GREEN ARCHITECTURE: A TECHNICAL OUTLINE

Produced by:
Students of AR-4010-003
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I. Site Location and Building Planning

A. Site Location, Kevin Thibault
B. Site Orientation, Katie Cressall
C. Building Configuration, Brandon Jenkins

II. Energy and Water Efficiency

A. Energy and Human Comfort, Jeffrey Quantz
B. Water Preservation, Zack Tanner
C. Various Energy Solutions, Jason Brownfield

III. Healthy Living Environments

A. Healthy Environments, Jeff Bolinger
B. Environmental Pollutants, Ben Hansen
C. Lighting, Paul Nielsen

IV. Site Location and Building Planning

A. Recycled Products, Moises Rivera
B. Products that Conserve Resources, Keith Hansen
C. Non-toxic Materials, Cindy Bithell
C. Sustainable Products, Anthony Lyman

LOCATION, Thibault

I. Site Location

A. Geographic Location

1. North or South Hemisphere

2. Rural or Urban

a. Site Access, Rural vs. Urban

b. Code requirements for urban and rural sites

B. Terrain

1. Sloping or Flat Site

a. Sloped site provides better daylighting potential

b. Flat site allows runoff control

2. Type of Soil

a. Undisturbed natural soil will have less embodied energy

b. Engineered fill has a high cost and embodied energy

C. Vegetation

1. Natural or Introduced

Natural vegetation will have less of an impact on the site

2. Species

a. Natural species will be more resilient to environmental conditions.

b. Introduced species may require additional irrigation

D. Water

1. Surface Water

a. Location of the site will have a high impact on the amount of surface water

b. Surface water is often used for irrigation and will have an impact on flooding conditions

2. Ground Water

a. Potable water

b. Well water or City Water

c. Know the source of water

d. Know water line location and how to access them

E. Climate

1. Average Temperatures

a. The temperature range may allow you to take advantage of several green design techniques.

b. Passive solar systems

c. Cross ventilation

d. Thermal massing.

2. Amount of Precipitation

a. Storm water collection

b. Reuse decreases amount of runoff and wasted water

c. Landscaping becomes more efficient.

3. Average Wind Speed and Direction

Use cross-ventilation instead of A.C.

II. Site Access

A. Transportation

B. Public or Private Transit

Less private traffic will lower the amount of fuel and energy used for transportation.

C. Train

D. Bus

E. Private Vehicle

1. Hybrid Vehicle

2. Alternative Fuels, bio-fuel

F. Bike

This can be a very good alternative to a motorized vehicle that requires high amounts of energy to run. Motorcycles may also be included here, they would be considered more efficient than other means of travel.

G. Foot Travel

Foot travel is going to be the best type to use if possible. It can be very hard to incorporate this in a project and expect it to be sufficient means of access for all users.

H. Year Round Access

Some sites may be very difficult to access during the winter. There may be places where snowmobiles or other means of travel are necessary.

III. Adjacencies

A. Buildings

1. Existing building heights

2. Shade and shadow over a property

3. Changed wind patterns

B. Utilities

1. Public Sewer system

2. Private Septic System

3. Fixture type

Dual-flush toilet, 1.6 gallons for solids and 0.8 gallons for liquid flush.

C. Private Properties vs. Public Properties

1. Ability to share water storage cisterns, or irrigation water rotations

2. Concentrating solar power

IV. Solar Orientation

A. Passive Solar

1. Glazing Methods

a. Side Lighting

b. Top Lighting

c. Amount of Glazing

2. Thermal Massing

a. Mass trombe Walls can be very effective when using passive solar systems. They absorb heat during the day and radiate it during the evening and into the night as it begins to cool off.

b. Rammed earth walls work much the same way, these walls may be constructed of local soils which is most efficient. Rammed earth is very labor intensive as each layer of earth is manually rammed or compacted during construction.

c. Adobe brick may be a good alternative to achieve thermal mass where soil for rammed earth is not readily available. Adobe Brick does not require the same intense labor as rammed earth.

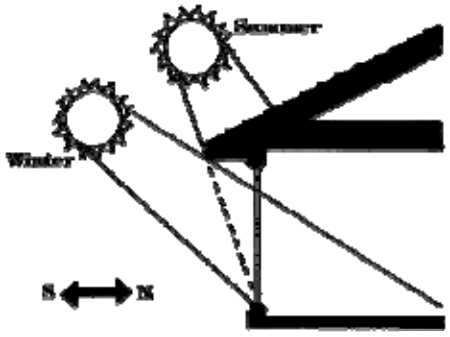
3. Solar Power

a. Off the grid construction can be more challenging, but with photovoltaic panels, power can be created and used by a building

b. Alternative energy source, it would be good to use this alternative method in an urban setting. It will minimize the amount of electricity provided by a power company. It is possible to sell power back to power companies.

ORIENTATION, Cressall

I. Sun for heat and light
   A. Direct solar gain
      1. Position windows, skylights, and shutters to control direct solar radiation
         a. Maximize daylight, minimize too intense sunlight
            i. Use overhangs, louvers, and other shading devices that prevent direct sunlight from penetrating the building
            ii. Ideal shading devices should block a maximum of solar radiation while still permitting views and breezes to enter a window.
            iii. Daylighting should be done as to allow just enough light to enter so that the electric lights can be turned off.
         b. Block sunlight in summer, allow sun in winter
            i. Design shading devices so they allow the lower angle winter sunlight to penetrate while still blocking higher angled summer sunlight
            ii. Prevent solar gain in windows in summer to keep building cool and keep out harsh sunlight
         c. Glazing area should be adjusted for sun and heat needs
            i. Climate should be studied to provide the appropriate amount of glazing



      2. Openings should suit the cardinal direction that a wall is facing
         a. North – Large windows because the light is less severe and it is at a lower angle. It may allow too much cold infiltration however.

i. In hot climates, north windows need to be shaded because during the summer the sun rises north of east and sets north of west. Since the sun is low in the sky at these times, the horizontal overhang is not very effective and small vertical fins work best

b. East/West – Because of the range of sun angles that face these directions, light needs to be controlled through shading devices.
   i. They collect 3 times the solar radiation of a southern window.
   ii. They are not desirable from a heating and cooling point of view.
   iii. If these windows are needed, try to have the windows on the east and west facades face north or south as much as possible.
   iv. Another option is to use horizontal overhangs and/or vertical fins. But to be effective, they will severely restrict the view.
   v. Moveable devices would be appropriate because they can accommodate the changes in sun angles. Use movable shading devices for both better shading and better views.
   vi. If views of the ground and horizon are important, use a horizontal overhand with backup indoor shading
   vii. When some obstruction views are acceptable, vertical fins are an alternative. Slant the fins toward the northwest if shading is required most of the year. Slant the fins towards the southwest if winter sun is required.
c. South – Southern openings let in more daily solar radiation in the winter and less in the summer which makes them very desirable for both shading and passive solar heating.
   i. The horizontal overhang on south-facing windows is very effective during the simmer because the sun is then high in the sky.
d. Skylights collect an excessive amount of solar radiation
   i. They need effective shading or should be avoided
   ii. Have 4 times the amount of solar radiation as a southern window
   iii. They collect a great amount of solar radiation in summer and little in winter.

iv. Clearstory windows are a more appropriate alternative to skylights in passive solar systems.

3. Brise soleil, Egg crate
    a. Shading can be used as a strong visual statement
    b. Blocks light in the horizontal and vertical position
    c. This device is most appropriate on east and west facades in hot climates and on the southeast and southwest facades in extremely hot climates.
    d. Many small devices can have the same shading effect as a few large ones. The ratio of length of overhang to the vertical portion is the same.
    e. When shading is critical and views are not, use an eggcrate system.
4. Movable shading devices – blinds, curtains
    a. They let in heat and block out light
    b. They are not the most efficient system for heating and lighting
5. Movable shading devices
    a. These respond better to the dynamic nature of weather than do static devices
    b. They can be in phase with seasonal passive solar needs.
    c. Movable devices take into account temperature of interior spaces along with sun orientation.
    d. They can adjust at any time, from twice a year to daily.
    e. Awnings, blinds, and roller shades are very common movable shading devices.
    f. They are not low maintenance.

B. Indirect solar gain
1. Solar radiation is captured by the building envelope
    a. The radiation is then absorbed to the interior of the building without the interior receiving any direct sunlight.
    b. Heat allowed to enter one part of the building and move to another
2. Heat is transmitted through conduction, convection, and radiation

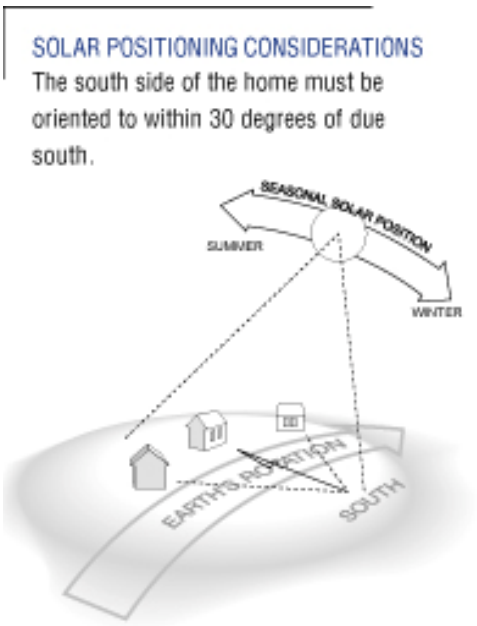
a. Conduction is the transfer of thermal energy through matter, from a region of higher temperature to a region of lower temperature, and hence acts to even out temperature differences.
b. Convection is the movement of energy through fluids. When part of a fluid expands due to heating, its density is reduced relative to the rest of the fluid, causing a net upward buoyant force due to the effect of gravity on the surrounding cooler fluid. When heat is carried by the circulation of fluids due to this effect, the process is known as natural convective heat transfer.
c. Solar radiation transmits light and heat. Infrared radiation gives heat and can be affected by a material's r-values to give the desired amount of heat and light

3. Trombe walls, water walls, and roof ponds

C. Isolated solar gain

1. Sun spaces, greenhouses, and "solar closets"
   a. Well-designed sunspaces can provide up to 60% of a home's winter heating requirements. (http://www.ncsc.ncsu.edu/fact/21sunspc.html)
   b. Sunspaces contain the following elements:
      i. Glass panels, or "glazing," permit light to enter a room, but prevent infrared heat from escaping. This process warms the interior space.
      ii. Thermal mass, such as masonry or water, absorbs heat and releases it into the room during extended cloudy weather or at night.
      iii. Insulation in ceilings, walls and windows retard heat loss at night and during cold weather.
      iv. Climate control features such as operable windows, vents, and fans keep the sunspace from overheating and move warm air to other parts of the house.
   c. When designing a sunspace, there are several important factors that must be taken into consideration. The planned primary use of the sunspace will influence some planning decisions.

i. Sunspaces must face south. Due south is ideal, but 30 degrees east or west of south is acceptable. If the south side of the house faces the street, the sunspace must be integrated into the house to avoid a "tacked-on" look.
ii. The sunspace must receive direct sunlight between the hours of 10:00 a.m. and 3:00 p.m. Any object over 10 feet tall within 15 feet of the south glazing is likely to block solar gain.
iii. If the primary function of the room is to provide heat, you can maximize heat gain by using sloped glazing, few plants, little thermal mass, and insulated, unglazed end walls.
iv. However, compared to vertical glazing, sloped glazing loses more heat at night, can be covered with snow in the winter, and can cause overheating in warmer weather.
v. Vertical glazing can maximize heat gain in winter, and yields less heat gain in the summer. A well-designed overhang may be needed to shade the glazing in the summer.
vi. If the space is to be used as a greenhouse, remember that plants require lots of light, fresh air, water, and protection from extreme temperatures. Plants consume energy that would otherwise be available as heat. Plants require overhead glazing, which complicates construction, and glazed end walls, which are net heat losers.
vii. As most homeowners wish to use their sunspaces year-round as living areas, the rooms should be designed to have minimum glare and moderate humidity. Carefully sized thermal mass materials will improve comfort levels by stabilizing temperature extremes. (http://www.nesea.org/buildings/passive.html)
viii. Ventilation and insulation may be needed if overheating occurs.



D. Site

1. Position building towards or away from the sun depending on building needs.
2. Design the microclimate – add more shade, take into account other buildings on the site, block or encourage wind.
3. Deciduous trees planted shade in summer and allow sun in during winter.
4. Trees can be planted to block winds or direct them
5. Configure building according to thermal patterns and usage needs

II. Wind

A. Site

1. Wind moves up mountain sides during the day
2. Air moves down mountain slopes at night
3. Valleys tend to have very strong winds up along the valley floor during the day and down the valley at night.
4. Day-night reversals of wind also occur near large bodies of water. During the day, the air is hotter over land than over water. The resultant air pressure differences generate sea breezes.

5. At night, the temperatures and air flows reverse. In the late afternoon and early morning, when the land and sea are the same temperature, there is no breeze.
6. Furthermore, at night the breezes are weaker than during the day because the temperature differences between land and sea are smaller.

B. Cooling Methods
   1. Wind towers are useful when there is no prevailing wind direction.
      a. Rectangular towers are divided by diagonal walls, which create four separate airwells facing four different directions.
      b. Wind towers have shutters to keep out unwanted ventilation. In dry climates, they also have a means of evaporating water to cool the incoming air. Some wind towers have porous jugs of water at their base, while others use fountains or trickling water.
   2. Wind scoops work like wind towers, but take into account prevailing wind direction.
   3. Evaporative cooling
      a. Whenever the humidity is low, evaporative cooling will be very effective.
      b. Fountains, pools, water trickling down walls, and transpiration from plants are all useful to cool the incoming air stream.
   4. Comfort ventilation
      a. It brings in outdoor air, especially during the daytime when temperatures are at their highest. The air is then passed directly over people to increase evaporative cooling on the skin.
      b. Although thermal comport is achieved, the warm air is actually heating the building.
   5. Night-flush cooling uses cool, night air to flush out the heat of the building, while during the day very little outside air is brought indoors so that the heat gain to the building can be minimized.

C. Air flow
   1. Air flows because of natural convection currents, caused by differences in temperature, or because of differences in pressure.

2. Through the Bernoulli Effect(involving air going from high to low pressure areas), air will be sucked out of any opening near the ridge of a gable roof.
3. Indoor ventilation is better with oblique winds because they generate greater turbulence indoors. Thus, a large range of wind directions will work for most sites.
4. Ventilation
    a. Cross-ventilation between windows on opposite walls is the ideal condition
    b. Ventilation from adjacent windows can be poor or good depending on wind direction.
    c. Fin walls can significantly increase ventilation through windows on the same wall
    d. Some ventilation is possible in the asymmetric placement of windows because the relative pressure is greater at the center than at the sides of the windward wall.
    e. Poor ventilation results from fin walls placed on the same side of each window or when two fins are used on each window.
    f. The greater positive pressure on one side of the window deflects the airstream in the wrong direction. Much of the room remains unventilated.
    g. The solid horizontal overhang causes the air to deflect upward
    h. A solid horizontal overhang placed high above the window will also straighten out the airstream
    i. A fin wall can be used to direct the airstream through the center of the room. A louvered overhang or at least a gap in the overhang will permit the airstream to straighten out.
5. Streamlines
    a. Inlets and outlets should be the same size. If they cannot be the same size, the inlet should be smaller to maximize the velocity.
    b. For comfort ventilation, openings should be at the level of the occupants. High openings vent the hot air collecting near the ceiling and are most useful for night flush cooling.

6. Wind and circulation
    a. In regard to natural ventilation, single-loaded corridor plans are far superior to double-loaded plans.
    b. In single-story buildings, a double-loaded corridor plan can use clerestory windows instead of transoms.
7. Site
    a. Tall buildings placed toward the north not only protect from the cold winter winds, but also permit good solar access.
    b. Trees and bushes can funnel breezes through buildings
    c. By preventing the wind from spilling around the sides of a building, a few trees or bushes can significantly increase natural ventilation.
    d. The maximize summer winds, use trees with high canopies
    e. To maximize summer ventilation, place bushes away from the buildings and trees.
    f. For winter wind protection, place bushes between the buildings and trees.
    g. In hot and humid climates, buildings should be staggered to promote natural ventilation.
    h. Use row or cluster housing for protection against wind in cold climates.

Sources –

Norbert, Lechner. Heating, Cooling, Lighting. New York: John Wiley and Sons, 2001.
http://www.nesea.org/buildings/passive.html
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www.wikipedia.org

CONFIGURATION, Jenkins

I. Compact Mass

A. Desirable surface area for your design.

1.What sizes are necessary for the spaces in your building?

a. large amounts of wasted space

b. unnecessary circulation

c. gigantic sleeping spaces

2. How much of the space in your building designated to livable areas compared to spaces of minimal use and circulation.

B. How does the mass of your structure relate to heat retention?

1. Use of massing walls to conduct heat can be efficient. Relating the size of the massing to your building size will keep you from filling usable space with mass walls.

a.building size : thermal wall ratio

b. larger size will quicken rate of heat loss

c. Average mass when the exposed mass area is equal to the floor area.

d. Wall height to thickness ratio must be compatible for stability.

2. Limit the size of certain interior spaces to avoid unnecessary heat loss.

3. Varied thickness of massing to insulation values.

a. 10 inch thick adobe has an r value rating of 3.8

b. 14 inch thick wall of similar construction has r value rating of 4.9.

c. Although small r values high thermal mass charecteristics.

4. Embodied energy of Common massing materials.

a. Adobe block has embodied energy of constraction of 2500btu

b. Common concrete block has embodied energy of construction of 29,018btu

c. Common brick has embodied energy from construction of 13,570btu

C. What types of materials work well with a compact design.

1. High strength materials with small massing.

a. PTFE Coated Glass Fabric

a. Tedlar Topcoating

b. PVC Coated Polyester Materials

c. Structural Insulated Panels

2. Higher R values in insulation with relatively little special usage. Styrofoam insulation is often no more than a few inches thick and can provide needed insulation between roofs and floors.

a. STYROFOAM Extruded Polystyrene

b. Dow Polyisocyanurate Insulations

3. Space saving materials will usually cost a small amount more than those which are not designed for it. Using normal materials in an efficient manner is as effective and can cut your building costs.

D. The Impact the Building will have on a site.

1. How does the construction of the building impact the site:

a. pollution

b. excavation

c. land clearing

d. movement of natural elements

e. effects on wildlife

2. What will be the influence of the buildings lifecycle: effect on the site while it is in use, after it has been abandoned (Entrada hippie complex for example)

II. Complex Geometry

A. The Passive Solar Relationships your building has.

1. How does your building relate to the sun.

a. Orientation

b. Window relation to sun

c. Passive Systems

2. The size of your building will play a factor in the amount of heat gained through passive solar relationships. A smaller building will gain heat more rapidly than a larger one.

a. spherical shapes & boxes have lowest surface area to volume ratios.

b. Few larger buildings comparatively more efficient than many smaller buildings.

3. A smaller building will also retain the gained heat for a longer period than a larger building.

B. Compact Designs relationship to Daylight.

1. What kinds of possibilities does a compact design allow?

a. Better area to necessary amount of light comparison

b. Limited amounts of windows.

c. Large windows expand feel of small areas.

d. Unique day lighting elements to define spaces.

C. How does the building appear visually.

1. Does a complex design have any sacrifice on your building visually?

a. Order contains building complexity and creates pleasing aesthetic

b. excessive organization creates possible drawbacks

D. How does your building relate spatially?

1. Your building should provide a relationship to its surroundings.

a. location

b. surrounding materials

c. adjacencies

2. Your building should also relate spatially to its surroundings. Do not oversize your building for its site; on the opposite do not create something that is two minuscule to be noticed.

III. Spatial Usage

A. Creating Spaces for multiple use.

a. Design spaces to fit your lifestyle.

b. Works well practically in compact designs.

B. Building with size limits.

2. Building relation to lot size.

a. Large design will overpower.

b. Compact design presents clear relationship.

3. Design to money constraints.

ENERGY AND HUMAN COMFORT, Quantz

I. Utilization of Renewable Energy Sources:

A. Types of Renewable Energy:

1. Passive Solar Energy

a. The square house is not the optimum form in any location

b. Orient the building with long axis running east/west to minimize impact of direct, harsh morning and evening sun.

c. The building's southern exposure must be clear of large obstacles that block the sunlight.

d. Provided the building faces within 30 degrees of due south, south-facing glazing will receive about 90 percent of the optimal winter solar heat gain.

e. Select, orient, and size glass to optimize winter heat gain and minimize summer heat gain for the specific climate.

f. Locate major window openings to the southeast, south and southwest according to the internal requirements of each space.

g. On the east, west and especially the north side of the building, keep window areas small and use double glass. When possible, recess windows to reduce heat loss.

h. Use movable insulation over all glazed openings to prevent the heat gained during the daytime from escaping rapidly at night.

i. Consider selecting different glazings for different sides of the house.

j. Size south-facing overhangs to shade windows in summer and allow solar gain in winter.

k. Reflectors should be used to catch more light

l. Reflectors should be used on any side but the south side.

m. These reflectors should roughly equal in width and 1 to 2 times the height of the glazed opening in length.

n. Add thermal mass in walls or floors for heat storage.

o. Floors should be a dark color, walls can be any color, paint all lightweight construction (little thermal mass) a light color.

p. Avoid direct sunlight on dark colored masonry surfaces for long periods of time. Do not use wall to wall carpeting over masonry floors.

q. Use natural ventilation to reduce or eliminate cooling needs.

r. Use daylight to provide natural lighting.

s. Must determine the width of the building depth of spaces along the south wall of the building to ensure that sunlight will penetrate the entire space.

t. To cool a home passively in the summer you should make the roof a light color or reflective material.

u. Open the building up at night with operable windows or vents to ventilate and cool interior thermal mass.

v. Arrange large openings of roughly equal size so that inlets face the prevailing nighttime summer breezes and outlets are located on the side of the building directly opposite the inlets or in the low pressure areas on the roof and sides of the building.

w. Close the building up during the daytime to keep the heat out.

2. Active Energy

a. Solar Thermal: Transforms solar radiation into useful heat or cooling. Does this by heating tubes on the roof of the building which contain water that circulates throughout the building giving off heat.

b. Disadvantages are that the sun could be blocked due to overcast or cloudy sky.

c. Photo Voltaic Panels: Light sensitive panels attached to the roof or near by the structures which contain light sensitive electrons that generate electricity when sunlight hits them.

d. Disadvantages of photovoltaic panels are that the sun is not always out and that the sky could be overcast or cloudy.

e. Geothermal: literally the heat contained within the earth.

f. Pipes filled with water are run in the earth below a structure, usually around 80 feet down. Because the ground at that depth stays at a

much more reliable temperature year round than the outside, the water heats the building in the winter and cools the building in the summer.

g. Wind: Giant wind turbines catch the wind and convert the kinetic energy into electricity through a generator.
h. This electricity can be used to power anything.
i. Disadvantage of this is that the wind is not always blowing or blowing at too little of a rate to turn the turbine.
j. Hydropower: Uses the energy of moving water to turn a turbine attached to a generator.
k. Advantages of small hydropower are that it is an efficient resource and can satisfy energy demand without depleting the resource and can with little impact on the environment. It is a secure resource; small hydropower guarantees the security of supply. It is a clean resource and does not involve combustion therefore avoiding pollution emissions. It is a renewable resource the fuel for hydropower is water which is not modified in the electricity generation process. It is a sustainable resource meeting the needs of the present without compromising the ability of the future generations to meet their own needs.
l. Primitive examples of this were waterwheels which were used to grind flour.
m. Must have access to water source.

n. Passive solar energy techniques are very inexpensive such as orienting your building with the long axis facing east and west.

o. Thermal walls are very labor intensive but relatively inexpensive due to the fact that they are usually made out of adobe or rammed earth.

p. Day lighting using the sun saves energy costs by not having to light a space during the day.

q. Solar heating pipes are somewhat expensive due to the copper tubing that has to be run throughout the building and also labor costs.

r. Photovoltaic panels are still extremely expansive to install.

s. Will only become more available once price drops significantly.

t. Geothermal is expensive due to digging so deeply into the ground and running tubes into the floor.

u. Wind energy depending on the turbine you have can be as inexpensive as a simple wind mill or as expensive as an ultra efficient wind turbine.

v. While many renewable energy sources have a very high upfront cost, the cost is offset throughout the lift time of the building.

II. Choice of Heating and Cooling System and Fuel:

A. Role:

1. To provide the energy to a building not able to be provided by renewable energy sources or passive sources.

2. Only should be used as a last resort.

B. Types:

1. Fireplace: perhaps the most primitive and longest used.
    a. Fueled by typically coal or wood although any combustible material can be used.
    b. Provides limited warmth in the close proximity of the front of the fire.
    c. Must be maintained on a regular basis with more wood or coals.
    d. Must be close to fire to feel any significant warmth.
2. Traditional HVAC
    a. System has a compressor to cool the air in the summer and a furnace to heat the air in the winter.
    b. The treated air circulates through the spaces through a system of ductwork in the floors or ceilings.
    c. Must be fueled with gas or electricity.

1. Fuels:
    a. Majority of fuels are non-renewable
    b. Fossil fuels such as oil natural gas and coal make up 90 percent of energy used in our world today.
    c. These energy sources are beginning to run out and as such the prices are starting to rise.
    d. New technologies are being made with fuel.
    e. Biomass is generated by plants through the process of photosynthesis with energy being provided by the sun.
    f. Wood is the oldest form of biomass fuel known to mankind and was used for centuries for heating and cooking.

g. Available in variety of forms such as solid or wet biomass, vegetable oil or sugar.

h. Advantages of biomass are widespread availability, contribution to security of supply, can usually be stored in large amounts and as a consequences bio-energy can be produced when needed, creation of stable jobs, especially in rural areas, good opportunities to export developing technologies and know-how, carbon dioxide mitigation and other emission reduction.

i. Types of biomass include industrial byproducts from wood industry, wood wastes, forest residues, short rotation forestry, herbaceous lingo-cellulosic crops, sugar crops, starch crops, oil crops, agricultural by-products and residues, organic fraction of municipal solid waste and refuse sewage sludge.

j. Burning still release many pollutants into the atmosphere.

k. Semi-renewable.

WATER PRESERVATION, Tanner

I Greywater / Stormwater Catchments.

A Definition of greywater and stormwater:

1 Greywater:

a Any water that has been used in the home, except water from toilets, is called grey water. Dish, shower, sink, and laundry water comprise 50-80% of residential "waste" water. Dish water will contain organic material and is more suitable for irrigation while shower and laundry water will be contaminated with soap which is more suitably used to flush toilets.

b The primary use of greywater is to irrigate foliage. The process of irrigation is also a process of “purifying” the water. This is different to treating/filtering greywater for potable use because the filtering process is also the intended use.

c The other two goals for catching greywater is to responsibly and naturally discharge of it instead of putting it through public infrastructure and treatment and to lower overall water consumption by using greywater for irrigation.

2 Stormwater:

a Any water that originates during precipitation events is called storm water. The term may also be applied to runoff water that results from over-watering.

B Why harvest greywater and stormwater?

1 Lower fresh water use.

a It is a waste to irrigate with great quantities of drinking water when plants thrive on used water containing small bits of compost.

b Saves money on water bills.

c Lowers extraction of water from rivers and underground aquifers.

2 Groundwater recharge

a Keeps water on site rather than taking it off the site via gutters and sewers to treatment plants.

b This creates less strain on public infrastructure – less energy use and chemical pollution from treatment.

3 Household use

a Greywater from showers, household sinks, and washing machines are more suitable for household uses like flushing toilets.

b Greywater from the kitchen sink can be treated and filtered to a “cleaner” state to be used in similar fashion; however it is more suitable for irrigation because of the inclusion of organic material.

C Problems and concerns with Greywater / Stormwater.

1 Health and safety.

a Greywater is not freshwater (white-water) therefore it is not for human consumption. However greywater can be chemically treated and filtered to be potable.

b Greywater contains chemical residue and/or organic (food) matter. Try to avoid irrigating with greywater that includes bleach, sodium, borax, or an excessive amount of grease, fats and oils or try to limit the discharge of these elements.

c Untreated greywater should be not be applied directly to foliage, rather apply it straight to the soil. This prevents the exposure of microorganisms

d There are virtually no health concerns with stormwater.

2 Errors and common mistakes.

a Greywater storage should be restricted to 55 gallons for residential systems unless treated or filtered. Storage rapidly turns grey water into blackwater (sewage) and therefore should be limited to 24 hours.

b Do not apply untreated greywater directly to lawn or other plants. The preferred method for is irrigation trenches or underground drip systems.

c Do not use greywater to irrigate vegetables – it may transmit disease.

d Some trees and plants have a hard time dealing with greywater, especially acid-loving plants.

e Avoid any situation in a system where greywater can sit and fester.

f Stormwater can be stored but depending on the contents of the water caution should be used.

3 Codes and restrictions.

a Greywater harvesting and reuse is virtually never an issue for residential retro-fits. The most common form of greywater harvesting systems are jury-rigged/bootlegged systems that homeowners throw together.

b Greywater harvesting systems are almost always an issue for new construction and remodeling, unless you live in Arizona and New Mexico.

D Systems and methods of harvesting.

1 Traditional methods of stormwater catchment

a Abanbar – Iran – a communal sub-surface bath house.

b Shuijio – China – Excavated clay-lined water cellar, used like a well to retrieve water.

c Chultun – Mayan – stucco cement/lime-plastered underground tank

d Adobe Granary bins – Mali – similar to a modern-day steel cistern, sat at ground level next to a complex of buildings and collected rooftop runoff.

2 Roof catchment of stormwater

a Almost always includes utilizing the shape and slope of the roof to direct water into a holding tank or cistern.

b Cisterns range from small – 10 gallons to large – 255 gallons and can be built from metal to rubber.

c Butterfly (v-shaped) roofs collect water about a central gutter and funnel to one side of the roof

d Shed roofs funnel to a gutter at the low end and into a cistern somewhere along gutter.

e Corrugated iron or other metal roofs are popular to route water to collection system. – see Glenn Murcutt.

3 Ground catchment of stormwater

a Usually a series of ditches or trenches that re-direct the water to foliage.

b Sometimes incorporates a holding pool or tank

c If sloped, system incorporates terraces to direct water flow while also providing a place to grow crops.

4 Rock or dam catchments of stormwater

a Usually built into natural contours of the land – primitive irrigation dams and ditches

5 Greywater Catchments

a Usually includes a system of piping, as rigid and straight as possible to minimize standing water, separate and in addition to regular plumbing.

b Piping diverts greywater from normal sewage lines and usually directly into a dispersal system.

c Water is usually injected directly into the soil via a drip system or open ended pipes and is rarely sent to a traditional open-air sprinkler system.

d Unlike stormwater, greywater rarely get stored – unless it is intended to be filtered and used for another purpose than irrigation.

e If greywater is to be collected not for irrigation but rather to avoid public infrastructure, a process called evotranspiration is utilized. This is a process where trenches are dug where greywater will be discharged with the intention of allowing the water to evaporate.

E Further information

1 Greywater

a http://www.oasisdesign.net/greywater/

b http://www.greenbuilder.com/sourcebook/Greywater.html

2 Stormwater

a Design for Water by Heather Kinkade-Levario

b Rainwater Harvesting by Arnold Pacey

c Rainwater Catchment Systems by John Gould

II Landscaping that conserves water / Native plants.

A What is water-wise landscaping?

1 Water-wise landscape design and management focus on working with nature and natural forces (such as rainfall) to create an aesthetically pleasing, livable landscape, while using less water from the local supply.

B What are the benefits?

1 A water-wise landscape is one that is functional, attractive, and easily maintained within its natural surroundings.

2 Conserves water

a Utah is the 2nd driest state in the nation, yet we rank in the top ten per-capita water use.

b In Utah 65% of our annual water consumption is applied to landscaping

3 It protects the landscape by preventing erosion

4 Prevents invasive species from take-over which can harm the native eco-cycle.

C Problems and concerns with Native plants and low-water landscaping.

1 Although it is improving it can be hard to find native plants and water-wise plants.

2 It is hard to accept the climate you live in.

The average person believes a lush, green landscape is most beautiful.

3 Can be costly and labor-intensive to set up, however like most things by putting more money and work in at the beginning the less money and maintenance will be required later.

D Implementation

1 Plan your landscape

a Observe the site and note high-use areas, desirable views, wind direction, slopes, shaded and exposed areas, as well as permanent structures.

b Consider maintenance and water requirements for each area or zone.

c Prepare adequate soil

d Compost – organic matter – is essential to good soil

e Sandy soils allow for better drainage while clays can prevent water absorption. Adding compost to these soils can neutralize these extreme effects, however some plants prefer sandy soil and likewise with clays.

f In general a soil rich in organic matter is a healthy soil.

2 Select plants wisely for climate

a Know and accept the climate you live in – don't try to grow a citrus fruit tree in a cold climate or a high-water demanding plant in the desert.

b Select trees, shrubs, and groundcovers based on their natural ability to grow well in your climate.

1 Native plants work best

2 Limit exotics or plants with high-water requirements to areas where water can be applied efficiently.

3 Mulch your garden/landscape

a Mulch conserves soil moisture

b Mulch cuts down on waste that must be taken off site

c Organic mulch improves the quality of the soil.

4 Limit amount of turfgrass (grass)

a General grass is an inefficient user of water in dry landscapes.

b Limit to areas where it provides a functional use i.e. a play area

c Select turfgrass that is appropriate to your climate – there are thousands of species

d Shape and area of grass should be designed to make watering more efficiently – avoid long narrow strips.

5 Use the best watering method

a Avoid watering by hand – it often produces excess runoff and water doesn't regularly penetrate the top 1 inch of soil.

b Ooze hoses or drip systems work better than traditional sprinklers because they eliminate airborne evaporation.

c Water at night, preferably pre-dawn morning to minimize airborne evaporation and to allow the water to soak into the soil longer to minimize solar evaporation.

d Occasionally re-evaluate and adjust the amount and time of watering to better suit the current conditions – cool and wet spring vs hot and dry summer.

E On-site Flora at Entrada

1 Woody perennial dicotyledons – trees and shrubs

a Fremont Cottonwood – 30 to50 feet tall broad leaf deciduous tree

b Cliffrose – flowering deciduous shrub 1 – 2 feet tall with white, pale yellow, or pink.

c Shinnery Oak – shin-high deciduous shrub that grows in thick patches. Similar to poison oak.

d Skunkbrush – 1 – 8 feet tall deciduous shrub. Fruit was used by Native Americans in food, drink, and medicines.

e Coyote Willow – 16 foot tall deciduous shrub/tree. Grows in thick groups near water sources.

f Tamarisk – native to the Mediterranean, this invasive shrub/small tree grows near streams and rivers and chokes out native plants. Capable of producing 500,000 seeds per plant it reproduces and moves quickly. An average tamarisk can consume 300 gallons of water a day.

g Greasewood – 1 – 8 foot tall deciduous shrub with spiny branches and green-grey succulent leaves.

h Resinbush – deciduous shrub, weed-like appearance with yellow flowers

i Narrowleaf Yucca – 15 inch long, light green, sword-like leaves extending from a central point at base of plant. Yucca fibers were used by Native Americans to make belts, sandals, baskets, and matting.

2 Non-woody perennial dicotyledons – shrubs

a Blueleaf Aster – 1.5 to 3 feet tall, unbranched except at inflorescence where pale blue to purple daisy-like flowers grow.

b Russian knapweed – Toxic, creeping shrub flowers through summer to fall.

c Curly Gumweed – Yellow daisy-like flower, grows 1-2 feet tall.

d Hairy Golden Aster – Another yellow –daisy-like flower, 0.5 to 2 feet tall. Native Americans used it for tea.

e Evening Primrose – 4-5 foot flower/shrub. Rough-hairy leaves with yellow to red buttercup-like flowers.

f Globemallow – Bright orange, 5-petaled, cup-shaped flowers bloom year round. Low growing up to 3 feet.

3 Annual dicotyledons

a Bur Ragweed – shin-high bushy shrub produces annoying 1/8" burs that stick to socks and shoe laces. Reproduces via rootstock

b Halogeton – salt-tolerant noxious weed, poisonous to sheep and cattle.

c Kochia – also known as fireweed was introduced to the U.S. around 1900 as an ornamental plant from Eurasia. It produces bright red foliage in the fall. Often grown as a forage crop in the Southwest because of its extreme drought tolerance.

d Portulaca - Yellow-flowering plant native to India, it is groundcover that can be considered a noxious weed.

e Tumbleweed – small shrub native to Africa, Asia, and Europe, it grows in salty, dry soils. In the fall the plant breaks away from its ineradicable taproot and "tumbles" away spreading seeds.

4 Annual grasses

a Cheatgrass – grows up to 2 feet, it is native to Europe and parts of Africa. It is highly invasive and causes major problem as the fuel for many quick-moving wildfires. It can eliminate the natural grasses in and completely change the ecosystem it invades.

b False Buffalograss – fairly uncommon grass with shallow roots

F Further Information

1 http://www.waterwiseplants.utah.gov/

2 http://www.ext.vt.edu/pubs/envirohort/426-713/426-713.html

3 http://www.dixiegardener.org/water_wise_landscaping.html

4 http://www.austinenergy.com/Energy%20Efficiency/Programs/Green%20Building/Sourcebook/waterWiseLandscaping.htm

5 http://www.utahschoice.org/utahs-choice-native-plant.htm - Utah Native Plant List

6 http://www.bewaterwise.com/ww_landscaping.html

7 Earth-Friendly Desert Gardening by Cathy Cromell, Jo Miller, Lucy K. Bradley

8 Desert Landscaping by George Brookbank

9 Native Plants for Southwestern Landscape – Judy Mielke

10 Plants for Dry Climates by Duffield

11 Desert Landscape Architecture by John C. Krieg

ENERGY SOLUTIONS, Brownfield

Composting Toilets:

I. Definition:

Composting toilets convert human waste into organic matter and usable soil.

1. Waste is broken down by a natural process of breaking organic matter into its essential minerals.
2. Moisture and air assist microbes in the process by oxidizing the carbon in the organic material to carbon dioxide gas. Also converts hydrogen atoms to water vapor

II. Types:

Self-contained, central unit and vacuum-flush

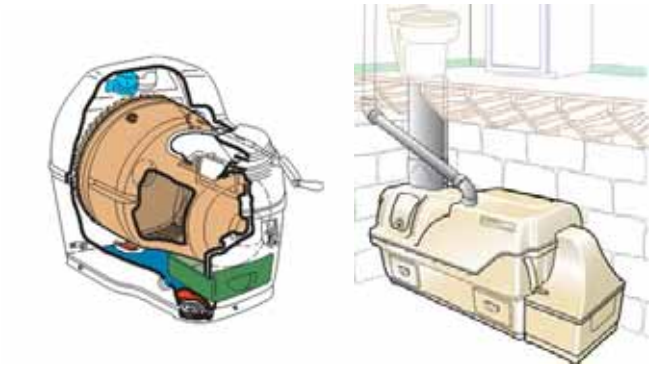
1. Self-contained composting toilets compost in place.
2. Central unit composting toilets compost in a remote location below the unit itself.
3. Vacuum-flush systems have the ability to flush horizontally or even upward.

III. Installation:

A. Install anywhere

- Cabins, boats, homes, cabanas, cottages, etc…

B. System mechanics:



- Electric and manual

1. Some composting toilets use electricity to aid the process while others use a manual handle to rotate the drum in order to allow for aerobic breakdown of waste.
2. Some toilets have large drums while others are slightly larger than a conventional toilet.
3. Some require water while others are no water systems.

IV. End product removal:

Occupancy use

1. System size

- Large systems will allow composting to continue for decades without filling.

2. This requires at least three times the volume of the yearly addition.
3. Waste volume continually decreases to as much as 1-2% of its original after 5 years.
4. In the decreased state it is considered a mineralized soil which will not decompose any further.
5. Smaller systems may have to have solids removed several times a year.

V. Commercial application “case studies”:

A. Applications

- Composting toilets are beginning to compete with conventional systems due to their resilience to failure and lack of pollutant discharge.

B. C.K. Choi Building houses the Institute for Asian Studies located at the University of British Columbia.
   - Building usage explained
      a. 3-story, 3,000 square meter building that uses composting toilets.
      b. Reduces water consumption by 1000 liters per day.
      c. Gray water management system uses a bio-filtration network of soils and plants.
      d. Rain water captured and stored for irrigation.
      e. Systems in combination allow the building to be independent from the campus sanitary sewer system.

C. IslandWood School located on Bainbridge Island, WA utilizes:
   Composting toilets for all facilities
      - Immaculate facilities and a fan system that rids the misconception of smelly systems.

VI. Use of humanure after composting:

After the required composting period, humanure may be used for agricultural purposes.

VII. Conclusions:

Appealing alternative use

1. Properly functioning compost toilets consume a small amount of water, reduce pollutants into the environment, and are odor-free.
2. The waterless and odorless composting toilets allow facilities to be used in drought climates and places with only periodic water supply.

Building Envelope Design:

I. Importance:
   A. Thermal barrier and controls energy flow between indoor/outdoor
   B. Determines amount of daylighting, ventilation, and heating cooling opportunities.
   C. Consists of roof, walls, windows, doors, bottom floor.

II. Foundation walls
   A. Control and regulate passage of air, moisture, heat, sound, etc…
   B. Thermal mass can be used to regulate heat into a building and used for reradiating heat into or back out of a building at night.
      1. Trombe walls are thermal walls that absorb heat through a window or other opening, store the heat and re-radiate the heat back into the space at night.
      2. Great in climates that have a large diurnal change in temperature such as many desert climates.
   C. Moisture

      Leading cause of damage in sub-grade conditions
   D. Leaks

      Leaks related to material and system failure
      - 99% of waterproofing leaks are causes other than material or system failure and are attributed to poor design, poor attention to detail, or poor installation
   E. Subsurface water

1. Subsurface water should be taken into account when designing.
2. Shallow ground water is problematic for basement situations.
3. Assess depth of water prior to designing basement or below-grade buildings

F. Frost depth should be considered when exposing foundation walls.
   1. Insulate foundation walls
   2. Code may require foundations to be insulated to protect from freeze/thaw cracking and failure.

G. Thermal Mass – what is it and when to use it:
   1. Thermal mass explained
      a. Absorbs heat and re-radiates heat at a later time
      b. Thermal mass is a material with the ability to absorb a large amount of heat and alter the occupant comfort level without mechanical means
   2. Types of thermal mass materials.
      a. Masonry
      b. Earth
      c. Water
   3. Climate usage
      a. Climates with large diurnal temperature changes should consider designs with thermal mass.
      b. Thermal mass has the ability to absorb solar radiation during the long hot days and reradiate the heat during the cool nights.
      c. Such climates occur in desert type settings such as the southwest however, most North American locations have temperature swings above and below the comfort level throughout the day and year.
      d. Tight envelope with well insulating materials with high R-values should always be a top priority.

III. Glazing:
   A. Impacts aesthetics

1. Amount and type of fenestrations change a buildings aesthetics dramatically
2. Influences occupant comfort and productivity
3. Influences mechanical system size and amount of required lighting
4. Influences amount of noise transfer into a building
5. Types of tints, coatings, films, panes, etc… all alter aesthetics

B. Daylighting.
   1. Site analysis

   Analyze the site for the angle of sun incidence in order to block direct light during summer months while allowing direct light during winter months.
   2. Building design to maximize available light to all spaces including interior core
   3. Borrowed light from room to room or space to space
   4. Use of sidelights, toplights or both
   5. Placement of sidelights and toplights
      - Maximize interior daylight and minimize energy consumption
   6. Daylighting must be incorporated early in the design for maximum potential

IV. Photovoltaics:

building integrated

roof integrated

A. Roof applications:
   1. May be placed on top of roof
   2. Integrated into roofing materials in applications such as metal roofs

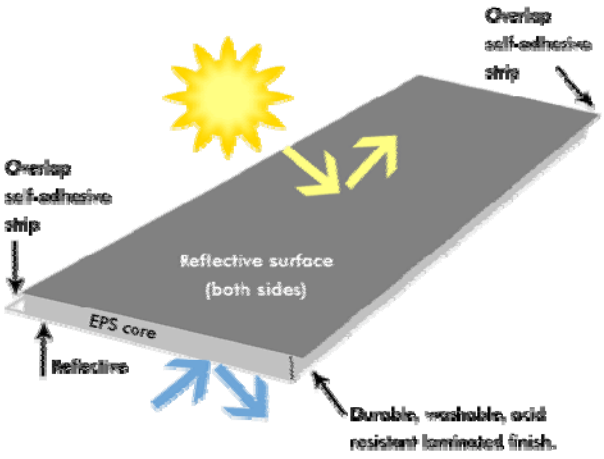
- This provides a cleaner aesthetic and appears to be a part of the metal roof

B. Glazing or wall applications
    1. Louvers are now available as shading devices for glazing and contain photovoltaics
        - Designed into the system and fully integrated
    2. Glazing contains photovoltaics as part of the system
    3. Wall panel applications are available in different shapes, colors, and sizes.
        - Such panels can be design features added to the façade

V. Insulation overview:
    A. The building envelope consists of the walls, floor and ceiling.
        - Proper insulation should be provided to protect foundations (where required by code), walls, floors and ceilings to keep major temperature swings to a minimum, and increase occupant comfort.
    B. Heating and cooling loss
        1. Heating and cooling losses caused by lack of insulation account for 50% to 70% of the energy use in the average American home.
        2. Insulation minimizes mechanical unit sizes for heating and cooling.
        3. Caulking
            - Caulking around windows, doors, and siding will help to insulate the building against heat loss through air transfer.
        4. Insulation usage
            a. Should be used in the attic, floors, above unheated spaces, and around walls in a heated basement or non-vented crawl space.
            b. Insulate around the ductwork of heating and cooling systems.
            c. Insulate around piping to reduce damage for cold water lines, and reduce heat loss in hot water lines.
    A. Types of insulation:
        1. Blanket: batts and rolls
            - Use for walls, foundation walls, floors and ceilings

2. Concrete block
    a. Walls, foundation walls
    b. For new construction or major renovations
3. Foam board or rigid foam
    - Walls, foundation walls, floors and ceilings, unvented low-slope roofs
4. Insulating concrete forms (ICFs)
    a. Walls, foundation walls
    b. For new construction
5. Loose-fill (Blow-in)

    - Enclosed existing wall or open new wall cavities, unfinished attic floors, and hard to reach places
6. Reflective system



    a. Unfinished walls, ceilings and floors.
    b. Foam core insulating interior with reflective laminate exterior surfaces.
    c. Easy to cut and install and has great insulating properties.

7. Rigid fibrous or fiber insulation
    - Ducts in unconditioned spaces and other high temperature places.
8. Sprayed foam and foamed-in-place
    - Enclosed existing wall or open new wall cavities, unfinished attic floors.
9. Structural insulated panels (SIPs)
    - Unfinished walls, ceilings, floors, and roofs for new construction.

VI. Walls:

A. Walls can be structural, insulating, aesthetic, retaining

B. Earth berms against retaining walls.

1. Minimize heat transmission and radiant loads on the building envelope.
2. Lessens thermal transfer caused by major high and low temperature swings.
3. Made with any type of material including, stone, concrete, wood, recycled content, etc…

VII. Roofs:

A. Protects from the elements.

B. made of a variety of materials

C. Roof types

- Bonnet, cross gabled, front gabled, gambrel, hipped, mansard, pavilion-hipped, low slope, side-gabled, salt box, pagoda, shed, Victorian.

Salt box. Mansard Gambrel

Flat Shed Hipped

Images from: http://blog.oregonlive.com/homesandgardens/2007/11/roof_styles.html

VIII. Doors, windows, & openings

A. Usually chosen for aesthetics

1. When choosing materials for aesthetic value, U-value (the energy rating of a system of materials in a component) should be a major consideration.
2. Well insulated doors and windows minimize heat loss.

B. See “glazing” above for more information.

C. Openings should be well-placed for cross ventilation and solar chimney affects.

IX. Thermal efficiency

A. Energy transfers through conduction, convection, or radiation.

1. Conduction is the transfer of thermal energy through matter, from a region of higher temperature to a region of lower temperature.
2. Convection is the transfer of heat through the warmed matter, especially through water, steam and air.
3. Radiation is the transfer of energy in the form of waves.

B. Determines the building function and amount of equipment required for heating and cooling.

C. Determines the rate a building gains or loses heat through its envelope

D. Build walls, roofs and floors with adequate insulation

E. Thermal transfer

- Occurs through members

1. Members that protrude from the inside to the outside.
2. Minimize heat loss by stopping members at the exterior wall, then starting the member again at the wall outside, or insulate the member outside of the exterior wall.

X. Reflectivity

A. Light color roofs

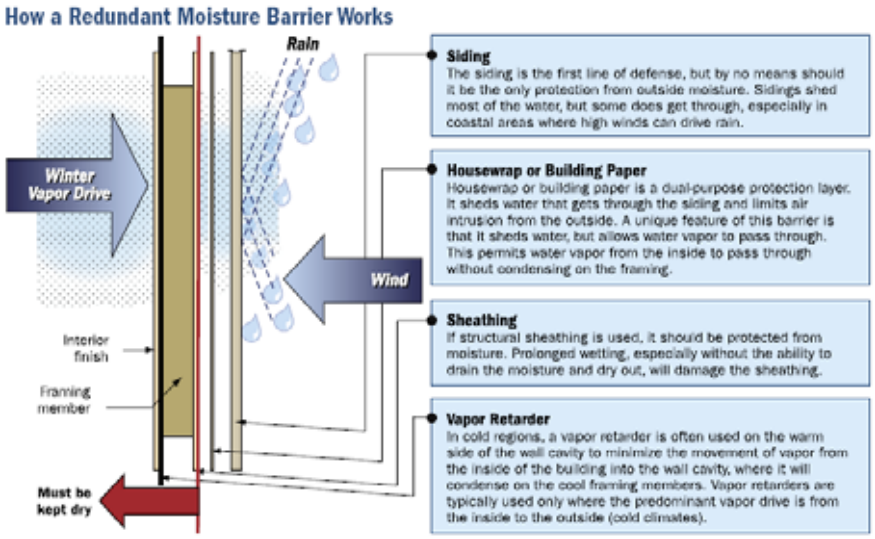
- Use light color roofs where major heat gain occurs during hot summer months

B. Dark color roofs

- Should be utilized in cooler climates to take advantage of heat gain and heat that can be re-radiated into the building at night.

XI. Moisture Buildup

A. Moisture barriers.



1. Known as vapor retarders and in cold climates, are placed on the interior side of the exterior wall assembly to keep moisture from condensing on the cold framing members and damaging the structure.
2. Building wrap is placed on top of the exterior sheathing to shed water that penetrates the siding, and allows vapor to escape from inside the wall.
3. Proper installation including lap distances, sealants and placement of the membrane to the warm side of the wall are crucial for the system to work properly.

B. Major cause for deterioration of the building envelope.

C. Protect walls, roofs and slab-on-grade floors with moisture barriers

D. Weatherstrip all openings

1. Use sealing gaskets and latches on all operable windows.

Convective losses occur through small openings around windows, doors, in floor, wall and roof assemblies.

HEALTHY ENVIRONMENTS, Bolinger

Strategies for Creating a Healthy Living Environment

I. Off-gassing defined

A. The emission of harmful VOC's (Volatile Organic Compounds).

B. "The Release of chemicals from non-metallic substances under ambient or greater pressure conditions." – NASA

1. The emission process occurs continually, but can be greatly reduced when the "polymeric material" is fully cured.
2. Can produce a white film, as with car windows.
    a. It is necessary to utilize masking systems or personal ventilation systems when dealing with products that off-gas due to harmful side-effects.
    b. Side effects of exposure without the existence of ventilation devices can create serious brain damage and even death, if exposure is for an extended period of time.

II. Materials that "off-gas"

A. Paint

-Occurs mainly during application, but if plasticizers are in the paint, off-gassing can occur when direct sun exposure reaches the painted surface.

B. Vinyl

-Consists of polymer vinyl bonds, bonded together to produce a continuous product. The polymer in the bond is the off-gassing agent in this case.

C. Wood

-Only the case if the wood has been processed with an additive coating.

a. Examples of processed wood are: glulam beams
b. PSL (Parallel Strand Lumber).

D. Formaldehyde

1. In building applications, formaldehyde is used in polymer adhesives. When mixed with other applications, such as melamine and urea, formaldehyde creates a resin type of substance that hardens as a very powerful consistency.
2. Formaldehyde is powerful enough to maintain cadavers so that they do not rot. Needless to say, it is highly dangerous to human consumption.

E. Insulation

-There are many types of insulation, some of which are more harmful than others:

a. Fiberglass
    i. Made from silica-based glass product separated into many strands.
    ii. Often used for acoustics and for insulation of attic spaces, etc, in the form of “Pink Panther” fiberglass batts.
b. Perlite
    i. A glass material formed from obsidian deposits.
    ii. Expands rapidly with heat.
    iii. Highly formed with silicone dioxide, which is highly toxic.
c. Polyurethane
    i. Effective in areas that receive water exposure.
    ii. Not completely waterproof, but more water resistant than many other insulation applications.
    iii. Used in highly flexible foam applications, such as:
        -Wheels and tires made from durable elastomeric.
d. RCPS (Rigid Cellular Polystyrene)
    -Styrofoam is a primary example of RCPS.
e. Phenolic
    i. Very high strength and much less flammable.

ii. Downside is that it is a spray-on adhesive so it emits particulates in the air.

f. Polyisocyanurate
    i. High temperature flammability resistance and stability.
        -Over 400 degrees Celsius.
    ii. High R-value.
    iii. More expensive than polystyrene panels.
    iv. Highly utilized in energy star homes.

g. SIP (Structural Insulating Panels)
    i. Made from polystyrene foam sandwiched between two oriented strand boards.
    ii. An advantage is in their structural strength, which is very similar to the strength of a w-flange beam.
        -SIP is often used in place of structural members for that reason.

h. Vacuum Insulation
    i. Effective based on the existence of thin panels with an air-tight seal.
    ii. R-value of R-50.
    iii. If the seal breaks, the product becomes much less effective.

i. Cork

i. Effective due to its tight sealing capability.

ii. All natural material also makes it a very environmentally friendly material to use.

iii. Well suited for green building applications.

j. Aerogel

i. The best insulating agent on the market because it is impenetrable.

ii. Composed of a typical gel material, with the liquid drained and replaced by gas.

-Achieved through a process called supercritical drying.

1. waterproof
2. semi-transparent
3. feels like Styrofoam

iii. The downside is a high level of expense.

k. Straw bales

i. Green, all-natural, material for insulation.

ii. Straw bales are inexpensive as a material.

iii. Labor intensive, which creates high labor costs.

F. Fire retardants

1. Fire retardants works in one of three ways:

a. Dilution

-Extinguishing the fire after burning.

b. Cooling

-Cooling the material so it does not catch on fire.

c. Formation of protective material.

-Creating a barrier between the material and heat source.

2. The best, most natural, retardant is water.
    a. The problem with water is that it can not sit on walls as a fire prevention mechanism.
    b. It must be applied after the fire initiates.
3. The alternative to natural water is chemical fire-retardants.

Types are:

a. Class A foam

-Creates a fire break and is used to contain brush fires.

b. Fire Aid

-Used in conjunction with water. Together, fire retarding can be over six times as effective.

c. Arctic Fire

i. Cools heat faster than foam and water.

ii. Can be applied to human skin.

III. Other materials are harmful to humans.

A. Garden poisons

1. Weed-and-feed

2. Plant protection

B. Mold

1. Especially harmful to humans if turned black.

2. Can cause brain-damage to people breathing its toxins.

C. Mildew

-Typically grows on organic materials or in places that are not well ventilated.

D. Combustion materials

1. Gas for the BBQ.

2. Gas for the stove.

3. Gas for the furnace system.

E. Electromagnetic fields

-This can be especially harmful if it occurs where the person sleeps. Hour on end in the field can cause brain damage.

F. Water pollutants

-This includes anything that gets into water that is in the range of human consumption or contact.

IV. Alternative, “non-off-gassing” materials.

A. Non-VOC emitting paints and sealers.

B. Non-VOC emitting insecticides.

-Many materials for building come in the “non-VOC” variety. It may just mean a slight upgrade in material (higher performance material).

Ventilation Strategies

I. Ventilation is defined as, according to the ASHRAE handbook, “air used for providing acceptable indoor air-quality.”

-Ventilation is especially necessary when animals or off-gassing substances are present.

II. The most “green” ventilation system is natural ventilation.

A. Created with designed openings at different ends of a structure.

B. Created with openings in the roof or flooring system.

1. Allows for air to freely move in and out of a structure, consistently bringing new, fresh air into the workable space.
2. An added component is that the natural air flow acts as a natural cooling system, assuming that the wind temperature is less than the indoor, static air temperature.

III. The mechanical ventilation is part of the HVAC system in a building. Specifically, the V in HVAC stands for ventilation.

-Allows for air regulation in the interior spaces.

1. Keeps a constant circulation of fresh air, or at least the air that is in the building.
2. Utilizes air-intake vents on the exterior of the structure and re-used air from the interior.

IV. Types of mechanical ventilation systems, besides HVAC, include:

A. Fume hood

-A device that is placed over stoves, chemical disposal areas, and experimentation areas, in order to create a direct means of ventilation out of the livable space.

-Characteristic of vents over:

a. Stoves

b. Fireplaces

c. Etc.

B. Room air distribution

2. This is the process of mixing air from different rooms in a structure so as not to allow for any single space to maintain stagnant, contaminated air.

-The air is typically sent through filters and diffusers.

3. Without room air distribution, the carbon dioxide levels in a given space can elevate and create sleepiness and productivity inefficiency.

-Specifically the case in schools or small spaces.

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ENVIRONMENTAL POLLUTANTS, B. Hansen

I. Noise Pollution (or Environmental Noise): Man or machine made noise that is displeasing and/or disruptive to the environment.

II. Sources of noise pollution

A. Transportation and motor vehicles

1. Source of most noise pollution

2. Hybrid vehicles are the first to make a widespread reduction of noise within the last one hundred years

B. Poor Urban planning-An example of poor urban planning is placing an industrial site next to a residential community creating adverse consequences for the residential acoustic environment

C. Office Equipment

D. Factory Machinery

E. Power Tools

F. Lighting Hum - Noise created from the use of electric lights

G. Audio Entertainment Systems

H. Recreational Vehicles (ATVs and Dirt Bikes)

III. Health

A. Can affect physiological and psychological health

1. Annoyance

a) If listener dislikes sound (i.e. dislikes loud playing music)

b) If cannot control the noise source

c) If noise is controlled by a third party and the third party has lost control

d) If sound is inherently unpleasant

e) If the sound is not contextual (i.e. noises from a race track carrying over to a picnic ground)

2. Aggression

3. Hypertension

4. High stress levels

5. Tinnitus - Can lead to forgetfulness, severe depression, and panic attacks

6. Hearing Loss

a) Elevated sound levels irritate and damage the cochlear, the auditory portion of the inner ear

b) Rosen's Seminal work – by following the Maaban tribesman and comparing them to control groups in the united states Rosen proved that hearing loss is attributed to chronic exposure to loud noise and not old age.

7. Cardiovascular Health

a) Exposure to moderate to high noise levels during a single eight hour period leads to high blood pressure and stress

IV. Environment

A. Noise and loud sounds can have adverse affects on the environment and animal life

1. Causes stress

2. Disrupt the balance between detection and avoidance amongst predator and prey - Mortality rate could increase

3. Interrupt the use of communication

a) Disrupts navigation

b) Disrupts reproduction

4. Hearing loss (temporary and permanent)

5. Habitat reduction

a) The amount of usable habitat is reduced which could lead to extinction

b) Numerous whales have been beached and died because of loud military sonar devices

6. Lombard vocal response

a) Scientists have shown that whales' song lengths are longer and louder when submarine detectors are on. As a result more animals might attempt to speak louder drowning out noise from other species of animals that might be communicating vital information such as warnings, finding prey, or net bubble preparations.

7. Other

a) Zebra Finch - Become less faithful to their partners while living in an environment with excessive noise pollution.

(1) Could alter a population's growth

(2) Could alter a population's evolution trajectory

V. Responding to Noise pollution

A. Good Urban Planning

1. Good planning could reduce the amount of noise that travels over to other spaces. Important factors include:

a) Adjacencies

b) Traffic (proximity, acceleration, and deceleration)

c) Materiality

2. Barriers

a) Natural

(1) Hills

(2) Trees

(3) Low to tall vegetation

b) Synthetic

(1) Wall Materials: some materials might be better for absorbing sound and/or better for the environment (e.g. sound barriers between freeways and neighborhoods)

VI. Carbon Monoxide

VII. Toxic gas produced from the burning of carbon based products such as fossil fuels

A. Odorless

B. Colorless

C. Tasteless

D. Gas at room temperature

E. Non-irritating

VIII. Has always naturally been present in the atmosphere

A. The most common source of natural production of carbon monoxide is from volcanic activity

1. Carbon monoxide can make up 0.1% to 2% of a volcano's gas composition

B. Carbon monoxide is a resultant of bushfires

C. Carbon monoxide is naturally oxidized into carbon dioxide

1. Concentrations of carbon monoxide have a short life span in nature

IX. Carbon monoxide may contribute to global warming

A. Carbon monoxide impedes the release of some of earth's natural gases out of the atmosphere. Due to the build-up of gases in Earth's atmosphere ultraviolet rays are bounced back, instead of being released, causing a warming affect in the Earth's atmosphere.

X. Toxicity

A. The most common type of fatal poisoning

1. Carbon monoxide attaches to the oxygen receptors of the hemoglobin found in blood cells, making it so that body parts cannot obtain the oxygen needed

2. Excessive exposure to carbon monoxide leads to damage of the central nervous system and heart

3. Has severe effects on the fetus of a pregnant woman

4. Long term exposure may lead to sequela

5. Symptoms

a) Headaches

b) Dizziness

c) Flu like effects

d) Depression

e) Chronic fatigue

f) “Haunted Houses”

(1) Some of the symptoms related to carbon monoxide poisoning are similar to the sensation that one feels in a haunted house such as dementia, emotional disturbances, listlessness, and hallucinations

(2) Dr. Wilmer, an ophthalmologist, describes a case from 1921 when a family who had thought to be haunted had been over exposed to carbon monoxide: “moved into a new home, but soon began to complain of headaches and fatigue. They began to hear bells and footsteps during the night, accompanied by strange physical sensations and sightings of mysterious figures. When they began to investigate the symptoms, they discovered the previous residents of the house had similar experiences. An examination of their furnace found it to be severely damaged, resulting in incomplete combustion and forcing most of the fumes (including carbon monoxide) into the house rather than up the chimney”

6. Effects of carbon monoxide in parts per million

a) 35 ppm (0.0035%) Headache and dizziness within six to eight hours of constant exposure

b) 100 ppm (0.01%) Slight headache in two to three hours

c) 200 ppm (0.02%) Slight headache within two to three hours

d) 400 ppm (0.04%) Frontal headache within one to two hours

e) 800 ppm (0.08%) Dizziness, nausea, and convulsions within 45 minutes. Insensible within two hours.

f) 1,600 ppm (0.16%) Headache, dizziness, and nausea within 20 minutes. Death in less than two hours.

g) 3,200 ppm (0.32%) Headache, dizziness and nausea in five to ten minutes. Death within 30 minutes.

h) 6,400 ppm (0.64%) Headache and dizziness in one to two minutes. Death in less than 20 minutes.

i) 12,800 ppm (1.28%)Unconsciousness after 2-3 breaths. Death in less than three minutes.

XI. Prevention

A. Education about the proper use of equipment such as household appliances, heaters, fireplaces, and internal combustion engines

B. Carbon monoxide detectors

1. Device sounds an alarm if it detects high levels of carbon monoxide

2. Placed in homes and around heating devices - Unlike smoke detectors they do not need to be placed at ceiling height

3. Consumer Product Safety Commission stated, “carbon monoxide detectors are as important to home safety as smoke detectors are.”

C. Smoke detectors - Carbon monoxide is a byproduct from household fires; therefore smoke detectors can help prevent carbon monoxide inhalation.

ENVIRONMENTAL LIGHTING, Nielsen

XII. Light – can be used as therapy for seasonal affective disorders

A. Blue/red light treatment

1. Sunlight helps to improve acne

a) But too much can cause long term skin damage

b) Artificial uv rays don't work as well as the sun, which correlates with the 4human physiology

2. Red light activates ATP (energy) in the skin cells, and helps improve response rates

3. These lights can be produced from fluorescent lamps and LEDS

B. Fluorescent lamps

1. Are illuminated by excited mercury vapor, argon or neon gas, and give off ultra violet light.

These uv rays are not as harmful as the sun in low doses, but consistent use in tanning beds can cause damage.

2. Over use can cause diseases such as skin cancer, fatigue, headaches

3. Fluorescent lamps are more <u>efficient</u> than <u>incandescent light bulbs</u>, and give off an equal brightness

Need to be operated at around 68 degrees Fahrenheit or the efficiency decreases

4. They can cause health issues

a) Headaches

b) Fatigue

c) Light sensitivity to those who have epilepsy, lupus, chronic fatigue syndrome, and vertigo

C. LED – a semiconductor diode that emits an incoherent narrow spectrum

1. Depending on the material it can be infrared, visible, or near ultraviolet.

2. LEDs produce more light per watt than do incandescent bulbs; this is useful in battery powered or energy-saving devices.

3. LEDs 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.

4. When used in applications where dimming is required, LEDs do not change their color tint as the current passing through them is lowered, unlike incandescent lamps, which turn yellow.

5. LEDs are ideal for use in applications that are subject to frequent on-off cycling, unlike fluorescent lamps that burn out more quickly when cycled frequently, or HID lamps that require a long time before restarting

6. LEDs, being solid state components, not a filament like normal light bulbs, are difficult to damage with external shock. Fluorescent and incandescent bulbs are easily broken if dropped on the ground

7. LEDs have an extremely long life span. One manufacturer has calculated the ETTF (Estimated Time to Failure) for their LEDs to be between 100,000 and 1,000,000 hours.[19] Fluorescent tubes typically are rated at about 30,000 hours, and incandescent light bulbs at 1,000-2,000 hours.

8. LEDs do not contain mercury, while compact fluorescent lamps do.

9. LEDs cost a lot more in comparison to fluorescent lighting.

D. Sky lights

1. Allow for natural sun.

a) Supports life on this planet earth

b) Photosynthesis in plants

2. Human physiology

a) Affects on the adrenal gland which regulates stress response and metabolism.

b) Lack of sunlight can cause seasonal affective disorder.

c) It up regulates the manufacture of vitamin D.

XIII. Maintenance

Reasons for low maintenance materials

1. Low maintenance materials = more time in other activities

2. Helps older people by not having them have to maintain items that may be hard for them.

3. Health issues with fumes to repaint, sand, stain, labor, etc.

XIV. Materials

A. Xculsive Brand resilient sheet flooring

Durable, stain resistant flooring contains silver to protect bacteria, mold and mildew. It looks like linoleum flooring, but with a little added care. The aesthetic look comes in all different styles from the color to the texture.

www.congoleum.com

B. Correct Deck – composite deck

Stain, mold, and fade resistant deck that will not rot splinter or crack. This decking looks like standard wood decking, but without the maintenance issues. It comes prefinished in many different colors and finishes.

www.correctdeck.com

C. Blue Linx – railing

Railing is resistant to warping, twisting, and decaying. Can be cut formed, and drilled just as normal wood. The railings come prefinished to look as wood, or in white plastic vinyl finish.

www.bluelinxco.com

D. Crane – low maintenance siding

This looks like hardiplank exterior siding but looks like natural wood. It comes in a variety of colors. An added bonus is this siding has insulation qualities within it, which will help the overall function of the building as well as the maintenance issues.

www.cranesiding.com

E. LP – low maintenance molding

Like typical wood molding for the interior and exteriors finishes, this has the appearance of wood, not only in colors but as well as texture. This is strong and lightweight as well as moisture resistant which makes it an excellent choice for low maintenance applications.

www.lpcorp.com

F. Dixie-Pacific - synthetic railing system

Quick Installation, UV protected, impact resistant, maintenance free, never need painting. This product has polymers within it which give it the impact resistance, as well as a nice aesthetic quality of white vinyl railing.

www.dixie-pacific.com

G. FrameSaver – rot-resistant frames

These frames can be used in a variety of things from doors to windows. The composite materials give it a resistance to rot and other insect damage. The finish on it can be anything you want, from a natural stain to finish paint.

www.framesaver.com

H. Wilsonart Flooring – high pressure laminate

Wear resistance, fewer scratches and scuffs, no dimpling, no denting, moisture resistant. This is a linoleum floor system which has been improved from the previous version. The prints and colors you can choose are nearly endless.

www.wilsonartflooring.com

I. Royal Building Products – siding, Energy start rate, don't need paint

The materials that make up the compound give it a uv fade resistance look, strength, and insulation qualities. It is a great project to be used in colder applications. In section it looks like normal metal siding, but looks like hardiplank in elevation views. It doesn't need to be finished, and has the wood grain texture to it.

www.royalbuildingproducts.com

J. Arch Wood Protection – already water proofed wood for outside applications

Architectural wood treated in various ways to protect it against the weather, fire, mold, and fungi. This wood is used for framing and other things like that. It is not usually used for finish product.

www.wolmanizedwood.com

K. Sashco – sealant that can be applied in any condition and expands well in big temperature swings

Sealant can be used in harsh weather conditions, and can expand and contract better than other sealants. These sealants vary in applications from rooftops, to calking around showers and tubs. It comes in a few colors to allow the user to hide it somewhat.

www.sashco.com

L. Wayne-Dalton – fiberglass steel garage doors

These garage doors are fiberglass on the outside with an underlying steel structure to give it strength. The fiberglass gives it the insulation qualities. It can be finished in a variety of different ways, but does not need to be. Its man use of applications are garage doors.

www.wayne-dalton.com

RECYCLED PRODUCTS, Rivera

I. Considerations for green and recycled products

A. Foundations

1. SIPs & ICFs – Use recycled plastics to insulate Structural Insulated Panels and Insulating Concrete Forms. Use of SIP's and ICF's can reduce energy costs by 50%, can also provide the building great wind and seismic resistance, snow loading, and soundproofing characteristics.
2. Aggregates – Glass chips, metal chards, straw, and old concrete as an aggregate base can help out in minimizing resources and keep on budget.
    a. The LEED Green Building Rating system recognizes recycled concrete in its point system.
    b. Innovation opportunities – material characteristics

B. Floor Systems

1. Bamboo flooring - Elegant, versatile, very durable, stable, anti-microbial, and water resistant. Nail-down or floating floors both can come prefinished with an aluminum oxide in order to provide long life to product.
    a. Bamboo can be used for flooring, countertops, walls, furniture, molding, and much more.
    b. Slightly less expensive than hardwood flooring.
2. Cork flooring - Natural Cork brand comes directly from the bark of the Cork Oak tree and is layered with UV cured acrylic. Cork is highly durable, comfortable, controls sound, and is thermally insulating.
    a. Available in a variety of colors.
    b. Use for flooring, walls, and underlayment.
    c. Costs about the same as hardwood flooring.
3. Wood flooring - Engineered wood flooring comes in wide planks and can be easily installed as a floating floor.

a. It is also perfect for in-floor radiant heating, and is available in Maple, Oak, Ash, Beach, Birch and Cherry.
b. Costs about the same as hardwood flooring but easier to install.

C. Wall Systems
1. Earth Walls – can be built from local earth from site. They are extremely environmentally friendly, in that embodied energy is minimized drastically. Does require intense labor, which keeps our heart-rate at a good pace.
a. Adobe – consists of good clay, sand, and aggregate mixture, and can be shaped into uniform blocks.
b. Cob – can have a wildly freeform, characteristic. Due to its composition of straw and earth its insulation values increase.
c. Rammed earth – is compressed or tamped into place. Walls can be thick and can act as thermal mass.
d. Poured earth – as like concrete, it uses cement as its binding agent, materials for poured earth must meet engineered standards. Compressive strength is of 800-1200 psi.
e. Cordwood – walls have both properties of insulation and thermal mass, using this method produces a bold, rustic, defined look.
f. Strawbale – great insulating value, labor intensive construction.
g. Light weight concrete – walls need less structural reinforcement, requires smaller foundations, and is fire resistant.
h. Local stone – walls use local stone and provide identity to a project.

D. Roof Systems
1. Cool metal roofing – is a sustainable building product that can reduce energy costs.
a. Energy efficient through its radiant reflectance properties that block out most of the UV rays.
b. Durability is long due its material properties

c. Recyclable in the products to manufacture it, to being the recycled product.
d. Strength to Weight ratio is great.

2. Ferrocement – can be used to shape over head planes or roofs.
3. Green roof tops – add outdoor spaces and provide maximum protection from UV rays.
    a. Greenroof technology requires an appreciation and knowledge of plant biology, hydraulic engineering and architecture. These are detailed engineered systems which address all the critical aspects of design, including: the bulk weight of the system and load bearing capacity of the underlying roof deck; moisture and root penetration resistance of the waterproofing membrane; resistance to wind shear; management of drainage; and the adaption of the proposed plant material
    b. The two basic types of roof greening covers are extensive and intensive greenroofs. The difference lies in the desired function of the roof space. Some designs will require different soil depths to accommodate various plants, shrubs and trees. This means that some additional structural support will be necessary to accommodate higher live roof loads.
    c. Green roofs last a long time and can be warranted for 20 years.

E. Finishes
    1. Coats, Paints, Sealants, can all have green building characteristics. Specifications can be provided from the manufacturer.
        a. VOC – are toxic chemicals found in paints, coats, or sealants. There are products that reduce or completely eliminate such chemicals.
        b. Resins – can be made from biodegradable products.
    2. Finished Materials – is the final finish on any system. With the choices available one can create interesting environments. The following are brand name products, which were found in;

http://greensource.construction.com/products/, under the months of June 2006, November 2006, January 2007, April 2007, July 2007, and October 2007. The detailed information about the product is the description from the manufacturer and the editor of the article. All rights belong to such parties.

a. Earthtex – "wall coverings are a high-performance alternative to PVC materials, providing durability and ease of maintenance. The understated patterns are woven with solution-dyed polypropylene and thermoplastic olefin (TPO) monofilament yarns that contain no heavy metals or plasticizers, and are made with 44 to 50 percent post-consumer waste."

b. Scan – "Instead of shipping excess post-production carpet yarn from various lines away for recycling, the manufacturer gathers it up and uses it right there to make first-quality carpet. Scan is a commercial pinstripe broadloom featuring the hues and tones of separate dye lots in subtly variegating color ways."

c. Tensioned fabric structures – "Pink creates tensioned fabric structures for architectural interiors that range from eye-popping to serene—including room dividers, ceiling treatments, and public art. The framing components range from polycarbonate to aluminum, and the fabrics are typically a poly-spandex blend. The company will work to accommodate any specified frame and fabric material. More than an artful presence, these structures can reduce material use in almost any application from architectural dividers to store displays, and can contribute to reduced impacts from remodeling churn."

3. New Products – are always emerging due to scientific development and human understanding. New products are always available and provide design opportunities. The following are brand name products, which were found in; http://greensource.construction.com/products/, under the months of June 2006, November 2006, January 2007, April

2007, July 2007, and October 2007. The detailed information about the product is the description from the manufacturer and the editor of the article. All rights belong to such parties.

a. Salvaverde – "made from recycled high-density polyethylene (HDPE)—the stuff plastic milk bottles are made of—is an interlocking modular system used for creating extra-strength lawns for car parking areas, alleys, and walkways. The grid, which can support loads of up to 35 tons per square foot while preventing soil compaction, allows rainwater to filter into the ground naturally without creating puddles or mud."
b. Ezkote Green – "is a release agent applied to the forms used in concrete work. Unlike conventional form-release oils that can be a major source of VOCs, soil contamination, and human health risks, Ezkote is made with a zero-VOC, biodegradable vegetable oil carrier rather than a petroleum product. It can be used on wood, metal, or plastic forms, leaving the concrete free of stains and voids."
c. Triton Logging – "harvests the billions of available board feet of old-growth forests-underwater. Hydroelectric dams built decades ago flooded forests that still stand beneath reservoirs. Triton uses a logging submarine to recover these well-preserved trees. Its entire product line, ranging from poles and timbers to flooring and paneling, is certified SmartWood."
d. Bio-Glass – "is a solid surface material made from 100 percent recycled glass that is partially melted and agglomerated under pressure—either pre- or post-consumer, or a blend of the two, depending on the color. The translucent, nonporous material can provide visual depth to easily maintained countertops, walls, and floors. Bio-Glass is available as 110-inch by 47-inch slabs, about 4.7 inches thick with a lightly textured, slip-resistant surface and also in smooth-surfaced slabs approximately 4 inches thick. The

product is being introduced in white and light green; blue, brown, and dark green are to follow."

II. Manufactured Systems

A. Autoclaved Aerated Concrete

1. Autoclaved Aerated Concrete (AAC) is a precast structural product made with all-natural raw materials. In 1914, the Swedes discovered a mixture of cement, lime, water and sand that expands by adding aluminum powder.
2. It is an economical, sustainable, solid block that provides thermal and acoustic insulation as well as fire and termite resistance. AAC is available in a variety of forms, ranging from wall and roof panels to blocks and lintels.

B. Thermalwall Forming System

1. This system for forming concrete is a hybrid of standard forms and ICF's. It offers the big advantage of placing the concrete mass on the inside of the building shell, where it can do the work of moderating temperatures effectively. The outside of the form is composed of 4 inches of EPS insulation.
2. Produces walls where the concrete is on the inside of the insulation line of the building utilizing the thermal mass potential to its fullest.
3. Comparative analysis indicates that buildings constructed using the thermalwall require 50% less energy to maintain a comfortable living environment (in either a cold or hot climates) than well constructed wood frame buildings.

C. Shortcrete Systems

1. Shotcrete is sprayed concrete. There are both wet and dry methods of doing this. The aggregate must be some-what fine, like mortar, to be able to do this, and usually the percentage of Portland cement to sand is quite high to create a very strong product. An advantage of the systems that employ shotcrete is that the concrete shell of the building can be exposed to the inside, where its thermal mass can be fully

utilized. Usually some form of steel mesh is provided to give tensile strength to the wall, which is then insulated in various ways from the atmosphere.

2. For more conventional vertical wall buildings, there are several manufacturers of shotcrete sandwich panel systems. These systems use an EPS core for insulation, with wire mesh attached to both sides of it. Once the panels are erected on site, the shotcrete is applied to both sides. Depending on how thick the EPS insulation is the potential R-values can be quite high.

D. Light-gauge Steel
    1. Light-gauge steel is being used more often these days to replace wood studs for framing a house. The cost is comparable to wood, and much of the steel is recycled.
    2. Steel is actually stronger and lighter than wood, and is termite and fire proof. Also the use of steel conserves our forest resources.
E. Magnesium Oxide Panels
    1. All-natural magnesium oxide cold ceramic cement based building panel that can replace drywall, OSB and plywood.
    2. Can be used as a cement product, comparing it to Portland cement and proving to have many benefits.
F. Enviro-bricks
    1. Fire-proof bricks made from compressed earth, fly ash and recycled wood have an interlocking pattern for easy assembly.
    2. Earth block - are building blocks made out of recycled fly ash and wood fiber.
G. Gigacrete
    1. Recycled Aggregates are common in GigaCrete Panels. Made with recycled waste materials including bottom ash and fly ash. These materials make up to 80% (by volume) of the overall finished product, this level can-not be achieved by construction materials made out of cement. The “extraction burden” of materials (also known as the

ecological rucksack) is much more environmentally inclined for GigaCrete products.

2. The manufacture and use of GigaCrete cement products results in 50% less CO2 emissions compared to the manufacture and use of Ordinary Portland Cement (OPC) building materials.

III. Salvaged Products

A. Timbers, wood planks, and engineered wood

1. Reduce waste in landfills, increase efficiency of wood use, reduce pressure on forests, increase access to high-quality grades.
    a. As a building material, wood has many lives and can be reused in countless ways. Today these salvaged or reused products are often referred to as ‘reclaimed’ or ‘rediscovered’ wood products. Vast quantities of high-quality wood can be found in old warehouses, dilapidated barns and other structures that await deconstruction and reuse as products that range from clear vertical grain (CVG) flooring to structural timbers and beams.
    b. Using salvaged wood products alleviates pressure on overflowing landfills and natural forests alike. Another added benefit of using reclaimed or rediscovered wood products is that high quality grades can be found without having to use tight-grained wood from slow-growing older forests.
2. Strategies for Specifying and Sourcing Salvaged Wood Products
    a. Identify Areas
    b. Check guidelines of the Green Building program
    c. Research availability of species, grade, and products
    d. Specify in construction documents
    e. Use the vendor reference list

B. Brick, stone, concrete

1. Identify Areas of salvage and types of stone or masonry products.
2. Products include pier caps, sills, gate posts, cobbles and quoins.

3. Keep in mind an idea of the characteristics and patterns you are looking for. This will make the search progress a lot smoother.
4. Reclaimed Stone – Reclaimed stone is a very unique product. Each piece of stone was hand cut and contains a history, appearance, and quality of craftsmanship from another era things that just cannot be reproduced in today's market.

C. Steel, aluminum, and metals
   1. Different type of Applications with-in the buildings components
      a. Roofs
      b. Mullions
      c. Window and Door Frames
      d. Wide flange members
      e. Metal details
      f. Hardware
   2. Strength due to recycle cycle – Steel is known to have stronger properties as you recycle it than virgin steel.

D. Plastics
   1. Good use of unwanted material
      a. Can be used as insulation
      b. A lot of plastic is available and ready to be processed and recycled
   2. Material properties and characteristics
      a. Manufacturers can achieve qualities that mimic other building products.

New technologies allow the exploration and exploitation of plastic properties.

Products that Conserve Natural Resources, K. Hansen

XV. Reduce Material Use

A. QuickFlash Envelope Flashing - prefabricated flashing for exterior-wall plumbing, electrical, gas, and HVAC penetrations and protrusions.

1. A caulkless, friction-fitting polyethylene, or rubber, panels help prevent moisture, air, and insect entry for an appropriately functioning building envelope.

2. Products for plumbing and gas accommodate 1/2- to 4-inch pipes;

3. HVAC flashings will handle up to 6-inch sheet-metal ducts.

4. The electrical line offers specific solutions for single-gang, pancake, and round boxes, as well as depth variations for different exterior cladding

B. Haworth Access Flooring - TecCrete and Nexus access flooring are SCS Indoor Advantage Gold certification for low emissions.

1. The TecCrete concrete-and-steel system, which requires no finish flooring, is quiet and sturdy underfoot.

2. It’s available in heights from 3 to 30 inches to accommodate nearly any cabling and air distribution requirement.

3. The Nexus system is a low-profile (2.5-inch) raised floor made of steel-wrapped MDF panels, with cable management designed right in—no need for cable trays.

4. And since it is not used for air distribution, less expensive non-plenum cable can typically be used.

C. Hycrete - Hycrete is a waterborne admixture for concrete that replaces densifiers and waterproof coatings in high-performance applications like commercial foundations, plaza decks, and roofing systems, including living roofs.

1. It reacts with metals in the water and concrete mix—as well as with rebar and other embedded metal reinforcement—to create a compound with a long hydrocarbon chain that fills up the capillaries in the concrete, and which repels water.

2. Hycrete has achieved Cradle to Cradle certification from McDonough Braungart Design Chemistry (MBDC) as a “biological nutrient.”

3. It is available by the gallon, tote, or tanker.

D. Retroplate Concrete Polishing - the RetroPlate Concrete Polishing System grinds, polishes, and densifies old or new concrete floors to achieve very low-maintenance, extremely durable high-sheen finished floors for schools, retail stores, warehouse and industrial buildings, office buildings, and homes.

1. A uniform finish or a terrazzo look are options, as is coloring via acid dyes, pigments, or colored aggregate.

2. The structure-as-finish system is free of VOCs, epoxies, polyurethanes, waxes, and strippers, and requires no caustic or acidic cleaning or maintenance compounds.

XVI. Very durable, long-lasting products

A. PrariePicket, by Heartland Bio Products - PrairiePicket™ is the composite fence picket component of Heartland BioComposites' privacy fence system, PrairieFence™..

1. Won’t require the annual staining and sealing that wood fencing does to retain its beautiful appearance.

2. The composite fence pickets are available in 4’, 6’ and 8’ lengths to accommodate the length requirements of most fencing applications.

3. Fence™ is primarily composed of reclaimed HDPE and wheat straw. The use of HDPE diverts used, non-biodegradable plastic (plastic water jugs, milk bottles, bleach & fabric softener bottles, liquid detergent bottles, etc.) from public landfills and gives it new life by creating green building supplies.

B. Surface IQ, by Carnegie Fabrics

C. RoofRoc - RoofRoc Synthetic Slate looks and feels like natural slate, but it's made with high-density polyethylene (HDPE) recycled from post-consumer sources and limestone.

1. As in real slate, the black, gray, green, or brown tiles vary slightly in color, but they weigh two-thirds less.

2. Four separate profiles give the natural, random look of quarried slate. RoofRoc provides a 50-year warranty on this Class A fire-rated product.

D. Vetrazzo Crushed Glass Countertops - Vetrazzo surfaces give you an alternative to using non-renewable resources (like virgin granite, for example), and provides a new market for recycled glass, including glass that cannot be recycled elsewhere. Even reusing glass to create bottles or fiberglass comes with a HUGE energy cost.

1. 100% of the glass we use is recycled

2. Vetrazzo is made in the U.S. all material is from the U.S.

3. workers are paid a living wage…

E. Paper Stone - Dense, hard, moisture-resistant PaperStone-certified countertops are made with a water-based resin that's processed from cashew nut shell oil, and mixed together with 100 percent post-consumer recycled paper.

1. In addition to not being petroleum-based and having no measurable formaldehyde offgassing.

2. These countertops are certified by SmartWood to carry the Forest Stewardship Council (FSC) recycled-content label.

3. Similar in appearance to soapstone or slate, they're heat resistant to 350 degrees, and most household cleaners and foods won't stain them.

4. They don't support mold or bacteria growth.

5. A variety of warm, contemporary colors are available, including slate black, chocolate brown, straw yellow, and concrete grey.

6. An outdoor siding product made from this material is also available.

XVII. Certified wood products

A. Wood Floor Resource Group - The Wood Floor Resource Group (WFRG) supplies a comprehensive range of environmentally friendly wood flooring products, including FSC-certified wood, salvaged or reclaimed wood, rapidly renewable non-wood materials, and low- or zero-formaldehyde products.

1. The Eco Products Selector on its Web site allows users to select products based on relevance to LEED credits or according to environmental attributes; by width, color, solid, or engineered construction; and whether the product is finished or unfinished.

2. WFRG also provides LEED assistance and other support to customers, acting as an expert resource to the architectural community.

B. Triton Logging - Triton Logging harvests the billions of available board feet of old-growth forests-underwater. Hydroelectric dams built decades ago flooded forests that still stand beneath reservoirs. Triton uses a logging submarine to recover these well-preserved trees.

1. Its entire product line, ranging from poles and timbers to flooring and paneling, is certified SmartWood Rediscovered by the Rainforest Alliance.

C. Environ Biocomposites - Microstrand panels are an industrial-grade replacement for particleboard or plywood.

1. Made from chopped wheat straw and formaldehyde-free, non-off-gassing urethane resin, they're 10 to 15 percent lighter than traditional particleboard, yet are stronger.

2. The panels are harder, smoother, and more resistant to impact than the wood-based alternatives.

3. Tree-free, rapidly renewable Microstrand accepts paints, stains, and lamination, and can be custom-engineered to meet specific requirements, such as increased fire-resistance.

D. Certified Red Cedar - Mary’s River Lumber, the leading U.S. producer of western red cedar, has chain-of-custody certification from the Forest Stewardship Council (FSC).

1. Not stopping with that, their mill recovers its scraps and shavings for things like animal bedding, landscaping, and packaging.

2. Their second-growth, tight-knotted products include boards, decking, fencing, paneling, and siding.

3. The textured appearance, hardy durability, and easy workability of western red cedar make it a preferred choice by many people as a material for decks and outdoor furniture.

4. It’s more stable than other softwoods, and naturally resists decay and insects.

5. It can be finished with an oil stain, or allowed to weather to an attractive finish.

E. Bamboo molding - JMX International offers precision-milled, prefinished bamboo architectural moldings as an attractive, more environmentally appealing option to solid wood moldings.

1. Durable and scratch-resistant, these moldings carry factory-applied multi-coat finishes with a ten-year warranty.

2. Many profiles are available, including crown moldings, stair noses, thresholds, chair rails, quarter-rounds, and wall base.

3. Bamboo, which is actually a grass, grows faster than any tree and is exceptionally strong.

4. JMX produces its bamboo products in China, verifying the standards of the manufacturing processes involved in their entire line of bamboo floor panels, plank boards, and moldings.

Products Which Do Not Emit Toxins, Bithell

I Minimally processed products

A. Natural Materials

1. Properties

a. Any product that comes from plants, animals, and mineral

b. Do not pollute

c. Easily processed

d. Aesthetic and blends with landscape

d. Vernacular

e. Local

2. Stone straw

a. thermal mass insulation

b. widely available

c. natural and blends with landscape

3. Slate

a. Composed of clay or volcanic ash through low grade regional metamorphic rock

b. Thermal stability

c. Non toxic to environment

4. Wood

a. Natural aesthetics

b. Diverse uses

c. Wood is composed of fibers of cellulose (40%–50%) and hemicellulose (15%–25%) held together by lignin (15%–30%).[1]

5. Adobe

a. Thermal mass

b. Dirt that has been moistened with water

c. Sometimes has chopped straw or other fibers added for strength

d. Easily shaped

6. Rammed Earth

a. Compresses damp mixture of earth into an external supported frame that molds the shape of a wall section creating a solid wall of earth

b. High thermal mass

c. Heats up slowly during the day and releases its heat during the evening

d. Fire-proofed

e. Reduces need for lumber

f. Two thirds lower cost compared to standard construction

g. Time consuming construction

7. Straw

a. Renewable resource
b. Good insulation
c. Must be kept dry
d. Breathable moisture barrier
e. Quick construction with adequate training

II Alternatives to hazardous/ ozone-depleting products
A. Substitutes for PVC or harmful insulation
1. include cellulose insulation
a. Substitutes fiber glass insulation
b. High R value
c. Energy used to maintains interior climate is minimized, reduces both utility bills and the environmental costs of fossil fuel use
d. Medium and high density types
e. Made from recycled paper, loose fill or spray
f. Good acoustics

http://www.builditgreen.org/resource/index.cfm?fuseaction=factsheet_detail&rowid=7

2. Cotton Insulation
a. Made from natural fibers
b. Non toxic, no safety equipment required
c. Does not itch or cause irritation during installation
d. Can be recycled
e. Batt or loose fill
f. No formaldehyde off-gassing
g. Not common
h. 10% less sound transmission
i. Good performance at low temperatures and windy conditions
j. Same fire rate as fiberglass
k. Contains a low toxic boric acid
fiberglass can lose 35-50% of its R value when the outdoor temperature is 70 degrees colder than the indoor temperature

http://www.ecoproducts.com/Building/build_insulation/build_cotton_insulation.htm

3. mineral wool insulation
a. glass wool is recycled
b. rock wool is made from igneous rock
c. slag wool made from steel mill slag
d. reduce energy
e. thermal insulation

f. absorb sound
g. with vapor retarder can reduce condensation
h. non-combustible

http://www.naima.org/pages/resources/safety/rock1.html

4. plastic fiber insulation
   a. made from polyethylene terephthalate (PET) (recycled milk containers)
   b. difficult to cut and low melting point
   c. formed as a batt insulation like high density fiber glass
   d. fire retarder allows to stop burning
   e. R value of 3.8 per inch

http://www.daviddarling.info/encyclopedia/P/AE_plastic_fiber_insulation.html

5. Insulating foam
   a. Polyurethane foam insulation uses HFC-134a, non chlorine blowing agent
   b. Low density
   c. Damage to wetlands
   d. Spray foam insulation can seal and fill all the tiny cracks
   e. Higher R-value per inch
   f. Save money in framing cost
   g. Help control moisture intake
   h. Nitrogen based plastic foam
   i. Two-component plastic foam insulation, uses compressed air as the form of insulation material
   j. Breathes better than Polyurethane

http://www.powerhousetv.com/stellent2/groups/public/documents/pub/phtv_se_in_bu_000575.hcsp

6. Insulating masonry
   a. Insulated concrete systems developed
   b. Braced, rigid, polystyrene or polyurethane separated by ties
   c. Covered in concrete
   d. Better insulation
   e. Makes different shapes
   f. Thermal mass

B. Products reduce storm water pollution
1. Permeable pavers
   a. Allow natural drainage
   b. Migration of water goes into earth through pores
   c. Holes filled with vegetation
   d. Holds heavy loads, easily repaired, durable, and high quality

e. High maintenance, grass on top layer of dirt divided by pavers
f. Environmentally friendly
g. Appealing aesthetics
h. Ground water recharge
i. Control erosion of stream beds
j. Low impact development to achieve storm water management

2. Green roofs
   a. Covered in vegetation
   b. Water repellant system included
   c. Lightweight plants used
   d. Types - intensive, semi- intensive, extensive, depends on depth and amount of maintenance
   e. Drainage, structural, and insulation included
   f. Utilizes biological, physical, and chemical processes found in plant and soil complex
   g. Prevents airborne pollutants from entering storm drain system
   h. Reduce runoff, holds water on roof preventing erosion from run off
   i. Reduce heat island effect and CO2 impact
   j. Reduce summer AC cost, reduce winter heat demand
   k. Lengthen roof life 2 to 3 times
   l. Negate acid rain effect
   m. Infiltration
   n. 25% reduction in summer cooling
   o. Sound barrier

III. Pollution reducing products
   A. Masonry fire places
      1. When wood is burned in places it is locally available it is highly sustainable
      2. Growing of trees will make up for burning the wood
      3. Good thermal mass
      4. Burns significantly cleaner
      5. Less smoke emitted, better for cities
   B. Pellet stoves
      1. Supplemental heat in winter
      2. Produce small fire inside
      3. Measure heat output
      4. Downside is they use electricity
   C. Minimal emission fire places
      1. Moberg Fireplaces, Inc.
      2. Renewable energy and fuel cells
      3. Burn fuelwood with few emissions

SUSTAINABLE MATERIALS, Lyman

Products that reduce heating/cooling loads:

F. Concrete

1. Geopolymer concrete:

a) The chemical bond is as strong as the bonds found in rocks.

b) Reduces the carbon dioxide emission associated with regular concrete by 80-90%.

2. Recycled crushed concrete:

a) Can be used for less-demanding structural elements.

b) A disadvantage is that the material has issues with quality control. The quality of concrete with recycled concrete aggregates is very dependent on the quality of the recycled material used.

G. Glass

1. Electrochromic glass:

a) Can darken in stages depending on the amount of current passed over it.

b) Trials indicate that this glass can save up to 50% of the energy required for air conditioning.

c) Even when the glass is fully darkened external views are not impaired.

2. Hydrophilic glass:

a) A new type of glazing that is self cleaning.

b) Layers are deposited on the glass to produce the photocatalytic characteristics.

c) After exposure to ultraviolet light in the daylight the coating reacts chemically in two ways.

(1) First it breaks down organic deposits – tree sap, bird droppings, etc. – by introducing extra molecules of oxygen into the deposit.

(2) Second, the coating causes the glass to become hydrophilic.

- Droplets of rain coalesce to form sheets of water which slides down the glass removing dirt particles.

d) This product stores enough ultraviolet light energy during the day to sustain the process overnight.

3. Thermochromic glass:

- Fully darkens in response to heat creating a passive solar solution.

H. Insulation

1. Cellulose fibre:

a) Derived from recycled newspaper.

b) Treated with boron to give fire resistance and to protect against vermin infestation.

c) Has almost the same thermal conductivity as most of the main insulants on the market.

2. Sheep's wool:

a) Also treated with boron similar to the cellulose fibre.

b) This material is hygroscopic, that is, it absorbs moisture without any damage to its functional integrity.

3. Transparent insulation:

a) Offers the double benefit of providing insulation and space heating.

b) One product consists of a honeycomb structure of glass coated polycarbonate.

I. Smart Fluids

1. By introducing a strong electric field or magnetic field, certain fluids can change to a near solid state.

2. They can be made intelligent by coupling them to sensor devices which detect sudden movement.

XVIII. Equipment that Conserves Energy:

A. Energystar.gov:

- A very good resource for finding appliances, electronics and lighting that is highly efficient.

B. Appliances:

1. Energy Star qualified appliances incorporate advanced technologies that use 10–50% less energy.

2. For top performance, premium features, and energy savings, look for energy-efficient appliances that have earned the Energy Star certification.

C. Air Conditioners:

- Energy Star qualified central air conditioners have a higher seasonal efficiency rating, which makes them about 14% more efficient.

D. Boilers:

1. Energy Star qualified boilers have an annual fuel utilization efficiency rating of 85% or greater and can achieve greater efficiency with the following:

a) Electric ignition, which eliminates the need to have the pilot light burning all the time.

b) New combustion technologies that extract more heat from the same amount of fuel.

c) Sealed combustion that uses outside air to fuel the burner, reducing draft and improving safety.

E. Furnaces:

- Energy Star qualified oil and gas furnaces have annual fuel utilization efficiency ratings of 83% and 90%, or higher.

F. Geothermal Heat Pump:

1. Similar to ordinary heat pumps, but use the ground instead of outside air to provide heating, air conditioning and hot water.
2. By using the earth's natural heat, they are among the most efficient and comfortable heating and cooling technologies currently available.

G. Clothes Washer:

1. Energy Star qualified clothes washers clean clothes using 40% less energy.
2. The higher the Modified Energy Factor (MEF), the more efficient the clothes washer is.
3. Energy Star qualified washers use 18–25 gallons of water per load, compared to the 40 gallons.
4. The Water Factor measures the gallons of water used per cycle per cubic foot. The lower the water factor, the less water the machine uses.

H. Dishwashers:

1. Energy Star qualified dishwashers use at least 41 percent less energy than the federal minimum standard.
2. Energy Star qualified dishwashers use much less water than conventional models.

I. Compact Flourescent Light Bulbs:

1. Energy Star qualified bulbs use about 75 percent less energy than standard incandescent bulbs and last up to 10 times longer.
2. Produce about 75 percent less heat and can cut energy costs associated with home cooling.

XIX. Renewable Energy Equipment:

A. Photovoltaics:

a) Typically, an array is incorporated into the roof or walls of a building.

b) Roof tiles with integrated PV cells are becoming more available.

c) Arrays can also be retrofitted into existing buildings.

d) Arrays can be located separately from the building but connected by cable to supply power for the building.

e) Where a building is at a considerable distance from the public electricity supply - in remote or mountainous areas – PV may be the preferred possibility for generating electricity.

f) In such off-grid circumstances batteries are usually used to store the electric power.

g) Solar tracking can also be utilized to access even more perpendicular sunlight, thereby raising the total energy output.

h) A review life cycle energy analysis of the three types of photovoltaic (PV) materials that make up the majority of the active solar market:

(1) Single crystal silicon
(2) polycrystalline silicon
(3) amorphous silicon

i) found that solar cells pay for themselves in terms of energy in a few years (1-5 years).

j) As of early 2006, the average cost per installed watt was about $6.50 to $7.50, including panels, inverters, mounts, and electrical items.

k) They generate enough energy over their lifetimes to reproduce themselves many times (6-31 reproductions).

B. Geothermal Power:

a) Energy is generated by heat stored beneath the Earth's surface.

b) Three different types of power plants:

(1) dry steam - produces steam but very little water.

(2) flash - produces mostly hot water ranging in temperature from 300 - 700 degrees F.

(3) binary - reservoir with temperatures between 250 - 360 degrees F is not hot enough to flash enough steam but can still be used to produce electricity

c) Used to generate electricity from geothermal energy, depending on temperature, depth, and quality of the water and steam in the area.

d) In all cases the condensed steam and remaining geothermal fluid is injected back into the ground to pick up more heat.

e) The depth of drilling varies depending on the soil mermeability and availability of the water source to the surface.

f) Most geothermal fields have more fluid recharge than heat, so re-injection can cool the resource.

g) Enhanced Geothermal Systems, involve pumping water into hot rocks in the earth, rather than harvesting hot water already in the earth.

(1) This type of geothermal system has many advantages over the others, as it can be used anywhere, not just in tectonically active regions.

(2) It requires deeper drilling than the other forms of geothermal energy harvesting.

h) It is also sustainable because the hot water used in the geothermal process can be re-injected into the ground to produce more steam.

i) Geothermal power plants are unaffected by changing weather conditions.

j) Geothermal power works continually, day and night, providing baseload power.

k) Geothermal energy is extremely price competitive in some areas and reduces reliance on fossil fuels and their inherent price unpredictability.

C. Wind Power:

a) Wind power is generated in the form of electricity by converting the rotation of turbine blades into electrical current.

b) Plentiful, renewable, widely distributed, clean, and reduces toxic atmospheric and greenhouse gas emissions.

c) Small Wind is defined as wind generation systems with capacities of 100 kW or less and are usually used to power homes, farms, and small businesses.

d) Wind turbines have been used for household electricity generation in conjunction with battery storage.

e) Increasingly, U.S. consumers are choosing to purchase grid-connected turbines in the 1 to 10 kilowatt range to power their whole homes.

f) Small scale turbines for residential-scale use are approximately 7 feet to 25 feet in diameter and produce electricity at a rate of 900 watts to 10,000 watts.