install Heat Recovery Ventilation Unit (HRV)

- **Description**: An HRV is a mechanical ventilation system that recovers heat from exhausted indoor air and transfers it to the incoming fresh air stream.
- **Application**: The unit should be designed into the HVAC system to capture heat from exhausted air from the house. Note: Use of this equipment is particularly appropriate with blower door test results of less than .35 Natural Air Changes per Hour (NACH), which measures the air tightness of the house.
- **Benefit**: Air-to-air heat exchangers provide for fresh air in winter while exhausting stale indoor air. Heat is captured from the exhausted air stream and transferred to the incoming air.

15. Install Separate Garage Exhaust Fan

- **Description**: According to the U.S. Environmental Protection Agency (EPA), an attached garage is the single most significant contributor to poor indoor air quality. Car exhaust contains many known carcinogens and can migrate into living spaces through doors and cracks in walls and ceiling adjacent to the garage.
- **Application**: Install exhaust fan on the opposite wall from the door to the house. It can be wired to an electric garage door or put on a timer to run for 15 minutes after door has been opened or closed.
- **Benefit**: An exhaust fan creates a healthier indoor environment by reducing the potential hazard of car exhaust from entering the house.

K. RENEWABLE ENERGY & ROOFING

1. Pre-Plumb for Solar Water Heating

- **Description**: Insulated copper pipes are installed from the attic to a hot water closet or mechanical room for future solar installation. This option allows the homeowner to install an active solar system at a later date if they desire.
- **Application**: Provide south-facing roof area for collectors and access for piping to a mechanical room.

- **Benefit**: Solar hot water pre-plumbing can save money for the homeowner if, at some point in the future, they want to install a solar system.

2. Install Solar Water System

- **Description**: Solar water heating systems use solar panels to collect heat from the sun. The hot water is stored for use at a later time. Water pre-heated by a solar system can also supplement use of a standard water heater.
- **Application**: Provide sufficient south-facing roof area for collectors, and allow space in a hot water closet for the additional hot water storage tank.
- **Benefit**: Solar hot water systems can pay back in as little as seven years and reduce the use of gas or electricity for water heating.

3. Pre-Wire for Future Photovoltaic (PV) Installation

- **Description**: Running wires from the roof to the electric service entrance/circuit breaker panel can save costly installation of photovoltaic panels at a future date.
- **Application**: Run two pair #10 THHN wire plus #8 ground in conduit from the south facing roof to a junction box near the panel (don't wire the panel). East and West facing roofs can work if the south is unavailable or shaded for panels.
- **Benefit**: Photovoltaic panels and systems will continue to drop in price over the next few years. Homebuyers may not be able to afford the system today but may be interested in the future when the price comes down.

4. Install Photovoltaic (PV) Panels

- **Description**: PV panels contain hundreds of small cells that collect the sun's energy and convert it into electricity. Excess electricity can be sent back into the utility grid.
- **Application**: Typical PV installations include flat roof, sloped roof, building integrated PV and ground mount. Items to consider when installing PV include: sunlight minimum of 4 hours required during peak period (8 a.m. to 4 p.m.) with no shade; orientation-anything but North; angle-flat to 60 degrees; adequate roof area-depending on type of PV selected (monocrystal, polycrystal or amorphous).
- **Benefit**: PV panels can be used as a means to decrease reliance on conventional power plants that contribute to air pollution.

5. Install Solar (PV) Walkway Lights

- **Description**: Solar walkway or exterior lighting use photovoltaic cells (PV) to create electricity during the day and store it in batteries for night time use.
- **Application**: Lights can be placed anywhere without the need to run wires as long as they receive sunlight during the day.
- **Benefit**: PV lighting is cost effective and reduces the need for grid-provided electricity.

6. Select Safe and Durable Roofing Materials

- **Description**: 40-50 year asphalt composition, tile, slate, fiber-cement and metal are examples of safe and durable roofing materials. Avoid cedar and wood shake shingles.
- **Application**: Applicable anytime roofing material is specified.
- **Benefit**: A durable and safe roof is cost effective and reduces landfill deposits.

7. Install Radiant Barrier Roof Sheathing

- **Description**: When radiant energy from the sun strikes a surface, it is converted to heat energy. A radiant barrier reflects radiant heat and does not emit it to the cooler surfaces around it. Radiant barrier sheathing is a roof sheathing material with a reflective layer (film or foil) applied to the underside.
- **Application**: Radiant barrier sheathing can be used in place of conventional roof sheathing. Apply reflective material to the underside of rafters.

- **Benefit**: Radiant barrier sheathing reduces heat build-up in attic spaces by not re-radiating heat from to roof to the attic. It can prevent up to 97% of the sun's radiant heat from entering the home and can bring attic temperatures down as much as 30 degrees on hot days, keeping the whole home cooler and reducing energy consumption for air conditioning.

L. NATURAL HEATING & COOLING

1. Incorporate Passive Solar Heating

- **Description**: Passive solar design provides heat to the structure through south facing windows in conjunction with thermal mass.
- **Application**: The house must incorporate windows that face within 30 degrees of due south and have the ability to store excess heat in massive elements such as a slab floor or stone fireplace.
- **Benefit**: Passive solar design can reduce heating requirements by 30-50%, saving energy and money.

2. Install Overhangs or Awnings over South Facing Windows

- **Description**: Properly sized overhangs or awnings on south facing windows are important components of passive solar heating and natural cooling. Overhangs and awnings help keep the heat of the sun from entering the home during unwanted times, but allow heat to enter in the winter. These shade control devices can be oversized roof overhangs, wood trellises/arbors with deciduous plants, or adjustable or demountable awnings made of fabric or metal.
- **Application**: The overhang or awning design should keep out summer sun by shading the entire window during the hottest month(s) of the year. Size overhangs or awnings above south windows so that winter sunlight is allowed into the space, where it can be 41 41 M absorbed by thermal mass, and be re-radiated as heat. Also, consider shading devices on the west and east facing windows to protect from morning and afternoon heat, especially in hotter climates.
- **Benefit**: Overhangs, awnings and trellises are an integral part of making passive solar heating and natural cooling work. Removable/retractable fabric awnings offer a low-cost solution to reduce heat gain, lower energy bills, and make the home more comfortable in the summer

3. Plant Deciduous Shade Trees on the West and South Sides of the Home

- **Description**: During summer months, the sun shines on the south and west sides of the home causing the home to heat up which in turn makes air conditioners work their hardest. Trees offer the best solution for keeping out low-angle sunlight from west and south windows in summer. The additional cooling demanded by low-angle sun penetration of west windows in late summer afternoons create the most significant summer peak utility costs.
- **Application**: Plant shade trees on the west and south sides of the home to provide shade and summer cooling. The most important areas to shade are windows and paved areas. Keep trees three feet from the foundation to avoid introduction of pests and root intrusions. Avoid planting trees too close to the home or utilities.
- **Benefit**: Planting shade trees can reduce summer air-conditioning costs by 25% to 40%. Trees provide numerous additional benefits to the environment including cleansing the air, creating habitats for birds and play places for children as well as adding aesthetic beauty to the neighborhood. Through shade and evapotranspiration, trees can create a microclimate that is up to 15 degrees cooler than the surrounding area.

M. INDOOR AIR QUALITY & FINISHES

1. Install Whole House Vacuum System

- **Description**: Whole house vacuums exhaust the dust from the house outside rather than collecting it in a bag that may not filter the dust effectively.
- **Application**: Whole house vacuum systems must be vented outdoors, not into a garage, and not to any area where air may be taken back into the house.
- **Benefit**: New generation portable vacuum cleaners may have HEPA filter that reduce the size of dust particles blown back into the house. Most vacuum cleaners do not filter the dust effectively and merely redistribute the dust that is most harmful to the respiratory system. This can aggravate asthma and other respiratory problems. Whole house vacuums expel the dust outside the house.

2. Use Low/No-VOC and Formaldehyde-Free Paint

- **Description**: Most paint releases volatile organic compounds (VOCs), a major indoor air pollutant, into the home. Once outside, VOCs react with other pollutants, producing ground-level ozone that also affects human health. Often low/no-VOC products are manufactured without mercury or mercury compounds, or pigments of lead, cadmium, chromium, or their oxides.
- **Application**: Paint with low/no-VOCs is available from most major manufacturers and is applied like traditional paint products. High washability should be specified for bathrooms, kitchens and children's bedrooms. Every finish and most colors are available in low/no-VOC paints. 42
- **Benefit**: Low/No-VOC paint reduces the emissions of VOCs into the home, improving indoor air quality and reducing the formation of urban smog.

3. Use Low VOC, Water-Based Wood Finishes

Description: Conventional solvent-based wood finishes can "offgas" for months, and can be harmful to children. "Offgassing" means the solvents are continuously released into the air, which contributes to poor indoor air quality. Low VOC finishes, such as water-borne urethane and acrylic, are lower in toxic compounds compared to conventional solvent-based finishes while providing similar durability.

Application: Low VOC wood finishes can be used in most applications where solvent-based finishes are typically used. If solvent-based wood finishes must be used, they should be left to offgas for three to four weeks prior to occupancy.

Benefit: Using low VOC wood finishes reduces off-gassing into the home, improving indoor air quality, and reducing the formation of urban smog.

4. Use Solvent-Free Adhesives

- **Description**: Unlike solvent-based adhesives that offgas toxic compounds for months, solvent-free adhesives reduce toxic gasses such as aromatic hydrocarbons or solvents that contribute to air pollution.
- **Application**: Use solvent-free products in place of standard adhesives for all interior applications such as installation of flooring, countertops, wall coverings, paneling and tub/shower enclosures.
- **Benefit**: Solvent-free adhesives are often stronger, emit fewer pollutants, and reduce the potential harmful impacts on the health of the occupants and installers.

5. Substitute Particleboard with Formaldehyde-Free Materials

- **Description**: Particleboard is made from wood fibers and an adhesive that contains urea-formaldehyde, a suspected human carcinogen. The formaldehyde is continuously released, which contributes to poor indoor air quality. Particleboard is typically used for cabinets, countertops, stair treads, and shelving.
- **Application**: Whenever possible, eliminate new particleboard inside houses

by using solid wood for stair treads, certified exterior grade plywood or formaldehyde free medium density fiberboard (MDF) for shelving, cabinets and substrate for countertops.

- **Benefit**: Elimination of particleboard reduces formaldehyde exposure to residents, particularly children, who are most susceptible.

6. Use Exterior Grade Plywood for Interior Uses

- **Description**: Exterior plywood uses phenolic resins that offgas much less than interior plywood. Interior plywood typically uses urea-formaldehyde glue which offgasses into the house.
- **Application**: Substitute interior plywood with exterior plywood for custom cabinets and shelving.
- **Benefit**: Formaldehyde is a suspected human carcinogen and should be avoided whenever possible.

7. Use Formaldehyde-Free Medium Density Fiberboard (MDF) and Materials

- **Description**: Most MDF is made from sawdust and an adhesive that contains urea formaldehyde, a suspected human carcinogen. MDF without formaldehyde binders is now available. Other alternatives include certified plywood and boards made from agricultural waste, such as wheatboard, a straw-based particleboard manufactured with non-formaldehyde and emission-free binders.
- **Application**: Whenever possible, eliminate formaldehyde-based MDF inside the home. MDF is typically used for cabinets, trim, and shelving. Use alternatives such as certified plywood, formaldehyde-free MDF, or wheatboard for shelving and cabinets. Use tile, stone, concrete or natural linoleum for countertops.
- **Benefit**: Reduces formaldehyde exposure to residents, particularly children, who are most susceptible. Some boards made from agricultural waste are superior to wood-based particleboard in moisture resistance and structural properties, and provides for the reuse of a former waste product.

8. Seal all Exposed Particleboard or MDF

- **Description**: Using less-toxic, low permeability paint or sealer to seal exposed particleboard or MDF will reduce the release of harmful gasses and is the next best solution to elimination of particleboard.
- **Application**: Whenever formaldehyde-based MDF or particleboard is used, seal all exposed edges of cabinets, undersides of countertops, stairs, shelving, etc. with at least two coats of less-toxic, low permeability paint or sealer prior to installation.
- **Benefit**: Sealing all exposed particleboard reduces exposure of harmful emissions to residents, particularly children, who are most susceptible.

9. Use Forest Stewardship Council (FSC) Certified Wood Products

- **Description**: FSC certified materials (e.g. trim, doors, shelving) come from forests that are managed in accordance with sustainable forest practices. It is particularly important to specify certified wood instead of clear, knot-free trim as this material is typically harvested from non-sustainable, old growth forests.
- **Application**: Use FSC certified materials in any application that normally uses conventional stain-grade materials
- **Benefit**: Sustainable forest certification assures that the forest from which the trim is produced is managed in a way that will assure the long-term availability of these precious woods while protecting ancient, old growth forests.

10. Use Finger-Jointed or Recycled Content Trim

Description: Finger-jointed trim is manufactured from short pieces of clear wood glued together to

create finished trim. Recycled content trim is made from recycled polystyrene/plastics.

Application: Use finger-jointed or recycled content trim in any application where trim is to be painted.

Benefit: Finger-jointed or recycled content trim is straighter and more stable than conventional clear wood, and uses materials more efficiently

N. FLOORING

1. Select Forest Stewardship Council (FSC) Certified Wood Flooring

- **Description**: Certified wood flooring comes from forests that are managed in accordance with sustainable forest practices. Certified wood flooring products are available in a wide variety of domestic and exotic species.
- **Application**: Use FSC certified wood in place of conventional hardwood flooring.
- **Benefit**: Sustainable forest certification assures that the forest from which the flooring is produced is managed in a way that will assure the long-term availability of these precious woods while protecting ancient, old growth forests.

2. Use Rapidly Renewable Flooring Materials

- **Description**: Bamboo and cork flooring are alternatives to hardwood flooring. Bamboo is a fast-growing grass that can be harvested in three to five years. Cork is a natural flooring material that is obtained from the outer bark of the cork oak tree that is regenerated every 10 years.
- **Application**: Use these alternative flooring materials in place of conventional hardwood. Make sure that a durable finish is used on the product
- **Benefit**: Fast growing, rapidly renewable floor substitutes are attractive and reduce pressure on hardwood forests. Bamboo is as durable as wood; cork is naturally fire and moisture resistant as well as sound absorbing.

3. Use Recycled Content Ceramic Tiles

- **Description**: Recycled content ceramic tiles can contain up to 70% recycled glass. Originally developed for high traffic commercial conditions, recycled content tiles are very durable and wear well in residential applications.
- **Application**: Install recycled content tiles wherever conventional tiles are specified.
- **Benefit**: Some recycled content ceramic tile is very dense which significantly reduces the amount of moisture and stains that are absorbed into the tile, making it more durable and easier to maintain.

4. Install Natural Linoleum in Place of Vinyl Flooring

- **Description**: Natural linoleum is manufactured from natural materials such as cork and linseed oil. Unlike vinyl, linoleum does not contain petroleum-based products or chlorinated chemicals such as PVC, which may be a source of VOC offgassing. There is also concern of by-products such as cancer causing dioxins, which may be produced during the manufacturing of vinyl.
- **Application**: Use natural linoleum in place of vinyl flooring.
- **Benefit**: Linoleum is low-toxic, easy to repair, durable, and stain resistant. Linoleum can last up to 40 years, whereas vinyl lasts typically 7-10 years.

5. Use Exposed Concrete as Finished Floor

- **Description**: For slab-on-grade construction, the concrete can be polished, finished with expansion joints in various patterns or stained with pigments to make an attractive finish floor. This approach is especially appropriate for radiant, in-floor heating systems.
- **Application**: Use this approach for slab-on-grade construction. Finish must be designed and constructed when slab is being poured.

- **Benefit**: When using the slab as a floor finish, it eliminates the need to use other flooring materials. Additionally, it is durable and easy to clean.

6. Install Recycled Content Carpet or Natural Fiber Carpets with Low-VOCs

- **Description**: Recycled content carpet is made from recycled plastic bottles, recycled nylon/wool or recycled cotton. Recycled content carpet does not differ in appearance or performance and the price is comparable to conventional carpet. The Carpet and Rug Institute (CRI) has a Green Label Indoor Air Quality Test Program which labels the VOC (volatile organic compounds) content of carpeting. Natural fiber carpets and rugs 45 45 O made from wool, sisal, etc. are rapidly renewable and naturally low in VOCs.
- **Application**: Use recycled content carpet in all applications where conventional carpet is specified. Choose carpet that meets or exceeds the CRI Green Label requirements. Resource: www.carpet-rug.com
- **Benefit**: Recycled content carpet saves resources and diverts waste from landfills. Approximately 40 two-liter soda bottles are recycled per square yard of carpeting. Recycled carpet is often more resilient and colorfast than carpet made from virgin fibers.

O. OTHER

1. Install Built-In Recycling Center

- **Description**: Built-in recycling centers provide bins for separated recyclables and food waste.
- **Application**: Recycling bins can be built into kitchen cabinets, as well as stand-alone units in the garage.
- **Benefit**: A built it recycling center keeps materials separated and free from contamination, making it easy and convenient to recycle.

BUILDING CHECKLIST

Measure	Select
SITE	
1. Recycle Job Site Construction and Demolition Waste	☐ yes ☐ no
2. Donate Unused Materials	☐ yes ☐ no
3. Protect Native Soil	☐ yes ☐ no
4. Minimize Disruption of Existing Plants and Trees	☐ yes ☐ no
5. Implement Construction Site Stormwater Practices	☐ yes ☐ no
6. Protect Water Quality with Landscape Design Features	☐ yes ☐ no
7. Design Resource-Efficient Landscapes and Gardens	☐ yes ☐ no
8. Reuse Materials or Use Recycled Content Materials for Landscape Areas	☐ yes ☐ no
9. Install High-Efficiency Irrigation Systems	☐ yes ☐ no
10. Provide for On-Site Water Catchment / Retention	☐ yes ☐ no
FOUNDATION	
1. Incorporate Fly ash (recycled material) in Concrete	☐ yes ☐ no
2. Reuse Form Boards	☐ yes ☐ no
3. Use Aluminum Forms	☐ yes ☐ no
4. Use Recycled Content Aggregate	☐ yes ☐ no
5. Insulate Foundation / Slab	☐ yes ☐ no
6. Install Rigid Foam, Insulated Concrete Forms (ICFs)	☐ yes ☐ no
STRUCTURAL	
1. Substitute Solid Sawn Lumber with Engineered Lumber	☐ yes ☐ no
2. Use Forest Stewardship Council (FSC) Certified Wood for Framing	☐ yes ☐ no
3. Use Wood I-joists for Floors and Ceilings	☐ yes ☐ no
4. Use Steel Interior Web Trusses	☐ yes ☐ no
5. Use Oriented Strand Board (OSB) for Subfloor and Sheathing	☐ yes ☐ no
6. Use alternatives to standard wood studs	☐ yes ☐ no
7. Use Recycled-Content Steel Studs for Interior Framing.	☐ yes ☐ no
8. Use Structural Insulated Panels (SIPs) for Walls and Roof	☐ yes ☐ no
9. Use Reclaimed Lumber	☐ yes ☐ no
10. Use OVE Framing Techniques	☐ yes ☐ no

EXTERIOR FINISH	
1. Use Sustainable Decking Materials	☐ yes ☐ no
2. Use Treated Wood That Does Not Contain Chromium or Arsenic for Decking and Sill Plates	☐ yes ☐ no
3. Install House Wrap under Siding	☐ yes ☐ no
4. Use Alternative Siding Materials	☐ yes ☐ no
PLUMBING	
1. Insulate Hot and Cold Water Pipes and install heat traps	☐ yes ☐ no
2. Install Flow Reducers in Faucets and Showers	☐ yes ☐ no
3. Install Ultra-Low-Flush or Dual Flush Toilets	☐ yes ☐ no
4. Install Chlorine Filter on Showerheads	☐ yes ☐ no
5. Install Tankless Water Heater	☐ yes ☐ no
6. Install a Graywater System	☐ yes ☐ no
7. Install Water Filtration	☐ yes ☐ no
8. Install On-Demand Hot Water Circulation Pump	☐ yes ☐ no
ELECTRICAL	
1. Install Compact Fluorescent Light Bulbs (CFLs) and standard fluorescent bulbs to replace incandescent	☐ yes ☐ no
2. Install Insulation-Compatible (IC) Recessed Lighting Fixtures for Compact Florescent Lamps	☐ yes ☐ no
3. Install Lighting Controls	☐ yes ☐ no
4. Install High-Efficiency Ceiling Fans	☐ yes ☐ no
APPLIANCES	
1. Install ENERGY STAR® appliances	☐ yes ☐ no
2. Install Horizontal Axis Washing Machine	☐ yes ☐ no
INSULATION	
1. Upgrade Wall and Ceiling Insulation to Exceed Title 24	☐ yes ☐ no
2. Install Recycled Content, Formaldehyde-Free Fiberglass Insulation or Cotton Batt Insulation	☐ yes ☐ no
3. Use Cellulose Insulation	☐ yes ☐ no
4. Use Advanced Infiltration Reduction Practices	☐ yes ☐ no

WINDOWS	
1. Install Energy-Efficient Windows	☐ yes ☐ no
HVAC	
1. Use Duct Mastic on all Duct Joints	☐ yes ☐ no
2. Install Ductwork within Conditioned Space	☐ yes ☐ no
3. Vent Range Hood to the Outside	☐ yes ☐ no
4. Clean all Ducts Before Occupancy	☐ yes ☐ no
5. Install Attic Ventilation Systems	☐ yes ☐ no
6. Install Whole House Fan	☐ yes ☐ no
7. Install Sealed Combustion Furnaces and Hot water Heaters	☐ yes ☐ no
8. Install Greater than 12 SEER Air Conditioning with a Thermostatic Expansion Valve (TXV)	☐ yes ☐ no
9. Install Air Conditioning with Non-HCFC Refrigerants	☐ yes ☐ no
10. Install 90% AFUE (Annual Fuel Utilization Efficiency) or Greater Furnace	☐ yes ☐ no
11. Eliminate Wood Burning Fireplaces	☐ yes ☐ no
12. Install Zoned, Hydronic, Radiant Heating	☐ yes ☐ no
13. Install High-Efficiency Particulate Air (HEPA) Filter	☐ yes ☐ no
14. Install Heat Recovery Ventilation Unit (HRV)	☐ yes ☐ no
15. Install Separate Garage Exhaust Fan	☐ yes ☐ no
RENEWABLE ENERGY AND ROOFING	
1. Pre-Plumb for Solar Water Heating	☐ yes ☐ no
2. Install Solar Water System	☐ yes ☐ no
3. Pre-Wire for Future Photovoltaic (PV) Installation	☐ yes ☐ no
4. Install Photovoltaic (PV) Panels	☐ yes ☐ no
5. Install Solar (PV) Walkway Lights	☐ yes ☐ no
6. Select Safe and Durable Roofing Materials	☐ yes ☐ no
7. Install Radiant Barrier Roof Sheathing	☐ yes ☐ no
NATURAL HEATING AND COOLING	
1. Incorporate Passive Solar Heating	☐ yes ☐ no
2. Install Overhangs or Awnings over South Facing Windows	☐ yes ☐ no

3. Plant Deciduous Shade Trees on the West and South Sides of the Home	☐ yes ☐ no
INDOOR AIR QUALITY AND FINISHES	
1. Install Whole House Vacuum System	☐ yes ☐ no
2. Use Low/No-VOC and Formaldehyde-Free Paint	☐ yes ☐ no
3. Use Low VOC, Water-Based Wood Finishes	☐ yes ☐ no
4. Use Solvent-Free Adhesives	☐ yes ☐ no
5. Substitute Particleboard with Formaldehyde-Free Materials	☐ yes ☐ no
6. Use Exterior Grade Plywood for Interior Uses	☐ yes ☐ no
7. Use Formaldehyde-Free Medium Density Fiberboard (MDF) and Materials	☐ yes ☐ no
8. Seal all Exposed Particleboard or MDF	☐ yes ☐ no
9. Use Forest Stewardship Council (FSC) Certified Wood Products	☐ yes ☐ no
10. Use Finger-Jointed or Recycled Content Trim	☐ yes ☐ no
FLOORING	
1. Select Forest Stewardship Council (FSC) Certified Wood Flooring	☐ yes ☐ no
2. Use Rapidly Renewable Flooring Materials	☐ yes ☐ no
3. Use Recycled Content Ceramic Tiles	☐ yes ☐ no
4. Install Natural Linoleum in Place of Vinyl Flooring	☐ yes ☐ no
5. Use Exposed Concrete as Finished Floor	☐ yes ☐ no
6. Install Recycled Content Carpet or Natural Fiber Carpets with Low-VOCs	☐ yes ☐ no
OTHER	
1. Install Built-In Recycling Center	☐ yes ☐ no

ADDITIONAL RESOURCES

Oikos Green Building Source www.oikos.com

Green Builder Sourcebook www.greenbuilder.com/sourcebook

Rocky Mountain Institute www.rmi.org

PATH (Partnership for Advanced Technology in Housing) www.toolbase.org

Environmental Building News www.buildinggreen.com

Natural Home Magazine www.naturalhomemag.com

Eco Structure Magazine www.eco-structure.com

Clean Power Estimator www.consumerenergycenter.org/renewable/estimator

Quiz Questions

The following forty (40) question quiz will test the student's comprehension of the course. The student must past this online quiz with a score greater than 80%.

Question 1: Construction waste and demolition waste accounts for how may lbs per person per day?

a) 1.2
b) 2.1
c) 2.8
d) 3

Question 2: True or False. Biodegradable products should be disposed of at local landfills.

a) True
b) False

Question 3: Wood products that are FSC certified means,

a) The product comes from a managed forest which is less destructive to the forest ecosystem
b) The product is formaldehyde-free
c) The product is manufactured from recycled material
d) The product has low VOC's

Question 4: Which of the following is not a renewable product?

a) Bamboo
b) Straw
c) Natural fiber
d) Wood from an old growth clear cut

Question 5: What is the definition of a sustainable product?

a) A product that can be produced with minimal impact to the environment
b) A product that can be produced today without impacting the ability to produce the same product in the future
c) A product that never deteriorates
d) A product that has been salvaged

Question 6: During a home build, the homeowner requests the most efficient light bulbs be installed, you suggest what?

a) Incandescent
b) CFLs
c) LEDs
d) Skylights and wax candles

Question 7: Oriented Strand Board (OSB) for exterior sheathing and subfloor is _____ than plywood.

a) Less financially achievable
b) More financially achievable
c) Less environmentally responsible
d) More environmentally responsible

Question 8: Interior wall framing should be?

a) light gauge steel framing with recycled content
b) FSC-certified lumber
c) All the above
d) None of the above

Question 9: Which of the following is an example of composite lumber?

a) FSC certified wood
b) CCA lumber
c) Polywood
d) ACQ treated lumber

Question 10: In regards to the construction site, which of the following are good practice for green building?

a) Recycling construction and debris materials
b) Donating unused materials
c) Protecting the native soil
d) All the above

Question 11: Insulate foundation with extruded polystyrene insulation of at least?

a) R-1
b) R-2
c) R-3
d) R-4

Question 12: True or False? Engineered lumber should be used for floor and ceiling joists.

a) True
b) False

Question 13: What is OVE framing?

a) Obtrusive Extra Over framing
b) Original vs. Environmental framing
c) Open View Environment framing
d) Optimum Value Engineering framing

Question 14: What's the main difference between recycled plastic and composite lumber

a) Recycled plastic lumber cannot be cut
b) Composite lumber must be screwed in
c) No difference between the two
d) Recycled plastic lumber may expand

Question 15: Recycled content siding is often called?

a) Hardboard
b) Polywood
c) Fiberboard
d) RCS board

Question 16: Increasing wall and ceiling insulation not only decreases heating/cooling uses but also has the added benefit of?

a) Increasing solar heating
b) Minimizing hot water consumption
c) Decreasing the required foundation insulation
d) Making the home quieter

Question 17: During winter months, windows can account for as much as _____ of the heat loss.

a) 10%
b) 15%
c) 20%
d) 25%

Question 18: True or False? It is preferred to use duct tape rather than mastic for sealing ducts.

a) True
b) False

Question 19: True or False? Wood burning fireplaces should be used where possible.

a) True
b) False

Question 20: According to the U.S. Environmental Protection Agency (EPA), _____ is the single most significant contributor to poor indoor air quality

a) An unsealed HVAC duct
b) An attached garage
c) Radiant heating
d) VOC's from interior paint

Question 21: To deter the risk outgassing of formaldehydes (which are carcinogens), _____ should be installed indoors as they outgass much less.

a) Interior plywood
b) Exterior plywood
c) Particleboard
d) None of the above

Question 22: A better alternative than using medium density fiberboard (MDF) is?

a) Wheatboard
b) Particleboard
c) Toeboard
d) Skateboard

Question 23: Regarding flooring, why is bamboo and cork flooring preferred over hardwood flooring?

a) Both have low outgassing of formaldehydes
b) Both are biodegradable
c) Both require less harsh of chemicals to seal and keep clean
d) Both are sustainable products which come from trees that regenerate rapidly

Question 24: True or False? Recycled content ceramic tiles may contain up 70% recycled glass but unfortunately are less durable then standard ceramic tiles.

a) True
b) False

Question 25: Which of the following could be installed to promote a continued environmental home?

a) A security system
b) Formaldehyde detectors
c) Built-in recycling center with multiple bins to separate recyclables and other waste
d) Wood burning furnace

Question 26: Why are volatile organic compounds (VOCs) a risk to the environment?

a) They are the leading cause of ozone layer depletion
b) They cause multiple disorders in household plants
c) They are heavier than air so tend to hover around air intakes
d) They are toxic to humans and contribute to smog

Question 27: What is the average percentage of time an American citizen spends indoors?

a) 37%
b) 55%
c) 65%
d) 87%

Question 28: What is one of the most effective means to improve home energy performance without costing anything?

a) Installing a wood burning furnace rather than a gas furnace
b) Having a detached garage
c) Building with ICF
d) Building orientation

Question 29: Energy Star is a rating system associated with what product?

a) Air Conditioning units
b) Appliances
c) Doors
d) All of the above

Question 30: Which of the following would be the best choice for a roof color?

a) Dark color to absorb the sun's energy
b) Light color to reflect the sun's energy
c) Color does not matter
d) Completely black surface

Question 31: What's the advantage of using a permeable paving system?

a) Enables a water tight system decreasing toxins in water run-off
b) Allows rainwater to penetrate the soil and replenish the local aquifer
c) Helps promote natural irrigation of adjacent landscape
d) None of the above

Question 32: Photovoltaic refers to what renewable energy source?

a) Solar power
b) Geothermal power
c) Wind energy
d) Volt power

Question 33: Preserving existing landscape such as plants and tree is essential as it?

a) Prevents soil erosion
b) Maintains existing sources of natural cooling (e.g. shade from a mature tree)
c) Diverts waste from landfills
d) All of the above

Question 34: True or False? Cement use is a leading industrial source of carbon dioxide (greenhouse gas) emissions.

a) True
b) False

Question 35: Wood I-joists should be used primarily for?

a) Detached garages
b) Outside applications only
c) Floors and Ceilings
d) Should never be used

Question 36: What is meant by the acronym SIPs and what are they used for?

a) Stress Isolated Panels used to minimize a load on a load bearing member
b) Solar Integrated Panels used in modular solar power systems
c) Significantly Improved Pipes used to retain heat in hot water pipes
d) Structural Insulated Panels used rather than wood framing for floors, walls, and roofs

Question 37: Approximately 40 two-liter soda bottles are recycled per _____ of recycled carpeting.

a) 10 sq. ft.
b) standard room
c) square foot
d) square yard

Question 38: Conventional water heaters lose ___ of their energy through standing tank losses.

a) 5%
b) 15%
c) 20%
d) 45%

Question 39: Cellulose insulation has multiple benefits including being made from recycled materials, is 22-55% more fire resistance, reduces air-leakage, and _____.

a) Makes the home quieter
b) Reduces energy use by 20-40%
c) Reduces moisture intrusion
d) All of the above

Question 40: Which of the following window frame would be preferred on a green build?

a) Vinyl frame
b) Fiberglass frame
c) Aluminum frame
d) Wood frame