Guidebook

The Green Building Decision Kit

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Green Building Decision Kit (RSC 2.0)

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The authors hope you enjoy this updated, second edition (RSC 2.0) of the Green Building Decision Kit which was originally published in 2007.

Produced in the United States of America.

Congratulations! Getting Started…

The Green Building Decision Kit Version RSC 2.0 (for Residential and Small Commercial Buildings) by DYO® Kits is designed to help you build or remodel the green building way.

What does the term 'green' mean? Actually, green can have different definitions, depending on whom you ask and/or how you ask the question. The main object of designing and building or remodeling a green building is to take into account the various aspects and components of the building and make them as environmentally friendly and resource conserving as possible. It is even possible to construct buildings that produce as much or more energy than they require (known as zero-energy buildings).

Therefore, a building designed to save energy could be considered green. A building designed to conserve water using natural landscaping could also be considered green. In essence, the more you design/build/rebuild a building to save resources and help the environment, the more green your building could be considered to be.

With this in mind, the Green Building Decision Kit will take you through the typical decision process involved in designing and building, or remodeling, a building. Additionally, the Green Building Decision Kit is intended to help you prioritize your decisions while considering just what kind of sustainable (green) building you want to invest in and live or work in.

Start by reviewing the home building process… read through the Informational Pages provided on the CD to refresh your memory (or learn for the first time) about your options. Then go through the Workbook and mark it up with your preferences. Don't worry if you aren't sure, just use a pencil so you can update your choices/decisions as you get closer to what you feel are the best decisions for you. Use the software to help you finalize your choices… enter a variety of scenarios and save them under different names on your computer so you can do comparisons.

We believe we have given you a very comprehensive listing of things to consider, however, you may come up with some we have not listed. Feel free to contact us with your suggestions and additions at contacts@DYOKits.com.

Your Green Building Decision Kit Workbook with CD includes the following items:

- ✓ Getting Started and Workbook pages — Printed (and on the CD)
- ✓ Information Pages in Acrobat Reader (making them fully searchable) — on the CD
- ✓ Display pages that can be printed for design charrettes — on the CD
- ✓ Green Building Decision Matrix™ Software — on the CD

The intent of the Green Building Decision Kit – RSC 2.0

The Green Building Decision Kit is designed to provide ideas and assistance to anyone interested in building a new (or updating an existing) residential or small commercial structure. For the user to gain the maximum benefit from using this kit, it is important to take a few minutes to understand the reasoning behind and formulation of this useful tool.

For each Section in the Workbook there is a corresponding information page that provides details that help to clarify that particular item. For example, if you are considering building a new home and

you reach the item entitled, "Choosing a Foundation Type" on the display page, the information page might then list the various common foundation types, such as: basement, crawl space (vented or unvented) or slab-on-grade. In evaluating this item, it may be that the type of foundation has already been decided on, i.e. you have decided that the home will be built on a crawl space because of a high water table, local restrictions or for other reasons. If this is the case, you need not spend any time on this particular item because no discussion is necessary. However, if the type of foundation has not been decided or even discussed, it may be important to consider the pros and cons of the various foundation types with your hand-picked team. (Wait a minute… You haven't thought about gathering a hand-picked team? Don't worry, we will cover that in the ***Initial Considerations*** section.) **The main objective of the Green Building Decision Kit is to afford you the opportunity to think about and discuss many of the items you will encounter or have to consider when building or remodeling a residence or small commercial building.**

You might notice that many products and concepts have brief descriptions. You may wish that more information were detailed. There are several reasons the answers on the matching information pages are kept relatively brief:

First, the information pages are intended to stimulate discussion or cover a variety of topics and items that may not typically be addressed by other means. Therefore, the information contained in the information pages is topical and informative, but not too detailed.

Second, additional information on various topics and the items listed under them can be found in the Green Building Decision section of the DYO® Kits website at: www.DYOKits.com.

Third, since the intent of this kit is to be as green as possible, we provided the information pages in a PDF digital file (use Adobe Reader to view) to conserve the amount of paper to be printed; both what you received in the Green Building Decision Kit and what you may want to print yourself. We recommend using the digital files primarily and printing only what is absolutely necessary.

Fourth, the clientele for the Green Building Decision Kit can come, literally, from anywhere in the world. Therefore, a concrete slab foundation intended to go under a home in Minnesota, in the northern United States of America, may have very stringent requirements regarding frost protection, insulation installation and more. However, a concrete slab for a home built in Mexico may not have any requirements for frost protection at all. Much depends on the location, climate, national building codes, local codes, etc. Additionally, it would not be feasible to offer information pages that attempt to cover every possible situation or contingency.

NOTE: This publication is created in the Northern Hemisphere of the Earth. We have endeavored to word solar orientation hemisphere-neutral; however, in the event that we have used 'south' as the proper orientation for solar installations, please substitute 'north' if you live in the Southern Hemisphere. Thank You!

Using the Green Building Decision Kit for design charrettes: Included on the CD of your Green Building Decision Kit are display pages that can be printed out as large as 11 x 17 inches so as to be viewable from a distance for persons seated around a rather large table, such as a dining room table or perhaps a conference table located in an architect's or engineer's office. Regardless of where this table is located, the concept is for the display pages to stimulate discussion of each item listed under each section. There will likely be a need for a key person to be in charge and help direct the discussion(s), keep the comments on track and act as a timekeeper. This person could be the owner

(or manager) of the project or a pivotal contact in the process, such as the architect, engineer or green/sustainable consultant. Typically this person would stand next to the display pages and ask questions to stimulate the discussion interaction.

PLEASE NOTE: These kits are designed to be informational and educational in nature and are not to be used as a substitute for professional information and services; such as those provided by architects, engineers, builders, carpenters, plumbers, heating/cooling professionals, etc.

We expect to learn a great amount from you, our customer. We will be making updates to the DYO® Kits website and to our kits. We want to help you find answers to your questions and are looking forward to helping you build or update your residential or small commercial building(s).

Now that you have an idea of the nature of the Green Building Decision Kit, **read on about the prioritizing software.** After that it's up to you how you use the Kit (see 'QuickStart').

Helpful Symbols

The following symbols are provided to show:

questions relative to the Topic or Item that you may want to consider.

the definition of an industry-specific or uncommon word or phrase. A glossary of energy and environmental words and phrases is available in the Green Building Decisions Kit section of www.DYOKits.com.

(NOTE: The Matrix is in Microsoft Excel 2007 Format - Use at Your Own Risk)

The Green Building Decision Matrix™

Included as part of your Green Building Decision Kit is a tool that can help guide your decisions using important information YOU PROVIDE about what is MOST IMPORTANT TO YOU. This tool is called the Green Building Decision Matrix™ (Matrix). You tell the Matrix what areas you are most focused on and input information you glean from your research. The Matrix analyzes the data using the weighting process based upon what is most important to you. It then develops a prioritized, ranked listing of the building components you are considering that best meet your criteria. A sample report printout is included as a separate file on the CD.

The Matrix comes with many building products already listed and detailed; but you can add products and/or change the included product information. Based on the information detailed for each product, it is 'scored' using green performance factors. The products are grouped according to the construction phase they are associated with (just as you find in the Information Pages).

The Matrix is fully compatible with Microsoft® Excel® versions 97, 2000, 2003, 2007; and uses macros to operate. You will need to have Excel® (or a compatible spreadsheet program) installed on your computer. The Matrix program is attached to the Adobe Reader (PDF) file. We recommend you download the most recent version of Reader.

NOTICE: If you use a spreadsheet program other than Microsoft® Excel®, the Matrix may not function properly. As with all software, meaningful output results are dependent upon accurate input information. The Matrix is supplied to help evaluate green products and educate users on basic trade-off or proprietary functions. It is intended for educational and information purposes only, no warranties or guarantees are made regarding the program's accuracy or reliability.

INSTALLING THE MATRIX

Insert the Green Building Decision Kit CD into your computer's CD drive (if you purchased the download version go to the next step). Locate the Adobe Reader file named 'GreenBuildingDecisionKit.pdf' and open it.

Select the attached file (within the PDF) named "Green Building Decision Matrix Version RSC 1.xls." and then press 'Open" (or double-click on the file name) to activate your Microsoft® Excel® (or compatible spreadsheet) program.

A window will appear to tell you that the file contains macros, select 'Open this file' and press 'OK'.

A second window may appear with a Security Warning about macros, select 'Enable Macros' for the Matrix to be loaded and work as programmed.

NOTE: You will need to save this file to your computer to save your work. We suggest you save it (with a name that you will remember so that you can come back to it later). We recommend making a folder under 'My Documents' to keep all of your Matrix files in one place. If you save the Matrix file on your computer, you won't need to use the CD to use the Matrix software in the future.

USING THE MATRIX

Green Component Weightings

Start with the Component Weights Page; it is the first tab located in the farthest left position at the bottom of the worksheet. (Figure 1)

The Green Component Weightings table lists nine (9) aspects relative to green construction.

Rate the importance for each aspect by placing a percentage value in the Weight column relative to your project, making sure that the total adds up to 100%. Once you have finished, select the 'Populate Product Tables' button to share these priorities with all of the pages in the Matrix. (Figure 2)

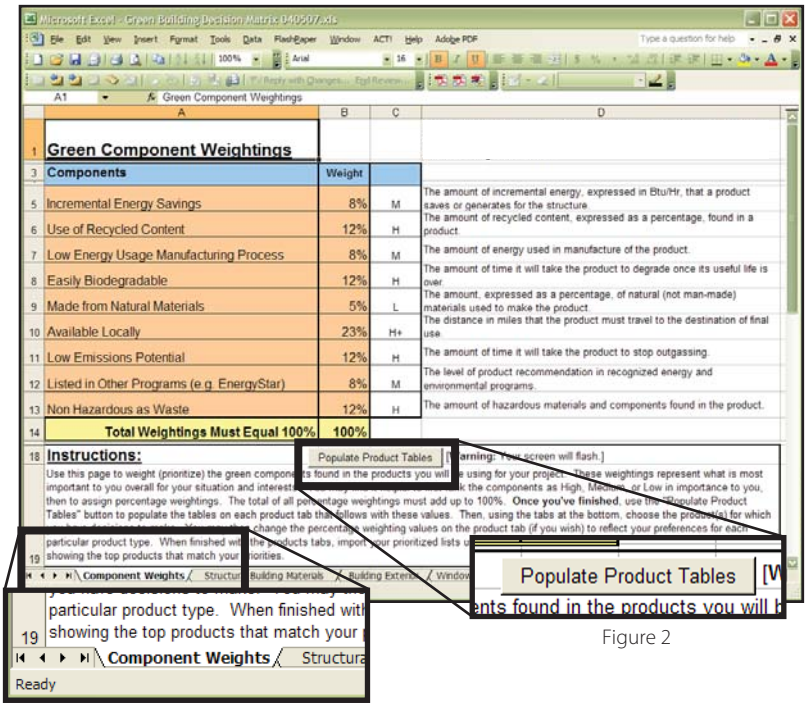
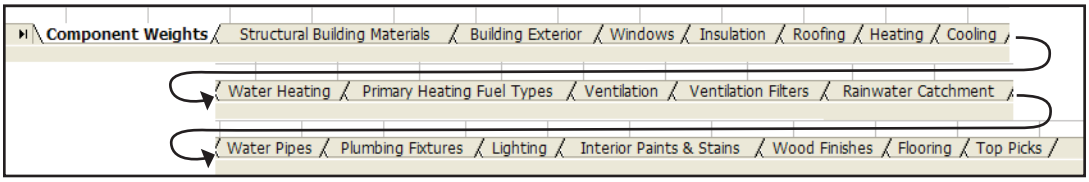


Figure 1

Figure 2

Product Pages

Review the various Product Pages by selecting the appropriate Product Tabs.



Scroll down to see all products listed for that Product Page. Each row represents a separate product and there may be several listed for your convenience. Place your cursor over the component title for the rating description of each column. You may add products to the end of each list and populate the performance for that product. Not all of the columns are pre-populated; for instance, you will always have to enter the values for the 'Available Locally' column. You do not have to enter values in all of the columns for the Matrix to work; but the more data you enter, the more accurate and complete the results will be.

	A	B	C	D	E	F	G	H	I	J
1	**Instructions:** Scroll down to see all products. New products may be added to the end of the list. Rate the performance of each product as "N, L, M or H." (Hover over the component title for the rating description.) Use your Backspace button to clear values. The Sort button (below) will incorporate your priorities as currently stated on the **table to the right.** (Scroll to the right to see the table.) Sort	Available Locally	Incremental Energy Savings	Use of Recycled Content	Low Energy Usage Manufacturing Process	Easily Biodegradable	Made from Natural Materials	Low Emissions Potential	Listed in Other Programs	Non Hazardous as Waste
				Incremental Energy Score: N = None; L = Low (1 - 10,000 Btu/Hr); M = Med (10,001 - 50,000 Btu/Hr); H = High (50,001+ Btu/Hr)						
2	Straw Bale Construction		H	H	H	H	H	H	M	H
3	Rammed Earth		H	M	H	H	H	H	M	H
4	Wood Framing - "Stick Built"		M	L	H	H	H	H	M	H
5	Adobe		M	L	H	H	H	H	M	H
6	Engineered Wood – Trusses – Laminated Beams		M	H	M	M	H	M	H	H

Adding a New Item

To add a new item, simply replace the ***(Enter Custom Product Here)*** text with the name of the item you wish to add and populate the values in each of the columns accordingly. Again, you can place your cursor over the component title for the rating description of each column. You can enter up to six additional products per Product Page. If you need to evaluate more than six additional products please contact us for an expanded, professional version of this software at contact@DYOKits.com.

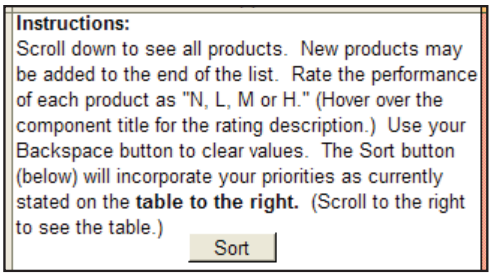
11	Fiberglass/Plastic		L	N	N	N	N	N	N
12	*(Enter Custom Product Here)*								
13	*(Enter Custom Product Here)*								

Product Specific Component Weights

Next, scroll to the right to see the Product Specific Component Weights table of that Product Page. If you pressed the 'Populate Product Tables' button on the Component Weights Page, the table should reflect the weights that you entered at the beginning.

If these weights are appropriate for the products on this specific Product Page, do nothing.

Component Weights for Structural Building Materials	**Weight**		
Incremental Energy Savings	8%	M	The amount of incremental energy, expressed in Btu/Hr, that a product saves or generates for the structure.
Use of Recycled Content	12%	H	The amount of recycled content, expressed as a percentage, found in a product.
Low Energy Usage Manufacturing Process	8%	M	The amount of energy used in manufacture of the product.
Easily Biodegradable	12%	H	The amount of time it will take the product to degrade once its useful life is over.
Made from Natural Materials	5%	L	The amount, expressed as a percentage, of natural (not man-made) materials used to make the product.
Available Locally	23%	H+	The distance in miles that the product must travel to the destination of final use.
Low Emissions Potential	12%	H	The amount of time it will take the product to stop outgassing.
Listed in Other Programs (e.g. EnergyStar)	8%	M	The level of product recommendation in recognized energy and environmental programs.
Non Hazardous as Waste	12%	H	The amount of hazardous materials and components found in the product.
Total Weightings Must Equal 100%	**100%**		



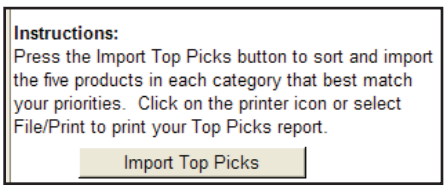
If, however, you would like to change the values for this Product Page, you should do so now.

Once you have the weights to your liking, they add up to 100%, and you have entered any additional items that you want to evaluate, select the 'Sort' button in the top-left cell of the Page.

The Matrix will arrange the items on the worksheet according to the personalized priorities that you entered in the Product Specific Component Weights table from highest to lowest match.

Top Picks

Additionally, you can view the top five results for all of the Product Categories by clicking on the Tab entitled 'Top Picks' (the farthest right position at the bottom of the worksheet).



When you press the 'Import Top Picks' button, it will sort all of the Product Pages according to the values in each of their respective Component Weights tables and import the top five listings into this page, along with the original Green Component Weightings table. You may then print this final report using the print features within Microsoft® Excel®.

	A	B	C	D	E	F
16	**My Top Picks:**					
17						
18	**Structural Building Materials**			**Exteriors**		**Windows**
19	Straw Bale Construction			Wood		Composite - Double Pane w/Low-E
20	Rammed Earth			Artificial Stone		Composite - Double Pane w/Low-E & Argon
21	Wood Framing - "Stick Built"			Composite		Composite - Double Pane w/Argon
22	Adobe			Brick		Composite - Triple Pane w/Low-E & Argon
23	Engineered Wood – Trusses – Laminated Beams			Masonry		Composite - Triple Pane w/Argon
24						
25	**Roofing**			**Insulation**		**Flooring**
26	Plant based "Green" Roof			Cellulose		Wool/Cotton Carpeting
27	Wood			Recycled Denim		Wool/Cotton Area Rugs
28	Eco Slate (made from recycled materials)			Cotton		Recycled/Reclaimed Wood Flooring
29	Slate (natural stone)			Soy Foam		Bamboo Flooring
30	Clay Tile			Vermiculite		Natural Linoleum
31						
32	**Heating**			**Cooling**		**Water Heating**
33	Radiant Heat System/Hydronic			Ceiling Fans		Instantaneous/Tankless Style - Gas
34	External Heat Source			Heat Pump		Instantaneous/Tankless Style - Electric
35	Geothermal System			Central Air Conditioning, Eco-Friendly		Ground Source Heat Pump - Desuperheater
36	Radiant Heat System/Electric			Window Air Conditioners, Eco-Friendly Refrigerant		Heat Pump Water Heater - COP 2+
37	Fireplace Insert			Evaporative Cooling System		Standard Tank Style - Gas
38						
39	**Fuel Types**			**Interior Finishes**		**Wood Finishes**
40	Bio-Mass Burning			Water Based		Natural Oils
41	Pellet Burning			Low VOC		Water Based
42	Maize Burning			No VOC		Low VOC
43	Solar Thermal			Oil Based		No VOC
44	Electric – Direct Current (DC) - from Solar, Wind, Hydrogen, Water (on-site)			*(Enter Custom Product Here)*		Alcohol Based
45						
46	**Ventilation**			**Ventilation Filters**		**Lighting**
47	Heat Recovery Ventilator			High-Efficiency Pleated		LED (Light Emitting Diode)
48	Energy Recovery Ventilator			Medium-Efficiency Pleated		Compact Fluorescent
49	Passive Wall Vents			Carbon/Charcoal		Metal Halides (exterior)
50	Atmospheric Dampers			Low-Efficiency Pleated		Standard Fluorescent
51	Combustion Air Supply/Outside Combustion Air Ports			HEPA		Low Pressure Sodium (exterior)
52						
53	**Rainwater Catchment**			**Water Pipes**		**Plumbing Fixtures**
54	Cistern/Above Ground			Galvanized Steel		Composting Toilet
55	Cistern/Below Ground			Copper		Waterless Urinal
56	Metal Drums			PEX		Dual Flush Toilet
57	Fiberglass Tanks			PVC		Low-flow Gravity Toilet
58	Plastic Barrels			Chlorinated PVC		Standard Urinal
59						

Remember to 'Save' your progress! We suggest you use different file names for different scenarios and for separate Green Building Construction Projects. You can re-run the Matrix with different items entered as often as you wish.

Initial Considerations

1A. Assembling the Design Team

Assembling your own hand-picked design team can prove to be very beneficial to your pocketbook, health and well being. Time spent in planning and communicating up front can help avoid costly rework during the project, saving time and money. The process of pulling together the key members of all phases of your project, communicating your project goals, discussing the project details and schedule, and working together to determine solutions and make decisions is known as a design charrette. Scheduling one or many design charrettes helps ensure that everyone working on your project is making educated decisions regarding products used, techniques implemented, materials chosen, changes considered, etc. based on your priorities and your vision of the end product.

NOTE: Plan your meetings for 2-hour time periods (or less). It may be necessary to meet with sub-groups to concentrate on specific aspects of your project before bringing the primary team together. Conversely, it may be beneficial to bring the primary team together prior to sub-group meetings. There is no rule to coordinating a design charrette. Experiment to discover what works for you.

SELECTING YOUR TEAM

- ☐ Do you want to work with professionals who already have an established track record in the sustainable residential building arena?
- ☐ Are you willing to work with professionals who are making the transition to sustainable residential building practices?
- ☐ Do you already have a relationship with a team of professionals with whom you want to work, but who (some or all) will have to be convinced (or educated) to use sustainable building practices and techniques?

(These last 2 groups will likely require someone who is well versed in many areas of sustainable construction to oversee the project and help teach these professionals while they work through your project.)

Assembling a design team can be as unique as the construction project itself. Here is a partial listing of potential design team members/representatives[1]:

- Architect
- Engineer
- Lender
- Realtor
- Real Estate Attorney
- Certified Home Energy Rater
- Accredited LEED® Professional
- Alternative Construction Consultant
- General Contractor or Builder
- Job Site Foreman
- Concrete Supplier
- Foundation Contractor
- Concrete Flatwork Contractor
- Structural Insulated Panels Co.
- Insulated Concrete Forms Co.
- Lumber Supplier
- Conventional Siding Supplier
- Siding Installer
- Alternative Siding Consultant[2]
- Roofing Supplier

[1] This list may seem intimidating… do not expect that you will need a representative from each entry. We have provided as complete a list as possible to encourage you to think beyond your Builder.

[2] For items such as: Exterior Insulation and Finish Systems-EIFS/Latex Stucco/Cementatious Siding.

Potential Design Team Members/Representatives (continued)

- Roofing Installer
- Alternative Roofing Consultant
- Window Company
- Door Company
- Head Plumber
- Plumbing Fixture Supplier
- Alternative Plumbing Fixture Supplier[3]
- Heating/Cooling Equipment Supplier
- Heating/Cooling Equipment Installer
- Radiant Floor/Alternative Comfort Distribution Specialist
- Renewable/Alternative Energy Consultant
- Wood Stove Supplier
- Fireplace Supplier
- Conventional Flooring Products Supplier
- Alternative Flooring Supplier
- Head Electrician
- Head Carpenter
- Conventional Insulation Supplier
- Alternative Insulation Consultant[4]
- Paint Supplier
- Head Painter
- Lighting Fixture Supplier
- Electric Utility Supplier
- Natural Gas Supplier
- Other Fuel Supplier
- Interior Decorator
- Green/Sustainable Products Store Supplier
- Indoor Air Quality Consultant
- Mold Tester/Mitigation Company
- Radon Tester/Mitigation Company
- Water Catchment/Cistern Consultant
- Home Automation Specialist
- Landscaping/Xeriscape® Professional

The green or sustainable movement is relatively young when compared to the conventional trades. Fortunately, as a general rule, the people who get involved in local, regional or national green organizations are quite knowledgeable and motivated to help others learn. You can find information about progressive builders and green professionals from several sources, including: Home Builders Associations, American Institute of Architects chapters, US Green Building Council chapters, The Green Building Initiative (and others) or your hometown's building inspection department.

ORGANIZATIONS

National Association of Home Builders
www.nahb.org
1201 15th Street, NW
Washington, DC 20005
202.266.8200 Ext. 0 or 800.368.5242
Fax: 202.266.8400

The American Institute of Architects
www.aia.org
1735 New York Ave., NW
Washington, DC 20006-5292
Phone: 800.AIA.3837 or 202.626.7300
Facsimile: 202.626.7547
E-mail: infocentral@aia.org

U.S. Green Building Council
www.usgbc.org
1015 18th Street, NW, Suite 508
Washington, DC 20036
Phone: 202.82-USGBC (202.828.7422)
Fax: 202.828.5110

The Green Building Initiative
www.thegbi.org
2104 SE Morrison
Portland, OR 97214
Phone: 877.GBI.GBI1 (877.424.4241)
Facsimile: 503.961.8991
E-mail: info@thegbi.org

[3] For items such as: Waterless Urinals/Composting Toilets

[4] For items such as: Cotton/Soy Foam/Castor Bean Foam/ Whipped Concrete/Recycled Denim Jeans/Cementatious Foam Insulation

Your local building inspection department can be located by contacting the main information phone number for your city or county through the local phone book or by using the Internet.

- ☐ Have you contacted your local zoning commission and building inspection department to determine what is and is not allowable at your building site? (Don't forget that you can ask for exemptions!)
- ☐ Is your local zoning or building departments familiar with or have a green building program?

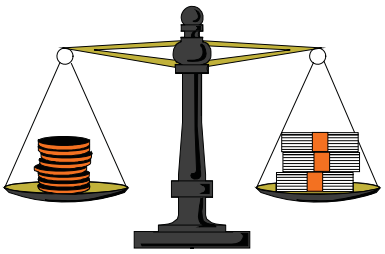
1B. Developing a Budget

- ☐ Have you incorporated unconventional attributes into your budgeting process:
  - ☐ Trade-offs,
  - ☐ Lifecycle Costs/Benefits (including Maintenance),
  - ☐ Avoided Health Issues, and
  - ☐ Environmental Preservation?

Before you get too far into the design and decision-making process, it is highly important that you determine what you are able to spend on the building project. Keep in mind, however, that there are different methods for evaluating costs.

INCORPORATING ALTERNATIVE CONSIDERATIONS

Most people tend to look at 'first cost' and compare this number against their budget. This method often eliminates creative thinking or even profitable long-term decisions because first cost can appear to be a barrier to what you ultimately want or, possibly, even need. So, to gain the maximum benefit from the use of your Green Building Decision Kit, you must open your mind to possibilities and work through to the end of the decision making process, incorporating 'lifecycle' costs, before you make your final judgments.



Trade-Off

Let's start with a basic example: If you are building a 2,000 square-foot home using the minimum insulation in the walls and attic allowed by code and conventional construction techniques, you will probably need to install at least a 4-ton air conditioner to cool this home in the summer months in many climate zones. This is called 'rule-of-thumb' sizing. However, if you add extra insulation (which will increase the insulation cost) you will likely be able to downsize your air conditioning unit by a ton or more. Plus, you may be able to reduce the size of your ductwork. The reduction in size of the A/C unit and related ductwork could save you as much or more than the increased cost for the insulation. This approach is called the 'trade-off' method, where increasing the amount spent on one or more components of a building can decrease the size, cost or need for other components.

Lifecycle

Some materials and products you are considering incorporating in your design may have a higher first cost, but lower operating costs, or help lower the overall operating costs of the structure itself. It may cost more up front to purchase highly rated ENERGY STAR® appliances, but they could potentially save enough through reduced energy and water usage to allow you to recoup their cost well before their useful life is over. This approach is called the 'lifecycle' cost method, where analysis of costs includes both the purchase and operating costs for the life of the item being considered.

Avoided Health Issues

There are a few more key concepts that should be considered. Most people spend the majority of their time indoors, so having healthy indoor environmental quality is becoming more and more important. There is an alarming trend of increased asthma in young children in the United States of America, much of which can be attributed to poor air quality or pollutants found in indoor air. So, if you build a home that has excellent indoor air quality and avoid taking your family members to the doctor's office or even the emergency room at the hospital… how much is this worth to you in terms of dollars?

Environmental Preservation

Avoiding damage to the environment is a key priority in green construction. Heating your building with renewable energy (such as a solar thermal system) is often a very viable option with a payback or Return on Investment (ROI). Installing photovoltaic (PV) solar electric panels and systems can also be another high ROI option… depending on local electricity rates, location of the building and other factors. Both of these methods of providing required energy avoid damaging the environment by reducing the consumption of fossil fuels such as coal and natural gas for the creation of electricity.

As you can see, there are many considerations involved in designing and/or constructing a green building. Perceiving first cost as a barrier can discourage the exploration of options that might appear expensive at first but will offer future savings and/or a better living environment. It is important to know what your budget is, but not to allow the budget to become an excuse not to build a green, healthy building. Work through the Green Building Decision Kit to discuss and explore your options, then see if you can bring your final project in alignment with your budget. You probably can't have everything you want, but you may be able to afford many of the important things that you need while helping the health of the occupants of the building and the environment at the same time.

Building to Code: Most builders are quick to tell you that they 'build to code' and that's good because you don't want a sub-standard construction job. But did you ever stop to consider what else that means? A built-to-code structure is the worst construction allowed by law. Sustainable buildings qualify well above the built-to-code standard.

1C. Designing a Building to be Durable

- ☐ Is durability a concern to you?
- ☐ How long do you intend the building to last:
  - ☐ Five years?
  - ☐ Ten years?
  - ☐ 20 years?
  - ☐ 50 years?
  - ☐ 75 years?
  - ☐ 100 years or longer?
- ☐ Is it your desire to pass this building along to future generations?

Many countries have residential and commercial buildings that last for centuries. It takes a tremendous amount of energy, materials and resources (such as water) to construct a building, so why not make it last for a good long time? In fact, constructing a building with durability in mind is a key green concept.

A building that can withstand the test of time requires the use of durable, strong materials, intelligent design and moisture/water control. Water and moisture control is paramount in importance for a building to last. Building a house using lower quality materials, such as particle board siding, may have a lower first cost than other options, but the maintenance will likely be high and the life span low. For example, this type of siding may need to be painted often and be thrown away after a relatively short time span.

A building with a temporary or shorter life span may be exactly what you need. If this is the case, then the Deconstruction item that follows will be especially important for you to consider.

1D. Deconstruction of Existing Building or Planned Deconstruction of New Buildings

- ☐ If you have a residential or commercial building that has come to the end of its life cycle, what will happen to that building's components and materials?
- ☐ Will you (or a future owner) be able to recycle or reuse/donate the building's components at the end of its life cycle so they won't contribute to landfill problems?
- ☐ Will there be products that could be considered toxic waste involved in the building that will require special treatment?
- ☐ Can the toxic products involved in the building be replaced with versions that are not so toxic or are safe or inert?
- ☐ Do you feel that these things are important for you to consider?

More and more businesses are springing up that will help deconstruct and recycle or reuse the various components of the building. It is alarming to consider the amount of reusable or reclaimable products that we place into landfills every year. Some components of older buildings can be highly desirable and valuable, including the wood framing, steel, copper and other metals and fixtures. If you take the time to check your local or regional phone directory for companies or organizations that can deconstruct and recycle a building, you might be surprised.

1E. Local Sourcing of Building Materials and Components

- ☐ How far away are you willing to go to get the materials to construct your new building?
- ☐ Are you willing to have a percentage of your materials be local and some not local?

It is universally considered to be a good green practice to purchase your building materials and components from local sources. You may have to do some investigation to determine if the products you purchase come from local sources or if they are simply handled by a local company, distributor or wholesaler who ships the products in from distant sources.

Often the most economical and sustainable choice is to obtain as many materials and components locally as you can. Some components will probably have to be shipped from a remote location unless you happen to live near large factories. For example, you may be able to purchase your wood and stone products locally, but your water faucets and major appliances will likely come from distant factories that ship to regional storage facilities, then to your local store or to your location. You may have to obtain certain products for your building directly from the retailers or distributors who handle that product. However, you can combine your shipments to minimize the number of trips by truck to your location by shippers.

1F. Financing Options and Programs

- ☐ Does the lender you are considering make special financing programs available, such as Energy Efficient Mortgages or Green Mortgages?
- ☐ Are you willing to look for a lender who offers special financing if your local bank or other lender does not?

Every major entity on the secondary mortgage market in the United States of America

Fannie Mae	Ginnie Mae
Freddie Mac	FHA and VA

offers Energy Efficient Mortgage (EEM) options to their primary lenders. So, the bank, credit union or other financial institution that you are considering probably can offer EEM mortgages, even though they may not be aware of it. Many national lenders are offering special mortgage products and will be happy to inform you about them. You may need to do research to find out about the mortgage and other programs offered by lenders in your locale.

Energy Efficient Mortgage (EEM): An EEM is a mortgage that credits the energy efficiency of a home in the home loan. Some EEMs allow for a larger debt-to-income ratio or 'stretch' that can allow a person to purchase a slightly larger or improved home. Other EEMs have a reduced interest rate (usually one-quarter to one-half point) or reduced closing costs for energy efficient homes. It is even possible to find EEMs that have a combination of all the benefits listed here.

Energy Improvement Mortgages (EIM): An EIM is a mortgage with incentives similar to EEMs primarily intended for existing residential buildings that finances cost-effective energy efficiency improvements. Some EIM lenders provide a listing of energy measures or products that they will automatically approve for installation. Other energy improvements may need to be justified via cost savings or other energy or economic measures that are recommended from an energy rating inspection.

Energy Star®: Discussed specifically in the ***Other Decisions*** section, Energy Star® is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy which helps people save money and protect the environment through energy efficient products and practices. Find them on-line at: www.energystar.gov.

Residential Energy Services Network (RESNET): A non-profit organization that works to ensure the success of the building energy performance certification industry, set the standards of quality, and increase the opportunity for ownership of high performance buildings. Certified home energy raters who are qualified to perform energy tax credit inspections are listed on the RESNET website at www.resnet.us.

1G. Understanding Heating, Cooling, Radiation and Other Important Concepts

Before you start evaluating your options for your new building or renovation, it is important that you understand some key concepts and laws of physics; otherwise, you may not make the best choices possible.

Once, during the course of a conversation, a very educated architect mentioned something very profound. He said, "It's amazing to me how many otherwise intelligent people seem to forget that heated air rises." A quick look at most building designs will reinforce his statement. Buildings are commonly designed without thinking about the sun or, worse, they allow the sun to enter the building unobstructed on hot summer days and then force the air conditioning system to deal with the consequences.

Let's begin with the basics of heat transfer: conduction, convection and radiation.

CONDUCTION

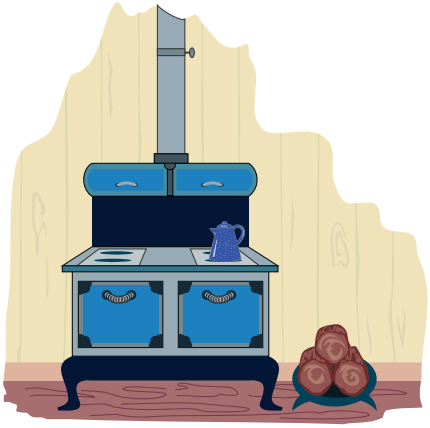
Conduction is the transfer of heat energy through an object or series of objects. A good example of conduction is the increasingly hot handle of an iron skillet placed over a flame; even though the handle is not directly over the flame.

Some materials naturally resist heat flow, such as wood, and others conduct heat easily, such as metals and glass. This is why kitchen matches are made with wooden sticks and not metal or glass.

CONVECTION

Convection is the process in which heated air rises and cooled air falls. If you have a baseboard electric heater located on the wall of a room you might notice that there is no fan attached to this unit. When the electricity flows through the baseboard heater it tends to get very hot. As it gets very hot the heated air above the unit will rise, which pulls cooler air through the unit. Over time, a convective loop forms; the heated air from the unit rises up the wall and travels across the ceiling, where it starts to cool. The cooler air drops and then migrates across the floor to the baseboard heater where it is reheated and rises again. This convective loop will continue as long as the baseboard heater is on. This is the same phenomenon that allows hot air balloons to rise and float over the landscape. Many types of heating systems rely on convective loops to distribute the heated air around the building. Steam heat, hot water heat, gravity furnaces (the big octopus-looking furnaces in older homes) and electric baseboard heat are examples of these types of systems.

RADIANT



Last, but certainly not least, is radiant heat. Radiant heat is basically a wavelength that travels through space until it hits a solid object, and then the energy in the wavelength is converted into heat. You have experienced radiant heating when you have walked outside on a cool day and noticed the heat from the sun warming your face and hands. The heat from the sun travels through space in the form of a wavelength in the infrared spectrum of visible light. This wavelength will travel along until it hits a solid surface. The energy contained in this wavelength tends to warm the surface of the solid object it hits. Another example is the heat coming across the room from a wood-burning stove. If you were to hold a piece of cardboard between you and the source of radiant heat, then you would be shielded from the wavelength and its heat. This is why people get under umbrellas at the beach in order to find a shield or shade against the heat radiated by the sun.

Radiant heating systems create the wavelength that will heat the objects in the room but not the air itself. This is a very important concept to understand. The sun does not heat the air outside but it heats the trees, rocks, grass, soil, cars, asphalt, concrete, buildings and all other solid objects and they, in turn, heat the air. If there is a lot of dust or pollution in the air, the sun can warm these particles floating in the air which will help heat the air itself. But the air around us is transparent to the sun in its virgin state. If you have radiant heat in your building, it will heat the people, desks, chairs, floors, walls and other solid objects and they, in turn, will help heat the building. Radiant heat from the sun is what we try to capture with our thermal solar systems, both passive and active. We will delve more into all these concepts and design features as you go through the Green Building Decision Kit. However, understanding radiation is key for most innovative designs because most involve the use of the sun or some component of radiant heat.

Why is radiant heat so important? Because people are fantastic receptors and generators of radiant heat. We tend to easily absorb heat, which is why we get sunburns, and we tend to radiate heat easily, which is why

we need coats in the winter to keep our skin from radiating heat and freezing. If you have ever walked through a building or down a hallway and noticed that you felt cold when you passed by a large window, then this is because your skin radiated heat toward the cold surface of the glass window and toward the cold outside air. If your home has no insulation in the walls, they are probably cold to the touch in the winter. Being surrounded by cold walls can make a person feel cold, even if the room air temperature is considered high.

CONVENTIONAL VS. INNOVATIVE SYSTEMS

Most conventional heating systems heat air and move the heated air with a fan. Nearly all cooling systems (air conditioning) utilize a coil to cool the air and a fan to move the cooled air throughout the building. The movement of air as a function of the heating/cooling system is an accepted design strategy, but it can consume a large amount of energy to heat or cool the air using these systems.

Radiant systems, such as a radiant floor or ceiling panels, can be designed to offer the same degree of comfort while potentially using less conventional energy. Solar heating systems that utilize radiant heat can potentially offset the use of conventional energy more than other types of heating systems.

MEASURING HEAT ENERGY

The earlier reference to the common wooden kitchen match was intentional. Most heating and cooling systems are measured by the amount of heat energy or cooling energy they produce. The universal standard of measurement for heat energy is the British Thermal Unit or BTU. A BTU is the amount of heat needed to raise a pound of water one degree Fahrenheit (or °F). Also, a BTU is approximately the same amount of heat energy produced by completely burning a common wooden kitchen match. So, if you happen to have a 100,000 BTU per hour natural gas furnace heating your home or small commercial building, you can imagine that for every full hour this furnace runs it is burning the equivalent of 100,000 kitchen matches.

Since the typical natural gas furnace installed by builders in the United States are approximately 80 percent efficient, this means that 20% of the heat energy is wasted as it is sent up the chimney. Or, for every full hour that this 80% furnace runs it will burn 100,000 matches and 20,000 of them will go up the flue as wasted heat energy. If you were to replace this 80% furnace with a 95% furnace, you would only waste 5,000 kitchen matches per hour instead of 20,000. This waste may not seem like very much but if your furnace runs 2,000 hours per winter season, you are wasting a lot of matches worth of energy.

HEATING STEPS TOWARD AN ENERGY EFFICIENT, GREEN BULDING

So, is there an answer?

Actually, there is no one best answer but typically the first thing to do is to ***increase the energy efficiency of your building's envelope*** so that the heating/cooling system(s) will not have to run as much. Then you are decreasing the amount of energy wasted and also likely making your interior environment more comfortable. You can also opt to ***install a dual-fuel (add-on) heat pump to your furnace to reduce the amount of fossil fuel that your furnace will use*** and could also obtain a special favorable electric rate from your local electric energy provider. If you ***add a solar heating system***, you can again reduce the amount of time that your furnace will run which will also reduce your heating energy bills.

As you proceed through the Green Building Decision Kit you will have the opportunity to evaluate these and other options that should help you obtain a very energy efficient and economical building to own.

MEASURING COOLING ENERGY

Cooling systems are also evaluated or sized in terms of BTUs of energy, but most people don't realize this. If you happen to have a central air conditioner that cools your building, most likely you have heard about its size or cooling capacity in terms of 'tons'. For example, a conventional 1,500 square foot home might have a 3-ton air conditioner. One ton of air conditioning is equal to 12,000 BTUs of energy. So, a 3-ton air conditioner is equivalent to a 36,000 BTUs per hour sized air conditioner. The math is simple: a 2-ton air conditioner produces approximately 24,000 BTUs of cooling energy, a 3-ton produces 36,000, a 4-ton 48,000 and so on. The half-ton sizes are equal to 6,000 BTUs of energy. So, a 3.5-ton air conditioner produces approximately 42,000 BTUs of cooling energy.

Why is this important to know?

Because most heating and cooling calculations and software programs break energy use into small segments, such as BTUs, in order to accurately measure heating and/or cooling requirements. You will likely be evaluating different heating and cooling systems by their BTU outputs, so it is important that you become somewhat familiar with the terminology and concept.

MEASURING ELECTRICITY

Another key aspect of energy use that you will need to understand is how electricity is measured. Most residential living units have electric meters that measure kilowatt-hours of electrical use.

What is a kilowatt-hour?

Let's start by discussing watts first. A 'watt' is a very small amount of energy. It measures about 3.413 BTUs or the amount of heat energy from 3.5 kitchen matches. A kilowatt (kWh) is the same as 1,000 watts or about 3,413 BTUs of heat energy. A good example of a device that uses approximately 1,000 watts is the common hair dryer. The amount of heat you feel coming from the end of the hair dryer when it is set to 'high' is roughly equivalent to 3,413 matches being burned at the same time. If you were to set that hair dryer on high and let it run for a full hour, then you would have used 1,000 watts for one hour or basically a kilowatt hour. Electricity is very easy to calculate using basic math, if you know how much electrical energy a device uses. For example, if you have ten 100 watt standard electric light bulbs burning for one hour, then you will have 1,000 watts of energy being used for that hour (one kilowatt hour).

If your refrigerator uses 500 watts of electricity to run, then for every 2 hours it runs it will use one kilowatt hour of electricity. If your computer uses 200 watts, then it will use a kilowatt hours' worth of electricity every 5 hours. As you look around your residence or small commercial building and add up all the electrical items you have, you can start to determine what your average monthly electric bill should be. If it seems higher than expected, you can look for items that use extra energy and try to eliminate them. For example, that old refrigerator in the garage that only has two 6-packs of beer and last summer's fish in it is probably costing you quite a bit per month to operate. That waterbed in junior's room could have its heater unplugged; now that junior has gone to college. Maybe you can consolidate the three fish tanks you have into one or two and save on the heating energy it takes to keep the tanks warm. All these items can add-up to a fairly significant monthly electric bill.

Electricity is measured in terms of demand as well as energy use or kilowatt hours.

What is demand?

Electric demand is similar to the speedometer in your vehicle. As you drive down the highway, you are traveling at a certain speed. Let's say you are traveling at 50 miles per hour (MPH). As you drive at a constant 50 MPH you will travel 50 miles in an hour. In terms of electricity, the speed you are driving is your 'demand' and the miles you have traveled is your 'energy'. A demand and energy electric meter measures both your demand for electricity, normally in either 30 or 60 minute increments, and the amount of 'distance' you have traveled in terms of kilowatt hours. If your building used a constant 10 kilowatts of electricity all day and night you would have a demand of 10 and would use 240 kilowatt hours every day or every 24 hours. If this remained constant for a full month, then you would have a demand of 10 and a monthly energy use of 240 kilowatt hours per day times 30 days or 7,200 kilowatt hours per month.

However, people are inclined to use electric energy only during certain times of the day. For residences, people tend to use significant amounts of electricity in the early morning and around suppertime when they return home from work or school. In the summertime, residences may use large amounts of electricity during the afternoon and early evening hours to help keep the buildings cooler. This seasonal demand for electricity puts extra stress on the local electric utilities and causes them to 'peak'. Electric utilities keep track of the demand for electricity and factor the cost to provide this electricity into their electric rate structure. So, even though residences vary in the amount of electricity they use during the course of a day and during the various seasons of the year, most utilities traditionally only charge for kilowatt hours of residential electrical energy. Electric utilities are starting to look at demand and energy rates and other types of electric billing structures as the cost for producing electricity continues to climb.

Small commercial buildings are typically charged for both demand and energy, so it often pays to control the amount of demand that the building places on the electric utility in order to help keep the electric bills down.

This has been a quick explanation of these concepts without going into great detail, but we hope that this overview will help as you work through the Green Building Decision Kit.

Building Site

☐ Does your lifestyle and financial situation lend itself to your choice of building site?

There are green building considerations in virtually every building decision you will make during the life of your project. One key is to continually think about the long-term, complete life-cycle impacts on the environment of each decision. You may not think that the choice of a building site has much impact, however, the environmental impacts can range from disturbing (or eliminating) the habitat of another species to negating all the positive green building decisions made on the structure if there is a long commute required every day from now on.

Choosing between a lot, acreage or infill property depends greatly on your choice of lifestyle and financial situation.

2A. Lot Versus Acreage Versus Infill

LOT

A building lot is generally what you find in urban or suburban developments. Lot sizes vary considerably depending on geographical location. The lot size potentially dictates the size and shape of the structure. If you want to live in the city or suburb, you will probably be looking at building on a lot.

ACREAGE

Acreage refers to land that is measured in terms of acres (an acre is a unit of area that is 4,840 square yards) and can be small (e.g. 1/4 acre) or very large (e.g. 160+ acres) or anywhere in between. If you want to live in the country or on the fringe of the city, you will probably be looking at acreage.

INFILL

Infill is the reuse of urban or industrial property and buildings. Typically, infill is designed to combine new development of residential and commercial activity, redevelopment of underused buildings and sites, and rehabilitation of historic buildings for new uses. If you want to be part of economic development of urban or industrial areas, you will probably be considering infill property.

2B. Proximity to Services

☐ Have you considered proximity in the choice of your building site:

- ☐ Public Services?
- ☐ Schools?
- ☐ Shopping?
- ☐ Green Spaces, Parks?

It is an old running joke with real estate professionals that the top three things that home buyers are interested in are: 1) Location 2) Location 3) Location.

In reality, the potential building site should be more than just a good location. For residences, it is important to know about the quality of schools in the area, the reputation of the local police force, the availability and proximity of good fire protection services, how far it is to get to the grocery store, gas station, shopping district and (perhaps) place of worship.

'Green spaces', such as common areas, parks, etc. provide for stronger neighborhoods. They draw people into them and support interaction among neighbors.

Older home buyers and residential tenants are also interested to know about the proximity of the nearest hospitals and pharmacists as well as the quality of medical care in the area.

For small commercial buildings, zoning is important, as well as parking, highway access and community restrictions.

2C. Covenants, Zoning, Land and Mineral Rights, Previous Use and Restrictions

- ☐ Do zoning or other restrictions apply to your building site?
- ☐ Are there covenants or restrictions on using solar power?
- ☐ What was previously located on your building site?

ZONING, RESTRICTIONS

Before you purchase or lease any land parcel or lot, it is important to review the zoning and other restrictions that may be placed upon the type of building you plan to construct and its usage. Nearly all cities and townships have zoning regulations dictating what you can and cannot do and build. These zoning restrictions are normally available for review at the local city hall. Land that has been divided into lots will typically have zoning or other restrictions. Land in rural locations may not have much in the way of zoning rules and restrictions. However, it is always important to get the details on the zoning for the property you are considering and understand the implications of that zoning on your intended use. If the zoning is not easy to understand or appears to have nonspecific or gray areas to you it is prudent to employ an attorney who specializes in zoning and land use to help you determine your best course of action.

COVENANTS

If you have studied the zoning and believe that you can build on the property, the next step is to find if there are property use covenants in place by the developer (if there is one) or if there is a neighborhood association. There could be covenants placed on land use and buildings which could have a negative effect on your plans. For example, let's say you want to build (or already own) a single family home and plan to install photovoltaic (PV) solar electric panels to reduce your electric bills. However, the neighborhood association has a covenant restricting the installation of solar panels in that neighborhood. Now, you have to decide if you still want to build there and forego the panels, build somewhere else, or attempt to change the association rules (potentially having to fight with your neighbors). It is not recommended that you choose a course that involves fighting with your neighbors, but you can try meeting with them to see if they can understand what you are doing and

allow it. The main point here is that you must understand the rules before you build/remodel or you might end up with problems, disappointments or legal troubles.

MINERAL RIGHTS

Most people assume that when they purchase land that they are also purchasing the mineral rights to the land. This is not necessarily true. The mineral rights can be a separate issue from the acquisition of the property located above. Owning the mineral rights may not be an issue with you, but it still is important to find out if you can own the mineral rights or if not, or who does own them. It might just happen that you build on a piece of ground that has natural gas located below ground. This natural gas might help heat your building for free or provide supplemental heat if you can tap into it. This would be important to know and take advantage of.

PREVIOUS USE

One often overlooked item is previous use of the property. For example, a nice vacant lot near town may seem appealing, but there used to be a gas station located there. A little research tells you that this lot may be polluted or involve some clean-up issues. Another prime example is the fact that old garbage dumps are often covered with soil when they reach the end of their life span. There are many people who would prefer not to build above an old dump but someone else may see this as efficient re-use of land resources. Many towns and civilizations have vanished over the years, only to be replaced with new ones. Cities such as San Francisco spend millions of dollars researching the locations of old towns, cemeteries, burial grounds and ancient ruins before they undertake a major new building project or build a new road. A little time spent on due diligence may help avoid an unpleasant surprise later.

2D. Access to Roads and Mass Transportation

In this day and age of high energy prices and long distance commuting, a major consideration is ready access to highways and interstates and what public transportation is close at hand.

- ☐ Have you included parking, access to roads and/or mass transportation in the choice of your building site?
- ☐ Is there adequate road maintenance in and around your building site?
- ☐ Is the potential commute within the range of your alternative fuel vehicle?
- ☐ Does the community budget to properly maintain bridges, sidewalks, etc.
- ☐ Do the roads delineate space for bicycles or are there bicycle trails available?
- ☐ Are there adequate sidewalks so that adult pedestrians and children have a place to walk at a safe distance from traffic?
- ☐ Are there safe crosswalks or overhead walkways for use to cross busy streets?

2E. Access to Utilities

- ☐ Have you included access to utilities in the choice of your building site:
  - ☐ Sewer?
  - ☐ Public Water?
  - ☐ Electricity?
  - ☐ Natural Gas or Propane?
- ☐ Do you plan to be self-sufficient and have no need for public utilities?

A possible disadvantage to purchasing acreage is lack of available utilities, such as sewer, water, electricity, natural gas, etc. However, it is possible to build 'off-the-grid' using photovoltaic (PV) solar electric panels and/or wind or hydro energy. You can heat your building using solar energy, wood or other renewable resources. A well-designed building can minimize the use of water, recycle gray water for landscaping and other purposes and utilize a rainwater catchment system, with rain barrels or cisterns.

Some potential problems due to lack of utilities might be resolved with good design and careful consideration by you and your design team. But, all these considerations need to be adequately researched, discussed, decided and communicated so that you don't have problems.

A developed lot or infill property should have the advantage of access to water, electricity and possibly sewer and natural gas.

SEWER

- ☐ Are you required to be hooked up to a public sewer system?
- ☐ Is a septic system possible and desirable in your chosen location?
- ☐ Are you interested in pursuing environmental sewage treatment options?

If you are planning to build within city limits it is likely that you will be required to hook-in to the municipality's sewer and water systems. If not then you may be concerned about whether or not you have access to a sewer and public water system. It is a smart idea to pay for a percolation test (or soil morphology) before choosing a property without sewer access. If the ground will not percolate properly, your option for a septic tank and leaching field system could be compromised. However, there are still other sewer options, such as lagoons, composting toilets, Living Machines, etc.

WATER

- ☐ Do you have access to a public water supply?
- ☐ Would a well be a viable option at your site?
- ☐ Is there a water delivery service available?
- ☐ Do you have room for a water tank? Above or below ground?

For areas where rural or city water is not available, you will need to think about drilling a well or trucking water to your site.

ELECTRICITY

- ☐ Do you have access to grid-provided electricity?
- ☐ Is net metering an option with your electricity provider?
- ☐ Do you have solar access for a PV system?
- ☐ Is there adequate wind for a microturbine?

Electricity is generally available to most building areas except for very remote sites. If you plan to build a distance from power lines, it may cost less to install a photovoltaic (PV) solar system than to pay for power line extensions. Some states and localities offer subsidies, tax breaks or other incentives to pay for the installation of solar electric – PV systems.

NATURAL GAS OR PROPANE

- ☐ Do you have access to natural gas lines?
- ☐ Are there covenants or zoning restrictions for the propane storage tank?
- ☐ Will you have room for the tank?
- ☐ In inclement weather will it be difficult or impossible to get the propane tank refilled?

While generally available, natural gas is not found in all communities. Propane is a common alternative when natural gas is not available. With propane there is a monetary and environmental cost factor involved to have it trucked in.

It is extremely likely that the cost of conventional energy sources will continue to increase over time. Designing an energy efficient building that includes alternative energy will likely prove to be a very smart strategy and is definitely a green consideration.

Off-the-Grid: Relying on renewable energy sources generated on-site instead of utility provided electricity.

2F. Land Characteristics

- ☐ Are you looking for:
  - ☐ A flat building site?
  - ☐ A great view from a plateau or hillside or mountain?
  - ☐ Seclusion in a treed area?
  - ☐ Location in an exclusive neighborhood?
  - ☐ Location in an historic neighborhood?
  - ☐ Location in a small town?
  - ☐ Location downtown?
  - ☐ Location in a reclaimed infill community?
- ☐ Have you included land characteristics and natural features in your choice of building site?
- ☐ On your site, does water flow toward the building location or away?
- ☐ How will your construction affect or change the water run off onto a neighbor's property?
- ☐ What are the wind patterns for the various seasons or is there a lack of wind?
- ☐ Is the ground rocky?
- ☐ Does it have good soil?
- ☐ How deep is bedrock?
- ☐ Where is the best view?
- ☐ Do you want to limit the windows on the afternoon side of the building to help reduce the air conditioning load?
- ☐ Are you restricted as to where you may place your structure?
- ☐ Is there likely to be:
  - ☐ Flooding?
  - ☐ Fire?
  - ☐ Earthquakes?
  - ☐ Mud-slides?
  - ☐ Hurricanes?
  - ☐ Exposure to other weather related disasters?

There are a wide variety of land characteristics and some of them might come at a premium price. You will need (at least) to consider the slope, the water run-off, the natural wind patterns, the soil and the form and function of your building in relation to nature and other structures around it.

If you have already found your site, these are questions to consider in the set-up and building(s) placement of your project. If you are still in the looking stage, these are items to consider before you purchase.

2G. Solar Access

- ☐ Have you included solar access in your choice of building site?
  - ☐ Does your building site have a clear view of the sun throughout the day?
  - ☐ Is it shaded most of the time by other buildings or trees? (Are the buildings or trees on yours or someone else's property)?
  - ☐ What percentage of the day will you have sunlight on your structure?
  - ☐ Are there restrictions in the community that will assure that your solar access is not impeded by your neighbors and their future construction plans?
  - ☐ Will you be impeding your neighbor's access to solar energy?

If you are considering the use of solar energy for either passive or active purposes, you will need to ensure that your building site has clear access to sunlight. Solar siting and solar usage is discussed in the ***Energy Alternatives*** section.

2H. Natural Features

- ☐ Does your building site have woods? Lake/pond? Stream/river? Underground spring? Can you (or do you want to) incorporate this in a positive way into the layout of your building site?
- ☐ Can you locate your building where the water will run away from it naturally, such as a natural high spot or berm, or on a slope?
- ☐ If there is a spring-fed river or stream nearby would you be able to install a small hydro-electric system to provide electricity to your building?
- ☐ Does your building site have a significant wind resource?
- ☐ Is your site already a home to other species or a migratory path?

You want to avoid locating your building where the water runoff will hit the building or run toward the building. Definitely avoid locating the building in a natural depression or sink hole. While locating a building in a natural depression may look tempting since the dirt removal may be easier and there may be less rock to contend with, natural depressions tend to hold water and moisture, similar to a pond.

Small hydro-electric generators have become smaller and more efficient in recent years.

If you have adequate wind levels, you might want to consider a micro-turbine system.

Be sure to educate yourself on the animals and plant life that already live there and fully understand the long-term impact of adding your building to the site.

2I. Waste Management, Reduce/Reuse/Recycle

WASTE MANAGEMENT

- ☐ Will you have to remove natural obstacles to build your home?
  - ☐ Rocks?
  - ☐ Trees?
  - ☐ Other things?
- ☐ Will you have to dispose of these natural obstacles?
  - ☐ Can you recycle or donate them?
- ☐ Do you have a plan to use natural obstacles in your project?
- ☐ Will you want to have a compost area?
  - ☐ Are there restrictions about having a compost area?

Sometimes you can crush larger rocks into smaller pieces for use in landscaping or to form driveways or aggregate for concrete.

REDUCE AND RECYCLE CONSTRUCTION WASTE, REUSE LUMBER

- ☐ Have you considered the construction waste that will be generated and sent to a landfill?
- ☐ How much of the construction waste can/will you reduce, reuse, recycle?

Rather than tossing excess materials into a dumpster (or many dumpsters, more likely) and spending a sizable sum of money to send it to the landfill, choose to spend some time planning ways to reduce, reuse and recycle during the construction phase of building.

Reduce your construction waste by evaluating your plans and using standard lumber lengths wherever possible to minimize cutting at the site. Pre-fabricated construction options also exist. For example, Structural Insulated Panels (SIPS) can be cut to your plan specifications at the factory and shipped ready to be erected with a minimum of waste on-site. (Also, some SIPS manufacturers will use the cutouts and unused pieces of SIPS panels to make 'regrind' panels.)

If you are using wood forms to pour your foundation, consider using that wood again in areas of your home such as floor trusses, roof decking supports or cross-members, stair treads, etc. There are a multitude of options for reusing this and other lumber. If there is a finger-jointing machine available, you can take 2X4 or 2X6 lumber and finger-joint into standard stud size or longer pieces. There are several brands of low-VOC or water-based adhesives on the market that will work well in this application. Save longer pieces of lumber to use as cripples (cut-off framing members for above and below windows), braces and other similar applications.

Excess drywall pieces can be incorporated into the soil because gypsum is a beneficial nutrient and is especially good at neutralizing excess salt used on roadways in winter, which kills foliage near

roads. Spread the pieces around and till it into the soil or pulverize it and cast it into already existing landscaping.

If you break a window or glass door you can have the glass recycled at a number of locations. Chances are that the distributor or retailer who sold the glass to you will have a list of locations that will recycle broken glass. Also, there are some beautiful tile pieces made with inset glass pieces that can be used as flooring or counter tops.

Don't let the concrete truck driver dump excess concrete on your property or the property of others. You can utilize excess concrete in a number of ways: You can form a square with leftover wood pieces where the air conditioning condenser will be located. Excess concrete can be poured into this form for a free A/C pad. If you will have a mailbox near the road, you can dig a quick hole and have the excess concrete poured in as a base for the mailbox. You will need to insert a length of treated lumber into the unset concrete, so you might want to keep extra pieces of different types of wood handy in your truck or at the job site.

You can dump excess concrete from the foundation pour on the area where the driveway will eventually be located. This excess concrete can be spread while wet with a Bobcat or other bucket/front or skid loader. If you are planning a pad for a hot tub or gazebo, you can outline the slab with excess wood and fill with some gravel. If there is excess concrete, you can pour it into the forms for the hot tub/spa/gazebo or other outdoor item. Even a small concrete pad on which to place a barbeque grill at a later date will come in handy.

Evaluating Plans

Whether you have an existing set of plans or are creating new ones, the following items are important to consider:

3A. Smaller Footprint or Smaller Building

- ☐ Have you considered what the 'footprint' of your building will be as it relates to:
  - ☐ Physical size?
  - ☐ Resource friendly?
  - ☐ Pollution created (or 'carbon footprint')?
- ☐ Do you need a large building to accomplish what you want?

One of the first items to consider is the size of your home or small commercial building. There are many good reasons to evaluate your needs before deciding on the size of the building. For homes and other residences, you typically will pay more as the square footage increases. Commercial buildings also typically sell or lease at a cost per square foot. So, keeping the size as small as possible will likely keep your monthly costs (including your mortgage) as low as possible.

A 'Smaller Footprint' can mean several things.

ACTUAL LAND SPACE

The footprint of a building is the size of the building based upon the amount of actual land space that the building needs. Normally, this can be measured by the size of the foundation, however, some buildings have substantial overhangs or cantilevered rooms that extend past the foundation line. External additions, such as a deck, porch or patio are not usually considered to be part of the footprint, but may require more actual land space.

RESOURCE FRIENDLY

'Less is More' in sustainable building. Green buildings are resource friendly. The fewer materials required, the fewer natural resources expended. Small, well-designed buildings can mean a much lower amount of fuel to produce and deliver construction materials.

The amount and cost of materials you need for a building is always a consideration. If you are on a tight budget, this is simple common sense. Even if you can afford a mansion, by making considered decisions regarding space usage you can put your money to use increasing the quality of the materials or investing in alternative energy systems.

By building smaller, you may be able to afford the personalized extras that make a building a home or custom business location, rather than a typical generic building. A little extra time and money placed into the trim work and a better grade of windows, doors, fixtures and appliances will make the building appear more luxurious than a few extra square feet might do. Consider going up (and down) as opposed to spreading out. You get more 'bang for your buck' this way.

Carbon Footprint: Very simply defined – how much pollution you and your building create.

ENERGY CONSUMPTION

A smaller, well-designed and constructed building requires less heating and cooling to maintain a comfortable living or working area. This will reduce your 'carbon footprint'.

When you are considering the size of your building, you will want to decide how LITTLE square footage you actually need… the size that your final foundation footprint will be… and the amount of pollution and energy consumption your final building will produce.

3B. Floorplan: Buffer Areas, Room Use

- ☐ Is the design of your building usefully functional:
  - ☐ How do you plan to use this new space?
  - ☐ Do you need separate rooms for each facet of your lifestyle?
  - ☐ Can you combine activities in common rooms?
  - ☐ Are private areas separated from public areas?
- ☐ For small commercial buildings:
  - ☐ How do you and others intend to use the building?
  - ☐ How large do your offices and other work areas need to be?

As was mentioned in the Smaller Footprint section, sustainable building is smart, common sense building. When formulating plans for a new or newly remodeled home or other residence, think about your present and future lifestyle.

By careful consideration about how you will live in your residence, you can create an efficient floorplan that provides private areas in balance with common areas.

BUFFER AREAS

Think about buffer areas. Buffer areas are those less used, but very necessary parts of your structure. They can provide a shield from cold winter winds or hot summer sun by protecting the inner conditioned spaces. Buffer spaces can be closets, hallways, garages, bathrooms and other occasionally used rooms. They can have multiple purposes to save square footage. Brainstorm with all the members who will be living or working in the new spaces about how much space they really need, whether activities can be combined in common areas, and the relationship of placement of these areas (such as placing the dining room next to the kitchen or the utility/mudroom room next to the garage).

ROOM USE

Think about the path of the sun as compared to room usage. Many people like to have a breakfast room or nook located on the southeast side of the residence so that they can enjoy the morning sun. Solar rooms perform well when located on the south side of the building and can provide a buffer space. Family rooms, living rooms and other rooms for evening activity are often located on the southwest or west side of the residence. Bedrooms are commonly located on the northern side of the

residence so that they can be cooler at night and provide a space that cushions the main living area from winter cold. Not all floorplans or building sites will accommodate these design options but they are worth consideration.

For commercial buildings, talk with the other people who will be using this building and ask them about their space requirements. You might be surprised to find that many of them prefer to share an open area rather than be confined to a cubicle. Open areas allow creative and intelligent placement of windows and light shelves or skylights to provide natural daylighting (see ***Advanced Features Planning***). There are a surprising number of ways to accommodate the needs of the majority of people planning to locate in your new commercial building.

The key is to take the time to talk with everyone involved in using the new building and get his or her input. Then bring those items to your design team so they can present you with an efficient floorplan, usage pattern, room size and other considerations.

3C. Energy Efficient Building Envelope

☐ Is your building designed to incorporate a highly energy efficient building envelope?

For the most efficient building possible, you will need to pay attention to the building's thermal envelope.

It is important to design and construct your building so that your conditioned space does not leak conditioned air to the exterior world. It has been proven through many detailed studies and experiments that a tightly built building will save energy and can increase comfort. However, a very tight building will need fresh air introduced for the health of the occupants. It is our recommendation that you involve a Certified Home Energy Rater or HERS rater early in the planning stage of your building to evaluate how tight your new building will likely be. If your new or improved building is too tight, the rater will have suggestions to eliminate potential problems.

You may want to consider insulating unconditioned spaces such as garages, workshops, outbuildings or similar areas/structures, especially if you may need to condition them in the future.

The amount of insulation and other energy efficiency considerations may be dictated by the building codes in the jurisdiction where your new building is to be located or remodeled.

Certifications (such as ENERGY STAR®) are discussed in the Other Green Building Decision Sections and should be considered and discussed with your builder or contractor early in the design process.

Thermal Envelope: the boundary between conditioned space and unconditioned space.

Building to Code: Most builders are quick to tell you that they 'build to code' and that's good because you don't want a sub-standard construction job. But did you ever stop to consider what else that means? A built-to-code structure is the worst construction allowed by law. Sustainable buildings qualify well above the built-to-code standard.

3D. Construction Types

- ☐ Are you willing to leave the choice of building materials and construction techniques up to the contractor/builder?
- ☐ Have you chosen a particular type of construction which uses specific materials and techniques?
- ☐ Are you willing to educate your contractor/builder to use green building materials and techniques?

The majority of residential buildings built in the United States are built using standard wood framing, normally with either 2X4 or 2X6 wood studs. This type of construction is referred to as 'stick-built' framing.

It is possible to build a very energy efficient structure that is sufficiently airtight using stick-built construction; however, many of today's construction crews are pressured to build too fast and use too many shortcuts, which can be detrimental to proper construction. To get the best results from stick-built construction you will need to work with the construction crews, supervisors and others to make sure they understand that resource efficient construction practices are important to you. It is often necessary for the owner of the building to visit the building site often, paying attention to and taking care of the little details that often get overlooked by the crew.

Now is the time to get familiar with the various types of construction products and techniques so that you can discuss their merits with your design team. Newer products include prefabricated structura units (walls, floors, etc.), Insulated Concrete Forms (ICFs) and Structural Insulated Panels (SIPS). Other alternative building products include: straw bale construction, rammed-earth, adobe, stone or brick and earthships. All of which are discussed in detail later in this Kit.

3E. Optimized for Dimensional Lumber, Alternatives

- ☐ Is the design of your building taking advantage of engineered lumber?

There are green alternatives to using standard dimensional wood studs and timber in your building.

ENGINEERED WOOD

One product is called 'engineered' lumber or wood. Engineered wood typically consists of thin strands of wood stacked in layers and glued into laminated dimensional lumber sizes or even engineered wood beams. These engineered replacements for virgin timber can actually be straighter and stronger than their solid wood counterparts. Engineered wood floor joists can be designed to reduce and/or eliminate squeaks that can often occur with solid wood versions. When you use engineered lumber you are conserving trees.

METAL FRAMING

Metal framing, especially metal studs, can be used as an alternative to wood in residential construction. Metal framing is commonly used in commercial construction.

STANDARDIZED SIZES

Another resource, money and time saving consideration is incorporating the use of standard lengths and sizes of dimensional lumber into the building's construction. Another term for this is value engineering.

3F. Natural Ventilation, Shading

- ☐ Is your building designed to ventilate properly?
- ☐ Which direction does the wind typically come from:
  - ☐ In the spring?
  - ☐ In the fall?

Most residential and nearly all commercial buildings are designed with little or no thought regarding natural ventilation. Natural ventilation does involve the installation of operable windows, but there is more to it than that. To design a building to ventilate properly, the direction of the prevailing winds in the different seasons must be taken into account.

These temperate months are the normal times when windows can be opened without discomfort.

Just as it is important to consider how the Sun can contribute to the comfort of your home by taking advantage of solar energy in the winter months, you must also consider how it can contribute to the discomfort of your home by overheating it in the summer months. Proper use of overhangs and shading components to keep the sun's heat out of the house will keep the house from getting too hot.

Now is the time to make decisions about the design of the house to take advantage of these items in regards to natural ventilation. You will also want to be sure that any excess heat that does happen in the home is able to escape. Ventilation is also important because of issues such as condensation, poor indoor air quality, high humidity levels and mold growth. It is important to discuss these things with your team to be sure you don't create problems for yourself or the occupants of the building, plus to limit future damage to the building due to excessive humidity or poor ventilation. By discussing and handling these issues and decisions in the design process, you avoid having to add equipment that uses energy to fix the problem(s) later.

3G. Basement, Crawlspace, Slab-on-Grade, Other Foundations

- ☐ Does your design use the appropriate foundation for the land characteristics?

It is important to have predetermined your building site before you can intelligently discuss and decide on the foundation. Different soil types, bedrock depth, floodplains, earthquake considerations, etc. all play a part in determining which foundation is appropriate for your building site.

In brief, slab-on-grade and crawlspaces will work in most climate zones and soil types. Basements can only be built in certain soil types and in areas that have a low water table. Crawlspace and basement walls can be made of natural field stone, concrete, Insulated Concrete Forms (ICFs), masonry blocks or

innovative blends of concrete and other materials. A concrete slab can be a monolithic pour (slab and footings poured as one solid unit), a floating slab with separate walls and footers or frost-protected shallow slabs, to name juist a few. If a crawlspace is used, careful thought should be given to decisions about whether it should be vented, unvented or use forced ventilation with timers, sensors or thermostats.

Consider the foundation as you decide on your house plan. You may need to think about things such as expansive soil, high water tables or blasting through stone to put in a basement. It is important to have a member of your team who is familiar with what type of foundations can be safely built where you plan to live. You want to avoid having to replace or repair your foundation in the life cycle of your home… this is very expensive, so consider it now.

We also recommend that you properly install insulation in your basement, crawlspace or slab. Adding insulation during the construction process can be somewhat of a hassle, but the benefits are immense. Not adding insulation to your foundation during the construction process can be problematic later and would be a large and expensive retrofit. There are a number of products and techniques available to insulate a foundation wall and under a slab floor. As with other building products, there are certain advantages and disadvantages for the various products and techniques, so some research will likely be required to determine the best foundation insulation system for your project and/or climate zone.

3H. Garage, Vehicle Charging Station, Recycling Center

- ☐ Will you have an attached or detached garage?
- ☐ Do you want to plan for the eventuality of having an electric (or other alternative fuel-type) vehicle that you can refuel at your building?
- ☐ Do you want an area of your home, business or the garage dedicated to being a recycling center?
- ☐ Do you want or need a whole house vacuum system?

GARAGE

Attached Garage

Attached garages can introduce carbon dioxide, carbon monoxide, particulates and other pollutants into your interior living space. Also, an attached garage can be a source of energy loss, depending on the design of the building, the quality of the garage doors and the type, amount and quality of the insulation. Many green designers now recommend that attached garages have a fan with a damper on an exterior wall that comes on periodically to exhaust the gases from vehicles. You can have this fan activated by a motion-sensor or place it on a timer. It is also possible to attach the fan to a carbon monoxide detector or other sensing device.

Unattached Garage

Unattached garages remove the danger of vehicle exhaust entering the building. However, many people do not like unattached garages because they don't want to have to brave the

elements to get to their vehicle. You can help resolve this issue by building a breezeway or covered sidewalk between the building and the garage. Some people do not want to enter an unattached garage in the winter because it will be cold. This also can be somewhat resolved by insulating the structure and installing radiant-style heaters in the garage and connecting passageways that comes on with a timer or by a motion sensor.

VEHICLE CHARGING STATION

Chances are good that the plug-in hybrid vehicles will be on the market in the next few years, so it may pay to have access to electricity (both 110-120 volt and 220-240 volt) available in the garage. For those of you who are really thinking ahead, it will probably pay dividends down the road to plan space for a hydrogen reformer or other future power source for your vehicle, rather than try to figure out how you will fit these things in at a later date.

RECYCLING CENTER

The easier you make recycling, the more likely it is that you and others will adopt the practice. Many landfills are approaching the limit of their capacity and the mindset of a disposable society is actually against a principle of nature. In the wild, nothing is wasted. A tree will provide a home for animals and insects, produce oxygen, create it's own soil-enhancing nutrients and have many other benefits while alive. When it dies, it becomes food for insects, housing for other types of animals and eventually becomes compost and nourishment for new trees. This circle of life carries on through other natural species. It is really an invention of mankind to produce items with only one limited lifespan or use, which is the 'planned obsolescence' or throwaway mentality. It is becoming evident to many individuals, companies, and governments that products designed for reuse, recycling or return to nature is actually a sound and astute business practice and personal ethic.

OTHER CONSIDERATIONS

Garages also make a good location for items that produce quite a bit of noise, such as a whole house vacuum system.

So, take enough time to consider these items up front and decide what level of importance they have to you or your building in the scheme of things.

The Story of Stuff: The Story of Stuff with Annie Leonard is a truly brilliant 20-minute presentation that looks 'at the underside of our production and consumption patterns.' It is available to everyone through the internet at www.storyofstuff.com. 'It'll teach you something, it'll make you laugh, and it just may change the way you look at all the stuff in your life forever.'

3I. Double Entry/Airlock Entry, Utility/Mud Room

☐ Have you considered the entry areas of your home in regard to energy savings and cleanliness?

Not all locations or designs require the extent of creating a double or airlock entry or vestibule at your primary entrance. However, if you have prevailing winds that will hammer your entrance with cold

blasts in the winter, or hot winds in the summer, creating a double entry or vestibule may be a cost effective solution. What you pay for the extra construction will make itself up in energy savings over the lifecycle of your home. In the same vein, putting a utility or 'mud room' in the area of your back door (meaning an entrance where you will more commonly track in dirt and debris) is not only going to save mental frustration but create a cleaner living area. This does not have to be extra construction like a double entry, but a planned feature of your floorplan.

One of the lifestyle changes that can be incorporated into a green home or commercial building is the removal of shoes when entering the building. Many cultures use this practice to keep the floors and interior environment clean. Alternatively, you can keep slipcovers for shoes handy by the entrance rather than have visitors remove their shoes. This is one of the practical changes you can institute to keep your interior environment healthy. It is a nice gesture to have a seating area near the entrance if you want to require visitors and family members or fellow workers to remove their shoes or use slipcovers over their shoes upon entry. A built-in chest with a padded cover can be used for both storage and a place to sit.

If these things are important to you, this is the time to discuss it.

3J. Porches, Decks, Patios, Gazebos, Out Buildings

- ☐ If you enjoy spending time out doors, have you considered living spaces that can be projected beyond your building envelope?
- ☐ Will you have other buildings that create a complex?
- ☐ What purpose will these other buildings serve?
- ☐ Where will they be in relation to the main building?
- ☐ Are your outbuildings organized to be walked or driven to; so do you need to consider additional roads or pathways?
- ☐ Where will you place a barn so that it is somewhat convenient and yet you don't constantly have to smell it?

You may have already thought about porches in your consideration of shading. However, they can have an even larger part to play in the design of your building. A porch, deck, patio and/or gazebo can be projected living space outside of your building envelope.

These outdoor spaces may also be a consideration in your landscaping decisions, but it is best to start thinking about how they relate to both your building and the surrounding area.

For small commercial buildings, a quiet location outdoors can provide a place to 'get away' for a few minutes to collect your thoughts or get some fresh air. Some businesses like to hold meetings outdoors when practical so that it provides a change of pace and scenery for the workers. If you live or work in an area that has banned cigarette smoking indoors, a deck, porch, patio or other similar space provides a place for smokers to have a cigarette when needed.

There is an ever-expanding selection of products made from recycled materials that can be used for decking or patios. Many of these newer products have a very long life expectancy and may not need

painting, staining, waterproofing or other maintenance. There are also new replacement products to the green-colored CCA lumber that can be used outdoors and in contact with soil. This newer treated lumber offers a safer alternative to the arsenic coatings used in CCA to repel insects.

Keep in mind that there are many types of outdoor furniture available made from recycled products, FSC lumber or other sustainable harvested materials.

Instead of concentrating on the house or commercial building alone, think about the additional buildings that you may ultimately need. Include the location of the outbuildings while you are designing your primary building. You then have the choice to design and build the outbuildings at a later date. By creating a plan that incorporates all the buildings of your complex, you will come home (or to work) to a beautiful and productive view instead of a confusion of structures.

CCA lumber: Chromated copper arsenate treated lumber. Manufacturers voluntarily agreed to stop producing this product as of December 31, 2003.

FSC lumber: Wood certified by the Forest Stewardship Council that it comes from suppliers that practice good forestry management.

3K. Fences, Trees, Hedges, Sight and/or Sound Buffers

- ☐ Do you need to establish a barrier between your property (or area of your property) and another space?
- ☐ Is there a privacy issue involved?
- ☐ Is there a containment issue involved (e.g. do you have small children or pets to keep close to home or in a playground)?
- ☐ Is there an attractive nuisance nearby, such as a pond or climbing trees that you want to keep children away from?
- ☐ Is there something you would like to block from view?
- ☐ Are you close to a highway, railroad track or other audible annoyance?

These items will be covered more extensively as part of the ***Landscaping*** section; however, we want to bring them up now so that you will also consider their functionality as part of the comfort of the total design of your building.

If you think of solutions to these questions as part of the structure, you can design your home or small commercial building and add any external barriers to compliment your comfort.

Fences are not just made of posts and barbed wire anymore. There is a large selection of colors and types to choose from. Some fences are made from recycled plastic, which is a significant green consideration.

Advanced Features Planning

4A. Designing for Natural Benefits from the Sun

- ☐ If you are interested in using the natural benefits of the sun, is the side of your house that faces the sun during the day clear of obstructions (i.e. trees, hi-rise buildings)?
- ☐ Have you considered the effects of the sun on your building and rooms layout?

Most buildings are designed and built with little or no consideration for sun. This is one reason many buildings have rooms that are too cold or too hot during portions of day.

Without trying to sound overly simplistic, people seem to have forgotten that the sun rises in the east and sets in the west. Therefore, rooms that you would want to use in the early part of the day, such as a breakfast nook or exercise room, should probably be located on the east side of the home.

Depending on your preferences or the primary design strategy of your building, you might want to locate rooms that are used all day long in the middle of the home or near the center of the southern wall. In residences, this could be the kitchen or family room. In commercial buildings, these could be the conference rooms or break areas and offices. In contrast, if you have extensive southern glass (glazing) areas and are designing for maximum solar heating, these middle rooms might be rooms that are not often used in the middle of the day. In residences, these rooms could be a solar room, greenhouse area or solarium, or perhaps an enclosed and insulated porch. In commercial buildings, these rooms might be the storage areas, closets or eating areas/break rooms.

As the day progresses and the sun heads westward, the rooms that tend to get the most use in homes are the living, family and dining rooms. In commercial buildings, these rooms could be the conference rooms or open areas. For some designs, the west and southwest rooms may also be the hottest rooms, so you will want to consider placing bathrooms, closets, garages, guest rooms, solar rooms or other buffer rooms on the southwest or west side.

The offices in commercial buildings should be located in the east, southeast, center and northern areas of the building. Offices on the south, southwest and west wall will likely run hot for large portions of the year. However, because space is often at a premium for many office buildings, locating offices in only portions of the structure may not be an option. If this is the case, the heating and cooling systems should be designed to allow the occupants of the offices along the southern and western walls control over their comfort within their own zone.

Rooms that are used primarily at night, such as bedrooms, home theaters, recreation rooms or exercise rooms should be located on the northeast or north-center of the building. Rooms on the northwest will likely be the coldest rooms in winter, so they should be buffer rooms: closets, bathrooms (with plumbing to the interior walls), storage rooms, garages or enclosures for additional storage space, outbuildings and/or extras, such as hot tubs.

4B. Energy Analysis and Conservation Strategies

- ☐ Does your design lend itself to zone heating and cooling?
- ☐ Are you designing your building to conserve energy?
- ☐ Will your building design be evaluated by an Energy Rating professional?

BUILDING LAYOUT

What does the layout of a building have to do with energy analysis and strategies? Quite a lot, depending on the thought (or lack of thought) placed into the design. Many homes are built with the living room windows facing the primary view. If this view happens to be to the west or southwest, these extra windows can add significantly to the summer cooling load.

Consider the following example: Since this is the living room, people tend to gather there after dinner (which can be part of the hottest time of the day) and will turn the thermostat down in hope that the air conditioner will produce more cooling. These people will watch television or play games until bedtime and then retire. Meanwhile, the air conditioner keeps running to reach the lower temperature now set on the thermostat. In the middle of the night (when it finally achieves that temperature), someone gets very cold, gets up and turns the thermostat way up to shut the air conditioner off. The same sequence of events repeats every day throughout the summer and the homeowner can't understand why the air conditioner energy bill is so high. If the living room had just a few windows, instead of a wall full, or if shading strategies were employed, such as awnings, low-E glass or trees planted to help shade the home, the cooling bills could be noticeably reduced.

Another common design mistake is to place the living room on the northwest corner of the home where the prevailing winter winds blast the room all day long. In this example, the room is freezing cold, so the thermostat is turned way up, in hopes that the furnace will add more heat. The furnace struggles all evening to heat the living room while the temperature in the bedrooms climbs to an uncomfortable level. When it is time for bed, the bedrooms are too hot to sleep, so one family member opens a window to let some cool air in while another turns the thermostat way down to shut off the furnace. The next night, this same sequence repeats. The heating energy bill is sky high and yet the occupants aren't comfortable. As you can see, thought should be placed into room usage and location during the planning stage so that energy wasting scenarios like these don't occur.

In commercial buildings, similar energy analysis considerations include not locating offices along the west wall if possible, due to the hot afternoon sun. Move these offices inward or along the eastern, northern and southern walls (preferentially, in this order). Place buffer rooms on the southwest corner of the building. If you have rooms that are only used occasionally, either by temporary staff or traveling sales people, place these offices along the western wall.

ZONE HEATING AND COOLING

If possible, do not use one large HVAC system for the office. Instead, use a few smaller units so that occupants will have more control over the temperature within their specific area. Have one HVAC system located along the western wall with a high efficiency cooling rating, since this unit will be doing a lot of work in the summer months. Have another HVAC unit that handles the offices located

in the center, another for the offices on the north, another for the east and another for the south. The ability to incorporate zone conditioning for the second unit will work as well. This strategy will help keep the occupants comfortable and keep the complaints down.

CONSERVATION THROUGH DESIGN

There are many options when designing a building to conserve energy. Minimize the window sizes and area on the afternoon side of the building. Designate the use of low-E glass. Specify highly efficient heating and cooling equipment. Employ passive solar strategies. Include the installation of active solar systems. Specify the use of extra insulation in the walls, floors, ceilings and foundation and take care to make sure it is installed properly. Information on these strategies and products (and more) will be provided as you utilize this Green Building Decision Kit.

PROFESSIONAL ENERGY RATING

Energy analysis of your plans should occur and recur throughout your design process and include physical evaluations/inspections of your building at critical points in the construction phase. We recommend that you have a professional certified energy rater evaluate your plans, especially at the beginning when early objectives and considerations are being discussed. This will cost you some money up front, but because they are trained to make suggestions on ways to improve your energy efficiency (by making alterations to your design before construction begins), chances are that you will make up the cost for the rater with energy savings. There may also be energy tax credit incentives that will offset that cost. We recommend that you include a rater in your design team. Commercial buildings need to have a Certified Energy Manager, a PE engineer or licensed contractor review their energy savings numbers before they can apply for the commercial energy tax credits. Many energy raters are also licensed contractors.

4C. Intelligent Design

- ☐ Have you incorporated intelligent design into your building plans?
- ☐ Are you integrating ways to make future expansions as easy as possible?
- ☐ Have you considered making your building ADA compliant?

Now that we have discussed room location for the sun and comfort, let's delve into intelligent design. Some aspects of intelligent design are simply common sense and some are not. Here are some intelligent ways to design a building floorplan:

KITCHEN

In residences and commercial break rooms and kitchens, there is a design triangle that is used to locate the refrigerator, the sink and the stove. This triangle is optimum when these components are within a few feet of each other and there are no obstacles in the way.

When entering from the garage, the pantry/food storage area and the kitchen should be within a few steps. Plans that have the kitchen located on the opposite side of the building from the garage make the process of bringing in groceries more difficult than it needs to be. The pantry should be located near or as part of the kitchen, so that retrieving food items is an easy task. If there is a basement,

a stairway in the garage or near the doorway to the garage makes it easy to take staples from the vehicle to the basement for storage.

FUTURE ADDITIONS

Many designs, either residential or commercial, give little thought to the location of the HVAC equipment, or where the duct runs will go or if there will be space allocated for future additions, such as solar storage tanks or batteries, hydrogen fuel cells or micro-turbines, back-up generators and such. Every home and small commercial building can be 'solar ready', which means that there is PVC or other larger diameter piping running from the attic to the basement or utility/mechanical room. These pipes make it easier to install a solar liquid or photovoltaic (PV) system in the future because you have a chaseway in which to run the piping or electrical wiring from the roof to the inside solar components. Be sure to place caps on the top and bottom of these pipes until they are used for their intended purpose otherwise they will transport heated and cooled air for the lowest level of the building directly to the attic, where it will then escape outside.

AMERICANS WITH DISABILITIES ACT (ADA) COMPLIANCE

Commercial buildings need to be ADA compliant in most jurisdictions, which means that the building is designed for easier access and to accommodate the needs of handicapped individuals. Homes should be designed to be ADA compliant also, but many of them are not. Most homes have 2 foot 8 inch (32 inch) interior doors (or narrower). A simple change to most home plans is to add a 3 foot wide (36 inch) door pathway through the home so that a wheelchair can navigate to the main rooms and bathroom. Provisions for a ramp to be installed on the front entry or interior garage door are also a good idea. If handicap accessibility is important to you, consider bringing an ADA specialist in as part of your team.

4D. Addition of Solar Features

- ☐ Are you including the power of the sun in your building design:
  - ☐ Passive solar features?
  - ☐ Active solar (thermal)?
  - ☐ Active solar, photovoltaics (PV)?

There are several ways to use the power of the Sun. The following features should be considered during the planning stage. For information about implementing them, visit the ***Energy Alternatives*** section.

PASSIVE SOLAR

Passive solar is simply allowing the sunlight to enter your building (or solar addition) and shine on the floor or walls. The sunlight's infrared spectrum or wavelength will warm the surface of the wall or floor. If the wall or floor is comprised of massive materials (thermal mass), such as concrete, stone, tile, brick (or even water), the heat energy will tend to be retained (or stored) in the mass. At night when the sun no longer enters there and the room begins to cool naturally, the heat collected in the thermal mass will be released to warm the air in that room or area overnight. A well designed

solar room, passive solar building or other passive solar structure will need to have the correct ratio between the amount of glass (glazing) to thermal mass. Passive solar can be incorporated into most building designs for little or no additional cost, especially direct passive solar.

Direct Gain Passive Solar

Direct gain passive solar is the introduction of the sun's light directly into the living space or working space of a building. When the sunlight enters a window or skylight and the strikes a surface inside a room the heat from the sunlight is released directly into that room. If the room needs to be warmed-up, the addition of sunlight helps to reduce the need for space heating by a mechanical heating system. However, if the room is becoming too warm, the heat from the sunlight needs to be removed either by opening windows (ventilation) or by an air conditioning (space cooling) system. By orienting a building properly, the passive solar gain from the sun can be maximized.

Indirect Gain Passive Solar

Indirect gain passive solar is solar heat that is released into an attached room or space. This attached room can be isolated from the main living area of the building by either doors, windows or other partitions. Indirect passive solar rooms can be used to add heat to a main structure when heat is needed and then isolated from the main area when heat isn't needed. This gives a degree of control to how and when the heat from the sun is used. The indirect rooms often become too hot or too cold because they are independent of the main area of the building. If the room is used to grow plants, too much temperature swing can hurt certain plants.

ACTIVE SOLAR, THERMAL

Thermal active solar refers to solar systems that heat either liquid or air. It can also refer to thermal collection/ distribution for heating.

ACTIVE SOLAR, PHOTOVOLTAIC

Also called 'PV,' photovoltaic active solar refers to using photovoltaic products to produce a direct electric (DC) current. This also requires consideration of space and placement of battery storage systems and the other components necessary to make this electricity accessible.

Why should you consider these items early in the design process? Some folks think that solar is an extra as opposed to an essential consideration. This used to be true when conventional energy sources were inexpensive. Most people believe that conventional energy will continue to increase in cost, so it is a smart decision to consider the building design and orientation if you decide you want to take advantage of the power of the Sun, either now or in the future.

This is the time to decide how important solar features are to you. If you decide, after reviewing the ***Energy Alternatives*** section, that cost consideration restricts the use of Active Solar systems in your current plans, you still can plan to benefit from Passive Solar design. You may still want to add solar systems to your building in the future; consider making your home at least solar ready.

If solar is important to you, consider bringing a solar power specialist in as part of your team.

4E. Window Tuning and Natural Daylighting

- ☐ Are your windows 'tuned'?
- ☐ Will you incorporate natural daylighting into the design of the building?

WINDOW TUNING

The term window tuning is new to most people. It is a strategy that does require some thought in the planning stage of a building, but as a concept, it is not hard to understand. First, a little history: Many years ago homes and commercial buildings had single-pane windows. This is because single-pane glass was the only product available. Over time, double and triple-pane glass became available. More recently, window films were invented that can limit the amount of infrared, ultraviolet and the total amount of sunlight allowed through the window.

It is now possible to fine-tune the windows in any building. This means that you can order windows for the west (afternoon) side of the building that have a low-E (low-emittance) coating on the interior glass surface that can limit the infrared wavelength of sunlight and reduce the summer heat load of the building. This strategy can lower the size of the cooling equipment needed and significantly reduce the summer cooling energy bills. Windows are required to come with a sticker that tells you the specifications of the window, including how much visible light can pass through the glass, the insulating value of the glass and other factors. It is possible to order coatings with different characteristics but this is a somewhat scientific endeavor that may require the help of a window specialist. Windows with low-E coatings are readily available from window manufacturers and distributors/retailers.

As just noted, the savvy building designer can now order glass for the west, north and east sides of the building with low-E coatings. However, adding low-E coatings on the south side of the building will limit the amount of winter sunlight and heat energy entering the building in the winter. Therefore, the designer may want to order clear glass with no coatings for the windows and glass doors located on the south wall. That way the sun's heat can pass through unrestricted in the winter. Unfortunately, the sun's heat can also pass through unrestricted in the summer. However, you can use roof overhangs, awnings and other shading devices to shade the southern windows and glass doors in the summer months. The result is a building that has window tuning strategies employed.

Daylighting: An industry term, 'daylighting' refers to the controlled admission of natural light into a room or area to reduce or eliminate the use of artificial light.

NATURAL DAYLIGHTING

Natural daylighting is the intelligent placement of skylights, windows, glass doors, glass blocks, light shelves and other devices to maximize the amount of natural light entering the building. The use of natural light can reduce the number of artificial lights needed during the daytime hours, which can lower the cooling energy bill. Natural daylighting can involve some serious thought in the building design stage about the type of glazings (windows, skylights, etc.) to be installed and the best placement for these glazings. You can use software programs to help determine the best location for glazings and more. There are also special products available, such as light shelves, which help reflect

sunlight from windows and other glazings deep into the building's interior spaces. In fact, there are so many specialized products available for designers to use to help maximize the natural daylighting of a building that we suggest you might want to add a lighting specialist to your design team.

4F. Incorporating Home Automation, Energy Controls and Electronics/Grounding

☐ Are you planning ahead for home automation, energy controls and electronics/ grounding?

HOME AUTOMATION

You will need to think about all the items you want to automate (whether that is when the building is completed or in the future). If you want to have motorized skylights, for example, then you will need to make sure that the appropriate size and type of wiring is specified in the plans and drawn from the skylight to the connecting box or control device.

If you want to have automated lighting that can be turned on and off from remote sources, you will need to determine the products you will use to enable the automated lighting and, again, show where the specialized wiring will go, if needed. Manufacturers of automated equipment often have detailed diagrams and sample wiring schematics on their websites or available through their literature. A brief listing of items you might want to automate are: drapes/blinds, door locks, televisions, security systems, entertainment centers, small kitchen appliances, accent lighting, garage doors, gates, fountains, swimming pools, landscape watering systems and more.

Some remote devices, such as gate operators and outdoor water fountains, will need to have the wiring run underground. You will need to show on your plans where the wiring exits the building and the path it will take to reach the item.

The main point here is that if you are considering installing automated devices, you will want to ensure that the proper wiring is installed during construction. It is possible to add wiring to buildings after construction is completed, but it is much easier to install wiring during the construction phase when there is easy access to walls, ceilings, soffits and such.

An intercom system requires locations for the speakers and main station. You will also need to show the wire runs for the intercom units. A home theater will probably need speaker wires placed behind walls or above ceilings and, again, you will need to show where these wires will be located.

Nearly every home and many commercial buildings have televisions and/or security monitors. Install plenty of cable (coax) in your walls to allow for the number of televisions or monitor locations that might be needed. The type of cable and location(s) should be drawn on your plans to ensure that the cable is there when it is needed. Digital satellite and regular television cable companies also require cable to hook to at your building.

ENERGY CONTROLS

The control of the heating, cooling and ventilation equipment can be more sophisticated than the common thermostat. Intelligent software programs are available that can control the HVAC of a building using either digital equipment or pneumatic controls. Futuristic devices, such as scanners

that can read your thumbprint or understand your voice, are now readily available at a reasonable cost. You can install a card reader at the entrance of your business that reads the employees card information and can allow access to the building or other functions. There are even monitoring devices that workers can wear that track where they are inside a building and can forward phone calls to the phone nearest the worker and can open doors and turn on the lights needed by that particular worker. There are too many items and possibilities available to list here. And, as with most things, the more sophisticated the energy control system and building's logic, the more expensive the system can be.

If you are planning to have a rather sophisticated residential or commercial building, it may make sense to involve a person from a local energy controls company or home automation specialist on your design team.

ELECTRONICS/GROUNDING

It is necessary to ground your electronics to minimize the potential for shock and other hazards.

Additionally, consult a professional electrician to ensure that power grounding is sufficient for your entire building's requirements.

More information is provided in the ***Electrical*** section.

4G. Wired/Wireless Network, Internet-Connected Appliances, AC/DC Wiring

☐ Are you planning ahead for special wiring, networking and other 'smart' technologies?

NETWORKING

There are two main ways to install a computer network in a building, either hard-wired or wireless. Hard-wiring for networks is typically Category 5 cable for Ethernet or Cat-5E for enhanced Ethernet. Wireless comes in many forms from many manufacturers and can be set to different frequencies. Wireless networks can be compromised (hacked) by others if they aren't set-up properly. Hard-wired networks are typically more secure, but you are limited as to where you can locate computers and related equipment depending on where the wiring is located. As with all wiring, you will need to predetermine the location of the wiring runs for the network and show this on the building plans.

SMART APPLIANCES

Internet-connected appliances are becoming commonplace in the market. You can now purchase refrigerators that have flat screen monitors built-in. We will discuss ***Appliances*** in it's own section. However, many appliances will be designed to talk to the Internet and will probably come with the option to go wireless or have a wired connection to the network. You may want to install a run of Cat-5 or 5E wiring to the refrigerator location, the utility room where the clothes washer and dryer are located and to the area where the main HVAC equipment is located, plus one to each thermostat. Other large items that you might want to connect to the network are: spas/hot tubs, steam rooms/saunas, zones for heating or cooling and wine or beer cooler cabinets.

Some refrigerators come equipped with a bar code scanner/reader that can read the products as they are removed or added to the refrigerator. If the milk does not get replaced, the smart refrigerator will assume that more milk is needed and add it to the grocery list. When RFID (Radio Frequency Identification Chips) become commonplace in the near future, a smart refrigerator will know what items are inside it and probably which shelf that they are on. It will certainly be possible to program a refrigerator to know the likely expiration dates for common items, such as milk and cheese, and have it give you reminders of when to buy more. It might even tell you that the open beer hidden behind the mayonnaise jar has probably gone flat. The mind boggles at the possibilities. The point is that the building you are currently planning to build or remodel has the possibility to become much smarter in the near future and that you should probably start planning for that now.

WIRING

All buildings have electrical wiring installed. In the USA, the wiring is installed for alternating current (AC) cycling at 60 cycles per second or 60 Hertz (60 Hz). In parts of Europe, the AC current cycles at 50 Hz.

Some homes and commercial buildings opt to have direct current (DC) for some or all of their electrical needs. Most electrical devices, such as computers, televisions and other solid state devices, actually operate on DC current. They utilize transformers to convert the AC current to DC. As the price of photovoltaic (PV) solar electric systems goes down and as the energy requirements for many common items drops, more and more PV systems will be installed to provide 'free' electricity from the sun for the building. While you are in the planning stages of your residential or commercial building, you may want to consider installing some additional heavy-duty wiring for future use by a DC system.

We suggest that you think about extra wiring runs to your main lighting, such as your hallways and exterior lights, and to your security system and home network components. Even if you do not install a PV system to power your entire building, you can provide power to components that you will need in an emergency or electrical utility power outage. Some of these critical items are: telephones, security systems, lighting, refrigeration and communication/radios.

4H. Feng Shui

☐ Will your building design be evaluated for intangible properties such as Feng Shui (or the equivalent in your culture)?

In addition to physical aspects to evaluating your building plans, there are also intangibles associated with a residence or commercial building. 'Flow' is a word often used to describe creating a traffic pattern through a building. Similarly, there are many cultural disciplines that look at a building, room, or space from an energetic flow perspective. Feng shui (commonly pronounced "fung shway") is the ancient Chinese practice of placement and arrangement of space to achieve harmony with the environment (and specifically, your environment). The literal translation is 'wind and water'; both of which can have constructive and destructive flows. The primary goal in Feng Shui (and other disciplines like it) is to create a comfortable atmosphere that enhances your life experiences and safety. If you are interested in the intangible aspects of energetic harmony in your building, consider adding a Feng Shui (or the equivalent in your culture) practitioner to your design team.

Excavation / Foundation

5A. Save Existing Trees and Foliage to Use for Natural Landscaping

- ☐ Are there trees (mature or not), bushes, foliage that are beneficial to keep in place?
- ☐ Is there foliage that you would be purchasing already existing on your site?

When you examine a potential subdivision or building site, identify plants and trees that you want or need to leave as they are. For example, mature trees can provide shade to help cool your home and lower the cost to cool mechanically.

Now is the time to make decisions about what to leave in place, transplant to a safe location during construction then relocate into a permanent location, or remove entirely. Consult with a landscaper, master gardener, or the local extension service to find out if relocation is an option.

It is a common practice for developers to 'clear cut' acreage, stripping the land of all trees and vegetation. They do this to make it easier to conduct surveys of the property, dig utility lines and to allow maximum freedom in placement of the buildings, roads and easements. Once the new buildings are constructed, they sometimes come back and plant tree saplings (often of non-native trees) to replace the natural greenery that once existed there. The non-native trees and replacement vegetation often require considerable amounts of water, fertilizer, herbicides, pesticides and ongoing maintenance just to survive. While this practice is expeditious for the developer and builder, it can wreak havoc on the local ecosystem.

A savvy green developer is able to save a large percentage of the existing trees and valuable foliage by creative placement of the buildings, roads and other amenities. Some green developments have clustered the buildings together in a portion of the land and then surrounded the development with green space, often consisting of parks, playgrounds and walking trails. These green developments are becoming more commonplace as people learn about them and find their natural beauty desirable. With intelligent planning, it is quite possible to combine green residences with a green development for the maximum benefit of the occupants/owners. Green commercial projects are also possible where the buildings in the project (e.g. a shopping mall) are all green.

Leaving a tree in place during construction requires special attention to the root system. Consult with an expert to determine the extent/depth/placement of the tree's root system and then protect it from compaction (driving over it, for example) and encroachment (cutting into it during excavation). Damaging the root system will kill the tree slowly. Your local energy utility or municipal government may have a forester on staff that can come to your building site and evaluate your trees and foliage. There will likely be some cost and hassle factor involved in protecting trees during construction and relocating bushes and other foliage so compare this option to the price of replacing them at their current maturity level. You may find that it can be much less expensive to use what is already on your site.

5B. Utilize Felled Trees and Conserve Soil

- ☐ If you must remove trees prior to excavation, will you reclaim them and not send them to rot in a landfill?
- ☐ Is your house designed to work with the terrain and minimize excavation?
- ☐ Is your site flat and you want to use an earth berm?

If it is not feasible to leave trees in place on your building site, consider reclaiming them rather than sending them to a landfill or ditch somewhere.

Conduct a little research to find if there is a reclaimed timber facility operating in your area. These facilities take felled trees and mill them for use as flooring, siding, veneer, and other wood products. Find out if you can get credit for your trees; for example, can you get already milled products in exchange for the board feet that they will get from your tree? Or, perhaps you could have your tree turned into flooring, etc. for your building.

There are other ways to utilize felled trees if no reclamation facility is available.

- Save the large sections for later use as firewood.
- Allow interesting pieces to dry thoroughly and use them as decorative posts, mantles, wall hangings, etc. in your new home.
- Most landscaping plans call for the use of wood chips as mulch for foliage and other decorative uses. You can have the remainder of the tree chipped on site.
- Donate the bulk wood chips or wood fiber to reclamation projects.

Excavation must disturb the soil on your site. In some locales, it is a requirement to remove the topsoil from the construction area and save it for use elsewhere on the site. Even if this is not required in your area, it is a beneficial use of the rich topsoil, so consider protecting it and reusing it.

With some prior planning you can determine a balanced fill. By raising or lowering the building slightly, you can make a significant difference in the amount of soil to be moved.

By determining if your building 'fits' into the terrain you will determine the most effective use of the soil.

5C. Water Runoff

- ☐ How are you going to handle the water (created by rain and storms) that moves across your site?
- ☐ Are you bound by neighborhood covenants or zoning regulations regarding the materials you use to pave your parking areas, driveway and walks?
- ☐ Is your home designed to use gutters?
- ☐ Are you taking care to protect your foundation or basement from water infiltration?

Fast moving water is a major cause of soil erosion and a build-up of water around your foundation can cause structural damage and flooding. So now is the time to make decisions about what the issues with water movement and capacity on your site are and what you need to do to lessen their impact on your construction and buildings.

PAVING

If you are not bound by neighborhood covenants or zoning regulations regarding the materials you use to pave your parking areas, driveway and walks; you might want to consider permeable pavement options instead of asphalt or concrete. Permeable pavement products allow water to pass slowly through instead of running over the top and rushing into nearby drains, streams or ditches. These same products are also great for patios and other personal high traffic areas.

ROOF WATER

If your home is designed to use gutters, then the downspouts carry a great deal of water into small areas of your yard close to your home. You might want to consider capturing this water for your garden and other uses in a rain barrel or even a cistern system. If this does not appeal to you, then consider a rain garden. Rain gardens are small depressions located in yards that can hold the runoff from a fairly large rain and then allow the water to absorb into the ground within a few hours. Rain gardens do not hold water for longer than 24 hours, which means that mosquitoes can lay their eggs in the water but the water drains away before the larvae get the chance to hatch. Therefore, the use of rain gardens is a good way to control rain runoff and mosquito populations at the same time.

RETENTION BASINS

When you have runoff that you cannot abate, natural retention basins may be a solution for you. These basins are great when there is a considerable amount of rain runoff, typically from a parking lot or other larger solid surface area. A natural retention basin is similar to a levee in that it slows the flow of the runoff water and holds it in a natural basin filled with native plants. These plants allow the water to be absorbed into the ground rather than into the storm sewers and possibly overflow into a nearby river (or worse, to overwhelm a sewage treatment plant and force raw sewage into our streams and rivers). A natural retention basin will typically have a smaller diameter pipe that allows a measured amount of flow to exit the basin. This controlled flow is what helps slow the onslaught of water in storm sewers, streams and rivers.

FOUNDATION DRAINAGE

There are several ways to move water away from your foundation. Make it a point to discuss the best course of action for your soil type and site layout with your builder. A few examples are:

Waterproofing

Waterproofing treatments are useful in helping discourage the introduction of water into a basement or foundation area. Water membranes are better than treatments because they are designed to prevent water from entering the structure. Waterproofing is necessary in most climates to retard the entry of water into a structure.

Drains

French drains or drain tiles allow the water that tends to build-up around foundation walls and footers to 'drain to daylight'. Cloth-covered or permeable-faced water membrane systems allow water to drop unobstructed downward to the French drain tiles.

Sump pump

Sump pumps are sometimes necessary to remove excess water build-up under a slab or basement floor. Remember that this is a mechanical pumping device that uses electricity, so a back-up power source (such as batteries) and/or a water power sump pump is important in case of an outage during a heavy storm or while you are away. You can opt to drain the water from the sump pump onto the yard, into an open-air pipe or into a gray water system. Most municipalities have restrictions against dumping sump pump water and other runoff into sewer systems.

We strongly recommend that you use an exterior drainage product on your underground walls that takes moisture directly to your drain tiles or sump pit. Traditional water treatment using sprayed-on tar will provide a membrane between your foundation walls and the surrounding dirt or sand, but excess moisture can place a strong hydrostatic pressure against your foundation walls and cause them to crack. Conversely, if you have an extended dry season, the surrounding ground may pull on your foundation as it shrinks or the ground may crack and cause your foundation walls to do the same. If you look in the phone book in any major city you will probably find a number of companies specializing in foundation repair. There is a reason for this. Most foundation walls are not designed to withstand the damaging cycles of too much moisture and then excessive dryness. Exterior drainage products provide a solid barrier between your foundation walls and the surrounding dirt or sand and help protect them from these cycles. They are available from a number of manufacturers.

5D. Poured Concrete Foundation

- ☐ What kind of foundation is called for at your building site?
- ☐ Are you willing to leave the choice of foundation materials and construction techniques up to the contractor/builder?
- ☐ Are there foundation material alternatives with a sustainable aspect that will work for your site?

The most commonly used foundation material is currently poured concrete. Concrete can be ordered in different strengths or pounds per square inch. Most poured concrete used in residential construction is around 3,000 psi (pound-force per square inch) although concrete can be ordered up to 7,000 psi for general purposes. Between 7,000 to 14,500 psi is considered 'high-strength' concrete.

There are several ways to 'green' a poured concrete foundation:

RE-USABLE FORMS

Use of re-usable aluminum forms to create foundation walls makes economic and environmental sense in this application.

FLY ASH

Fly ash is a by-product from coal-fired electric power plants and can be added to cement in amounts from 15% to 50% without degrading the integrity of the concrete. Studies show that the addition of fly ash can actually make a stronger end product. You have the option to specify that fly ash be added to your cement mix and at what percentage.

RECYCLED AGGREGATE

Pulverized stone (i.e. gravel, typically limestone) is mixed in with concrete, placed under concrete slabs and as filler for other purposes, including drainage pits and around French drains. Some cement plants take their excess concrete (that returns unused from clients), spread it out on the ground and use heavy equipment to break-up this layer of concrete into smaller chunks, similar to virgin aggregate. Demolition of large concrete structures has also created another source of recycled aggregate. This recycled product can be mixed into new concrete and/or used under slabs, footers and for other purposes. When discussing concrete and/or cement, the term 'cement' refers to the product before it has a chance to set and harden, hence the term 'cement plant'. Concrete refers to the hardened end product, such as concrete driveways, sidewalks and slabs.

INSULATED CONCRETE FORMS

Insulated Concrete Forms (ICFs) are typically expanded polystyrene sheets/blocks that act as forms while the concrete is being poured between them and become part of the foundation (automatically adding an interior and exterior insulating property). ICFs create a well insulated foundation and prevent mold or encroachment by termites or other pests. One drawback to ICFs is that they do not allow for a thermal mass.

SANDWICH-WALL POURED CONCRETE

A different insulated foundation system places the insulation in the middle of the concrete wall. These can come precast or be poured on-site. Unlike iCFs, this type of insulated concrete foundation provides for thermal mass while providing excellent protection from mold and pests. The most visible system in the United States of America currently is THERMOMASS by Dow.

5E. Alternate Common Foundation Materials

There are many other options to create your foundation depending on your structure, soil and site specifications.

MASONRY BLOCK

Concrete or masonry blocks may be appropriate for some situations. They do require an experienced labor force because this is a masonry type of foundation. Consider filling them with foam (if there are openings) or another water resistant insulation product. They can also be filled with poured concrete and rebar if extra strength is required.

FIELD STONE

Field stone was originally used for foundations because it was the only material available. Modern stone block can be used with good end results and this foundation type can still be insulated.

TREATED WOOD

In some areas, treated wood foundations are fairly common. A quick check of the local building codes will inform you if treated wood foundations are allowed in your jurisdiction.

BEDROCK

Bedrock is a highly desirable foundation component. In some parts of the country it is possible to pour concrete slabs on bedrock. If a basement is desired on bedrock, blasting may be required (creating a possible byproduct: aggregate).

PIERS

Piers can be used as a type of foundation. Piers can be made of treated wood, recycled utility poles, poured concrete or stacked materials. Piers with extra rebar and high poundage concrete can make a structurally strong foundation for earthquake-prone areas. Piers are commonly used to hold up highways and bridges because of their structural integrity and resistance to wind, earthquakes and pressure from waves.

5F. Uncommon Foundation Materials

If you are adventurous and want a hands-on experience with your foundation, there are other green options that may be more to your taste.

TIRES

Automobile tires filled with dirt, sand or other dense materials (especially if rebar is added) can be used as an alternative foundation. Some homes built with this type of foundation are called 'Earthships'.

RAMMED EARTH

Rammed earth is an ancient foundation method of compacting or 'ramming' dirt into a vessel of some sort that works well today. Rammed earth is typically used in warmer, dryer climates.

BRICKS

Bricks made of local clay are used for foundations in some climate zones, but primarily in countries other than the United States of America.

BLOCK SYSTEMS

Mortarless block systems are available that lock together with rebar and the cavities in these block systems are then filled with grout and insulation.

EXPANDED POLYSTYRENE

Expanded Polystyrene (EPS) that is molded into steel frame panels.

CONCRETE PANELS

You can also get concrete panels reinforced with steel.

STRUCTURAL INSULATED PANELS

A treated, oriented strand board (OSB) product is used on Structural Insulated Panels (SIPS) and can be placed underground.

5G. Slab-on-Grade Foundation

Slab-on-Grade foundations can be constructed in a variety of ways. Most climate zones will require some form of frost footing be installed around the perimeter of the slab and the footings need to be deep enough to be at or below the frost line for that geographical region. Normally, the footers are poured first, then the below grade foundation walls and the slab is poured last. Some slabs, walls and footers are poured all at once. This is called a 'monolithic' pour. It is important to remember that gravel (aggregate) must be in place before the concrete is poured. Also, metal rebar must be installed prior to the pour. Most jurisdictions require an inspection of the foundation dig that shows the amount of aggregate and rebar used before the concrete is poured. It is common to 'tie' rebar together with metal wire or other fasteners prior to pouring the footers. Rebar is also commonly required in the foundation walls. We recommend that you seek information regarding the local requirements for foundations your area from the local building inspector's office or division of building codes.

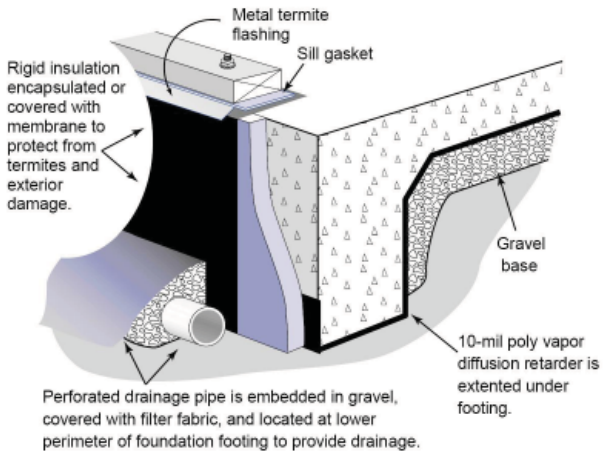


Image Courtesy of www.energycodes.gov.

Frost-Protected Shallow Foundations (FPSF) are available that provide protection against frost damage without the need for excavating below the frost line. An FPSF uses insulation that is placed strategically around the outside of a foundation to direct heat loss from the building toward the foundation, and also to use the earth's natural geothermal energy. Because FPSF are protected from freezing by thermal insulation, bottoms of footings can be just twelve to sixteen inches below grade instead of several feet. This reduces excavation costs, making this an economical alternative for protecting foundations against frost damage.

Some slabs are formed from a mold set into the ground. The concrete is then poured into the mold, leaving no space between the ground and the structure. This type of construction is most often seen in warmer climates, where ground freezing and thawing is less of a concern and where there is no need for heat ducting underneath the floor.

If you desire to have a heated slab it is relatively easy to fasten special plastic piping to the rebar before you pour the concrete. There are also electric heating systems that can be placed below the concrete slab and used for in-floor radiant heating.

5H. Crawlspace Foundation

Crawlspace foundations are, as the name implies, a space designed to be tall enough to allow a person to crawl around in it. It is common to have sewer pipes and water pipes located in the

crawlspace. Often the ductwork for the heating/cooling system is located in the crawlspace. In colder climates it is advisable to place insulation around the ductwork and the water pipes to prevent freezing. Crawlspaces nearly always have a plain dirt floor. It is recommended that most crawlspaces incorporate a layer of thicker plastic (typically 4 to 6 mil) that covers the dirt floor to keep the moisture, soil gases and radon from rising up into the living space above.

Crawlspaces can be either vented or unvented. A vented crawl space has vents located around the perimeter walls that allow outside air to enter under a home. These vents are intended to let moisture and soil gases escape and can reduce the likelihood of mold forming. This type of foundation works best in warmer, dryer climates.

Vented crawl spaces can allow cold air to get in the crawlspace in winter months and cause water pipes to freeze, so care must be taken when using this type of foundation in colder climates. Some crawlspaces use operable vents that can be opened in the summer months and closed during the winter season.

An unvented crawl space will stay warmer in winter months than a vented crawlspace, but can also allow moisture to build-up and potentially cause problems. One solution is to install a fan in an unvented crawlspace that can activate when certain conditions are present such as too much moisture, high radon levels or other situations .

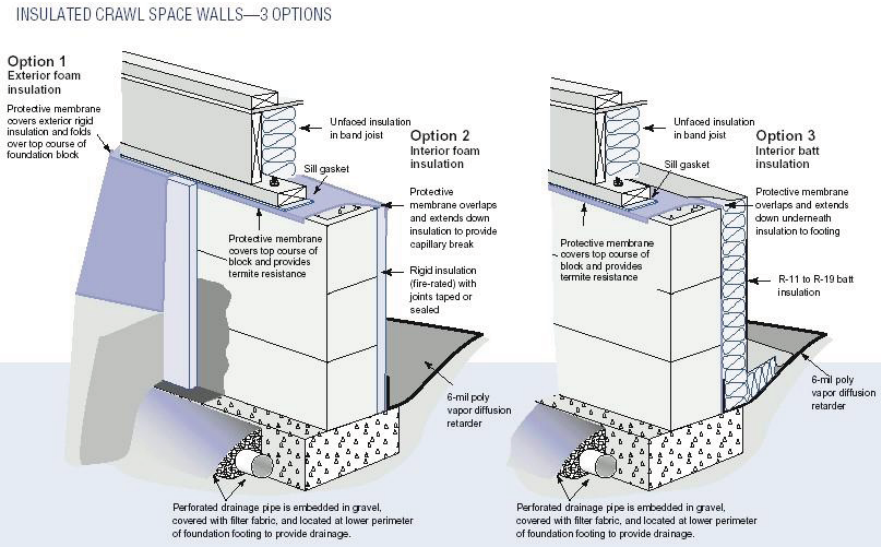


Image Courtesy of www.energycodes.gov.

5I. Basement Foundation

Basements are very common in many parts of the United States of America and other parts of the world that have favorable soil conditions and a lowered water table. They are generally eight feet tall, but many new homes opt for nine feet or taller basement walls. A taller basement allows for the addition of duct and plumbing runs below floor joists and beams while still being tall enough to install a suspended or conventional drywall ceiling. Basements can be either finished, unfinished or a combination of these.

A conditioned basement means that the basement is heated and/or cooled. An unconditioned basement does not have heating or cooling from the HVAC system, so it tends to be affected by the outdoor and ground temperatures. Unconditioned basements tend to run cooler than the floors located above, both summer and winter. However, the addition of insulation in the basement walls and/or slab floor can help regulate the basement temperature so that it will be closer to the upstairs temperature.

Conditioned basements should have insulation on or around the walls because concrete is a very poor insulator. If you touch an uninsulated basement wall on a cold winter's day, you will notice that the concrete is very cold to the touch.

Basements can be fully below-grade, partially below-grade, and walk out types. There are advantages and disadvantages to each type of foundation, you will want to discuss the needs of your structure with your builder when determining which is best for you.

If you choose to put a basement under your home, you will need to consider if outside access is necessary or desired. A walk out basement implies that there will be a full size door which allows access outside.

Both partial and fully below-grade basements can include window wells to allow for light, ventilation and egress purposes. There are specialized window wells available that are designed for egress should an emergency occur.

If you have windows installed in your basement we suggest that you install those that have vinyl framing and are double pane. It is traditional to install metal-framed sliding windows in the basement that are single pane. These windows tend to leak significant amounts of air and often do not close tightly. They can make a basement harder to heat and cool and can increase the annual utility bills for the entire building. The vinyl sliding double-pane windows can be much tighter and more energy efficient. If you plan to have a bedroom, office or other living space located in the basement, it is advisable to have at least one large window with an egress window well for emergency evacuation.

Structural Building Materials

- ☐ Are you willing to leave the choice of building materials and construction techniques up to the contractor/builder?
- ☐ Have you chosen a particular type of construction which uses specific materials and techniques?
- ☐ Are you willing to educate your contractor/builder to use green building materials and techniques?
- ☐ Have you done a cost benefit analysis/comparison of traditional materials/techniques vs. the green building materials/techniques you plan to use?
- ☐ Will you be participating in the construction process?
- ☐ Have you investigated local sources for the materials?

There are many opportunities to incorporate green building products and techniques in the structural aspects of your new home. The products and technologies in this section deal primarily with the above grade (above ground) aspects of the building; the 'rough-in' (which includes the walls, roof/ceiling trusses, floor and ceiling joists) and related items. Information regarding below grade walls can be found in the ***Foundations*** section.

You can specify that your wood comes from new growth 'managed' forests so that you are assured that your timber is not coming from older established forests. This wood is FSC Certified in compliance with the Forest Stewardship Council (FSC). The FSC is an international network of loggers, foresters, environmentalists and sociologists who work together to promote responsible management of the world's forests.

Note: All wall systems can settle somewhat over the course of time. Settling is what causes the doors and windows to not open or close properly and can create gaps or cracks around items that penetrate the walls, such as fireplaces, windows, doors and more. The best defense against settling is to have a good foundation.

6A. Structural Insulated Panels (SIPS)

The standard SIPS panel is a combination of a virgin expanded polystyrene (EPS) core sandwiched between oriented strand boards (OSB). SIPS panels are available in standard sizes, such as 4X8, 4X9 and 4X10 foot panels, but you can order panels that are 24 feet long or even longer. SIPS can also be used for vaulted or cathedral ceilings and eliminate the need for trusses. The use of SIPS can add usable area in upper regions of a home by converting a trussed area attic into a usable storage space.

The width of SIPS panels is typically dimensionally the same as conventional lumber framing widths. This means that a standard SIPS width is approximately the same as a 2X4 stud (3.5 inches) plus the OSB board on either side (or OSB outside and drywall inside) for a total width of approximately 4 inches. SIPS panels to replace 2X6 studs will have approximately 5.5 inches of foam or other insulation in the center surrounded by OSB. You will need to check with the manufacturer of the SIPS panels you are considering to obtain the exact dimensions.

SIPS panels come from the factory plumb and square, so that on-site adjustments for level, plumb and square are minimized. SIPS panels can save considerable time and labor at the job site, meaning the building can be constructed faster. Also, some SIPS panel manufacturers will precut the windows, doors and other openings at the factory so that the onsite construction time is even faster. SIPS normally have chaseways or channels bored into the panels at proper locations to expedite the installation of electrical switches and outlets. It is not advisable to install plumbing runs in the outer walls made with SIPS. Most manufacturers of SIPS advise that plumbing runs be kept to interior walls.

Image Courtesy of www.energycodes.gov.

SIPS panels can typically withstand high wind speeds and other extreme conditions, so they are a good choice for areas prone to natural disasters. They are becoming a popular building product because of the speed of installation and higher insulation R-Values that can be achieved versus conventional insulation products such as fiberglass or cellulose.

There are many other combinations of SIPS available on the market, some inherently more green than others. One of the greenest SIPS products on the market today is made from compressed straw fibers. This product uses agricultural by-products to make a structural building component that includes insulation. Some SIPS panels are made from reground EPS while others can have polyurethane or other forms of foam for the central insulation core. We expect to see SIPS panels made from soybean or castor bean based foam and other more natural foam products in the near future. Some manufacturers will create SIPS panels from soy-based foam now, if the customer supplies the foam using the appropriate specifications.

SIPS also can create a very air-tight building, so it may be necessary to install a mechanical ventilation system, either active or passive, to help the indoor air quality. See the section on ***Ventilation*** for more information.

6B. Insulated Concrete Forms (ICFs)

As discussed in the ***Foundation*** section, ICFs are typically molded or extruded sheets or blocks, typically made of expanded polystyrene or similar foam products that act as forms while the cement is being poured and become part of the foundation and wall (adding a significant additional R-Value automatically). While typically used in below-grade circumstances, ICFs may be used for multiple story walls above grade as well. Like SIPS, they have become popular due to the ease of installation and high insulation R-Values. Also like SIPS, they can create a very airtight home; so installing a mechanical ventilation system may be necessary. There are many configurations of ICFs to choose from; you will want to do some research and consult with your builder, architect or home energy rater to find out what is best for your application. We suggest that you discuss the pros and cons of the various products available to determine the best choice(s) for your building.

Image Courtesy of www.energycodes.gov.

6C. Engineered Wood

While wood is a renewable resource, there are still environmental concerns about the way wood is grown and harvested. There is also the problem with the quality of much of today's lumber stock. If traditional wood studs and lumber are not harvested properly and/or dried correctly, the wood may twist, bend (or crown) as it dries. If this happens after the wood is installed in your building, then your walls or siding may show signs of warping or have popped nails or screws in the drywall.

ENGINEERED WOOD

Image by Warren Gretz. Courtesy of DOE/NREL.

One way to avoid the twisting of studs and to improve the green aspects of your building is to use engineered wood. Engineered wood is smaller pieces of wood glued together to make larger sections. Trusses can be made of engineered wood.

Laminated beams

Laminated beams are a type of engineered wood and can be structurally stronger than solid wood beams, in addition to being straighter and more dimensionally accurate than solid wood beams.

Value Engineered

Many building plans call for non-standard lengths of framing members, which increases cost and waste. For example, if a floor joist is specified at 12 feet and 4 inches, the contractor is forced to purchase the next longer size of lumber (which is 14 feet). Each 14-foot floor joist will need to have 20 inches of length cut from it to be 12 feet and 4 inches long. A 14-foot board costs considerably more than a 12-foot board, and the 20-inch pieces that are cut from each board will likely be thrown away because the pieces are too short to use for most purposes. This results in an unnecessary waste of precious materials. The answer is to have an architect review the plans and eliminate these odd lengths of lumber. By using standard dimensional lumber, you can value engineer your building to be less expensive to build and to have much less construction waste. You can often offset the fees of an architect or engineer from the savings accrued by eliminating unnecessary expense and waste.

Finger-Jointed

The use of finger-jointed wood is also a form of engineered wood. Finger-jointed wood is comprised of smaller pieces of dimensional lumber, such as 2X4 pieces, that are glued together using finger-joints to make a longer board. Finger-jointed wood tends to have less twist and bend than virgin wood and, if done properly, the joints can be stronger than the wood itself. Finger-jointed wood is used quite a bit for trim pieces. If you look at unpainted wood trim at the local lumberyard you will notice that a good percentage of the trim pieces are finger-jointed together. Some progressive builders have a finger-joint machine located at their building sites that can take scrap lumber and make those pieces into usable lumber and studs again. The expense of new virgin wood will make the practice of reusing pieces more and more popular. Reusing scrap wood reduces the amount of waste heading to the landfill, which reduces the 'tipping fees' or cost of generating trash.

6D. Stick-Built Construction

Stick-built construction is the use of standard dimensional wood framing (e.g. 2X4 studs). Walls can be built on-site or pre-fabricated to include insulation and more extensive finishing. The typical home built in the United States of America has 2X4 studs in walls that are 92 inches tall and spaced every 16 inches, also referred to as 16-inches on center (OC). This 16-inch spacing is designed to match-up with 4 foot wide sheets of a standard panel product such as plywood, OSB board, foam board, insulating sheathing, or drywall. Since a 2X4 inch stud is really only 1.5 inches wide by 3.5 inches deep, there is only a depth of 3.5 inches for wall insulation placed in the cavities between the studs. Most builders use fiberglass insulation in the walls; so the typical R-Value for the wall insulation will either be R-11, R-13 or R-15.

All stick built walls should have some form of cross-bracing to keep the walls strong against side winds, which can cause racking (bending) of the walls. If the walls twist in the wind, the drywall will tend to crack and also pop nails. Homes that are not adequately cross-braced will make thumping or popping sounds during high wind or other extreme conditions.

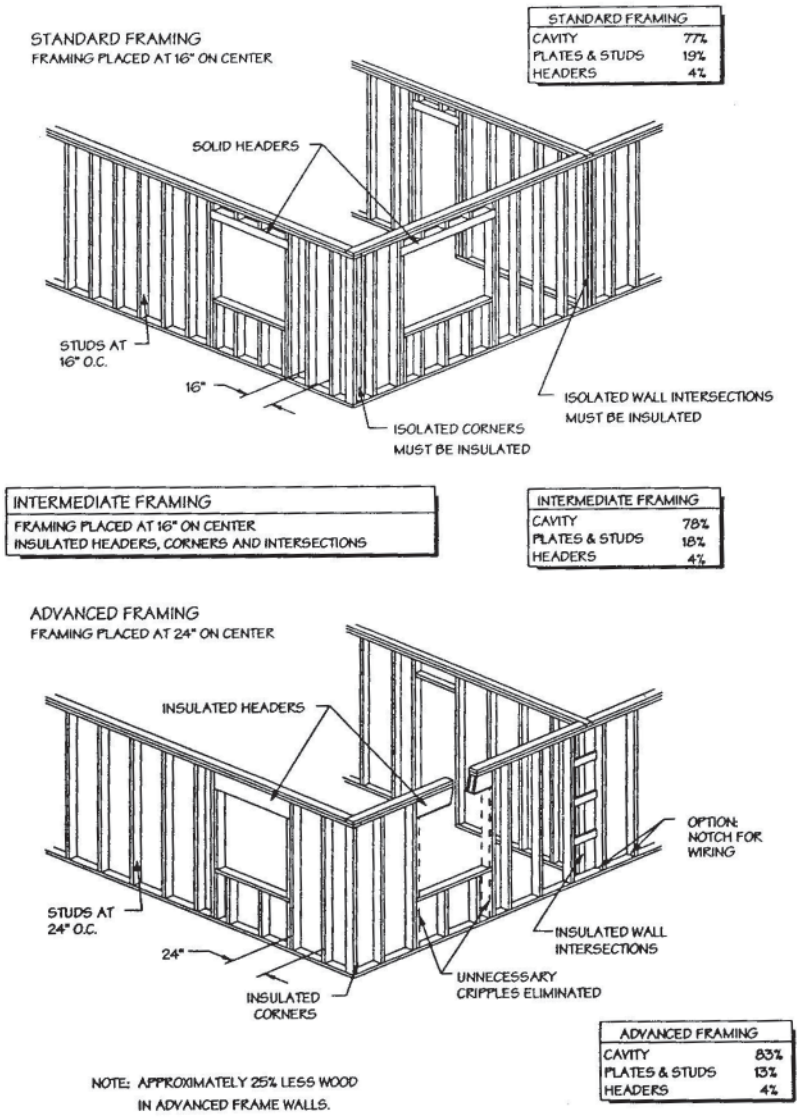


Image Courtesy of www.energycodes.gov.

6E. Metal Framing, Steel Studs

Metal structural components can be more than just beams to support long spans. Metal framing is commonly used in commercial construction but not as often in residential construction in the United States. Metal studs are, however, commonly used in some countries, such as Japan. Lightweight metal studs can be used on the inside walls of a home, even if the outside walls are built using standard wood studs, SIPS or other structural framing systems. The metal studs allow for uniform placement of pipes and wiring in walls. Electrical wiring chases are pre-punched into the studs, which means that

the wiring runs are located at specified heights. If your design requires you to run wiring at custom heights this can be problematic and time consuming.

Some of the advantages of metal framing are lighter weight than wood, reduced shipping costs, perfectly straight and plumb studs and beams, and metal framing is recyclable. Metal framing requires considerable energy to manufacture (called embodied energy), and is not considered by some green programs to be as green as wood.

A disadvantage of metal is that it is not as easy to cut as wood, at least not as easy using hand tools.

Metal studs and framing will conduct heat energy easily, so it is important to use an insulating sheathing product to cover the exterior of metal studs and framing. This will isolate the metal from the exterior (ambient) temperatures and will reduce the energy loss through the framing members.

When finding a supplier, be sure to ask about the recycled content of the metal.

6F. Framing Techniques: Balloon vs. Platform

BALLOON CONSTRUCTION

Balloon construction was used extensively before World War II in the construction of homes. Balloon framing is the use of long dimensional lumber, such as a 16 or 18 foot long 2X4 wall board instead of the standard 96 inch wood stud used today. The longer board is then notched to allow the floor joists under the first and second floor to have support. This means that the wall cavities extend from the basement to the attic and are open to the floor cavities. Not only does this allow outside air to move throughout the home and result in high energy bills (if not very well insulated) it also means that fire can spread very quickly throughout the home. Fire-stops should be placed at each floor level.

PLATFORM CONSTRUCTION

The common framing system used in today's homes is referred to as platform construction. This means that the first floor is built, and then the second floor is built upon the first floor 'platform'.

In standard platform construction, a 2X4 board is laid vertically on the bottom of the wall (called the bottom plate) and then there are two layers of 2X4s running along the top of the wall (normally called a double top plate). By using a double top plate, the roof joists or rafters do not have to line-up perfectly with the wall studs below; therefore, some allowances can be made for walls that are out of plumb or out of alignment. One method to conserve wood is to use only a single top plate instead of the double. Single top plate use is described later in this section

6G. Advanced Framing Techniques

CALIFORNIA 'ENERGY' CORNERS

Most stick-built structures have double studs at every corner of the walls and also multiple studs, cripples or braces around the windows, doors and other sizable penetrations of the walls. Instead of having double studs nailed together in parallel, one stud can be turned at 90 degrees from the other. This allows space for insulation to come closer to the corner and still offers a surface for the drywall installer to nail or screw to. Extra bracing around window and doors can also be turned 90 degrees to allow for additional insulation.

INSULATED HEADERS

Headers above doors, windows and other sizable spans are often 2X10 or 2X12 inch boards that are nailed together to form the proper width to fill the area above the span. Many jurisdictions allow the use of one board to span this distance and then the space where the other identical board would be placed is filled with foam board, spray foam or other insulation product.

SINGLE TOP PLATE

It has been standard practice for many years to place a double top plate along the top edge of wood frame stud walls to support the weight of the trusses or floors located above. However, it is the studs that carry the actual weight, so if the studs or trusses on the upper floor are located directly above the lower studs then the weight is supported via the vertical stud members. Therefore, the need for a double top plate is negated and the amount of lumber needed to build the frame walls is reduced.

2X6 AT 24 INCHES ON CENTER

Standard 2X4 stud construction can be replaced with 2X6 studs spaced 24 inches on center versus 2X4 studs spaced at 16 inches on center. This can reduce the total amount of lumber needed (with less heat loss) and increase the R-Value of the insulation to R-19 in the framing cavities. The 2X6 lumber can be better for some conditions, such as building sites with high winds.

6H. Panel Products

ORIENTED STRAND BOARD

Oriented Strand Board (OSB) is a dimensional framing product made from linear shards of wood (or strands) glued together to form a flat sheet that is typically 4X8, 4X9 or 4X10 feet in size. OSB can be obtained in low and no formaldehyde versions and it can also be made from FSC certified wood. If out-gassing and management of wood resources are important to you (this is a subject that is often neglected in the decision making process) you may have to do extra research and extra discussion with your builder or green design consultant.

PARTICLEBOARD

Particleboard is typically made from sawdust that is glued together and formed into a standard dimensional sheet. Particleboard historically is made with petroleum-based glues that can outgas formaldehyde and other volatile organic compounds (VOC). You can search for particleboard that is made using more environmentally friendly glues, but if you are striving for low out-gassing building products that can be used indoors, you might want to consider hardboards.

HARDBOARDS

Hardboards are similar to particleboard in that they are typically comprised of small pieces of wood or filler. However, particleboard is made using forms that shape the sheet and it is primarily the strength and quality of the glue that holds particleboard together. Hardboards are also made using glue but they are compressed with very strong presses during the glue drying process so that the finished product is much harder and more durable than particleboard. Hardboards tend to outgas less than particleboards, OSB or plywood. One well known brand name of hardboards is Masonite. Many companies have experimented

with hardboard products and processes over the years and some very innovative and durable products have become available on the marketplace.

PLYWOOD

Plywood is made from thin, wide strips of wood peeled from trees in a similar process as peeling a potato or apple. The thin and wide wood veneer strips are stacked on top of each other until the desired thickness is achieved. Strong glue is applied between the laminations or strips of wood to hold the pieces together. Some glues used to make plywood have strong outgassing tendencies. You can specify plywood made with low VOC glues from some sources.

It is important to differentiate between exterior and interior grade plywood. Exterior grade plywood, which is intended for use on the exterior of a home, can be used in the interior under specific circumstances. Interior grade plywood is intended for use on the interior of a home only and should not be used on the exterior. Plywood can be obtained in 'grades'. Grade 1 is finished on both sides and is the most expensive. Grade 2 is finished on one side and is very commonly used in construction. Grade 3 is not finished on either side.

You should avoid getting all forms of glued wood sheets wet. Don't leave them exposed to outside elements for extended periods of time. There are versions of each type of sheeting listed above that are designed for wetter environments, but it is still recommended that you keep them dry. Regular OSB board will tend to peel and degrade if left in the sun and rain over time. Particleboard will tend to become soft and eventually revert back to sawdust if left outdoors long enough. Hardboards will often do better than OSB, particleboard or plywood if exposed to water. But, hardboards will tend to degrade if left outdoors or exposed to high levels of moisture over extended periods of time. Plywood can delaminate and degrade if left outdoors or exposed to high moisture levels.

As you go through the Kit and learn about green sustainable building practices you will notice that keeping a building dry is a very high priority. Most bad things that occur in buildings can be traced back to moisture issues. Mold, mildew, dust mites, rot, corrosion and other destructive pathogens need a source of moisture to survive and thrive. See the item regarding Flashing & Trim for details about preventing the intrusion of moisture.

6I. Alternative Building Materials

STRAW BALE CONSTRUCTION

Straw bale construction was quite popular in the prairies and drier climates of the United States in bygone years. Construction with straw bales is making a resurgence due to several factors; low cost, durability, fire resistance, and R-Value to name a few. Straw bales also allow creativity with contoured walls and other unusual angles or features. It is important that you do not confuse straw bales, which are dry, clean and inert, with hay bales, which can be green/moist, dusty/dirty and full of insects or larvae. Straw bales must be kept completely dry during the construction process or they will have mold and degradation problems.

RAMMED EARTH CONSTRUCTION

Rammed earth construction is the process of compacting (or ramming) dirt into a vessel of some sort. One of the best examples of rammed earth construction is the 'Earth Ship'. These homes and other

buildings are made from old vehicle tires that are rammed full of dirt and then stacked until they form the walls of a structure. Rammed earth structures do not necessarily have a high R-Value, but they do have significant weight or mass to them. This helps them weather the temperature swings, especially in desert climates, from day until night. The famous actor, Dennis Weaver, lived in an Earthship and was a strong advocate and promoter of this construction up until his death. Some people find Earthships to be odd looking but most people like the freedom of the open design once they have toured inside one.

ADOBE

Adobe has been used for centuries and is one of the oldest building methods, other than using stone. Adobe is typically made from clay and is stacked or formed to create a structure. Adobe is primarily used in dry climates and can be greatly affected by water and moisture.

FIBERGLASS AND PLASTIC

Fiberglass and plastic homes are starting to become available from several manufacturers. The use of fiberglass and plastics can make a strong and durable structure with less weight than most other building materials. Some manufacturers are looking at shipping fiberglass or plastic building components across the United States of America and to other countries. However, the rising cost of oil and gas will likely influence the manufacturing cost of these building materials over time.

STEEL WITH FORMED FOAM

Steel with formed foam is a newer building product. The steel framing members are encapsulated in foam so that you have a strong, lightweight and highly insulated building product. Steel framing with formed foam will likely become more widely accepted in the building trades as awareness of this product grows.

CONTAINER BUILDINGS

What do they do with those shipping containers that have reached the end of their life as shipping containers? Some architects, builders, communities, etc. are transforming them into buildings! Not a lot of information is available about container buildings at this time, but it is being done and could be a solution you find appealing.

6J. Flashing and Trim

Incorrect installation of flashing and trim can cause major structural damage to a building over time due to water intrusion. Sometimes, necessary flashing and trim is neglected entirely. A properly flashed door, window or other opening in a wall will divert rain water away from the structure and keep the components dry. Incorrectly installed flashing can allow or even divert water to enter into a wall or seep around a door or window.

Permanent flashing should be made of metal (or in rare cases, plastic). Caulking or other 'temporary' adhesive compounds are sometime used as a replacement for proper flashing. Just because a tube of caulk says that it is guaranteed for 25 years does not mean it will remain in place for 25 years if it is misapplied. See ***Caulks, Sealants, and Adhesive Compounds*** for more information.

Much of the flashing (and some of the trim) should be installed when the walls and skeletal structure are completed but prior to the installation of the windows and doors. If flashing is installed properly the building should remain dry for many years. Unfortunately, the job of installing the flashing is often relegated to the newest crew member or carpenter's helper. If the person installing the flashing doesn't understand the purpose of the flashing and how to install it correctly, there is a good chance that it will be installed wrong. It has been proven that water intrusion into a building structure can cause havoc and damage, which is why we are placing so much emphasis on the critical need to control water and moisture.

There are many newer products on the market that will help control moisture and provide long term protection for your building's components.

6K. Caulks, Sealants, and Adhesive Compounds

- ☐ Do you care about VOC and the toxicity levels in your caulks, sealants, and adhesive compounds?
- ☐ Will you encourage your contractors and installers to use water-based sealants and adhesives as much as possible?

CAULK

Caulk seems to have the same mystique to it as duct tape, which is: that you can't use too much of it. Or, stated another way, you can hide a lot of sins with enough caulk and duct tape. This makes for funny tee-shirts, but is really not true. Caulk needs to be installed properly to be effective. Regular duct (or duck) tape shouldn't be used on ducts, because it is not a good application for this product. Unfortunately, it is impossible to list all the various types of caulks and their proper applications here. We can, however, give you some good rules-of-thumb about caulks, sealants and adhesive compounds.

Caulks, in general, should be applied wherever two dissimilar materials meet, such as where the exterior siding meets the window or door trim. There are many types and brands of caulks, but they tend to be silicone, siliconized acrylic, pure acrylic, latex, butyl rubber and other combinations. You cannot paint pure silicone (because paint won't adhere to it) but you can use pure silicone in places where the surfaces can get hot. The information on the tube will tell you the temperatures that the silicone is designed to withstand. Acrylic and latex caulks can be painted and can come in many colors while pure silicone is clear. Butyl rubber is typically used to patch roofs, seal around chimneys (although flashing is better and more permanent), and fix driveways. Siliconized acrylic caulk seems to be a good compromise for a variety of applications, both interior and exterior. It tends to be strong and long-lasting, yet it can be painted.

SEALANTS

Sealants are used for a variety of purposes. Most concrete contractors will apply a sealant on top of freshly poured concrete to slow the drying process and help water-proof the concrete. Asphalt sealant used on asphalt driveways helps to seal cracks and renew the water-proofing aspects of the asphalt. There are sealants designed to be applied on the grout between ceramic or clay floor tiles. Your vehicle probably has a clear-coat sealant applied over the paint to help it stay shiny and new-

looking. It would be nice to state here that you can use water-based sealants to replace all the original versions, but in many cases the final result would not be satisfactory.

We suggest that you encourage your contractors and installers to use water-based sealants and adhesives as much as possible. Many petroleum-based sealants and adhesives can be harmful to the installer's health, especially over long-term exposure. You may be helping a lower-wage worker have better prospects for their long-term health by building green. One good turn often leads to another.

Fortunately, there are some good water-based sealants for many applications inside buildings, such as: sealants for hardwood floors and countertops, sealants for grout and sealants for cabinetry. Some research will likely need to occur for you to find the water-based versions of sealants that will replace the common versions on the market. You may also encounter some resistance from your crew if they have not used the water-based versions before. They may not want to be responsible if the finish does not turn-out like you/they expected. You should plan to work with your crews to establish expectations and guidelines for newer products.

ADHESIVE COMPOUNDS

Adhesive compounds have come a long way in the last few years. Decent water-based adhesives were hard to find a few years ago. Now, there are some good adhesives available that have lower VOC and other harmful compounds. Again, a little research on your part may be needed to find the best replacements available. Some of the members of your design team may have experience with water-based products or know where you can find them.

Exterior Building Components

7A. Windows

- ☐ Do you know the placement and number of windows you will use on your structure?
- ☐ Have you considered security, size, view, ventilation, daylighting, solar gain and aesthetics in your window placements?
- ☐ Have you determined what type, framing material, U-Value, number of panes, fill, coating, etc. to use for each window?

Windows, skylights and other glass components have been discussed as part of the early design/planning process. However, ordering windows for your new building can be a simple or compound process, depending on how you approach it. The simple method is to find out what brand of windows your local building supplier, lumber yard or distributor sells and order your windows using standard sizes and specifications. This is the easiest approach and is the method that the majority of builders and general contractors use when purchasing or specifying windows. However, the window choices are often quite limited with this approach and the final result may be less than satisfactory.

A more compound approach is to determine what type or size of windows you desire or that blend with your chosen design and then order these as custom units. You will find that some window manufacturers are resistant to custom designs while others promote their ability to deliver windows to your specifications. Since windows can be a major source of heat loss and/or heat gain, spending some time understanding how windows can affect the long-term performance of your building can be very worthwhile.

When you start the process of examining custom windows, you might hear a standard refrain from certain contractors that basically states "That'll cost extra". You'll soon learn that this refrain is the standard reaction from many of the building trades as you request them to explore options using non-standard products. The basis for the extra cost reaction could be due to the fact that the contractor or supplier wants to avoid the hassle of ordering non-standard items. Often you can educate the contractor and/or supplier about what you are asking for or specifying and why, and negotiate the price downward. You may have to locate a different contractor and/or supplier who is amenable to your requests and needs.

Ordering non-standard windows can be a challenge because there are a number of variables possible. If you have not had experience 'special ordering' windows, you might want to obtain the services of a specialist. A person who specializes in specifying and/or ordering custom windows and glass (glazed) doors is called a fenestration specialist. However, you probably won't find 'fenestration' in your local yellow pages. You will likely need to contact your local window and/or glass door supplier or installer and ask them about sales personnel or independent agents who are versed in ordering custom glazing. Once you find a fenestration specialist, you can go over your options and preferences with them. If you haven't developed a list of options and preferences, we suggest that you add this person to your design team and have a design charrette regarding your glazing options. Be sure to think about passive solar options.

The general glass (glazing) options you might want to discuss are: type of windows, placement/ location of windows, size of the glass/glazing area, the ratio of glazing area to wall surface area, the window frame material and U-Value, fill, coating and number of panes and (ultimately) cost. Other options to consider are: mini-blinds located between panes of glass, custom multi-pane components, 'pop-out' easy-to-clean glass and high security or tempered glass. If you are a progressive thinker (and depending on the design), you can also consider the use of glazing with solar electric components embedded in the glass that will provide electricity for the building.

COST

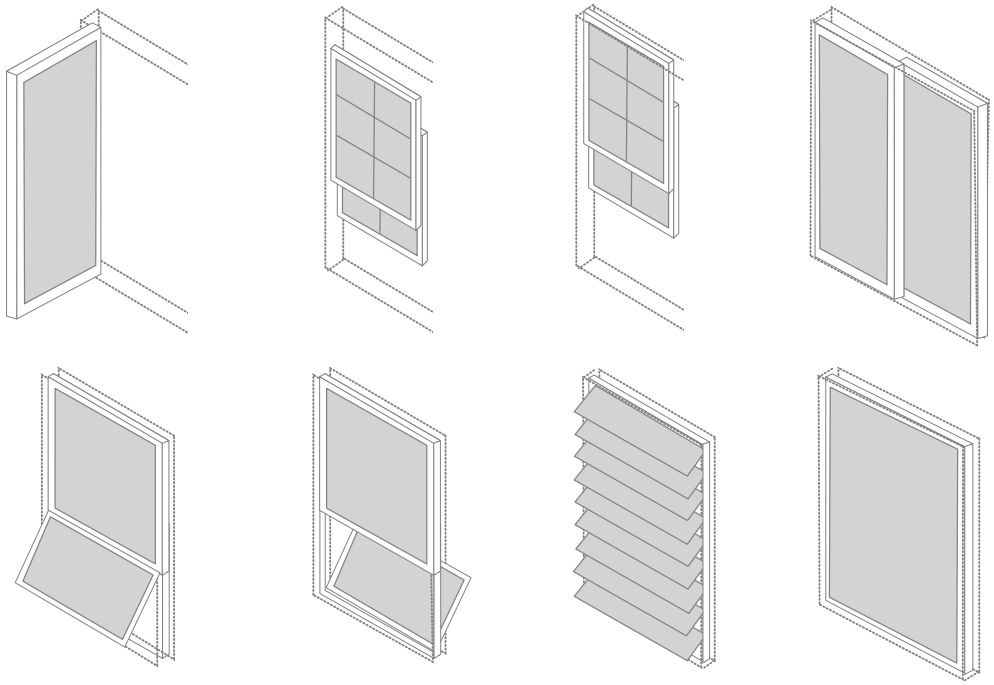
When discussing costs, it is important to consider the initial cost of the window and the on-going (or life cycle) costs of maintenance, environmental impact, recycling possibilities, wasted heating and/or cooling, and possible replacement or repair.

Be sure to consider each of the following:

- Security
- View
- Ventilation
- Daylighting
- Solar gain

TYPES

There are many different types of windows; each of which has its strengths and weaknesses. Decisions about which type to use will depend on where they will be placed, if they will be opened, and what your personal preference of style is. Among your choices are: Casement, Double Hung, Single Hung, Slider, Awning, Hopper, Jalousie, and Fixed (pictured below top left to bottom right).



FRAMING MATERIAL

Some considerations when choosing the material that forms the frame of a window are insulating value, maintenance, and renewable source. Window framing materials can be wood, vinyl, fiberglass, metal or composite.

Wood

Wood has a long history as a framing material for glass. Wood can be shaped, cut, chiseled, planed and sanded to any custom size or shape. However, most wood species are not water or insect resistant, so the wood frames must be painted or stained. Many wood-framed windows come from the factory prefinished, so it is important to make sure the finish matches or blends with the interior color scheme of the building. Unfinished wood frames are available and can be painted or stained at the job site with the exact stain or paint used elsewhere in the building. Wood is a natural insulator, so wood-framed windows are a good choice from an energy efficiency standpoint. However, proper installation of the window is critical to the overall energy efficiency of the window installation to ensure reduced air infiltration. Use non-expansive foam or other appropriate sealing products between the window frames and wall openings.

Vinyl

Vinyl windows are readily available and many manufacturers offer a wide variety of exterior colors. Interior color options are also readily available, but usually offer a smaller selection than the exterior colors. Vinyl is a good choice in terms of exterior maintenance since the vinyl shouldn't need painting for its useful lifespan. However, certain green programs take some exception to the processes used to create vinyl because of the toxic pollutants produced during their manufacture. We suggest that you investigate the environmental record of the window and vinyl manufacturers and opt to purchase from those with good histories.

Fiberglass

Fiberglass windows can be strong and lightweight, which makes them a good choice for many installations. The manufacture of fiberglass can produce pollutants, similar to vinyl, and the companies who manufacture fiberglass with good environmental records should be rewarded by sales to green advocates.

Metal

Metal has been used for framing for windows for many decades. In fact, metal-framed windows can be found in many older commercial buildings. New commercial buildings also use metal-framed windows because the newest versions perform quite well. Many older homes have single-pane metal-framed windows that leak air like sieves; however, it is possible to purchase metal-framed windows that have thermal breaks, double or triple-paned glass, low-E coatings and more. As with all types of windows, you will want to do some research on metal framed windows to find the correct windows for your building design, local codes and particular situation.

U-Value

The U-Value of glass is a method to determine the energy efficiency of the glass, tracks, coatings, and other factors. *The lower the U-Value, the more energy efficient the window.* You can calculate the U-Value of glass yourself, if you know the basics. One pane of glass roughly equals an R-Value of one. So, three panes of glass equal an R-Value of three. If you divide the R-Value into the number one, you get the U-Value. So, 1 divided by 3 equals 0.33. Three panes of glass have a U-Value of approximately 0.33.

Number of Panes

Single pane glass has only one pane, double pane has two and triple pane has three. Since every added pane of glass adds an additional R-Value of one, which is reflected in the U-Value, then why doesn't everyone use three or more panes of glass in their windows? In a single word—Weight. The more panes of glass, the heavier the window. Studies have shown that two panes of glass with a low-E coating perform approximately the same as three panes without low-E and they are much lighter. So, the building industry has mostly adopted double-pane windows and is also using low-E coatings in many applications.

Fill

The airspace between panes of glass can contain just air or it can have other gases or compounds injected. Often, glass will have an Argon gas between the panes. Why? Because Argon gas can do a better job of providing a 'dead' space between panes of glass than plain old air can. This dead space helps slow down the heat transfer through the window. However, Argon gas tends to dissipate and escape from between the windowpanes over time unless the window manufacturer makes an extremely tight window, so some research into test results for these windows is prudent.

Coatings

Glass can have a coating applied to any surface to help restrict the UV rays, the infrared wavelengths and amount of visible light that passes through the glass and coating. However, most coatings are easily scratched and can sometimes be washed away, which is why low-E coatings for windows is sprayed between the panes of glass.

Films

Films act like coatings in that they can restrict certain wavelengths of the sun and also provide some measure of insulation. Most films consist of a thin plastic sheet with a factory applied coating. This film can then be placed on the existing windows for residential and commercial buildings.

NOTE: Some window films can cause a build-up of heat between the panes of glass or can create other problems which can affect the windows. We strongly recommend that you check with the manufacturer of your windows and glass doors before installing window films. Some window films can make the glass too hot and melt or damage the spacers or sealants used between the panes. If this happens you may see condensation and/or white desiccant appearing between the two or three panes of glass, which means that the window is now

damaged and needs replacement. If the window is damaged by the improper usage of window films, some window manufacturers will void their warranties and you will be stuck with replacement costs.

7B. Daylighting other than Windows

☐ Does the design of your building take advantage of daylighting options other than windows such as skylights?

When designing your new home or small commercial building, another consideration is for daylighting that comes through your roof or higher wall areas. The most common way to take advantage of this light is with skylights.

SKYLIGHTS

Traditional

Traditionally, skylights are square or rectangular windows located in the roof. Traditional skylights can be either fixed glass or operable so that they can be opened for additional ventilation. Operable skylights can replace whole-house fans in certain climates or designs.

Traditional skylights can be major sources of extra heat, depending on placement and type of skylight. One way to avoid or limit the amount of sun passing through a typical skylight in the upper northern hemisphere is to have it face east, north, northeast or southeast. The worst directions are west and southwest. Even though flat skylights typically have a low-E coating and limit the amount of heat energy (infrared) that passes through the glass, they still allow some heat energy through.

Some building designs purposefully aim skylights south to help provide additional heat in the winter. Thought must be given to these designs to help avoid or limit overheating.

Tubular

Tubular skylights have a component of the skylight located on the roof and then a shiny tube that transfers the light to a lower ceiling level, which can be many feet below the roofline. This shiny tube can be made of either a metal or plastic surface. They can add significant lighting without adding much heat. The tubular skylights have the additional benefits of diffused light and greater flexibility of placement of the outer skylight component on the roof in relationship to where the light will be used inside the building.

CLERESTORIES

Clerestories are basically vertical windows that are located high on a wall to shine light deep into the interior of a building.

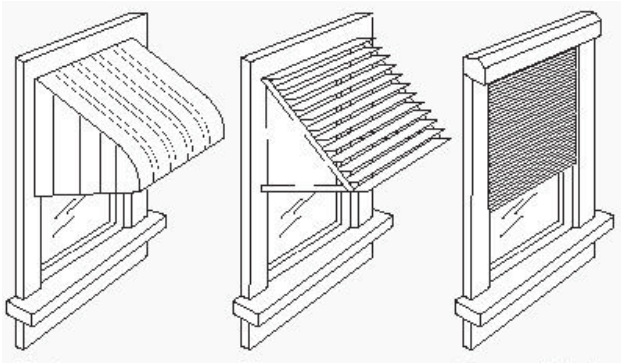
Any type of glazing opening, whether windows, doors or skylights, that allows the afternoon sun to pass through can help overheat a structure and place an extra burden on the air conditioning equipment. This extra burden can translate into high summer cooling costs.

If you want to install traditional skylights or clerestories and must face them toward the afternoon sun, look for models of skylights that have optional removable external shades for use in the summer months. Overhangs or awnings can provide proper summer shading for clerestories. All these factors should be discussed and factored into the building during the design stage.

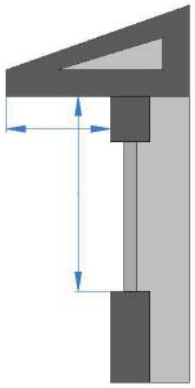
7C. Awnings, Overhangs, Shading

- ☐ Will you incorporate overhangs for your windows to minimize solar gain during the hot months?

You can shade windows and other openings by the proper use of awnings, roof overhangs, trellises, porches and other shading strategies. You can also reduce the amount of summer sun coming through your windows and glass doors by using low-E glass or tinted window films.



One method to calculate the correct overhang for a given structure is to multiply the distance from the bottom sill of the soffit by a factor based upon the angle of the sun. This factor will be different depending upon the latitude at which the building is located.



7D. Exterior Doors

- ☐ Do you know the placement and number of exterior doors you will use on your structure?
- ☐ Have you considered code compliance, security, insulating factors, type, glazing, maintenance and aesthetics in your exterior door placements?
- ☐ Are your exterior doors intended to:
  - ☐ Keep people out?
  - ☐ Be decorative?
  - ☐ A combination of both?
- ☐ Will your exterior doors be easily accessible?
- ☐ Are your exterior doors sheltered from the elements, but not too sheltered and hard to see?
- ☐ Will there be an additional 'storm' door in use on your exterior doors?
- ☐ Will your exterior doors be exposed to excessive heat or cold?

Like windows, choosing the placement and number of doors is part of the design process. When choosing your doors, considerations include code compliance, security, insulating factors, materials, type of door, glazing, maintenance, and (of course) cost.

CODE COMPLIANCE

Some building codes deal specifically with exterior doors. For example, the door between the garage and the house may need to have a specific fire rating. Make sure your doors meet or exceed your specific building code.

SECURITY

Security aspects of a door include the material from which it is made, the quality and functionality of locks, accessibility, and visibility.

INSULATED VS. NOT INSULATED

The decision to choose an insulated door depends on whether the door will have protection from the elements (both heat and cold). Many people do not realize that a glass storm door in front of an insulated door that faces south or west will tend to overheat the door and can cause damage.

MATERIALS

Among the considerations involved, when choosing the material that forms the door (and also its frame), are insulating value, maintenance, and renewable components. Among your exterior use choices are:

Insulated Steel

Insulated steel is a good choice when security is paramount. Insulated steel doors with deadbolt locks are difficult to force entry.

Insulated Fiberglass

Insulated fiberglass doors hold paint or stain very well and can look like new for many years.

Solid Wood

Solid wood doors can provide basic security and can be very ornate. However, solid wood doors will need periodic maintenance to look good and are not as energy efficient as insulated doors.

Composite

Composite doors are relatively new on the market. These doors can be made from recycled materials and can be very low maintenance. Some research may be required to find the composite door that is right for your project.

GLAZING

All of the doors listed above can have glazing. We suggest that you use double-pane security glass in your doors, if you decide to have glazing.

OPENINGS

Doors can open from either the right- or left-hand side or can be double opening (e.g. French doors). Most exterior doors are designed to swing into the room for safety reasons. Doors also can slide from right or left (e.g. patio doors) or they can disappear into a wall cavity (e.g. pocket doors). Doors can open accordion style or they can be split (e.g. dutch doors) so that you can open only the top or bottom or both.

LOCATIONS

The number and location of exterior doors will depend on your building design. Common locations include Primary Entrance, Utility (such as the Garage Door and Back Door), Secondary Entrance, Deck or Patio, Basement.

MAINTENANCE

The maintenance requirements of any door are dependent upon the type of material from which it is made (discussed previously), the environment in which it is placed (extreme temperature changes, direct sunlight, humidity, etc.), and whether it is afforded additional protection (a storm door, sheltered location, etc.). The manufacturer may have maintenance suggestions.

COST

When discussing costs, it is important to consider the initial cost of the door and the on-going (or life cycle) costs of security, maintenance, environmental impact, recycling possibilities, wasted heating and/or cooling, and possible replacement or repair.

7E. Exterior Skin

- ☐ Have you determined what kind of 'exterior skin' the building will have?
- ☐ Will the building be subjected to damaging storms?
- ☐ Are the color(s) of the exterior of the building aesthetically pleasing?
- ☐ Do the color(s) of the exterior of the building increase heating or cooling problems?

As you are deciding on the design of your house, the exterior skin (siding/cladding) may seem like an afterthought, but it can be integral to the unification of the design. It is important to keep the choices in mind during the design process so that if one doesn't work, you know what is next in line:

SIDING

Wood

Wood siding comes in many forms—lap siding, vertical siding, clapboard, hardboard or composition board, plywood, plank (rectangular, linear, patterned), shakes (cedar shingles) and regular wooden shingles—just to name a few. Wood siding can become an attraction for insects and animals. Certain birds, such as woodpeckers, can start attacking the wooden siding in search of a meal. A multitude of insects (such as carpenter ants, boring beetles, termites and wood-boring wasps) can riddle your siding with holes or hidden passages. Some

types of wood siding, such as cedar or redwood, are naturally insect resistant and weather better than more common types of wood, such as pine or fir. Wood siding can require ongoing maintenance such as painting or staining. Most types of wood siding need periodic replacement.

Vinyl

Vinyl siding is often considered to be a maintenance-free product. Once you install vinyl siding you shouldn't have to paint or stain it for the lifespan of the product. Vinyl siding can be used to cover other types of siding and is a popular product for companies who specialize in remodeling or re-siding buildings. Normally, vinyl siding is a relatively thin material that can be damaged by rocks thrown by lawn mowers or large hail. Some brands of vinyl siding are made of thicker material than others, so some research may be needed to select the correct product for your particular climate or location. The manufacture of vinyl can be a toxic process and is not considered to be green by many green building designers and advocates. Vinyl siding normally is made using PVC (polyvinyl chloride) and there are many green designers who want to minimize or avoid PVC in their buildings. However, new manufacturing methods and inventions may make vinyl siding less objectional. You may want to conduct some research before you select the brand and/or type of vinyl siding for your building.

Steel

Steel siding has been available for a long time and has some definite advantages and disadvantages. On advantage of steel is that it can be made using recycled metal parts, so the old junk car of today could be the siding on your building tomorrow. Steel is malleable, so it can be molded into any shape or size, and can be created to mimic wood grain or other topical features. Steel siding can last a long time and require little maintenance. On the downside, true steel siding can rust, so it has to be treated or coated to help it last. Steel siding can be dented or bent easily, so hail or rocks can pockmark the surface of the siding. Sometimes steel siding is combined with other products, such as a vinyl coating, so that the finished product has combined benefits.

Aluminum

Aluminum siding is the most popular type of metal siding and has been used extensively over the years because it is resistant to rust and is lightweight. Aluminum siding typically has an enamel surface that is baked on and permanent. However, it is relatively easy to dent and can be difficult to remove and replace once damaged. Aluminum trim is very common for siding installations. Aluminum trim can be bent easily and conforms to unusual shapes or sizes. Coated aluminum trim can last a long time without maintenance.

Composite

Composite siding is the blending of different products or materials to create a superior end product. Fiber-cement siding is made using cement, silica and sawdust and is a good example of composite siding.

CLADDINGS

Stucco

Stucco has been commonly used in the southwestern and western United States of America, although it has gained popularity in many diverse climate types and locations. Originally a clay-like coating, more recently stucco was made as a cementatious coating that was used over masonry to form a smooth exterior cover and the final product was often painted. Now there are versions of stucco that are designed to cover insulating foam board or wood products and some forms of stucco come with the coloring premixed.

Exterior Insulation and Finishing Systems

Developed in Europe in the 1950s, Exterior Insulation and Finishing Systems (EIFS) were introduced in the United States of America almost 30 years ago. They were first used on commercial buildings, and later on homes. EIFS typically consist of the following components: insulation board made of polystyrene or polyisocyanurate foam (which is secured to the exterior wall surface with a specially formulated adhesive and/or mechanical attachment), a durable, water-resistant base coat (which is applied on top of the insulation and reinforced with fiberglass mesh for added strength), an attractive and durable finish coat — typically using acrylic co-polymer technology — which is both colorfast and crack-resistant. EIFS have had some bad press due primarily to improper installation of the product, especially the flashing. However, if properly installed, EIFS are a good option because they allow flexibility of design.

Stone (natural or artificial) / Brick / Masonry

The use of stone as an exterior siding or cladding is an ancient practice. Stone churches in European countries date back many centuries. A stone facade or exterior surface makes a building appear solid and safe. This is why many banks and judicial buildings use stone on the building's exteriors. Many buildings mix stone with brick or other forms of masonry to gain a custom look. Nearly all forms of masonry/stone siding, as with other forms of cladding, will wick moisture. Many studies have shown that a hot brick sunlit wall will wick moisture from a sudden rain completely through the brick in a matter of seconds. Therefore, any type of masonry/stone cladding should have a waterproof membrane behind it with spacing in between so that moisture wicking through the masonry can run down the backside of the cladding or down the face of the drainage plane and then out the bottom, typically through weep holes. The art of properly building a structure with the use of drainage planes and weep holes has gradually disappeared. This is one reason why so many buildings now have water damage and/or mold in the exterior walls.

7F. Drainage Planes

 ☐ Is there a drainage plane to protect your structure from rot, mold, etc.

Drainage planes are not sexy. You don't see them and many times they are ignored in the construction of a building. Sometimes the drainage planes are value engineered out of a wall

structure, only to the regret of the building owner at a later date. The damage caused by not incorporating a drainage plane or drainage strategy into the walls and other exterior components of a building will soon show up as structural damage, rot, mold/mildew or staining. A common drainage plane in a typical home is the house wrap, which acts as a moisture barrier. However, if the siding is nailed directly onto the house wrap (causing penetration of the barrier) there may not be any space or weep holes for trapped rainwater to drain downward. In this case, damage from moisture can still occur over time.

7G. Exterior Extras

- ☐ Are shutters important to you?
  - ☐ Working shutters to protect your windows from damaging storms?
  - ☐ Decorative shutters?
- ☐ Will you have space between the ground and a porch or deck that you want to have covered?
  - ☐ Will you do that with lattice or plants or does it truly need to be enclosed?
- ☐ If you aren't designing a garage as part of your primary structure, do you want a car port situated close to your home or attached to it?
- ☐ If you have planned for a garage, will it accommodate yard maintenance items and gardening tools or do you need to consider a shed that is either attached to the house or not?

Extras may seem like something you add later after everything has been decided, but it's important to consider what you think is an extra and what is an integral part of the exterior of your structure.

Make a list of extras and discuss their importance so you don't overlook them. It's generally less expensive to consider and incorporate them up front, than to make changes after the plans are drawn and the house is being built. More information about carports and other buildings can be found in the ***Outbuildings*** section.

Roofing

- ☐ Do you want to leave the choice of your roofing system to your designer?
- ☐ Is your roofing contractor educated in green building materials and techniques?
- ☐ Have you done a cost benefit analysis/comparison of traditional roofing materials/ techniques vs. the green building materials/techniques you plan to use?
- ☐ Do you have a preference between trusses, rafters, SIPS, or another type of energy efficient roof system?
- ☐ Do you have a preferred style of roof?
- ☐ Will your roof add to or subtract from heat gain in your building?
- ☐ Have you made drainage considerations?
- ☐ Will your roof need to be vented?
- ☐ What kind of maintenance will your roof require?
- ☐ If you are using a gutter system for drainage, have you considered a rainwater catchment system?

8A. Trusses and Framing

Most residential and a large percentage of small commercial buildings have sloped roofs. A sloped roof can be achieved by using a wood framing system created on-site or the roofing framing can be manufactured off-site and shipped. Rafters have historically been built on-site and use the ceiling joists as part of the roofing system. This system leaves an open attic area in which you can move around easily (relatively speaking). Trusses are noticeably different from the traditional site built rafter/ joist assembly in that they are independent of the ceiling joists (resting instead on the top of the frame walls) and the interior space is segmented with supports that create triangular shapes. Trusses are typically made off-site.

The use of trusses has become more and more popular for a number of reasons such as time saved in the construction process, consistency of size-shape-dimensions, accuracy of plumb and square, strength, ability to span longer distances without supports, and less job-site waste. Trusses can be made from wood or metal materials. Metal trusses are typically used more for larger commercial applications and less often for residential.

The decision to utilize a truss system or build the framing rafter system on-site should be made relatively early in the design process. If pre-made trusses are the chosen option, you will have to order them well in advance of when you will need them to allow the manufacturer enough time to get your order processed. Certain roof designs lend themselves to the use of trusses, such as standard roofs with gable ends, while other roof designs, such as those with multiple angles or roofing levels, may require a custom roofing job that has to be built on-site.

If your design calls for a flat roof or one with a minimal pitch (slope), then the use of trusses may be essential in order to have a flat support system that can also handle the occasional heavy 'dead'

loads of snow or driving rain. You can also utilize SIPS panels for flat roof designs that are inherently insulated. We suggest that you employ the services of an engineer or registered architect, especially when designing flat roofs with trusses or SIPS, to verify the strength of the roofing system for the intended design.

8B. Types of Roof Designs

There are many types of roof designs—Gable, Hip, Gambrel, Mansard, Salt Box, Shed and Flat are just a few. Choosing a roof type can be a complicated process that is often best left to an experienced architect.

Many of today's homes feature multiple roof angles and levels that can become prone to leaks. Wherever a roof meets a wall, has a valley or forces a significant volume of water to funnel into a smaller area, it creates a potential point for water leakage. We suggest that you try to stay with the simplest roofing design possible that still closely achieves the desired look or end result you prefer.

GABLE

Also known as 'pitched', a gable roof is characterized by its straight sloped sides which fall from ridge to eave, creating a peak or triangle on the side or front façade. Gabled houses have rakes (close or extended from the building to allow for an overhang) on the gable façades and eaves on the edge of the roof that runs horizontally across the façade.

Side-gabled

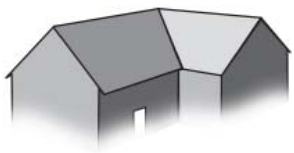
A side-gabled building has the front door on the non-gabled façade.

Front-gabled

The front door of a front-gabled building is on the peak façade.

Cross-gabled

Houses with additional sections (or wings) that cross perpendicular to the main gable are said to be cross-gabled and create a valley where they join.

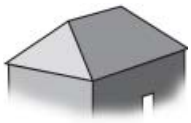


HIP

A hipped (or hip) roof slopes down from the ridge to the eaves on all sides, allowing the roof to bend or wrap around the building.

Simple

A hipped roof with four roof faces that rise to a ridge across the top; often with the broader façades at the front and back and narrower faces at the sides.



Pyramidal

A hip roof with equal sides that come to a point at the peak is called pyramidal.

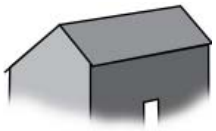
Cross-hipped

Houses with additional sections (or wings) that cross perpendicular to the main hip are said to be cross-hipped and create a valley where they join.

GAMBREL

A gambrel roof is a gabled roof that peaks at the ridgeline then falls away in a broad, low slope, breaks horizontally and changes to a steeper pitch. A gambrel roof has a broad upper story and side façade.

SALT BOX



The salt box roof got its name as its shape resembles the shape of the salt box. The salt box roof is another style of gable roof, but it is eccentric because one of the roof surfaces is larger than the other one.

MANSARD

A type of hip roof, a mansard is a four-sided roof with two distinct roof pitches, low-sloped from the flat top or ridgeline then breaking to a steep pitch above the wall junction.

SHED

A gabled roof with a single roof face falling away from the main building. Shed roofs are often used for porches, additions, and raised-roof sections.

FLAT

Actually its own roof type, flat roofs have no slope and may terminate with or without eaves.

8C. Substrate, Decking, Laminates

Once the roof framing structure is in place, the next step is to lay the substrate. The substrate is an often overlooked consideration used as the underlayment or decking of a roof (also called sheathing). This decking material must be capable of safely supporting the design loads (dead and live), including the weight of the roof systems, and the additional live loads required by the governing building codes. Decks are either non-combustible (e.g., corrugated metal, concrete, or gypsum) or combustible (e.g., wood plank, OSB, plywood or other composite), and provide the substrate to which the roofing or waterproofing system is applied. Many builders have turned to a specialized Oriented Strand Board (OSB) board, typically yellow in color, which is designed to be used as a roof decking material. This board is not intended to be left exposed to the elements for extended periods of time, but once it is covered with a roofing material, this OSB product should prove durable. However, this decking material, just like most others, will have degradation problems if the roof starts to leak or if exposed to high humidity levels for extended periods of time.

PLYWOOD

The use of plywood as a decking material substrate for roofs has been a common practice for many decades. It is important to note that there are several thicknesses and grades of plywood available.

Also, there is plywood intended for interior use only and plywood rated for exterior use. You will need to make sure that you specify the thickness of the substrate material, whether it is plywood, OSB or something else, and you should order the exterior grade.

Plywood can also come with one prefinished side (Grade 2) or both sides pre-finished (Grade 1) for use in visible areas, but you shouldn't need to pay the additional expense for pre-finished plywood to be used as a decking material. Grade 3 plywood should be the least expensive version available at your chosen lumber retailer or wholesaler.

ORIENTED STRAND BOARD (OSB)

OSB board has gradually replaced plywood to become the roof decking material of choice for many builders of residential and small commercial structures. OSB is manufactured to tight dimensional specifications and remains relatively straight over its lifetime, as long as it is installed properly. OSB is available in a variety of thicknesses and has versions for interior or exterior use. Since OSB can be manufactured from new growth wood and discarded material from lumber mills, it can be considered a sustainable material in some green programs. It is possible to find low VOC content OSB board and also versions of OSB are available from FSC certified forests.

NATURAL FIBER BOARDS

With a little diligent research, you can find sources of dimensional boards similar to OSB made from straw or wheat chaff, or other organic materials. These structural 'boards' can be as strong as the versions made from wood and are considered to be more environmentally friendly because they are made from 'waste' organic materials. It is also possible to find versions made from water-based glues or low-VOC petroleum-based glues. Depending on how 'green' you want your new building to be, these natural fiber boards can be a suitable substitute for the more readily available versions.

FOIL-FACED DECKING MATERIAL

Some versions of plywood or OSB can be ordered with an aluminum foil cladding on one or both sides that acts as a radiant barrier to reflect the sun's heat away from the attic or cathedral ceiling areas. This product can be highly effective in climate zones that have many hot, dry days by reducing the amount of the sun's heat that penetrates the building, thereby lowering the cooling load and cooling bill. If you intend to use this product in regions that have high humidity, we suggest that you check with the manufacturer prior to installing this product. The foil can act as a vapor barrier and cause a potential moisture buildup in the plywood or other structural product. This can lead to premature failure of this structural product.

If you intend to use a radiant barrier paint or liquid coating on one or both sides of your roof decking material, we again suggest that you check with the manufacturer before you install this product in a high humidity climate zone. There are some alternative installation methods for certain radiant barrier products that are effective at reducing the temperature in attics without risk of structural damage.

WOOD PLANKS

Wooden planks were used extensively prior to the invention of plywood. Many older homes and other residential/small commercial structures will have wooden planking under the roofing material, even on some flat roofs. Wood planks are still often used with wood shake shingle roofing because it

allows air to pass through the wood shingles and help them dry out after a rain. Some builders also use wood planks if the roofing material itself is heavy, such as cementatious roofs, slate or tile roofs.

STRUCTURAL INSULATED PANELS

SIPS are often used as in integral part of the roof structure. Since the SIPS panels have an insulating core and are covered with a decking-type material, such as OSB, they can make an ideal underlayment or substrate for a roof, especially for buildings designed with cathedral, vaulted or sloped ceilings. The use of SIPS as an insulating underlayment for roofs can also make an attic area become usable as an extra room or semi-conditioned storage space. SIPS can also be used in flat or low-pitched roofs. Make sure that the chosen roofing material used for flat or low-sloped roofs will be completely watertight and has the proper curbing, flashing and drainage to keep the interior dry.

8D. Drainage, Flashing and Water-Proofing Products

DRAINAGE

The features of the roof's design such as slope, shape, layout, etc., determine its ability to shed water. In addition, proper care should be taken to use techniques that carry water away effectively and products that retard water efficiently.

FLASHING

Once you install the decking materials (but prior to installing a membrane such as tar paper) you should install your flashing products. Most roofs are expected to last for a minimum of 15 to 20 years. Some roofs are designed to last 50 to 80 years. The flashing materials that you choose must be able to last as long as or longer than the roofing material itself.

The flashing material must be able to be shaped easily and have the capability to be easily soldered, brazed or welded. This ability is of the utmost importance. Copper, tin coated steel, galvanized steel and lead are examples of tried and true flashing materials that can be soldered, brazed or welded and should last for a long time. NOTE: Take care if you are considering the use of aluminum flashing. Aluminum cannot be easily welded, or attached to other flashings or to itself, so its usefulness can be limited. Also, aluminum flashing should never be used around a fireplace penetration in a roof because the chemicals released by a fire can attack and corrode an aluminum flashing, rendering it worthless.

Some products, such as skylights, come with their own flashing materials. If so, be sure to follow the instructions for the proper installation of the flashing. This is very important to minimize the possibility of future roof leaks.

Pipes that will penetrate the roof, such as plumbing stacks, have roof jacks available that come with a rubber boot (flexible seal) in the proper size to seal around the pipe. Other penetrations, such as flues for furnaces or gas/propane water heaters, will require a special kit available at building supply stores or lumberyards that will seal the flue and work with the roofing materials. Since the flue pipes can become hot, be sure to use only the products recommended for this application.

WATERPROOFING PRODUCTS

Do not use caulk, butyl rubber, silicone or other sealants in lieu of proper flashing. These products rely on elasticity to work and the sun's radiation (plus exposure to the elements) will degrade these products over time. Once they lose their elasticity, they will likely crack or separate from the primary materials and allow water to enter the structure. A high percentage of leaking roofs can be traced back to over reliance on expansive compounds or poor installation of flashing. Do use caulks and sealants in conjunction with proper flashing to help add a measure of waterproofing to the finished installation. Be sure to check on the caulks and sealants every few years and reapply fresh sealants to any weathered, checked or cracked compounds.

GUTTERING

Guttering gathers watershed and directs it a specific location. The width of the guttering is determined by the amount of water runoff from your roof. Typical gutter sizes for residential and small commercial buildings are either 4- or 5-inches wide.

LEAF GUARDS

Leaf guards provide a deterrent, keeping leaves from building up in the gutter and choking it. There are several versions of leaf guard systems on the market.

DOWNSPOUTS AND SPLASH-BLOCKS

Downspouts need to be installed so that they direct the rainwater to flow away from the structure. The farther you can divert water away from a building, the better. Hopefully you have chosen a building site based on decisions made regarding the proper slope away from the building.

ORNAMENTATION

Wind direction arrows and other ornamental features are sometimes installed on roofs. The main consideration here is that any ornamental feature should be installed so that it won't cause leaks, even in high winds or other weather events.

8E. Membrane

Used as a second layer of protection for the roof decking (should the primary roofing material fail); the membrane may be a tar, felt, or rubber product. Typically it is a felt paper impregnated with tar (thus the name), which creates a waterproof material that is also semi self-healing. This allows nails to be punched through it when the exterior roofing materials are installed and the tar paper 'seals' around the nails to prevent water leakage. Roofing felts may be manufactured principally from wood pulp and vegetable fibers (organic felts), asbestos fibers (asbestos felts), glass fibers (fiberglass felts or ply sheet), or polyester fibers. Some common membranes are:

- Tar Paper
- Roofing Felt
- Rubber Sheeting

8F. Exterior Roofing Products

Your exterior roofing material, whether it is shakes, shingles, tiles or something else, is your main protective surface against sun, rain and other weather elements. There may be requirements regarding the type of roofing material you must use in neighborhood covenants or other local restrictions. If your building is in an area that is prone to getting large hail, you will want to install a roofing material that can hold up against this type of destructive force. Lighter colored roofs tend to be better for climates that are hot because the lighter shades help reflect the heat.

Most people are familiar with different types of roofing products, so we will simply list them here. The exceptions in the list below that you may not be as familiar with are the versions of roofing that have integrated solar electric components, 'cool' roofs and the plant based living roof. It is now possible to purchase metal roofing with integrated solar Photo Voltaic (PV) components pre-installed or a thin laminate PV material that can be bonded onto a metal roof in the field. There are also solar PV shingles available in various colors that can be integrated into your building's roof among other shingles to provide power. The larger the area of PV installed, the more power you can obtain from these units.

COOL ROOFS

The Energy Star® program website has a section regarding cool roofs. Generally they are metal roofs have a special coating that helps reflect the sun's heat and can keep an attic area as much as 100°F cooler than a conventional metal roof. Coatings and single-ply membranes are also available. In hot climates, these cool roofs can make a big difference in the annual cooling bill and in the comfort of the building, so it can be beneficial to look into cool roofs.

LIVING ROOFS

Residential and/or small commercial roofs that are flat or that do not have a steep slope can install a living roof that is comprised of actual living plants located above the main roof area. These plants help cool the roof and protect it from the elements, so the roof can last longer. Living roofs help reduce the 'heat island' effect in metropolitan areas, so many large cities are now encouraging the installation of living roofs on new and existing buildings.

EARTHEN ROOFS

It is possible to build a home or other structure totally underground and have an earthen roof above. Underground homes have been built in various locations around the United States of America and other parts of the world. This is a very viable option, so if you decide to explore an underground building we suggest that you learn as much as possible about this subject and then contact an engineer or architect who is well versed in underground construction. The underground structure must be designed to withstand tremendous weight on the roof area and also be completely waterproof.

Some exterior roofing products are:

- Metal Roofing, Seamed
- Metal Roofing, Seamless

- Metal Roofing with Solar Electric Panels Laminated onto it
- Slate (natural stone)
- Eco Slate (looks like slate but is made from recycled materials)
- Clay Tile
- Simulated Tile
- Concrete Tile or Shingles
- Wood
- Asphalt (short life)
- Asphalt (long life)
- Simulated shingles with integrated solar electric panels
- Plant based Living Roof
- Membrane, Single Ply
- Coatings

8G. Roof Venting Choices

NOTE: Be sure that your contractor uses the appropriate vent for your roofing material. Failure to do so may lead to infiltration problems.

STANDARD ROOF VENTS

Typically the standard roof vent is installed near the top or crest of a roof. They can look like small square or rectangular boxes mounted close to the roofline. These vents cover holes cut into the roof and work in conjunction with eave vents to provide a passive venting system.

POWERED ROOF VENTS

Powered roof vents are somewhat larger in size than standard roof vents and include a fan typically powered by the building's electric system. This fan comes on when the temperature inside the attic exceeds a preset threshold.

SOLAR POWERED ROOF VENTS

Similar to the powered roof vents mentioned above, the solar powered roof vent uses solar electricity to power the fan. This is an ideal match of solar to end-use because the fan runs fastest when the sun is the brightest and will shut off at night.

GABLE END VENTS

These vents are usually large and are located below the gable end of the roof. These vents can be triangular, square or rectangular in shape. A power fan can be added inside these vents for extra ventilation.

SOFFIT/EAVE VENTS

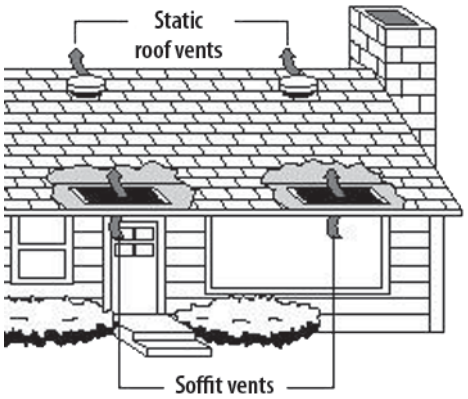


Image Courtesy of www.energycodes.gov.

These vents are located underneath the overhang of a building and can be either one long vent or a series of smaller vents. These lower vents provide the air intake for the upper roof vents so that heated air in the attic can flow out the upper vents by a natural passive convective current. Care must be taken to not block the lower vents with insulation. It is recommended that you install baffles along the outer interior edge of a roof so that the insulation is held back from the vent.

RIDGE VENTS

Ridge vents are vents along the very top (crest or crown) of a roofline. These vents allow heated air to escape at the topmost point of the roof, which is the natural location to which heated air wants to rise. You will need vents located along the low areas of the roof or eaves to allow cooler air to come in and replace the heated air that is escaping.

TURBINE VENTS

Turbine vents are sometimes called whirlybird vents. These are the round, metal vents that stick up above the roof surface and have fins designed to catch the wind causing them to spin. This spinning creates a negative pressure in the attic pulling fresh air through the lower vents and exhausting stale air through the turbines. This makes the turbine vent into a power exhaust system utilizing a renewable resource for its power.

CUPOLA

Cupolas are small square structures that stand higher than the roof. These small units were originally designed to provide venting for a building and some modern designs still include cupolas for this purpose; however, many times they are simply ornamental. A cupola acts like a chimney in that they allow an area for the heated air in the attic to rise and then exit.

ICE HOUSE

An ice house roof venting system incorporates soffits and roof vents with a radiant barrier to create convection air flow in an effort to scrub heat from the roof and to provide attic ventilation. An ice house roof is basically a roof with an air gap between it and another surface (often a reflective surface) that allows air to move behind the roofing deck and helps keep the roof surface cool. This moving air also helps reduce the air temperature in the attic significantly. If you combine the ice house roof with a properly installed radiant barrier inside the attic space, the attic temperature can be further reduced, which significantly reduces the load on the air conditioner and reduces summer cooling bills dramatically. Studies have shown that this system reduces air-cooling loads by as much as 46% and can increase the life of the shingles.

8H. Rainwater Catchment Systems

Rainwater catchment systems are discussed in the ***Water Heating and Use*** and ***Landscaping*** sections, however, it is important to think about the location of the downspouts and provide allowances for rain barrels, cistern, or other water storage containers for rainwater as you design the roof.

Electrical

9A. Choosing your Contractor

- ☐ Do you want to leave the choice of your electrical contractor to your Builder or General Contractor?
- ☐ Is it important to you that your electrical contractor have experience with green building techniques, renewable energy production and products?
- ☐ Are you willing or able to direct or hire someone else to direct electrical people who don't have experience with green building techniques?
- ☐ Can you specify that your electrician install all the wires/cables or do you have the various subcontractors add them separately?

Choosing your electric contracting company or solo electrician is a very important decision. Depending on your goals and priorities, a new or remodeled building can have several wiring systems.

- There will be a higher voltage system (or primary system) that services your lights, outlets, heating and cooling system, appliances and other electric needs.
- There will also be lower voltage systems for certain required items, such as thermostats, doorbells and other transformers required by primary systems.
- There will also be a low-voltage system for any security system installed in the building.
- Another series of low-voltage wires will be required if you decide to install a computer network using Category 5 wiring.
- Telephones will probably have their own set of dedicated wires.
- Yet another series of low-voltage wires will be necessary if you decide to hard-wire your smoke detectors together.
- Plus, a series of cables will be required for your cable or satellite television, security cameras, home theater and other video signals.
- Some lighting control systems and building automation systems can require yet another set of wires.

All these wires (plus any others not listed above) are best installed during the construction process while access to the building's structure is available. They can be added later, but doing so will be more difficult.

If you plan on installing a sophisticated security system, building automation system, lighting control system or audio/video (home theater) system, we suggest that you involve your primary electrician in your design team to resolve these issues as well as help with design specifications and set expectations prior to construction. If possible, you may want to include a home automation specialist and a security company representative on your team as well.

Because home automation/building automation systems can be very sophisticated, as well as security systems and closed-circuit cameras, we suggest that you contact some customers of the systems that you are considering and find out if they are happy with their systems. Also, bear in mind that all systems will eventually require maintenance and/or upgrades, so try to choose systems with good product support and customer reviews.

9B. Reducing your Load

☐ Have you reduced your load as much as possible?

Reducing the amount of electricity required for a building is a primary consideration in sustainability and energy conservation. The evolution of many products has significantly reduced their respective energy requirements. Some examples: Computers have progressed from heavy tube monitors to flat screen versions with a huge reduction in the amount of electricity required to operate. Lights have progressed from incandescent bulbs that can use 100 watts and last about 1,000 hours to compact fluorescent bulbs that use only 23 watts to produce the same amount of light and last 10,000 hours. Soon LED lights that produce the same amount of light using only about 10 watts and will last over 100,000 hours will be readily available and cost effective. New and even more efficient lighting technologies are ever evolving.

If you study the energy use of each appliance and electricity-consuming item before purchasing, you can significantly reduce your total electric bill. The reduction of energy use is even more important if you are considering the installation of a solar (PV) or wind system to provide power for your building. The lower your power requirements are, the smaller and less expensive your PV or wind system can be. It makes sense (and cents) to lower your electricity consumption as much as possible. Here are a couple strategies to help you reduce your electricity consumption:

Demand Controllers (Whole Building Energy Control)

The concept of demand control is not easily explained in brief, but we'll try. First, review the information regarding Measuring Electricity in the Initial Considerations Section to become familiar with that important concept.

If your electric meter measures both demand and consumption, then it would pay you to control demand and reduce consumption. A demand controller or whole building load controller is designed to monitor the demand component of your electric usage and keep it within pre-specified limits, as set by you. It does this by turning off or limiting the use of non-essential or lower priority items when you turn on items that call for more electricity and raise your whole building demand.

In regions of the world that have high electric rates or severe peaks of electricity consumption at certain times of the year, a demand controller matched with a suitable demand and energy rate from the local electric utility can produce reasonable electric bills for the customer by placing the control in the customer's hands. We expect that you will be hearing more about demand and energy rates, and other variations such as time-of-day rates and real time rates, in the near future as demand for electricity starts to stretch the capacity of the local electric utility or the regional electric grid.

Low Voltage Wiring

Many low-voltage products can be inherently more energy efficient than their high voltage counterparts. For example, low voltage accent lighting kits are popular for lighting the exterior of a building and sidewalks because they are energy efficient. So, consider the installation of low-voltage wiring and products to replace the high voltage versions inside your building whenever possible as well. Low-voltage lighting works well for interior accent lights, such as track lights, that are used to highlight paintings and other artwork.

Ghost Loads

Some electrical devices draw a small amount of current when turned off. This draw is referred to as a ghost load (also known as phantom load, parasitic load or simply leaking electricity). Examples include the clocks on the microwave oven, coffee maker, VCR, stove; the 'ready' light on the television; and AC adapters (transformers). Even though the ghost load of each individual device is small, it all adds up and increases your overall load requirements and your electric bill. A 1998 study by Thorne & Suozzo estimates that ghost loads account for approximately 5% of an average household electrical load.

9C. Distribution System

The traditional method of delivering electricity throughout a building has been copper wire. In fact, copper wire is still the specified wiring component for the vast majority of buildings. There have been some significant innovations in how a building can be wired, either through intelligent (Smart) wiring or structured cabling.

SMART WIRING

Smart wiring is an intelligent wiring system that is able to sense the device connected to it and supply the appropriate signal or voltage. Common appliances, such as a toaster, would have a microchip installed in them that would 'talk' to the main control panel and tell it what it needed. In the case of the toaster, all it would need is 110/120 volt AC power to make toast. A computer might only require 12 volts DC power, so it would tell the controller to supply this. A small television might only need to have a connection to an antenna or to the cable company/satellite dish, so the control panel would supply this. The concept seemed plausible and Smart wiring was heavily promoted as the wiring of the future for a while. The concept has not actually caught on to any significant degree.

STRUCTURED CABLE

Structured cabling is gaining momentum. The idea behind structured cable is to order the wiring for the building pre-bundled so that all the wires required for the various rooms are in the bundle or group. For example, a structured cable may have 12- or 14-gauge copper wire, plus some Category 5 wires and some RG-6 cables, so that the one bundle of wires will connect to the outlets and also provide wiring for the computer network and the television or security monitors. More advanced structured cable/wiring systems may include Category 5e (Enhanced) or fiber optic cables.

DUAL WIRING

Dual wiring is the concept of running an additional set of wires for future use by a DC power system. DC systems typically require a heavier gauge of wiring than AC. It can get expensive to run copper wiring throughout a building twice, so you may want to run a second set of wires in the main areas that may eventually convert to DC, such as hallway/emergency lighting areas, security/communication system power and backup refrigeration.

9D. Conduit System

☐ Is your wiring easy to access or alter in the future?

Whichever form of electricity you choose, you will need to run wiring. There are several methods (and materials with which to do it) to encase the wiring for safety and aesthetics.

STANDARD WIRING

Standard copper wire typically comes encased in a plastic protective covering or non-metallic sheathing known in the trades as romex. (Romex™ is actually a brand name for this type of product, but it has become synonymous with standard copper wire just like Kleenex® is a brand name for facial tissue.) You can order copper wire with a flexible metal sheathing. This can be specified as BX cable or AC cable.

USING METAL CONDUIT

It is common in commercial buildings to encase the electric wiring inside metal tubing, typically galvanized steel. This metal conduit provides protection for the wiring, especially in case of fire. Metal tubing used as conduit is not common in residential buildings, unless the wiring has to be attached to the surface of a wall (such as a basement or crawl space application) or if there is outside wiring. There are alternatives to using galvanized metal tubing as conduit.

USING FORMED ENCLOSURES

There are wiring enclosures available on the market that are designed to be placed on walls. You can get metal versions and plastic versions of these products. These special enclosures run along or can even replace the floorboard of a room so that electric wiring can be installed in locations that otherwise would be difficult or impossible to wire.

USING PVC

PVC tubing can be used to encase wires, especially inside the building's walls. PVC is somewhat easier and faster to install than galvanized metal. However, PVC is not fire-resistant like metal conduit.

9E. Safety

☐ Are you incorporating whole house safety features?

Safety is of utmost importance when working with and using electricity. Precautions need to be in place that will prevent personal injury and fire (at the very least). There are many ways to protect yourself and your home from damage.

STANDARD SAFETY FUSE

The screw-in type safety fuse has been in use for many decades. These fuses contain a thin metal strip or wire that is designed to burn away if a certain power requirement is exceeded. Electric fuses work well, but only work once. If the fuse is burned out (or blown), then a replacement fuse of the same capacity is needed. Many a late-night trip has been required to search for a replacement fuse.

CIRCUIT BREAKER

A circuit breaker is a device that automatically shuts-off (or trips) when the circuit is shorted or overloaded. The circuit breaker can then be reset once the short or electrical problem has been resolved. Circuit breakers are rated by amperage and available in many sizes.

As of January 1, 2002, the National Electrical Code (Section 210-12) of the United States of America requires that an AFCI (Arc Fault Circuit Interrupter) be installed on bedroom circuits (at least) to help reduce home fire deaths.

INTELLIGENT BREAKERS

There are breakers available that will trip when a small short or imbalance of electricity occurs. These are called GFI breakers, which stands for Ground Fault Interrupt. A GFI breaker is used in areas where exposure to electrical hazards can be higher, such as bathrooms, utility rooms and outlets near spas, hot tubs, swimming pools and other water hazards. There are also intelligent breakers that are designed to be controlled remotely. These breakers can be controlled by a building automation system or a security system, or can be activated by a smoke alarm system, etc.

WHOLE HOUSE SURGE PROTECTOR

Whole house surge protectors are typically installed at or near the electric meter and provide a measure of protection against voltage spikes, lightning surges and other power-line transients. Some electric utilities offer whole house surge protectors for a nominal monthly fee and also offer insurance to cover electric items damaged if the surge protector fails.

POINT-OF-USE SURGE SUPPRESSORS

Another protection device for your valuable electronics is a surge suppressor located at the outlet(s) where you plug-in your electronic devices.

UNINTERRUPTIBLE POWER SUPPLY (UPS)

A UPS is a device that contains batteries that can be sized to provide temporary power to critical electronic devices, such as network computers, so that they can continue to operate for a period of time in the event of a power outage. UPS devices also have surge suppression and protection installed to help protect valuable electronics from being damaged by fluctuations and spikes from the electric grid. It is advisable to have a UPS system connected to every computer in a home or business.

9F. Renewable Energy Production

- ☐ Are you making your home Solar and/or Renewable Energy Ready?
- ☐ What will your site allow:
  - ☐ Wind?
  - ☐ Solar?
  - ☐ Hydro?
- ☐ What can you afford?
- ☐ What is the best return for your investment?
- ☐ What are you willing to change or do without to take advantage of renewable energy?
- ☐ Will you be storing excess energy and/or 'selling it back' to the grid?
- ☐ Is Net Metering available in your area?

Renewable energy options for electricity include wind, solar, biomass and hydro. In brief:

WIND ENERGY

Wind energy is a rapidly evolving industry, with new products becoming available on a continuous basis. A small wind system that produces between 2 and 10 kilowatts will likely be sufficient for most residential and small commercial applications. Wind systems need to be installed in open spaces with decent average wind speeds. Many jurisdictions and codes will not allow wind systems to be located within a certain distance of surrounding buildings, due to concern about high wind speeds rotating the blades too fast and causing them to fly off. However, some newer systems have fail-safe modes and can be installed in close proximity to other structures. Also, there are new wind systems available that have fail-safe blade designs and can be installed close to ground level. We suggest that you check with the local code officials and your neighbors before installing a wind system of any significant size.

SOLAR ENERGY

See the ***Energy Alternatives*** section.

BIOMASS ENERGY

Biomass refers to recently living biological material used as an energy source. It does not include bio-fuels (such as bioethanal, biobutanol or biodiesel). Some plants used for biomass energy include switchgrass, hemp, corn, willow and sugarcane. Animal waste can also be used as a biomass. Though biomass is a renewable fuel, it can still be unfriendly to the environment due to deforestation and poor management practices. It is also still part of the 'carbon cycle' and produces air pollutants that must be contained.

HYDRO ENERGY

We are not referring to Hoover Dam; but to a small-scale hydro system (usually consisting of an enclosed water wheel or turbine), which is made to spin by jets of high-velocity water. The water is

taken from the stream and moved down slope to the turbine through a long pipe called a penstock. Water flowing through the penstock picks up speed, and is directed at the blades of the turbine by nozzles. The turbine spins continuously, as long as there is water to drive it. The turbine is connected to an electricity generator, and the electricity is then available for running appliances or charging batteries. The spent water is returned to the stream. This kind of system is called a micro-hydro system, run-of-stream hydro or low-impact hydro.

If you are storing energy, you will need a battery system. If you are putting it back into the grid, you will need Net Metering.

Regardless of the source and what you do with the excess, you will need inverters. An inverter is an electronic circuit for converting Direct Current (DC, the type of electricity produced by these renewable energy options) to Alternating Current (AC, the type of energy used by most electric items and the type of energy supplied through the commercial electric grid).

If you are considering renewable energy production, you will want to include an expert in this field on your design team.

Plumbing

10A. Primary Water Source

- ☐ Do you have a choice for your primary water source?
- ☐ Are you required to hook your building into a public water system?
- ☐ Will your primary water source be piped directly into your home from an urban or rural source?
- ☐ Is it possible or feasible to drill a well at your building site?
- ☐ Is there a clean water source on your site?
- ☐ Are you concerned with depletion of aquifers?
- ☐ Are you concerned about contaminated water?
- ☐ If you must have water trucked in, where will you situate your cistern?

Most people have their primary water piped directly to their home from an urban or rural water district. In rural areas, some people drill a well for their primary water source; while other people have water trucked in. A rainwater catchment system is not recommended for a primary water source; however, in arid climates without public water, there may not be another option.

It is difficult to present a definitive answer here regarding which option is most conducive to green building. There are ecologic and health aspects to each choice. If you have the luxury of choice in this area, we suggest that you research the water sources available to you.

SOURCES OF WATER

- Hook Up to Rural or Urban Water Supplier
- Dig a Well
- Use water from a local stream, pond, lake or river
- Use water storage and have water delivered
- Use water storage and utilize a rainwater catchment system

10B. Gray Water

- ☐ Do your local codes allow for a gray water system?

There are two basic types of waste water that comes from the average home or business, black water and gray water.

BLACK WATER

Black water is waste water that must be treated, water from sinks with garbage disposals, used toilet water and other sewage.

GRAY WATER

Gray water is the water that comes from bath tubs, showers, sinks (without garbage disposals) and clothes washers. This water typically has some lower levels of dirt, detergent and other mild pollutants in it.

Most gray water can be stored and used for secondary purposes, such as watering lawns and gardens, washing vehicles and other outdoor uses. If gray water is to be used for landscape watering, the use of mild detergents without phosphates is recommended. It is possible to reuse gray water indoors for flushing toilets and other similar uses, but the plumbing required for this extra system can be expensive and may be against local codes.

Check with your community about zoning for this alternative use of 'used' water that comes from sources other than your toilet. If you are not required to send the water from your washing machine, sinks, showers, etc. through the sewer system, you might want to add a gray water system for non-potable uses.

Potable: An adjective that means 'fit or suitable for drinking.' Therefore, non-potable water is NOT fit to drink, but IS fit for other purposes such as a gray water system.

10C. Sewer, Septic Systems

- ☐ Are you required to hook your building into a municipal sewer system?
- ☐ What type of sewer system is appropriate and desirable for your building site?
- ☐ Are you interested in pursuing environmental sewage treatment options?
- ☐ Is your plumber familiar with green (alternative) sewer systems?
- ☐ Who will maintain your sewer system?

For most people who live within city limits, the only option for dealing with black water (sewer waste) is to hook up to the municipal sewer system. If you have the opportunity to choose another method, or if you are building in a location that does not have access to sewer service, you have many options from which to choose.

SEPTIC TANK SYSTEM

Septic tank systems have come a long way since the only option was a concrete tank and standard laterals. You can now get septic tanks made from a variety of plastics and laterals are not simply piping encased in gravel or brick pieces anymore. There are engineered systems that require less land space than the original systems and the newer systems can operate better and are more environmentally friendly.

SEWAGE LAGOON

Basically, a pond or lagoon that is strictly intended for sewage waste; a sewage lagoon is normally an option only when installed in areas of 10 acres or more. If poorly managed, a sewage lagoon can

have the potential to smell bad and is a possible attractive nuisance to kids who don't realize what it is. Check with your Zoning Commission to determine if sewage lagoons in your region are required to have a fence around the entire perimeter and have a signage system that warns people to stay away.

PRESSURE MOUND SYSTEM

When properly sited, designed, constructed, operated and maintained, pressure mounds provide a proven alternative method of sewage disposal. A pressure mound system relies on subsurface distribution. This is an effective solution where soil and site conditions are not suitable for conventional treatment and disposal systems.

LOW-PRESSURE PIPE SYSTEM

A low-pressure pipe (LPP) system is a shallow, pressure-dosed soil absorption system with a network of small diameter perforated pipes placed in narrow trenches. LPP systems were developed as an alternative to conventional soil absorption systems to eliminate problems such as: clogging of the soil for localized overloading, mechanical sealing of the soil trench during construction, anaerobic conditions due to continuous saturation and a high water table. The LPP system has the following design features to help overcome these problems a) shallow placement, b) narrow trenches, c) continuous trenching, d) pressure-dosed with uniform distribution of the effluent, e) design based on areal loading and f) resting and reaeration between doses.

PLANT-ROCK FILTER SYSTEM (CONSTRUCTED WETLANDS)

Constructed wetlands have four parts: the liner, distribution media, plants and underdrain system. The size of the system depends on the level of treatment desired balanced against the wastewater strength. The length of the wetlands should be two to three times the width to ensure that the wastewater is not flowing too quickly through the system.

LIVING MACHINE

Typically located in a separate enclosure (such as a sunspace or greenhouse), the Living Machine takes raw sewage and pumps air into a series of linked plastic tanks in which up to 200 species of plants are suspended in wire mesh containers. While the plants drink up nutrients in the sewage, countless bacteria and microbes break down pollutants. As the sewage proceeds from tank to tank, it progressively becomes cleaner. Fish and snails join in on the feast and at the last tank is sparkling water good enough for irrigation, toilet flushing or vehicle washing. The plants produce enough flowers to delight any gardener and provide abundant material for composting. These 'machines' cost about half as much to install as traditional treatment plants laden with concrete and plumbing. They don't smell, they are nice to look at and they are educational.

10D. Toilets

- ☐ Have you determined how many toilets are necessary for your building?
  - ☐ Are composting toilets an option?
  - ☐ Have you considered using waterless urinals?

Toilets are a necessity with a sewer/septic system, but there are options available.

GRAVITY TANK

The original toilet design relies on the weight of water and gravity to force effluent down the drain. Early versions used as much as five gallons of water per flush.

LOW-FLOW GRAVITY

The newer toilets are designed to use about 1.6 gallons per flush and are considered to be 'low-flow' versions.

PRESSURIZED TANK

Some toilets come equipped with an internal tank that is pressurized by the incoming water stream. When the toilet is flushed, the internal tank provides an extra push to force the water down the drain. You can also install these tanks as retrofits for existing toilet fixtures.

DUAL FLUSH

Dual flush toilets are a relatively recent invention. They typically have two handles, One for flushing urine using a smaller amount of water and another for flushing solids. These toilets are not as easy to find as the more common 1.6 gallon per flush versions, but they are available at certain retail outlets and on the Internet.

HIGH TECH

There are high technology toilets available that offer special features, such as: heated toilet seats, mechanisms that open and/or close the toilet seats automatically and heated water to wash your backside, similar to a bidet (see below). Of course, most of the previously mentioned features require energy to work and therefore have a higher 'cost'. We expect to see other features available in toilets, including automatic fragrance and built-in music plus telephone. After all, you can now purchase a toilet-paper dispenser with built-in speakers and base for your IPOD and toilets with built in fish tanks, so who knows what is coming next!

COMPOSTING

Composting toilets rely on bacteria to decompose the waste products. Some composting toilets need additional materials and maintenance while others are relatively maintenance-free.

NOTE: The porta-potties that are used for construction sites and at the ballparks are not composting toilets. These versions rely on chemicals to reduce the smell of waste and are similar to the chemical toilets found in airplanes and in RVs.

HEAT/ASH TOILETS

Some toilets use a small amount of electricity to quickly reduce waste into a pile of ash. This ash will have little or no odor and can be used as a soil treatment for landscapes and gardens. This type of toilet is handy where there is no running water but there is electricity available.

STANDARD URINALS

The standard urinal uses approximately one gallon of water per flush. Some urinals are equipped with motion sensors so that the unit will automatically flush after each use.

WATERLESS URINALS

A relatively recent invention that holds significant promise is the waterless urinal. These units do not need to be connected to the water line of a building but rather can simply contain the urine in a special chamber. Some units treat the urine with a special chemical while others rely on a tight lid to seal after each use. These units still have to be connected to the sewage piping to be able to drain excess urine.

BIDETS

Pronounced 'Bid-ay', the bidet has the singular purpose of using water to clean yourself after using the toilet (instead of using toilet paper). How much water is used depends upon the user. Bidets have been widely used in Europe and other countries for a long time and have many health benefits, but are not a common feature in the United States of America. There are several bidet products that can be added to a toilet; and toilets are now available that have a bidet component.

10E. Water Piping

- ☐ Will you leave the choice of piping to your plumber?
- ☐ Have you done a cost benefit analysis/comparison of traditional plumbing materials/ techniques vs. the green plumbing materials/techniques you want to use?

Early homes and commercial buildings relied on galvanized steel piping for water. The galvanized pipe tended to clog with minerals over time and could also corrode or rust, depending on the hardness or pH level of the water. Copper pipes proved to be a marked improvement over galvanized steel; therefore, many residential and commercial buildings have been built over the last few decades with copper water lines. Now, there are more choices for water lines and some have distinct advantages over copper.

GALVANIZED STEEL

The forerunner for today's water lines, galvanized steel was able to withstand significant pressure and offered some flexibility in installation.

COPPER

Copper gradually replaced galvanized steel as the water piping of choice for residential and commercial buildings. Copper was easier to use and could be bent to fit in difficult locations.

PVC

Polyvinyl chloride (PVC) pipe is an option for water and sewer lines in a home. PVC pipe can withstand a certain amount of water pressure and is slightly elastic. But, it is not recommended to use PVC piping in areas prone to freezing. PVC is a highly polluting product during its production and recent studies are suggesting growing health concerns.

CPVC

Chlorinated PVC (CPVC) is a version of PVC piping that is more resistant to corrosion and chemicals than its chemical cousin. CPVC also is slightly more resistant to crushing and will bend a little more

than PVC. CPVC is commonly used in commercial and industrial applications where exposure to chemicals and corrosive environments is possible. CPVC is a highly polluting product during its production and recent studies are suggesting growing health concerns.

PEX

PEX tubing is made from cross-linked high-density polyethylene. PEX tubing is used predominantly in hydronic radiant heating systems and is able to withstand high crushing weight and 90 degree turns. PEX tubing is also being used for water supply applications in residential and small commercial buildings. There is some concern about the ability of PEX to withstand long-term exposure to chlorine, which is added to most drinking water to limit bacteria and fungal growth. However, PEX is approved for use in many jurisdictions for use as water supply piping and has proven to be successful in this application.

METAL AND PLASTIC BLENDS

There are piping systems available that are a blend of metal and plastic pipe in one. One version has an aluminum core that is an oxygen barrier between the liquid in the system and the plastic exterior. Blends are a relatively recent invention so we recommend that you research these products for your particular application before purchasing.

POLYBUTYLENE

Polybutylene is a form of plastic resin that was used extensively in the manufacture of water supply piping from 1978 until 1995. It was a low cost material and was easy to install. In the 1980's structures with polybutylene pipes started reporting leaks and when the pipes were replaced, it was noticed that the interior walls of the pipes and fittings were breaking down and flaking apart.

While it is unlikely that you will find this product for sale or recommended by a plumber, it is important to know that it was used in many structures for almost 20 years and why you should be wary of it. If you are remodeling an existing structure, it is especially important to know if this product has been used and why you should make it a priority to have it replaced.

Polybutylene plumbing may fail without warning, damaging properties, personal belongings, and disrupting lives. It is highly unlikely that any damage will be covered by insurance. Factors that may contribute to failure include: chemicals in the water supply (such as chlorine) that slowly destroy the structural integrity of poly and fittings, the age of the pipe (the older the pipe, the more likely a problem will occur), and faulty installation.

Since the 1980's class action suits have been brought and settled with hundreds of millions of dollars set aside to help consumers. Strict qualification guidelines have been established to determine if someone may participate in one of these suits. You should contact the appropriate settlement facility to find out if you qualify for assistance.

10F. Water Pumps

☐ Will you need a water pump?

If drinking water is not obtainable from a local water utility, then the most common alternative is to dig or drill a well. Wells are often used to provide water for livestock or for agricultural and landscaping

purposes. Unless you decide to hand-dig a well, you will likely need mechanized equipment for digging or drilling. There are a large number of contractors and companies who specialize in constructing wells, so discuss the decisions regarding well construction with the experts.

You will need a water pump for extracting water from the well and you have options.

STANDARD PUMP

The standard pump used for extracting water from a well is powered by 110/120 volt alternating current. These pumps are commonly available from a variety of retail outlets and via the Internet.

SOLAR PUMP

One of the best applications for solar electricity (PV) is pumping water for residential, commercial and other uses. The direct current (DC) produced by the PV panels can provide a significant amount of force (or power) to a DC pump. The PV pump can run all day long to store water in tanks or cisterns or to build pressure in a water system. The pump will not work after sundown, but will operate again on the next sunny day. Usually this is more than adequate for many water uses. Or, you can use batteries to store excess electric energy from the solar PV system to continue to pump water at night.

10G. Filters

 ☐ What kind of filtration system will you use?

Many people think about filtering the air when building or remodeling, but are unaware that filtering the water is just as important. The water we drink can contain a multitude of impurities, chemicals and other things that you probably don't want to ingest. There are different types of filters and filter strategies available on today's market that can help clean and purify the water you drink.

WHOLE HOUSE

Whole house filters treat all the water used in the home. You can install a simple filter to catch the larger pieces of debris in the water supply and then install better filters at the point of use or you can install a high-efficiency filtration system at the main water entry into the building. The advantage of treating all the water with a high efficiency filter is that all uses (showers, baths and drinking water) have been treated. Because you can shorten the useful life of a whole house water filter prematurely if you use it to treat a significant amount of water; the disadvantage is that all uses (such as toilet flushes, landscape watering and other exterior uses of water), have also been treated.

CHLORINE

Many types of filters and filtration strategies can remove chlorine from water including carbon filters, sulfite-bisulfite-sulfur dioxide dosing filters and reverse osmosis.

POINT-OF-USE

Point-of-use filters are normally located at the specific plumbing fixtures where maximum filtration is desired, such as kitchen faucets, shower heads and refrigerator ice-maker water lines. There are a multitude of brands and options available for point-of-use filters.

10H. Water Purification

☐ Will you install a water purification system?

REVERSE OSMOSIS

Reverse osmosis is a process that uses a semi-permeable membrane (similar to a human cell lining) to separate the good, clean water from a contaminated source using high pressure.

DISTILLATION

The use of heat to create steam which then condenses on a surface and runs into a storage container is called distillation. The water derived from the steam will be free of minerals and contaminates. However, the cost of energy to create distilled water can be significant.

CARBON FILTER

Carbon filters can trap contamination as the water passes through. Carbon can also help neutralize and mitigate certain compounds found in water.

CARBON FILTER WITH SILVER

Traces of silver in a carbon filter can react with chlorine and help reduce or neutralize the chlorine.

The membranes and filters used to purify water will eventually get clogged with contaminates and will need replacement. Some water purification systems cost less than others while performing the same basic tasks. Replacement costs for cartridges and/or filters can be significant. Some research will likely be needed to determine the type of water purification system you require for your project.

10I. Other Plumbing Related Items

☐ Will you use fixtures and faucets that conserve water?

☐ Will you need a water softening/conditioning system?

WATER SOFTENING/CONDITIONING

In parts of the United States of America and other regions of the world where the water is considered to be 'hard' (too many minerals and chemicals), a water softener or conditioning system is a proven method to soften the water used inside a building. Hard water can cause a mineral build-up inside water lines, fixtures and other plumbing items. Most water softeners utilize a salt product and, therefore, the conditioned water should not be ingested in large quantities.

FLOW RESTRICTION

Flow restriction uses low-flow faucets, showerheads and other plumbing fixtures to reduce the amount of water used during normal operation. By reducing the flow, the amount of water needed for many uses is reduced, which lowers consumption. Also, the amount of heat energy used by the water heater needed to heat water is lessened when flow restrictors are used, thereby potentially resulting in lower energy bills.

VALVES

There are a variety of valves available on the market, some have certain advantages over others. Gate valves are a good choice for the main water supply valve, whereas ball valves are a good choice for individual appliances, such as dishwashers and clothes washers. A visit to the local hardware store or building supply store will educate you on the types of valves commonly available. A good plumber will match the proper type valve to the use for a good end result.

FIXTURES

Plumbing fixtures are a huge component of the building supply market. One visit to a large building expo, such as the International Builder's Show, and you will see an incredible variety of plumbing manufacturers and fixtures. Some manufacturers utilize cartridges for the internal water control system in their fixtures while others employ compression or piston-type strategies. We suggest that you study the internal dynamics of the fixtures you intend to purchase so that you will become knowledgeable about future maintenance and replacement schedules. We also suggest that you standardize your choice of plumbing fixtures inside your building so that you do not have to have a large variety of replacement parts stored for future use.

Water Heating and Use

11A. Water Heaters

- ☐ Will your water heating system be natural gas, propane, electric, solar assisted or 100% solar?
- ☐ Have you determined the quantity of heated water your facility will require?
- ☐ Do you prefer tankless water heaters?

The conventional way to heat water in the United States is to use a tank-style water heater that is powered by natural gas, propane or heating oil, or electricity. Recently, tankless water heaters have gained popularity.

STANDARD NATURAL GAS TANK WATER HEATER

Commonly available in 40-, 50-, 80- and 120-gallon sizes, a standard gas water heater must have a metal flue installed for combustion gases. Higher efficiency models can have more efficient burner units and an exhaust fan. Highest efficiency models can have sealed combustion.

STANDARD PROPANE OR HEATING OIL TANK WATER HEATER

Also commonly available in 40-, 50- and 80-gallon sizes, propane or heating oil water heaters must have a metal flue installed for combustion gases. Higher efficiency models are also available.

STANDARD ELECTRIC TANK WATER HEATER

Electric water heaters are available in 40-, 50-, 80- and 120-gallon sizes. Electric units do not have flues but must have sufficient electrical capacity available.

INSTANTANEOUS/TANKLESS WATER HEATER (ELECTRIC OR GAS MODELS)

An attractive alternative to the standard tank water heater is the tankless or instantaneous type water heaters. These units do not operate unless there is a demand for hot water. Therefore, the tankless water heater does not have standby heat loss when not in use. Tankless water heaters can use less energy overall than the tank versions, but the electric tankless units can place a higher demand of electric usage on the local utility during peak conditions. We advise that you check with your electric utility before installing an electric tankless water heater.

If you decide to install an instantaneous (tankless) water heater, it is important to use flow restricting faucets and showerheads. If you use water at a high GPM (Gallon Per Minute) rate, the tankless water heater will have little time to heat the water to the desired temperature.

OTHER OPTIONS

Ground and water source heat pumps commonly offer a water heating option that provides heat energy for water heating from the excess heat produced by the heat pump during operation. This heat is essentially free since it would otherwise be wasted. In fact, by scrubbing heat from a ground or water source heat pump's 'desuperheater', the unit can actually operate more efficiently, especially in the cooling mode. Some air source heat pumps can also offer this option. It is possible to heat water using wood, wood pellets or other combustible fuel sources, but this type of water heating is not commonly used in the United States of America.

11B. Solar Assisted Water Heating

You can reduce your energy costs for heating water by using a solar system in conjunction with a tank style water heater or instantaneous tankless water heater. See the ***Energy Alternatives*** section for more information on domestic hot water solar heating systems.

11C. Water Tank Insulating Blanket and Low Flow Fixtures

☐ Do you have extra insulation for your water heater?

WATER TANK INSULATING BLANKET

An option for the tank style water heater in order to reduce heating costs is to insulate the water tank with an insulating water heater blanket. This blanket is normally comprised of a white plastic exterior cover and an approximately 1- or 2-inch thick fiberglass blanket. If you decide to install a water heater blanket be sure to follow the instructions completely.

LOW FLOW FIXTURES

Another low cost option to lower the water heating usage and energy cost is to install flow restrictor rings or low flow faucets and showerheads in your building.

Multiple showerheads are very popular in the United States of America, but can use a great deal of water. The less hot water you use, the lower the energy bills for hot water.

11D. Rainwater Storage Systems

☐ Are you interested in incorporating a rainwater storage system?

Most people have their primary water piped directly into their home from an urban or rural water source. Some people drill a well for their primary water source; while other people have water trucked in. If you have the space to include a water storage system, consider adding one of the following to trap and store rainwater and help reduce your water bills and consumption of purchased water for non-potable uses.

- Drums
- Barrels
- Tanks
- Cistern Above Ground
- Cistern Below Ground

Potable: An adjective that means 'fit or suitable for drinking.' Therefore, non-potable water is NOT fit to drink, but IS fit for other purposes such as a gray water system.

11E. Drip Irrigation, Watering Systems

☐ Does your landscaping require an irrigation system?

Review the ***Landscaping*** section to determine if you will even need an outside watering system. If you do, the decisions you have made regarding the type of vegetation and watering needs will be the primary factor determining the extent and cost of the watering system.

DRIP IRRIGATION

Drip irrigation involves the use of small piping that is either slightly above ground level or at ground level, which slowly drips or trickles water onto the ground to minimize evaporation and maximize absorption by the soil and plants. The amount of water wasted can be greatly decreased by the use of a drip irrigation system.

CONVENTIONAL SPRAY HEADS

A common sound in many subdivisions and along many commercial streets is the sound of a water spray head as it shoots water into the air. This type of watering system can have relatively high evaporation losses and can increase your watering bill versus other systems. The time of day that the watering system runs can impact the amount of water needed. Watering in the early morning or late evening will reduce losses by evaporation. We also suggest that you install a rain-sensing device that prevents the watering system from operating during or immediately after a rain.

IRRIGATION TRENCHES

Irrigation trenches may be possible for certain landscape styles. Also, the trenches can be hidden underground and consist of gravel and/or coarse sand.

11F. Water Conserving Appliances

☐ Have you researched water conserving appliances?

Toilets used to use as much as five gallons of water per flush. Now, toilets use 1.6 gallons per flush and urinals use one gallon or less per flush. The mandate for low water use toilets has helped conserve water, which is becoming a precious resource in locations around the world.

A recent invention is the waterless urinal, which is available from several manufacturers. Due to their unique design, they do not need to be connected to the water supply to operate. They do, however, need to be connected to the sewer line for waste elimination. More information regarding waterless urinals can be found in the *Plumbing* section.

Dishwashers and clothes washers with the Energy Star® label are designed to conserve both water and electricity. More information about water conserving appliances is located in the ***Appliance*** section.

11G. Sinks, Bathtubs, Showers

- ☐ When choosing your sinks, bathtubs and shower products, have you looked for local and/or recycled materials?
- ☐ Are there safety bars and ADA compliance aspects to your bathing facilities?

SINKS

Sinks are another item that has a growing list of options.

- You can get sinks that surface mount, top mount or are mounted under the countertop.
- You can get sinks that are round, square, rectangular, and oval. There are sinks shaped like leaves, hearts, barrels and any number of other unusual shapes.
- Sinks can be made of stainless steel, composite materials, recycled materials, porcelain, granite, cultured marble and more.

Early kitchen sinks had pump handle fixtures so that water could be brought up from the well. As communities began to have municipal water systems with pressurized water, the pump on the kitchen sink was gradually replaced with the combo faucets that allow for both hot and cold running water. The options available in kitchen and bathroom faucets, as well as faucets for utility sinks, are immense. If you travel to one of the larger home shows around the USA, especially the International Builder's Show, you will notice that the manufacturers of kitchen and bath hardware have some of the largest and most elaborate displays in the show. New designs are offered annually by most of these large manufacturers, so the best way to view their wares is either online or by visiting one of their display rooms located in the larger cities.

BATHTUBS

A bathtub is a plumbing fixture used for bathing. Most modern bathtubs are made of acrylic or fiberglass, but alternatives are available in the form of porcelain-coated steel or, increasingly, wood. Older western bathtubs are usually made of galvanized steel or porcelain over cast iron.

Until recently, most bathtubs were roughly rectangular in shape but with the advent of acrylic thermoformed baths, more and more shapes are becoming available. Bathtubs are typically white in colour although many other colours can be found.

Modern bathtubs include an overflow tube and drain and may, or may not, have taps mounted on them. They may be built-in or free-standing or sunken.

Two main styles of bathtub are common: 1) Western-style bathtubs in which the bather lies down. These baths are typically shallow and long, and 2) Eastern style bathtubs in which the bather sits up. These are known as 'ofuro' in Japan and are typically short and deep.

The issue of intended use is what separates a bathtub from a hot tub or other recreational bathing facilities. A bathtub is usually placed in a bathroom either as a stand-alone fixture or in conjunction with a shower.

A recent addition to the variety of bathtubs available is the 'step-in' type. This bathtub is designed with a self-sealing door (which swings in and is, therefore, held shut by the water) so that you can

enter it with a minimal step-up height. They generally come equipped with a seat and often a shower option. A couple of things to consider when choosing this type of bathtub is how many gallons of water will it take to fill and how long will it take to drain.

SHOWERS

Showers are available in a variety of colors, styles and options. You can get a shower stall for a relatively low cost at your local building supply store or other outlet, an expensive a custom shower stall from a local manufacturer of cultured marble. and anything in between There are combination units that have both a tub and shower doors for both types of bathing. These types of combo units are often found in hotel/motel rooms. You can get larger shower units that have multiple spray heads (which can use a great deal more water, both hot and cold), built-in music systems and you can even get steam saunas and infrared heaters as options.

Many home builders offer a walk-in shower option for their larger homes. The walk-in shower can have several shower heads, built-in seats and other custom options. Many of these are built using glass block and can also be built using recycled glass block, recycled ceramic or other types of tiles. Saunas are available from factories that have steam heat, dry heat or both.

11H. Pools

☐ Have you considered energy saving features for swimming pools?

Swimming pools require a large amount of energy to heat the water to a usable temperature in most climate zones. Historically, the most common method to heat a pool was with a natural gas or propane boiler specifically designed for this purpose. However, as the price of conventional energy increases, the cost to heat a pool with fossil fuels has risen significantly and can have a negative impact on a home or business owner's budget. Electric boilers have also been used to heat pools but the cost of electricity has been a limiting factor.

Our suggestion is to heat the swimming pool with renewable energy and to keep a clear solar-blanket on the pool at all times except when in use. Heating pool water with the sun is a natural fit and can significantly lengthen the season in which the pool can be used. Highly insulated pools with insulated covers or those that are located indoors can sometimes be heated all year long using solar energy. Also, the excess heat produced by a fuel cell or micro-turbine could potentially be used to heat a pool or other stored water source.

11I. Spas, Hot Tubs

☐ Have you considered energy saving features for spas and hot tubs?

Spas and hot tubs can require a large chunk of energy to keep them hot, especially if the tub is not well insulated. We suggest that uninsulated tubs have foam insulation installed and that renewable energy be used to heat the water. There is a significant recreational and therapeutic value available in using a hot tub of water, so it can be important to maintain the temperature in these tubs.

Heating and Cooling

If you have not done so already, please read 'Understanding Heating, Cooling, Radiation and Other Important Concepts' in the *Initial Considerations* section.

12A. Basic Heating, Cooling, Ventilation and Air Conditioning (HVAC) System Information

USING PRIMARY AND SECONDARY SYSTEMS

When designing a building there are often both primary and secondary heating and cooling systems involved. Let's take a moment to understand the basic concept of primary and secondary systems.

Most residential dwellings have one primary heating unit (which often is a forced air furnace) and one primary cooling unit (typically a central air conditioner). When sized correctly, your heating and cooling systems should be running constantly on the coldest and hottest days of the year respectively.

Heating

A primary heating system is sized to produce enough heat to keep the interior of a building at a desired temperature (e.g. 65 or 70°F) during the coldest outdoor temperatures for the particular climate zone. All-electric buildings typically use electric resistance heating strips inside an air handling unit or they may have baseboard units or some other electric resistance system sized to keep the building comfortable at the coldest temperatures of the year.

Cooling

Likewise, a primary cooling system is sized to produce enough cooling to keep the building at a desired temperature during the hottest outdoor temperatures for the particular climate zone.

Adding a Heat Pump

If you decide to add a heat pump to your forced air furnace, you now have both a primary and secondary heating system, but still one primary cooling system. Why? Because the add-on heat pump is designed to produce heat in the winter, as well as the furnace, but the heat pump itself will replace the central air conditioner.

In most designs, even though the furnace is the primary heating system, it is considered to be the back up heating source to the heat pump. This is because heat pumps are extremely efficient and so, should be utilized over any less efficient system whenever possible. However, a typical heat pump can only produce enough heat to provide comfortable temperatures inside a building until the outside temperatures get so cold (usually at or just below freezing) that the heat pump can no longer extract heat from the outside air. Once the outside temperatures get too cold, the furnace has to activate to maintain comfortable interior temperatures in the building. As the exterior (ambient) air warms up, the heat pump can take over heating the building.

In the summer, the refrigerant flowing inside the heat pump reverses direction so that the heat pump becomes a cooling unit and operates exactly like a central air conditioner (extracting the heat from inside the building and displacing it to the outside). Some buildings have more than one heating and cooling system or have 'zones' with thermostats on the primary heating/cooling system.

HEATING

As previously discussed there are three methods of heat transfer: Conduction, Convection and Radiation. Most heating strategies do not take advantage of all three methods, but it is very possible (and even practical) to do so.

There are so many combinations of options available that it is not possible to list them all here. Some heating systems burn fuels (such as natural gas, propane, heating oil or other combustible product) to produce heat; other heating systems can get heat via electricity (through the refrigerant cycle process) or from the sun. As you examine the various types of heating systems available, you may want to consider including passive or active solar systems along with the conventional system(s) in your plans.

COOLING

Most cooling systems in the United States use electricity and employ a refrigerant. A primary example is the central air conditioner cooling system. Basically, the air conditioner is absorbing the heat contained in the inside air and then 'expels' this heat to the outside.

There are a smaller number of cooling systems that use heat to produce cooling, which sounds impossible but it actually does work. This system normally employs an absorption material or desiccant that releases stored moisture and produces cooling through the evaporation process.

In drier climates, the use of evaporative coolers (or swamp coolers) is an effective cooling strategy. These systems take advantage of the cooling effect caused by the evaporation of moisture.

12B. Choosing an HVAC Contractor

- ☐ Do you want to leave the choice of your HVAC contractor to your Builder or General Contractor?
- ☐ Is it important to you that your HVAC contractor have experience working with Green Building Techniques?
- ☐ Does your HVAC contractor work with an Energy Rating Company?
- ☐ Does your HVAC contractorknow how to appropriately size your equipment based on your home design instead of assuming conventional calculations?
- ☐ Does your HVAC contractor have experience with extremely energy efficient structures?
- ☐ Are you planning to have your HVAC installation commissioned?

Choosing the right HVAC contractor will be important for your building project. Many HVAC contractors install heating/cooling systems as fast as possible, and quality can suffer. It is important

that the contractor you choose understands that a quality installation is critical to your building's long-term performance.

Here are a few tips to help you choose a quality HVAC contractor:

FIRST

Check with anyone you know who has had HVAC work done recently. Word of mouth information about contractors is important to hear.

SECOND

Get at least three bids for the building. Since HVAC contractors are used to giving bids for free, take advantage of this service. If the contractor insists on a fee to review your plans or come to your building's location, we suggest that you look for other contractors who will do this service for free before choosing to pay for this service. We understand that contractors need to make a living, but once you pay for this service you might feel obligated to use this contractor. You must keep an open mind and get several bids to ensure that you are getting the best deal.

THIRD

Ask for upgrade bids while the contractor is at your site. For example, if you are planning to build a home, ask the contractor to bid the most inexpensive option first. They will likely bid an 80% efficient furnace with a 13 SEER (Seasonal Energy Efficiency Ratio) air conditioner. Now, ask the contractor to bid the same air conditioner with high efficiency furnace. Then, ask for another bid with an 80% furnace and a 13 SEER heat pump. If possible, ask for more bids with higher efficiency air conditioners or heat pumps. After you get multiple bids from at least three contractors, compare the bids and determine the best pricing for the system you have chosen.

FOURTH

Ask about warranty upgrades, rebates and other special offers. If you purchase your heating/cooling system in the spring or fall, you will likely get a better deal than the winter or summer.

FIFTH

Be sure to get heat load and cooling load calculations from the contractor you have chosen to install your system. If they won't provide this service, choose another contractor.

COMMISSIONING

Commissioning is the process of verifying that the system(s) are designed, installed, functionally tested, and capable of being operated and maintained to perform to the standard of the design intent. By proactively ensuring that your building starts with optimal performance and continues that way; you can save money otherwise spent on problems and repair costs.

12C. Fuel Source

 ☐ What fuel choices do you have?

There are several fuels to choose from to heat your home. Most people opt to use conventional energy sources for their new or remodeled buildings, such as electricity from the electric grid and

available fossil fuels such as natural gas, propane or heating oil. Unfortunately, these historically 'safe' selections are becoming more and more expensive and contribute to air and water pollution.

The factors to consider when making your choice are availability, pricing and the environmental impact of each.

CONVENTIONAL FUELS

- Natural Gas
- Propane
- Heating Oil
- Electricity from Fossil Fuels
- Wood Burning

NON-CONVENTIONAL FUELS:

- Solar Thermal: heating of liquids or air via the sun
- Electric: Direct Current (DC) - Electric from Solar, Wind, Hydrogen, Water (on-site)
- Electric: Alternating Current (AC) - Electric from Solar, Wind, Hydrogen, Water (on-site)
- Pellet Burning: Pellets are typically made from compressed sawdust. This includes Auger Pellet Stoves, which add pellets from a large hopper on a continuous or timed basis so that the stove does not have to be hand-fed.
- Maize Burning: The burning of dried corn and corn by-products.
- Biomass Burning: The burning of waste products such as agricultural scraps, paper, cardboard, etc.

12D. Heating Equipment

- ☐ Have you done a cost benefit analysis/comparison of traditional heating and cooling techniques vs. the green techniques you plan to use?
- ☐ What type of heating system(s) do you prefer?
  - ☐ Is there an ENERGY STAR® version available?
  - ☐ Is there an alternative technology that uses minimal energy?

STANDARD FORCED AIR FURNACE

The forced air furnace (whether natural gas, propane, heating oil or other fossil fuel) is the most common residential heating system found in the United States of America. Furnaces are typically natural gas-fired; however propane and fuel oil models are available. There is a simple explanation why forced air heating systems have become so popular. Cooling a building requires some form of ductwork system to enable the air conditioner or heat pump to move air and operate properly. These same ducts can be used to distribute heated air throughout a building. Therefore, it has been cost-

effective to install a ductwork system for both heating and cooling purposes and furnaces that force air through the ductwork for heat delivery have been widely installed.

A standard efficiency furnace is one that has metal flue pipes and is approximately 80% efficient. These units are called 'naturally aspirated' appliances because they count on natural air convection to force the flue gases up the chimney. Units that rely on natural aspiration can have back-drafting problems when located in rooms with exhaust fans (such as the one inside your clothes dryer or range hood). If you specify a standard 80% efficient forced air furnace be sure to also specify a model with an exhaust fan so that it forces the combustion by-products up the chimney.

Is a forced air system the most efficient, economical, comfortable, reliable and the least expensive heating system to operate? The short answer is: No. Radiant heating systems are often considered to be the most comfortable, followed by hot water or steam heat. Solar designs that incorporate passive solar features, such as sun-heated walls or floors, can offer a radiant heating source with no fuel cost. You can also supplement forced-air heating with radiant source heating to help reduce the annual heating bill.

HIGH-EFFICIENCY SEALED COMBUSTION FORCED AIR FURNACE

A high-efficiency furnace will have plastic PVC piping used for the exhaust or flue pipe, typically extending out of a nearby wall in the building. Most sealed combustion furnaces also have a PVC inlet pipe to supply fresh air to the burner, but there is not always an inlet pipe installed. The pipes are used to provide both a combustion air inlet for the fire and flue for the by-products of combustion. These high-efficiency furnaces are often called condensing furnaces because they wring so much heat from the combusted gas that they actually condense moisture inside the combustion chamber (which must be allowed to drain). Sealed combustion furnaces can be installed in locations where it is difficult to install a standard metal chimney.

FORCED AIR VIA AIR HANDLER WITH ELECTRIC RESISTANCE COILS (USED WITH ALL ELECTRIC HEAT PUMPS)

An air handler looks somewhat like a standard furnace from a distance to most people, but the trained eye will notice that there is no flue and no gas lines connected to the unit. The air handler will typically have larger electrical wires connected to provide larger amounts of electricity in the winter when heat energy is needed. If this air handler is connected to a heat pump, the heat pump unit will provide the heat energy for the building during the milder weather periods and the electric resistance units will provide power during the coldest time periods. If there isn't a heat pump attached to the air-handling unit, then the electric resistance heating is possibly the only form of heat for the building. This can be a very expensive heating system to operate.

AIR SOURCE OR CONVENTIONAL HEAT PUMP

The outside condensing unit looks just like a central air conditioning unit, but the air source heat pump can heat as well as cool. Air source heat pumps have been getting more efficient as technologies improve. You can now purchase an air source heat pump with a SEER of 18 or higher. This is approaching the cooling efficiency of a geothermal system.

GEOTHERMAL SYSTEM

Geothermal systems are basically ground source or water source heat pumps. Since these units use heat energy from underground they are not excessively influenced by outside air temperature conditions. Ground and water source heat pumps can be oversized or have more than one speed so that they can both cool and heat a building, no matter the time of year. Since the geothermal heat pumps are often highly efficient they can be extremely economical to operate. Also, these systems can now be installed in tight spaces because the newer well drilling rigs can drill at angles, making it possible to have a number of wells radiate from a single location.

ELECTRIC BASEBOARD

Electric baseboard units can have a thermostat in each room so that certain rooms can be turned down or off when not in use. Also, this allows each occupant to select the preferred temperature in their bedroom. The key to baseboard heaters is airflow; anything blocking the flow of air into and out of the heating unit will decrease the energy efficiency. If you have furniture or draperies in front of your baseboard heaters, move them out of the away. It's also a good idea to vacuum the coils regularly because a coating of dust and dirt can reduce the amount of heat produced, increase the energy consumption and shorten the unit's lifespan.

BOILER/STEAM OR HOT WATER

A central boiler system that heats water or produces steam is an effective heating system. There are radiators installed in various locations around the building to provide the heat. Steam boilers were used extensively in large buildings in the past, but hot water systems have replaced steam as the preferred heating system these days. Also, it is getting harder to find an experienced person or company to work on a steam system, which is why many buildings are switching from steam heat to hot water or forced air systems.

RADIANT HEAT SYSTEM/ELECTRIC

There are a few types of radiant heating systems that utilize electricity. One type utilizes embedded wire in drywall/sheetrock that can be installed on the walls or ceilings of interior rooms. This type of radiant system is hidden from view and produces a comfortable form of radiant heat. Typically, each room has its own thermostat. There is also a radiant heating system that uses embedded wire inside glass to heat rooms and other spaces. Some versions of embedded wire in glass are cove systems or electric panels. A third type of electric radiant heat is mats or electric elements that can be installed under floors, including concrete. The radiant elements can be installed in thin-set concrete or embedded in other materials. The mats can be installed under wood or tile floors, laminates and other flooring materials. Each of these electric radiant options offer a thermostat for each room or can be tied to one central thermostat.

RADIANT HEAT SYSTEM/HYDRONIC

By circulating hot water or a hot anti-freeze solution under a floor, the room above can be comfortably heated. Since hot water can be produced in a number of ways, including solar, the hydronic radiant floor heating method has been deployed in many buildings around the world. Typically these systems utilize polyethylene piping that has been specifically designed for use in radiant floors. Also, it is common for these pipes to be installed in the concrete slab in the lowest level

of a building and to be installed in a thin-set concrete mix on upper floors. The heated water can be controlled by pumps or valves with one central thermostat or multiple thermostats, depending on the design.

WOOD STOVE

The dependable wood stove has been used for hundreds of years as either the primary or secondary heating source. The technology of wood stoves has evolved and you can now purchase a wood stove that is extremely energy efficient. Wood stoves produce radiant heat as they get hot and are an effective way to heat a larger area in a relatively rapid manner. Some wood stoves are made of materials that are extremely dense and heavy, so that the stove will continue to produce heat long after the fire has gone out. It is possible to purchase a wood stove that has an outside combustion air port so that it doesn't use conditioned inside air for combustion. However, most wood stoves do use inside air for combustion.

FIREPLACE INSERT

A fireplace insert is like a wood stove in that the rate of combustion can be controlled so that the wood does not burn too fast, and the insert will produce radiant heat just like a wood stove. Fireplace inserts are a good addition to the typical fireplace because nearly all fireplaces produce little or no heat when in use. In fact, the typical fireplace consumes so much interior conditioned air for combustion that there is more energy going up the chimney than into the room, and therefore it costs you additional money to use it. There are many fireplaces that are net energy losers and should not be used as a source of heat in the winter. So, a fireplace insert provides a proven way to gain valuable heat from the existing fireplace. Most inserts come with large glass doors so that you can view and enjoy the fire.

FIREPLACES/WOOD

As a general rule, it is best not to install a wood-burning fireplace in a newer building. Most fireplaces are net-energy losers and are often a source of cold air and drafts in a room. If you must have a wood-burning fireplace, be sure to specify that you want to have outside combustion air ports in the firebox and also install glass doors. A wood stove is a much better choice if the need to view a fire is important.

FIREPLACES/GAS

A natural gas fireplace can also be a net-energy loser unless care is taken to order an energy efficient model. If you want a natural gas fireplace, you should specify that it have outside combustion air ports in the firebox and glass doors. Better yet, specify a sealed-combustion gas fireplace that is isolated from the interior air so that there is no chance of combustion by-products and carbon monoxide entering the interior air.

EXTERNAL HEAT SOURCE

There are heating units available that can be installed in a separate enclosure or building in proximity to the main building being heated. These external heating units can be designed to burn wood, waste products or other combustibles. The external heating units can also be designed to provide heat to more than one location (such as to a garage or workshop) or to a swimming pool/hot tub.

12E. Cooling Equipment

- ☐ What type of cooling system(s) do you prefer?
  - ☐ Is there an ENERGY STAR® version available?
  - ☐ Is there an alternative technology that uses minimal energy?
  - ☐ Is there an environmentally-friendly refrigerant?

There are not as many options to cool a building as there are to heat it. However, you do have some viable options, depending on your local climate and other factors.

CENTRAL AIR CONDITIONING (CHOICE OF TRADITIONAL OR ECO-FRIENDLY REFRIGERANT)

Central air conditioners are the cooling system of choice for most residential and many small commercial building owners. The central air conditioner can be highly energy efficient, depending on the specifications of the building owner, architect, engineer or contractor. Higher efficiency air conditioners typically come with longer warranties and are built with better components.

The traditional refrigerant used in central air conditioners is R-22, which will slowly be phased out of production over the course of time. The most common replacement refrigerant for R-22 is R-410A (also called Puron refrigerant) which is more environmentally friendly than R-22 in terms of harm to the ozone layer. However, R-410A requires a higher pressure and is not considered as efficient at heat transfer as R-22, so some energy advocates state that the increased amount of pollution created at the electric power plant to run the less efficient units offsets the environmental benefits of the R-410A. Research is continuing to find an environmentally friendly refrigerant that is also has a high heat transfer capability.

WINDOW AIR CONDITIONERS (CHOICE OF TRADITIONAL OR ECO-FRIENDLY REFRIGERANT)

Window air conditioners have improved markedly in efficiency in the last few years. Window units are often used as supplemental cooling for smaller areas or rooms of a building.

RADIANT COOLING SYSTEM

A radiant cooling system relies on cooled or chilled water to flow through a series of tubes or capillaries to provide a cool surface for a ceiling or wall. These systems are not often used in residential or small commercial buildings, but are an acceptable method of cooling in certain climates. However, if air filtration for pollen is needed or if there is a need for humidity removal in the air, then an air conditioning system that utilizes ductwork is also required.

EVAPORATIVE COOLING SYSTEM

An evaporative cooler (or swamp cooler) relies on the evaporation of water to provide the cooling effect in the air it circulates. This type of system works best in climates that have relatively dry air in the summer months. An evaporative cooler is an inexpensive way to cool the air in a building and it will provide a little extra moisture in the air for excessively dry climates.

HEAT PUMP

A heat pump in the cooling mode operates exactly like a central air conditioner. The cooled air is circulated throughout the building via the ductwork. Heat pumps are highly efficient heating and cooling systems.

CEILING FANS

Ceiling fans provide air movement inside a building's interior environment. This air movement can help facilitate the evaporation of moisture on the occupant's skin surfaces, which hastens the effect of evaporative cooling, decreasing the skin temperature and increasing the person's comfort level. Fans can make a room more comfortable even if the actual temperature is somewhat higher than the comfort range.

12F. Zones

- ☐ Are you interested in zone systems?
- ☐ Does your design call for a whole house system or zone system?

The conventional way to condition the air in a home or small commercial building is by a single heating/cooling unit that blows the conditioned air throughout the entire house. More recent thinking is to divide the building into regions or 'zones' and condition them separately from each other. The advantage of zones is that you can have more than one thermostat on a single heating/cooling system so that it will condition the various areas or zones based upon the thermostat's setting. This can be beneficial when the zones are designed correctly. You can also zone a building by having more than one heating/cooling system installed. A typical zoning strategy for larger homes and other buildings is to have one HVAC system per floor.

12G. Ductwork

- ☐ Does your design call for a whole house system or zone system?
- ☐ Will your building require ductwork?
- ☐ Does your HVAC contractor keep the registers covered and clean during construction and/or have the ductwork cleaned before use?

Most methods for conditioning the air in a home require ductwork. Most ductwork installed in the United States leaks, sometimes quite severely. These leaks add to the energy bill for that building, especially if the leaky ductwork is located in an attic or crawlspace allowing air leakage to and from unconditioned areas outside the home's thermal envelope. Also, if you install a heat pump, the ductwork design becomes more important than if you install a furnace and air conditioning unit only. A well-trained heating/cooling professional will know how to design the ductwork properly for the system you have specified. (See 'Choosing an HVAC Contractor' for more information.)

As the ductwork is being installed, you should specify:

SEALED DUCTS

Specify that the ducts be sealed with a water-based mastic or aluminum duct tape. This will reduce or eliminate duct leakage, improve the performance of the heating/cooling systems, and help reduce energy bills. Do not use standard gray duct tape or 'duck' tape because the glue will dry out over time and the tape will pull free. Water-based mastic or aluminum duct tape will last a long time. If you use the black petroleum-based mastic, be sure to open all the windows and doors when installing. This product can out-gas petroleum distillates and VOC for a period of time after installation. We suggest that you use the water-based versions instead.

TEST DUCTS FOR LEAKAGE

If possible, you should have your ducts pressure tested as soon as they are installed. If leaks are found, it may still be possible to seal them with water-based mastic or aluminum duct tape. Once the ducts are hidden behind drywall, it is virtually impossible to seal them. Discourage your HVAC contractor from using interior wall cavities for duct runs and cold air returns. This practice, called interstitial ductwork, can have severe leaks to the outside and significantly increase your heating and cooling bills.

CLEAN DUCTS

When the time comes to finish construction and occupy the building, it is a good idea to have the ducts cleaned to remove any dirt, sheetrock dust and other irritants that may be in the ductwork. We highly recommend that you cover all openings to the ductwork during the construction process and not let the construction crews operate your heating or cooling equipment during the construction phase. Otherwise, the ducts will likely get full of dirt and construction debris and the heating/cooling system may become compromised. If the heat exchanger in the furnace gets coated with dirt/dust or if the air conditioning coil gets covered with sheetrock dust/dirt/chemicals, then they will not operate at peak efficiency for the remainder of their lives. Many HVAC systems have been de-rated or made less efficient by the introduction of construction dust because they operated during the construction process. You can look at the A/C coil or furnace heat exchanger after construction is complete. If they appear dirty, you can have a HVAC contractor clean them. However, it is much better to keep them clean in the first place.

12H. Registers

 ☐ Where will you place registers (if using a duct system)?

If you have ductwork in your home, you need registers that allow the air to pass from the duct system into the living areas. Where do you place these openings?

FLOOR

Registers located in the floor can sometimes be covered by rugs or other floor coverings, or be blocked by furniture. Also, debris on the floor can often find its way into floor openings. However, locating cold air returns in the floor is an effective strategy.

WALL

Locating registers in walls is common and offers some latitude as to whether the openings should be located high or low. Often the supply registers are located low on the wall and the return registers are located high. Wall registers can be blocked by furniture unless located high.

CEILING

Ceiling registers are effective for cooling system supply ducts but are not as effective for heating systems because the heat air tends to remain along the ceiling level. Ideally, heating registers should be located along the floor or lower wall areas and the returns up high. The inverse is better for cooling systems. However, the building design often dictates the placement of registers.

Ventilation

13A. Controlled vs. Natural Ventilation or Uncontrolled Ventilation

- ☐ Does your building allow for both natural and controlled ventilation?
- ☐ What type of attic ventilation is appropriate for your building?

Buildings constructed in the United States of America prior to 1970 were often leaky and drafty. This is because windows tended to fit loosely and leak air, plus there were gaps and cracks around doors, in foundations, in walls, and unsealed plumbing and electrical penetrations. These buildings did not hold moisture inside or have poor indoor air quality, as a rule, because of all this excess uncontrolled ventilation. It is now possible to make a building too tight to ventilate naturally due to products and installation techniques designed to make a building energy efficient. Making the building as airtight as possible is a large factor in saving energy. Since making a tight envelope is so critical to energy efficiency, it is very important to be sure you get fresh air into your building to avoid indoor air quality problems, mold, and other issues. A mechanical air exchange system makes this possible, especially for buildings that have non-operable (fixed) windows. Even if you do have operable windows, there likely are many times of the year when it may be too hot or cold or wet to open windows. A mechanical ventilation system will provide fresh air during all seasons.

One of the methods used to take advantage of natural ventilation is the 'stack effect', which refers to the natural tendency of heated air to rise. If you have operable windows placed high on the wall and/or operable skylights at the roofline, then when you open these upper units the heated air trapped near the ceiling will tend to rise out. For air to be able to leave a building an equal amount of replacement air must enter the building. So, if you have some windows located on the lower walls of the building that are opened at the same time the upper windows and/or skylights are opened, then cooler air will be drawn in through the lower windows to replace the heated air rising out of the upper ones. This stack effect can be used effectively to provide natural cooling and ventilation for most buildings. You have probably noticed the stack effect when you walked up to an elevator on a lower floor of a building and heard a whistling sound of air trying to enter the elevator shaft. This air is trying to enter to replace the heated air trying to rise out near the top of the elevator shaft. Tall buildings can have enough stack effect that doors are hard to open on the ground level.

An uncommon but effective way to cool a building using natural ventilation is the ice house roof venting system (discussed in the section on ***Roofing***).

13B. Heat or Energy Recovery Ventilators

- ☐ Will your building use an HRV or ERV system?
- ☐ Will you have a professional size the HRV/ERV?

The most efficient mechanical method of delivering fresh, filtered air into a residential or small commercial building is with a fresh air heat exchanger, also known as an ERV or an HRV. Both Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV) transfer the heat or cool energy from the stale exhaust air to the incoming filtered, pre-conditioned fresh air without actually mixing the

incoming and exhaust air streams. This is accomplished by a heat exchanger core, which is typically comprised of a thin material, such as metal, plastic or polymers that can scrub the heat (or coolness) from the outgoing air and transfer it to the incoming air stream. Both HRVs and ERVs have heat exchanger cores that operate in the following manner:

In the summer, the cooled interior inside air is exhausted from high humidity areas, such as bathrooms and kitchens, and this cooler air helps to lower the temperature of the incoming air. If the incoming air contains a high level of humidity the cooling effect from the outgoing air helps to wring moisture out of the incoming air as well.

In the winter, the heated inside air that is being exhausted helps to warm-up the incoming colder air from outside. Moisture contained in the interior air may be removed when this warmer air hits the colder heat exchanger. This excess moisture from either air stream falls into a drip pan and flows down a tube to a floor drain. This is the total operation of a HRV but an ERV has yet another function.

An ERV also helps equalize the moisture from the incoming and exiting airstreams via either a desiccant or a heat exchanger core that can transfer moisture. Desiccants are normally adhered to a small revolving wheel that slowly turns between the two airstreams. This desiccant can remove moisture from the hot and wet summer air, for example, and transfer this moisture to the outgoing cooler airstream. This process helps dry the incoming air to lessen the air conditioning load and also provide some additional exchange of energy, so ERVs are often slightly more energy efficient than HRVs, capturing up to 85% of the energy of the outgoing air. They also help to keep indoor humidity within a healthy range. Discuss which type is most appropriate for your situation with your HVAC contractor or Energy Rater.

Energy Rating Company: An Energy Rating Company will analyze your buildings' energy efficiency level and make suggestions to improve that level. Choose one that is certified and that is an independent, third-party to avoid potential conflicts of interest.

13C. Filters

☐ What kind of filters will you use?

Another step in improving indoor air quality is removing particulates, pollen/allergens, viruses and other pollutants from the air. This can be accomplished by the intelligent use of air filters in your heating or cooling system and in your HRV/ERV or other ventilating device. We will give a brief description of each type of filter listed below.

HEPA

High Efficiency Particulate Air (HEPA) filters are designed to trap extremely small particles, including dust mite feces, viruses and even cigarette smoke, inside the filter. HEPA filters can be installed in the air streams of furnaces, air conditioners and heat pump air handlers, but the amount of restriction on the air can cause the furnace fan to work too hard and overheat or fail prematurely. It is preferable to use HEPA filters on lower air speed devices, such as HRVs or ERVS, or in portable devices that can be moved from room to room.

CARBON/CHARCOAL

Carbon (or charcoal) filters are extremely good at removing odors and freshening the interior air. Carbon filters tend to 'load-up' after a period of time and must be replaced or else they lose their effectiveness. Carbon filters are available in a variety of sizes and for a variety of uses. If you decide to place a carbon filter in the high speed airstream of your furnace, air conditioner/heat pump, then be sure to choose one rated for this application. Carbon filters work very well on the incoming air stream of an ERV or HRV.

ELECTRONIC

Electronic air filters use electricity to form a negative static charge inside the filter which helps attract the positively charged dirt particles. These particles tend to cling to the surface of the filter until the filter has been cleaned. Cleaning an electronic air filter is normally a simple task and most electronic air filters are reusable. Electronic air filters are available for a variety of applications, including the high speed airstreams of heating/cooling systems and the low speed airstreams of HRVs and ERVs.

ELECTROSTATIC

Electrostatic air filters form a negative electronic charge via the movement of air passing the filter. No outside source of electricity is needed to make these filters operate. Electrostatic filters can be used in both high speed and low speed air streams. Some electrostatic filters can be washed and reused while others must be replaced on a periodic basis.

HIGH-EFFICIENCY PLEATED FILTERS

Many HVAC contractors offer the option of a high efficiency pleated filter installed with your new furnace or air handling unit. A high-efficiency pleated filter offers a significant amount of surface area to the high speed airstream so that the flow of air is not unduly restricted but the smaller sizes of particles are still trapped by the filter. However, there still can be a significant loss of airspeed in the duct and heating/cooling system, so make sure that the filter is approved for use in your HVAC system. There are several manufacturers of pleated filter units for use in HVAC systems and replacement filters are available through many retail outlets and via the Internet.

MEDIUM-EFFICIENCY PLEATED FILTERS

The medium-efficiency pleated filters work the same as the high and low efficiency versions, except that the size of particles trapped by the filter medium is bigger than the high efficiency version and smaller than the low. A little research may be necessary to determine the type of particulates that prevail in the interior environment of your building. Also, certain filters work better for health reasons, such as trapping viruses and pollen/allergens, while other filters are better for environments that aren't as critical. Medium-efficiency air filters are not as restrictive to the airflow in the ductwork and are often used in forced-air heating systems.

LOW-EFFICIENCY PLEATED FILTERS

Low-efficiency pleated filters offer little or no impact on the high speed airstream of a furnace or air handler. However, they also cannot trap particles in the air much smaller than approximately the size of a human hair. So, while these filters are better than the standard cheap filter provided with most HVAC units, they are not able to trap the smaller particles such as duct mite feces, pollen/allergens,

viruses and other irritants. However, a low-efficiency air filter in the high speed airstream combined with a high-efficiency filter or HEPA filter in an ERV or HRV produce good results.

STANDARD THIN FILTERS

These filters are generally only about 1 inch thick or so and are normally comprised of a woven fiberglass product. These filters can only trap the larger items that can float in the air, such as hair, flecks of dirt or human skin or the larger pieces of animal dander. The smaller particles commonly found in the interior air of a building will pass right through these filters. We recommend that you replace the standard filter with a better version, such as an electrostatic version or one that can trap finer particles. Many of these replacement filters can fit the same slot size as the standard filters. The thinner filters do not have the surface area of a wider pleated filter and, therefore, will not trap as many pollutants. So, you should change a thinner filter often to get the best performance.

Keep in mind that you can have more than one filter strategy in play inside your building. For example, you can replace the standard air filter in your HVAC system with a better version and also have a portable HEPA filter in the main living area or office. Or, you can upgrade the HVAC filter to a medium-efficiency pleated version and have a HEPA filter installed in your ERV/HRV system. These combinations are an effective means to improve the interior air quality.

13D. Exhaust Only Fans

 ☐ Where will you locate exhaust fans?

Nearly all residential and small commercial buildings are designed to have small exhaust fans in the bathrooms. Typically these fans are cheap and noisy. However, you can now purchase exhaust fans that are extremely quiet and can come with extra features, such as lights, night lights and heat boost. There are also fan units available that can exhaust air from several rooms using only one central unit.

Several areas of the house are prone to high humidity and vapor issues. Putting exhaust fans in bathrooms, the kitchen and the garage will improve the indoor air quality of your home. A garage fan can be controlled by a timer, a motion sensor or a carbon dioxide detector so that it only runs as needed. Bathroom and kitchen fans can be placed on timers or humidity/motion sensors. Make sure that the garage fan exhausts directly to the outdoors and not into an attic or other enclosure. Bathroom and kitchen fans should also exhaust directly outdoors or have their piping terminate next to a large roof vent.

Many residential and commercial buildings have the bathroom and other fans vent directly into the attic areas. This is a bad idea because this practice can allow the buildup of moisture in the attic space or moisten insulation and cause problems such as mold, mildew or dry rot/black rot and make the space attractive to pests.

13E. High Power Fans

 ☐ Will you include a whole house fan (or something similar)?

Powerful fans are used in homes and commercial buildings to exhaust fumes from kitchens and for other duties, such as cooling and venting. Some of the most common high power fans are:

DOWNDRAFT

These powerful fans are commonly used for stovetops. The steam from cooking is drawn downward through a venting system and then blown outdoors by a large, commercial grade fan. A large industrial grade electric motor is used to move large amounts of air through a large ductwork system. These fans can cause a negative pressure to occur inside the building during their use.

WHOLE HOUSE FAN

Commonly called attic fans, these powerful fans are typically located at the highest area of a home or other building and are used to draw air through the windows and out the attic or sidewalls. Attic fans usually have louvers that close when not in use. These louvers are often a significant source of air loss (even when the fan is off) because of gaps and spaces around the louvers. Kits are available to cover the interior of the fan or enclose the upper fan unit to either insulate and/or reduce air losses.

CLOTHES DRYER

Clothes dryers can suck a considerable amount of air from a room or building during operation. This exiting air requires replacement air from another source, which can be the cracks and gaps around doors and windows or other leaks. However, if the dryer is located in the same room as the gas water heater, the dryer can draw air backwards down the fluepipe of the water heater. If the water heater is operating, the flue gases (by-products of combustion) can rapidly fill the room.

In fact, any naturally aspirated appliance that uses fire (combustion) with an open flue, such as a gas water heater, standard efficiency furnace or gas/wood fireplace, can be back-drafted via a powerful exhaust fan of any kind. So, take care when using combustion appliances in conjunction with powerful fans. You can avoid this by installing sealed combustion appliances or combustion appliances with flue exhaust fans. Electric water heaters do not have flues and solar storage tanks with or without electric heating elements also do not have flues.

13F. Additional Venting Options

- ☐ What other venting options does your building design call for?
- ☐ If you have a fireplace, wood stove, etc. will you incorporate a combustion air supply system?

PASSIVE WALL VENTS

Passive wall vents are made from conduits that extend through the wall with a weatherproof outer cover and a screen to inhibit bugs. These passive vents provide fresh make-up (outside) air to help balance indoor vs. outdoor air pressure. These are normally located in rooms or areas that have larger exhaust fans. These conduits need to have a good damper installed.

ATMOSPHERIC DAMPERS

Atmospheric dampers open when there is any negative pressure in the room or building, typically caused by a mechanical exhaust fan.

QUICK-RELIEF DEVICES

Relatively new on the market, quick-relief devices are designed to provide a large quantity of make-up air when a large fan turns on. These devices are especially designed for use in very tight structures and can work in combination with an ERV or HRV.

COMBUSTION AIR SUPPLY FOR FURNACE, STANDARD WOOD STOVE/FIREPLACE INSERTS AND CERTAIN FIREPLACES

These are normally tubes or flexible pipes that are extended outdoors on one end and then terminate close to the fire chamber of a combustion appliance, such as a standard efficiency gas/propane furnace, gas water heater or gas-fired clothes dryer.

OUTSIDE COMBUSTION AIR PORTS FOR FIREPLACES

New fireplaces can have an outside combustion air port installed inside the firebox of the fireplace so that outside combustion air enters directly into the fire chamber to feed the fire. Some older fireplaces with cleanouts located in the firebox can sometimes be retrofitted with outside combustion air. However, it is preferable to install the outside combustion air ports for fireplaces during construction and, better yet, to not install a standard fireplace at all.

SEALED COMBUSTION WOOD STOVES AND FURNACES

The higher efficiency furnaces are available in sealed combustion models and so are some wood stoves. These models get their combustion air delivered via a conduit directly into the fire chamber and then the exhaust gases are ported outdoors via a flue conduit.

NON-VENTED GAS HEATERS AND OTHER COMBUSTION APPLIANCES

It is possible to purchase heaters that burn natural gas that claim they do not need to be vented. The rationale for this is because the heaters burn a very high percentage of the natural gas and so do not produce much exhaust, per se. However, these items are not recommended for home or small commercial building use because the combustion of natural gas produces moisture in the form of water vapor and can produce particulates. Plus, if something occurs that causes an incomplete combustion in the unit, such as a spider web, chunk of dirt, etc., the unit might produce dangerous amounts of carbon monoxide during operation. If you decide to heat using one of the units, please read the instructions carefully and watch for flu-like symptoms or drowsiness, which can indicate carbon monoxide poisoning. We also suggest that you not use these units in bedrooms or other areas where you sleep and that you have a carbon monoxide detector plugged into an electrical outlet in a location near the unit.

AIR CYCLER

An air cycler is a device that operates your central heating/cooling system fan periodically to move the air in your building. This helps to eliminate stagnant and uncomfortable air that a thermostat cannot detect. Thus an air cycler helps to improve the effectiveness of heating, cooling, humidification and/or filtration systems. It does not replace these systems and, in some climate zones at certain times of the year, an over-ride may be needed to accomodate temperature and/or humidity control. Most models only turn on the central system fan after a specified interval of time during which the fan as not operated.

Insulation

- ☐ What type and what R-Value should be installed in your building?
- ☐ Have you done a cost benefit analysis/comparison of traditional insulation materials vs. the green materials you plan to use?
- ☐ How much insulation do you need in a given application (per code or per design)?
- ☐ What is the environmental factor of your insulation?
  - ☐ Is it hazardous during installation or removal?
  - ☐ Is it environmentally friendly, biodegradable or recyclable?
- ☐ What are the codes regarding insulation in your area?
- ☐ Do you want to qualify for any programs such as Energy Star®?
- ☐ Are you interested in tax credits (if they are available)?

14A. Commonly Used Wall and Attic Types

Most jurisdictions in the United States of America have building codes that require insulation in the walls and attics or sloped ceilings of residential and small commercial structures. With the cost of energy escalating all around the world, neglecting to install insulation in new buildings or in major retrofits can be an expensive mistake. Here is a listing of the types and forms of insulation commonly installed in walls and attics/ceilings of residential and small commercial buildings:

FIBERGLASS

Fiberglass comes in many forms and can be used for nearly all applications requiring insulation. Coated fiberglass is commonly used as duct insulation (inside the ductwork) and can also be used for a below-grade insulating product when installed as part of a system. Attics in homes and other buildings commonly have loose-fill fiberglass that can be white, pink, yellow or blue in color. The color of the fiberglass denotes the manufacturer of the product. Fiberglass used in walls and between floor or ceiling joists can be either blankets (also called batts), which can have a Kraft paper facing or vapor barrier on one side, or can be encased in plastic. There are also unfaced fiberglass batts that are typically used in cathedral or sloped (vaulted) ceilings or below floors. The thickness and density of the batt determines its resistive value (R-Value). Also, the thickness of the batt corresponds with the width of standard lumber. A 2X4 stud is 3.5 inches thick, so the batts in the cavities between studs are also 3.5 inches thick. A 2X6 stud is 5.5 inches thick so the batts in the cavities between studs are also 5.5 inches thick and so on. Fiberglass is actually made of (as its name implies) very thin glass fibers. It works by trapping air within the fibers and the trapped air provides insulating qualities. Fiberglass works best when it is enclosed on all six sides to help trap the air and prevent it from moving through the fibers. The R-Value of blown fiberglass varies based on a combination of its density and depth. Evaluating R-Value based strictly on depth is not an accurate measure for fiberglass.

Fiberglass is considered to be a carcinogen in certain geographic areas of the world (such as Europe) and also certain regions or states in the United States of America (such as California). A high-

quality filtration mask should be used when handling fiberglass, eye protection and gloves are also recommended.

CELLULOSE

Cellulose insulation is comprised of ground-up newspaper that is treated with a boric acid or borate solution to make the final product fire resistant and unattractive to pests and vermin. Cellulose insulation is often used in attics since its effective R-Value per inch is somewhat better than fiberglass and cellulose insulation has air-sealing characteristics. Cellulose can also be used in walls, either blown-in dry to fill existing wall cavities, or it can be wet-sprayed to adhere to open cavities. Special care must be taken to allow the wet-sprayed cellulose to dry fully before covering with drywall or a vapor barrier product or else mold, mildew and/or dry rot can result.

Cellulose is normally calculated to provide an R-Value of 3.7 per inch, so the total R-Value of cellulose in walls or attics can be determined by the depth or thickness of the installed cellulose, measured in inches, times the 3.7 R-Value per inch number. Cellulose is always a lighter shade of gray and feels like soft tissue.

14B. Older or Less Common Wall and Attic Types

If you are planning to remodel or conduct an energy upgrade on an existing building, you might want to identify the insulation product(s) that currently exist in your structure. Some older insulation types did an effective job of insulating while others were not so good. There are also a few other items to learn about or be aware of before adding a significant amount of insulation to an existing building.

PLEASE NOTE: If you are looking in the attic of an older building, be aware of the possibility of bare (exposed) electrical wiring running through the attic. This wiring could run through some porcelain keepers or insulators as it traverses the attic. This type of wiring is called 'knob and tube' wiring and was very commonly used in the early days of electricity, typically around the turn of the century. Knob and tube wiring did work for the limited needs of homes and small commercial businesses back then, but it can be overloaded with today's electronics and appliances. Some of the early wiring was made from aluminum instead of copper, so if you see light silver or gray bare wiring in your attic, please be advised that this wiring is probably a fire hazard and should be replaced with modern copper wiring encased in a protective sheathing. Modern copper wiring can be purchased at lumberyards, home supply stores and many other sources.

Here is a brief description of some older types of insulation:

VERMICULITE

Vermiculite was used as an attic insulation product in the 1950s and 60s. It looks like small grayish light-weight rocks or pebbles that are piled in the attic. Typically, the depth of vermiculite is only a few inches and the total R-Value is relatively small. But, considering that many homes and other buildings built in this timeframe had no insulation, even a small amount of insulation is better than none. Vermiculite was often used as a retrofit insulation product for homes that were very old, so the existence of this product does not necessarily date a building. Vermiculite is still available in many locations because it is used in potting plants and has other landscaping uses as a soil conditioner. It is

not often used as an insulator today because other forms of insulation can provide more R-Value for less cost and weight.

PERLITE

Perlite looks very much like vermiculite, but is often a lighter shade of gray or off-white in color. Perlite has a similar R-Value as vermiculite and is still available as a soil conditioner for landscaping and planting purposes.

MINERAL/ROCK/SLAG WOOL

Mineral or rock wool became available with the advent of the mass production of steel and iron products. Mineral wool is a basically a by-product from the slag as steel and iron is produced. The slag is placed in a device that spins at a high rate of speed, similar to how cotton candy is made, and the resulting finely spun hairs form an insulating product. Mineral and rock wool are similar in appearance to the steel wool that is commonly used in kitchens to scrub metal pots and pans.

UNUSUAL TYPES OF INSULATION

There have been a variety of products used as insulation over the years, with varying degrees of success. Most of them were found lacking in performance or were attractive to pests and vermin. Here are just a few of these more unusual types of insulation:

Horse Hair

Horse hair might be found in homes and buildings on farms and in rural locations.

Newspaper/Magazines

Newspapers and magazines: found in homes and buildings all over the United States of America.

Old Currency

Over the years certain currency and monetary notes have become worthless and were used as wall paper or stuffed into walls and attics as a form of insulation. This use of old paper and parchment probably made the holder of this currency feel better, but it wasn't and isn't a good insulation product because of fire hazard and attractiveness to vermin.

Dried Organic Plants

Straw, grass and other dried organic plants may be a decent insulator but also a home for bugs. (Straw bale construction is different than loose straw in attics and does perform well.)

Meerschaum

Yes, Meerschaum (the lightweight stones used to make those white carved smoking pipes in tobacco stores) has also been used as an insulation product. It is not available in large quantities anymore and is also expensive to purchase and ship.

Plastic beads or packaging peanuts

Yes, plastic beads and packaging peauntes are good insulators per se, but not good attic insulation products because they can catch fire and burn easily.

Corrugated Cardboard

Again, corrugated cardboard is a potentially good insulator but also catches fire easily.

14C. Innovative and New Wall and Attic Types

The search for less toxic, greener, better insulating and higher air sealing characteristics in insulation continues. Some of the more recently developed insulations are:

CARBON DIOXIDE-BASED FOAM

Carbon Dioxide **(**CO^2) foam is a newer insulation product that offers health and other benefits. Most foam products on the market rely on either chemical reaction or the use of an accelerant, such as a refrigerant product, to cause the foam to expand. Some expansive agents create toxic fumes or gases while expanding and setting, so they should be used in well-ventilated areas only and not breathed into the lungs. CO^2 foam uses heat and carbon dioxide, the same product used to produce the bubbles in soft drinks, as the expansive agent. When the CO^2 foam dries it releases moisture in the form of steam. The end product is inert foam that does not release fumes or VOC. Plus, the use of foam in walls and ceilings can make a building airtight, so that noise, dust and pollution can be kept outdoors. Buildings properly insulated with foam can be extremely quiet and also can have great indoor air quality. However, you may need to install a mechanical ventilation system, such as an HRV or ERV, if the building is too tight.

SOY-BASED FOAM

The increasing desire of many people to find green alternatives to conventional products has led in many directions. One development is the invention of soy-based foam insulation. This innovative insulation product uses soybean oil in the foam product and the end result can be every bit as good as any other foam on the market. Several companies are producing soy foam, so you will need to do some research to find the one nearest you or the one that produces the product closest to your specifications. Soy foams typically are treated with a natural product that deters insects and other pests.

CASTOR BEAN FOAM

Foam made from castor beans is similar to soy foam, except that castor beans are a natural deterrent to insects. Castor bean foam has the potential to gain acceptance in the market as fast as soy because it is made from renewable, natural products.

WHIPPED CONCRETE

Yes, it is possible to make a thin mixture of cement and 'whip' it with air so that the finished concrete will contain zillions of little air bubbles or trapped air pockets. These air pockets will make the whipped concrete an excellent insulator that can be used in adverse environments that could affect other insulation products (such as high moisture or near chemicals). Whipped concrete cannot be eaten by insects and is resistant to digging by rodents.

COTTON OR RECYCLED DENIM

Good old fashion cotton is now being used as a natural insulation product for walls and attics. Cotton is lightweight and can be compressed for ease of shipping. However, the production of cotton can

require man-made chemicals, which is a concern for the environmentally minded. An alternative to using virgin cotton is to recycle cotton clothing as it becomes out of fashion or too worn to wear. Old blue jeans can now be made into an insulation product by shredding and fluffing the old material. Now you know where all your missing socks went…

If you have chosen to use ICF, SIPS, or straw bales in the construction of your home, you have already accounted for a large portion of your insulation.

14D. Sheathing

- ☐ Are you in a region where a continuous barrier will benefit your structure?
- ☐ Will you incorporate house wrap, water barriers, drainage planes?

What is sheathing? In simple terms, sheathing is placed around the outside of a wall structure to give the wall greater strength and/or additional R-Value. Sheathing can come in many forms. Most forms of sheathing have distinct advantages and disadvantages, which means that you will likely have to do some homework to determine the best sheathing product(s) for your building.

Some common sheathing products are:

TAR-IMPREGNATED BOARD

Increases the structural integrity of a frame wall but has a relatively low R-Value. This product was used extensively in previous decades but has gradually been replaced with sheathing products that have a higher R-Value per inch.

PLYWOOD

Plywood is often used around the corners of frame walls to add stability and rigidity. However, plywood has little R-Value.

OSB

Oriented Strand Board (OSB) is also used around the corners of frame walls to add stability and rigidity. But, like plywood, OSB has little R-Value per inch.

FOAM BOARD

Foam board is a good insulating sheathing product because of a relatively high R-Value per inch, but it is not very strong structurally. Also, foam board sheathing can potentially be a vapor barrier on the outside of the walls and can lead to a build-up of moisture inside a wall in certain climate zones. This moisture build-up can cause problems such as mold, mildew and dry rot. Foam boards can come in a variety of thicknesses and are commonly available in 4X8 or 4X9 foot sheets or in a fan-fold configuration.

FOIL-FACED FOAM BOARD

The R-Value of foam board sheathing can be enhanced by the addition of foil on one or both sides. The foil face(s) provide a radiant barrier when installed correctly that theoretically increases the R-Value of the insulating sheathing. Foil-faced foam board can potentially be a vapor barrier on the

outside of walls and can lead to a build-up of moisture inside a wall in certain climate zones. This moisture build-up can cause problems such as mold, mildew and dry rot.

HOUSE WRAPS

House wraps can also be considered sheathing, although their main purpose is to keep water from getting inside the wall structure while allowing water vapor to pass through. The composition of house wraps is such that the surface of the wrap contains microscopic holes that are large enough to let water vapor pass through but are too small to allow actual water droplets to pass through. House wrap can allow a wall to breathe so that water vapor won't become trapped inside the wall and build up, which can lead to structural and other problems including dry rot, mold and mildew. Damp walls can also be inviting to unwanted guests, such as termite and other insects. Besides house wraps, other products that can be used as a water barrier are: Tar Board, Foam Board, Foil-faced Foam Board, Tar/Kraft Paper, fan-fold and similar products. Please note that some of these products are also vapor barriers or retarders, which can be problematic if installed incorrectly or in the wrong climate zones.

DRAINAGE PLANE

In simple terms, a drainage plane is a flat area or vertical plane (surface) located behind an exterior siding or cladding that provides a surface for water to run down, if it has penetrated past the siding or other exterior product. Dimpled plastic or covered dimpled plastic, expanded polystyrene, encapsulated fiberglass, and tarpaper are just a few of the products that can be used as a drainage plane. Taking the time to understand the rationale behind the use of a drainage plane as a critical component of a building's wall structure is important, especially when drainage planes are often overlooked in today's building designs. Without providing for proper drainage of water intrusion, a wall system can ultimately fail or become severely damaged.

The incorporation of drainage planes in a building's wall was well understood by journeymen carpenters and other craftspeople in past years, but proper water control is often ignored since speed of construction in today's building market has overtaken quality. We believe that the time taken to understand the purpose of drainage planes in buildings is time well spent.

14E. Vapor Barriers/Retarders

The use of vapor barriers or vapor retarders in buildings came to prominence as buildings became more insulated, which made them more energy efficient and air tight. Old buildings typically had so many gaps and cracks around windows, doors and other penetrations that the building naturally ventilated (or breathed). These older buildings tended to avoid moisture problems in walls because of the constant exchange of air through all the cracks and gaps. However, as buildings became more insulated, they also started to become more airtight. By having less exchange of air, the buildings began to retain more humidity or excess moisture in the interior environments. When you add the fact that people also generate excess moisture (from cooking, spas or hot tubs, showers or baths and even breathing) and this moisture was being trapped, buildings started to have too much moisture inside the wall cavities, which was degrading the performance of the insulation and also affecting the physical structure of the building. New problems started occurring, such as mold, mildew and dry rot.

The initial solution to these problems was to install a watertight membrane or vapor barrier/retarder inside the walls to keep the moisture inside the building from entering the wall cavity. The common

practice was to install this vapor barrier/retarder on the warm and moist side of the wall framing, under the drywall or interior paneling.

Vapor barriers tend to work rather well behind the drywall/sheetrock in colder climate zones but what about areas of the world where the warm moist side of the wall is inside in the winter and then moves outside in the summer? Some climate zones have little or no cold weather and plenty of hot weather. The installation of vapor barriers on the interior wall side in 'mixed-humid' climates and high humidity regions can actually cause more problems than not installing a vapor barrier/retarder at all. So, what is the answer? The best answer is to use an 'intelligent' vapor barrier (a barrier that can breathe when needed) or investigate and employ other building strategies that work best for your particular climate zone.

A vapor barrier is supposed to remain intact, so that it can act as a shield for moisture penetration. However, many times after the vapor barrier/retarder is installed (which is typically 4 or 6 mil plastic sheeting) the remaining trades involved in the finish work of the building would tear, cut or remove sections of the vapor barrier to get to the section of the wall that they still needed to work on. This violated or destroyed the effectiveness of the vapor barrier and allowed moisture to enter the wall cavities unabated.

14F. Foundation Insulation

☐ Do you plan to insulate your foundation?

As building science for residential and commercial buildings has progressed over the years, it has become evident that foundation insulation is very important if you want your building to perform properly. Certain programs, such as the Energy Star® program, have realized that foundation insulation is necessary in many climate zones. The use of an infrared (thermal imaging) camera on a heated building in the winter will show the lack of foundation insulation quite vividly. So, if foundation insulation helps buildings save energy why doesn't every building contractor install it?

The basic answer is that foundation insulation comes with its own set of challenges. If you install an insulating foam board, such as expanded polystyrene, on the exterior of a foundation wall you must cover it with a protective surface. Otherwise, the foam board will degrade in the sunlight and can be easily damaged by rocks throw by lawn mowers, weed cutters and little children's curiosity. Once you cover the foam board with a protective surface, it is no longer easy to see if there are termites or other destructive pests burrowing into the building. It is possible to install a termite barrier to restrict the entry of these pests. But, some jurisdictions do not allow concrete to be covered on the exterior because they want to see the concrete or masonry wall during routine inspections.

There are foundation insulation systems that use a coated fiberglass product for both insulation and moisture drainage purposes. The coated fiberglass has a special UV resistant covering to help protect the fiberglass from the elements. These systems provide a reasonable R-Value and add extra moisture control. But, for jurisdictions that do not allow exterior coverings over the concrete these are not viable.

So, perhaps insulating the interior of the foundation walls is the answer. This is quite possible, but care must be taken when installing interior insulation. Certain climate zones have temperature and

moisture variations that may cause the interior insulation to become moist and be a host to mold, mildew or other fungi. There are methods of installation of the interior foundation insulation that can help limit the possibility of mold growth so some time should be spent becoming familiar with the correct methods of installing interior foundation insulation for your particular climate zone. Many interior insulation products, such as foam board and fiberglass, need to have a fire resistant covering to meet local building codes.

One foundation insulation method that is viable in many climate zones is to use a foundation insulation system that places the foam board insulation in the center of the concrete wall. By doing this, there is a concrete face for both the interior and exterior surfaces. This will meet many local code requirements and yet can provide a measure of insulation. Another possibility is the projected availability of OSB board that is approved for underground installations. This treated board can be used as an exterior surface for a SIPS panel, which will provide both a foundation support system and a high R-Value foundation insulation.

14G. How much Insulation… Wall? Attic? Foundation?

Now that you have some information about the types of insulation products that are available, it is time to determine how much to use and whether it is possible to have too much.

What type and what R-Value should be installed in your building? The short answer is that, typically, the more insulation you install, the better or more efficient your building will be. However, there are practical limits to how much insulation you should install to get the maximum return on your investment. First, you likely have building codes in your city, county or state/providence/region that have minimum guidelines regarding how much insulation you need to install. Typically these insulation guidelines are simply the minimum R-Values allowed and are not the most efficient or cost-effective amounts of insulation you could install. Different regions of the United States of America have different requirements, as will different countries. In the United States of America, the Environmental Protection Agency and Department of Natural Resources' websites for your state will have good guidelines regarding the amount of insulation that makes sense for your region.

There are some increased insulation requirements if you want to build or remodel your building to meet Energy Star® guidelines or want to obtain tax credits for a new residential or commercial structure's building envelope.

If you meet the Energy Star® residential program requirements, you will not automatically qualify for tax credits. Information about the Energy Star® program, plus details regarding the residential and commercial energy tax credits can be found at www.energytaxcreditinformation.com.

Building to Code: Most builders are quick to tell you that they 'build to code' and that's good because you don't want a sub-standard construction job. But did you ever stop to consider what else that means? A built-to-code structure is the worst construction allowed by law. Sustainable buildings qualify well above the built-to-code standard.

14H. Water Pipe Insulation

- ☐ Will your water pipes be in conditioned or unconditioned space?
- ☐ Will your pipes be in a crawl space or attic?
- ☐ What insulation strategy will you employ if your pipes are in an attic or crawl space?
- ☐ How much pipe needs to be insulated?
- ☐ Should you add a reflective and/or vapor barrier as well?
- ☐ Are your pipes in an exterior wall and in danger of freezing?
- ☐ Should you use electrical heat tape to prevent your pipes from freezing?

There are pros and cons to using various types of pipe insulation and certain strategies to consider. All of the types of pipe insulation listed below offer some R-Value based upon the thickness of the insulating component. You should try to insulate your water pipes with a minimum R-5 but any insulation is much better than no insulation. Types of water pipe insulation to consider are:

- Sponge-felt-paper insulation
- Molded cork pipe covering
- Wool felt pipe covering
- Flex rubber insulation
- Open cell Foam Pipe Insulation
- Closed cell foam pipe insulation
- Shaped Fiberglass Insulation
- Anti-sweat insulation
- Frostproof insulation

14I. Water Heater Insulation

- ☐ Will your water heater be in conditioned or unconditioned space?
- ☐ Will you insulate your water heater?
- ☐ Do you understand how to insulate a natural gas/propane water heater differently than an electric model?

When installing an insulating blanket around a natural gas or propane water heater, you should make sure that the blanket is kept at least three inches from the floor. The flame at the bottom of the water heater needs to draw air from the bottom of the tank for combustion, so you do not want to restrict the airflow. We suggest that you trim the bottom of the insulating blanket even with the bottom edge of the water heater to be sure that the proper airflow for the fire is achieved. All fossil-fuel water

heaters should have the insulating blanket installed in this manner, including fuel oil (heating oil) and other versions.

Electric water heaters have internal heating elements to heat the water, so there is no combustion air involved. However, some electric water heater manufacturers recommend against enclosing the removable covers for the thermostatic controls in an insulating blanket. We suggest that you check with the manufacturer of your particular brand of electric water heater to make sure that there are no restrictions to the use of an insulating blanket.

If you install your water heater in an unconditioned space, such as a crawlspace or an unconditioned basement, you should insulate the pipes that connect to the water heater. If you are in a severely cold climate zone, you may want to also install electric heat tape around the pipes before insulating to help insure that the pipes don't freeze. Your local hardware store or lumber store will likely be able to help you purchase the appropriate products to prevent your water lines from freezing.

Choose from:

- Fiberglass Blankets
- Reflective Foil/Bubble Wrap Blankets

14J. Window/Glass Door Insulation

☐ Are the windows energy efficient enough to need no additional insulation or window treatments?

Quilted window coverings, insulated draperies, pop-in shutters, insulating blinds, insulating cellular shades, insulating window films, valances, cornices, swags, shutters and more can be used to insulate doors and windows.

If you decide to use an insulated pop-in shutter or other version of window insulation that has a relatively high R-Value, be sure that you remove this insulating product from your windows during every sunny day. Otherwise, the insulating product can make the space between itself and your glass window too hot and cause the window seal to fail. You will know if you have a failure of the seal if you see moisture build-up between the panes of glass in your window or if there is a white powder coating between panes. These indicators signify that it is time to replace your glass.

If you happen to have single pane windows and exterior storm windows, it is not uncommon to see moisture occur between these two panes of glass. This does not mean that the seal has failed, only that there is some air leakage through the primary interior window. You can address this in a number of ways, including locating and caulking the air leak, ensuring your interior windows close and lock tightly, installing window weather strip or installing an interior storm window kit made of clear plastic.

14K. Insulation Recommendations for Older Buildings

Older buildings may not have insulation in the exterior wall cavities. If this is the case, the primary thermal envelope is probably a combination of the interior walls, the exterior siding material and the air space in between, commonly known as uninsulated walls. An older building also may have little or

no insulation in the attic region. Adding more insulation in the walls and attic (or ceiling areas) should be a primary consideration in your plans to upgrade an existing building.

Older buildings also tend to have high air infiltration rates (or air leakage). You can limit the amount of air leakage in both existing and new buildings by planning to incorporate air sealing products and strategies. Air sealing products can include the liberal use of various types of caulk, proper weather stripping and also foam caulking materials. Be sure to use 'non-expansive' foam around windows and doors so that you don't cause any warping of the frame, otherwise you may void your warranties and your windows and doors may not open and close properly.

Interior Building Materials

- ☐ Is indoor air quality important to you?
- ☐ Have you investigated architectural salvage options in your area?
- ☐ Will you use leave the choice of interior building materials to your contractor?
- ☐ Will you be participating in the interior construction of your building?
- ☐ Have you done a cost benefit analysis/comparison of traditional interior building materials vs. the green materials you plan to use?

15A. Environmental Considerations

EMBODIED ENERGY

When thinking of a product from an environmental point of view, it is important to consider the energy consumed in creating it. The embodied energy is the energy consumed during the entire life cycle of a product, from the processes of resource extraction, manufacturing, packaging, and transportation, down to the energy consumed during installation, use, maintenance, and disposal.

INDOOR AIR QUALITY

Interior wood and panel products (such as medium density fiberboard) are discussed in the *Indoor Air Quality* section. The same considerations apply to the information provided in this section because it includes products made from the same materials.

ARCHITECTURAL SALVAGE

Another environmental consideration that can be less costly (but not necessarily) is architectural salvage. Businesses that dismantle buildings often resell components (doors, windows, decorative features, bricks, bathtubs, sinks, hardware, etc.) that are still useable. Additionally, organizations exist (such as Habitat for Humanity's ReStore) that receive donated overstocks, slightly damaged pieces, custom orders that were not correct and other architectural salvage items and make them available for sale at greatly reduced prices. Reusing items keeps them out of landfills and reduces the need for replacements of these items to be manufactured. Remember though, that salvage items are 'what you see is what you get' and/or are 'one of a kind'. Be prepared to purchase something that works for you when you see it, because it may be gone the next day. Check to see if any of these businesses and/or organizations has a presence in your area.

15B. Wall and Ceiling Substrates

Interior building materials include both substrate and finish components. Once your structure is safe from the outside elements and the essentials of plumbing, electricity, heating, cooling, and insulation are in place; it's time to contain everything with the interior skin. We will focus on wall and ceiling components in this section, *Flooring* is discussed in a separate section.

DRYWALL

Drywall, which is also known as Gypsum Wall Board (or Sheetrock, a trade name of US Gypsum) is the most common sheet product used for interior walls in the United States of America. Drywall is basically a flat sheet of gypsum with a paper facing on both sides that is normally painted or covered on the interior surface after installation. It is 4-feet wide and is generally available in 8-foot and 9-foot lengths. Virgin gypsum still accounts for most drywall produced but recycled and synthetic gypsum are increasingly available. Recycled gypsum board is derived from in-plant scrap & clean construction waste. Synthetic, or flue-gas, gypsum is a waste product taken from stack scrubbers that are used for removing sulfur from coal-fired power plant emissions. In these scrubbers, calcium carbonate is converted to calcium sulfate, or gypsum. Synthetic gypsum can replace up to 100% of the natural gypsum in drywall, if locally available.

PLASTER

Plaster is an alternative that is durable, conserves resources, and is low-maintenance, made from abundant resources and there is less job-site waste than from sheet materials. Integral pigment color can be added to the dry mix and it can be left untreated or finished with a wax or water based sealant.

CONCRETE BACKER BOARD

Concrete backer board (sold under the tradename WonderBoard) is a concrete based sheet material that is normally used as a backing for ceramic tile. It consists primarily of cement particles bonded with wet cement and captured between two layers of fiberglass fabric.

GREEN ROCK

If you are tiling in a bath or kitchen where there is high exposure to water, 'green rock' or moisture resistant drywall should be applied over the studs as a basic wall surface.

15C. Finishes for both Walls and Ceilings

PAINT

Paint is discussed under the *Indoor Air Quality* section.

WALLPAPER

Wallpaper is material used to cover and decorate interior walls; it is one aspect of interior decoration. It can come either plain so it can be painted or with patterned graphics. Wallpapers are usually sold in rolls and are put onto a wall using wallpaper paste. Like paint, wallpaper requires proper surface preparation before application. Proper preparation includes the repair of any defects in the drywall or plaster and the removal of loose material or old adhesives. Additionally, wallpaper is not suitable for all areas. For example, in a bathroom wallpaper may deteriorate rapidly due to excessive steam. In a basement, or other area that is in contact with external soil, wallpaper can trap moisture in the wall and lead to mold issues.

PANELING

Wall paneling is typically installed as solid, interlocking boards and comes in many forms. The most common form of wall paneling is a thin wooden sheet or composite wood backer with a simulated stained wood face. Sheets of wood are fairly thin, normally 1/4- to 3/4-inch thick, and are made of different kinds of hardwood that can be given a clear finish or less expensive woods that are meant to be stained or painted. Boards may be milled to overlap or to interlock with tongue-and-groove or shiplap edges. Wood paneling is also sold as a 4X8 foot sheet material with a wood-veneered or simulated wood surface. Simulated wood paneling comes in a large variety of colors and patterns.

Wall paneling can also be made out of other materials including plastics and even organic renewable products such as straw, wheat stalks and other agricultural byproducts. Some of the newer paneling options include bamboo, cork, recycled glass tile, cast metal tiles and earthen plaster.

Paneling may be applied to drywall, directly to wall studs, or to furring strips applied over masonry surfaces. In many areas, building codes require installing wood paneling over a fire-resistant backing of drywall.

STUCCO

Stucco is a material made of an aggregate, a binder, and water which is applied wet and hardens as it dries. It is used as a coating for walls and ceilings and for decoration. Stucco may be used to cover less visually appealing construction materials such as concrete, cinder block, or clay brick and adobe.

PLASTER

Plaster is used as a building material similar to mortar or cement. Like those materials plaster starts as a dry powder that is mixed with water to form a paste which then hardens. Unlike those materials plaster remains quite soft after drying, and can be easily manipulated with metal tools or even sandpaper. These characteristics make plaster suitable for a finishing, rather than a load-bearing material.

EARTHEN PLASTER

Earthen plaster is a unique combination of clay, aggregates, and pigments, and makes a beautiful wall finish. There is no out-gassing, inherent waste on-site, or difficulty in repairing. In addition, the plaster is non-flammable, offers additional masonry mass in rooms, and resists mold growth. It can bring fantastic texture and color to any room of your home, naturally. Earthen plaster can be painted, stained or plastered over.

15D. Finishes Specific to Ceilings

DROPPED

Acoustical tile ceilings are often less expensive than gypsum board ceilings. They also do not require painting or other finish materials to complete the installation. Some ceiling tiles are made from recycled newspaper, mineral wool, perlite and clay. Due to the grid organization, acoustical tile ceilings may not be as adaptable to renovations as a gypsum board ceiling, though they are easier to reuse.

Acoustical ceiling installations are not for beginners though. They require accurate planning and layout. There is little room for mistakes. Installing suspended ceiling grid is not as easy as one may be lead to believe. Proceed slowly and methodically. Keeping the gridwork level is a challenge. Humps and dips in the ceiling are real possibilities. Closely follow instructions for a first class job.

SPRAYED

Spray texture, called popcorn finish by some, is a paint-like coating used primarily on ceilings. It is also used on exposed metal beams. The texture comes from polystyrene bits of varying sizes mixed into a sticky liquid base. The product is purchased dry and mixed with water, and is available in various textures. The amount of water used in the mix is critical to a good job. Too little water and the product will not spray smoothly. Too much and it will tend to show small cracks as it dries, plus the hiding ability and adhesion will decrease. The product is applied to large areas with a compressor-powered hopper gun… it looks very much like a futuristic assault weapon. One or multiple coats can be applied, though too thick a single coat is not advisable. The material should be allowed to dry overnight if a second coat is desired.

Be cautious of finishes containing asbestos, formaldehyde, or crystalline silica, as these items are possible cancer and respiratory tract hazards. According to a Cornell University study, one cause of Sick Building Syndrome (SBS)is mineral fibers (rock wool or fiberglass); these fibers do not decompose in a landfill.

METAL

The metal ceiling industry was introduced in America just after the Civil War. The industry peaked in popularity at the turn of the century as the middle class population used this decorative technology to copy the rich hand-carved plaster work found in the desirable mansions of the upper class. Commercial establishments quickly adopted the material because of its durability and fire resistance.

There are numerous manufacturers of metal ceilings and accessory pieces. Most manufacturers use recycled materials in their tiles, however, they differ in the percentages of recycled materials available in their finished products, so you will want to shop around. There are nearly 100 different patterns to choose from and a multitude of decorative cornice and crown moldings. Many of these patterns are exact copies of the original metal ceiling panels. They are often available in 2X2 foot squares or 2X4 or 2X8 foot rectangles and even in solid copper, brass, or chrome. Pre-painted metal ceiling assemblies can also be purchased.

Installation of metal ceilings is not too hard. Most of the ceiling patterns are designed so that nails driven on twelve inch centers will blend into the pattern. As such, the instructions packed with your ceiling panels will probably tell you to install 3/4 inch furring strips 12 inches on center that run perpendicular to the ceiling joists. Check the furring strips with a string to make sure they are all in the same plane. If the strips have waves and humps in them, the metal ceiling will duplicate this look. To insure against rust from a future water leak above the ceiling, prime the back side of the steel panels with an oil based primer.

15E. Interior Doors

- ☐ Have you considered code compliance, security, insulating factors, type, glazing, maintenance and aesthetics in your interior door placements?
- ☐ Is safety and security the primary issue when choosing an interior door?
- ☐ Do you want total privacy (including locks) from your interior doors?
- ☐ Do you intend to use an interior door to restrict air movement between rooms?
- ☐ Do you simply want to use an interior door to restrict the view between one room and another?
- ☐ Do you want an interior door to keep children or pets out of a specific room, but want visual or auditory access to the room?
- ☐ Have you decided if each interior door in a given location should swing in or out, to the left or right?

When you decide why you want to use a door in an opening, you will narrow in on the choices pertinent to each situation. For example, if you plan to have an interior storm shelter or security room/vault, you remove from consideration doors with any kind of glass panes and wood hollow core doors entirely. Instead, an (exterior type) insulated metal door would be suited to this application. Conversely, you may discover that you don't need to use a door at all. A curtain made from cloth or beads can visually separate one area from another. A 'baby gate' can restrict access while leaving the doorway open.

Generally, the value awarded to an interior door is its price. Aesthetics, sound penetration, fire rating and other factors, however, can also come into play when placing value on the appropriate door for a given interior space.

Most interior doors are currently made from wood. FSC wood is an environmental consideration, but can be costly. Salvage is another environmental consideration.

You can choose a door and then install the millwork/door jamb in a doorway that is constructed to fit it or you can choose a pre-hung door. A pre-hung door is a door that comes with a fully assembled frame, hinges, seal and door ready for paint and installation. A pre-hung door does not come with door handles or locks. You will usually need to choose and purchase door handles and locks separately. There are a wide variety of styles and prices to choose from.

TYPES OF DOORS

There are many styles of interior doors to choose from (several of which can be used with or without glass panes); but there are two basic types of doors:

Flush

A flush door is a door with the frame completely covered on both sides with a thin skin. The skin may be wood veneer, hardboard, plastic laminate, or other materials. Flush doors may be hollow or solid.

Stile-and-Rail

A stile-and-rail door has a frame made up of vertical members called stiles and horizontal members called rails. Panels or glazing (glass) fill the spaces between the members.

STYLES OF DOORS

Some styles of doors include:

Bifold doors

A door unit that consists of either one or two pairs of doors that fold in half to open.

Bypassing doors

A door assembly that consist of two or more doors that slide on a track.

Dutch doors

A Dutch door consisting of two units horizontally divided so that each half can be opened or closed separately.

French door

A sash door that is mostly glass with a narrow bottom rail, divided into five or more lights.

Hollow-core door

A flush door with nothing but lightweight wood or cardboard spacers to separate the two face skins.

Louvered

A louvered door is made up of fixed or moveable horizontal slats. Louver doors are often used as closet doors, both for style and in climates where air circulation is important to prevent mold and mildew.

Panel door

A stile-and-rail door with solid panels between the frame members. Door panels may be flat or raised, and are typically made of wood, hardboard, or metal.

Pocket door

A door that rolls on a track installed inside the wall.

Solid-core door

A flush door with a core of particleboard or solid wood.

Swing (or swinging) door

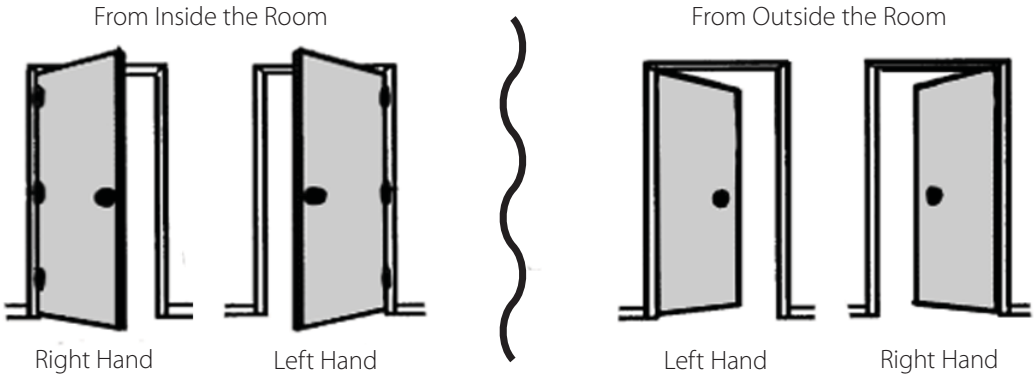
A Swing door swings open on being pushed or pulled from either side and then swings closed by itself.

Light or Lite: The industry terminology for a window located in a door.

DIRECTION OF SWING AND HANDING

How do you decide if the door should swing in or out, to the left or right? As a rule, most interior doors swing into the room (unless the room is very small… such as a closet or furnace room) and so the hinges are on the inside side of the door. Doors that swing into traffic areas can be dangerous. Deciding if the door should swing to the left or right is dependent on traffic flow. The door should swing away from traffic. If there is a wall nearby, swing the door to the wall.

A more tricky consideration is what is called 'handing'. Handing is the description of whether a door is left or right handed. The industry tends to follow the American National Standards Institute (ANSI) published standards (see diagram below). Make sure you and your builder understand the swing, or there's a chance that the swing will be wrong. Always draw a diagram showing both sides of the room with the door half open.



Quick Handing Determination: One simple way to determine a door's handing is to stand with your back to the side where the hinges will go and whichever arm you extend indicates the correct handing (left arm = left handed, right arm = right handed)..

15F. Built-ins

- ☐ Does your building design call for built-in components?
- ☐ Have you discussed insulation and sealing requirements for built-ins with your contractor?

Countertops and cabinets are discussed in the *Indoor Air Quality* section; here we will focus on built-in wall elements such as book or display shelving.

Built-in components need to be planned for during your design process mainly so that you allot enough space for them. These are components that become part of the structure and would (for instance) be left with a new owner if you sold the building. Of course, it is always possible to remodel later, but that is generally more costly than planning ahead. It is common for built-in components to be unsealed, uninsulated or under insulated, so it is very important to address this in the planning phase and to make the air-sealing and insulation requirements for areas behind built-in components very clear.

BOOKCASES/DISPLAY CASES

The very permanence of a built-in bookcase/display case (custom-designed and stocked to your needs and tastes) adds to a house's character and substance in a way that freestanding bookcases/display cases simply cannot.

Most bookcases and display shelves are placed in a room wherever they fit. Other times however, they become the focal feature in a room… or at least one wall of it. Another nice thing about a built-in bookcase/display case is that it takes advantage of wall space that typically goes unused.

Enormously flexible, built-ins can be placed just about anywhere. Besides familiar locations like lining a wall or flanking a fireplace, a bookcase can create an alcove, surround a window or door, sit under a stairway, follow you up the steps, and even gracefully divide a room in two.

OTHER BUILT-INS

Examples of other built-in components are desk areas in kitchens, window seats in bay window areas, mantles above fireplaces and other custom work.

Built-in components that are situated on the thermal envelope of the building are often not insulated properly. It is much less costly to be sure they are insulated during construction than to correct this problem later.

Flooring

Flooring options can affect indoor air quality, which is the subject of a separate section. Indoor air quality will be noted for each choice as it relates specifically to that choice.

- ☐ Have you done a cost benefit analysis/comparison of traditional flooring materials vs. the green materials you plan to use?
- ☐ Are you willing to research and possibly pay more for the sustainable flooring choices available?
- ☐ Is Indoor Air Quality important to you?

16A. Flooring Substrate

No matter which flooring you choose, there is an underlayment system required for each of them. Some types of flooring require a specific type of substrate, so be sure that the appropriate type is used for that area.

SOLID WOOD PLANKING

Many years ago, the typical floor consisted of thinner boards, 1X6 inches wide, laid next to each other on the floor joists. This flooring system is quite excellent, but it can be expensive unless you locate some boards from a building demolition project or other low-cost source. This type of flooring became less available with the invention of plywood.

PLYWOOD

Plywood was the dominant choice for sub-floors or underlayments for many decades. Plywood is easy to install, faster than planking and less expensive. Also, plywood is available in various thicknesses, which allows for creative flooring choices and combinations. Plywood can be obtained in interior grade versions and, with some research, can also be found in water-based glue versions and from FSC certified forests.

OSB

Oriented Strand Board (OSB) has significantly replaced plywood as the underlayment of choice for new construction. OSB has been less expensive than plywood until recently; now they are both pretty pricey. OSB is available in various thicknesses and allows for creative flooring choices and combinations. OSB can be obtained in interior grade versions and, with some research, can also be found in water-based glue versions and from FSC certified forests.

CONCRETE IMPREGNATED BOARD

Concrete impregnated board is typically used above another underlayment product (such as plywood or OSB) but under tile or other stiff flooring choice to help prevent the flooring from bending and cracking the tile. Concrete impregnated board can also be used in high moisture areas, such as behind shower enclosures and bathtubs. Concrete impregnated board is available in a variety of thicknesses and sizes.

POURED CONCRETE

Some flooring system utilize poured concrete as the primary or secondary substrate; such as flooring systems that have joists and forming systems that allow cement to be poured and set. Once the cement has dried into concrete, the forming boards can be removed. Other flooring systems have a sub-floor of plywood or OSB and then a thin veneer of concrete (maybe two or three inches) on top. This veneer can be used for radiant floor applications or when the floors must be quiet, such as in hotels or office buildings.

PRE-STRESSED CONCRETE

Pre-stressed concrete is pre-formed off-site or before installation and then placed into service as flooring once it is cured. Pre-stressed concrete is used in certain applications, such as multi-floor buildings, where it is impractical to pump wet cement upwards. Pre-stressed concrete can also be extremely strong and is a desirable product to use in areas prone to earthquakes or tremors.

16B. Carpeting

Carpeting is used extensively in new residential construction. Carpeting rooms wall to wall is standard practice, including many kitchens and dining rooms. It is generally less expensive than other flooring choices and is relatively easy to install. However, maintenance of carpeting can be problematic because it accumulates allergens, dust, food particles, and moisture and can be difficult to clean thoroughly. Carpeting generally makes a convenient home for dust mites (dust mite excrement is an airborne pollutant in many indoor environments). Carpeting in commercial environments is often placed in high traffic areas and becomes a trap or filter for dirt, particles of asphalt or concrete, snow-melting salt particles, moisture and other potential pollutants.

If carpeting is allowed to stay moist it can become an environment for mold. Most vacuums and rug cleaners only clean the top of the fibers and do not get deep enough into the fibers to get to where the real dirt and other problems are. Some carpet cleaning machines can delve deeper into the fibers than others but deep cleaning of carpets is difficult. This is why carpet replacement occurs relatively often in residential and small commercial buildings. The disposal of old carpet is problematic and is a contributor to our rapidly filling landfills.

Some progressive companies now offer carpet in squares that are small (perhaps two feet square) that can be replaced in sections when soiled or damaged. The most progressive carpeting companies will recycle the damaged/soiled carpet so that no carpet reaches the landfill. In fact, it is possible to 'lease' your carpet from some of these companies and they will handle the replacement and recycling of soiled or damaged sections as part of their service. This type of service is called Evergreen because of the ongoing environmental advantages.

There are several options regarding carpeting. In addition to quality and type of carpet (shag, loop, plush, etc.), the material the carpet is made from should be considered. More companies are making recycled content products and natural fiber products as an alternative to synthetic (petroleum based) fiber products.

SYNTHETIC FIBERS

Synthetic fiber area rugs can have a large variety of images and patterns on them and can have very bright, vibrant colors. Synthetic fibers are commonly made using petroleum-based plastics and other synthetic materials and can have high concentrations of formaldehyde, especially in the glues used to bind the fibers together. Versions of lower VOC and formaldehyde carpeting are available, but research will be needed to find the right products for your particular application.

WOOL/COTTON

Wool and cotton carpeting are made using natural fibers. Depending on the binding agent or glue used to hold the fibers together, wool and cotton carpets can be more healthful than synthetics. Cotton carpeting withstands moisture better than wool, but both can be cleaned with modern cleaning methods. One of the ways to thoroughly clean carpeting is to remove it from the structure and wash it. Cotton throw rugs and carpeting are very easy to clean; normally you can just throw them in a washing machine. However, cotton that is not organically grown is very bad for the environment due to the chemicals required to grow, process and bleach it. Wool can be a little harder to clean, but if you can take it outdoors and beat it with a 'carpet beater' you can remove more deep-seated dirt than by using a typical vacuum.

PET CARPET

One of the true success stories to come from recycling is the introduction of PET (polyethylene terephthalate) carpeting. PET carpet is manufactured with yarn created from reclaimed polyester resins of recycled two-liter soda bottles and ketchup containers. Commonly known as Pop Bottle Carpet, recycled PET polyester carpet is uniquely strong and durable. Indeed, recycled PET has a higher melting point and higher density than nylon, which gives the carpet many superior characteristics. PET carpeting is commonly used in high traffic areas, such as airports and hotel lobbies.

16C. Area Rugs

Area rugs are small areas of carpeting. While they can still be a problem for Indoor Air Quality, there is less area to accumulate allergens and these rugs can be easily removed for cleaning purposes. An area rug is an alternative to carpeting for situations such as the bedroom where you want to avoid stepping on a cold floor when getting out of bed, but want to avoid allergens that can be bothersome to sleeping. The same choices are available for area rugs as carpeting: Synthetic fibers, Natural fibers (e.g. wool, cotton), PET (recycled plastic).

16D. Wood Flooring

Standard wood flooring choices are many and varied. Pricing can run the gamut depending on quality and ease of installation. To add to the mix, many home improvement stores carry products you can install yourself. It is often difficult to determine the process of production and cultivation of many wood flooring products. However, it is possible to do so if you are willing to conduct some research to become knowledgeable about such things. There are certification processes by

independent, third party organizations (e.g. FSC) that guarantee the wood comes from well managed forests.

HARDWOOD FLOORING

Certain woods are inherently harder and/or denser than others. These woods lend themselves to use as flooring. Some of these are: ash, beech, birch, cherry (black), hard maple, mesquite, Douglas fir, hickory, pecan, oak (red and white), Pine (antique heart and southern yellow) and the American black walnut. Hardwood floors generally have to be sanded and finished during installation. These processes introduce irritants and toxins reducing the building's indoor air quality.

RECYCLED/RECLAIMED WOOD FLOORING

Some vendors offer recycled or reclaimed wood flooring that has been salvaged from the demolition of older buildings because much of the high quality wood that was installed in older buildings is no longer available.

FSC CERTIFIED WOOD FLOORING

There are certification processes by independent, third party organizations such as the Forestry Stewardship Council (FSC) that guarantee the wood comes from well managed forests.

16E. Wood Substitute Flooring

When you want the durability and warmth of wood, but don't want to use actual wood for the floor, there are substitutes that may satisfy your requirements.

HARDWOOD SUBSTITUTE FLOORING

There are a large variety of simulated hardwood flooring products on the market today. Some of these are also designed to be low in VOC and formaldehyde. Nearly every type and grain of natural hardwood flooring can be found in a substitute. Substitute hardwood floors can typically withstand more abuse than the hardwoods, especially scratching and denting. Most substitute hardwood floors can be cleaned with mild soap and water, which helps the indoor air quality. However, be sure to investigate and understand the materials used in the simulated flooring and how they will age. Some of these floors are made of solid inert materials that will last at least as long as the structure, while others are similar to particleboard and could potentially break down with time and heavy traffic and start releasing fine dust and compounds into the air.

BAMBOO

Bamboo is a very fast growing grass that can be used as a hardwood floor substitute. Bamboo floors are very durable and can be quite beautiful. Since bamboo grows quite readily in many areas of the world, it is considered to be a renewable resource. Bamboo flooring can be obtained from a fairly large variety of retailers and distributors and it will become more available as it becomes more popular. Environmental concerns include concerns for wild-harvested vs. plantation-grown sources, affect on wild-life and transport overseas. At this time the only known third-party certification process for bamboo is through the FSC.

16F. Glass, Ceramic, Stone, Concrete

Ceramic, stone and stone-like floorings are extremely durable and range greatly in price depending on the quality and type of flooring. Many home improvement stores carry products you can install yourself. When choosing ceramic, stone or stone-like flooring, traffic and noise should be considered (among other things). Most stone or stone-like floors are tiled and require a grout product and a sealant of some kind. There are both eco-friendly and toxic products for these uses, so it is important to investigate what is available.

DO IT YOURSELF CERAMIC TILE

Some ceramic tiles come with a netting-style backing that holds a number of tiles apart with the exact spacing needed for grout. These tile 'sheets' are commonly used for bathroom walls and other high-moisture areas. The popularity of these sheets was at its peak in the 1960s and 70s; newer tile products and installation methods have overtaken its popularity.

CERAMIC OR TERRA COTTA TILE

Ceramic tiles are usually square, thin and extremely rigid. These tiles need to have a substantially stiff underlayment, such as cementatious board or poured concrete, to prevent them from cracking or breaking. Ceramic tiles come in a huge variety of colors, styles and patterns. Ceramic tiles usually need to be sealed upon installation to prevent discoloration due to dirt, water and debris.

QUARRY TILE

Quarry tile is similar to ceramic tile but can come in smaller sizes, and can be much thicker in width. Quarry tile is usually more porous than ceramic and needs a sealant applied upon installation.

RECYCLED CONTENT TILE

There are some tile products available on the market that have recycled content and/or inlaid items, such as pieces of colored glass. The recycled tiles can be used for many purposes, including flooring.

CUT STONE TILE

Some types of stone can be cut into relatively thin sections and used as a tile product. Marble, granite and shale are sometimes used for tiles.

MANUFACTURED STONE TILE

You can obtain tiles that look like natural stone, but are, in fact, either a manufactured (cultured) stone or simulated stone made from a plastic material.

STAINED/COLORED CONCRETE SMOOTH

Concrete can be stained or colored during the curing process. Traditionally concrete staining is a coating on the top surface and can be scarred or scratched. It is possible to mix the coloring into the top layer of the concrete, which helps keep the coloring uniform despite nicks or chips.

STAINED/COLORED CONCRETE TEXTURED

Textured boards or mats can be placed on the formable concrete and will inscribe patterns or shapes during the curing process (while it is still rather wet and pliable). Once the concrete cures to a certain

stage, the boards or mats are removed. Coloring or stains can be applied at this stage or coloring can be mixed into the wet cement prior to using the molds. The textured concrete can simulate tile, stone, brick, wood grains or any other surface pattern.

16G. Linoleum

Originally, linoleum was a natural composition of renewable materials. Now, most linoleum is a petroleum-based product. Some linoleum is made from vinyl and some is made from the natural products that constituted the original linoleum (and name). Each of these versions of linoleum offers the same durability, flexibility and resilience. Some versions of linoleum have a natural or raw surface that requires frequent maintenance in the form of cleaning, waxing or other surfacing. Other versions of linoleum have a hard, clear topcoat, which minimizes the amount of work it takes to maintain the floor. There are a growing number of natural products on the market designed to help you clean and maintain your linoleum flooring without harming your indoor air quality.

PETROLEUM-BASED LINOLEUM

Any product made with petro-chemicals will outgas petroleum distillates and other VOCs into your interior environment. It is worth spending some time investigating the particular product line that you are considering purchasing.

VINYL

Vinyl is made of synthetic ingredients that can sometimes be more inert than some types of conventional linoleum. Vinyl flooring will offgas petroleum distillates and the manufacturing process to make vinyl can be very toxic and polluting. The production and incineration of vinyl flooring creates dioxin, a dangerous carcinogen. Vinyl flooring has only a 10- to 20-year lifespan and is a lower durability product than some other types of flooring. A little research into the corporation making the vinyl will likely reveal how environmentally compliant they are and if they have had run-ins with the EPA or government. We suggest that you avoid manufacturers with a history of damaging the environment, either in the United States of America or other countries.

NATURAL LINOLEUM

Made of natural ingredients, natural linoleum will outgas natural oils. Natural linoleum is made from renewable and biodegradable materials such as linseed oil, wood flour, rosin, jute and limestone. It is available in a wide range of colors, styles and designs, is durable and self-healing and has a long lifespan of 30 to 40 years.

16H. Other Flooring

CORK

Cork is less well known than previously discussed floorings, but is highly resilient, durable and a sustainable product because (very basically) the tree sheds the cork bark and is not damaged in the harvesting process. It also has natural anti-fungal properties and does well in damp situations so it is especially good for use in a bathroom or other moist environments. In addition, cork is a natural resource that is antimicrobial, which means it is resistant to mold and mildew. Cork flooring can be

obtained in many colors and designs, in both planks and tile configurations. It can be glue-downed or floated over a wide variety of sub-floors, including wood, concrete slabs and some types of existing floors. Cork floors are also available with an interlocking system that doesn't require glue for faster, no-mess installations. Some cork floors can be purchased unfinished that require finishing at the jobsite, while most cork floors come with a special vinyl finish layer to help protect the cork and make regular cleaning easier. The newest development is a non-toxic oil finish that can be walked on immediately and yet still be refinished.

WOVEN NATURAL FIBERS

Sisal (from the agave sisalana cactus plant), seagrass and mountain grass woven area rugs and wall-to-wall carpet have excellent durability for residential and light commercial applications. The machine woven, natural fibers are anti-static, non-toxic and colorfast. The plant material creates healthy indoor humidity levels and prevents the build-up of static.

Indoor Air Quality / Health

- ☐ Will you leave the choice of interior finish materials to your contractor?
- ☐ Is it important to you that your finishing contractor have experience working with Green Building Techniques?
- ☐ Will you be participating in the finish work on your building?
- ☐ Is your building well ventilated?
- ☐ Are you, or others who will live in or use your building, sensitive to chemicals, allergens, pollution?
- ☐ Are you willing to invest additional research (and possibly additional money) into using products that minimize exposure to products that cause problems?
- ☐ Are you willing to pay for cleaning during construction and on-going building maintenance to reduce pollutants?

17A. Paint, Stains

LEAD, OIL-BASED, LATEX

Paint has a toxic history. Older paints contained lead, which has been linked to a variety of ailments — especially in children — including reduced IQ (intelligence quotient), stunted growth, damaged internal organs and much more.

Oil-based paints were not as dangerous as the lead versions, but the petroleum distillates needed to clean the paintbrushes of oil-based paints were also toxic.

The introduction of latex-based paints was a vast improvement over lead and oil, but latex paints can outgas significant amounts of Volatile Organic Compounds (VOC).

LOW AND NO-VOC

Low and no-VOC latex paints (and some oil-based versions) have become available through most paint retailers. The price for low/no-VOC paints are often approximately the same as the premium paint line for that retailer. Beware, however, all low-VOC paints may not really be that low in volatile organic compounds and should be scrutinized.

Another welcome trend is the introduction of low/no-VOC stains for wood. These stains are typically water-based and have little to no smell when being applied.

WATER-BASED

Water-based paints and stains can be cleaned with water, so the ease of use has greatly improved as well.

17B. Wood Finishes

Traditionally, the installation and maintenance of wood floors and cabinets meant the use of strong varnishes and wood treatments.

PETROLEUM-BASED

Most of these products were petroleum-based, which meant VOC and petroleum distillates permeated the air inside the building during installation, and for some time thereafter.

WATER-BASED

Many companies now offer water-based products as opposed to alcohol or polyurethane-based products (which are high in VOC). And, the price difference between products that outgas VOC and those that don't has reduced significantly. Because this has become a desirable feature in home products, there is the possibility that some product misrepresentation will occur in the marketplace. You must research if the product you are interested in is truly water based or one that claims to be but is not.

17C. Sealants, Coatings

After ceramic or quarry tile and/or brick inlay floor tile is laid, the next step is to seal it to keep the dirt and moisture from penetrating it. This sealant is often a silicone-based product that can outgas harmful compounds while drying. There are also coatings for the grout that will also outgas.

Now there are products on the market that have less outgassing potential. Some research will be necessary to find the products that are right for your application.

17D. Petroleum-Free Caulks, Adhesives, Solvents

Some products that produce the most VOC are adhesives, solvents and caulks. While there are some water-based glues and adhesives available, some contractors will not use them because they believe that they will fail inside the average interior environment due to humidity. There have been some major strides in solvents that use organic components versus petroleum-based versions. Some research may be necessary to find the proper adhesives for your project and we suggest that you talk with contractors, as well as suppliers, to find the best choices available.

Caulks present other challenges, especially when used in the wrong application. Latex caulks are cheap and paintable, but may become stiff and crack over time, which can allow water to enter the area the caulk was intended to protect. Silicone caulks will generally last longer than latex versions and pure silicone can withstand relatively high temperatures. But, silicone caulks should be used in well-ventilated buildings and paint will not stick to pure silicone caulk.

17E. Interior Wood and Panel Products

It is worth the effort to minimize the amount of outgassing that can occur inside your new or remodeled building. Many studies have shown that the indoor air quality (IAQ) of most buildings is worse than the outside air. Since people tend to spend the majority of their time indoors, it is important to have the best indoor air quality possible.

ORIENTED STRAND BOARD

Oriented strand board (OSB) is a dimensional framing product made from linear shards or 'strands' of wood glued together. OSB can be obtained in low and no formaldehyde versions and it can also be

made from FSC certified wood. If outgassing and management of wood resources are important to you (this is a subject that is often neglected in the decision making process) you may have to have extra research and additional discussions with your builder.

If low VOC, water-based glue OSB is not available, it is recommended that you purchase the OSB wood you will need well in advance and store this wood in a well-ventilated area, such as a carport or gazebo (take care that it doesn't get overly wet). The highest amounts of VOCs tend to outgas in the first few weeks of exposure to air.

PARTICLE BOARD

OSB is not the same as Particle Board. Particle Board is produced from combining sawdust and other waste wood with a special resin. If exposed to water, it will tend to swell and warp, unless it is one of the newer waterproof versions. It should be sealed with a water-based sealant to minimize the release of particles.

MEDIUM DENSITY FIBERBOARD

MDF (Medium Density Fiberboard) is similar to particleboard but is much more dense and the particles are smaller. It has the same problems of outgassing and release of particles so it should be sealed also.

PLYWOOD

Plywood is a dimensional building component, typically available in 4 by 8 foot sheets in various thicknesses. Plywood is made by peeling thin sections of wood from a tree, similar to peeling an orange, and then gluing these sections together to form a plywood component. The glues used to hold the sections together can be a water-based version or a low formaldehyde version. It is important to differentiate between exterior grade plywood (which is intended for use on the exterior of a home, but can be used in the interior under specific circumstances discussed in *Roofing*) and interior grade plywood. Interior grade plywood is intended for use on the interior of a home and should not be used on the exterior. Plywood can be obtained in grades. Grade 1 is finished on both sides and is the most expensive. Grade 2 is finished on one side and is very commonly used in construction. Grade 3 is not finished on either side and can have a rough (or grainy) texture or a large number of knots.

It is possible to find interior plywood that is made with glues that have low VOC content and also FSC certified plywood. If you cannot find low VOC content interior grade plywood for your building and want it to be as non-toxic as possible, many green programs recommend that you purchase your plywood well in advance of installation and store it in a ventilated building for a period of time. As with OSB, the plywood will tend to outgas a large percentage of the VOCs in the first few months after manufacture, so using aged plywood is a method used to reduce the outgassing of the final product. This same strategy holds true for the purchase of other VOC-laden materials, such as certain carpets, cabinets and furniture. Let them age in a ventilated storage building for a lengthy period of time and the VOCs will be lessened by the time you install these products in your new residence or small commercial building.

When using OSB, Particle Board, MDF or plywood for interiors, formaldehyde is a primary concern; however, it is just as important to determine the source of the wood used in the product.

☐ Are your interior wood/panel product being made from waste wood or is the company chipping logs (that could be used as linear board feet) to create the product?

The use of waste wood that would otherwise be burned or buried is an eco-efficient use of the resource; but chipping full logs to make the same products is not. Again, many companies now offer low- or no-VOC products. And, the price difference between outgassing products and those that don't has reduced significantly.

17F. Cabinetry, Counter-Tops

There is a significant industry of cabinet and furniture manufacturers that sell their products in the United States of America. You can see examples of their product lines at your nearby home supply store, retail lumber yard and discount furniture outlets. However, you will likely see (upon close inspection) that many of these products are manufactured using particleboard, OSB or MDF. The reason is that it is less expensive to use these products than solid wood or a water-based plywood product. Alternatively (with a little research), you can probably find cabinetry of solid wood; especially if there is an unvarnished wood store or a store that sells Amish products or other original wood products.

KITCHEN CABINETRY

Whether or not you choose custom or pre-made components depends on several factors including your desired overall appearance, the scope of the project, and your working budget. Home improvement centers and furniture stores often have a wide selection of mass-market kitchen cabinets and cabinet hardware. Selection often cuts across a wide range of affordability.

Generally agreed upon definitions pertinent to cabinetry follow:

Custom: built to project-specific dimensions, standards and specifications.
Semi-custom: customer selected products from a standardized library of cabinets with a wide variety of styles, quality standards and specifications. Home improvement kitchen design centers are an example of semi-custom cabinetry.
Stock: one size fits all, what you see is what you get.

COUNTERTOPS

Low-cost countertops are typically made using a particleboard substrate under a thin veneer surface, such as Formica®. A local or regional cabinetmaker may be able to use solid wood or water-based glue plywood as the substrate under the thin veneer surface, which will then limit or eliminate the outgassing of VOC. Heavy or hard materials, such as real or cultured marble or granite, can often be obtained from a local or regional dealer, which can reduce transportation costs and related pollution. Products that are hard and inert (such as cultured marble) tend to have little to no outgassing of VOC once they are fully cured.

There is an ever-growing list of countertops becoming available, especially green versions. Countertops can be made of recycled glass tiles and recycled glass inlays, butcher block, bamboo, cork, cast metal, granite, marble, cultured marble, plastic and more. Some of the bigger names in the countertop business are offering or starting to offer environmentally-friendly versions of their products instead of virgin material only.

17G. Sealants for Exposed OSB, Particle Board, MDF

If you have purchased an existing residence or commercial building that already has particleboard cabinetry and can't afford to replace the cabinets in an existing building, you can purchase a water-based sealant to seal the woodwork and keep the VOC and other compounds from outgassing. Water-based sealants are available from several sources. If you are unsure about the amount of formaldehyde and/or petroleum products used in the manufactured wood products in your building, it may pay to seal them all with a water-based sealant prior to covering them. Beware, however, this has become a desirable feature in home products and you must determine if the product is truly low- or no-VOC or one that claims to be but is not.

17H. Closets and Storage

The location of closets and storage areas can affect the indoor air quality of your building. Some closets are lined with cedar to help reduce the incidence of pests, but cedar may be an irritant for some people. Closets can also contain mothballs, which definitely outgas fumes as their primary function. Storage areas may contain cleaning chemicals that can become a nasty mixture of pollutants inside your living area. It is best to locate closets and storage areas to the outer wall areas of the building, so they can have a window or operable fan to exhaust gases, if needed.

17I. Whole House Vacuum

Vacuuming removes allergens such as dust, dust mites, pollen, pet hair, etc. The decision here is to choose between a conventional vacuum cleaner (whichever type it is: bag or bag less) and a whole house vacuum system that is built into the walls and deposits the dirt, dust, etc. into a single bin with filters (and bag, if you like) that is emptied less frequently. Some of the newer conventional (portable) vacuums have HEPA filters or other high-efficiency filters to reduce the amount of micro-sized particles released into the interior environment in the process of vacuuming. Whole house vacuums should have the exhaust port dump the dirt particles and other micro-sized particle outdoors. The advantages of the whole house system are improved air quality, convenience, and warranty. The disadvantage is the initial cost.

Lighting

18A. General Types of Lighting

- ☐ Where do you need artificial light?
- ☐ In each situation/location where artificial light is required, how bright does the light need to be?
- ☐ Are you including an emergency lighting system with backup batteries?

You wouldn't use a 100-watt bulb in a night light, nor a 7-watt bulb in a reading lamp. These are examples of choosing the appropriate light level for a specific application or task. Not only is this applicable to the brightness of your lighting, it is applicable to the type of lighting you use. Take the time to consider how much light and what quality of light is needed for specific tasks in specific locations. Consider each of the following:

AMBIENT

Ambient is the general amount or intensity of lighting in an open area. Some designs use overhead lighting, others use side lighting/sconces, or indirect lighting and others use a combination of these.

TASK LIGHTING

Fixtures located near the work location for a specific purpose, such as a reading or desk lamp, are examples of task lighting. Task lighting can be controlled by the person(s) in that area.

SPOT

Spot lighting is a light that focuses into a smaller beam of light, usually designed to call attention to or illuminate an object, such as a work of art or a dartboard.

FLOOD

Flood lights cast illumination over a wide area and are used for general lighting purposes or to light specific regions of a building or area.

ACCENT/DECORATIVE

Accent lights and decorative lighting is used to highlight certain features of a building or draw attention to smaller details that may otherwise go unnoticed. Lights inside curio cabinets or glass displays are accent lights. A string of lights in the shape of a desired object, such as miniature Chinese lanterns or lights on a Christmas tree, are examples of decorative lighting.

EMERGENCY

Emergency lights are intended to come on when the primary lighting system fails, such as during an electric outage or in a fire. Emergency lights are often connected to batteries or alternate sources of power and are intended to guide the way to safety. Emergency exit signs are a form of emergency light.

18B. Lighting Specifications

COLOR TEMPERATURE

Correlated color temperature (CCT) relates to the color of light produced by a light source, measured in degrees Kelvin. Imagine a piece of tungsten metal being heated. As it is heated the color of the metal will gradually shift from red to orange to yellow to white to bluish white. The color of light is measured along this scale, with the more orange color light being referred to as 'warm white' and the bluer color light being referred to as 'cool white'.

COLOR RENDERING INDEX

Color rendering relates to the way objects appear under a given light source. The measure is called the color rendering index (or CRI). A low CRI indicates that objects may appear unnatural under the source, while a light with a high CRI rating will allow an object's colors to appear more natural. For lights with a warm color temperature the reference point is an incandescent light. For lights with a cool color temperature the reference is sunlight.

LIGHT INTENSITY/LUMENS

A footcandle is a measure of light intensity. A footcandle is defined as the amount of light received by one square foot of a surface that is one foot from a point source of light equivalent to one candle. Lumens represent the amount of light emitted by a light source, such as a light bulb. Preferred light levels will vary based on the person and the task. When purchasing light bulbs, however, don't assume that more watts equals more light, because more lumens means more light. As lamps and fixtures age and become dirty, their lumen output decreases. Most lamp ratings are based on initial lumens when the lamp is new.

MOOD OR STYLE

Warm white, cool white, daylight, heat lamp, black light, grow lights… These are terms that have been adopted by the lighting industry to help describe the lighting effect given from various bulbs in language generally understood by the consumer.

18C. Types of Light Bulbs

There are many, many types of light bulbs and many resources for determining which is appropriate for specific uses. Following is a short list of common bulbs.

STANDARD WHITE

Standard white is the typical light bulb that most everyone is familiar with; it has a white diffused coating.

CLEAR

A clear glass enclosure allows you to see the filament inside and produces a harsher form of light than the coated versions.

ORNAMENTAL

Ornamental bulbs can come in the shape of a flame, a tapered bullet shape, perfectly round or other specialty shapes.

UTILITY

Utility bulbs are designed to withstand more rugged conditions and/or impact shock than a regular bulb. These bulbs are for rough use in items such as trouble lights, garage door openers and utility closets.

SPECIALIZED

Specialized bulbs are for specific applications, such as the inside of an oven, refrigerator/freezer or microwave.

18D. Lighting Technologies/Interior

- ☐ Have you designed your building to take advantage of natural daylighting?
- ☐ Is there an ENERGY STAR® version of the light available?
- ☐ Is there an alternative lighting technology that uses less energy?

Once you determine the task or application for which the light is to be used, you can decide which technology to use as well.

NATURAL DAYLIGHTING

The thoughtful placement of windows, skylights, clerestories and light shelves can provide enough natural daylight to light an area from sun-up to sun-down and cut lighting costs to zero during these hours. Other consideration should given to heat-loss/heat-gain, in addition to supplemental lighting for dark and cloudy hours.

HALOGEN (HIGH OR LOW VOLTAGE)

Halogen or tungsten-halogen lighting has improved somewhat over the past few years and has become the lighting option of choice for residential, commercial and specialty stores that need high light quality or precise light focusing. Really a specialized type of incandescent lamp, halogen often features a parabolic aluminized reflectors (PAR) in order to focus the light. In terms of energy efficiency, halogen bulbs are somewhat more efficient than incandescent versions but are not as efficient as fluorescent bulbs of equal light output. Since halogen bulbs can be focused using reflectors, they may be more effective than other forms of lighting to help 'spot light' features in retail, architectural and other settings, including museum artwork. Halogen lamps can produce a significant amount of heat so care should be taken when placing bulbs near items that can melt or combust. A high number of halogen bulbs can contribute to the interior temperature of a building and add to the cooling load of an air conditioner, which can increase the cost of cooling the building.

INCANDESCENT LIGHTS

Incandescent lamps generate light by passing an electric current through a thin, filament wire until the wire is white-hot. They are used mainly in residential applications because they emit a warmer

light that contains less red and blue. Incandescent lamps include enclosures (bulbs) made from a ribbon of hot glass that is first thickened and then blown into molds. Incandescent lights produce a significant amount of heat as compared to the amount of light given. As a matter of fact, most of the energy consumed by an incandescent light is wasted as heat.

Incandescent light bulbs are being phased out around the world. Early in 2007 Australia became the first to ban them by 2010. It is recommended that you find out what your government mandates are for incandescent light bulbs.

COMPACT FLUORESCENT LIGHTS

A compact fluorescent lamp (CFL), also known as a compact fluorescent light bulb or an energy saving light bulb, is a type of fluorescent lamp that screws into a regular light bulb socket or plugs into a small lighting fixture. CFLs may have a conventional ballast located in the fixture or ballasts integrated in the lamps which allows them to be used in lamp holders normally used for incandescent lamps. In comparison to incandescent light bulbs, CFLs have a longer rated life and use less electricity. In fact, CFLs can typically save enough money in electricity costs to make up for their higher initial price within about 500 hours of use.

A common concern regarding CFLs is the mercury necessary for them to operate. The amount sealed within the glass tubing averages 4 milligrams. Most manufacturers have reduced even that amount and some CFLS have as little as 1.4 to 2.5 milligrams per bulb. A larger mercury concern should be the amount released into the atmosphere by creating electricity from coal. One 60 watt incandescent light bulb used for the same length of time as a 13 watt CFL creates more than three times the amount of mercury from a coal-burning power plant.

CFLs should be not be discarded with trash, but as hazardous waste (like batteries, paint, etc.) Several retailers in the United States of America provide for the disposal of CFLs at their facilities. It is recommended that you find out what the requirements for disposal are in your area.

STANDARD FLUORESCENT LIGHTS

A fluorescent lamp is a gas-discharge lamp that uses electricity to excite mercury vapor in argon or neon gas, resulting in a plasma that produces short-wave ultraviolet light. This light then causes a phosphor to fluoresce, producing visible light. Unlike incandescent lamps, fluorescent lamps always require a ballast to regulate the flow of power through the lamp. In common tube fixtures (typically four feet or eight feet in length), the ballast is enclosed in the fixture.

LED LIGHTS

A Light Emitting Diode (LED) is a special type of semiconductor diode. LEDs are significantly more energy-efficient than incandescent bulbs; this is particularly useful in battery-powered devices. They can emit light of an intended color without the use of color filters that traditional lighting methods require. This is more efficient and can lower initial costs. The solid package of an LED can be designed to focus its light. (Incandescent and fluorescent sources often require an external reflector to collect light and direct it in a useable manner.) LEDs are built inside solid cases that protect them, unlike incandescent and discharge sources, making them extremely durable. LEDs have an extremely long life span. Further, LEDs fail by dimming over time, rather than the abrupt burn-out of incandescent bulbs. LEDs give off much less heat than incandescent light bulbs with similar light output. LEDs light

up very quickly. An illumination LED will achieve full brightness in approximately 0.01 seconds, ten times faster than an incandescent light bulb, and many times faster than a compact fluorescent lamp.

18E. Lighting Technologies/Exterior

Because of operation in uncontrolled environments, exterior lighting has special considerations separate from interior lighting. It is important to select lamps (bulbs) that are designed for use in the outside elements. The wrong lamps may not operate correctly and could become a fire hazard. Exterior lighting includes:

LANDSCAPING

Lights can highlight features in the landscaping or other items such as sidewalks. These lights can use regular or line voltage, or can be low-voltage.

ACCENT

Lights can be used to illuminate the sides of a building or other notable features such as gates, statues, fountains or flags.

HIGH PRESSURE SODIUM

A special high pressure bulb and fixture combination that gives off a pinkish-orange light. High pressure sodium lamps offer good CRI and are often used when colors need to be present, such as in an automobile lot.

LOW PRESSURE SODIUM

Low pressure sodium lamps and fixtures produce a significant amount of light for the amount of energy consumed, so they are commonly used to light streets and large outside areas. The low pressure lamps give an orange/yellow light color and have a very low CRI.

METAL HALIDES

Metal halide lamps, a member of the high-intensity discharge (HID) family of lamps, produce a blue/white white color light and offer high light output for their size, making them a compact, powerful, and efficient light source. Metal halide lamps are available in a variety of sizes and configurations for both commercial and residential applications. Like most HID lamps, metal halide lamps operate under high pressure and temperature, and require special fixtures to operate safely. Since they are considered a 'point' light source, reflective luminaries may be required.

SEASONAL

Seasonal lights are used for certain times or seasons of the year such as Christmas lights.

18F. Fixtures

 ☐ What kind of fixtures do you need for each situation?

Obviously lamps require some type of receptacle to hold them. By choosing Energy Star® fixtures you can be assured that they are energy efficient.

TABLE LAMP

Table lamps are variously sized and intended for placement on tables (as the name implies). They come in a myriad of designs, sizes, shapes and colors.

OVERHEAD LIGHT

Overhead light fixtures hang from the ceiling of a room and (usually) hold multiple bulbs so that they light the entire room.

CEILING FAN WITH LIGHT

Many ceiling fans are able to incorporate a light kit that allows the fan to also serve as an overhead light for the room or area.

RECESSED (CAN) LIGHT

Recessed lights are light fixtures that are installed with the bulk of the fixture above the ceiling line. Recessed lights that are 'builder's grade' leak significant amounts of conditioned air into the attic spaces of buildings and can significantly increase the energy bills for that structure. Insulation contact air tight (ICAT) recessed lights are a better alternative to builders grade and must be used in conjunction with CFLs to minimize a fire hazard. However, from an energy efficiency point of view, it is best to avoid any penetrations through the ceiling.

TRACK LIGHTING

Track lighting is surface-mounted and can have multiple fixtures per track or bar.

CHANDELIER

Chandeliers are mostly ornamental in nature and can be host to multiple light bulbs.

SCONCE

A sconce is a light fixture mounted on a wall. Sconces can be plain and functional or they can be ornamental in nature.

TORCHIERE

A torchiere is a free-standing, floor type of fixture whose bulb is hidden from view because it shines upward. Torchiere floor lamps, which have become quite popular in recent years, are actually quite inefficient because they direct the light to the ceiling. Even though a smooth white ceiling can reflect some light, bathing a ceiling with light wastes much of the light quality. Most torchieres are sold with halogen bulbs (which can easily cost more to operate each year than it cost to purchase in the first place); however, it is possible to replace them with CFL bulbs made to fit.

OUTDOOR SAFETY

Parking lot lights, street lights and other lights used to light large areas are typically intended to provide a measure of safety at the expense of light pollution. If you are concerned about safety and light pollution, there are lights designed to accommodate both of these issues.

WALKWAY LIGHTS

Lights are often used to illuminate a sidewalk or other exterior walkway. Often ornamental in nature, they can be practical as well. Many walkway lights are available with integrated solar collectors/ battery systems.

18G. Controls

☐ Are special control considerations needed for each situation?

How you control your lighting can make a difference in your energy consumption.

MANUALLY

The ubiquitous light switch is the most common form of manual control for lights. The adage, "turn the lights off when you leave the room" is still a good energy saving strategy, if people would do it.

REGIONALLY

Some light switches can control multiple lights or some locations in buildings can have multiple light switches.

WHOLE HOUSE

Lighting control systems are becoming more affordable and some are relatively easy to retrofit into existing buildings. There are many advantages to whole house lighting control systems, such as being able to turn off all lights from one location before heading to bed or being able to turn on all lights in an emergency. They can also be programmed to manipulate regions of the building in addition to the entire building. Lighting control systems also allow the 'tweaking' of lights so that you can have mood lighting or lower levels of lighting, perhaps for watching movies in a home theater.

TIMED

Lights can be placed on a timer so that they will operate only for a predetermined length of time.

SECURITY

Security systems can be designed to operate lights in a certain sequence during an emergency and using other sequences during routine maintenance. Commercial buildings have tied lighting with the security system so that the cleaning crew has adequate lighting while working at night and then the lights will turn off when the crew leaves.

DAYLIGHTING CONTROLS

In buildings with natural daylighting, the installation of light level controls help save energy. When the light levels are adequate from daylight, the artificial lights will automatically dim or turn off.

18H. Lighting Accessories

MOTION SENSOR/DETECTOR

A motion-sensing device uses infrared or other technologies to recognize movement and activate a switch. Motion sensors are commonly used in security systems and to turn lights on in bathrooms and closets.

LIGHT SENSOR

A light sensor detects the presence of light in the surrounding environment and activates or deactivates a switch. Most light sensors are used to turn lights on after dark and off at sunrise.

TIMER

Timers are used for a multitude of applications. One common use of timers is to turn lights on and off, which can be used to simulate activity in a building and deter burglars. Timers can be used to activate lights for preset lengths of time.

Appliances

19A. Resource Efficiency

- ☐ Is there an Energy Star® version available?
- ☐ What appliances (large or small) do you consider a necessity?
- ☐ What appliances (large or small) do you consider a luxury?
- ☐ What luxury appliances can you live without?
- ☐ What luxury appliances do you want if you can afford them?
- ☐ Is there an alternative that uses minimal energy?
- ☐ Must your appliances be brand new or are you open to recycled, refurbished items?

There are more choices of energy and water efficient appliances available on the market than ever before. Due to a number of factors, (including utility rebate programs, government mandated appliance efficiency standards, the Energy Star® program and energy tax credits in the United States of America, to name a few) the manufacturers of appliances, both large and small, offer efficient versions of their latest models. As late as 1990, a larger side-by-side refrigerator would often use more than 1,000 kilowatt hours per year. Now, there are many Energy Star® refrigerators of that same size that use around 500 kilowatt hours per year or less. At 10 cents per kilowatt hour, that's a savings of $50 per year or $1,000 over a 20-year lifecycle. So, an energy efficient refrigerator could literally pay for itself in energy savings over its lifetime. Other appliances are available (such as dish and clothes washers) that use a fraction of the water and electricity of older models and still do a great job.

The up front cost of energy efficient appliances can be more than other appliances. However, the savings in energy costs over the life of that appliance often more than makes up for the difference. All major appliances are required to have an 'Energy Guide' (a bright-yellow tag that indicates the amount of energy used by that appliance group in a sliding scale) that has an arrow indicating projected energy use for the specific model appliance you are considering. Appliances that meet Energy Star® guidelines will be labeled with the Energy Star® logo. Also indicated on an appliance's label is an annual average projection of water use. Water conservation has mainly been an environmental issue until recently. Now, saving water is becoming critical in many locations around the world, including the western United States of America. Lowering water consumption also reduces the cost of filtering, conditioning and heating water. It is not just major appliances that are now more efficient. Other energy-consuming items, such as computer monitors, printers and televisions are available in Energy Star® versions, as well as office equipment such as copiers and fax machines.

Study the Energy Star® website (www.energystar.gov) for resource consumption information on the various models available.

19B. Kitchen

Some appliances are a necessity while others are a luxury. It can pay to find alternatives that use little or no energy. A good example of this is the new ice cream maker that is shaped like a small barrel and

is designed to roll on the floor while making ice cream. You can kick this device back and forth while watching TV or another family activity. When the show is over, the ice cream is ready! And no energy is used in the process, except for the stored or embodied energy inside the ice (and the muscles in your legs). Now this is a way to save energy that we can all relate to!

Other hand appliances that make sense are: egg beaters, hand operated food choppers and graters and handle-operated meat grinders.

LARGER APPLIANCES

Refrigerator

There is a wide spectrum of refrigerator models available… generally, the less expensive the model, the less energy efficient. Look at the Energy Guide label for energy usage information and also look for the ENERGY STAR® label.

Oven

ENERGY STAR® versions are available. This appliance is worth spending a little time researching before purchasing.

Stove

Stove tops can be part of an oven/burner unit or purchased as a separate unit from the oven and can be packaged as ENERGY STAR®.

Dishwasher

ENERGY STAR® dishwashers not only save energy but also save water too!

SMALLER APPLIANCES:

Microwave

Microwaves are energy efficient when compared to traditional cooking methods, so any model you buy will save energy. The smaller units use less power during operation than the larger ones, so it would be appropriate to purchase the smallest unit that will serve your needs. Microwaves emit microwave radiation which is a controversial topic regarding health concerns.

Food Processor

Food processors are typically used for such brief bursts of time that the actual energy usage is negligible. However, if you do use your food processor every day or many times per week, then the size of the motor will affect the amount of energy used by this appliance.

Hand Appliances

Mixers, electric knives and other hand appliances are used for such short periods of time that the energy use is negligible.

Coffeemaker

Considerable energy can be saved by using a coffee maker that has insulated carafes versus the models that have glass or metal carafes. The glass or metal versions need to have electric

energy continually added to keep the coffee warm over time. Plus, the insulated carafes keep the coffee much fresher versus the warmers because the water in the coffee evaporates and leaves a bitter coffee after time spent on the burner.

Trash Compactor

Again, a trash compactor is not used often enough to make much of a dent on the old energy bill.

Instant Hot Water

Most instant hot water dispensers have a small tank and keep the water hot all the time. So, there are standby losses for these just like the tank style water heater. And, like hot water created in any water heater, there is an added taste not found in cold water that is heated in a kettle (for example). It is much more energy efficient to heat water with a microwave as needed than to have hot water on tap with these type units. However, if you do need hot water available on demand, then the price you pay may be worth it.

Garbage Disposal

Typically a garbage disposal is used on a sporadic basis and for short bursts of time. Use only when necessary and as directed (or don't install one, save energy for sure, and start a compost pile for your garden).

Determine if there is an alternative appliance that uses less energy and decide if it is appropriate for your use.

19C. Bathroom

Some appliances are a necessity while others are a luxury. It can pay to find alternatives that use little or no energy.

These items consume energy and should be used with care for the shortest operational time possible.

HAIR DRYER

Sorry, but it takes a certain amount of energy to dry hair. So, using a lower wattage version or a bigger dryer on the low setting just means that you have to run the hair dryer longer to get the same amount of dry, using basically the same amount of energy as the high setting for a shorter usage time. This same phenomenon holds true for clothes dryers.

MISCELLANEOUS

All of the following items are used for short periods of time and do not consume much energy.

- Curling Iron
- Hot Rollers
- Beard Trimmer
- Electric Shaver

19D. Laundry

Some appliances are a necessity while others are a luxury. It can pay to find alternatives that use little or no energy.

CLOTHES WASHER (TOP LOADER)

Here's where purchasing an Energy Star® version can really pay off. Resource efficient clothes washers can save both electricity and water, so you enjoy both lower energy and water bills. Plus, most Energy Star® models also have a special spin cycle that really wrings the moisture from the clothes, which lessens the amount of time spent in the clothes dryer.

CLOTHES WASHER (FRONT LOADER)

Clothes washers that load from the front and tumble clothes naturally use less water than top loading models. It only takes a small amount of water to saturate the clothes and it is the tumbling action that cleans them. Still, it is a good idea to look for the Energy Star® label on front loading models as well.

As a bonus, these machines also require less detergent. Be sure to follow the manufacturer's recommendation to use HE (High Efficiency) detergents to eliminate problems due to excessive suds.

CLOTHES DRYER

As with hair dryers, it takes a certain amount of energy to dry clothes. So, a hot dryer (using more energy) will dry clothes faster than a warm dryer. It will save time (but can have a horrible effect on your clothes). The warm dryer will need to run longer to get the clothes dry, ultimately using about the same amount of energy as the hot dryer. The energy savings for drying clothes actually comes from the Energy Star® clothes washer. These models are designed to spin the clothes very fast and wring them as dry as possible before you place them in the dryer, thus reducing drying time. The best energy efficient alternative to a clothes dryer is to hang out your clothes on a clothes line.

IRON

Energy efficient versions are available.

19E. Entertainment

Some appliances are a necessity while others are a luxury. It can pay to find alternatives that use little or no energy.

Any version of entertainment device that can be turned on by a remote control uses energy in the standby mode. Some models use more energy on standby than others. In fact, some models use so much energy on standby that it can add a significant charge to your monthly electric bill. It can pay handsomely to check the standby wattage of the entertainment unit you are considering purchasing and compare. Most Energy Star® models have minimal standby losses.

TELEVISION

If the initial cost of a flat screen television isn't too prohibitive, choose flat screen versus tube style as a general rule. The flat screen versions of televisions use less energy than the tube types. Therefore, it

may be advantageous to purchase the flat screen especially if you leave the unit on for several hours every day.

VIDEO CASSETTE RECORDER (VCR)

Look at the standby wattage and purchase the VCR with the lowest wattage rating.

DIGITAL VIDEO/VERSATILE DISC (DVD)

Again, purchase the DVD player that has the lowest standby wattage usage.

STEREO SYSTEM

Some stereo audiophiles can hear the difference between a Class A amplifier or tube system versus the lower wattage, lower cost versions. If this is true for you, then purchasing a lower wattage version may be irritating to your ears. However, if you don't really notice the difference, then go with the lower wattage one. Also, there is sometimes a relationship between the weight of the amplifying unit and the amount of energy it will consume. The heavier ones tend to consume more. Do your homework and if there is an alternative that uses less energy that you can be happy with, that will likely be your best choice.

19F. Office

Some equipment is a necessity while others are a luxury. It can pay to find alternatives that use little or no energy.

Office equipment, specifically the computer monitor, was the first item to be evaluated and improved under the Energy Star® program. For homes, the amount of energy consumed by a tube-style computer monitor was comparable to the amount of energy consumed by the tube-style television. Most home and apartment owners didn't notice much increase in their electric bills from their computers. However, for commercial business owners with 300 employees using computers, the amount of energy used started to really add up, especially if the computers were left on over the weekends for maintenance or software installs and upgrades. The EPA worked with computer monitor manufacturers to come up with the 'sleep' function. If you don't use it for a while, it goes dormant until the next use, unless over-ridden by the computer user. Now that monitors go to sleep, they save significant energy when not in use. The same theory holds true for other equipment, such as copiers, faxes, printers and CPUs. Laptops and tablet PCs especially utilize sleep and other energy conserving modes to conserve battery life.

HOME/COMMERCIAL EQUIPMENT

Look for Energy Star® versions of the following home office/commercial office equipment:

- Computer
- Monitor
- Scanner
- Printer
- Back-up System
- Copy Machine
- Fax Machine

COMMUNICATION EQUIPMENT

Look for digital versions of the following items, which tend to use less energy than the analog versions:

- Phone
- Answering Machine

MISCELLANEOUS EQUIPMENT

Other office equipment to consider is:

- Adding Machine
- Label Printer
- Bar Code Scanner
- Laminator
- Scale

If there is an alternative that uses less (or no) energy, consider that item for purchase. You can also place several rarely used items on a power strip and keep the strip turned off unless the items are in use. This will eliminate standby mode electric usage on those items.

19G. Home and Garden

Part of the decision about choosing equipment is whether that equipment is a necessity or a luxury and if there is an alternative that uses less energy.

LAWN MOWER

Available in gasoline and electric versions, especially the smaller push types. Rechargeable mowers can be supplied with electricity from solar electric (PV) systems, making them even less expensive to operate.

POWER TOOLS

Rechargeable tools should have the charging station on a timer, so that the batteries are not on a constant state of charge. Otherwise, considerable energy can be expended simply keeping the batteries 'topped off'. Again, if solar electricity is used there is no energy cost to recharge or run these items.

TRIMMER

Rechargeable versions tend to have less power than the ones that plug into the building's power system or are gasoline powered.

CHAIN SAW

Electric models can be much quieter to run than gasoline and you don't have to purchase gas, oil and other items. However, be careful not to cut the cord.

Energy Alternatives

20A. Solar Siting, Solar Ready

SOLAR SITING

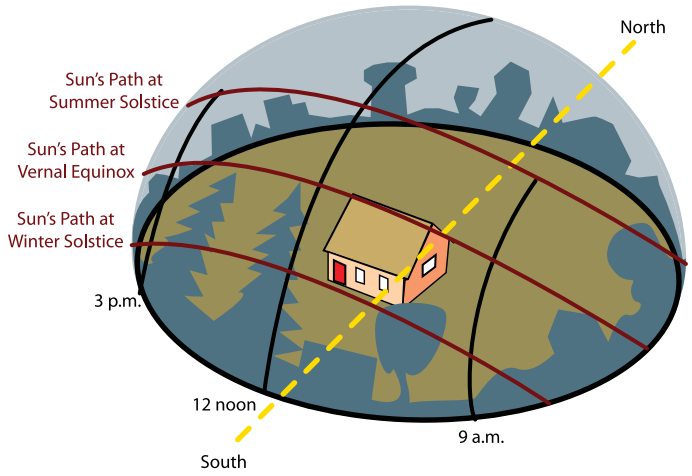
☐ Is the side of your house that faces the sun during the day (your solar window) clear of obstructions (e.g. trees, hi-rise buildings)?

There are methods and products available to help you determine if you have good access to the sun's energy during the strongest hours and the various seasons.

A careful analysis of the building site is essential. For people in the Northern Hemisphere, true south can be as much as 20 degrees different than where a compass points, depending on your location.

For winter heating purposes, your solar system(s) will need a clear view of the sun from approximately 9 A.M. to 4 P.M. for maximum solar gain. Since the sun's angle to the horizon will be at its lowest, any tall buildings, geographical structures (hills, mountains), evergreen trees and other vertical objects can interfere with the ability to 'see' the sun and cause shading on your solar system(s). This is especially problematic for a photovoltaic (PV) solar electric system because even a small amount a shading, such as the thin line of a flag pole, can seriously degrade the performance of the solar panels and the entire solar array.

No shading of the solar system during the daytime hours is the ideal, but sometimes this is not possible. The creative placement of solar panels and passive solar apertures (windows/skylights) can sometimes increase the amount of sun's energy available and/or decrease the shading. There are computer models available to help determine the best placement of solar components of a building.



A handy tool for visualizing how the sun travels across a building site is called a Solar Site Selector. You may be able to borrow one from a local energy agency, or you could purchase one.

The Solar Window Diagram (at left) illustrates that in the Northern Hemisphere from November 1st to about February 15th there will be shadows cast on the house between 12:00 and 3:00 p.m.
The deciduous tree in the south-southeast will cast some shadow, but will not be in leaf when it does.

SOLAR READY

☐ Will you be adding alternative energy systems (some or all) during the construction of your home or plan to do it at a later date?

If adding any form of solar to your new or existing building is not an option for you now but may be in the future, we suggest that you make your building solar ready by installing piping from the attic or top area of the building down to the utility room or area where the water heating system is located. (Be sure to securely cap the pipe so the unconditioned attic air does not infiltrate through the building.)

By making your building solar ready during the construction or remodeling process, it will be easier to install a solar system at a later date. Also, even though the concept of using solar is not necessarily complicated, we recommend that you include a person (or persons) on your design team who understands how to integrate your requested solar components and systems to achieve the desired results. Adding solar is not just a science. To many people involved in the industry, it is almost an art form that requires careful thought, knowledge and insight to achieve the best end results.

20B. Solar Systems – Passive vs. Active

- ☐ Are you including the power of the sun in your building design (e.g. passive solar)?
- ☐ What will your site allow:
  - ☐ Solar?
  - ☐ Wind?
  - ☐ Hydro?
- ☐ What can you afford?
- ☐ What is the best return for your investment?
- ☐ What are you willing to change or do without to take advantage of renewable energy?

Incorporating passive and active solar was covered briefly in the ***Evaluating Plans*** section because it is important to consider during the planning stage whether you want to add solar to your building. Just like other major components of a building, incorporating passive and active solar is typically much easier and less expensive during the construction stage than adding it after the building's completion.

The primary difference between passive and active solar is that passive solar is the ability for the sun to enter the building and warm the structure without the assistance of fans, pumps or motors. Active solar must rely on a mechanical device, such a pump, to push heated liquids (for example) from the exterior solar panels to a storage system, normally located in a lower level inside a building. Active solar systems can also use air as the heat transfer mechanism and must have fans involved to push the air through the system. Also, active solar systems can produce electricity. Solar electric or photovoltaic (PV) systems convert the sun's energy into electricity, which then can be used by the building, stored in batteries or tied to the regional electric grid. More on these systems follow.

20C. Passive Solar

When discussing passive solar options there is the potential for some confusion around terminology and/or definitions. Normally, when a room located inside a structure is designated as a solar room, greenhouse or solarium or other solar definition, it is inside the thermal envelope of the building and

is considered to be a direct gain, passive solar room. How you use this room and how you define this room is basically up to you. However, if you add (or attach) a solar room to a building, either during the construction phase or as a retrofit, the definitions become more important. Attached solar room additions are, by definition, isolated rooms in that you can shut the doors and/or windows and block the heat from the room from entering the main structure. How you intend to use this attached room helps define the room, in passive solar terms. Each of the following room spaces allows for specific uses and are, therefore, listed separately.

SUNSPACE/SOLARIUM

A basic term for a passive solar room addition is solarium or sunspace. A sunspace is a room that is primarily intended to provide extra heat in the winter to the main building and can be used as extra living space. Sunspaces tend to have insulated ceilings/attics and have mostly vertical glass (glazing) with some angled glass, such as skylights. Solariums are similar to sunspaces, except solariums tend to be made entirely of glass, both walls and ceilings. Solariums can be used to grow plants, but their primary purpose is to provide heat to the attached main structure. Solariums can overheat in the summer months and get cold overnight in winter months. Solariums tend to have higher temperature fluctuations from day to night than sunspaces.

GREENHOUSE

A greenhouse is similar to a solarium in that the typical greenhouse will have glass (glazing) on the walls and most, or all, of the ceiling. The primary purpose of a greenhouse is to grow plants, either for decoration or for food. A secondary purpose of the greenhouse can be to provide excess heat to the main building structure. Greenhouses tend to fluctuate in temperature from day to night and from season to season. Greenhouses that are required to have stable inside temperatures require the use of an energy source to help heat or cool the structure.

PASSIVE LIQUID OR AIR SYSTEMS

It is possible to install either liquid or air solar panels or collectors that do not need pumps, fans or other mechanical means to move the liquid or air. These systems rely on the 'convective loop' principle, in that the heated air or liquid will tend to rise to the top of the solar collectors and be replaced by the cooler portion at the bottom of the panel or collector. As the heated air or liquid rises, it slowly enters the room(s), storage container(s) or thermal mass and displaces the cooler air or liquid. These passive systems will slowly heat the room(s) or storage media over the course of the day and then the heat can radiate into the building over the course of the night. The liquid systems are used primarily in the southwestern United States of America or other semi-arid regions where freeze protection is not a concern. The air systems can be used anywhere. Both air and liquid systems need to have backflow or back draft dampers to keep from thermo-siphoning backwards at nighttime.

20D. Passive Thermal Storage

For most passive solar designs to work to their maximum potential, a thermal storage system must be included. To store the heat from a passive solar air system you need to specify a thermal mass (walls and/or floors or heavy items located in side the room which can be concrete, stone, brick, tile or even water stored in containers). As the sun heats the air it also heats the mass. Over time, the thermal mass

becomes saturated with heat. At night, the thermal mass then radiates the heat into the building. For liquid passive solar systems, the thermal mass is typically a storage tank or containers that are insulated and hold a large quantity of liquid.

TROMBE WALLS

A Trombe wall is a sun-facing wall built from material that can act as a thermal mass (such as stone, concrete, adobe or water tanks), combined with an air space, insulated glazing and vents to form a large solar thermal collector. Trombe walls can be considered an isolated gain passive solar component if they have a curtain or insulating wall between the Trombe wall and the building when the heat isn't needed. Trombe walls are normally controlled by the exterior shading or building overhangs and do not need to be isolated, per se. Trombe walls can be various thicknesses, which can dictate how much solar energy the wall stores and how soon it will re-radiate the heat to the interior of the building. If you want to have the heat from a Trombe wall start to warm the inner room in the early afternoon, then a 4- or 6-inch wall might be right. If you want the heat to radiate into a room used late at night, then an 8- or 12-inch thick wall might be best.

MASONRY WALL MASS

A well designed passive solar room will allow the sunlight from the winter sun to strike the back and/or side walls, but the room should have shading or overhangs to prevent the summer sun from penetrating the structure. By understanding the winter and summer sun angles and then designing your passive solar room, you can incorporate a significant amount of thermal storage (mass) into the back and/or side walls without causing too much summer solar gain.

MASONRY FLOOR MASS

The floor of a passive solar room is a natural area to incorporate thermal storage. Most solar rooms have concrete slab floors that are typically four inches thick. You can specify the thickness of the concrete slab prior to construction, which will determine the amount of solar heat the floor can store. Also, you can cover the floor with tile, stone or other masonry covering and gain more storage. You can install expanded polystyrene foam sheets, insulating mats and/or radiant barriers under the slab to help insulate this thermal mass from the rock and dirt below. Also, you can install a radiant floor heating system to help heat the slab during cold spells and also remove or 'scrub' heat from the mass during hot spells.

BASEMENT/CRAWL SPACE/OTHER STORAGE

You don't have to have a concrete floor to have a passive solar room. Indeed, many building designs have the passive solar room(s) located on second, third or higher floors and, sometimes, on the roof. In these cases, incorporating a concrete floor or masonry walls may not be possible. However, you can design the passive solar room to circulate heat through the walls or floors into a storage area, perhaps in the basement, crawl space or another room that contains masonry blocks, rocks or liquid storage containers. These items become your thermal storage media or mass instead of the floor or walls. Many creative passive solar designs incorporate heavy items as mass, such as aquariums, large planters, statues and decorative rock which also serve as thermal heat storage.

PHASE CHANGE MATERIAL SYSTEM

The physics behind a phase change material is fascinating since these materials can store a tremendous amount of energy for their size and weight. What is phase change? A good example is when water turns to ice. Water turns to ice at 32°F or 0°C (Celsius). However, water does not instantly turn into ice at 32°F. It slowly begins to change from water to ice over time as the cold air removes energy from the ice. The same holds true when you place ice cubes in a glass of water. The water may be 32°F, but the ice does not instantly change to water. It slowly changes back to water as it picks up energy from the water (using that energy to melt). So, if you have a phase change material that changes state from a solid to liquid or vice-versa at a preset temperature, say 80°F, then once the room achieves 80°F, the phase change material will keep absorbing heat for a long time before it becomes saturated and heats to 81°F. When the room cools, the phase change storage system will release heat at 80°F for a long time before cooling to 79°F. This helps stabilize the room temperature around 80°F or whatever the phase change temperature might be.

NATURAL AIR MOVEMENT

Natural air movement from a solar room helps heat the room and also the entire structure. A convective air loop inside the solar room will help distribute the solar heat around the room. If the windows from the solar room to the rest of the house are opened, the heated air will tend to migrate into the rest of the building and make the building a giant heat sink or thermal storage system. Most buildings do not have very much internal mass, so only buildings with heavy items such as marble, granite or tile floors, heavy statues and other masonry or liquid mass items will store a quantity of solar heat energy.

MECHANICAL AIR MOVEMENT

Sometimes a fan or other mechanical device is needed to move the heated air from the solar room into the other areas of the building. This is technically considered to be a 'hybrid' solar system.

LIQUIDS STORAGE/MASS

The use of liquids for passive solar heat storage works well. Liquid storage containers can be placed inside a solar room to help hold heat or can be placed in the crawl space, basement or other rooms located below or adjacent to the passive solar room. Some products used for liquid storage are: 50-gallon drums, rain barrels, one-gallon milk jugs and anything that can safely hold water/liquids for extended periods of time. Be sure to use only drums or barrels that are clean and have never been used for toxic or petro-chemicals. All storage containers should have lids and be tightly closed.

20E. Active Solar Systems - Thermal

If you cannot incorporate passive solar into your new building or are working with an existing building, then adding an active solar system that heats either liquids or air may be the answer. Most active solar systems utilize solar panels or collectors located outside the building, typically on the roof, and then 'actively' bring the heated medium, either liquid or air, into the building using pumps or fans. You have tremendous latitude when adding an active solar system because they can be installed vertically or at various angles and they can be placed on the roof, ground and walls or on outbuildings. There is an optimum angle and direction that you should try to use if you are using the

solar system primarily for winter heating purposes. This angle is based on your latitude on the earth and other factors, including magnetic and true south/north (as referred to in Solar Siting).

There are many manufacturers of solar panels/collectors for both air and liquid systems. The amount of solar heat storage you need depends on the number of solar panels/collectors that you install and the intended purpose of the heat derived from the solar system. Active solar thermal systems require periodic monitoring and maintenance, so these costs should be factored into the decision process.

Because of the large variety of solar thermal systems and components available and the multitude of design options possible, it is not practical to go into design detail here. However, the basics are:

LIQUID SYSTEMS

For liquid systems, you can specify either a drain-down, drain-back or closed-loop solar system type. Each type has specific advantages and disadvantages. Liquid systems use pure water or an anti-freeze solution in the system. All liquid systems require one or more pumps to operate and a control device. All liquid systems need a storage container, such as a tank-type water heater or other type of tank or container. These tanks/containers need to be well insulated for best performance. The more solar panels/collectors that you have in your 'array', the larger your storage tank(s) will likely need to be.

AIR SYSTEMS

For air systems you will need to have one or more fans. Air systems can duct directly into the structure and have no thermal storage or they can have ductwork and thermal storage (mass). Air systems are typically simple to install and maintain and normally have long life spans.

MOUNTING

Most air and liquid systems are permanently mounted but there are mounting systems available that 'track' the sun. These tracking mounting systems cost more than the standard rigid mounting systems, but can produce more heat from the sun per solar panel/collector. Sometimes, gaining more heat per solar panel/collector is more important and/or efficient than adding more collectors.

20F. Solar Domestic Hot Water

- ☐ If you include a solar domestic hot water system:
  - ☐ How much water will you need to heat daily?
  - ☐ What type of system do you want: drain-down, drain-back or closed-loop?
  - ☐ Who will maintain your system?

Solar domestic hot water (DHW) systems are typically liquid solar systems designed to produce hot water all year long. To do this, the solar panels/collectors on a solar DHW system are placed at a compromise angle (generally an angle equal to the site latitude). This angle allows the sun to strike the solar panels throughout the year and heat the water. There are many versions of solar DHW systems available. All solar DHW systems need to have a storage tank or container. Some use the tank style water heater while others use specialized tanks/containers.

20G. Battery Storage

- ☐ Will you be storing excess energy and/or 'selling it back' to the grid?
- ☐ If you include a battery storage system:
  - ☐ How much electricity will you need to store?
  - ☐ How many batteries will it take to store the energy you need?
  - ☐ Where will you store your batteries?
  - ☐ Will you be using the electricity primarily in Direct Current (DC) or Alternating Current (AC) applications?
  - ☐ Who will maintain your system?

Battery storage systems can provide temporary power for some or all of your building's needs in the case of an electric outage. You can also design a building to be totally 'off-grid'; meaning that all the electricity that the building needs is supplied by an alternative power system or systems and stored in a battery storage system. You will need to determine your needs for electric power in order to plan for a battery storage system. Battery technology has slowly been advancing but most storage systems use either lead-acid batteries or deep cycle gel type of batteries.

20H. Active Solar Photovoltaic System: Solar Electric

- ☐ If you are including a photovoltaic system:
  - ☐ Is there enough sunshine to justify the purchase and installation?
  - ☐ How much electric load do you expect to have daily?
  - ☐ Who will maintain your system?
  - ☐ Will the system be a ground mounted system?
  - ☐ Will the system be a building mounted system?

A photovoltaic (PV) system converts sunlight into electrons and creates direct current electricity that can be used immediately, stored for later use in batteries or fed directly into the regional electric grid. (See 'Net Metering'.) PVs can be purchased as individual panels or integrated into roofing. As a rule, the larger the area of PV panels or roofing, the more output in terms of electricity. PV systems are normally measured in watts or kilowatts. (1,000 watts equals one kilowatt) A typical home needs between two and five kilowatts of electricity to provide enough power to meet its requirements. Apartments need somewhere between two and four and one-half kilowatts. Small commercial buildings can vary from two kilowatts to over 20 kilowatts, depending on need.

It is important that you have enough sun-facing roof area to mount your PV system or you will need to have good solar access to other areas of your property and perhaps mount the PV system on the ground or on outbuildings. There are several PV manufacturers located around the world, so finding a PV system that will work for your requirements should not prove to be too difficult. However, you

will need more than just the PV panels or roofing for the system to work. You also need Balance Of System (B-O-S) components to make the PV system function. Some of these components are:

- Special electric wiring made for PV installations that can withstand outside weather conditions
- An inverter (a special power controller)
- A special connection system to the batteries or electric grid.

20I. Grid-Connected Net Metering

- ☐ If you are considering selling electricity back (net metering):
  - ☐ Are you connected to the grid or do you plan to connect to the grid?
  - ☐ What are your states laws concerning net metering?
  - ☐ Does your local government allow for net metering?
  - ☐ Does your local utility allow for net metering? If so, what are the rules and guidelines?
  - ☐ Who will maintain your system?

Net metering is a rather new concept in that if you produce excess electric energy with your alternative energy system, and your utility offers net metering, you can 'feed' this excess electricity into the regional electric grid.

'True' net metering means that you get the exact value for your excess electric energy from the utility. In other words, if it costs eight cents per kilowatt hour to purchase electricity from your local electric utility, then the electricity you feed into the grid is also worth eight cents. As you feed electricity into the grid, your meter actually runs backwards, negating any usage you have had and, eventually, giving you a credit toward future electric use.

You should not expect to receive payment from the utility for excess electricity fed into the grid. Many net metering laws let electric utilities sell their electricity to you at retail rates, but allow the utilities to offer you wholesale or 'avoided cost' rates for your excess electricity. These net metering programs do not encourage the addition of alternative energy onto the grid.

There are several organizations involved in trying to get net metering laws corrected to reflect the value of electricity for everyone involved. However, it is recommended that you check with your state and local government for details on the net metering laws for your area. Also, you will need to check with your electricity provider to obtain their guidelines and rules before you can connect to the grid.

20J. Wind Micro Turbine

- ☐ If you are including a wind turbine system:
  - ☐ What zoning restrictions are there at your location?
  - ☐ Is there enough wind to justify the purchase and installation?
  - ☐ How much electrical load do you expect to have daily?
  - ☐ Who will maintain your system?
  - ☐ How long is the warranty?

Technology regarding wind-generated electricity has improved significantly in recent years. Newer wind systems can work in lower average wind speeds and can be mounted closer to the ground. Large scale wind farms are coming on-line across the United States of America and around the world. Green energy from these wind farms is often available from local utilities and is available to home and business owners.

Smaller scale wind systems are making rapid strides as well. It may soon be possible to have a wind system installed almost anywhere, as long as you have some open space on your property or on your roof. Even if you don't plan to install a wind system on your new or remodeled building, you can make your building solar ready so that the wind system will be much easier to install in the future.

20K. Hydro Power

- ☐ If you are including a micro hydro system:
  - ☐ What zoning restrictions are there at your location?
  - ☐ Is there enough water running throughout the year to justify the purchase and installation?
  - ☐ How much electrical load do you expect to have daily?
  - ☐ Who will maintain your system?

All across the United States of America, and in most locations around the world, water is being stored behind dams and used to create electricity from hydro power. If you happen to be lucky enough to have a spring, stream or river located on your property, you might be able to install a micro hydro turbine to produce enough electricity for your residential and/or small commercial needs.

20L. Fuel Cell

- ☐ If you are including a fuel cell system:
  - ☐ What zoning restrictions are there at your location?
  - ☐ What is the source of your hydrogen?
  - ☐ Will your system be the open or closed type?
  - ☐ How much electrical load do you expect to have daily?
  - ☐ Who will maintain your system?

Electricity generated from a fuel cell for residential or commercial use is no longer a futuristic idea. There are several types of fuel cell systems currently available that run (primarily) on hydrogen. Fuel cells for residential and commercial use are currently quite expensive but expectations are that the price will come down with mass production. The main drawback of fuel cells at this time is the availability of hydrogen. If it is derived from natural gas, it is not a renewable energy source and the cost will fluctuate with the price of natural gas. However, if hydrogen is generated from water using electricity (a process called electrolysis) from a renewable source (e.g. solar or wind) it is a renewable energy source. Hydrogen produced from electrolysis using renewable resources is being studied by many organizations around the world that are trying to lower the cost of production.

Landscaping

21A. Conventional vs. Environmental-Focus

CONVENTIONAL LANDSCAPE

A conventional landscape is one that requires significant amounts of water, fertilizer, herbicides, pesticides and maintenance to survive. In other words, most conventional landscapes are actually imports from another climate zone or are not utilizing naturally occurring plants from your region.

While it is possible to create an artificial environment for your landscape (such as growing grass in the desert) it may not actually be the foliage that nature intended to live there.

When oil and water are cheap and plentiful, then any landscaping plan is feasible no matter how exotic. As water and oil become less plentiful and more expensive, the cost to maintain that exotic landscape will skyrocket, especially if it requires extensive water and use of fertilizers made from oil.

ENVIRONMENTAL-FOCUS LANDSCAPE

Fortunately, most climates have a variety of plants that thrive in that environment without the need for excessive watering, fertilizer, herbicides, pesticides and maintenance. This environmentally focused (or green) landscaping for your home or business can have its benefits and disadvantages.

One disadvantage is that it can be somewhat more expensive and time-consuming to plan a natural landscape than it is to call the local lawn turf supply company to deliver grass and then pickup a few plants at the local store. However, with careful planning, natural landscape can provide a beautiful environment for your building while being easy and low-cost to care for.

Going green can require extra work and time, whether in the selection of a professional who will truly provide a green landscape or in the research to accomplish it yourself. There are also upfront cost and availability considerations to be weighed against life cycle costs.

But, the benefits can be truly enormous: buffalo grass does not have to be mowed very often; succulent plants may not need any extra water or care whatsoever and some plants, like Sunflowers, will grow in a large variety of soil types and conditions.

21B. Personal vs. Professional

- ☐ Will you do your own landscaping?
- ☐ Will you hire a professional landscaper?
- ☐ Is it important to you that your landscaper have experience working with native/natural species and techniques?
- ☐ Will you plan to complete your landscaping in a single phase?
- ☐ Will you make landscaping an ongoing project?
- ☐ Are you interested in using an environmental focus in your landscaping?
- ☐ Have you researched your landscaper?

When considering your home's landscaping, you want to weigh the cost of hiring someone else against your own experience/expertise. Another factor is the time frame in which you wish to have the project completed. Completed in this case can mean resulting in a fully finished looking landscape versus working in phases over several years to achieve a fully finished looking landscape.

If you decide to pursue having a professional do the job, consider the following when choosing the right landscaping contractor for you.

- Start with reliable references (family, friends, environmental organizations).
- Interview several companies (have them come to your site and get quotes).

Key factors in your research should include:

- ☐ How long has the company been in business?
- ☐ How many employees do they have and how many of them will be working on your job?
- ☐ What languages do they speak (it is very important that you are able to communicate clearly with the lead contractor and/or employees)?
- ☐ What services do they provide and what are their specialties?
- ☐ What are their hours of business and the best time to reach them (get their contact information)?
- ☐ What professional affiliations do they belong to (e.g. Better Business Bureau, national or state landscaping associations, etc)?
- ☐ Are they licensed?

Being certified by the state will mean that the service is accountable to you and operating legally. And it normally implies that the employees have passed tests which prove a higher level of education, professionalism, and quality of work.

- ☐ Are they insured?

VERY important. If not insured properly, you could be liable for accidents or injuries during their time on your property. Make sure you check for proof of insurance (make a photocopy if need be). Make sure the company's name is on the policy, make note of what the policy number is, expiration date, insurance company's phone number, etc. It is wise to call the insurance company ahead of time and verify that the policy is valid.

- ☐ What guarantees do they have, what specifically is covered and the length of the guarantee?
- ☐ Do they provide references?

Get at least three references from them. Drive by the locations if at all possible and/or look at photographs of their work. Take notes if necessary. If you feel comfortable, contact the people they did work for and ask questions regarding their overall satisfaction, quality, and if they did what they agreed to do and in a timely manner.

- ☐ Do they provide a contract?

Make sure the company provides a written contract with details of your project clearly laid out and prices for each detail. If you can get a detailed graphical layout of the work as well, do so. Also get a quote on changes or possible problems or unseen factors that may arise during the job

- ☐ Do they offer ongoing maintenance?

You may or may not be interested in the upkeep of your landscaping, but it is a good idea to find this out in case your interests change.

21C. Site Considerations

- ☐ Can you work with your land the way it is to achieve the landscaping results you desire?
- ☐ Are you willing to adjust your expectations to minimize disruptions to your land?
- ☐ Is it necessary to 'sculpt' your land to achieve the results you desire?
- ☐ Are there problems beyond aesthetics that need to be addressed?

Land characteristics was discussed in the ***Building Site*** section regarding the selection of your site and working with your site for placement of your home.

Steep slopes can require the use of special plants and retaining walls. Milder slopes offer options such as rain gardens and terraced plantings.

21D. Water Issues

- ☐ Is water runoff or retention an issue for your site?
- ☐ Is there already, or do you plan to add, a water feature (such as a pond or lake)?

Storm water runoff is becoming a serious issue for many localities. Water runoff/retention was discussed in relation to your building site in the ***Excavation/Foundation*** section. As it relates to landscaping, erosion problems are a primary consideration.

Be sure to consider the use of 'permeable' concrete or other similar products for your driveways, sidewalks and other parking areas so that water can soak through rather than simply run off. These items are discussed in a subsequent section.

Whether or not there is too much water or water in problematic locations; it is important to make decisions about how you will deal with water issues. Some issues are dangerous and must be handled by professionals. Others can be handled by changing your expectations. Some water retention solutions include:

RETENTION POND

This is an option only if you have enough land to accommodate a pond.

REDIRECT RUNOFF VIA A RIPRAP STREAM

If you have the space and can create a small storm water stream nearby; this may be the best way to redirect your excess rainwater. However, we suggest that you also install a rain garden or other water-absorbing feature to help reduce the amount of runoff.

INSTALL AN UNDERGROUND REDIRECT SYSTEM

If you live in an urban area, you may already have an underground redirect system (commonly known as a storm sewer). Small applications of this technique of water relocation can involve burying partially perforated tubing under low lying areas that then allows for a gravity flow to a pond or area with better drainage.

COLLECTION SYSTEM (I.E. CISTERN)

Collecting excess rainwater in a storage tank or cistern is an excellent way to have water available for landscaping when you need it. Some systems include a filtration system to cleanse the water of impurities. It is also possible to use this rainwater for other outdoor purposes, such as washing your vehicles. See the ***Roofing*** and ***Water Heating and Use*** sections for more on water collection.

RAIN GARDENS

Rain gardens are basically small depressions in your yard that have plants and flowers capable of producing long roots. These depressions hold rainwater for about a day or so, which is long enough to help water the plants but not long enough for mosquitoes to use the 'pond' for hatching eggs.

SWALES

A swale is a ditch on the contour. It does not direct water, but holds it and allows it to gradually infiltrate the soil down-slope of it. Soil and water run-off are caught in the swale which becomes a fertile area. Gradual infiltration of water and nutrients and the dead roots of plants growing in the swale slowly improve soil structure down-slope.

NATURAL SINKS

A natural sink is basically a natural depression in the ground that retains water during rain storms. Natural sinks differ from rain gardens in that they can be larger and are often mowed just like the other grounds.

EARTH BERMS

Earth berms are raised areas of earth, similar to dikes, that help redirect water to the locations that you have chosen, rather than randomly.

PONDS, LAKES

Generally, a pond or lake is a beneficial feature to have on your site. However, there are aspects that may be undesirable to you. A naturally occurring water feature will (generally speaking) need less maintenance than a man-made one. Be aware that alterations to the land around you (particularly land beyond your control) can introduce pollutants, change the watershed (which can either flood your water feature or dry it out) and cause it to silt in. Reptiles and insects are attracted to water features… so are people (which introduces possible liability issues).

21E. Natural/Native Plants

☐ Are you interested in incorporating natural/native plants in your landscaping?

When discussing a natural and/or native landscape, we are referring specifically to plants and trees that are native to the region. Just because the climate and conditions are appropriate for a plant does not mean the plant is naturally occurring or native to the area. The local nursery or lawn and garden center may know what plants are native to your area or region.

21F. Existing Foliage, Trees

☐ Are there specific plants or trees on your site before construction that you want to keep?

This is also discussed in relation to your building site in the ***Excavation/Foundation Section***. Keeping the existing trees on your site is less expensive than cutting them down and replacing them at a later date. The same basically holds true for foliage. There are exceptions in that some trees are considered to be trash trees and could be replaced with 'nicer' versions. Some foliage needs to be removed, such as poison ivy or vines with nettles, and replaced with more people and pet friendly plants.

21G. Xeriscape®, Edible Landscaping and Gardens

☐ Are you interested in using the Xeriscape® method of landscaping?

☐ Do you plan to grow your own food?

XERISCAPE®

Xeriscape® is a type of landscaping that creates a no maintenance situation (once established) because it is designed to thrive without additional water or artificial fertilizers, etc. Xeriscape® was invented to help provide an answer for climates where water is becoming scarce. While this type of landscaping is becoming more attractive, and there are more professionals doing it, it is not commonly available in most locales without some research.

EDIBLE LANDSCAPING AND GARDENS

As a proponent of green building, you may already have the same sensibilities toward your food. If not, healthy eating is an excellent complement to expand on a sustainable lifestyle. It is easier and easier to find natural food grocery stores, Community Supported Agriculture (CSA) programs and Farmers' Markets. However, you will find that nothing beats eating food you have grown yourself.

Growing your own food can be one aspect of making landscaping practices more environmentally sound. One way of accomplishing this is to trade out purely ornamental plants, shrubs and/or trees with those that will provide food for your table in addition to ornamentation.

Edible landscaping is a practice that proves it is possible to plan a yard that is both beautiful AND productive using resource-saving techniques. Even conventional gardens (areas dedicated to producing food) can be converted to edible landscaping by adding companion plantings that are

ornamental as well as function. With a bit of research and prior planning, your yard will be a treasure chest of bounty and beauty.

21H. Dry Climate

- ☐ Is there a shortage of water for landscaping?
  - ☐ Do you plan to address water issues by planting drought-tolerant or natural/native species?
  - ☐ Do you plan to irrigate?

Dry desert climates have unique landscaping concerns and opportunities. Certain types of cactus may only grow in the desert southwest, so this may present a unique attraction in your yard. Other plants may require more water than is naturally available and the question of water is whether you want to supply, distribute and pay for it. The other choice is to use Xeriscaping or, at least, natural/native plants which do not require an additional supply of water.

21I. Efficient Watering Systems

If you want areas of your landscape to be provided with additional water, it is often cost effective to install a distribution system that does not waste water. An in-ground watering system is convenient but it is also important to consider the up-front cost of installation, which can be substantial (and maintenance is also a consideration). Drip irrigation is a viable alternative, especially when combined with appropriate levels of mulch. Using collected water (i.e. gray water from home use and rain water) is an alternative to city water intended for consumption.

21J. Other Landscaping Considerations

- ☐ Will you include a composting area?
- ☐ Will you include a windbreak?

There are other options regarding your landscaping.

COMPOSTING

Organic matter decomposes and becomes nutrient-rich soil or humus (pronounced hue-muss). This process of aerobic decomposition (or composting) is a gardener's best friend because it replenishes what the plants deplete. So, if you are interested in naturally replenishing the nutrients in the soil of your landscaping (edible or not), it makes sense to set aside an area of your yard for composting.

There are two different approaches to composting: active and passive. In both approaches the decomposition is performed primarily by aerobes (an aerobic organism or aero is an organism that has an oxygen based metabolism), although larger creatures such as ants, nematodes, and worms also contribute. This decomposition occurs naturally in all but the most hostile environments (such as within landfills or in extremely arid deserts, which prevent the microbes and other decomposers from thriving).

Active

If you want to speed up the process of composting the waste of your yard and kitchen and ***you want to play an active roll in the process,*** try the active approach. Active (or hot) composting, allows aerobic bacteria to thrive, killing most pathogens and seeds, and rapidly produces usable compost. Aerobic bacteria produce less odor and fewer destructive greenhouse gases than their anaerobic counterparts. In addition, they are usually faster at breaking down material and the faster material is broken down, the faster compost is created for your garden.

Pasteurization of compost will occur in any garden compost bin if the temperature reaches above 131°F (55°C) for three or more days. To achieve it, you need to keep your garden compost bin warm, insulated and damp since this encourages the cultivation of actinomycetes (vital bacteria in the pasteurization process). Naturally created pasteurized soil through heat in the garden compost is very valuable for the composting gardener since it is both expensive and complicated to pasteurize material chemically (not to mention less healthy).

Passive

Passive (or cold) composting lets nature take its course in a more leisurely manner and leaves many pathogens and seeds dormant in the pile. For example, if you rake (or gather some other way) grass clippings and dried leaves into a pile and leave them alone, over time the pile will become smaller and smaller. If you then dig down through the remains you will find deep, dark soil that is a wonderland of burrowing insects and worms. This is an example of passive composting in action. A no muss, no fuss composting approach… just gather the material together and leave it alone to do its thing. All it takes is time… lots and lots of time.

Temperatures in most domestic garden passive compost bins never reach above 86°F (30°C). Passive composting is not recommended for kitchen scraps. In this circumstance, a garden compost bin becomes a storage container for scraps and has a very high moisture content which means it turns quite anaerobic and smelly. This passive kitchen scrap type of composting generates significant adverse green house gas emissions.

DISEASE RESISTANT AND DROUGHT RESISTANT STRAINS OF PLANTS

Disease resistant and drought resistant strains of plants are often available if you must have a particular plant that is not natural or native to your region. Also consider using perennial plants that come back year after year in place of or in addition to annual plants that have only one growth season (although many annuals may reseed themselves).

INSECTS

While it seems that insects are 'the enemy', many insects are beneficial to your landscape and can actually help you maintain its health and longevity. While insect resistant strains of plants are often available, there is concern that they help to create stronger insects (much as we see in diseases that are no longer affected by antibiotics).

ANIMAL HABITATS

Animal habitats are a great addition to your landscape. While bats are often feared, they actually feed on mosquitoes and are an excellent neighbor to help you control or combat that problem. Snakes, too, are a problem for many people, but because they eat rodents and insects, they can also make good neighbors. It is possible to become familiar with the types of snakes that are non-poisonous vs. the poisonous kinds so that you can co-exist with your non-venomous neighbors. If you are concerned about unwelcome animal guests in your residential or small commercial building, talk with your team about making it difficult and unattractive for them to gain entry.

WINDBREAK

There should be a windbreak for the prevailing winds in winter. This windbreak can consist of coniferous trees that keep their leaves or needles in the winter months. Deciduous trees (trees that loose their leaves in the winter) should be planted in such a way as to help keep the summer sun off the building while allowing the sun to come into the building in the winter months.

Driveways, Walks, Pathways

- ☐ Does your building site require:
  - ☐ a parking lot?
  - ☐ a long driveway?
  - ☐ pathways?
- ☐ How will you deal with water runoff?

22A. Non-Porous Concrete or Asphalt

Conventional concrete and asphalt are considered to be non-porous materials in that excess rainwater runs off the surface as opposed to being absorbed. Large areas of non-porous materials, such as parking lots and long driveways, can have significant amounts of water runoff, particularly during heavy rains. Considerable design time, materials and expense have been dedicated to dealing with excess runoff; and most of the modern methods to handle storm water leave much to be desired. Fast-moving water traveling across expansive parking lots rapidly becomes fast moving torrents in drainage ditches, streams and rivers. Massive soil erosion, loss of topsoil and tragic events, such as drowning, are attributable to the fast-moving water generated by today's storm-water runoff systems.

The storm-water situation is far from hopeless, however. Many municipalities are encouraging the use of rain gardens, drainage swales, water retention ponds and other strategies to slow the runoff of rainwater.

22B. Permeable Concrete

One of the newer strategies is to use permeable concrete (which allows water to percolate through) versus solid concrete for driveways, parking lots and even airport runways. This permeable product is designed to allow water to soak into the ground rather than to travel across the surface. Permeable concrete typically has a gravel base so that the water has ready access to the soil below.

22C. Porous Sidewalks and Permeable Pathways

Sidewalks and bike paths made of non-porous concrete or asphalt also contribute to the rainwater runoff problems. Sidewalks and bike paths can be made from permeable concrete so that a good percentage of the rainwater striking their surfaces soaks into the ground.

The use of stepping-stones, blocks and paving stones placed strategically on the ground is another method of providing a walking surface while minimizing the amount of non-permeable concrete or stone, thereby allowing the rainwater to soak into the soil.

Some pathways do not necessarily have to be paved. Certain bike paths and walking trails can be comprised of wood chips, crushed nut hulls (such as walnut) or even chunks of rubber from old car tires. Not only can these trails be made less expensively and with recycled materials, but they also can allow water to permeate the trail and reduce runoff. Care should be taken to use materials that do not leach chemicals into the soil.

22D. Concrete Lanes-Only Driveway

Many older farmsteads have driveways comprised of two narrow lanes of concrete spaced approximately the width of most tire tracks. These lanes of concrete keep the vehicle's wheels high and dry, and yet allow most of the surface taken by traditional driveways to be grass.

22E. Heated Driveways and Sidewalks

In some colder climates, driveways and sidewalks can be heated to provide snow and ice melt.

CONVENTIONAL ELECTRICITY

The expense for electricity can be significant, but likely much less than the cost of a lawsuit due to a customer or visitor falling on the sidewalk, driveway or steps.

HEATED WITH SOLAR ELECTRICITY

Newer ice melt systems for driveways and sidewalks/steps utilize direct current and can be directly attached to a solar electric (PV) system. The PV system provides power to the resistance strips or wires embedded into the concrete and can provide enough heat to melt ice and snow. There are special mats comprised of compounds that will heat to a certain temperature and then discontinue using electricity so that the remaining solar electric power can be utilized for other purposes.

HEATED WITH CONVENTIONAL HOT WATER

Rather than running electric wires or special electrically heated mats under a concrete/asphalt driveway or sidewalk, you can install special pipes under the concrete. These pipes can carry water or an anti-freeze solution that is heated by a fossil fuel-fired boiler or electric resistance water heater or boiler.

HEATED WITH SOLAR THERMAL HOT WATER

Instead of using a boiler or water heater to heat the water or anti-freeze solution circulating under the sidewalk or driveway, you can use a solar thermal water heating system.

HEATED WITH HEAT PIPES

Heat pipes are a unique invention that can transfer heat via an enclosed refrigerant. Similar to the old coffee percolators that had the hot water rise up the center tube, heat pipes allow the refrigerants to rise when heated and then migrate back to the point of origin as they cool. Various refrigerants 'boil' (transfer heat) at different temperatures and the range of temperatures can be changed by the amount of vacuum in the pipe. You can purchase heat pipes that are designed to boil at a relatively low temperature, such as 50°F. By putting long heat pipe (for example: ten feet) under a sidewalk, driveway or even an airport runway, the pipe will circulate heat from deep underground and transfer this heat to the opposite end of the pipe. Therefore, a heat pipe can continually transfer heat from deep in the ground to warm the concrete or asphalt to a temperature above freezing and will melt ice and snow.

Outbuildings

23A. Garage

- ☐ Are you concerned about gas and other chemical fumes relating to your vehicles entering your home?
- ☐ Will you be heating and cooling your garage?
- ☐ Is it important for you to have access to your vehicle without going outside?
- ☐ Will you be storing more than your vehicles in the garage?
- ☐ Will your garage also function as a workshop or something else?

For many residences the garage is located under the same roof as the rest of the building, so any chemical fumes or gasoline vapors released by the vehicle in the garage will possibly migrate into other rooms and cause indoor air quality and/or health problems. You may want to consider a detached garage when designing a new residence or commercial building. Consider designing your detached garage as part of the entire complex (as discussed in the ***Evaluating Plans*** section). You can connect a detached garage with a breezeway so that you do not have to get wet when going from home or business to the garage. If you do incorporate a garage into the primary building structure, be sure to have operable windows and/or a fan connected to a timer or sensor to help remove any fumes that accumulate.

If possible, consider adding some extra space in your garage for future use. Many experts predict that the use of fuel cells or hydrogen will become widely available in the future and the garage is the most likely space to locate the fuel cell or hydrogen generator.

Generally, you may be able to save yourself some money buy ordering the materials for your multiple buildings at the same time. Perhaps combining functions in your detached garage is also advantageous; one building to accommodate your garage, workshop, storage, etc. If you do not want to build them at the same time, be sure you have a secure structure in which to store the materials for later use.

23B. Workshop, Hobby Shop

- ☐ Do you use flammable or combustible products in your workshop?
- ☐ Do you need high voltage electricity for your workshop?
- ☐ Will you be heating and cooling your workshop?
- ☐ Is it important for you to have access to your workshop without going outside?

Regardless of the intended purpose of your workshop or hobby shop (woodwork, crafts, art studio, etc.) you might consider detaching it from your home or other buildings for safety reasons.

Perhaps you concluded from the above questions (and your answers) that having your workshop connected to your home is not necessary or even advantageous. In that case, consider designing your detached workshop as part of a home complex (as discussed in the ***Evaluating Plans*** section).

23C. Guest Quarters

- ☐ Do the guests you entertain require overnight or extended stay accommodations?
- ☐ Is your privacy important to you?
- ☐ Is there a possibility that a relative or friend may need to stay with you for an extended amount of time?
- ☐ Do you need permanent accommodations instead of or in addition to guest quarters?

If your zoning allows you to have more than one home on your property, you may want to build separate guest quarters. If you are not zoned for more than one home on your property, you might consider creating a separate entrance to a section of your home to serve as guest quarters or an apartment. If you are elderly or plan to remain in the residence for the long run, you may want to allow space for a nurse or hospice worker to live and/or work. Be sure to find out from your zoning commission how they define a guesthouse and semi-permanent apartment.

NOTE: The legal and financial aspects of renting a guesthouse or apartment is not what is being discussed here. If the zoning that applies to your building allows guest quarters or additional homes/apartments to be built, then we would encourage you to build them as green as possible. However, there can be legal ramifications that extend beyond the scope of this Green Building Decision Kit which is for educational and informational purposes only and does not include any legal or financial advice or recommendations. We suggest that you utilize a competent attorney for any legal questions that may arise and a competent CPA or other financial expert to help determine the financial aspects of a project.

23D. Heat Producing Exterior Furnace

- ☐ Do you want to use a separate building to house an exterior furnace?
- ☐ Are there zoning rules in your area about exterior furnaces?
- ☐ Are you subject to neighborhood covenants that restrict your ability to put other outbuildings in your yard?
- ☐ Are you willing to expend the effort to be sure the furnace has enough fuel at all times?
- ☐ Are you willing to maintain your exterior furnace yourself?
- ☐ Will you hire someone else to maintain your exterior furnace?
- ☐ Do you have a place and process to legally dispose of or reuse the waste produced by the furnace?

An alternative to placing a furnace in your utility room is to build a separate building to house an exterior furnace. This is especially advantageous if you need to store and burn biofuels to create heat (corn, wood, etc.) and you have access to a sustainable, abundant and less expensive product. However, you will need to find out if you are zoned for such a situation. You will also want to consider hiring someone who has experience with this type of heat source and including them in your design team.

23E. Battery Storage Building

☐ Are you interested in maintaining your battery storage in a building separate from your living space?

If you are using renewable energy alternatives such as wind power and solar, you will need to store the excess energy in batteries for later use. Generally, batteries are considered safe to locate in your home as long as there is adequate ventilation. A small fan will normally suffice for removal of gasses generated as the batteries are being charged. However, the size and quantity of batteries needed for your particular situation might take up a great deal of space. Plus, there are always safety concerns when dealing with large volumes of stored energy. For these reasons, consider your options for maintaining your battery storage in a building separate from your living space. Check with the zoning commission in your area about outbuildings. Also investigate if you are subject to neighborhood covenants that restrict your ability to put other outbuildings in your yard. Batteries need to be maintained at a constant temperature, so consider that the exterior building will need to be heated and/or cooled. (This exterior building should be built with insulation in the walls, ceilings and floors. It can be partially underground with an ice house roof.)

23F. Shed

☐ Will you need one or more sheds for storage?

Depending on your building site, the ability to use one or more sheds for storage may or may not be limited. A shed is typically a small building that is neither heated nor cooled and is often used for garden and yard tools, lawn mower storage and other storage needs. Some outbuilding designs incorporate daylighting or solar heating to make the shed more useful. Check with the zoning commission in your area about outbuildings. Also investigate if you are subject to neighborhood covenants that restrict your ability to put other outbuildings in your yard. Most sheds are built using either wood or metal, however there are some designs made from plastic and other materials.

23G. Larger Buildings, Barns, Specialty Buildings

☐ Do you need a barn or other specialty building?

If you have enough space to accomodate them, barns and large outbuildings can be extremely useful. Barns can be built using traditional or more advanced construction techniques. However, you may want to design your barn or other outbuildings to match the outer décor of your primary residence.

You might consider adding solar heat, such as passive or active solar air systems, to your barn to help warm it in the winter. You can also utilize the ice house roofing system to help keep your barn or large outbuilding cooler in the summer.

Barns and other large outbuildings can provide additional roof area for solar systems that are connected to the primary residence or small commercial building. Batteries and/or solar storage tanks

can often be safely stored inside a barn or other large outbuilding, provided that they are protected from freezing and/or over-heating.

Buildings that are specific to a function may include a greenhouse, a chicken coop, a stable, a dog kennel, etc. Since many specialized outbuildings are commercial in nature, you will need to prove your non-commercial use if your area is not zoned for such buildings. Otherwise, we suggest that you build these buildings where approved by code using the same green techniques and suggestions provided in this Green Building Decision Kit. It is possible to make buildings much more energy efficient and environmentally friendly than current standard practices. Renewable energy systems can be used to provide space heating and electricity for specialty buildings.

Check with the zoning commission in your area about outbuildings. Also investigate if you are subject to neighborhood covenants that restrict your ability to put outbuildings on your property. This will be especially true with large outbuildings like a barn.

Other Decisions

24A. Natural Pest Control

- ☐ How will you approach pest control:
  - ☐ Use poison or other kill methods yourself?
  - ☐ Hire a professional to use poison or other kill methods?
  - ☐ Use humane methods yourself?
  - ☐ Hire a professional to use humane methods?
  - ☐ Adapt sustainable habits that discourage unwanted pests?
  - ☐ Encourage beneficial insects and animals to cohabitate with you?

While we touched just a bit on this subject in the section on ***Landscaping,*** there is much more to pest control than encouraging beneficial insects into your yard. The basic answer to pest control is removing their food source. If they can't find food in your yard, they will move to where they can find it. For example, locating a garden next to your home will encourage both harmful and beneficial insects to live nearby.

When it comes to making pest control decisions the conventional methods is to spray with pesticides vs. sustainable methods, which can include plants that discourage pests, beneficial insects and using other strategies that don't involve chemicals or poisons. As odd as it may seem, your building design decisions can be a factor in discouraging pests or encouraging them. For example, natural wood siding may be enticing to woodpeckers, while buildings with overhangs may attract wasps looking for a place to nest. We suggest that you visit a building near your project location that is using the same or similar materials to what you are considering and ask the occupants about their experiences with that building.

24B. Natural Habitat

- ☐ Will you consider the habitat of beneficial creatures:
  - ☐ Minimize disruption of habitats during the building and landscaping processes?
  - ☐ Disregard the habitats of non-humans?
  - ☐ Add natural habitats that aren't too much trouble?
  - ☐ Encourage bats, birds, bees to 'move in' using houses, feeders, water features, etc.?
  - ☐ Incorporate natural habitats into your landscaping?
  - ☐ Create a mutually beneficial human and non-human habitat?

Another topic that was touched on in ***Landscaping*** is the creation of habitats for beneficial creatures. The very act of creating a human habitat and building a home destroys the natural habitats of many creatures. While conventional thinking considers this a moot point; green building encourages

considerations which minimize the disruption of natural habitats. Additionally, the creation of natural habitats within your landscaping can provide you with glimpses of rare wildlife and can be very fulfilling as well as good for the environment. A woodpile can make a home for a fox or woodchuck. Natural berries are attractive to birds and turtles. Bats can eat tons of mosquitoes and other insect pests, so the placement of bat roosts (homes) near your home or business makes good sense.

24C. Awareness, Lifestyle

- ☐ Are you likely to make adjustments to your past lifestyle due to the fact that you have built a green building:
  - ☐ Make no changes to your current lifestyle?
  - ☐ Open to making adjustments in the area that prompted you to build a green structure?
  - ☐ Open to making adjustments in other areas that you've learned about while building a green structure?
  - ☐ Consciously make changes to be mindful of your effect on the environment?
  - ☐ Live your life as an example to others regarding the effect humans have on the environment?
  - ☐ Promote your eco-effective lifestyle?

What comes first… awareness, lifestyle or becoming a green built homeowner? Obviously, if you have sought out this Green Building Decision Kit, you have awareness that a green building is beneficial to you in some way (i.e. less polluting, more healthy, etc.) There is a range of awareness associated with a green building (including the pros and cons). Once you have built or remodeled your new building and, hopefully, have made it as green as possible, what should you do to maximize your investment? Many ideas and strategies look good on paper and may even install flawlessly in the building. But, if not used properly, the energy or environmental savings that you were seeking will not occur. This could mean changes to your current lifestyle. Wearing sweaters inside in the winter is less expensive than turning up the thermostat. A recycling center will not pay for itself if everyone continues to throw recyclable items in the trash.

So, what kind of lifestyle change are we talking about? Do you have to commit to being an environmental activist if you build a green building? Of course not. Are you likely to look at your past lifestyle and make adjustments to your future lifestyle due to the fact that you have built a green building? Quite possibly!

For example, why would you build an energy efficient home or small business building and then use it in a way that burns more energy than before you had your energy efficient building?

How much you change or don't change your future lifestyle is truly up to you. However, building a green building can make some lifestyles adjustments easier because you now have that recycling center or the electric vehicle charging station.

24D. Building Owner's Manual

- ☐ Will you compile a system and maintain your green building in a sustainable fashion:
  - ☐ Build a totally maintenance-free building?
  - ☐ Maintain your building yourself, but don't want to spend much money to do it?
  - ☐ Maintain your building yourself to reap the benefit of your investment?
  - ☐ Hire a service to maintain your building to reap the benefit of your investment?
  - ☐ Maintain your building and set aside extra money yearly to expand its value?

Once you've built or remodeled your green home or small commercial building, you will want to get the best return on your investment possible. The way to do that is to treat it well and keep it in the best possible condition.

We recommend that you first gather the manuals you received with your appliances and write down the maintenance and service information and schedules. Then create an 'Owner's Manual' like the one you get with your car. We recommend that you use a three-ring binder with pockets so you have everything together to properly maintain your equipment or in case of an emergency.

Make routine preventative maintenance part of your new green lifestyle. Calculate the maintenance and service costs into your yearly budgets and spend what is necessary to keep your building healthy, energy efficient and eco-effective.

If you have decided to delay the inclusion of something because of the expense (such as adding PV solar electric panels), we recommend that you budget some extra money to put aside for it each year and then increase the value of your building by adding it as soon as it becomes viable.

24E. Innovative Design

- ☐ Are you interested in going above and beyond green building to using cutting edge practices and products:
  - ☐ Not interested in experimental things?
  - ☐ Interested in incorporating things that have been tried and tested?
  - ☐ Like to beta test new methods and/or products in your building?
  - ☐ Want to go all the way with innovative design?

We've gone over the basics of construction with green options included; however, we did not address the ultimate aspects of green building, which include innovative designs.

For those of you who want to go beyond the basics and want to incorporate the utmost green building practices, you will need to seek out experts in architecture, engineering, energy efficiency and green design who will help you get the most return for your investment during the design process.

You may also want to experiment with cutting edge practices and products. Remember that many ordinary things we take for granted, such as garage door openers, were once considered experimental and it is people like you incorporating them that caused acceptance and change.

24F. Green Building Certification, Green Tags

GREEN BUILDING CERTIFICATION

- ☐ Are you interested in having your green building certified?
- ☐ Has your zoning authority incorporated a green certification process?
- ☐ Is there a regional, independent organization that has a green certification process?
- ☐ Does your architect, or other member of your design team, know of a certification process?
- ☐ Did you know there are incentives for building a structure that is highly energy efficient?
- ☐ Is someone on your design team familiar with LEED® for Commercial Buildings or LEED® for Homes?
- ☐ Is there a LEED® facilitator in your area?

You decided to use as many green building practices as you could afford in your new home or small commercial building. You may now be interested in getting your new home or commercial building certified.

Just as a commercial building can be certified under the LEED® (Leadership in Energy and Environmental Design) program offered through the U.S. Green Building Council (USGBC); your residential project could be a candidate for the LEED® for Homes program. Keep in mind that it is time consuming and somewhat expensive to get a building certified under the LEED® program. Plus, you will need to contact the USGBC at the beginning of your design process to get the paperwork started. You cannot certify a building under a LEED® program ***after*** it is built if you have not contacted the USGBC.

There are other programs, such as the National Assocation of Home Builders (NAHB) Green Building Guidelines/Standards, that also certify green buildings. So, it might be the time to do some more research.

It is possible that there may be a certification process or green awards available to you through a local or regional organization. Many local, regional and statewide organizations are beginning to seek out and recognize green buildings built in their locales. Before you get too far in the process you will want to investigate how much paperwork and cost is involved in a certificate or award.

In the Design Team item of the *Initial Considerations* section, you will find contact information regarding the USGBC and NAHB programs.

GREEN TAGS

- ☐ Do you want to offset your fossil fuel energy use with Green Tags if you are not able to include renewable energy generation at your site?

What is it?

A Green Tag is another name for a Tradable Renewable Certificate (TRC). A TRC represents the separable bundle of non-energy attributes (environmental, economic and social) associated with the generation of renewable power (whether by wind, solar, geothermal or bio-mass). TRCs are sometimes also referred to as green tickets, renewable certificates, RECs (renewable electricity certificates or credits), and T-RECs (tradable renewable energy certificates).

What does it do?

TRCs are used in many different contexts for different purposes. This sometimes creates confusion for those unfamiliar with the full range of their use. They are generally sold separately from their associated energy as an independent 'product' or may be combined with electrical energy at the point of sale to create a renewable electricity offering. In these instances, the TRC is created as a tracking and accounting tool to show the environmental and other characteristics of the electricity that has been generated and sold.

TRCs may also be used as an accounting tool to support retail claims for differentiated 'green' products, i.e. to verify claims to customers that a supplier purchases renewable energy.

How does it work?

A TRC is created for every unit of renewable electricity output (usually denominated in megawatts, or MWh) and no more than one TRC can be created for any given MWh.

Third party certification is necessary to assure the validity of any TRC program, such as provided by Green-e®. Green-e® states on its website (Your Consumer Rights): "It is important for customers to understand that without verification of ownership or retirement on the their behalf, customers can make no claims about environmental benefits associated with generation of the renewable energy they have purchased, including but not limited to greenhouse gas or other emissions reductions."

A TRC is an excellent way to engage in the renewable energy generation movement; especially if you are not able to implement renewable energy generation at your building site. TRCs compliment conservation measures and other means of promoting the use of renewable energy. In some green building certification programs, TRCs can be included as part of the certification process.

Those people who want to become 'carbon neutral' can purchase TRCs to offset their total energy consumption; including the operation of equipment and travel (such as planes, trains, buses, automobiles). This is an important choice that all people ought to have so we can shift our energy supply to clean, domestic, renewable energy and reduce reliance on non-renewable fossil fuels.

For a more detailed discussion of what TRCs are, how they are used, and where you can purchase them:

- Green-e website: www.green-e.org
- Green Power Network: www.eere.energy.gov/greenpower/certificates.shtml

24G. Energy Rating Incentives

- ☐ Is someone on your design team familiar with Energy Star® for homes or commercial buildings?
- ☐ Is there an energy rating company in your area that can test your building to determine if it meets the necessary qualifications to achieve incentives?

You have decided to make your new home or small commercial building as energy efficient as possible. Did you know that there are incentives for making that decision? You will need to hire the services of an Energy Rater to verify the efficiency of your home and qualify for the incentives available. Your energy rater or local energy utility can help you find someone to help you with the commercial tax credits for your new home or small commercial building. Be sure to investigate Energy Tax Credits available for both new and existing homes. For details and updates regarding the tax credits, go to: www.energytaxcreditinformation.com

Energy Star® FOR HOMES

This government program is administered by the United States of America's Environmental Protection Agency and can offer additional benefits such as lower interest home loans and recognition on the their website.

Energy Star® homes are more energy efficient than conventional homes built to meet code* and Energy Star® products are more energy and/or water efficient than their counterparts.

*Except in California, U.S.A. Residential buildings constructed to meet Title 24 requirements (California energy code) can be more efficient than homes built to Energy Star requirements for other regions of the United States of America. Energy Star homes built in California work with a unique set of guidelines.

Energy Star® FOR COMMERCIAL BUILDINGS

The Energy Star® Program recognizes energy efficient commercial buildings as well. Information about the various Energy Star® programs is available online at: www.energystar.gov

This concludes the Information Pages for the Green Building Decision Kit.

Please utilize the information and the links listed in the Green Building Decision Kit Section of the www.DYOKits.com website.

About the Authors

Kenneth C. Riead

Ken Riead has worked with many diverse companies and organizations. He is a certified energy and environmental instructor and has Public Relations, Solar and Energy degrees. His certifications include:

- Senior Certified Energy Manager and Demand-Side Manager with the Association of Energy Engineers (AEE)
- Certified Sustainable Development Professional
- AEE Chartered "Legend in Energy"
- Certified Home Energy Rater (HERS) accredited through the Residential Energy Services Network (RESNET)

Ken is the Senior Consultant for Hathmore Technologies, LLC, an energy and environmental consulting and testing firm in the Kansas City area. He specializes in energy tax credits for residential and commercial clients and works with progressive green projects.

Ken is the past Residential Green Building Advocate (LEED for Homes Advocate) for the U.S. Green Building Council Central Plains Chapter - Kansas City Branch. In this role Ken has helped Greensburg, KS rebuild as a national green model and he developed a Greensburg Green Guide as a regional green resource tool. The USGBC has designated Kansas City as the national disaster recovery green program team due to all the work done for Greensburg, New Orleans and others.

Ken is now working with the Green Impact Zone of Missouri (GIZMO), located in Kansas City. GIZMO is unique in that it is the only green project formally funded by the ARRA Stimulus funds. Info about GIZMO, Greensburg, New Orleans and other projects can be found at www.Hathmore.com.

Background Information: Ken became interested in renewable energy and energy conservation in 1974 when he helped build one of the first solar homes in the Kansas City, Missouri area. He was intrigued by the fact that free energy was available daily from the sun. Ken moved to the Denver area in 1978 to become immersed in the energy and environmental fields. He immediately went to work for the Intermountain Rural Electric Association and became their Senior Energy Conservation and Solar Advisor.

Ken became actively involved with many energy and environmental organizations. He served on the board of the Denver Solar Energy Association (DSEA). During his tenure at DSEA he helped organize the first Denver Passive Solar Home tour, which soon became the Colorado Solar Homes Tour and eventually evolved into the National Sustainable Homes Tour. While serving on the board of the Colorado Thermal Insulation Association, Ken helped write the first set of energy codes for Denver in 1979, which were later enacted into law.

During the late 1970s and early 1980s, Ken was the Director of the Denver-area Energy Conservation Laboratory located at Arapahoe Community College and taught energy conservation courses at the Red Rocks Solar program, which at that time was the largest solar program in the United States. Because of his background, Ken was asked to help write the energy conservation curriculum that supported the solar curriculum being offered at Red Rocks. Some of this curriculum provided the groundwork to help start the

solar program at Colorado Mountain College, which has subsequently evolved into Solar Energy International or SEI. Information about SEI can be found at www.solarenergy.org. Ken also was involved in energy and environmental courses, and solar workshops taught at Pikes Peak Community College, Denver University and Arapahoe Community College.

After moving back to the Kansas City region, Ken wrote curriculum and taught at Johnson County Community College and at the Metropolitan Community Colleges: Blue River, Business and Technology Center, Longview, Maple Woods and Penn Valley.

During the 1990s, Ken was the Energy Applications Administrator for the City of Independence, Missouri Power & Light Department and he has consulted for several energy utilities, including the Kansas City Board of Public Utilities, Intermountain Rural Electric Association and Kansas City Power and Light. Other organizations that Ken has worked with are: the Metropolitan Energy Center, Energy Expositions, Inc., Weatherize KC. He has also performed new theater commissioning with Custom Control Services for American Multi-Cinema (AMC) Theaters.

Bobbi Walker

Barbara L. K. Walker (known as Bobbi) is a 'true-blue' environmentalist with a specific interest in sustainable building and design. She has a Communication Design degree, has over 15 years experience in the Graphic Design field and owns her own business (called Intuitive Design). Intuitive Design is dedicated to advance the quality of the Environment through the use of environmentally-friendly practices and products. In this way, Bobbi helps her graphic design clients to use alternative, low or no-impact techniques and resources to produce their marketing materials.

In order to achieve her own goal of designing and building a green home, Bobbi has researched and amassed a large quantity of knowledge about green building materials, design and construction. She has a personal goal to advance sustainable design and construction practices in existing and new construction for the average home owner.

Originally a city girl, Bobbi (with her husband and their Newfoundland Dogs) recently moved to a 20-acre spread outside Kansas City Missouri. There they are in the process of creating a self-sufficient, organic, sustainable, net-zero farm complex with renewable energy production. You are welcome to follow the progress of the Play Haven Green Building Project by visiting it on-line at www.playhavengreen.com.

Bobbi is a member of several environmental organizations, volunteers at Habitat for Humanity's ReStore and practices her beliefs by eating organic, composting yard and kitchen waste, recycling, using 'green' and recycled products, working from her home office, wearing recycled or sustainably produced clothing, using CFL and LED lights, driving a Honda Insight hybrid car, purchasing Energy Star® appliances and water-conserving products and investing in Alternative Energy and Socially Responsible Funds and businesses.

Sharla Riead

Sharla Riead is the Owner and Manager of Hathmore Technologies, LLC. She has strong credentials in systems, business, finance, accounting and energy. Sharla's energy and environmental experience spans decades

of progression from working as an energy auditor through construction and installation of solar panels to directorships and management of energy conservation and consulting companies.

Coming from a long line of women entrepreneurs, Sharla knew she wanted to build a business for herself. November 19, 1979, shortly after she married Ken Riead (who shared her strong social conscience and interest in alternative energy and energy conservation), she started her company; performing on-site energy inspections and providing customers with punch-lists of improvements that could be made to improve the energy efficiency of their homes and lower their utility bills. She performed heat load calculations, solar and alternate energy design, energy conservation instruction, contracting and consulting. As a Certified Home Energy Rater, Sharla works closely with builders and developers, educating them in energy efficient construction techniques and sustainable building practices. She supports their efforts to build to Health House and Energy Star standards and qualify for Energy Tax Credit incentives. Her company supports both commercial and residential projects and uses their knowledge of local and national Green programs to help clients plan and create sustainable buildings and projects that can achieve Green Program awards and recognition.

As Director of the Missouri Community Solar Workshop Program, through neighborhood organization speaking engagements, and in working with the Metropolitan Energy Center's Weatherization Workshops programs; Sharla has trained hundreds of participants in energy conservation techniques including leading 2-day workshops in which participants built and learned to install their own hot-water solar systems. She has chaired several industry boards and worked in Washington, DC as a lead examiner for the President's quality award under William J. Clinton and George W. Bush. Sharla is a seasoned speaker, presenter and trainer. She was founding president of three Toastmaster organizations, has spoken at conferences, tradeshows and forums. Sharla has been an environmental activist for decades and is currently the President of the Heartland Renewable Energy Society.

Acknowledgements

From Ken:

I want to thank my wife, Sharla, for always being there for me and putting up with my ongoing passion to help our planet. She has been my rock and anchor and I love her very much! Also, I want to thank my daughters, Lorien and Kaycie, for allowing me to be intensely focused on our business. Many family events and opportunities have been forsaken because I was involved in workshops, conferences and events. I hope to make-up for lost time in the near future since I am now a Grandpa.

Other people whom I owe a deep debt of gratitude are:

Bobbi Walker — for taking on the development, writing contribution, layout and editing of the Green Building Decision Kit. Without her help, it would not be nearly as well thought-out, content rich and user-friendly as it has become.

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I also want to thank my family and friends for their continuous support of my enthusiasm for everything even remotely pertaining to saving energy and the environment. They have given me renewed vigor when my internal motor was running down. In my mind, all peoples of this earth, and even the earth itself, are our extended family. I wish all of us a healthy, prosperous and safe future.

From Bobbi:

I want to express my appreciation and gratitude to:

Ken and Sharla Riead of Hathmore Technologies, LLC for 1) giving me the opportunity to do what I do best in the industry I like best, 2) expanding my network of associates in the energy and green building industry, 3) inviting me to participate in the creation of the Green Building Decision Kit, and 4) making me feel like one of the family.

My loving husband, Gary Walker, for his continuing support and patience with my idiosyncrasies.

My parents, Paul and Shirley Kanka, for 1) teaching me to think for myself and supporting me even when we think differently, 2) for showing by example what a successful marriage is, 3) for raising me in what seemed to be a completely normal lifestyle -- living in a home without air conditioning; spending wonderfully fun weekends at the lake cabin (recycled from an old garage and recreated using recycled windows, doors and building materials… with no phone, electricity or running water); vacations motoring around the U.S. in a homemade fold-down camper trailer -- and what turned out to be an excellent example of living simply, 4) for teaching me to use my hands and brain to make things myself and 5) for instilling the feelings of joy and satisfaction for a job well done.

My extended family and all the friends made through the passion of taking care of this planet we call home, through spiritual growth, through learning to grow food, through holistic healing and the love of Newfoundland Dogs…you all know who you are. But especially, Bonnie Kelly, Jane Kasten and Jim Fulbright.

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From Sharla:

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