WHAT'S IT MEAN TO BE GREEN?

An introduction for youth to the green economy and green career pathways

YouthBuild Las Vegas

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State Energy Sector Partnership


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CONTENTS

Overview and objectives 3

Section 1: So, What's the Big Deal and What's it Got to Do With Me?

1 The Truth About Global Climate Change 5
2 The Problems We've Created 6
3 My Personal Responsibility 10

Worksheet 1: How My Choices Impact the Environment 12

Worksheet 2: How Much I Spend to Live 13

Worksheet 3: My Carbon Footprint 15

4 Making a Difference, Part 1 16
5 Making a Difference, Part 2 19

Review 1 21

Section 2: A Better Way to Build

6 Buildings and our Environment 22
7 Best Practices: Site and Landscape 26
8 Best Practices: Water and Wastewater 31
9 Best Practices: Energy 36
10 Best Practices: Materials and Waste 43
11 Best Practices: Indoor Environment 53
12 Integrated Strategies 60

Review 2 63

Section 3: Tools to Build Better

13 Green Building Rating Systems 64
14 Doing my Part on a LEED Project 73

Review 3 77

Section 4: Green Career Pathways

15 Your Green Advantage 78

Index 81

About this curriculum

Overview

This training teaches you how our lives and our buildings impact our planet. It shows you ways to lessen the negative impact we and our buildings have on our environment.

This curriculum was based in part on *Your Role in the Green Environment* developed by the National Center for Construction Education and Research (NCCER), published by Pearson Education.

Objectives

1 Describe the building construction practices that can damage the environment.

2 Identify the choices we make daily that can affect the planet (good and bad).

3 Learn how to incorporate energy efficiency and renewable energy into our lives.

4 Explain how the Leadership in Energy and Environmental Design (LEED) Rating System operates.

5 Identify "What's it Mean to be Green?"

Power Note Taking System

Space for taking notes is provided throughout the text that follows the Power Note Taking System.

1. Put questions, words to define, dates, abbreviations, formulas, names, places and symbols on the left side.
2. Put answers, definitions, importance (of dates, names, and places), meanings of symbols, and examples of formulas on the right side.
3. Use numbers and space to show new ideas.
4. Review notes regularly. Highlight very important items. Spend your time studying them.

Notes

Section 1: So, What's the Big Deal and What's it Got to Do With Me?

1 The Truth About Global Climate Change

An Introduction to what global climate change is and why it's important

Task:

Watch the movie *An Inconvenient Truth.*

Questions:

1. Do you think Global Climate Change is real? Why or why not?
2. Is this important to you? Why or why not?
3. Do you think you can do anything about this? Why or why not?
4. What do you think you could do to reduce global climate change?
5. Discuss the movie's title, *An Inconvenient Truth*.

Notes





Top: a representation of greenhouse gases being released in to the atmosphere.
Above: A polar bear losing its habitat, due to global climate change

2 The Problems We've Created

The choices we make can harm the environment

People have done a lot of harm to the environment. We have been very wasteful in our use of important things like air, water, soil, and other resources. We have affected weather patterns by releasing **greenhouse gases**. This is called global **climate change** or **global warming**. The choices we make everyday can actually add to these huge problems. The products we buy, the electricity we use, the possessions we throw away, and the way we travel all count toward our **carbon footprint**. Our carbon footprint is one way we can measure how we make the environment worse. By thinking first about what we buy, how we use electricity, how we throw our possessions away, and how we get around and then making better choices, we can help to improve the environment. We can learn how to reduce, re-use, recycle, and rethink how we use energy, plant more trees, and find better ways of making electricity.

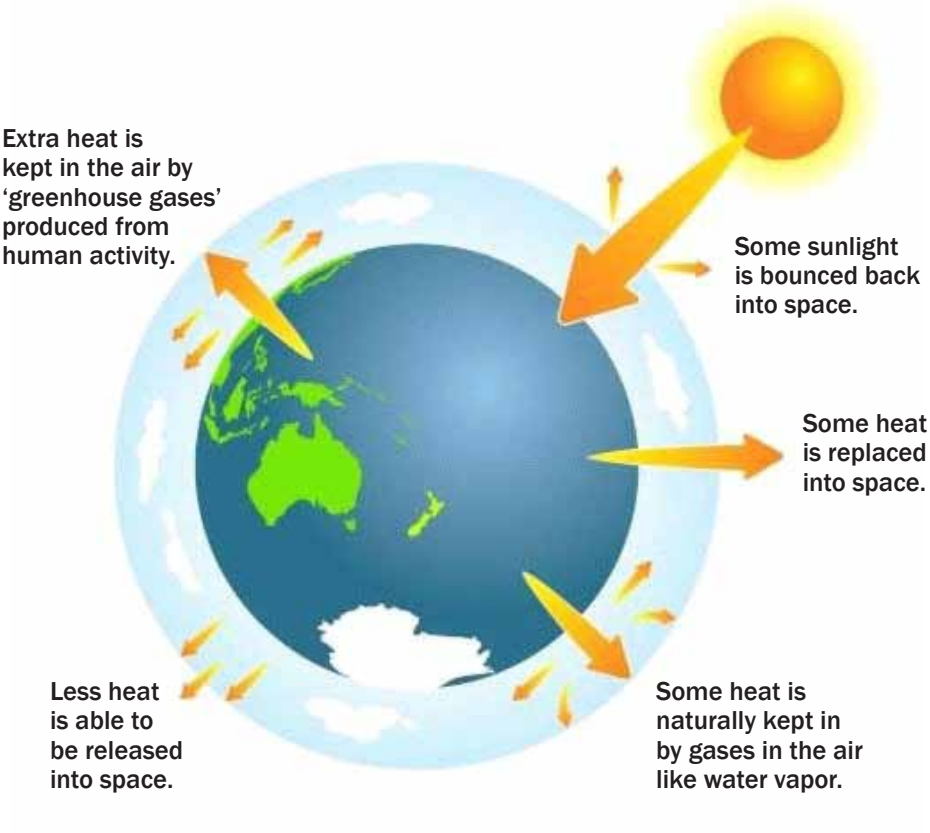
There are lots more people on the earth now than ever before. This means that more and more resources are being taken out of the earth to build buildings and make everything that goes into them like carpets, furniture, appliances, TVs, computers, and such. We also need more and more energy sources to make the electricity to supply power to everything we use and keep our buildings comfortable. We also need more and more fuel to power our cars, buses, trucks, airplanes, and factories. The exhaust from burning these fuels is harmful to the environment.

We have caused these major problems:

Global climate change is a long-term change in global climate patterns. Most of the world's scientists agree that the earth's atmosphere is rapidly getting warmer because there is more **Carbon Dioxide (CO_2)** and other greenhouse gases in the upper atmosphere. That's why this is also called global warming. Some parts of the earth can actually get colder, so it's less confusing to call it global climate change. As the earth's temperature goes up, the ice caps begin to melt and raise the sea level. This contributes to the development of more severe storms like hurricanes and tornadoes.

Carbon Dioxide is a colorless, odorless gas. When we make energy by burning **fossil fuels** (coal, petroleum, natural gas) CO_2 is released into the atmosphere. According to the U.S. Environmental Protection Agency (EPA), CO_2 that is produced in this way is very likely changing the earth's climate. After a thorough examination of the scientific evidence and careful consideration of public comments, the EPA announced on December 7, 2009, that Greenhouse Gases (GHGs) threaten the public health and welfare of the American people. On December 19, 2009, for the first time in history the world's major economies, including the United States, agreed to accept their responsibility in dealing with climate change. This agreement is called **the Copenhagen Accord**.

In the United States, the building and operation of buildings is responsible for nearly half of all human-caused greenhouse gases. Because people have been making their homes in the suburbs further away from where they work, they burn more fuel to get to work and back, thus creating more CO_2.



Deforestation is what happens when we cut down trees so fast that they can't grow back in time to replace the trees we've taken. This in turn leads to erosion of topsoil and the pollution of streams as well as taking away the habitat or homes of the plants and animals that used to live in the forest. Because trees actually use CO_2 to make oxygen, less trees means more CO_2 and less oxygen, which means more climate change.

Deforested land contributes to overall climate change



Loss of **biodiversity** is what happens when entire species of insects, plants, and animals are killed. Since they are all gone, they will never come back. They are killed because their homes are taken away or their food or water supplies are spoiled. It's important to have diverse **ecosystems,** because they purify the air and water. An ecosystem is a place in which landscape, climate, plants, and animals interact. They can be as small as a raindrop or as large as a forest and include living things you can only see under a microscope. Different species play different roles in ecosystems, and an ecosystem's health can

Notes

Keywords:

acid rain

aquifer depletion

biodiversity

carbon dioxide (CO_2)

carbon footprint

carbon monoxide (CO)

chlorofluorocarbons (CFCs)

climate change

the Copenhagen Accord

deforestation

desertification

ecosystems

erosion

fossil fuels

global warming

greenhouse gases

ozone depletion

be threatened when a new species is introduced or existing species are removed. We also get all sorts of useful products like new medicines and exotic wood from diverse ecosystems. We need to have healthy ecosystems in order to survive.





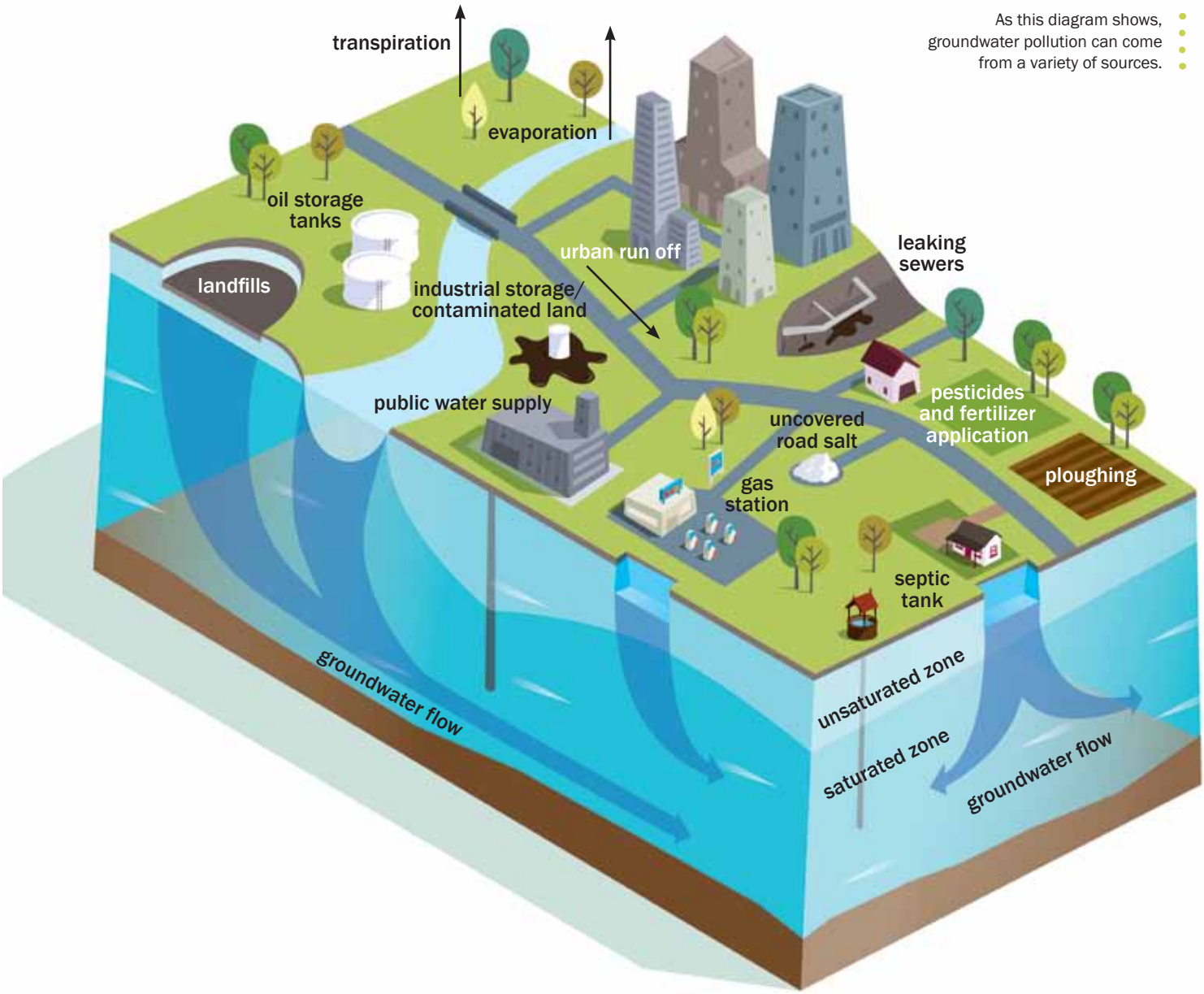
Top: Desertification means there is less available water for use. *Above:* A window mounted air conditioner will typically release CFCs into the air

Desertification and **aquifer depletion** means we have less water to drink. Desertification is what happens when the earth's temperature gets warmer and makes the deserts get bigger. An aquifer is a natural underground fresh water storage area. Aquifer depletion is what happens when we let our livestock eat too much and we use too much groundwater in our farms and factories.

Ozone depletion happens when **chlorofluorocarbons (CFCs)** are let out into the air. CFCs are Ozone-depleting compounds that contain chlorine, fluorine, and carbon. They were the liquid that air conditioners used to cool the air. Ozone is very important because it protects us from harmful radiation from the sun. We are seeing more cases of skin cancer and damage to ecosystems on land and in the sea because the **ozone layer** is getting smaller.

Air and water pollution are a consequence of how we live our lives. For instance, how we run our factories, how we travel, how we get rid of waste, how we create energy, etc. When we burn fossil fuels to get around or make electricity, we get smog and smog leads to **acid rain**. Acid rain kills trees and plants. We also get water pollution because when it rains, the poisonous materials that settle onto roads and buildings eventually gets washed down into a lake, stream or river. Also, the wastewater from factories not only makes the water of the river or lake warmer, which kills the fish and plants living in it, it fills it with all sorts of poisonous chemicals. We are also finding more and more prescription drugs and plastic residuals in our water that can't be taken out using normal treatment methods.

Soil contamination and depletion happens when we let underground storage tanks containing poisonous liquids leak into the ground, or when storm water runoff washes poisonous chemicals off our streets and into the soil. These poisons will eventually reach our water sources. Wherever we remove plants, we're exposing the topsoil and allowing it to erode.



As this diagram shows, groundwater pollution can come from a variety of sources.

Notes

3 My Personal Responsibility

The choices I make have an impact on the environment

Now that we know how much we have harmed the earth, it's important to know how we personally have contributed so that we can do less harm and start making better choices. You may think to yourself, "Well, I'm just like a drop in the ocean. My actions aren't going to make any difference." This is not true. Your actions DO make a difference. If we all begin to maker better choices, we will make a BIG difference!



Everything we use like our cars, our clothes, our music players, our computers, our food, our TVs - adds up to how much we harm the planet. One way to find out how much of a difference you make is to figure out your Carbon Footprint. This will tell you how much your style of living contributes to the harmful effects.





- *Top:* Examples of items that add to our Carbon Footprint. *Middle:* A typical garbage dump. *Above:* Think about the amount of aluminum cans you personally go through in a year. Do you recycle them?

A Typical American Household

Did you know that every year a typical American household throws away 1,640 pounds of garbage, or that it flushes away 450,000 gallons of water that could be used for drinking, or that it releases 54,600 pounds of carbon dioxide (CO_2) and other gasses into the air?

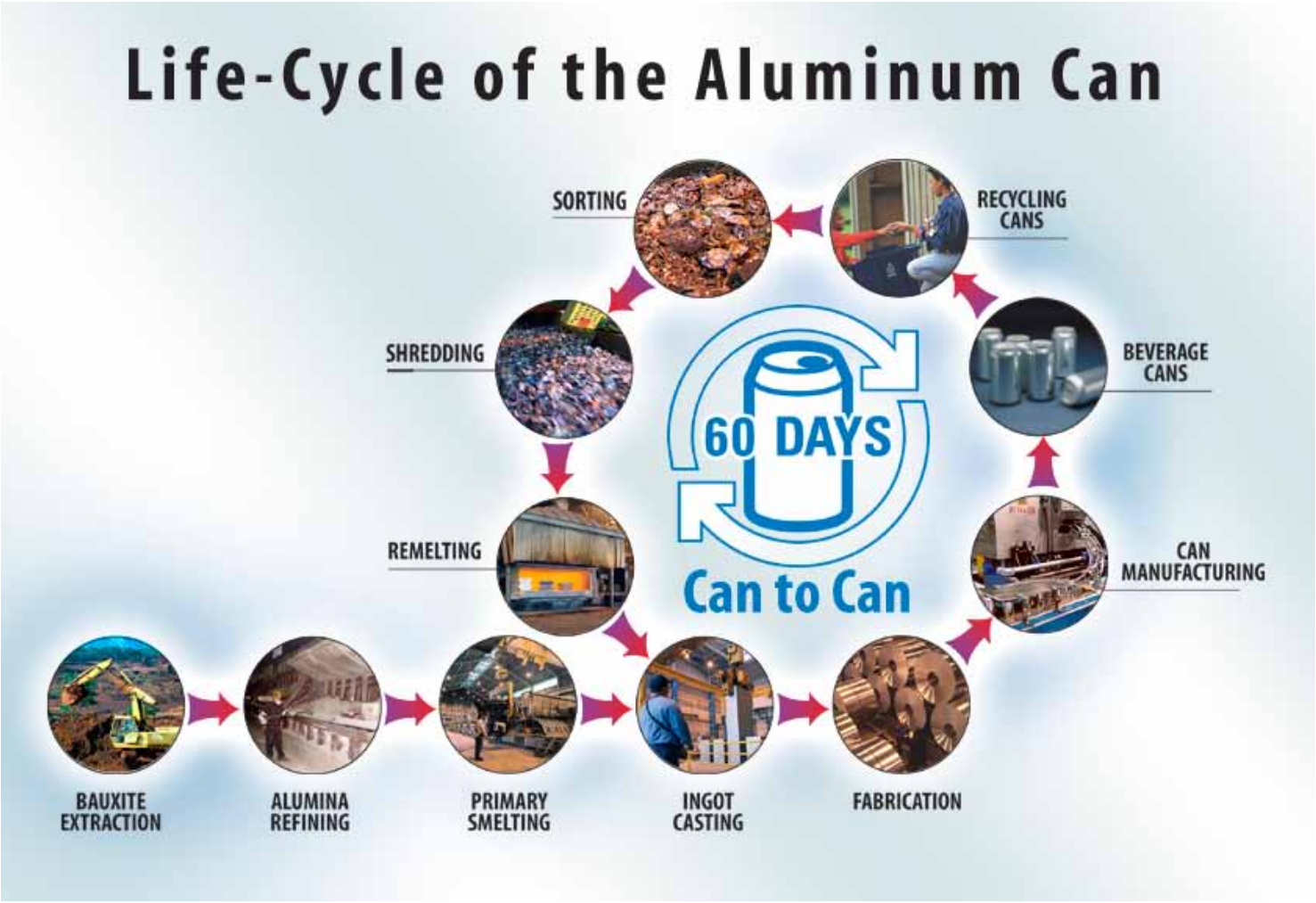
Every day one average American has 4.5 lbs of garbage to throw away, of which 3 lbs could be recycled but only 1 lb actually is. That means that every year one person puts about 1,300 lbs of waste into the environment. Also, every day one average American uses about 3 gallons of gas or 1,095 gallons per year. That's enough gas to fill 21 bathtubs!

All this is just to inform you that one person does make a big difference on the environment. Now it's time for you to find out what your impact on the environment is. It may surprise you.

The Products I Use

Everything we use comes from the earth's limited resources. Each item, grown or manufactured, required energy to make it useful. This energy is called **embodied energy** and is invisible to us as the end users. This energy includes the effort it took to take the raw materials out of the earth, the effort to shape it, mold it, and put it together, the work to make the packaging and put it in the package, and the energy to transport it.

For instance, an aluminum can is made from metals that come from many different countries and then put on a ship to the can factory. The ship uses fuel from another country, and the container the metal comes in comes from another country. The can is actually more expensive and complicated to make than the drink that goes in it. Now think about this: you finish your drink in a few minutes and you throw away the can in a few seconds, but the energy and effort that is thrown away with the can is huge!



Think about this: in the United States, 3 out of 5 cans are made from raw materials which uses 20 times more energy than using recycled aluminum. In three months, we throw away enough cans to replace all the jet airliners in our country!

Now it's time to find out how much it costs you to live your life.

Keywords:

embodied energy

carbon cycle

greenhouse effect

Notes

Worksheet 1: How my Choices Impact the Environment

These answers will help you figure out your carbon footprint later, so it's important to write these down. If you live with other people, just divide the answer for each question by how many people live with you to get your personal amount.

How many gallons of garbage do you throw out?

1 can = 32 gallons, so _____ can(s) each week x 32 gallons each can x 52 weeks a year = _____ gallons each year.

How much electricity do you use?

You can find out by looking at your electricity bill. If you can't get one, then just use 5 kilowatt-hours per month x 12 months = 60 kilowatt-hours per year. My actual use: _____ kilowatt-hours per year.

How much natural gas do you use?

You can look at your natural gas bill (if you use natural gas). If you can't get a bill, then just use 30 therms per month x 12 months = 360 therms per year. My actual use: _____ therms per year.

How much do you spend on water and sewage?

You can look at your water and sewage bills and add up twelve months worth. If you can't get a bill, then just use $75 per year for yourself. My actual use: $_____ for water and sewage per year.

How big is the place where you live?

You can draw a floor plan and guess. My living space: _____ square feet (the average home is 1,500 square feet).

How many miles do you travel in a car and how efficient is the car?

If you don't know, you can use 300 miles a week and 22 miles per gallon, which gives you 13.6 gallons a week. If you don't travel in a car, then just skip this part.

Car A: _____ miles a week / _____ miles per gallon = _____ gallons a week.

Car B: _____ miles a week / _____ miles per gallon = _____ gallons a week.

Car C: _____ miles a week / _____ miles per gallon = _____ gallons a week.

Add Car A + Car B + Car C gallons a week = _____ total gallons a week x 52 weeks = _____ gallons a year.

How much did you travel on airplanes this past year?

If you didn't travel on airplanes, just skip this part.

_____ number of trips less than 2 hours long. ____ number of trips 2 to 4 hours long. ____ number of trips longer than 4 hours long.

How much did you travel on public transportation this past year?

If you didn't travel on public transit, just skip this part.

_____ miles a year on a bus or subway + _____ miles a year on a train = _____ miles a year on public transportation.

Worksheet 2: How Much I Spend to Live

These answers will help you figure out your carbon footprint later, so it's important to write these down. If you live with other people, just divide the answer for each question by how many people live with you to get your personal amount. If you don't know the answer exactly, use your best estimate.

I spend about $_____ on eating out each month x 12 months is $_____a year.

I spend about $_____ on meat at the grocery store each month x 12 months is $_____ a year.

I spend about $_____ on cereal and bakery goods each month x 12 months is $_____ a year.

I spend about $_____ on milk and cheese each month x 12 months is $_____ a year.

I spend about $_____ on fruits and veggies each month x 12 months is $_____ a year.

I spend about $_____ on other food each month x 12 months is $_____ a year.

I spend about $_____ on clothes each month x 12 months is $_____ a year.

I spend about $_____ on items for my home each month x 12 months is $_____ a year.

I spend about $_____ on other goods each month x 12 months is $_____ a year.

I spend about $_____ on haircuts, dry cleaning, and other things like that each month x 12 months is $_____ a year.

Notes

Your Carbon Footprint

As we saw in the film *An Inconvenient Truth*, greenhouse gases like CO_2 lead to the **greenhouse effect**. Now, some greenhouse gas is important because otherwise all the warmth would go into space and the earth would become a frozen dead ball. However, too much greenhouse gas is bad, because it keeps in too much warmth and we get global warming.

The **carbon cycle** is the moving of carbon (CO_2) between the earth and the air. You see, plants (like trees) use CO_2 to live and give off oxygen. We then use this oxygen to live and give off CO_2. It's a very nice balance, but with our machines that burn oxygen and give off CO_2 in order for us to drive around and have comforts like electricity, we are now using way too much oxygen and giving off too much CO_2 for the plants to keep up. What's worse, because we want new places to build houses and factories, we're cutting down and killing lots of trees. This means we have even less plants to keep things in balance than ever before.

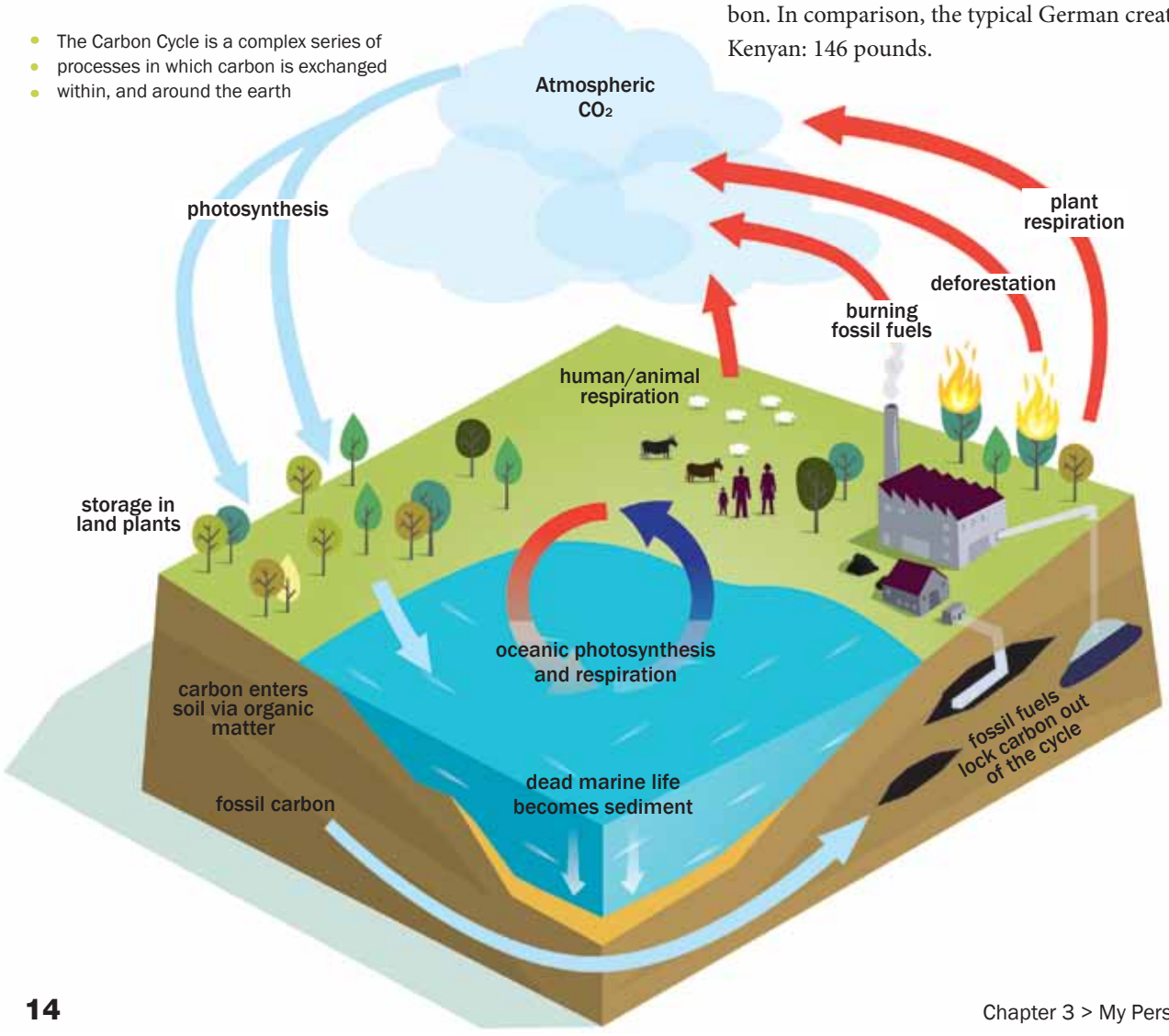
Here's what is happening with Global Climate Change:

- As the temperature of the planet goes up, parts of the polar ice caps are melting which is making the sea level rise. If you live near the coast, you may notice that the land is disappearing under the sea.
- As the climate changes, we are experiencing more rainstorms, tornados, typhoons, and hurricanes, and some are much stronger than normal. We are also seeing much dryer weather between these storms.
- As temperature goes up, there have been more forest fires. More plants and animals are on their way to dying off forever (extinction) like polar bears because the places where they live (ice caps) are melting.

With the information you found out in Worksheets 1 & 2, we can now figure out your personal Carbon Footprint. You'll know how much your share of the harm you have, and what you can do to start doing less harm.

The average American is responsible for 20,000 pounds of carbon. In comparison, the typical German creates 10,146 pounds; a Kenyan: 146 pounds.

- The Carbon Cycle is a complex series of
- processes in which carbon is exchanged
- within, and around the earth



Worksheet 3: My Carbon Footprint

Take your answers from Worksheets 1 & 2 to find out your personal Carbon Footprint.

Description	Amount	Carbon multiplier	Pounds CO_2 a year
Gallons of garbage per year	_____	x 2 lbs/gal	= _____
Electricity in kilowatt-hours per year	_____	x 1.4 lbs/kWh	= _____
Therms of natural gas per year	_____	x 11.7 lbs/therm	= _____
Cost of water and sewage per year	_____	x 8.9 lbs/$	= _____
Living place in square feet	_____	x 2.1 lbs/sq ft	= _____
Gallons of gasoline per year	_____	x 20 lbs/gal	= _____
Number of short flights per year	_____	x 304 lbs/flight	= _____
Number of medium flights per year	_____	x 726 lbs/flight	= _____
Number of long flights per year	_____	x 2,217 lbs/flight	= _____
Miles of public transportation per year	_____	x 0.5 lbs/mile	= _____
$ eating out per year	_____	x 0.8 lbs/$	= _____
$ meat per year	_____	x 3.2 lbs/$	= _____
$ cereals and bakery goods per year	_____	x 1.6 lbs/$	= _____
$ milk and cheese per year	_____	x 4.2 lbs/$	= _____
$ fruits and veggies per year	_____	x 2.6 lbs/$	= _____
$ other food per year	_____	x 1.0 lbs/$	= _____
$ clothes per year	_____	x 1.0 lbs/$	= _____
$ items for my home per year	_____	x 1.0 lbs/$	= _____
$ other goods per year	_____	x 0.75 lbs/$	= _____
$ haircuts, dry cleaning, etc. a year	_____	x 0.4 lbs/$	= _____
		Total	= _____ **lbs/year**

Notes

4 Making a Difference, Part 1

How I can do less harm to the planet



- Plant a tree, make a difference

Homework Discussion:

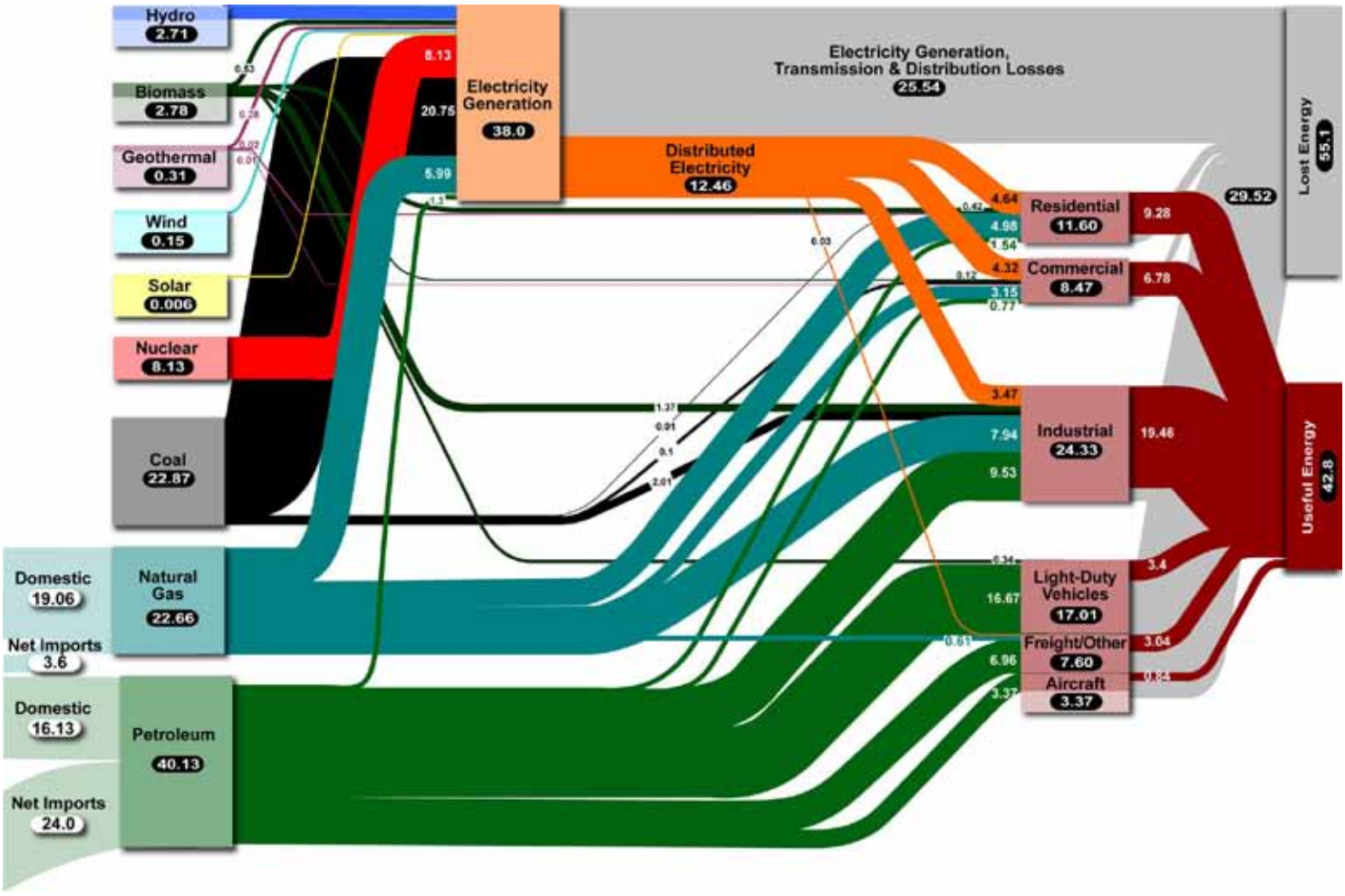
What is your carbon footprint?

Were you surprised? Shocked? Embarrassed?

How does your carbon footprint compare to that of your peers?

Starting today, what three things do you think you could do to make your carbon footprint smaller?

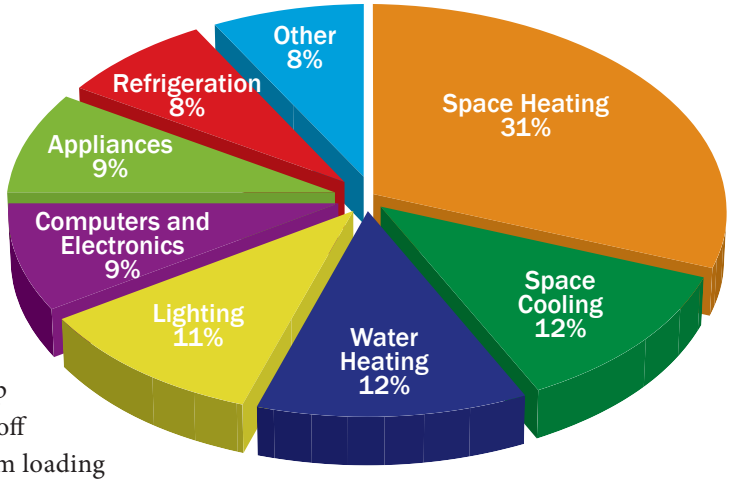
There are many things each of us can do to do less harm to the environment. For instance, if you plant a tree seedling, over the next 10 years that tree will take away 86 pounds of CO_2. If you save a gallon of gas, you save 19 pounds of CO_2. If you stop driving an average car for one year, you can save 11,760 pounds of CO_2. Now, that may not be possible, but you can try driving less.



Using Less Energy

The easiest and most important way to reduce your carbon footprint is to simply use less energy. This is called **conservation**. Here in the US, 87% of the energy we use is made by burning oil, coal, natural gas, and propane. These are known as fossil fuels. It is this burning of fossil fuels that causes the greatest harm to the environment, and is the root of many of our problems.

A normal American household spends its energy as shown here on the pie chart.



As you could probably guess, most of the pie is for heating, cooling, hot water, appliances, and lighting. These items are running most of the time and can require a lot of power. Now, look around and count how many household items are plugged into the walls that have clocks, timers, lit LEDs or batteries in them. All of these items are using electricity even though they look like they're turned off. This is called **phantom loading**. The way to stop phantom loading is to unplug them or use a power strip and turn off the strip when you're not using them. Another example of phantom loading that you may have noticed happens when the chargers we use to power devices such as cell phones and digital cameras are in use even when the battery is full. Go ahead and touch one while it's plugged in. Is it warm? That is wasted electricity being turned into heat.

There are many other simple ways we can use less energy. Here are a couple ideas:

- Use a programmable thermostat. By not using energy to heat or cool the place where you live when you're not there can save around 20% of the cost.
- Replace your old faucets and shower heads with low-flow faucets and shower heads to save on water.
- Wash your dirty clothes in cold water. Your clothes will actually last longer and you can save over $60 a year by not needing to heat the water.
- Replace your incandescent bulbs with **compact fluorescent lights (CFLs)** or LEDs. They use less energy and last longer than traditional bulbs.

Notes

Keywords:

compact fluorescent lamps (CFLs)

conservation

first costs

life cycle costs

light-emmitting diode (LED)

operational costs

phantom loading

First Costs and Life Cycle Costs



LED, traditional incandescent bulb, CFL

First costs are what we pay right away for something. **Operational costs** are what we pay to keep it working. **Life cycle costs** are what we pay over the life of the product and is found by adding first costs and operational costs. All of these bulbs give off the same amount of light.

LED Lights

A 2-watt **light emitting diode (LED)** bulb costs about $40 and lasts for 30,000 hours. It would only cost $6 to power the bulb for the entire 30,000 hours.

First costs =	$40.00
Operational costs =	$6.00
Total life cycle cost =	**$46.00**

Traditional Bulb

A traditional 60-watt incandescent light bulb costs about 60 cents and lasts for 1,000 hours. You would need to replace the bulb 29 times to match the life of the LED bulb. Also, it would cost $180 to power the bulb for the 30,000 hours.

First costs =	$0.60
Operational costs =	$197.40
Total life cycle cost =	**$198.00**

CFL

A 15-watt compact fluorescent lamp (CFL) costs about $3.50 and lasts for 10,000 hours. Although you would need to replace the bulb twice, it would cost $45 to power the bulb for 30,000 hours.

First costs =	$3.50
Operational costs =	$52.00
Total life cycle cost =	**$55.50**

Now think about what it's worth to pull out the ladder, get up to the bulb to replace it. Which bulb do you think is the cheapest long-term and better for the environment?

5 Making a Difference, Part 2

More ways I can do less harm to the planet

Using Less Fuel and More Fuel Efficient Transportation

The choices we make in getting around make up over half of the carbon footprint of most Americans. Here are a few ideas to help us use less fuel and make our choices more **fuel-efficient**:

- Use a fuel-efficient, low-emission vehicle. **Hybrids** can get over 50 miles per gallon. You may also consider a scooter or motorcycle. They can get up to 100 miles per gallon.
- Carpool or combine trips whenever you can. The greatest amount of pollution happens when the engine is cold. If you can do many errands in one trip, you will only have to warm the engine up once.
- Make sure the vehicle is maintained. Check the tire pressure regularly and try to keep the engine tuned for best performance and efficiency.
- Don't drive faster than 60 miles per hour. If you do, your car will not be as efficient.
- Don't idle your engine. Turn the engine off if you'll be sitting for more than a few minutes.
- Use public transportation whenever you can. The fuel use per person is much lower for buses and trains than for cars.
- Try not to fly. Airplanes are huge carbon emitters. Try to travel by bus or train on short trips.
- Purchase locally produced goods, especially food. Lots of foods, like fruits and veggies, come from thousands of miles away. Try shopping at local farmer's markets or support locally-grown products to reduce the fuel used to transport them.
- Be virtual. Use the telephone or Internet as much as possible to cut down on travel. For instance, call around or use the Internet to check on products and prices before driving to a bunch of different stores to shop.



Hybrid vehicles can get over 50 miles per gallon!



An urban garden helps to reduce the amount of carbon in the atmosphere

Reduce, Reuse, Recycle and Rethink

The "Three Rs" (**reduce**, **reuse** and **recycle**) remind us of how we can make greener choices. Reducing is better than reusing which is better than recycling. This is because

Notes





Top: A wind turbine supplies renewable energy. *Above:* Solar panels supply renewable energy

Keywords:

alternative energy

fuel-efficient

geothermal

hybrids

hydropower

photovoltaics

recycle

reduce

rethink

reuse

renewable energy

solar

wind turbines

using less of anything means less goods have to be made so there's less harvesting, manufacturing, and transportation, which means less harm is done to the environment. Along the same lines, each product that is reused is one less product that has to be made from scratch. Recycling means you can keep some of the embodied energy of the material in use. It's a good source of raw materials for new products, and it's a good way to save resources for the future.

The best choice of all is the fourth "R": **rethink**. This means that we should rethink our habits and ask ourselves if we really NEED to use things in the first place. Like when you only buy one item at the store, do you really need the shopping bag the store offers you? If you rethink it, the answer is likely "No," so you save one bag and it's one less thing to throw away.

Plants Play a Part

A really good way of reducing carbon is by planting trees or gardens. Remember, plants absorb CO_2 and make oxygen. Plants also give us shade, help with storm water runoff, and keep the soil in place. Here are some ideas for planting:

- Use plants that come from your local area instead of plants that come from other parts of the world. These local plants are called native plants and can be grown without using polluting pesticides and fertilizers.
- Place plants together in groups that have the same needs. This way you can put the water and other nutrients exactly where it's needed instead of spreading it all over the place.
- Plant fruits, veggies, or herbs that you can eat.
- Don't use equipment powered by gas engines. A normal lawn mower puts out as much pollution as 11 cars. A riding lawn mower puts out as much as 34 cars. Even though they have smaller engines, they don't have emission control systems like cars do.

Better Energy Sources

After you've done what you can to use less energy, you can look at other types of energy. These are called **alternative energy** sources and include **renewable energy** systems such as **wind turbines**, **hydropower**, **geothermal** or **solar** (for example **photovoltaics**). You can also see if your power company offers green power. They will charge you a bit more so they can develop renewable energy sources like large-scale wind, solar, and geothermal energy.

Carbon Offsets

Another way you can reduce your carbon footprint is by buying carbon offsets from certification companies. The idea is that you pay for your carbon use by giving to an organization that will do something that will make up for your carbon use. For example, you can buy offsets that will go towards an Indian tribe that will build a wind farm. You can buy offsets that will go towards a non-profit that will plant trees which will eventually absorb the amount of carbon you used. This way you can become carbon neutral.

Review 1: Questions

1. The most effective way to reduce your carbon footprint is to _____.
   a. use ink instead of pencil lead
   b. buy carbon offsets
   c. move to Germany
   d. reduce your energy usage

2. Global Climate Change is caused by _____.
   a. natural forces
   b. man-made forces
   c. UFOs
   d. super-natural forces

3. Deforestation is _____.
   a. a forest ranger outpost in section D
   b. a completely natural occurrence
   c. a solution to global warming
   d. a contributor to global warming

4. Burning fossil fuels _____.
   a. helps the environment
   b. is the only source of energy we have
   c. increases greenhouse gases
   d. hurts dinosaurs

5. Aquifer depletion is caused by _____.
   a. using too much oxygen
   b. the lack of biodiversity
   c. digging coal mines too deep
   d. the overuse of groundwater

6. Why is it important to have diverse ecosystems?
   a. they allow for erosion of topsoil
   b. they aren't important
   c. they purify the air and water
   d. they create more desert landscape

7. The most economical light bulbs in terms of life cycle costs are _____.
   a. Incandescent Bulbs
   b. LED Lamps
   c. CFL Lamps
   d. Fluorescent Lamps

8. Why should we be concerned about the products we use?
   a. we shouldn't be concerned
   b. because everything we use comes from the Earth's limited resources
   c. because we should only purchase brand name products
   d. we don't want to use recycled products

9. A carbon offset is _____.
   a. less expensive than an oxygen offset
   b. required when you take a long trip
   c. what happens after a carbon onset
   d. money you spend to help others to reduce their carbon emissions

Notes

Section 2: A Better Way to Build



Mold is harmful and can make people quite ill

6 Buildings and our Environment

Best practices for sustainable construction

Task:

Watch the video *High Performance Building.*

Have you ever stopped to think about the buildings we live, play, learn and work in? Why are these structures here? Simply put, we need them. There are all kinds of different buildings that are used for all kinds of different services. For instance libraries, schools, shopping malls, hotels, hospitals, factories, etc.

The Impact on the Environment

Buildings can have a hard **environmental impact**. They use over 10 percent of our drinkable water. They use over 25 percent of all the wood we have. They use over 40 percent of all the goods we make. Here in America, energy used in buildings and their maintenance adds up to 54 percent of all the energy we produce.

The indoor environment of 1 out of 3 buildings can be harmful. Indoor air quality (IAQ) is made worse by **volatile organic compounds (VOCs)** that seep out of paint, carpet, and furniture. Pathogens like mold occur when a building leaks. Bad indoor air quality makes people sick. This is called **sick building syndrome** and is a big problem. They say that over $60 billion a year is lost because workers in sick buildings call in sick or are less efficient.

Chlorofluorocarbons (CFCs) are gases that destroy the ozone layer in our atmosphere. We need the ozone layer to protect us from the sun's harmful rays. About 25



The night lights of Las Vegas, Nevada

percent of all CFCs come from air conditioners on buildings. The way building materials are made also creates CFCs. About half of all the CFCs made are used in refrigerators, air conditioners, fire extinguishers, and some insulation that are part of buildings.

Half of all the world's fossil fuels are used to keep buildings operating. Turning on the lights uses about 25 percent of all the electricity made in the US a year. For every dollar offices spend on energy, 30 to 40 cents goes to lights. Anywhere from 20 to 40 percent of the waste in our country's garbage dumps is from construction.



Above: The ozone layer in relation to the earth's surface. *Below:* Construction waste within a garbage dump



The Life Cycle of a Building

Like us, buildings go through a life cycle that is usually between 30 and 100 years long. The life cycle usually goes like this:

1 **Programming and conceptual design** – A building's life starts with an idea that is then worked out on paper. This is called programming & conceptual design. This is where you decide what the purpose of the building is, how big it needs to be, the overall look of the building, how much you are willing to spend to build it, and when you need it done. You also have to think about the laws and regulations for where you're building it. When you're done with this step, you'll have a document that says what the owner is expecting from the building when it's done.

2 **Detailed design and analysis –** This is where you take the document of the owner's expectations and work out all the details. You may have a meeting called a charrette where everyone who's involved can talk about what they want. At the end of this step, you'll have a document called a spec (specifications) and a bunch of detailed drawings for the builder of the building. These are called construction drawings.

3 **Fabrication and construction –** To build the building according to what the owner wants, you must follow the design documents that include the construction drawings and the specifications. When this step is finished, you will have a complete building ready to be used.

4 **Operation and maintenance –** This is the longest part of the building's life cycle. Operation is what occurs when you use the building for what it was designed for.

Notes

Keywords:

environmental impact

sick building syndrome

volatile organic compounds (VOCs)

For instance, to keep the people in the building comfortable you run the air conditioner in the summer and you run the heater in the winter. Maintenance is what you do to make sure the building keeps operating smoothly. For instance, you replace the light bulbs when they burn out and clean the filters for the heating and cooling systems. You also clean the building and repair items that break.

5 **Renovation or end of life cycle and disposal** – After a while, the building will no longer work the way the owner wants it to work. You can do a couple of things at this point: You can renovate or reconstruct the building (which is a lot harder than building it new), or you can end the life cycle of the building by either demolition or deconstruction. Demolition is tearing the old building down and just throwing it away. Deconstruction is carefully taking the old building apart piece by piece in order to reuse or recycle the pieces. Demolition is fast but wasteful. Deconstruction is slow but worthwhile.

To make a building less harmful, we can change how we build. Here are a few good ideas called best management practices that help:

1 **Site and landscape** – Site is the actual place we decide to build a building and the way we point the building to take advantage of the way the sun hits it during the day. Landscaping is the way we put plants and trees and walkways around the building on the site. If we're careful, we can save energy and keep the people in the building comfortable by our choices in what we use and where we put them. It's also a good idea to leave the ground the way it was as much as possible. Where we did make a mess, we should fix things so the ground is as close to the way it was as possible.

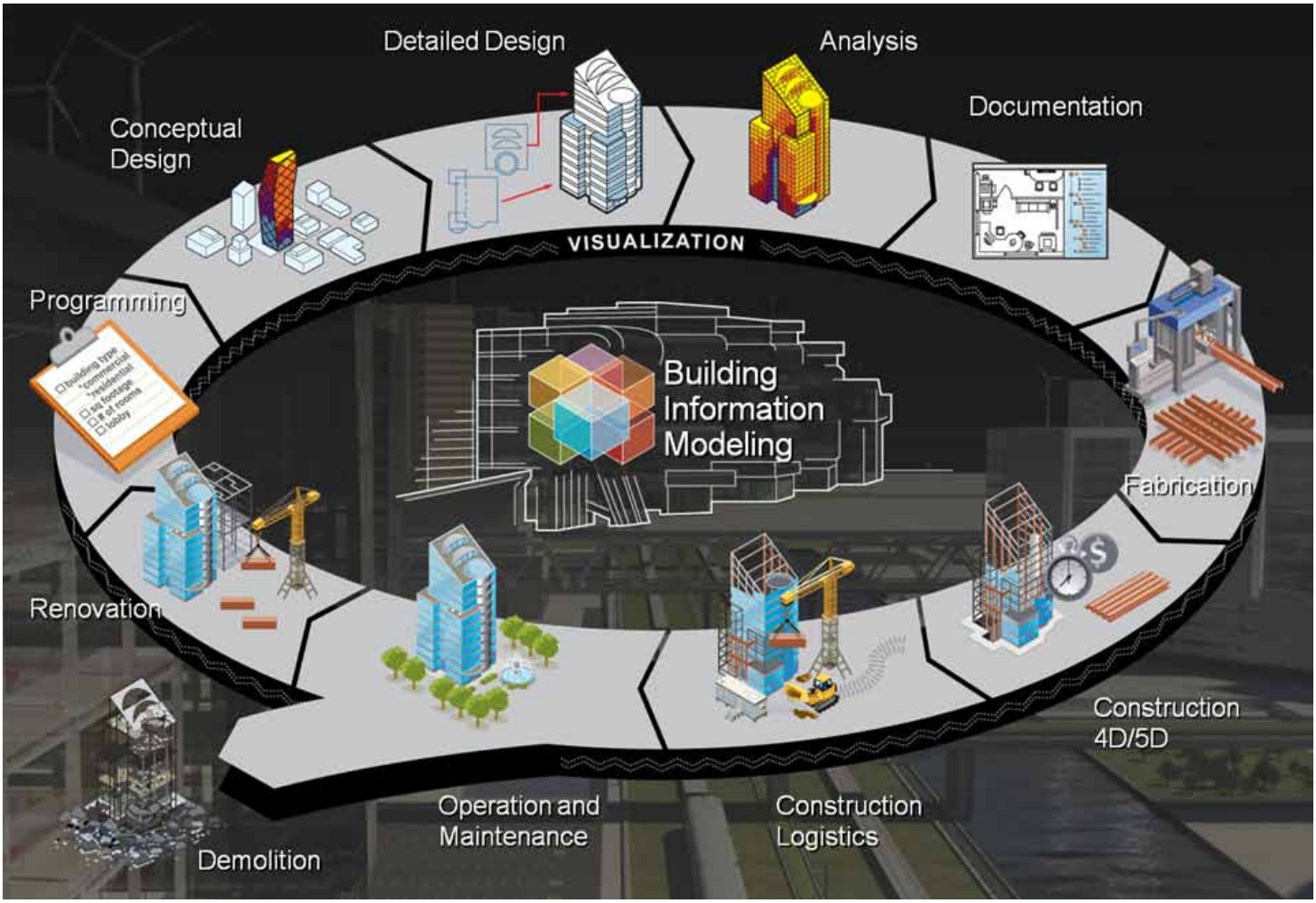
2 **Water and wastewater** – Buildings can waste a lot of water. By being smart, we can save water by not using it for things that are not necessary. We can also think about getting water from different places like catching rainwater or using the water that condenses from our air conditioners. We also need to think about where our wastewater goes. This is called a wastewater sink.

3 **Energy** – Here is where we can think about saving energy by not using it unnecessarily. We can also think about ways we can use the energy we have more efficiently, and finding new places to get energy.

4 **Materials** – Buildings use a lot of materials. We can reduce the amount of materials a building uses by thinking about places where we don't need to use it, and using materials that have been reused, recycled, or can be quickly replaced by nature (like bamboo). We can also think about finding new places for materials.

5 **Waste** – Buildings create a lot of waste. Here we can think about how we can reduce the waste, recycle the waste, or stop the waste all together.

6 **Indoor environment** – We spend most of our lives indoors, so having a healthy indoor environment is very important. We can be sure the building has a healthy environment by minimizing the amount of items that produce VOCs, creating a



central area for all ventilation, and giving the people in buildings the control to change things (like the temperature) so they're comfortable.

7 **Integrated strategies** – To integrate is to have processes work together. This way you can do one thing but get many different good results. This can be done in the way you build the building, the way you choose the technology that goes into a building, and the way that different systems in the building can work together.

The process of getting a building built begins with the programming and conceptual design phase and follows a systematic process, as shown in this diagram

Notes

7 Site and Landscape Best Practices

Choosing the place where we build wisely

The most important decision you make about a building is choosing a site for it. The next is where to put the building on the site. These decisions will make a big difference over the entire life of the building. Next, you need to think about working the ground in the least harmful way. When you're done, you should return the site to the way it was as much as possible.

- A public transit system allows residents of a city to choose using a city bus, or rail system, over driving a car.





Site Selection

- *Below:* A repurposed former brownfield
- *Bottom:* A wetland





The site you choose to build your building on will determine the energy you'll need and the harm you'll do to the environment. If you choose a place that already has other buildings like stores, then the people that will be in your building can use them. It's more likely that there will be a public transit station (bus stop or light rail stop) nearby so they wouldn't need to drive a car. Also, your building will be much closer to infrastructure that has already been built such as streets, water, gas, electricity, and sewer lines. This will save you time and money and is much less harmful to the environment. Sometimes a new building can really help an old neighborhood to become more interesting.

A site that was contaminated in the past is called a **brownfield**. By choosing a brownfield and cleaning it up, you can really help the community. There may be incentives from state and local municipalities for doing this.

Try not to choose a site that is sensitive to building like wetlands or places where endangered species live. This will help to protect the environment and save you money. Also avoid flood plains and places where mud slides and wildfires happen all the time.

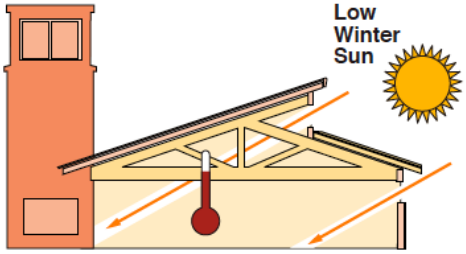
Sometimes you can share what your building needs with another existing building.

For instance, a church building that meets on Sundays could share a parking lot with an office that's only open on weekdays.

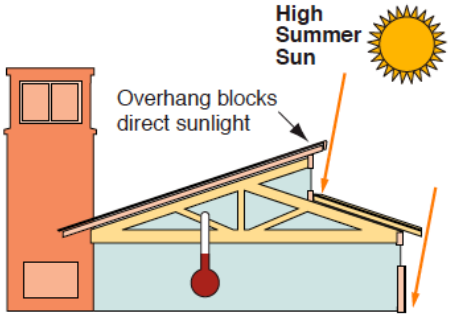
Building Orientation

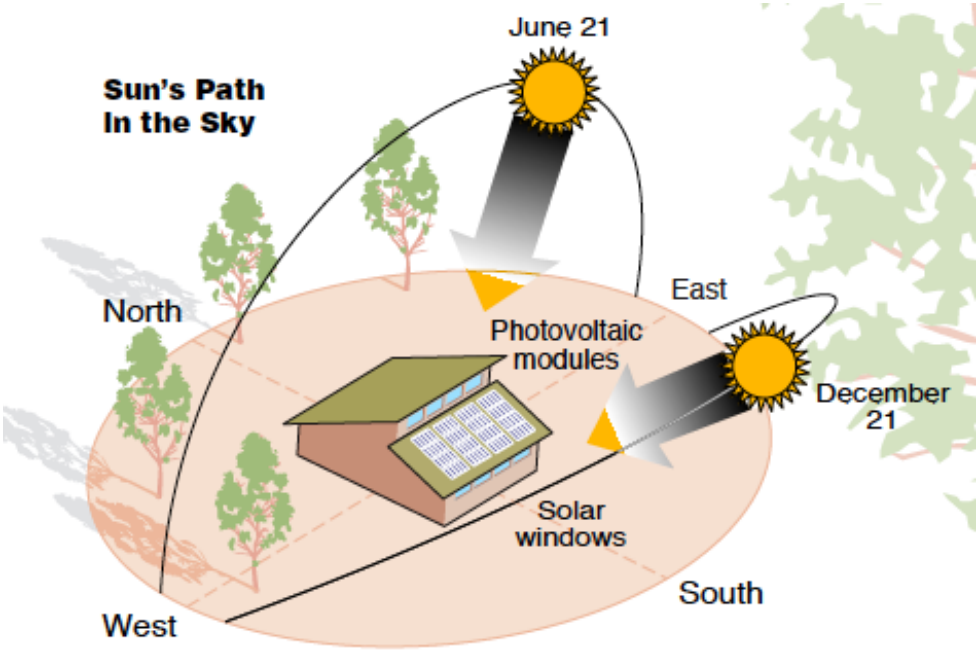
The way a building faces, so that it makes the most of sunlight, is very important in order to save energy. By doing this right, you could save up to 40% in your heating and cooling usage.

In this picture, you'll notice that the building runs east to west and most of the windows are on the south side. During the summer, the sun is higher in the sky and the overhangs of the roof shade the windows, which keeps things cooler. In the winter, the sun is lower and comes through the windows and warms the inside for free. This is what's called a **passive solar design**. Anytime you're clever enough to use the sun's energy to heat anything without using electricity is passive solar design.

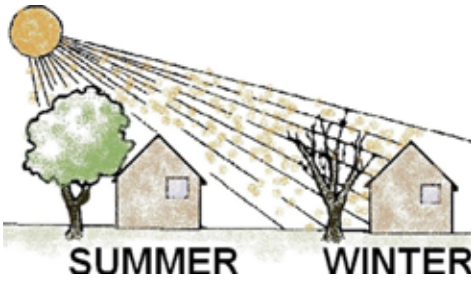


South windows accept direct sunlight to light and warm the building interior





In the summer, the tree shades the house and helps to keep it cool. By winter, the leaves of the tree have all fallen and the sun helps to heat the house



Notes





Examples of softscape (*top*), and hardscape (*above*)

If you put trees on the south, east, and west sides of your building, they will shade your building and keep it cool during the summer. During the winter, they drop their leaves and allow the sun to warm your building for free. Trees also protect your building from wind which means you won't have to spend as much to heat your building. If you have an old tree on your site, try to keep it. They not only save you energy, they also help with water, air quality, and making your place more valuable.

Landscaping

There are two main parts in landscaping: **softscape** and **hardscape**. Softscape means the plant parts of your site like grass, trees, bushes, and flowers. Hardscape means the parts that are man-made like sidewalks, pavers, walls, and such.

Best practices for landscaping are:

- **Native plants** – **Native plants** are the plants that grew on the site in the first place. Since they were already there, it means that they are already use to growing without any help from us. We don't have to water them, use fertilizer, or bug killer. Also, try not to use **invasive plants**. These are plants that came from other parts of the world, and can actually take over a site because they may be much more aggressive. You can go to *www.plants.usda.gov* under the noxious and invasive plants links to learn more about them.

- **Zoned landscaping** – Different plants need different amounts of water and care. By putting these plants together, you don't waste as much water, fertilizer, and bug killer.

- **Mulching** – Mulch can be made of bark chips, pine straw, or other natural materials. You can stop weeds from growing and help keep water for the plants by spreading mulch on the ground between your plants. This way you use less water and other chemicals.

Xeriscaping helps to reduce water usage



- **Xeriscaping** – When you choose native plants that don't need watering, you are **xeriscaping**. This happens a lot here in the Southwest where you see yards full of rocks, sand, and native plants instead of grass lawns that need lots of water to stay alive.

- **Runoff control** – This is where you use planted areas to catch the water that runs off of paved areas like sidewalks and parking lots. This is important because this water carries all the oil, coolant, asbestos, brake dust, and other elements that cars leave behind which can be poisonous to the environment. This area of plants is called a **bioswale**, and the plants actually take out the poisons in the water. You can also put in a **rain garden**. A rain garden does the same thing as a bioswale, but is designed to be much prettier.

- **Permeable pavement** – Permeable pavement is pavement that allows water to go through it rather than run off it. When water goes down into the soil, it is cleaned. Pervious concrete has spaces in it so the water can go through it. You can also use

grid systems and stabilized soil to do the same thing. Storm water runoff can also be bad because it can change the temperature of streams nearby. Water gets warm when it runs over hot pavement. This warm water can shock and kill the plants and animals in a stream when it hits the stream. This is called **thermal pollution**.

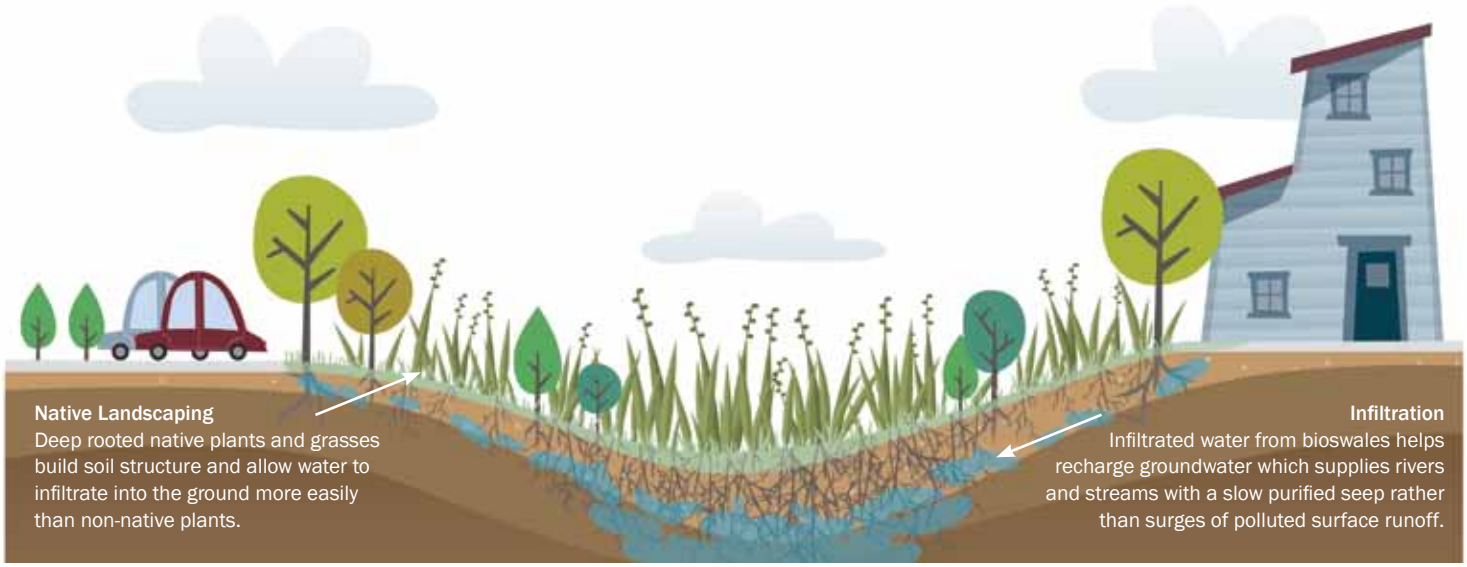
- **Light-colored pavement** – Dark colors absorb the heat from the sun. Light colors don't. Using pavement that is light-colored helps to prevent **heat island effect**. **Albedo** is a rating measure of how much something reflects sunlight. 0 is dark (low) and 1 is light (high). Using high-albedo materials can lower overall temperatures during the summer so you don't have to spend as much on air conditioning.

- **Alternative Transportation** – Sometimes you can put in transit stops, bike racks, bike paths, sidewalks, and walking trails in your landscaping to get people to use alternative transportation. You could also reserve special parking places for carpools or alternative fuel vehicles to reward people who make less harmful choices. **Biofuel** is a fuel made from plants.

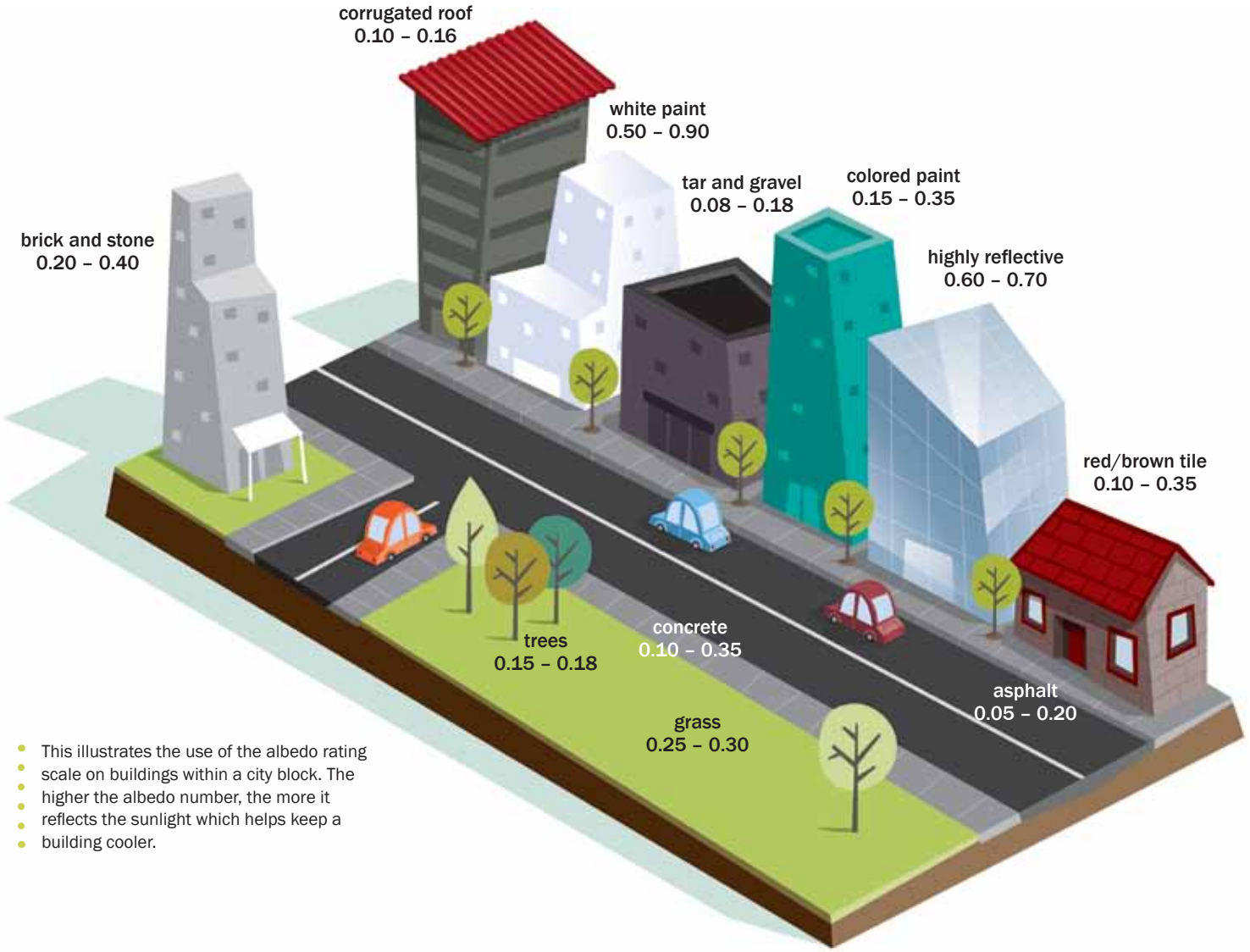


Pervious concrete allows for water to penetrate to the soil beneath it

This simple garden called a bioswale is a special form of landscaping that captures polluted water rushing off hard surfaces like roofs, roads and parking lots.



Notes



This illustrates the use of the albedo rating scale on buildings within a city block. The higher the albedo number, the more it reflects the sunlight which helps keep a building cooler.

Restoring Ecosystems

After you're done with your environmentally friendly landscaping, try to return as much of the site as possible to the way it was. Reserve a part of your site where you leave it exactly the way it was. This way the birds and the butterflies that live there still have a home. You may also try to work with the people who own sites next to yours so together you can make a much larger natural area.

Keywords:

albedo	*building orientation*	*passive solar design*
biofuel	*hardscape*	*rain garden*
bioretention	*heat island effect*	*softscape*
bioswale	*invasive plants*	*thermal pollution*
brownfield	*native plants*	*xeriscaping*

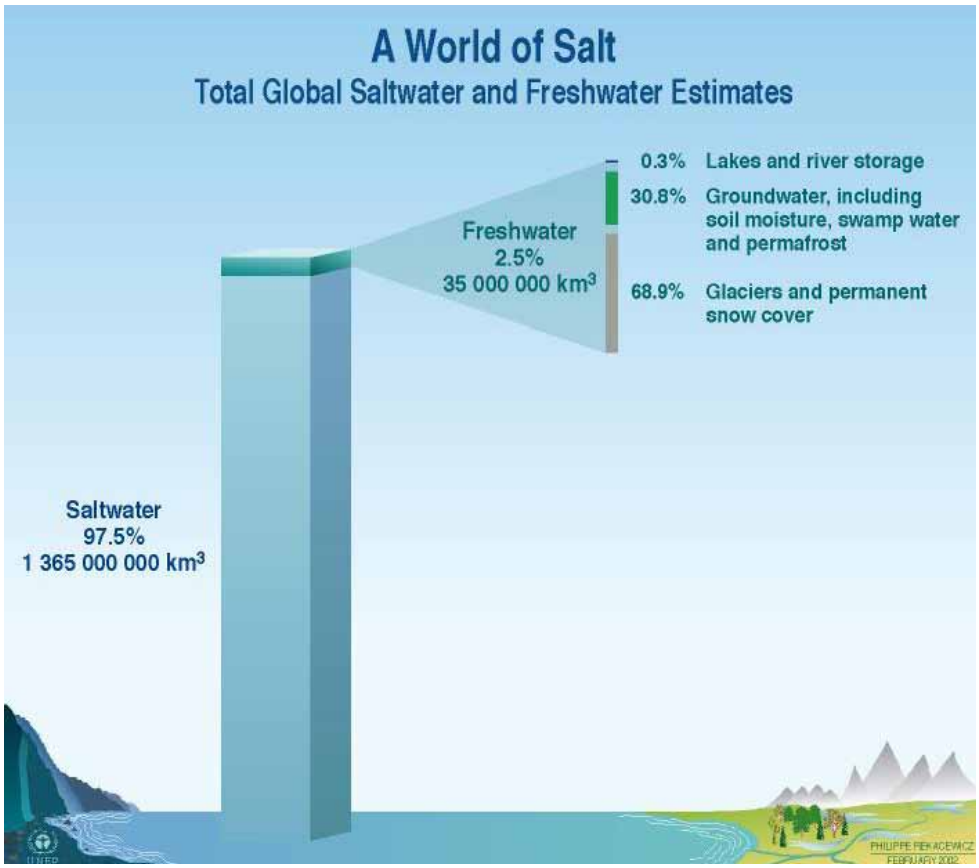
8 Water and Wastewater Best Practices

Using water wisely

Pretty much all buildings need water so the people inside them can drink, wash, and flush. When you look at pictures of the earth, you notice that there is a lot of water. What you may not know is that if you had 100 cups of water that represent all the water in the earth, only 2.5 of those cups are usable by us humans (2.5%). This is called freshwater. Of those 2.5 cups, only a few tablespoons are easy for us to get to because they are in rivers and lakes on the surface of the earth.

The **hydrologic cycle** is the way that freshwater is replaced. This cycle has five steps: condensation, infiltration, runoff, evaporation, and precipitation. In many places in the world, we use water faster than the hydrologic cycle can replace it. This means we start using up too much ground water, which is called **aquifer depletion**.

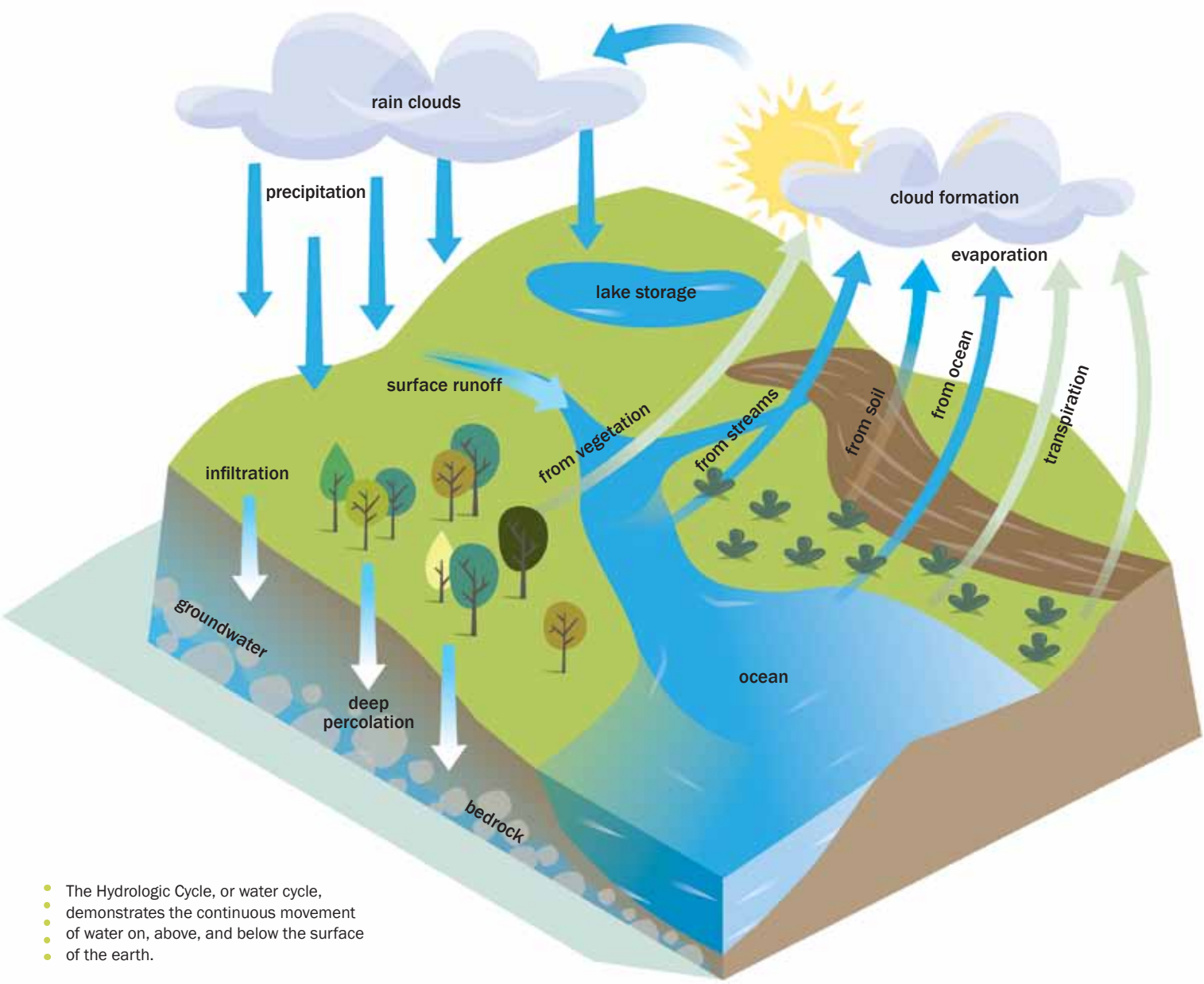
The best thing you can do to save water is to not use it in the first place. If you're using water to do something now, try and find another way of doing it. For instance, instead of using a hose to clean off your driveway, use a broom instead. The next best thing you can do is to use water as efficiently as possible. After you've done that, you can look for different sources of water.



Reducing Water Use

The first thing you should do is to find out if your building is leaking. Leaks are

Notes



The Hydrologic Cycle, or water cycle, demonstrates the continuous movement of water on, above, and below the surface of the earth.

a terrible way of wasting water since no one is using it and you are paying for it. After that, you can use waterless toilets and urinals. Waterless urinals and toilets don't need to be flushed and can take our waste and turn it into compost that can be used as an eco-friendly fertilizer for plants.

Increasing the Efficiency of Water Use

When we shower or wash our hands, we should try and use shower heads and controls that use less water. One way is to let less water come out of the head by combining it with air. This is called **aeration**, and it makes it seem like you're using a lot of water when you're not. Another way is to use foot controls so you can turn on and off the water without using your hands. You can also get faucets that turn on and off by sensing if your hands are there. The WaterSense program from the Environmental Protection Agency (EPA) has a way of helping you understand how efficient a fixture such as a faucet or shower head is. Visit *www.epa.gov/watersense* to learn more.





Left: This is an illustration of a rainwater harvesting system in which rainwater that is captured can be used for various purposes around a home. *Above:* Drip irrigation helps to conserve water and allows for less water evaporation. *Below:* Aeration of shower heads and faucets (*bottom*)helps to conserve water.



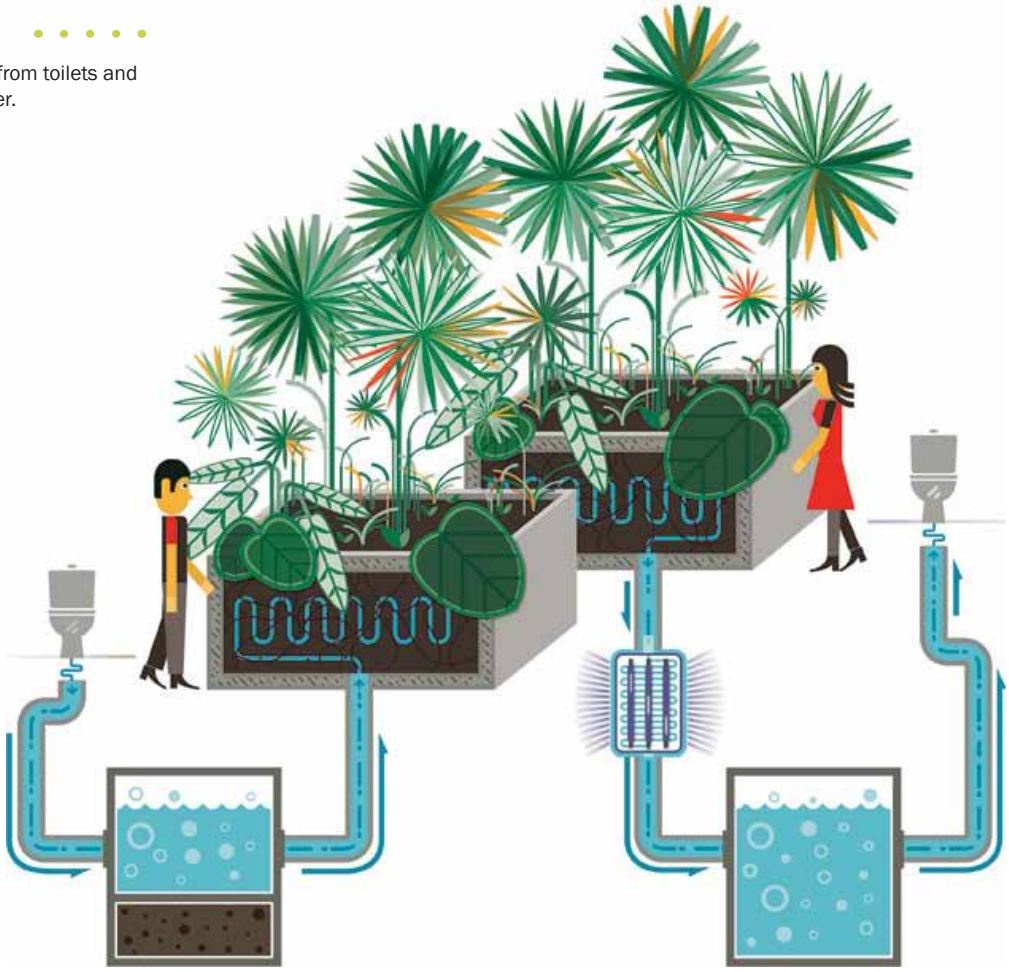


Besides low-flow toilets, you can also use dual-flush toilets. A dual-flush toilet uses less water to flush liquids and more water to flush solids.

To water your landscaping, think about using drip irrigation or irrigation that is turned on by moisture sensors and timers. Drip irrigation puts the water closer to where the plants need it. This is better than sprinklers because the water in the air evaporates. Make sure to do your watering early in the morning before the sun comes up. This way the water has time to get to the roots before evaporating. Make sure all the parts of your watering system are working correctly, otherwise you'll have a leak and waste water.

You should also look at using water-efficient dishwashers and washing machines. These units use up to 50% of the water required by other machines. They also use less hot water, so you can also save energy. Look for the **Energy Star** label and visit *www.energystar.gov* for a list of appliances that save water and energy.

Notes



Living machines clean blackwater, wastewater from toilets and dishwashers, which allows for reuse of the water.

Keywords:

aeration

aquifer depletion

blackwater

constructed wetland

Energy Star

graywater

hydrologic cycle

living machines

rainwater harvesting

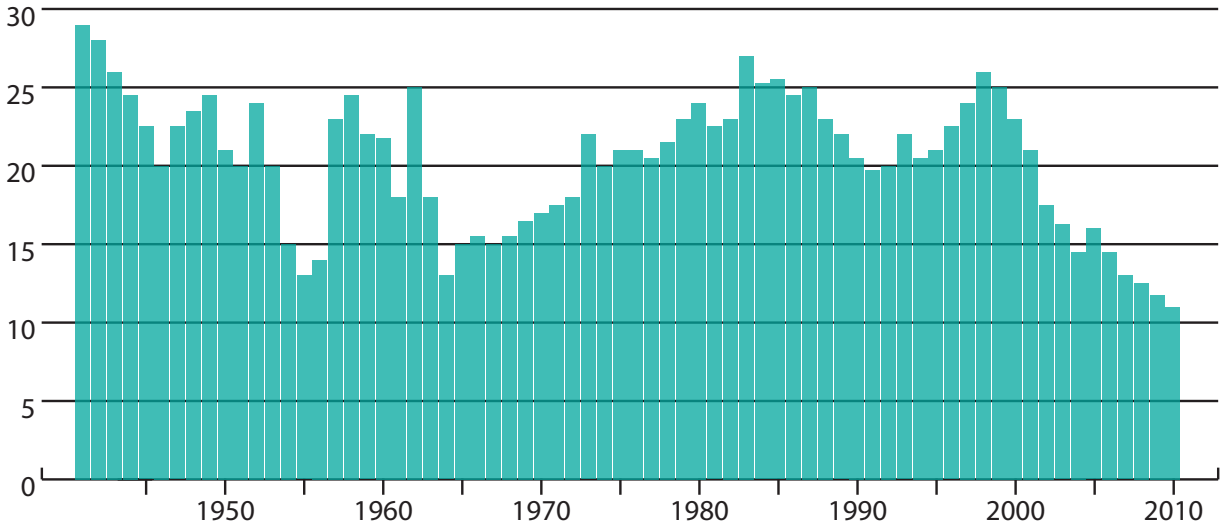
storm water

Finding Different Sources of Water

Did you know that all the water that comes to you through your tap has been cleaned to the point that you can drink it safely? It's actually a waste to use this drinking water on things like flushing a toilet or watering your plants. One different source of fresh water is collecting rainwater. This is called **rainwater harvesting**. You can use this to water your plants instead of using tap water. Be sure to check with your water company, because this may not be allowed in some parts of the country. Another different source of water is reusing the water we first used in our sinks, showers, and washing machines. This is called **graywater** because although it contains some stuff that could get us sick, it's actually a very small amount. A good graywater system will filter the water for flushing and watering your plants. Graywater systems need to be put together carefully because it can allow dangerous bacteria to grow where you store it. You must also use separate pipes and throw out old graywater after a certain amount of time.

Wastewater from toilets and dishwashers is called **blackwater**. This water has lots of harmful bateria in it that can make you sick and must be dealt with carefully before you can reuse it. Systems that clean blackwater are called **living machines** and are becoming more popular. These systems use plants, bacteria, and other microscopic animals that eat the waste in the blackwater to make the water clean.

August Water Volume in Lake Mead (millions of acres)



Finding Different Places for Wastewater

Reusing your water is already a different place for your wastewater to go. Remember that **storm water** is part of your building's wastewater, too. Besides rainwater harvesting, bioswales, rain gardens, greywater systems and Living Machines, you can also make a **constructed wetland**. This system copies nature, and is a series of retention ponds filled with plants that clean the water. Every time the water moves to the next pond, it gets cleaner and cleaner until it finally goes into a local stream.

The effects of Lake Mead's lowest water level in over 70 years.





Constructed wetland systems were devised to copy nature for the purpose of water being able to run through a series of ponds, filled with plants that clean the water.

Notes

9 Energy Best Practices

Using energy wisely

The energy we use in our homes and buildings can really harm our environment when that energy comes from burning fossil fuels. We can lessen the harm we do by:

- Getting rid of unnecessary energy use
- Using energy more efficiently
- Balancing electric loads
- Looking for different ways to get energy

Getting Rid of Unnecessary Energy Use

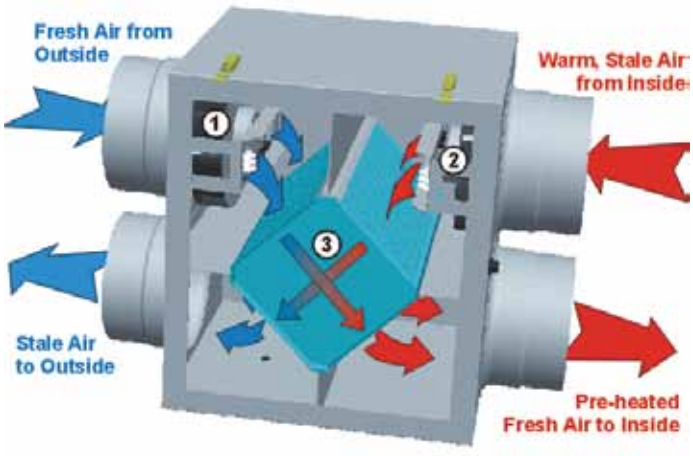
The best way to use less energy is to reduce our need for energy. One simple way of doing this is to lower the thermostat in your building and wear warmer clothes in the winter. You can also keep the setting on your thermostat higher and open a window when it is cooler. Another way to reduce our need for energy is to use timers or sensors to turn off the lights and heating/cooling when no one is there.

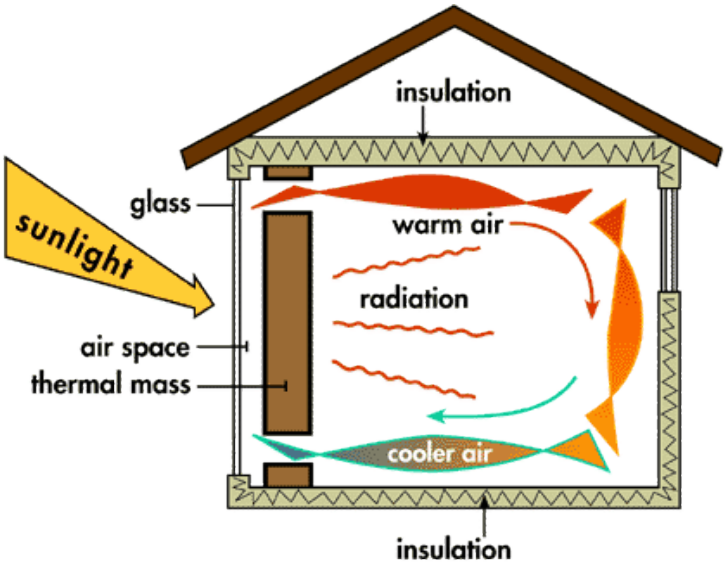
You can also use passive heating or cooling (which we already talked about), daylighting, and heat recovery ventilators (HVRs). HVRs take the wasted heat from a building's air exhaust and use it to warm up the incoming air. This makes the heater's job much easier and saves energy.

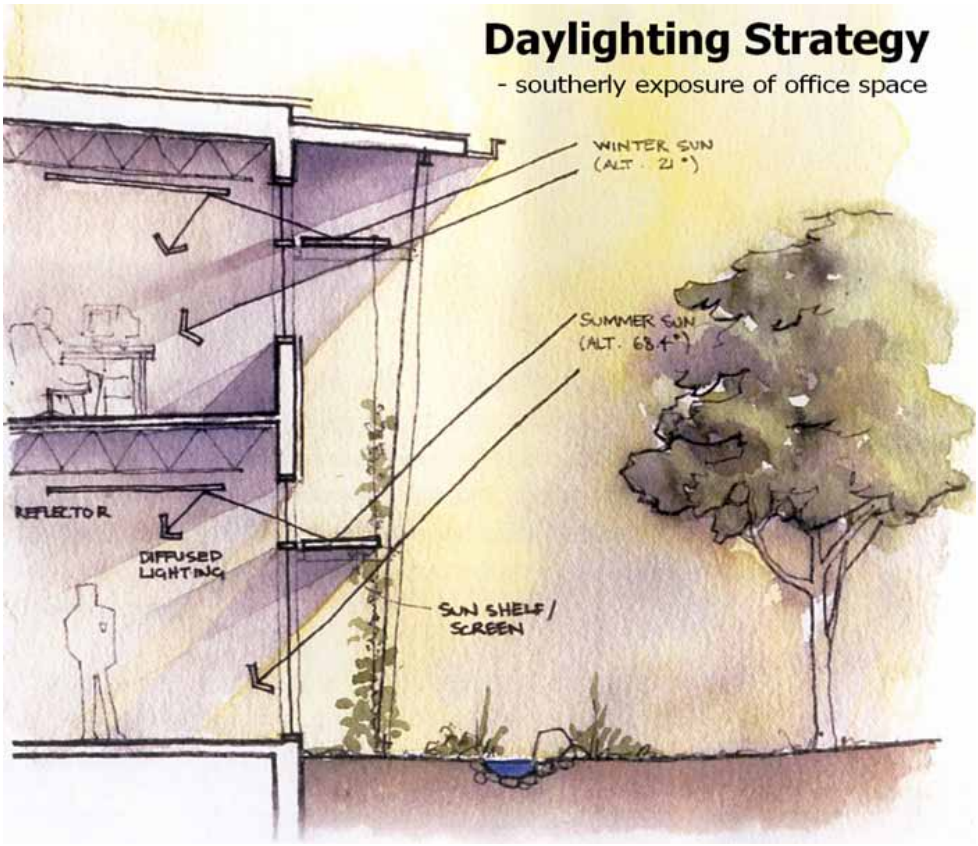
Daylighting is using sunlight inside a building instead of electric lights. Where windows give you light near the walls, you can put in skylights and light shelves to bring natural light into the middle of a building.

Using **thermal mass** can save energy. Thermal mass is a process of when materials take in heat during the day and slowly give it off at night. For instance, adobe walls will absorb the heat from the sun during the day and keep your building warm at night so you don't have to use a heater.

Below, left: Heat recovery ventilator systems help to reduce the cost of energy. *Right:* Thermal mass is the process of materials absorbing heat throughout the day, and slowly releasing heat throughout the night.









Above: Skylights allow for light to enter a home from the roof. *Left:* Day-lighting, using sunlight to light the inside of a building, is an easy way to save on electrical costs and energy.

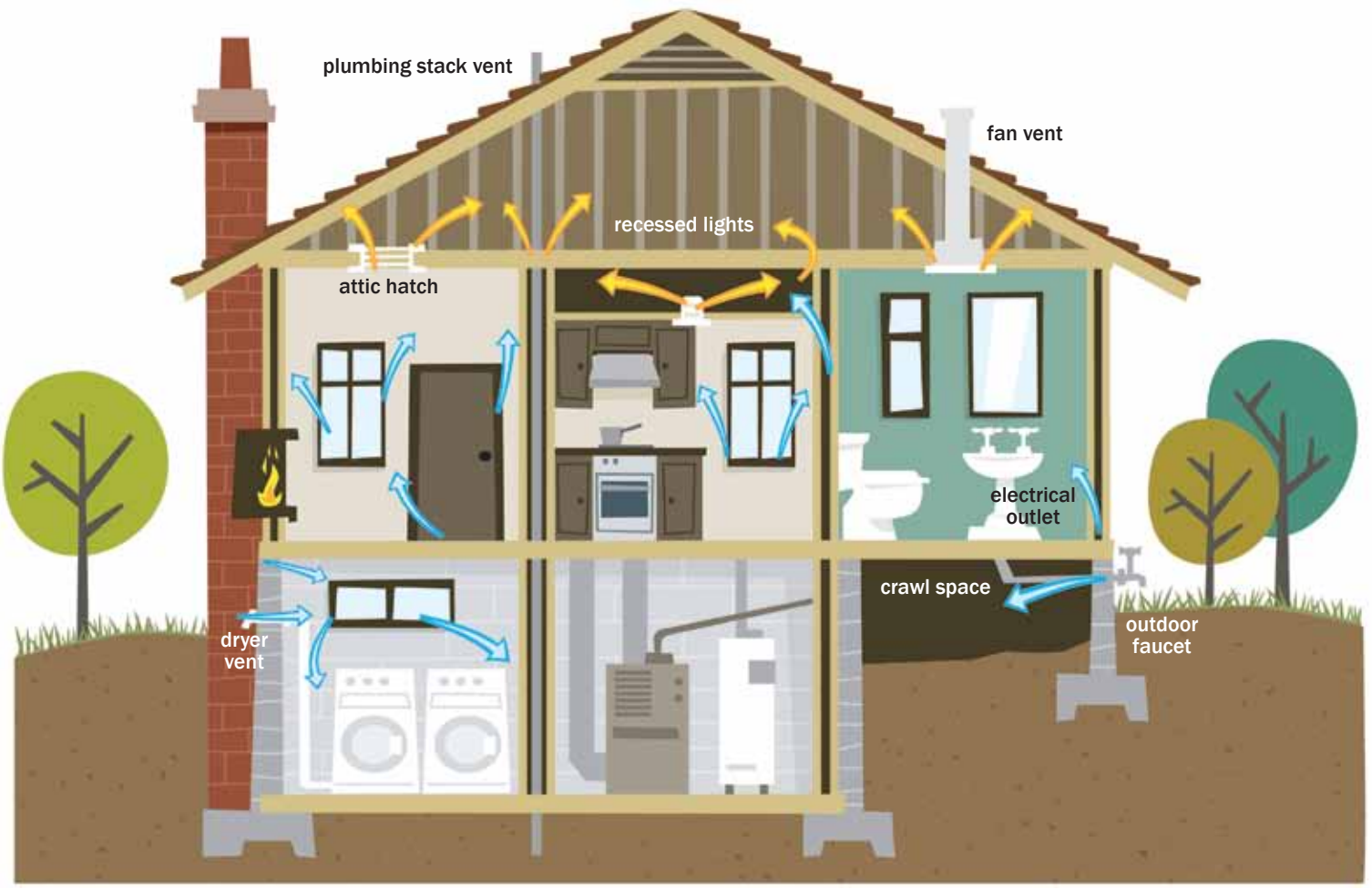


This light colored roof will stay fairly cool in the summer, because it will reflect much of the heat from the sun.

Using a high-albedo roof can save you energy on your air conditioning, because it reflects the heat from the sun instead of absorbing it. You can get a high-albedo roof simply by choosing a high-albedo color when your roof gets finished.

Making sure your **building's envelope** is tight is another way of reducing energy usage. A building's envelope is the outer shell of the building that protects it from the outside. If you added up all the cracks, holes, and openings of a typical house, it would be about 3 feet by 3 feet big. That's like having a window open all year round, even when the heater or the air conditioner is on. That's a lot of wasted energy. You can make your building's envelope better by:

Notes



As illustrated, there are numerous ways for unwanted air to enter a home and numerous ways for air to escape a home. This means more energy use, such as increased heating or cooling.

- Adding insulation in walls and the attic
- Sealing cracks and holes and using vapor-resistant barriers to stop drafts
- Putting in high-efficiency doors and windows
- Using low-emissivity paint or radiant barriers in the attic to reduce heat

All these suggestions make it easier and more efficient to heat and cool the building. They also make the people inside the building more comfortable.

Lastly, you can use lighting controls that turn lights off when there's enough daylight in the room (see below).



Using Energy More Efficiently

There are many ways you can use energy more efficiently. One way is to choose the right size of **heating, ventilation and air conditioning (HVAC)** equipment. If you get a system that is too big, it only runs efficiently a few days a year. It's better to use two smaller systems that work together. During normal weather, only one unit is used and runs efficiently. On those days when it's really hot or cold, then both units run. The extra cost of two systems will be quickly paid for in savings on your energy bill.

Another way to use energy more efficiently that most people forget about is to correctly run and maintain your equipment. Simple tasks like changing air filters or keeping the lenses of your lights clean can save you lots of money.

Building commissioning is what happens when someone checks to make sure all of your building's equipment is working the way it's supposed to. When you do this regularly, you can be sure your equipment is always running efficiently. Commissioning can also help you find new ways of saving energy. Also, making sure your building workers know how to use the equipment can keep it running smoothly.

Retrofitting is replacing old, less efficient technology with new, efficient technology. A good example is replacing your old magnetic ballasts and T-12 fluorescent lamps with new electronic ballasts and T-8 lamps. This can pay for itself in less than a year.

Retrofitting your old tank-type hot water heater with a new tankless water heater can save you money. Although tankless heaters are more expensive at first, they last longer and use much less energy. You also get rid of standing heat loss, since your water is heated only when it's needed.

Modern HVAC systems with variable speed fans, pumps, and motors are super efficient. They don't turn on and turn off as often, which saves energy. Better distribution systems can also help reduce costs, because they are much better at getting the heating or cooling where people need it. Making sure ducts are sealed and insulated is another way to make sure that the energy you spend on heating or cooling actually gets to the people in your building.

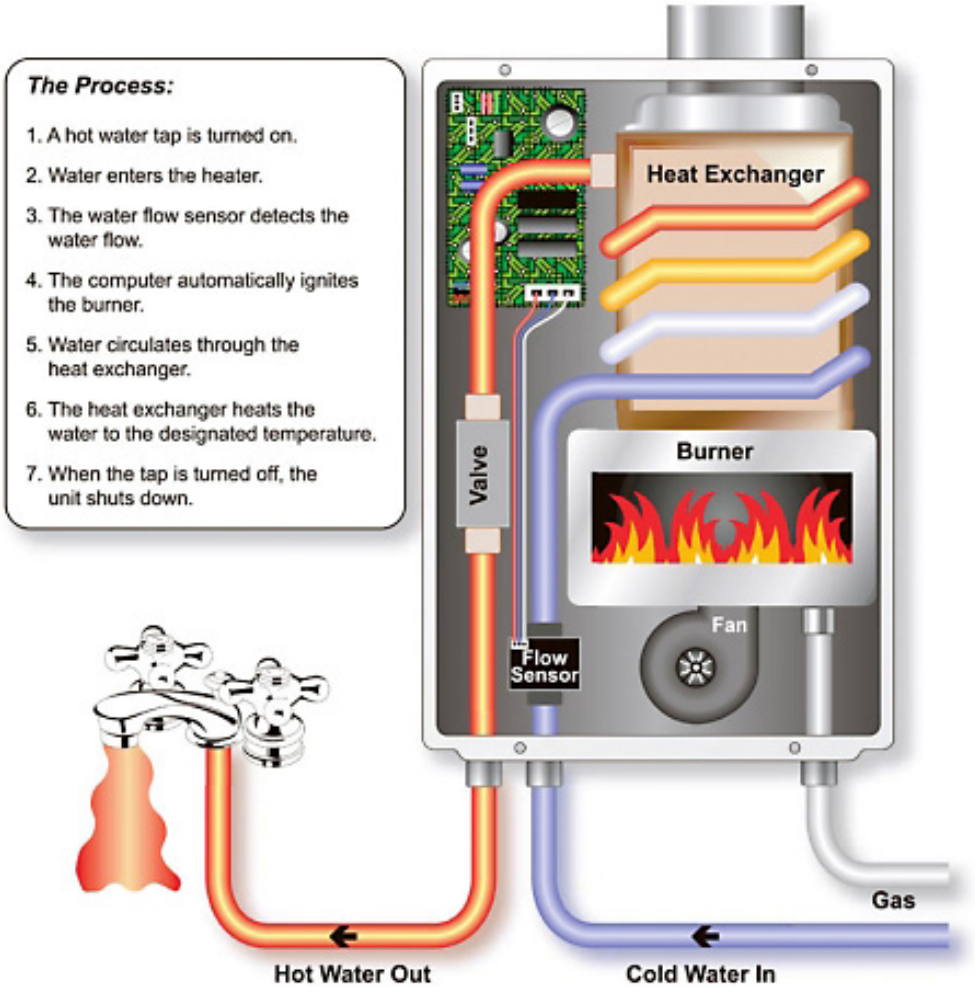


Above: This illustration is of the framing phase of a home being constructed. The pink represents the insulation of the home. *Below:* Filters for ventilation systems need to be changed regularly to ensure that clean air is distributed. *Bottom:* Tube-style fluorescent lights





Notes



Tank-less water heaters cost more to purchase, but they will save money on utility bills over time.

Again, Energy Star appliances and equipment can pay for themselves quickly. When you need to replace equipment or buy new appliances, it is best to get these.

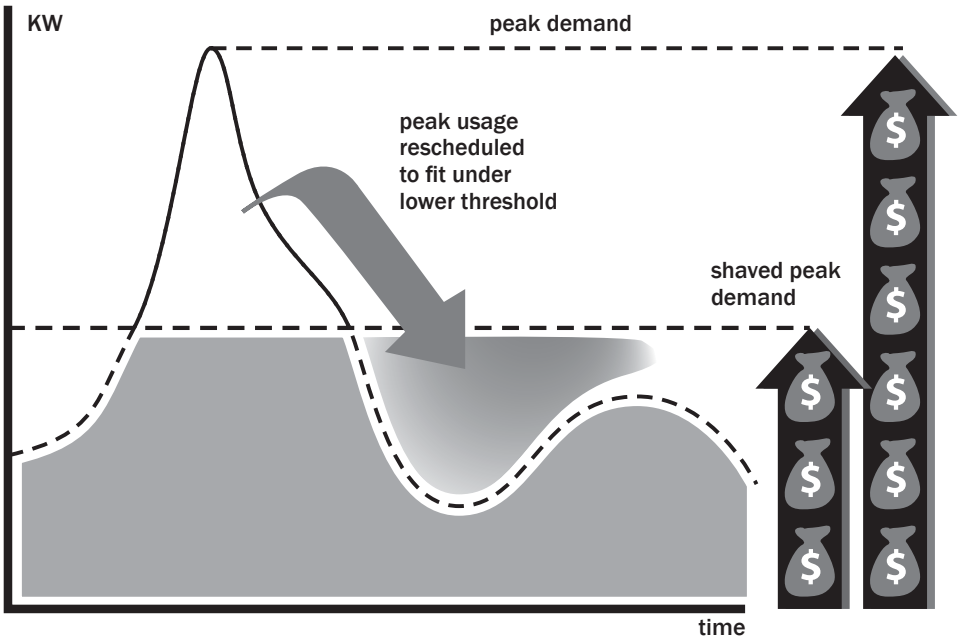
Balancing Electric Loads

The way power gets to our buildings is through what's called the **electric grid**. This grid is very complicated. Its job is to keep the electricity available and the electricity we need at any moment in time totally balanced. When we need more power, the grid turns on more power generators to keep things even. There are times when our need is greater than the extra generators can produce. What happens then is a **brownout** when you can see your lights dimming. When we need so much power that the grid is close to burning out, we get **blackouts**.

Load balancing is timing our need for power so we don't need such big generators for backup. We also don't need to build new power plants. The time we need the most power is usually in the middle of the day during the hottest part of summer. This is when factories are using the most power and we all have our air conditioners cranked to the max. Turning off equipment we don't need during this time is one way to lessen the need to turn on those backup generators.

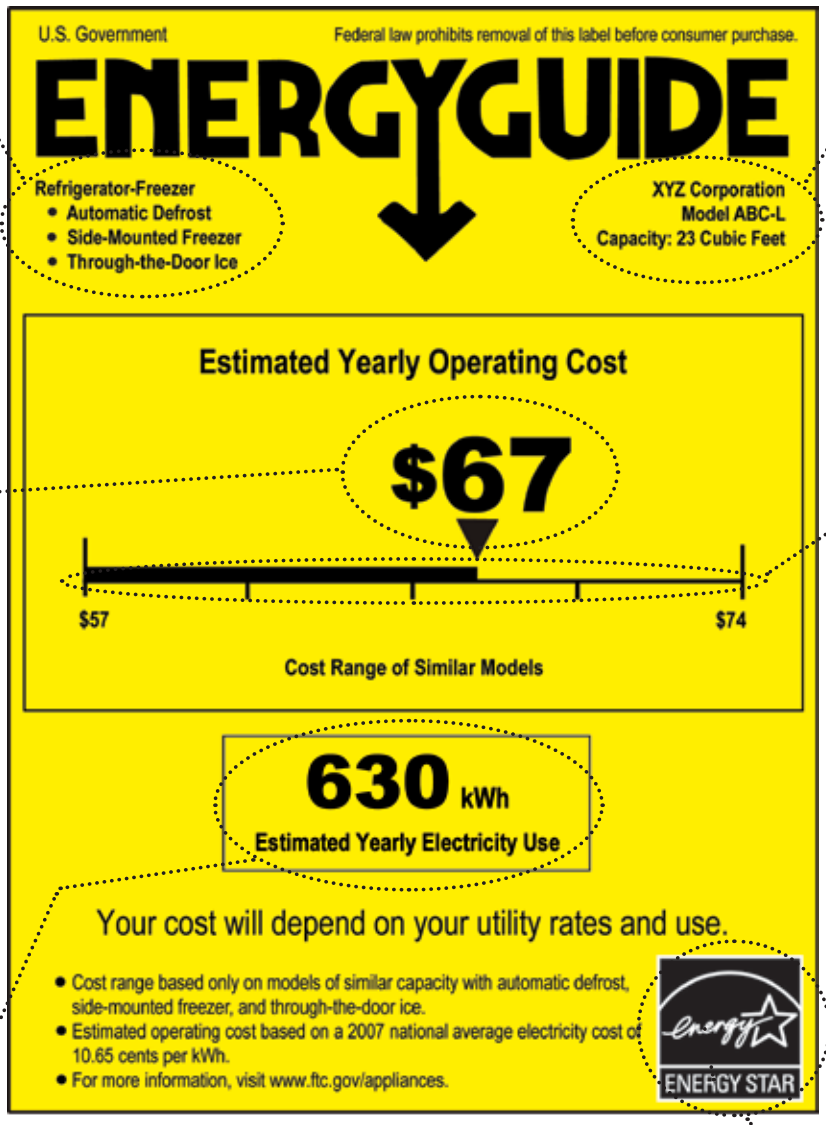
Peak shaving is running equipment you usually run during the day at night. The electric company usually charges you less for electricity at night, so you can save money and reduce the need for electricity during peak hours.

You can also use energy management systems to make sure you don't use too much energy during peak times. These systems will cut back on power to household



Peak shaving can save money and helps to avoid brownouts, and blackouts.

Lists key features of the appliance you're looking at and the similar models that make up the cost range below.



The maker, model, and size tell you exactly what product this label describes.

What you might pay to run the appliance for a year, based on its electricity use and the national average cost of energy. The cost appears on labels for all models and brands, so you can **compare** energy use just like you would price or other features.

The cost range helps you compare the energy use of different models by showing you the range of operating costs for models with similar features.

An estimate of how much electricity the appliance uses in a year based on typical use. Multiply this by your local electricity rate on your utility bill to better judge what your actual operating cost might be.

If you see the ENERGY STAR logo, it means the product is better for the environment because it uses less energy than standard models.

Notes

Keywords:

blackouts

brownout

building commissioning

building envelope

daylighting

electric grid

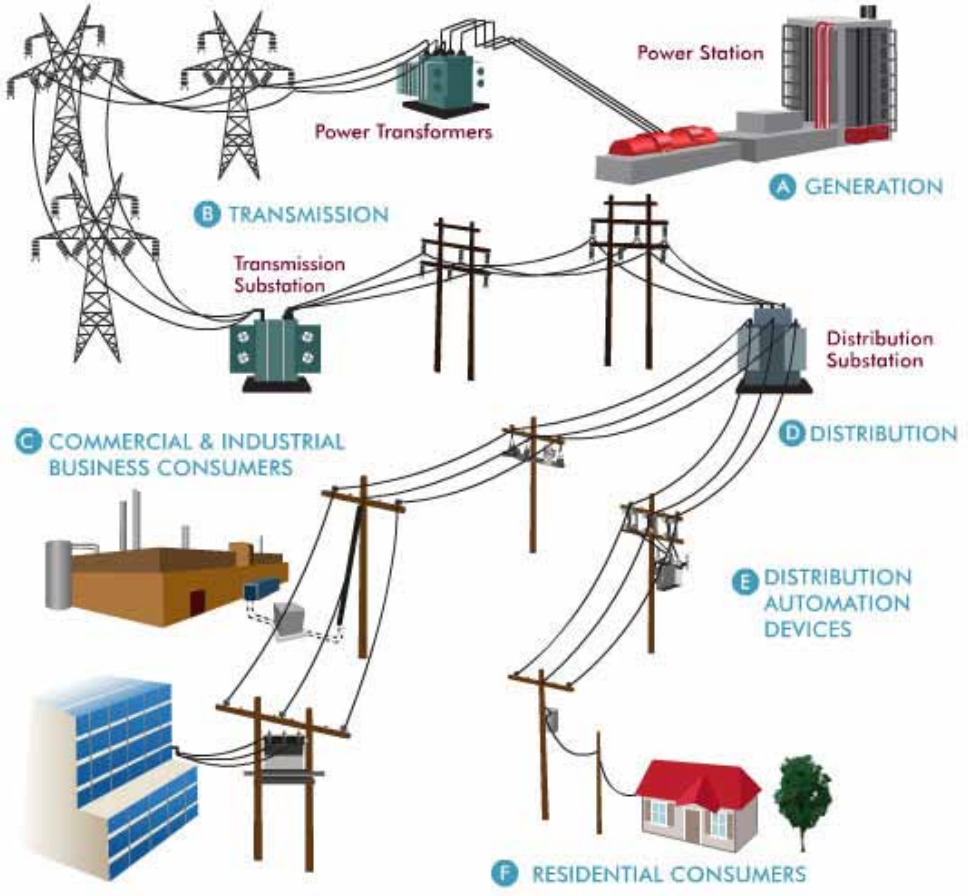
heating, ventilation and air conditioning (HVAC)

load balancing

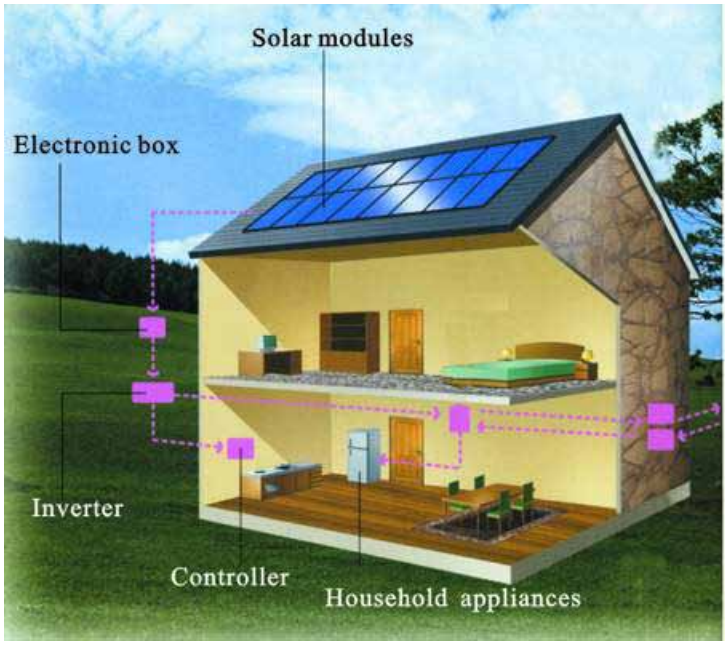
retrofitting

thermal mass

peak shaving



In order for power to reach any business or home, the power first has to be generated and then go through the electric grid system.



The solar panels on the roof of this house generate energy that is converted into electricity for use in the home.

items that can function with less (like HVAC systems), but keep power constant to those that will be disrupted by power changes (like computers).

Looking for Different Ways to Get Energy

After doing all you can to reduce your energy use, increase your energy efficiency, and balancing loads, you can look at different ways to get energy. The first way is to buy energy from a green power provider. These providers make electricity using renewable energy like wind and solar. You can find one near you by visiting *www.green-e.org*.

The second way is to make electricity for yourself. You can do this by putting in your own solar panels or wind turbines. You will need to choose whether or not to store the extra energy in batteries (which is expensive) or to tie into the electric grid. Depending on where you are, you can sell the electricity you generate back to the electric company. Visit *www.dsireusa.org* to find out.

10 Materials and Waste Best Practices

Using materials wisely

It takes a lot of material to build all types of buildings. The processes involved are not always environmental friendly. Buildings use about 25% of all wood that is cut down. An area the size of Georgia is cut down every year. Buildings also use about 40% of the world's energy and materials. Every piece of material that goes into a building has a life history of it's own:

- Finding and getting all the raw materials you need.
- The byproducts produced from the creation of the materials.
- The energy it takes to transport all the materials.

Don't forget that buildings make 20% to 40% of all the solid garbage that goes into landfills.



This picture of the framing phase of a home being constructed illustrates the amount of raw material required to build. This is just part of one home under construction.

A way to reduce the environmental impact this process creates is to not use all new materials to build. If you can use something from the dump, something **salvaged**, or something recycled, that is good. If you already have a building standing, you can try to renovate and reuse the existing building instead of tearing it down and building a new one.

You can also use materials more efficiently. Instead of cutting a new sheet of plywood, see if you can use the scraps left over from ones you've already cut. This helps to minimize waste and maximize use. There is a whole new family of materials that are **multi-functional**. That means that it can do many things such as be the structure, enclosure, insulation, and more. Using these materials means you reduce the raw materials needed for the building and save money on packaging and shipping.

Finding better places to get our materials is also important. This helps to ensure that we have enough materials for the future. Using products made of fast-growing, **renewable materials** means you don't have to use up the materials that are running

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out. Making sure that materials are sustainably grown and acquired means that you'll never run out of that material. Using materials that you can get locally helps to reduce the carbon that is created by transporting it from far away, as well as helping local businesses.

Lastly, finding better places to put waste materials (called sinks) helps the environment. Things like recycling, using **biodegradable** (made of natural materials that easily break down with water or sunlight) or reusable packaging, and salvaging or deconstructing buildings is very helpful. Also, some manufacturers will take back either the old materials when you're done with them, or the packaging, or both.



There are many shops in many cities that have stores that sell used items. Buying used items is one way to be eco-friendly, and it saves you money.

Don't Use Materials When You Don't Have To

Remember, reducing the use of new materials when building saves energy and raw materials. This helps to conserve our limited resources.

One of the best things you can do is to reuse or adapt an existing building instead of building a brand new one. If you can do this, you reduce the need for new materials and reduce the costs of preparing the site and infrastructure. This is much harder than it sounds, however, because many older buildings have lead-based paint, asbestos, or other harmful materials that have to be taken out. Also, some systems will need to be replaced. Don't reuse old windows, HVAC systems, appliances, and plumbing fixtures as they will most likely be very inefficient.









These are just a few examples of pre-consumer materials. These types of materials can be recycled before leaving the factory in which the materials were waste, from the manufacturing of goods.

You should also look at the packaging the materials come in. Sometimes you can tell companies to send it to you in reusable packaging that they will take back with them. Or, ask for recyclable or biodegradable packages. If the packaging is **bio-based** (or made from materials that were once alive —like trees), try and compost or chip it on your site, and use it as fertilizer for the soil. This also means you don't have to buy fertilizer later.

Salvaged materials can help a lot. If you are deconstructing an existing building, try and reuse as much of the materials as you can in the new building. For instance, you can reuse concrete and masonry rubble for fill, subbase for pavements, or drainage. Wood in good condition can be reused for framing or for flooring or siding once it's been remilled. Masonry units can be reused too. The materials you don't use on your current project like doors, hardware and fixtures could be saved for future projects. You could take them to your local recycled building supply store.

Recycled content in new materials also reduces the use of virgin materials. Steel and concrete are good examples. Other materials like recycled plastic lumber (RPL) have post-consumer (after somebody has used it —like an old soda bottle) or post-industrial (after the factory makes something and this is what's left over) plastic combined with wood fibers. What you get is a very good wood substitute.

All recycling is not the same. Real recycling is using the old material to create the same new material, like recycled aluminum cans. Other things can only be **downcycled**, which means they are made into something different and can never be made back into what it

was originally. For example, clear plastic bottles can never be made clear again because of the way the plastic works. What happens is that they are made into something else, like RPL, plastic bags, or carpet backing. Recycling plastics does its part in reducing virgin materials, but the plastic loses its purity and quality. The best thing to do in this case is to just not use it in the first place.



This in an illustration of how a large plastic bottle is down-cycled to become a bag.

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You can minimize the amount of materials you use in a building by staining a concrete floor instead of putting in another type of flooring, and you can keep a ceiling exposed instead of putting in a drop ceiling.

Recycled content comes from many different places. As mentioned earlier, post-industrial (or pre-consumer) material is waste from the factory making something. You can gather it and reuse it before it even leaves the factory. Post-consumer content is material that has actually been used by us and then recycled. This is better than post-industrial because it makes the material go full circle.

You can design products and processes to prevent pollution by not wasting materials. For example, don't use finishes and leave structural materials in the open, like staining and polishing a concrete floor instead of covering it with wood or tile, or not using a complicated drop ceiling system and leaving the ceiling exposed. This can give you something that looks cool and saves you money at the same time.

You can also replace engineered systems with natural systems and save money. For example, we talked about living machines made of plants, animals, and microorganisms. These natural systems can replace very complicated and expensive engineered systems to treat wastewater, and they do it without using expensive chemicals. Sometimes, natural systems can cost more up front first costs, than engineered systems, but they will pay for themselves over time.

If you take a good look around at nature, you can learn many lessons on how to put together buildings in a more economical and environmental way. This way of thinking is called **biomimicry**. An example is an African termite mound. Even though the outside temperature goes from one extreme to another, the inside temperature always stays the same. The termites are able to do this because they build their mounds with a tunnel system that controls the flow of air. Since the natural environment can be so harsh, plants and animals have come up with super-efficient answers in order to survive. We can learn a lot from imitating what they do.



We can learn a lot from nature about how to build in ways that mimic strategies used within nature (biomimicry). This termite mound is a good example in that the tunnel system within it controls the air flow, which keeps the temperature inside it consistently stable.

Using Materials More Efficiently

Do all you can to use materials more efficiently. This means getting more out of the same amount of material, or getting the same with less. One way you can do this is by using multi-function materials. These materials do many things at once. They help to ensure productivity, save materials, and reduce waste. For example, you could use insulating concrete forms (ICFs), structural insulated panels (SIPs), or aerated autoclaved concrete (AAC) as the building enclosure, the insulation, and the mounting surface for outside and inside finishes. These materials replace up to four ordinary building materials, so you save time, packaging, transportation, and money.



Structural insulated panels are energy efficient

Another example is building-integrated photovoltaics (BIPVs). These are solar panels that create energy but are built into other building materials like windows, roof shingles, and shade structures for parking lots. They do two things: create energy and work also as a window, roof shingle, and shade structure.

Another example of a materials and waste best practice is a **green roof** or vegetated roof. These are basically gardens that you put on top of a roof. They do many things such as: protect the waterproofing material so it lasts longer, keep the roof cooler so you can save on air conditioning, absorb rainwater so you can reduce storm water runoff, clean the air so you can have better air quality, give birds and insects a place to live so you can have greater biodiversity, and in some cases, give humans a place to relax so you can enjoy the outdoors on your building.



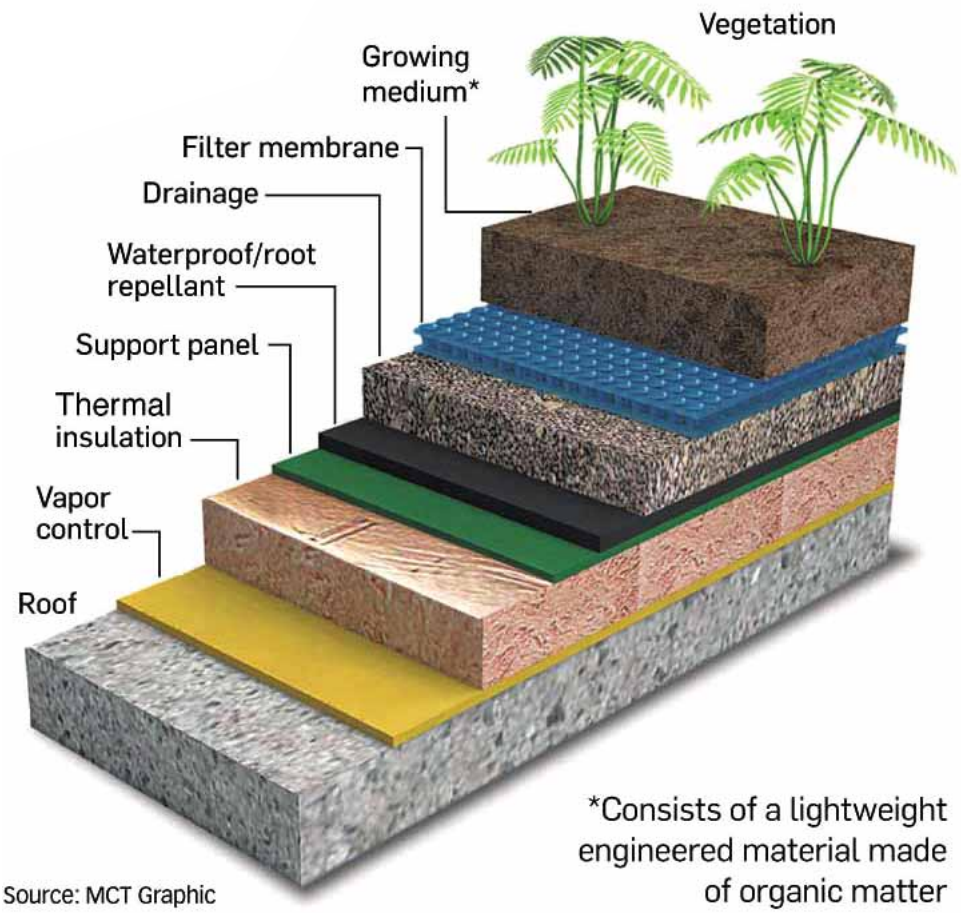
An example of a home with a green roof.

Another way to use materials more efficiently is optimal value engineered (OVE) framing for light wood frame construction. OVE is good because it gives you room to put more insulation in the walls. This means that less heat will be wasted.

OVE framing saves you a lot of wood. You also have fewer cuts and less waste. According to the U.S. Department of Energy, OVE framing includes:

- Design of buildings on two-foot modules so you can make best use of common sheet sizes
- Space wall studs, roof joists, and rafters up to 24 inches on center
- Use in-line framing where floor, wall, and roof framing members are vertically in line with one another and loads are transferred directly downward

Notes



Green roofs vary in the types of materials and plants used. This cross section illustration is an example of materials that may be used.

- Use two-stud corner framing and inexpensive drywall clips or scrap lumber for drywall backing
- Eliminate headers in walls that are not load-bearing
- Use single lumber headers and top plates where appropriate.

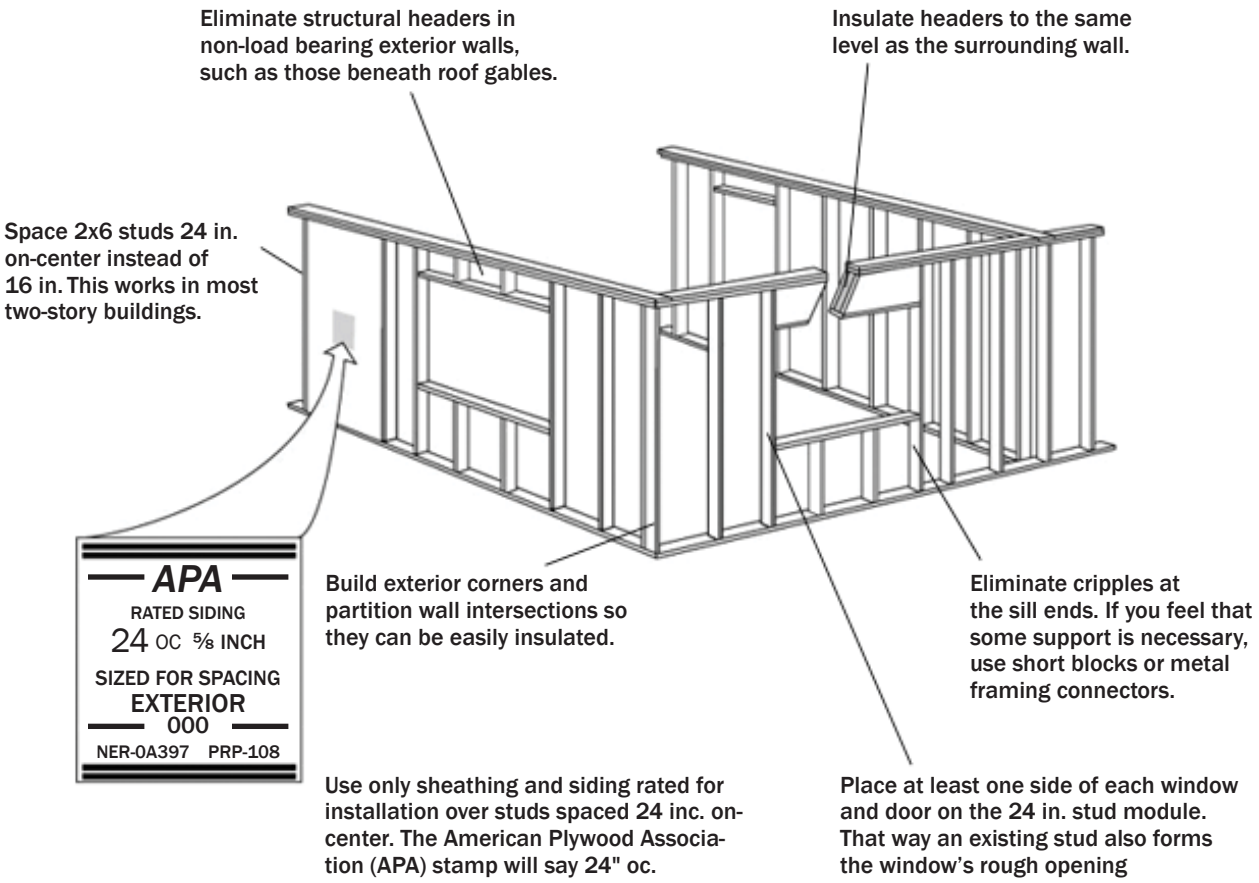
These methods reduce the wood you use and make a better thermal envelope. This also makes it easier for the plumbers, electricians, and HVAC people to do their work in the walls. Fewer studs means less drilling and less effort. OVE framing is a green way to go.

Then there are **smart materials**. They're smart because they change when the environment changes. A smart window will darken its tint when the sun gets more intense. A smart window blind would adjust to follow the sun. They're working on other materials that can change colors, too. This is similar to eyeglasses that change with the light in their environment.

Nano-materials use microscopic elements that allow building materials to be more efficient. A nano-coating can help paint stay clean. It can also help a piece of drywall kill germs and mold.



These building integrated photovoltaics (BIPVs) at the Springs Preserve in Las Vegas, create energy while being part of the structural design of the parking structure.



By building whole sections of a building in a factory, you can reduce waste and get better quality, because they're made inside away from the weather. This is called prefabrication. Like anything built in a factory, you can produce goods efficiently and use the least amount of materials with little waste.

Optimal value framing is a building strategy that conserves materials use and allows for optimal insulation installation.

Carpet tile, raised floor systems, and demountable furniture systems are modular components. They're like Lego® bricks and can be quickly put together and taken apart for different uses. If one of the pieces gets messed up, you can just replace the piece instead of the whole carpet. If you have a stain in your carpet, instead of replacing the carpet in the whole room because it's one piece, you only have to replace the carpet tile that's stained.

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Above: Carpet tiles are easy to install and easily replaced. *Below:* With the use of radio-frequency identification (RFID) tags, the exact location of an item stored in this truck could easily be known.

You can also think modular with regular materials when you're constructing your building. For instance, if you're building a deck, don't make it 9 feet long. Make it 10 feet instead because decking always comes in 2 foot increments. That way, you'll use the extra foot instead of chopping it off and throwing it away. After all, you'll save time by not needing to cut, and you've already paid for the extra foot of decking. Why waste it?

Durability is also something you need to think about when choosing materials. If you already know that the building you're working on is going to be remodeled every 5 years, don't use a granite counter top unless you already have plans for it after the 5 years is up. This idea is called design for disassembly. Make sure you have a way to take things apart cleanly so you can reuse them later.

Lean construction is all about efficiency and takes away extra steps, materials, and waste by changing how you build. For instance, just-in-time delivery of materials means you get what you need exactly when you need it. You don't have to store the materials anymore which saves you time (no need to stack things, just take them off the truck and put them in the building) and money (materials can be ruined by having them sit around the site which you will have to pay for to replace). Material tracking also reduces waste because you'll be able to find what you're looking for instead of buying more of the same thing. You can use radio-frequency identification (RFID) tags to find exactly what you're looking for in a crowded staging area.

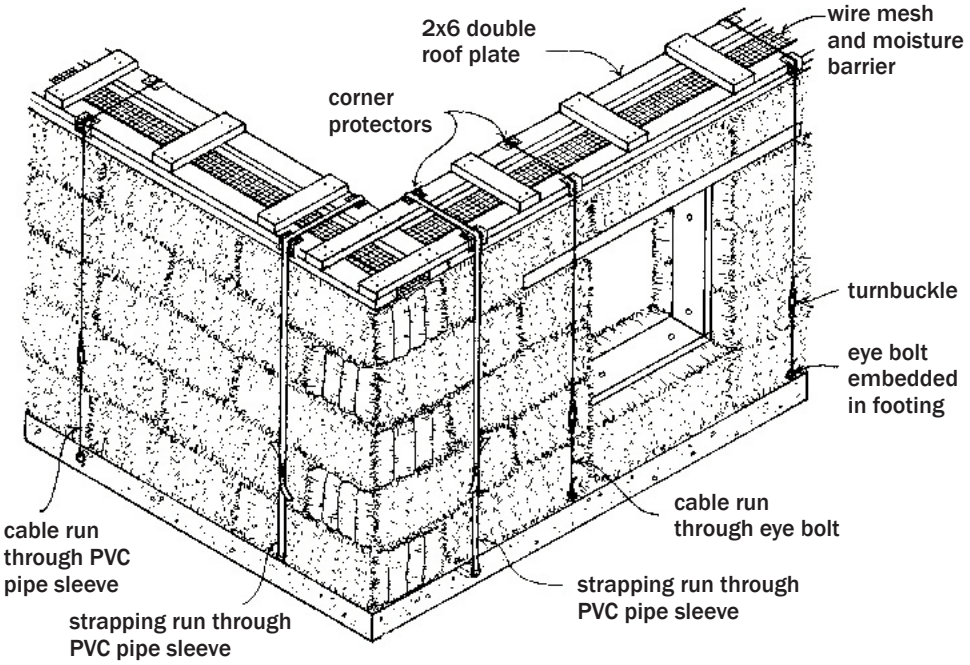
If materials must be stored on-site, be sure to protect them from rain and damage. If you don't, you will waste them and have to buy new materials to replace them. You should also do all of your cutting in one place. This way you'll know where all the remnants are and be more likely to use them rather than pulling a new piece of material from the stack.

Finding Better Places to Get Our Materials

Another way of reducing the impact that construction of a building has on the environment is to look for better places to get our materials. For instance, **rapidly renewable materials** are materials made from resources that grow back quickly. The U.S. Green Building Council (USGBC) says that rapidly renewable materials are those that can be sustainably harvested in less than a ten-year cycle. Bamboo, cellulose fiber, wool, cotton insulation, blown soy insulation, agrifiber, linoleum, wheatboard, strawboard, and cork are all rapidly renewable.

Other materials that help are those that are abundant (things we have a lot of). For instance, rammed earth, adobe, and cob construction all use dirt. Papercrete that uses wastepaper is another example.

Straw bale construction is both rapidly renewing and abundant. This can be used as the structure or as fill between studs, and is very good as insulation. You do need to be careful about waterproofing when using straw bale.





Strawbale construction is a rapidly renewable form of construction and is abundant.

As mentioned before, recycled materials are better than virgin materials. They tend to be composites, which means they are made by putting together many different materials. You can't really recycle composite materials, but they can be stronger, have less materials, and need less care than regular materials.

Recyclable and recycled are very different. Recyclable means that the item itself can be recycled when you're done with it, like a clear plastic drinking water bottle. Recycled means that the item was made with materials that have already been used like an aluminum soda can. Scientific Certification Systems is a company that makes sure the product actually has recycled material in it. Look for the SCS logo to be sure.

Sustainably harvested materials are also good. The **Forest Stewardship Council (FSC)** is an organization that looks at wood products to see if they are planted, cared for, and cut down in a way that makes sure there will be plenty of wood in the future. This textbook is FSC Certified. To find out more about FSC Certified wood products, visit *www.fsc.org*.



A label similar to this one will appear on products made from FSC Certified materials

Notes

Evergreen Recycling is a Republic Services Company in Las Vegas. They provide commercial, industrial, and construction recycling services.



Habitat for Humanity ReStore

Buy local, whenever you can. Using materials from local manufacturers reduces the amount of energy required for transportation. This use of energy to transport materials is one of the reasons why building materials affect the environment so much. Many times, local materials are less expensive than materials that come from far away. You can save time, and you can help local businesses.

Finding Better Places for Waste

The last thing you can do to make your materials use less harmful to the environment is to find better places for your building waste to go. For instance, you can work with a salvage company to take all the salvageable materials out of an existing building so they can be used in another project. You can call a non-profit like Habitat for Humanity (*www.habitat.org*) that can resell your salvaged and leftover materials. Habitat's store is called ReStore, and you can get a tax deduction for donating materials.

You should also think about recycling for materials that can't be salvaged. It's very easy to work with a company that will recycle your building waste. They will either give you a discount on waste removal or even pay you for your waste, if they can sell it.

Waste made of bio-based materials can be chipped, mulched, or composted on-site. Things like pallets, wood waste, and drywall can be used as a soil amendment to help your landscaping. Old concrete and masonry can also be ground and used as fill.

Keywords:

bio-based

biodegradable

biomimicry

downcycled

Forest Stewardship Council (FSC)

green roof

multi-functional

rapidly renewable materials

recyclable

renewable materials

salvaged

smart materials

11 Indoor Environment Best Practices

Making our indoor environment healthy

Most of us spend over 90% of our time indoors in buildings with HVAC (heating, ventilation and air conditioning) systems. These buildings are sealed to make sure they're efficient. At the same time, the modern materials used to build our buildings contain VOCs that are slowly being released as gases inside these airtight envelopes.

This is where **Sick Building Syndrome** comes from. People get headaches, become tired, and have other problems the longer they are in the building. If you have any water coming into the building, you can also get mold. All these ingredients put together are a recipe for disaster.

We oftentimes add to the problem because of the activities that take place inside buildings. Just breathing makes carbon dioxide (CO_2), and too much CO_2 makes people drowsy, less efficient, and can give them headaches. Smoking, cooking, or using printers and photocopiers all pollute the inside air. Of course, body odor and flatulence don't make things any better.

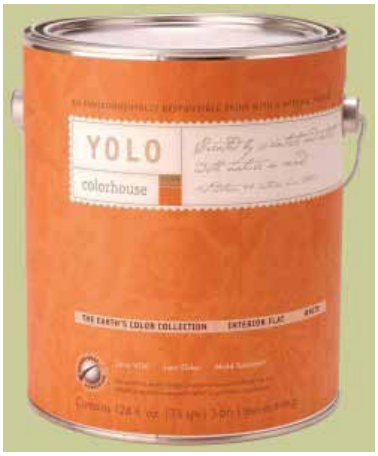




The location of a building can make a difference in terms of smells from outside sources, noise pollution, and the use of passive energy.

Notes

To achieve healthy **indoor environmental quality** within a building, we need to pay attention to the activities that take place within a building. First, we should look to stop problems at the source. Next, we should isolate those sources that pollute to prevent it from spreading. Then, we should use common sense to make spaces people can be happy in. Last, we should give the people in our buildings control over their space so they can be comfortable.



When purchasing paint, make sure it contains low or no VOC content

Stopping Problems at the Source

Many times the location where you construct your building makes a big difference in your indoor environmental quality. If you put your building upwind of power plants or garbage dumps, you won't have to worry about getting rid of the stink inside your building that can be caused by those sources. The same goes for noise pollution. Be sure to put the air intakes on your building away from places that pollute like your loading dock or your neighbor's air exhaust.

Be sure to choose paints, sealants, carpets and composites that don't **off gas** (give off toxic gasses). Many modern materials have **volatile organic compounds (VOCs)** like urea formaldehyde in them. Over time, these VOCs come out and poison the air. Make sure the materials you use have low or no VOC content.

For example, you can easily get paint that has low VOC content. These paints are water-based instead of solvent-based. Look for the GreenSeal logo on the can to make sure they are low VOC. You can find a list of Green Seal Certified paints and sealants at *www.greenseal.org.*

The Carpet and Rug Institute (CRI) has their Green Label Plus certification. They put this logo on carpets that have low or no VOC content. You can get a list of Green Label Plus certified carpets at *www.carpet-rug.org.*



Look for the Green Seal when purchasing paints and the CRI Green Seal when purchasing carpet.

By doing a good job of laying out your landscaping and drainage, you can avoid water coming into your building. This is important, because wherever there is warm air and water that collects, it is likely that mold and mildew will grow. You can avoid this by making sure you have good ventilation and the land around the building slopes away to make sure water doesn't come towards the building. You should also be sure you have a waterproof barrier between the soil and the part of your building that is heated.

Be careful about the plants you choose to put around your building. Many trees and shrubs give off huge amounts of pollen that can make people with allergies suffer. The pollen can also clog up air intakes and rainwater harvesting systems.

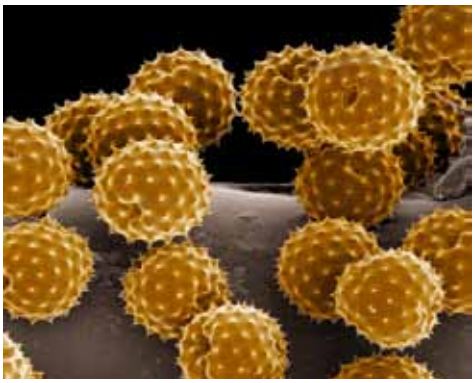
When you're building, make sure you do the jobs that create dust BEFORE the carpets, wall coverings, insulation, and ceiling tiles are put in. These are called absorptive finishes and should be protected from mold growth. Use just-in-time delivery if possible so there's less of a chance for them to get damaged. Also, never put in material that could be full of mold. Wait until the building shell is done and all the windows, doors, and roof is

in before putting in any materials that could stay moist. Make sure to give plenty of ventilation for curing of concrete and other finishes. If you don't, moisture will stay inside and cause problems in the future.

Choose finishes that are nonabsorptive like tile floors and painted walls. These finishes are easy to clean, water-resistant, and don't hold onto odors. You can also find finishes that have biocidal (germ-killing) or mold-resistant coatings. Natural linoleum is biocidal and is a good choice for your floors.

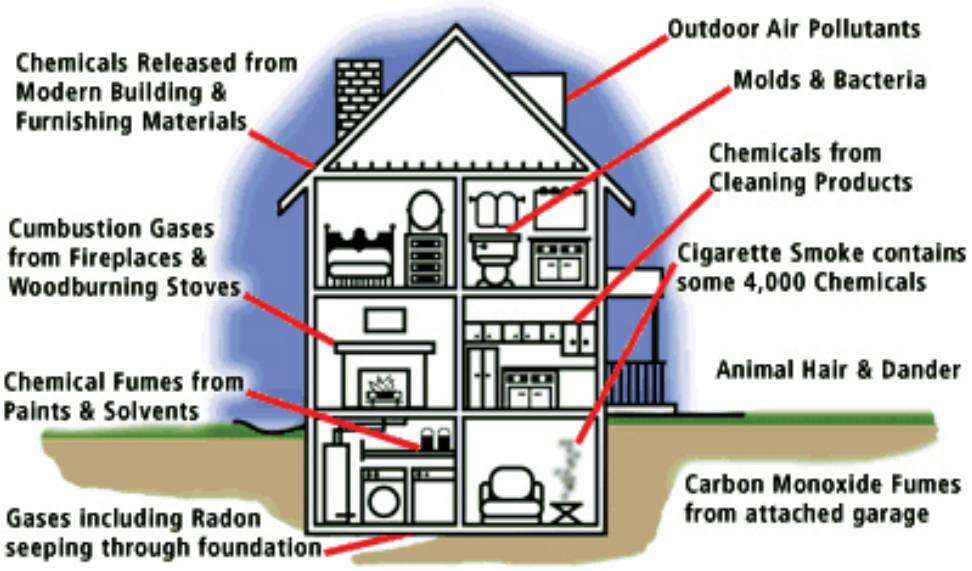
Once your building is done, be sure to keep it clean by vacuuming carpets often to get rid of dust mites. Don't use toxic chemicals to clean. Instead, use nontoxic, water-soluble cleaners.

Keep the humidity of your building between 30% and 50%. Look at your HVAC equipment regularly. This will help you fix problems before they create unhealthy conditions.









Sources of indoor irritants.

Notes



The louvers used on the outside of this building help to shield the sunlight from being too bright, or too hot, for the occupants.

Isolate and Ventilate

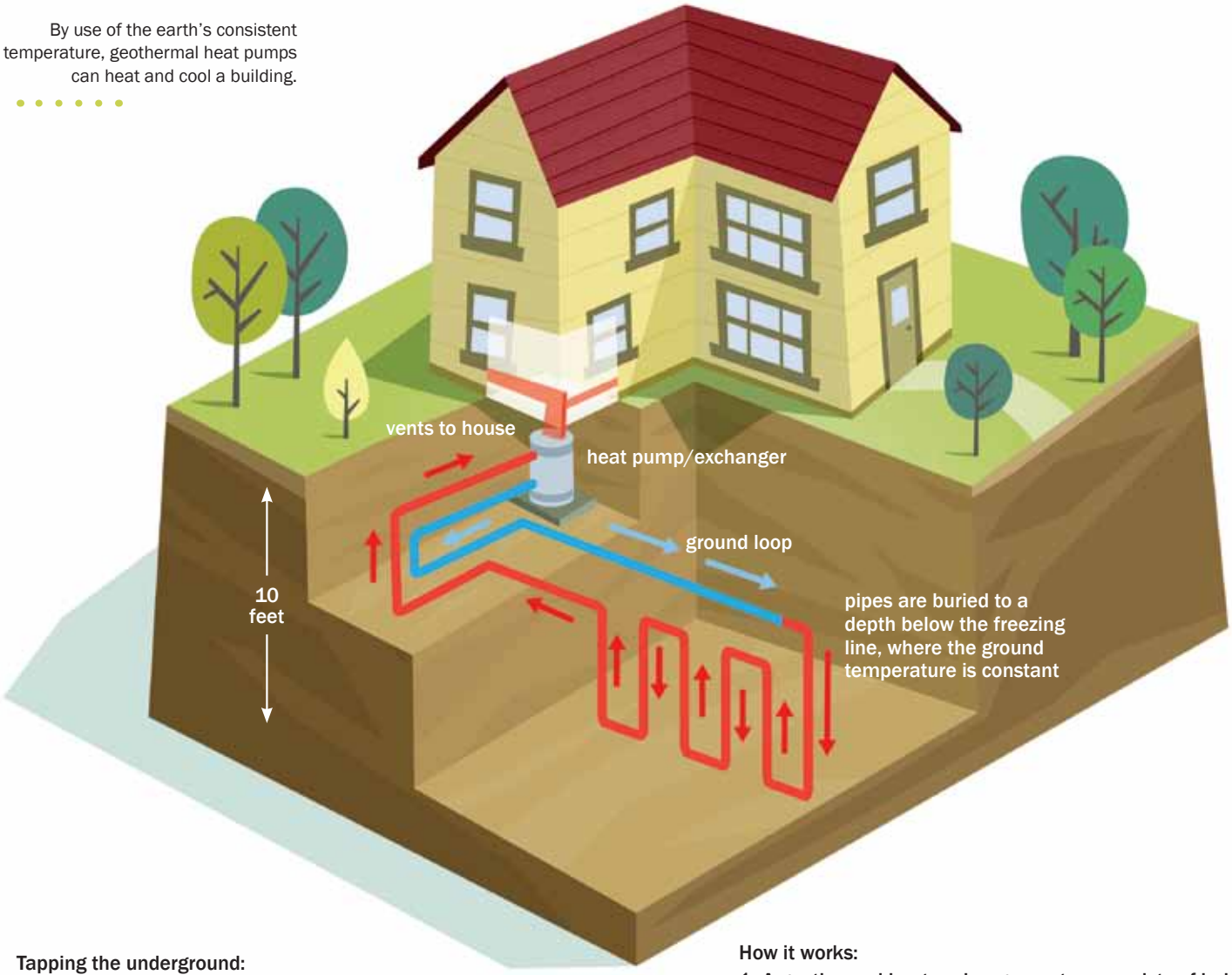
The next thing you can do to make sure you have good indoor environmental quality is to set apart or isolate the sources that pollute from the other parts of your building. This is especially important while you're building to make sure your building doesn't get polluted. You can use walk-off mats to get rid of pollutants on your workers' boots as they come into the building. Also, you can use separate ventilation for areas that have a lot of pollutants.

Any building activity can cause future indoor environmental quality problems, if you don't watch out. For instance, cutting and sanding give off lots of dust. Some materials give off VOCs as they cure. You must protect your HVAC system including all intakes, grills, and registers. Use plastic sheets and duct tape to seal all openings to the ducts or plenums. You should also seal off other parts of the building by covering entryways, stairways, and corridors.

Be sure to ventilate work areas so your workers can stay healthy. It's better to suck out the bad air, because that way it won't move into other parts of the building. This is called negative pressurization. Use a temporary ventilation system and not the building's HVAC system to avoid polluting the ductwork.

When you're finishing the building, be sure to take away all masking and sheeting you used to isolate the ventilation systems. You can then put in temporary high-efficiency filters before people start using the building. The minimum efficiency reporting value (MERV) rating is the way filters are measured. These filters will trap any pollution left over and stop them from getting into the HVAC system. Make sure to replace these filters before anyone starts using the building. The EPA says you should have a two-week flush

By use of the earth's consistent temperature, geothermal heat pumps can heat and cool a building.



Tapping the underground:

Geothermal heat pumps use stable ground temperatures for home heating and cooling. According to the EPA, the geothermal systems can save 40 to 70 percent on home heating and 20 to 50 percent on home cooling costs over conventional systems, although installation costs can be up to $12,000.

How it works:

1. A geothermal heat exchanger system consists of indoor heat pump equipment, a ground look, and a flow center to connect the indoor and outdoor equipment.
2. The ground loop geothermal system uses the constant temperature of the ground or water several feet underground.
3. The pump circulates temperature-sensitive fluid through the ground loop, which stays 50 to 60 degree year-round. In winter, warm fluid carries heat into the house. In summer, cool fluid draws heat out of the house.

Notes



This building at the Springs Preserve in Las Vegas is cooled by means of natural ventilation, much like the termite mound mentioned in chapter 10.

Keywords:

geothermal

indoor environmental quality

off gas

passive survivability

Sick Building Syndrome

volatile organic compounds (VOCs)

out when the building's ventilation system will run 24/7 with full outdoor air. This will help get rid of the off gases.

In your house, pollution comes mostly from paint, cleaners, personal care products, and building materials. Showering, doing the laundry, cooking and heating also impact indoor environmental quality.

Using Common Sense

Using common sense in your building means using natural lighting, ventilation, heating and cooling in a space that not only saves energy but also gives you a better indoor environmental quality.

Color is one of the easiest ways to make people feel good. Dark colors make people feel cramped, and rooms look smaller. Light colors make people feel more open and make rooms look bigger.

Natural daylight can also make people feel good. Too much of a good thing can also be a problem. For instance, heat from sunlight, fading of materials, and glare can happen when there's too much sunlight. You can get rid of these annoyances by using light shelves and louvers.

Natural ventilation can also make people feel good and save energy. Buildings at the Las Vegas Valley Water District's Springs Preserve are cooled this way.

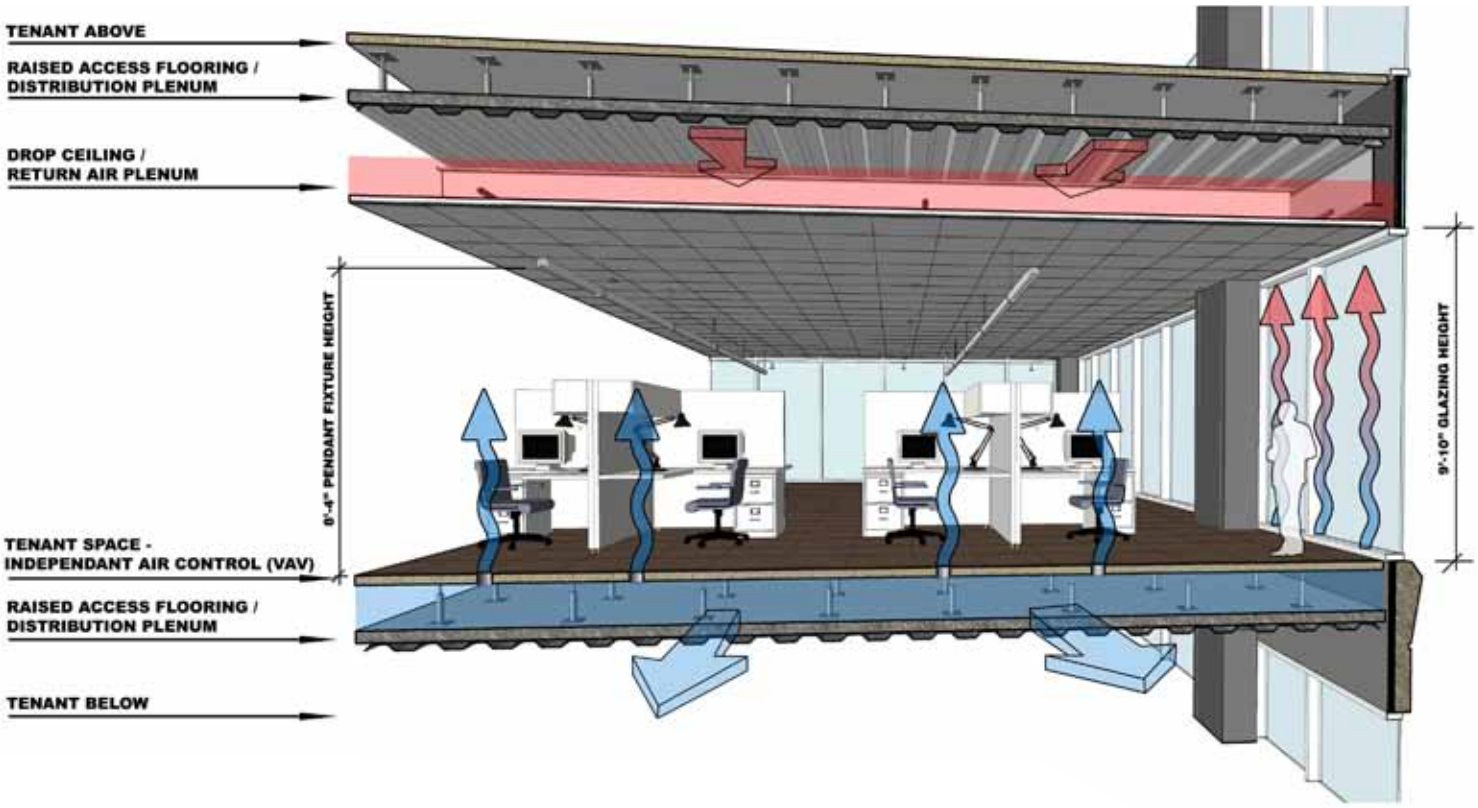
Geothermal heating and cooling uses the earth's consistent temperature below the frost line. These systems use pipes that go deep into the ground to get rid of heat during the summer and absorb heat in the winter. The fluid in these pipes is preheated or precooled by the earth and is used to heat and cool the building. Geothermal heat pumps can also heat water. They represent higher first costs but are very energy efficient. This translates to much lower operational costs and ultimately a lower life cycle cost.

Giving People in Your Building Control Over Their Space

When possible, you can improve Indoor Environmental Quality for the people in your building by giving them control over their individual space. Each individual person is different, so individual lighting, temperature, humidity, and ventilation controls help them to adjust things to make them happy. How?

Windows that they can open and close, a thermostat for them to choose their temperature, and under floor air distribution systems (UFADs) all give your people control over their space. When they have control, studies have shown that they are much happier, much more satisfied with their jobs, take fewer sick days, and are more productive.

Over the years, many buildings were equipped with HVAC systems that didn't work very well with uncontrolled fresh air inputs. This was one of the reasons buildings didn't have windows that could be opened. Nowadays however, the idea of **passive survivabil-**



Under floor air distribution systems are efficient and allow for a uniform flow of air throughout an entire space.

ity has become important. This is how well a building functions when all the power goes out. In an older building, a power outage meant that the HVAC system was totally shut down, and without ventilation, the people inside the building would really suffer. Modern HVAC systems are able to handle open windows, and a building where you can open windows and create drafts is much better at passive survivability. Also, in many places in the U.S., you can turn off your HVAC system and just open the windows to be comfortable. This can save you lots of money and keeps occupants in the building happy.

Under floor air distribution systems are one way to give your people control over their individual spaces. These systems allow people to control the temperature and ventilation at their own space. They also are more effective and give you a uniform flow of air through the entire space. You can put this together with modular office furniture so someone can quickly change their space to their liking. They are also less likely to use their own space heaters or fans that use power.

Notes

12 Integrated Strategies

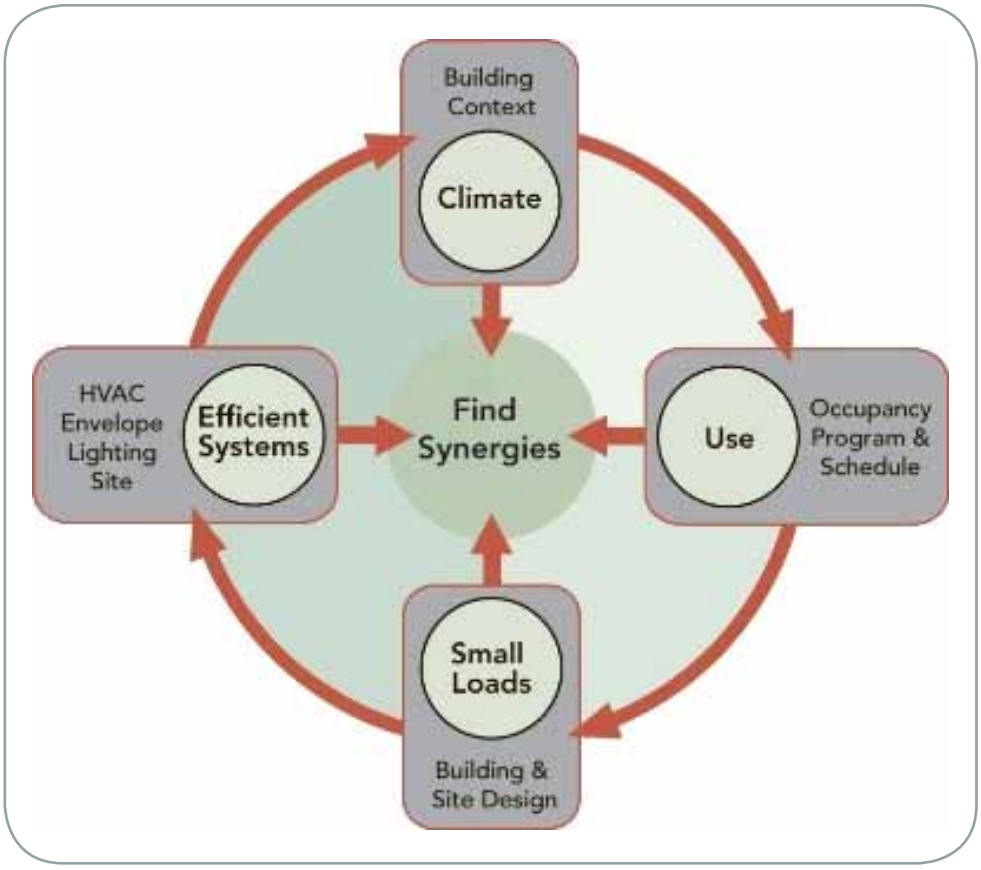
Putting everything together

So far, we have gone over different strategies that allow the construction of a building to be less harmful to the environment. The real trick is to come up with ways to meet our needs for the building and create processes that won't hurt natural ecosystems or deplete resources, and ensure that costs remain reasonable —all at the same time. The key is to make decisions while looking at the entire building process rather than just one system at a time. By doing this, you will create a better building that will cost less to build and give you long-term benefits.

Answering the Right Question

The first thing we should do is to make sure we're answering the right question. Many times builders jump to conclusions without figuring out what the real need is. For instance, someone may want to build a new house because their family is growing and they think their old house is getting too small. Instead of starting to design a new house, we should ask if remodeling and/or putting on an addition to the old house might actually be better.

The key to making sure you're answering the right question is not to look at the answers but to look at the problems the answers will solve. For instance, you want to send your friend a photograph ASAP and you're given a choice of sending it via FedEx or UPS overnight. "FedEX or UPS?" is not the right question. The right question is, "How do I share this photo with my friend ASAP?" With this question, your answer may be neither FedEX nor UPS, because you may decide that the best way is to scan it and then send it to your friend in an e-mail.



Integrated design takes into consideration the entire building process so that some features can be minimized, while others are maximized.

Taking Advantage of Relationships Between Systems

The next thing we should do is to take advantage of relationships between systems. In a building, all the systems are related. For instance, making a structure heavier means you have to make the foundation bigger. You can take advantage of these relationships by paying for a more expensive system through saving in another. This is called **integrated design**.

A good example is using high performance windows in your building envelope to give you daylighting. When you look at





High performance windows can cost more to purchase, but they are highly energy efficient and will save energy costs over time.

the cost of these windows alone, you will be paying more. These windows will help keep the heating and cooling lower and reduce the amount you spend on lighting. So the extra cost of these windows can be "paid for" by making the HVAC system smaller. In turn, a smaller HVAC system may allow you to use smaller pumps, fans and motors, and reduce the duct sizes. Then you can have lower floor to floor height, reducing the overall height of the building which means less materials and costs. Then you can also reduce the foundation since the building will now be lighter.

So you see, in the end the added cost of the **high-performance windows** was more than made up for by the reduction in costs of the integrated systems.

Using Services Instead of Products

Another option is to do what is called **dematerialization**. This means you use a service instead of buying a product to fulfill your needs. For example, you may rent a rarely used piece of equipment instead of buying it. So instead of taking on the responsibility (and potential liability) of owning something, you pay someone else to give you the benefits of that piece of equipment. When you're done with it, you just give it back.

Notes

Consider the Options

Keywords:

dematerialization

integrated design

high-performance windows

When you think about what you should do in a building project, it's important to make smart choices. Everything you do costs something.

One way to think about which choice to make is to ask yourself who has to do it: the building professional, the user, or both?

You should also think about whether the people who are using your building would have to change what they normally do to get what you want. Some changes are totally invisible to them. Others mean they have to do a lot. Usually, you can get what you want if you don't make people change what they normally do or their comfort level. For instance, asking the people in your building to turn down the heat to the point where they are uncomfortable will likely not last. Try to make choices where you don't make people change their habits but still get what you want.

Count All the Costs

Many times choices are made because of how much things cost up front (first costs). People forget to look at life cycle costs, and many green building systems get thrown out because the overall lifetime savings that the green system would have brought was never talked about.

Here are some other things to consider to make the cost of green buildings more attractive:

- Reduced costs of materials and waste disposal
- Reduced liability and environmental risk
- Happier building users with higher productivity, lower absenteeism, fewer sick building health problems, better moral, and less employee turnover
- Reduced operational and disposal costs
- Reuse of buildings that would otherwise be torn down

Each of these can mean a real savings for the project. Most of these costs are usually not counted as part of the project cost. If you were able to count these costs, then green projects would be much more attractive than traditional projects.

Review 2: Questions

1. The longest phase of a building's life cycle is _____.
   a. planning
   b. design
   c. construction
   d. operation and maintenance

2. The parts of a building that are paved are called _____.
   a. softscape
   b. hardscape
   c. landscape
   d. parkscape

3. A way to minimize the urban heat island effect is to _____.
   a. pave with asphalt
   b. choose light-colored pavement
   c. choose dark-colored pavement
   d. coat paved areas with a sealer

4. Most of the water on the planet is _____.
   a. groundwater
   b. ice
   c. salt water
   d. fresh water

5. Today, drinking water is commonly used to _____.
   a. dilute fossil fuels to make them less toxic
   b. flush toilets
   c. water lawns
   d. both b. and c.

6. The first step in greening water use is to _____.
   a. identify alternative toilets
   b. eliminate unnecessary uses
   c. install low-flow toilets
   d. install a water meter

7. A common technique to reduce the actual flow of water in faucets is _____.
   a. turning off the water
   b. aeration
   c. cooling
   d. heating

8. A green alternative source of water is _____.
   a. groundwater
   b. rainwater harvesting
   c. melting ice
   d. salt water

9. Systems that capture water and redirect it for use in irrigation or toilet flushing are _____.
   a. greywater systems
   b. blackwater systems
   c. brackish systems
   d. reclaim systems

10. A high albedo roof _____.
    a. absorbs solar energy
    b. is expensive
    c. reflects solar energy
    d. reduces light pollution

11. Green power generates energy from _____.
    a. nonrenewable resources
    b. coal
    c. renewable resources
    d. natural gas

12. Salvaged materials save the use of _____.
    a. raw materials
    b. labor
    c. equipment
    d. water

13. Material that is recycled from manufacturing processes is termed _____ waste.
    a. post-consumer
    b. consumer
    c. post-industrial
    d. pre-industrial

14. A smart material changes in response to _____.
    a. funding
    b. the user's needs
    c. environmental conditions
    d. a schedule

15. Rapidly renewable materials are _____.
    a. recycled
    b. bio-based
    c. unstable
    d. expensive

16. Modern finishes, like paint, release _____ as they age.
    a. air
    b. VOCs
    c. carbon
    d. energy

17. Passive survivability is the ability for a building to function when _____.
    a. the infrastructure goes down
    b. there is a labor strike
    c. there is a shortage of supplies
    d. the air is contaminated

18. How is passive cooling accomplished in a building?
    a. air conditioning
    b. use of shading
    c. location of building
    d. b and c

19. Why is it important to use sustainable materials?
    a. they are easier to produce
    b. it is more efficient and cheaper
    c. LEED doesn't require it
    d. to make sure we have enough materials for the future





- In Las Vegas, as well as nationwide, there are green building rating systems for both residential and commercial buildings.

Section 3: Tools to Build Better

13 Green Building Rating Systems

An Introduction to Green Building Rating Systems and LEED

Choosing which best practices to make your building less harmful to the environment can be very confusing. That's where green building rating systems can help. These rating systems can help you measure how your building will compare to other buildings. The rating systems are like a test, and buildings are graded on how well they protect the environment. These ratings are also important to the building's owners because it tells them, and the people who might be interested in buying their building important information. The rating systems can help you decide what best practices to use.

Right now there are two kinds of green building rating systems. They are local and national. Local systems have been made up by local builder associations and are mostly for houses (residential). There are over 25 local and regional housing rating systems in America. National systems cover the entire country and are for both houses (residential) and buildings (commercial).

The most important national system is the U.S. Green Building Council's **Leadership in Energy and Environmental Design (LEED)®** rating system. This was started in the early 1990s. LEED is the standard system being used in the U.S. for rating commercial buildings. Getting a LEED Silver certification is now a must for many government projects as well as private projects.

Other national **rating systems** for residential construction are LEED for Homes and the National Association of Home Builders' (NAHB) National Green Building Standard. On the commercial side, there is LEED (many versions) and Green Globes.

- U.S. Green Building Council logo.

The LEED Green Building Rating System

LEED was designed to be used for all different kinds of buildings in all regions of the U.S., therefore you can compare a LEED building in New York to another one in Las Vegas. It has four levels of **certification**. In order they are Certified, Silver, Gold and Platinum, with Platinum being the hardest to get.





An example of one of the four levels of LEED certificates.

Structure of LEED

LEED for New Construction (LEED-NC) was the first of the LEED rating systems put together. All the other LEED systems follow LEED-NC's structure. The structure is made up of seven different categories:

1. Sustainable Sites (SS) which covers the location of the project, where the building is built on the site, and how well you take care of the site when you're building the building.
2. Water Efficiency (WE) which covers the water used by your building and the waste water that it produces.
3. Energy and Atmosphere (AE) covers the use of energy by the building, where the energy comes from, and how it pollutes the air.
4. Materials and Resources (MR) covers where you get your building materials and what kind of materials you choose to use. It also looks at the amount of waste you make and where it goes, as well as if you were able to reuse any of an existing building.
5. Indoor Environmental Quality (EQ) covers your building's indoor environment and looks at ventilation to air quality to daylighting and views.
6. Innovation in Design (ID) gives you the chance to get credit for doing new things that really make a difference.
7. Regional Priority (RP) gives you the chance to get credit for doing things that are really important to your part of the country.

Each category is made of a number of credits and you can earn points in each of these credits. Five of the categories have prerequisites, that is, the things you have to do for your building to even be looked at for a certification. When you're done, you add up all your points and that tells you what level of certification your building gets.

LEED® for New Construction

Total Possible Points**	**110***
Sustainable Sites	26
Water Efficiency	10
Energy & Atmosphere	35
Materials & Resources	14
Indoor Environmental Quality	15

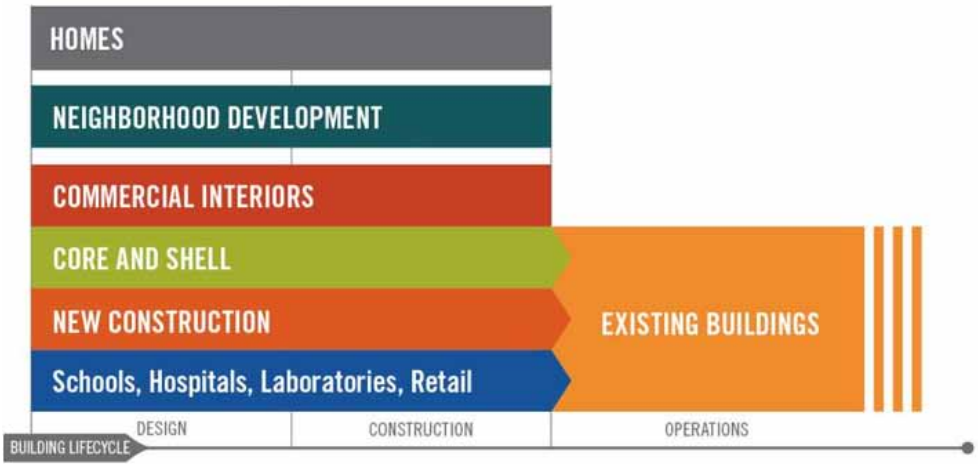
** Out of a possible 100 points + 10 bonus points*

*** Certified 40+ points, Silver 50+ points, Gold 60+ points, Platinum 80+ points*

Innovation in Design	6
Regional Priority	4

The total possible points for LEED new construction is 110. The breakdown of each category is listed in this diagram.

Notes



When the LEED system was first put together, it was targeted at new commercial construction. Now there are different rating systems for seven different kinds of buildings.

Types of Rating Systems and Levels of Certification

When they first put the LEED system together, it was targeted at new commercial construction. When the system got more popular, the USGBC had to come up with different rating systems for different kinds of buildings to keep things fair. Here is a list of the LEED rating systems today:

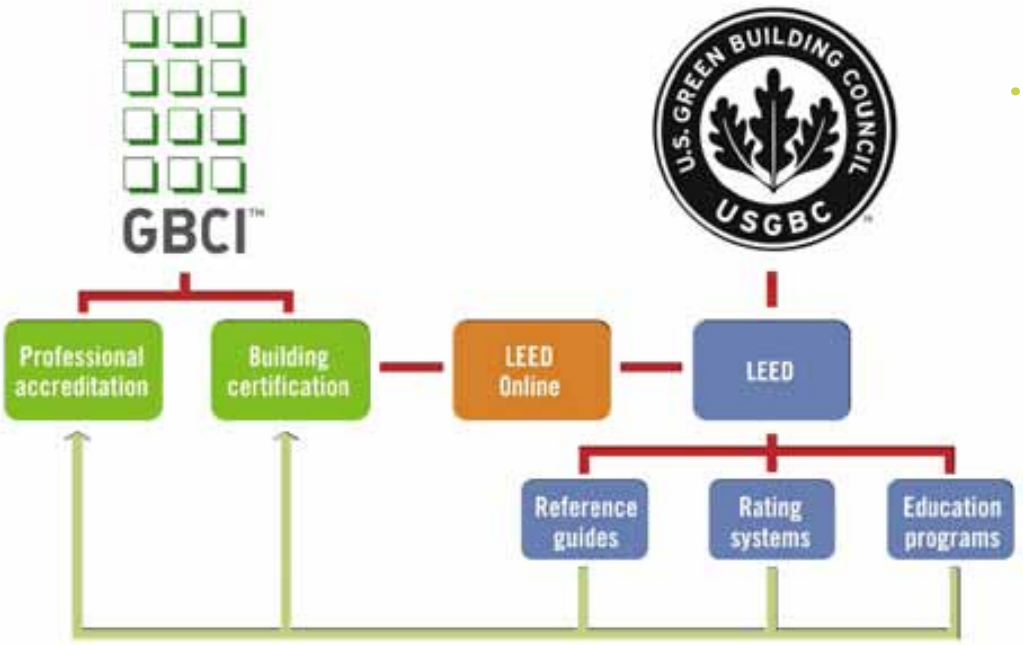
- Homes (LEED-H) is for residential building.
- Neighborhood Development (LEED-ND) is for residential and mixed-use groups of buildings.
- Commercial Interiors (LEED-CI) is for your space if you lease it inside a large building.
- Core and Shell (LEED-CS) is for the site and basic building that will lease the inside out to others.
- New Construction (LEED-NC) is for new buildings and buildings that are doing a major renovation.
- Schools, Healthcare, Retail (LEED-Schools, LEED-Healthcare, LEED-Retail) takes into account the special characteristics of these types of buildings.
- Existing Buildings (LEED-EB) is for buildings that didn't get rated while they were built but already have people using them.



Each of the four levels of LEED certification has its own points range. The level of certification a builder earns determines the type of LEED certification granted.

Under LEED Version 3 there are a total of 110 possible points and eight prerequisites or things that you have to do. Here is the scoring:

- Certified: 40 to 49 points
- Silver: 50 to 59 points
- Gold: 60 to 79 points
- Platinum: 80 points or more



This illustration is a broad look at the process of LEED building certification or LEED professional accreditation.

The Certification Process

Getting a building LEED certified takes many steps. Each step is done on the Internet using the LEED Online documentation system. The first step is to register your project and pay a fee. This will set you up in the database and you will be able to track all your documents online.

The next step is to document all the best practices you follow that allow you to get points. Usually, the project team will start this off by having a meeting to look at the LEED checklist and choose which credits to go after. This documentation work is ongoing and won't be completed until after you're done building and sometimes the first year after you move in.

You turn in the documentation to the USGBC for their review either when you're done with the design, and/or after you're done with construction of the building. When you submit or turn it in, you have to pay a review fee that is based on the size of your building. The USGBC then reviews your project and awards points.

Notes

LEED 2009 for New Construction and Major Renovations

Project Checklist

Project Name

Date

Sustainable Sites — Possible Points: 26

Y	?	N			
Y			Prereq 1	Construction Activity Pollution Prevention	
			Credit 1	Site Selection	1
			Credit 2	Development Density and Community Connectivity	5
			Credit 3	Brownfield Redevelopment	1
			Credit 4.1	Alternative Transportation—Public Transportation Access	6
			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
			Credit 4.4	Alternative Transportation—Parking Capacity	2
			Credit 5.1	Site Development—Protect or Restore Habitat	1
			Credit 5.2	Site Development—Maximize Open Space	1
			Credit 6.1	Stormwater Design—Quantity Control	1
			Credit 6.2	Stormwater Design—Quality Control	1
			Credit 7.1	Heat Island Effect—Non-roof	1
			Credit 7.2	Heat Island Effect—Roof	1
			Credit 8	Light Pollution Reduction	1

Water Efficiency — Possible Points: 10

Y	?	N			
Y			Prereq 1	Water Use Reduction—20% Reduction	
			Credit 1	Water Efficient Landscaping	2 to 4
			Credit 2	Innovative Wastewater Technologies	2
			Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere — Possible Points: 35

Y	?	N			
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
			Credit 1	Optimize Energy Performance	1 to 19
			Credit 2	On-Site Renewable Energy	1 to 7
			Credit 3	Enhanced Commissioning	2
			Credit 4	Enhanced Refrigerant Management	2
			Credit 5	Measurement and Verification	3
			Credit 6	Green Power	2

Materials and Resources — Possible Points: 14

Y	?	N			
Y			Prereq 1	Storage and Collection of Recyclables	
			Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
			Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
			Credit 2	Construction Waste Management	1 to 2
			Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	?	N			
			Credit 4	Recycled Content	1 to 2
			Credit 5	Regional Materials	1 to 2
			Credit 6	Rapidly Renewable Materials	1
			Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points: 15

Y	?	N			
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
			Credit 1	Outdoor Air Delivery Monitoring	1
			Credit 2	Increased Ventilation	1
			Credit 3.1	Construction IAQ Management Plan—During Construction	1
			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
			Credit 5	Indoor Chemical and Pollutant Source Control	1
			Credit 6.1	Controllability of Systems—Lighting	1
			Credit 6.2	Controllability of Systems—Thermal Comfort	1
			Credit 7.1	Thermal Comfort—Design	1
			Credit 7.2	Thermal Comfort—Verification	1
			Credit 8.1	Daylight and Views—Daylight	1
			Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process — Possible Points: 6

			Credit 1.1	Innovation in Design: Specific Title	1
			Credit 1.2	Innovation in Design: Specific Title	1
			Credit 1.3	Innovation in Design: Specific Title	1
			Credit 1.4	Innovation in Design: Specific Title	1
			Credit 1.5	Innovation in Design: Specific Title	1
			Credit 2	LEED Accredited Professional	1

Regional Priority Credits — Possible Points: 4

			Credit 1.1	Regional Priority: Specific Credit	1
			Credit 1.2	Regional Priority: Specific Credit	1
			Credit 1.3	Regional Priority: Specific Credit	1
			Credit 1.4	Regional Priority: Specific Credit	1

Total — Possible Points: 110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

Opposite page: This LEED project checklist gives the specifics regarding the categories and scoring for certification of a building.

Certification vs. Accreditation

Getting certification and accreditation mixed up happens a lot, when talking about LEED. In a nutshell, buildings are certified and people are accredited. You, as a building professional, can get a LEED accreditation by first becoming a LEED Green Associate, working two years, and then taking the Accreditation exam. When you pass, you become a LEED Accredited Professional (LEED AP). It is more important to know that there is no such thing as a LEED certified product.

Goals of the LEED Building Rating System

LEED has eight goals:

1. Select a good site for your building
2. Protect and restore your site
3. Provide amenities that encourage sustainable behavior
4. Use ecologically friendly resources
5. Find better waste sinks
6. Protect indoor environmental quality
7. Check systems to be sure they work
8. Look for ways to ensure best practices

1. Selecting the Site

The first goal of LEED is to help you pick a good site for your building. LEED rewards projects that don't build on vulnerable or ecologically valuable sites such as wetlands, habitats of threatened or endangered species, or flood plains. The rating system also rewards credits for building on sites that are already developed. LEED also encourages projects to build on brownfields.

2. Protecting and Restoring the Site

The second goal of LEED is to avoid harming the site or building while you're building. LEED also encourages ecological site restoration when you're done building. The construction team is very important in getting the credits and prerequisites for this goal. A prerequisite for all LEED projects is to follow the 2003 EPA Construction General Permit, which includes protecting the soil and water streams, and to keep dust and noise to a minimum.

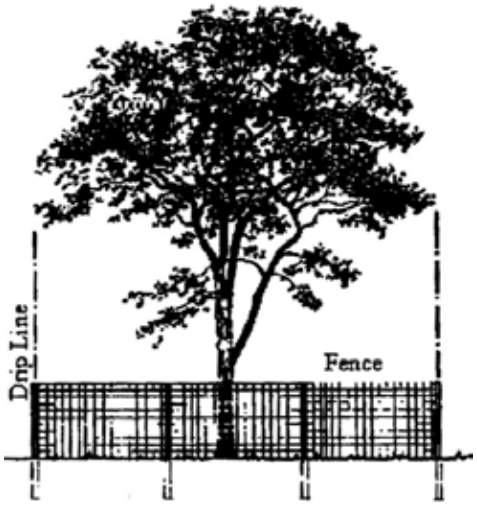
LEED encourages us to keep site disturbance, like digging, to a small area. You can help meet this requirement by knowing how far you can go outside your work area. Ask your supervisor to mark the boundaries and make sure you stay inside the lines.

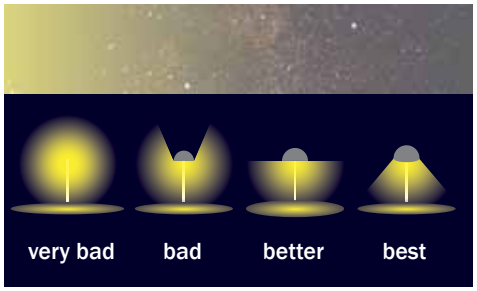
LEED rewards buildings that treat and retain storm water on-site to prevent polluting local streams and rivers. You must use



A building professional can become LEED AP accredited by first becoming a LEED Green Associate, working for at least 2 years, and then passing the Accreditation exam.

Notes





- *Top:* Putting up a fence at or past the drip line of a tree's outermost branches, helps to protect the root system during construction. *Above:* LEED gives points for reducing nighttime light pollution. This nighttime light pollution scale illustrates how "very bad" lighting uses too much energy (which costs more money) and lights up the night sky, whereas "best" lighting does not use as much energy (saving money) and does not light up the night sky.

erosion controls to prevent storm water runoff in general. You also have to take care of soil you've dug up, avoid any sedimentation, and avoid any dust leaving the site.

You should also put up protective fences when working near trees. Put the fence at or past the drip line of the tree's outermost branches to protect the root system. Tell your supervisor if you see unprotected trees in your work area.

Buildings that use light-colored roofs and parking areas get credit for reducing urban heat islands. If you remember, urban heat islands are places where the temperatures are warmer than normal because dark-colored pavements and buildings absorb heat from the sun.

LEED also gives points to projects that don't pollute the night sky with lights that don't have shades on them. **Light pollution** can confuse nocturnal animals and may not be good for people, either.

LEED also encourages you to reduce or eliminate chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and Halons from your building. These chemicals, usually found in air conditioners and refrigerators, kill ozone.

3. Providing Amenities that Promote Sustainable Behavior

The third goal of LEED is to promote green actions from the people in your building by providing amenities that will make it easier to be green. For example, you can encourage people to ride their bike to work by giving them showers and a place to park their bikes. Special parking slots for people who carpool or drive high efficiency cars encourage people to save gas. Water and energy performance credits require you to use efficient fixtures that save water and energy. Recycling areas encourage building occupants to recycle waste instead of just throwing it away. Giving smokers an isolated place to smoke protects nonsmokers from second-hand smoke.

4. Using Ecologically Friendly Resources

The fourth goal of LEED is to use the least harmful resource you can find. This can mean using graywater or rainwater for landscaping and toilet flushing. You can also use salvaged materials from an existing building, recycled materials, or rapidly renewable materials. Finding better sources for electricity is rewarded when you put in on-site power generation equipment. You can also get credit for buying green power from your utility.

- Given access, people will take advantage of being more green. For example, availability of bike racks, hybrid vehicle parking spots, and recycling containers to name a few.







Using local or regional materials is also rewarded. LEED considers materials purchased within a 500 mile radius from your site as regional.

You should carefully review all the specifications and understand all requirements before you go and buy green materials. Keep cut sheets and other documentation as evidence that you will need when you prepare the final LEED documentation.

Better sources for construction materials include:

- Salvaged or reused materials
- Materials with recycled content
- Materials from locations near the project site
- Rapidly renewable materials
- Wood products that are sustainably harvested

5. Finding Better Waste Sinks

The fifth goal of LEED is to reduce waste as much as possible and then recycle what's left over. Better sinks for construction waste is rewarded by LEED. If you are doing on-site recycling separation, be sure to put the waste in the right dumpster. Don't put garbage in the recycling. Make sure to keep treated wood separate from other materials. Keep anything with food on it out of cardboard dumpsters.

6. Protecting Indoor Environmental Quality

The sixth major goal of LEED is to design buildings that are healthy and comfortable for people by:

- Getting good indoor air quality through good design
- Keeping nonsmokers protected from second hand smoke
- Making sure spaces get good ventilation
- Restricting the use of materials that give off lots of VOCs
- Separating areas of the building that are likely to pollute from other areas
- Give people the control for temperature, ventilation, and lighting
- Getting thermal comfort for at least 80% of the people in the building
- Giving people natural daylighting and outside views as much as possible.

You can prevent moisture damage by storing materials in a protected staging area. Never install wet materials because that can create mold problems in your building even before it's finished.

7. Performing System Checks

The seventh goal of LEED is to make sure the systems you put in are actually working the way you wanted them to work. This checking is done through what's called commissioning, where someone else who is not the builder comes in to review, test, and balance the system.



Separation of recyclable materials is a must during construction.

Notes



This is an example of a Blower Door Test kit installed over an existing door in a building. The kits measure the air exchange rate of an existing home or building. There will be a Blower Door Test performed on the Green Mobile Classroom.

Keywords:

Leadership in Energy and Environmental Design (LEED)

certification

LEED Accredited Professional

light pollution

rating systems

LEED also rewards you for verifying and maintaining the performance of your systems. You can do this by putting in control systems that measure performance. These control systems also automatically adjust the systems within your building to make sure you're getting the most out of them. You can get points for using CO2 monitors to control the amount of ventilation in your building and for designing your building to keep your people comfortable. You can also get a credit for doing a yearly survey after moving in. This is to be sure that everyone's still comfortable after the building has been in use for a while.

8. Looking for Better Ways to Do Things

The eighth goal of LEED is to encourage innovation. If you find new ways to make buildings green that are not in the rating system, you can get credit for it. For instance, an innovation credit was given for green housekeeping using nontoxic, bio-based cleaners. You can also get innovation credits for going beyond the system credits in areas like water efficiency, energy, materials use, and waste diversion. You can get a point for having a **LEED Accredited Professional** as part of your project team. In the same way, you can also get a point for having a certain percentage of your building team be Green Advantage Certified practitioners.

If you have a good idea, don't be afraid to speak up. Good ideas come from everywhere.

In Las Vegas there are several successful LEED projects. They include but are not limited to: City Center, Lexus of Las Vegas, Lied Animal Shelter, the Miley Achievement Center, the Springs Preserve, Molasky Corporate Center, the Vegas PBS Educational Technology Campus, the North Las Vegas City Hall, Cashman Equipment, and the Ralph and Betty Engelstad Boys and Girls Club Clubhouse.



As consumers, just as we read food labels, it is important to read and understand the labels pertaining to products that are safe for the environment. For example, what does "planet-friendly" actually mean?

14 Doing My Part on a LEED Project

Documentation and Construction

LEED Documentation

Dealing with the documentation for a LEED project is difficult. The person assigned to handling the documentation will be very thankful if your materials and progress on-site is well documented. Be sure you know what information they'll need from you before you begin building, and ask questions if you're not sure.

Here is a typical form used to track the information that is used to do the LEED calculations. Notice that each material must have its cost to be on the worksheet. For recycled content, you need the percent by weight of both post-consumer and post-industrial recycled content for all parts of the material. This can get complicated very fast for materials like carpet and wallpaper, which are made of many different materials.

This is an example of a typical form used by LEED to calculate percentages of materials used during construction.

Table L-3. CSI Divisions 03-10, 31.60.00, 32.10.00, 32.30.00, 32.90.00 Materials

Fill in all columns with applicable material data for all attempted credits among MR Credits 3-7. Exclude materials included in MR Credit 1.1 or 1.2: Building Reuse and all mechanical, electrical and plumbing (MEP) components and equipment.

Note: This table will carry material data across MR Credits 3-7 to ensure consistent documentation; however, the summary table in this form only pertains to this credit. For more column information, hover cursor over abbreviated column heading.

Total CSI Divisions 03-10, 31.60.00, 32.10.00, 32.30.00, and 32.90.00 Materials Cost ($)	

General				MRc3	MRc4		MR Credit 5				MRc6		MRc7		20%
Name / Description of Material / Item	Cost per Item ($)	Number of Items Purchased	Manufacturer / Vendor Name	% Salvaged / Reused *	% Post	% Pre	% Reg	Extc Dist (miles) **	Mfc Dist (miles) **	Location Info Source(s)	% Ren	Ren Material Type	% New Wood	% FSC	Cut ***
Total ($)	0	Sustainable criteria value ($)		0	0		0				0		0		
Sustainable criteria percentage (%)				0	0		0				0		0		

Add Row | Delete Row

Table Indicator: Incomplete

* *Cost, in the case of a salvaged item, can be the actual or replacement value, but must be consistent with the cost used to calculate the total materials cost for the project.*

** *In lieu of exact distances, estimated distances may be used. If estimated distances are used, upload the manufacturer's letter stating that the material/ product was manufactured and extracted/recovered/harvested within 500 miles of the project site.*

*** *Product cutsheets uploaded for documentation of credit compliance should include material data for all applicable credits.*

Materials claimed for MR Credit 3 may not be applied to MR Credits 1, 2, 4, 6 or 7. Please select the appropriate credit and enter data in that credit column only.

Notes

LEED 2009 for New Construction and Major Renovation

MR CREDIT 2: CONSTRUCTION WASTE MANAGEMENT

All fields and uploads are required unless otherwise noted.

ALL OPTIONS

This form has been modified for offline access. Offline forms are for reference only. Modified fields and instructions pertaining to offline form functionality are indicated in purple

Unit of measurement:
Note: Units must be consistent throughout credit.

Tons
Cubic Yards

Table MRc2-1. Construction Waste Management

Complete the following table for all construction waste. For site-separated waste, list each waste type. For commingled waste, designate it as such using the drop down selection. Documentation is required for commingled waste only.

Construction Waste Description	Diverted or Landfill Waste	Commingled Waste		Total Waste	Hauler or Location
		Percentage Diverted [%]	Doc Provided		
			☐		
Total construction waste				0	
Total waste diverted from landfill				0	
Total percentage of construction waste diverted from landfill (%) *Must be at least 50% to achieve 1 point or 75% to achieve 2 points*					

Add Row | Delete Row

If 100% of commingled waste is diverted from landfill, select "Diverted" in the "Diverted or Landfill Waste" column

I have reviewed the information above and it is accurate to the best of my knowledge.

REQUIRED SIGNATORY
Initial Here:
CONTRACTOR

☐ Land-clearing debris and soil have not been included in calculations.

For Reference Only

- With any new construction or major renovation, construction waste must be monitored.

Another tough credit to calculate is the Regional Materials credit. This credit asks you for the origin of the material and it's components. A material only counts when it and all it's components come from within a 500-mile radius of the site, which is considered regional.

Materials credits are calculated based on percent of total materials cost, it would make sense to just look at materials that make up a large part of the total materials cost. For instance, steel and concrete often make up the most expensive parts of the whole project, and can contain lots of recycled content.

LEED Construction

There are ways you can mess up on a LEED project. Three of the most serious mistakes are poor execution of credit requirements, poor documentation, and not coordinating with other trades.

Poor Execution of Credit Requirements

Even when you know exactly what you need to do to get a **LEED credit**, it's not always easy to actually do it. Some credits are especially hard to get. For example, the Construction Indoor Air Quality Management Plan makes you protect the indoor air quality of the building by isolating your work area and keeping it clean. If you don't continue to do it correctly, even if you set it up correctly, you won't get the credit.

A potentially difficult prerequisite is for Construction Activity Pollution Prevention. If this is not done correctly, then it doesn't matter how many other points you get because your project's LEED certification will be denied. If you're the one who's in charge of this, be sure you know exactly what you need to do, and then check and repair the systems you set up. If you're not in charge, tell your supervisor if you see any problems so that they can be resolved.

Another credit that you need to watch out for is the Construction Waste Management credit. Make sure you understand what the project's recycling goals are and how you're going to get there. Ask questions in meetings, especially when you see that other workers are not recycling the correct way. If you see anything that doesn't belong in a recycling bin, tell your supervisor.

Buying green materials can also be hard. The specifications for a LEED project have been very carefully created in order to meet the project goals. You have to follow them exactly. Ask your suppliers for documentation to support the materials you buy. Don't just run down to the hardware store and buy any old product, because it may not fit the specifications as required.

Poor Documentation

The second mistake that could bring disaster is irresponsible documentation. You need a lot of information to certify a LEED project. You need to know the contents of materials and their costs. Keeping track of this information as it happens can help you provide the information you'll need when it comes time to submit.

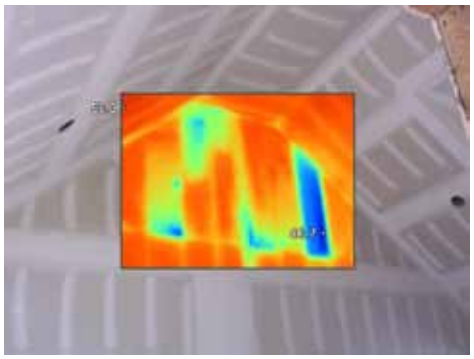
One credit that needs careful documentation is the Construction Waste Management credit. For this, you need to show where ALL of the waste your project created has gone. You need this information to figure out the percentage of waste that was diverted from going to a landfill. You must save all your landfill tipping receipts and bills of lading from the recycling companies. It is very helpful to set up a way of tracking this information.

Another credit that needs careful documentation is the Low-Emitting Materials credit. Here you need to show that all the carpets, paints, sealants, adhesives, and composite wood and agrifiber products met the requirements before they were brought to the site. A good way to track this is to keep a listing of the products you used and their labeled levels of VOCs. For carpets and paints that have certification labels, be sure to read it.

You can do the same thing for the other credits that talk about green materials. Make sure to keep a cut sheet or other data showing contents for each product. Also be sure to note the costs of each product.

Notes

Not Coordinating with Other Trades





- Monitored coordination between all trades during construction helps to alleviate any post construction problems such as thermal bridging (*top*) and structural notches (*above*).

The third big mistake is not making sure the other trades are talking with each other. Not only do you run the risk of not getting your LEED certification, you run the risk of a poorly constructed building as an end product.

Energy usage is what gets hurt the most when you don't coordinate. All the cracks and gaps between materials put in by different trades allow the heated or cooled air to leak out from the building. These leaks can cost lots of money.

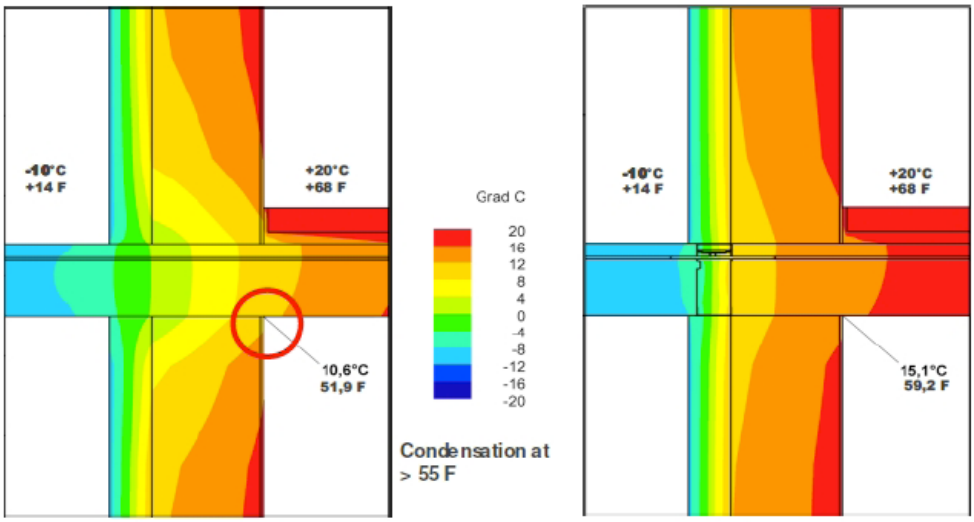
Coordination problems can also create thermal bridging. Thermal bridging is what happens when high conductivity materials like metal and wood pass through a wall without a thermal break. These materials then act like pipelines for cold or heat to pass through the building's envelope. This then creates cold spots, and cold spots create areas of moisture which then can lead to mold growth.

A building's structure can also be affected by lack of coordination. When you've got lots of trades with the systems they need to install in a small space, you're going to get conflicts. Plumbers or electricians can put notches in structural members when they're trying to run their lines. These notches could lead to the failure of the structural member!

Another problem that happens a lot is having the insulation get compressed or moved. Insulation doesn't work as well when it's compressed or when it's moved to the wrong place. Insulation also won't do its job when it gets wet. Make sure to check all insulation before the drywall goes up. This gives you time to fix things while the walls are still open.

Remember, you are a member of a team. Speak up if you see anything that might risk your project's certification. Tell your supervisor if you see problems with storm water management, dust containment, or any other protection.

Thermal Break Technology



Keywords:

LEED credit

Review 3: Questions

1. The LEED rating system was developed by the _____.
   a. Lean Building Institute
   b. U.S. Green Building Council
   c. Sustainable Built Environment Initiative
   d. United Kingdom

2. When can a project team submit documentation for LEED credits?
   a. Only at the beginning of construction
   b. Only at the end of construction
   c. Only at the end of design
   d. Both at the end of design and construction

3. A prerequisite for all LEED projects is to meet all the requirements of the _____.
   a. Lean Construction Institute
   b. EPA General Construction Permit
   c. LEED requirements
   d. local building code

4. During construction, trees should be protected with _____ around the trunk of the tree.
   a. tree protection fencing
   b. trenching
   c. erosion controls
   d. bark wrap

5. Construction projects can earn a Materials and Resources Credit by _____.
   a. using graywater
   b. using carbon monoxide monitors
   c. sending sewage to onsite treatment systems
   d. separating construction waste for recycling

6. Materials should not be installed in a building if they are _____.
   a. inefficient
   b. unsustainable
   c. damp or wet
   d. nonrenewable

7. The LEED credits that reward projects for finding new ways to be green are the _____.
   a. Innovation Credits
   b. Sustainable Sites Credits
   c. Water Efficiency Credits
   d. Materials and Resources Credits

8. A common pitfall to LEED certification during construction is _____.
   a. lack of coordination between the trades
   b. smoking on the job site
   c. not following directions
   d. using nonrenewable materials

9. Thermal bridging can create areas where _____ can condense.
   a. air
   b. moisture
   c. solvents
   d. carbon

10. When installing insulation be sure to _____.
    a. only use fiberglass batting
    b. compress the batting to fit spaces
    c. cut the batting to fit spaces
    d. only use spray-in foam

Notes

Section 4: Green Career Pathways

15 Your Green Advantage

Next steps





Top: Student performing the Eco-STEM micro-house lab exercise. *Above:* The Solar PV training panel. *Below:* The back and one side of the Green Mobile Classroom



Demand for greener products and services is increasing every day. Building owners and their users want their facilities to be more energy efficient, healthier, and more environmentally sensitive. Therefore, the job market for professionals with green credentials is also growing. Green credentials prove that you have the professional knowledge and skills to reduce the environmental impact of your work.

Some of the Benefits of Having Green Credentials are:

- You become more valuable and marketable in the new green economy.
- You will stand out from your peers who don't have any green credentials.
- You can prove that your green knowledge is practical, field-related, and up to date.
- Building owners, facility operators, developers and architects are beginning to require workers to have green credentials on their projects.
- You will be able to list your green credentials after your name on your business cards, e-mails, social media, etc.

The "What's it Mean to be Green?" certification is your first step on a green career pathway. There are other relevant green credentials you can pursue after you complete your first step. Below are a few examples.

- Green Advantage Incorporated produces certification programs for building sector practitioners and organizations, and promotes green building construction.
- The Center for Energy Workforce Development develops certifications and other solutions to address the coming workforce shortage in the utility industry.
- The Building Performance Institute and the Residential Energy Services Network both develop national standards and credentials for residential energy efficiency retrofit work.
- The United States Green Building Council offers LEED professional accreditations for individuals and LEED rating and certification for buildings.
- The Association of Energy Engineers provides certification programs in the areas of energy engineering and energy management.

Visit the following websites and take notes of additional useful information regarding the topics discussed so far in the "What's it Mean to be Green?" textbook:

Building America (*www.eere.energy.gov*)
Building Green (*www.buildinggreen.com*)
Environmental Protection Agency (*www.epa.gov*)
Energy Star (*www.energystar.gov*)
Green Globes (*www.greenglobes.com*)

Green Seal (*www.greenseal.org*)
Greener Building (*www.greenerbuilding.org*)
Health House (*www.healthhouse.org*)
NAHB Green Building (*www.nahbgreen.org*)
National Fenestration Rating Council (*www.nfrc.org*)
Whole Building Design Guide (*www.wbdg.org*)

The Exam and the Hands-on Experience

Your next step is to take the "What's it Mean to be Green?" exam! After you pass the exam, you will receive your course certificate and your commemorative T-shirt marking this milestone in your green career pathway. You then will be scheduled to attend the hands-on experience in our green mobile classroom: The Green Monster Truck!

The day you attend the hands-on experience you will be expected to wear your "What's it Mean to be Green?" T-shirt and to bring your textbook with you. Inside the mobile classroom you will put into practice all the green knowledge you have accumulated so far. You will engage in practical lab exercises and interactive activities focused around energy efficiency and renewable energy. You and your peers will even "wire up" a renewable energy system and "power up" a sound system without being connected to the utility grid (you can bring your own tunes if you want!). After you successfully complete the hands-on experience you will receive your skill achievement certificate to commemorate another milestone in your green career pathway.

Preparing for the Exam

- Review this textbook and go over your notes.
- Go over the review questions.
- Put the main ideas and information in the notes section of your textbook so that you can quickly review it, this makes it easier to retain the key concepts that will be in the exam.
- Get at least 8 hours of sleep the night before the exam.
- Set your alarm and have a back-up alarm set as well.
- Make sure you eat something before the exam.
- Try to show up at least 5 minutes before the exam will start.
- Go to the bathroom before taking the exam.
- Make sure you have the extras you might need like an extra pencil, tissues, etc.

Taking the Exam

- Although you will have limited time for the exam, don't feel rushed. Take your time to read the questions thoroughly and answer carefully.
- Read the whole question before you answer. Don't jump to conclusions.
- Come up with an answer in your head before looking at the possible answers, this way the choices given on the test won't throw you off or trick you.
- For multiple-choice questions, throw out the obviously wrong answers first. Then look at the remaining answers and decide which one is the best.
- If there seems to be more than one best answer, choose the most correct and most complete answer.
- Read all the answer choices before choosing your answer with the possible exception of cases where you have "All of the above" or "None of the above" choices.
- When you have an "All of the above" choice and you are sure that one of the options above is not the right answer, make sure you don't choose "All of the above".
- When you have a "None of the above" choice and you are sure that one of the options above is the right answer, make sure you don't choose "None of the above".
- A positive choice is more likely to be true than negative.
- If you are spending too much time on one question, skip it and come back to it after you have tried to answer all the

Notes

questions on the exam. Leave the space blank and mark your spot, so you can come back to it later.

- Answer all questions. If you don't know the answer for sure, make your best educated guess. You won't be penalized for wrong answers.
- If you finish the exam early, check your work at least once before you turn it in.
- You do not get extra points for finishing early.

Good luck!

Preparing for the Hands-on Experience

1. Review this textbook and go over your notes
2. Go over the review questions
3. Get plenty of sleep the night before you experience the Green Monster Truck!
4. Make sure you eat something before you show up since it will be at least a 4-hour activity.

During the Hands-on Experience

- Wear your "What's it mean to be Green?" T-shirt, a pair of jeans or other comfortable pants (no shorts), and closed toe shoes.
- Be ready, this will involve hands-on activities.
- Pay close attention to the instructor at all times.
- Follow instructions carefully and promptly.
- Always keep safety in mind.
- Have fun!





Top: Student wiring up the Solar PV system.
Above: Eco-STEM micro-houses



The Green Mobile Classroom with the hydraulic system in use!

Index

acid rain 8
aeration 32
albedo 29
alternative energy 20
aquifer depletion 8, 31
bio-base 44
biodegradable 44
biodiversity 7
biofuel 29
biomimicry 46
bioswale 28
blackout 40
blackwater 34
brownfield 26
brownout 40
building commissioning 39
building's envelope 37
carbon cycle 14
carbon dioxide 6
carbon footprint 6
chlorofluorocarbons 8, 22
climate change 6
compact fluorescent lights (CFLs) 17
conservation 17
constructed wetland 35
Copenhagen Accord 6
daylighting 36
deforestation 7
dematerialization 61
desertification 8
downcycled 44
ecosystems 7
electric grid 40
embodied energy 10
Energy Star 33
environmental impact 22
first costs 18
Forest Stewardship Council (FSC) 51
fossil fuels 6
fuel efficient 19
geothermal 20, 58
global warming 6
green roof 47
greenhouse effect 14
greenhouse gases 6
greywater 34
hardscape 28
heat island effect 29
heating, ventilation and air conditioning (HVAC) 39
high performance windows 61
hybrids 19
hydrologic cycle 31
hydropower 20
indoor environmental quality 54
integrated design 60
invasive plants 28
Leadership in Energy and Environmental Design (LEED) 64
LEED Accredited Professional 72
LEED certification 64
LEED credit 75
life cycle costs 18
light emitting diode (LED) 18
light pollution 70
living machines 34
load balancing 40
multi-functional 43
native plants 28
off gas 54
operational costs 18
ozone depletion 8
ozone layer 8
passive solar design 27
passive survivability 58
peak shaving 40
phantom loading 17
photovoltaic 20
rain garden 28
rainwater harvesting 34
rapidly renewable materials 50
rating systems 64
recyclable 51
reduce, reuse, recycle 19
renewable energy 20
renewable materials 43
rethink 20
retrofitting 39
salvaged 43
sick building syndrome 22, 53
smart materials 48
softscape 28
solar 20
storm water 35
thermal mass 36
thermal pollution 29
volatile organic compounds (VOCs) 22, 54
wind turbines 20

Notes

Notes

Notes

Notes


o-friendly
ying recycled
oducts
nserve
ssive energy
ttles
ink your habits
reuse
water
repurposing
conservation
recycle
carpooling
energy
efficiency
sustainability
using public transit
xeriscapin
wind energy
bei
disposing of waste properly


environmental
eco-frien
awareness
using
buying rec
energy conservation
less
products
using
rainwater
energy
conserve
eff
solar
harvesting
use less
passive
energy
refilling water bottles
us
ng resourceful
installing
rethink you
LED lightbulbs



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