

April 28, 2008



National Center for Appropriate Technology

Community Development and Housing Practitioners Conference
Green Building Techniques for Rehab and Retrofits

Dale Horton, Architect
 NCAT Sustainable Energy Program Manager



National Center for Appropriate Technology



For almost 30 years NCAT has been serving people by promoting and demonstrating energy efficiency, renewable energy, and sustainable agriculture.

Offices:
 Montana
 California
 Pennsylvania
 Iowa
 Arkansas
 Louisiana



Presentation at www.ncat.org
 Go to "Sustainable Energy" then "Presentations/Downloads"

Why is **Green Building** important to community developers?

It connects the well-being of people with the well being of the environment.



Social & Economic Justice → Green Building → Environmental Sustainability

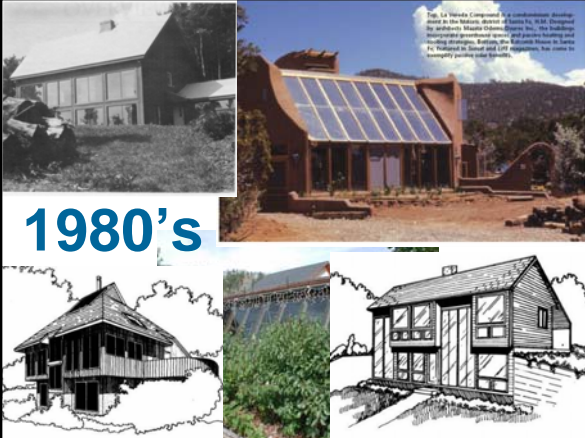
1973 Arab Oil Embargo
 Richard Nixon promised "Project Independence" would free America from energy imports by 1980.



1970's

In 1977 Jimmy Carter introduced his energy program as the "moral equivalent of war."

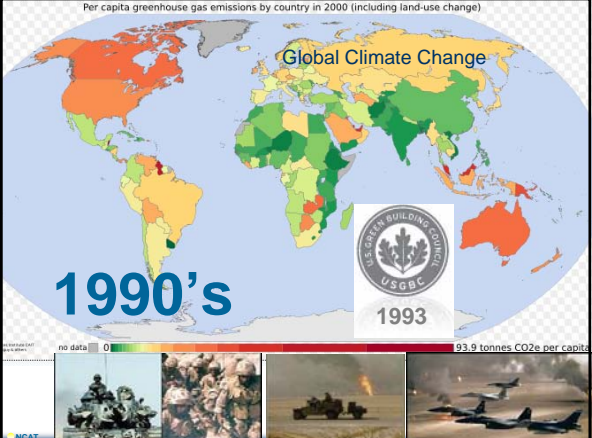
1980's



1980's

Per capita greenhouse gas emissions by country in 2000 (including land-use change)

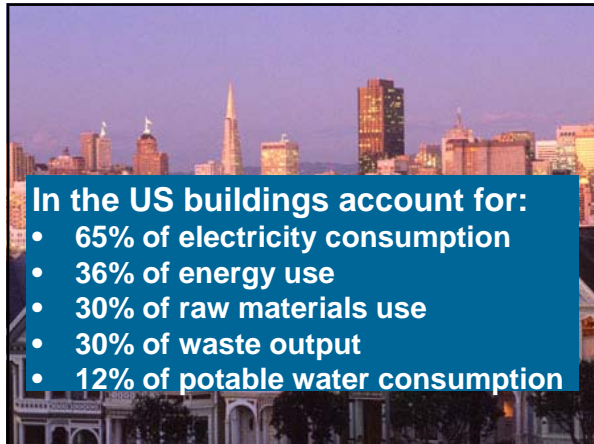
Global Climate Change



1990's

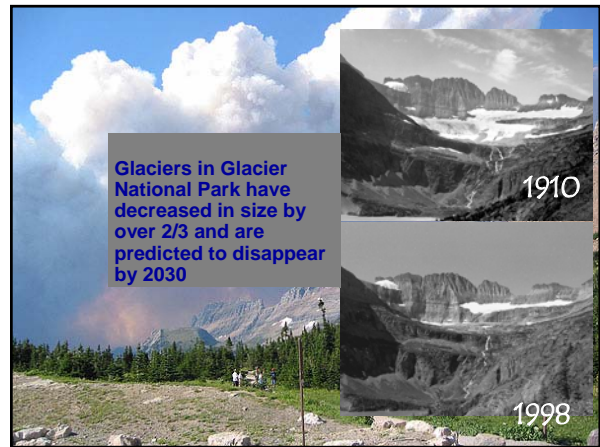
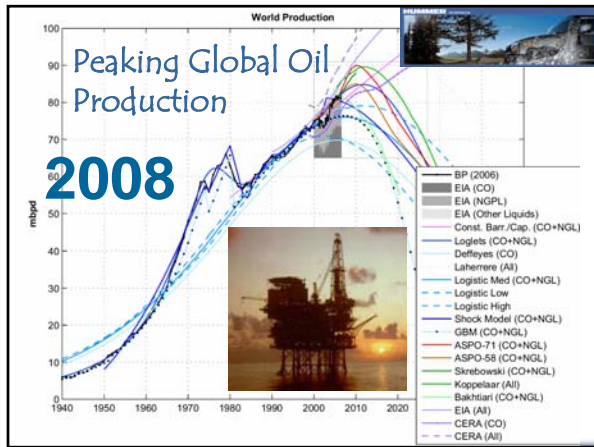
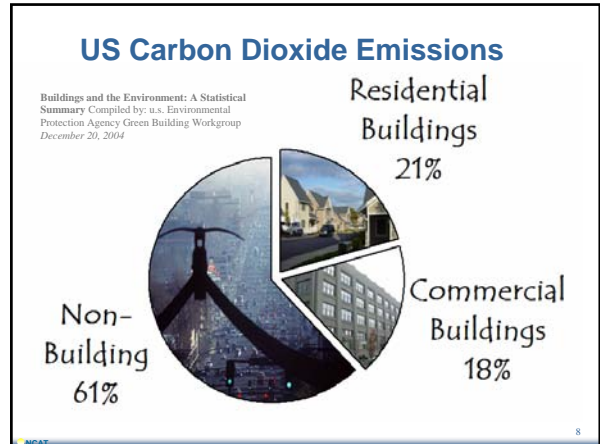
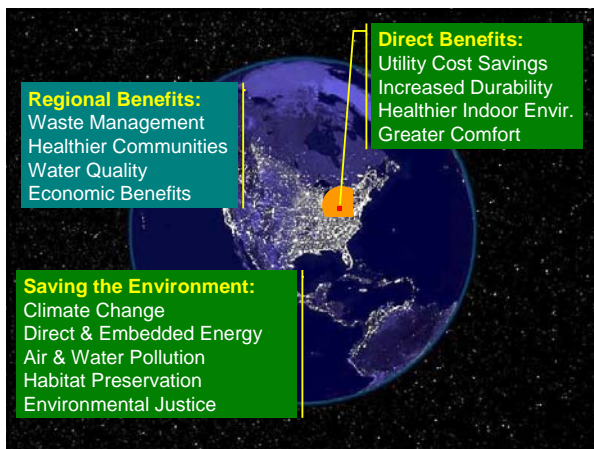
1993

0 93.9 tonnes CO₂e per capita



In the US buildings account for:

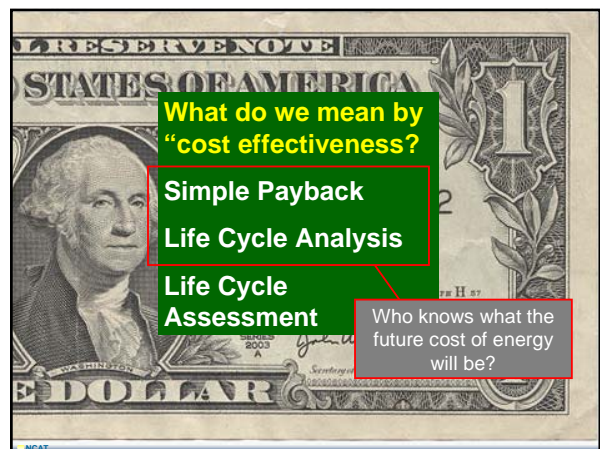
- 65% of electricity consumption
- 36% of energy use
- 30% of raw materials use
- 30% of waste output
- 12% of potable water consumption

Regional Benefits:
Waste Management
Healthier Communities
Water Quality
Economic Benefits

Direct Benefits:
Utility Cost Savings
Increased Durability
Healthier Indoor Envir.
Greater Comfort

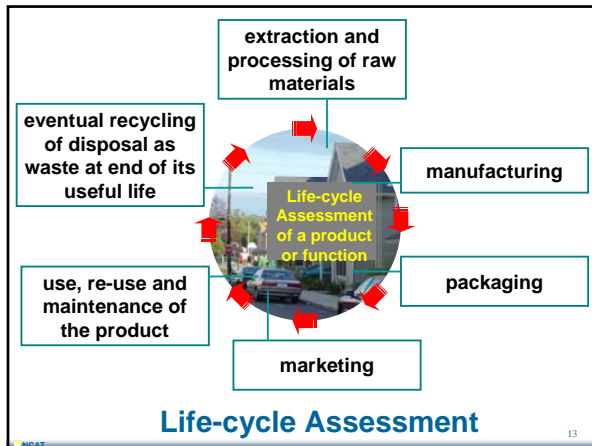
Saving the Environment:
Climate Change
Direct & Embedded Energy
Air & Water Pollution
Habitat Preservation
Environmental Justice



What do we mean by "cost effectiveness?"

Simple Payback
Life Cycle Analysis
Life Cycle Assessment

Who knows what the future cost of energy will be?



BuildingGreen.com

Green Building Priorities

- #1. Save Energy
- #2. Recycle Buildings
- #3. Create Community
- #4. Reduce Material Use - Reuse/Recycle
- #5. Protect and Enhance Site
- #6. Select Low Impact Materials
- #7. Maximize Longevity and Durability
- #8. Save Water
- #9. Make the Building Healthy

Integrated Design

- Integrated Project Team
- Comprehensive Green Design Approach
- Design Charrette

Getting Started

- Build Project Team
- Defining project priorities and adopt standards
- RFP for design of/consulting on a green building project
- Develop interview questions for selecting a green building consultant and/or architect

Green Building Rehab Strategies 15

Making Green Building Decisions

Which investments will do most good?

- Most significant environmental benefits
Energy Efficiency, Water Conservation, Indoor Health, Resource Conservation
- Specific opportunities presented by each project

Consider available resources

- No or low cost measures
- Greater first cost but savings over time
- Important environmentally but no direct financial reward

Green Building Priorities

- #1. Save Energy**
- #2. Recycle Buildings
- #3. Create Community
- #4. Reduce Material Use – Reuse and Recycle
- #5. Protect and Enhance Site
- #6. Select Low Impact Materials
- #7. Maximize Longevity and Durability
- #8. Save Water
- #9. Make the Building Healthy

17

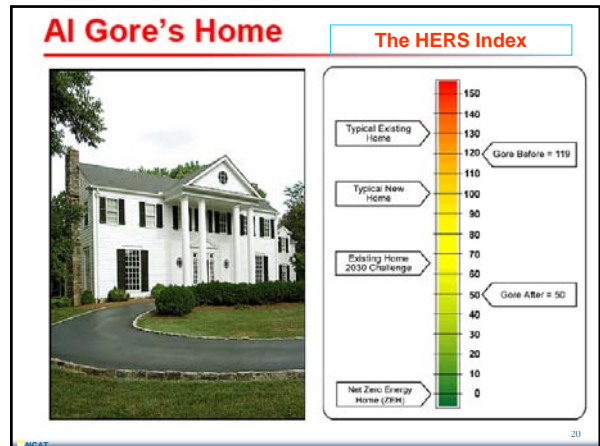
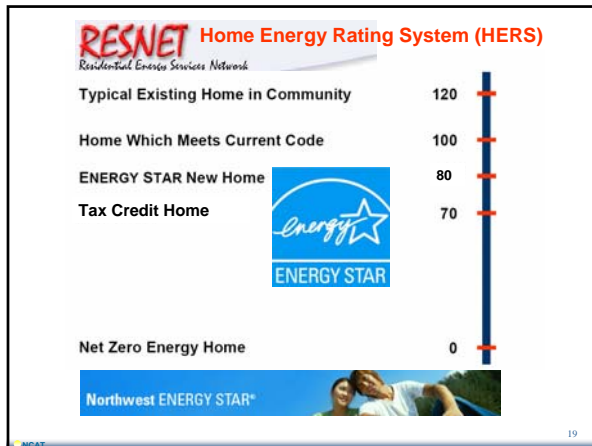
Start living **Green** with a new home that's earned the blue **ENERGY STAR**.
Learn more at energystar.gov

Choose a home that's earned the blue **ENERGY STAR** to start going **Green**.
Learn more at energystar.gov

ENERGY STAR Qualified Homes
Full Page 2010 EPA Template Update v

ENERGY STAR Qualified Homes
Full Page 2010 EPA Template Update v

18



ENERGY STAR logo and navigation menu. Sections include: PRODUCTS, HOME IMPROVEMENT, BUILDINGS & PLANTS, NEW HOMES, and PARTNER RESOURCES. The website URL www.energystar.gov is visible at the bottom.

ENERGY STAR Qualified Products

Products in more than 50 categories are eligible for the ENERGY STAR. They use less energy, save money, and help protect the environment. Ask for the ENERGY STAR.

Looking for a product that you don't see listed below? See [ENERGY STAR Specifications in Development](#), which includes information on both new specifications, and revisions to existing specifications.

Appliances

- Battery Chargers
- Clothes Washers
- Dehumidifiers
- Dishwashers
- Refrigerators & Freezers
- Room AC
- Room Air Cleaners
- Water Coolers

Heating & Cooling

- Air-source Heat Pumps
- Boilers
- Central AC
- Ceiling Fans
- Dehumidifiers
- Furnaces
- Geothermal Heat Pumps
- Home Sealing (Insulation)
- Light Commercial
- Programmable Thermostats
- Room AC
- Ventilating Fans

Home Envelope

- Home Sealing (Insulation and Air Sealing)
- Roof Products
- Windows, Doors, & Skylights

Special Offers: Find a Store

Features: Cool Your World with ENERGY STAR, See the ENERGY STAR Change a Light Pledge, People to Save Energy with a Simple Step at Home, ENERGY STAR PODCAST, ENERGY STAR Podcasts, Time to Replace your old

CHANGING WORLD: BUILDER LIABILITY: NEW STORM

ENERGY STAR logo

Defects no longer hidden...

A photograph of a modern building's exterior next to a thermal image showing heat signatures, indicating air leakage or other defects.

CHANGING WORLD: BUILDER LIABILITY: NEW STORM

ENERGY STAR logo

Images showing a person using a thermal camera to detect air leakage in an envelope and ducts, and another person using a blower door to test a building's air barrier.


air leakage in envelope

air leakage in ducts

air leakage and air barriers in envelope

ENERGY STAR Furnaces

- ENERGY STAR qualified furnaces (AFUE rating of 90% or greater),
- 15% more efficient than standard models.



25

COMBUSTION SYSTEM HIGHLIGHTS:
POWER/DIRECT VENTED EQUIPMENT



26



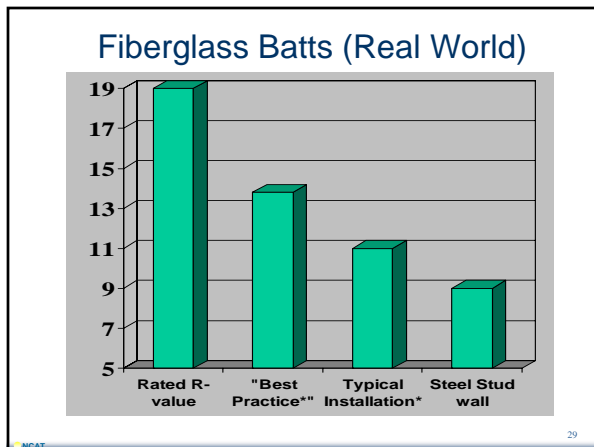
(Negative Pressure)

28

Typical installations...



28



Correct Installation



30

Damp spray cellulose





Dense-packed Cellulose



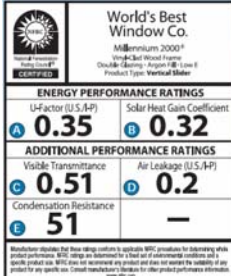

31

Spray Foams

- Excellent air sealing characteristics
- Excellent "fit" because it expands to fill spaces and glues itself to surfaces



32



World's Best Window Co.
Millennium 2000®
Triple-Paneled Windows
Double-Paneled Windows
Product Type: Residential Window

ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./IP)	Solar Heat Gain Coefficient
A 0.35	B 0.32
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance	Air Leakage (U.S./IP)
C 0.51	D 0.2
Condensation Resistance	
E 51	—

www.nfrc.org

A U-Factor measures how well a product prevents heat from escaping a home or building. U-Factor ratings generally fall between 0.20 and 1.20. The lower the U-Factor, the better a product is at keeping heat in. U-factor, takes into account more than conductivity. It also is affected by the airflow around the window.

B Solar Heat Gain Coefficient (SHGC) measures how well a product blocks heat from the sun. SHGC is expressed as a number between 0 and 1. The lower the SHGC, the better a product is at blocking unwanted heat gain. Assumes the sun strikes the glass at 90 degrees.

C Visible Transmittance (VT) measures how much light comes through a glazing. VT is expressed as a number between 0 and 1. The higher the VT, the higher the potential for daylighting.

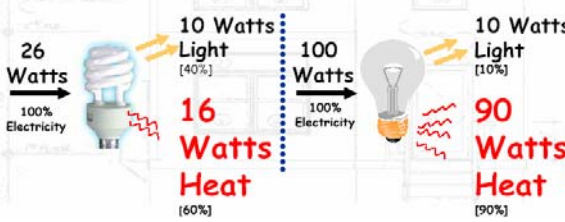
33

Window Rehab



34

CFLs vs. Incandescent Lamps



26 Watts → 100% Electricity → 10 Watts Light [40%] + 16 Watts Heat [60%]

100 Watts → 100% Electricity → 10 Watts Light [10%] + 90 Watts Heat [90%]







35

Use CFLs where lights are on for long periods of time or are in areas difficult to reach.

Don't use CFLs with dimmers, motion sensors, photocells, in enclosed fixtures (unless labeled on package).

CFL Sizes and Shapes

CFLs come in a variety of shapes and sizes. The majority of CFLs are designed to look identical to the incandescent light bulb version. The table below identifies the most popular CFL shapes that are available at retail:

Bare Products		Covered Products			Reflector Products
Mini-Spiral or Twist	Tube or Universal	Incandescent/A-line	Globe G25, G30, G40	Candelabra, Post or Bullet Shape	Indoor and Outdoor R20, R30, R40, PAR38
					

36



AFFORDABILITY

- Affordable Pricing
- Financing Packages based upon income levels
- Unique design features mean lower operational costs
- Active downtown within walking distance reduces car use and gasoline consumption
- Readily available public transportation reduces reliance on auto travel and related costs or potential need for 2nd family vehicle



Energy Efficiency

- Energy Analysis – Cost Effective Measures
- Performance Testing
- ENERGY STAR Appliances
- Energy Efficient Lighting
- Renewable Energy

Pine Street				
#	Code	ENERGY STAR	Savings	
1	15,587 _{kWh}	7,677 _{kWh}	7,910 _{kWh}	\$578
26	405,274 _{kWh}	199,590 _{kWh}	205,684 _{kWh}	\$15,028
Percent of kWh Savings			51%	



ACCESSIBILITY

- Universal Design
- Wider Doorways
- Higher Wall Outlets
- Lower Kitchen Cabinets
- Bathrooms Designed for Accessibility
- Adaptable Design for Further Modifications
- First Floor Bedroom in 2-story Units
- Two 1-story At Grade Units

Green Building Priorities

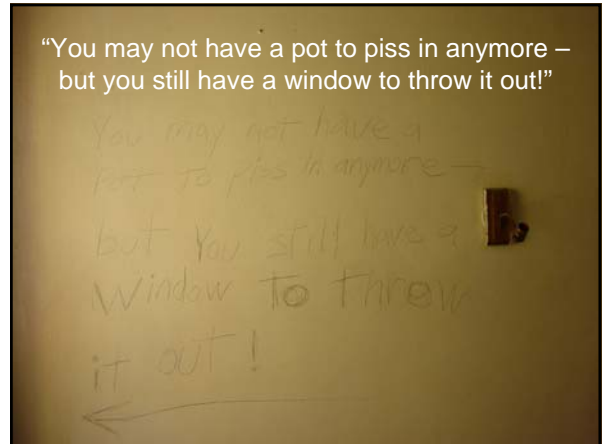
- #1. Save Energy
- #2. Recycle Buildings**
- #3. Create Community
- #4. Reduce Material Use – Reuse and Recycle
- #5. Protect and Enhance Site
- #6. Select Low Impact Materials
- #7. Maximize Longevity and Durability
- #8. Save Water
- #9. Make the Building Healthy

45



ACME Hotel, Billings, Montana

- \$3.4 million historic restoration
- Serves rental households (20% - 50% AMI)
- Rents ranging from \$250 - \$450
- 19 units and was
- Occupied in the Fall of 2004





Developing affordable housing and asset-building strategies for those most in need through innovative, sustainable and replicable methods

<http://www.homeword.org>

affordableHOUSING
homeownershipCENTER
policy&OUTREACH
buildingCOMMUNITY
aboutHOMEWORD
Job Openings
contactUS
Homebuyer Classes
Financial Fitness Classes
Affordable Rental Housing

Green Building Priorities

- #1. Save Energy
- #2. Recycle Buildings
- #3. Create Community**
- #4. Reduce Material Use – Reuse and Recycle
- #5. Protect and Enhance Site
- #6. Select Low Impact Materials
- #7. Maximize Longevity and Durability
- #8. Save Water
- #9. Make the Building Healthy

Location/Site

- Walkable Connections to Neighborhood
- Transportation Choices
- Community Resources
- Construction Erosion/Sediment Control
- Surface Water Management

Green Building Priorities

- #1. Save Energy
- #2. Recycle Buildings
- #3. Create Community
- #4. Reduce Material Use**
– Reuse and Recycle
- #5. Protect and Enhance Site
- #6. Select Low Impact Materials
- #7. Maximize Longevity and Durability
- #8. Save Water
- #9. Make the Building Healthy



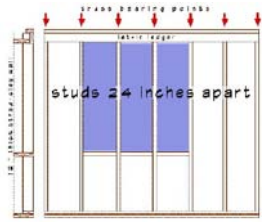


ACME Hotel

- Extensive **re-use of pre-existing materials** including grand stairway, wood floors, doors, and trim help maintain the building's historic nature and lower the amount of waste
- Approximately 1,700 pounds of **copper and brass were recycled** and 20,000 pounds of radiators and over 40 sinks were removed for reuse
- Use of **recycled content sound board, carpet, and carpet pads**
- Wheat board cabinetry and decking and interior wood composite doors are all **rapidly renewable resources**
- Salvage and demolition contract** to reduce on-site waste and ensure that building parts were reused

Advanced Framing (Optimum Value Engineering)

Wood-efficient framing
Advanced Framing





all windows 20 to 24 inches wide

walls studs at 24" spacing

single top-plate

second plate vertical as a ledger = no headers needed

Windows between studs...


Green Building Priorities

- #1. Save Energy
- #2. Recycle Buildings
- #3. Create Community
- #4. Reduce Material Use – Reuse and Recycle
- #5. Protect and Enhance Site**
- #6. Select Low Impact Materials
- #7. Maximize Longevity and Durability
- #8. Save Water
- #9. Make the Building Healthy

57


Synergy with rehab project: shade trees & shrubs
solar easements

If parking must be replaced: consider porous paving options



PINE STREET NEIGHBORHOOD Hazleton, PA.

design decision




Green Building Priorities

- #1. Save Energy
- #2. Recycle Buildings
- #3. Create Community
- #4. Reduce Material Use – Reuse and Recycle
- #5. Protect and Enhance Site
- #6. Select Low Impact Materials**
- #7. Maximize Longevity and Durability
- #8. Save Water
- #9. Make the Building Healthy

59

Materials and Resources

- **Construction Waste Management;** Minimize Waste (reduce, reuse, recycle on the construction site)
- **Recycled Content Material**
- **Certified and Salvaged Wood**
- **Water Permeable Walkways and Parking**



Green Building Rehab Strategies 60



Forest Stewardship Council

FSC is a non-profit organization devoted to encouraging the responsible management of the world's forests. FSC sets high standards that ensure forestry is practiced in an environmentally responsible, socially beneficial, and economically viable way.



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

61

Natural Materials



- Lime for plasters
- Milk Paint
- Sustainably-harvested wood flooring and decking
- Re-used heavy timbers
- Straw, earth & stone

62




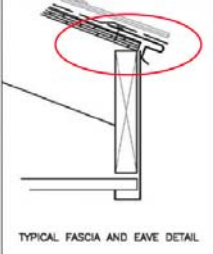
63

Green Building Priorities

- Save Energy
- Recycle Buildings
- Create Community
- Reduce Material Use – Reuse and Recycle
- Protect and Enhance Site
- Select Low Impact Materials
- Maximize Longevity & Durability**
- Save Water
- Make the Building Healthy


64

MOISTURE CONTROL HIGHLIGHTS:
WATER MANAGED ROOFS


TYPICAL FASCIA AND EAVE DETAIL

BITUMINOUS MEMBRANE AT VALLEYS

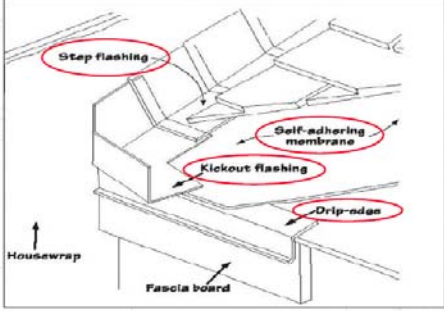


65

MOISTURE CONTROL HIGHLIGHTS:
WATER MANAGED ROOFS



MORE ROOF FLASHING DETAILS ...



66

**MOISTURE CONTROL HIGHLIGHTS:
WATER MANAGED WALLS**




WINDOW/DOOR PAN FLASHING



BEST PRACTICE INSTALLATION

WINDOW FLASHING

Building Tip
Always install flashing before any exterior wall finish or siding.







Cemplank


**Cemplank, Inc
Blandon, PA**



81999-2018 Cemplank
Tel: Five 717-CEMPLANK (877-336-7126)

Green Building Priorities



- #1. Save Energy
- #2. Recycle Buildings
- #3. Create Community
- #4. Reduce Material Use – Reuse and Recycle
- #5. Protect and Enhance Site
- #6. Select Low Impact Materials
- #7. Maximize Longevity and Durability
- #8. Save Water**
- #9. Make the Building Healthy



Water Efficiency

- **Efficient Fixtures** toilets - 1.3 GPF; showerheads - 2.0 GPM; kitchen faucets - 2.0 GPM; bathroom faucets - 2.0 GPM.
- **Very Efficient Fixtures** toilets - 1.1 GPF; showerheads – 1.75 GPM; kitchen faucets toilets – 2.0; showerheads - 1.5 GPM.

EPA WaterSense
<http://www.epa.gov/watersense/>

- **Efficient Landscape Irrigation**

Green Building Rehab Strategies



Green Building Priorities

- #1. Save Energy
- #2. Recycle Buildings
- #3. Create Community
- #4. Reduce Material Use – Reuse and Recycle
- #5. Protect and Enhance Site
- #6. Select Low Impact Materials
- #7. Maximize Longevity and Durability
- #8. Save Water
- #9. Make the Building Healthy**



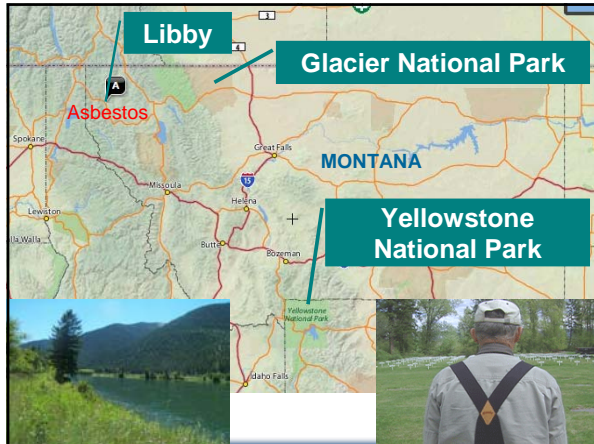
Renovate Right

Important Lead Hazard Information for Families, Child Care Providers and Schools

Test for lead paint

Follow lead safe practices



WHAT POLLUTANTS AFFECT IAQ?

- **Biological pollutants**
 - Mold & Mildew
 - Dust Mites & Pests
- **Combustion products**
 - CO, NO₂, Smoke
- **Radon & Soil gases**
- **Formaldehyde**
- **Other Chemicals**
- **Airborne Particles**
 - Dust, Pollen

Linked to health problems ranging from minor respiratory irritation to death, depending on exposure and sensitivity

House design and construction can reduce exposure risk for indoor air pollutants!

More IAQ Info available at:
<http://www.epa.gov/iaq/ip-intro.html>
 Or call 1-800-438-4318

NEW HOMES WITH THE ENERGY STAR® INDOOR AIR PACKAGE

HOW DO HOMES EARN THE LABEL FOR THE ENERGY STAR INDOOR AIR PACKAGE?

START WITH ENERGY STAR. A home must first be designed and built to earn the ENERGY STAR. The result is a home that is significantly more energy efficient than a code-built home.

SHOULD BUILDERS CARE ABOUT IAQ?

- **Asthma Epidemic**
(20 million Americans have it); ~2 million ER visits per year
- **Increasing Risks of Radon**
>20,000 lung cancer deaths per year
- **Increasing Respiratory Problems**
widespread indoor dampness (e.g. wet basements and visible mold)
- **Chemical Pollutants**
EPA estimates 2-5 times more than outdoor air

Now consider this:
 People spend >90% of their time indoors, and >60% in their homes!

IAQ RISK REDUCTION PRINCIPLES

1. **Source Control**
eliminate, substitute, or modify pollutant sources
2. **Dilution**
ventilate to dilute unavoidable pollutants
3. **Filtration**
remove targeted pollutants, last resort after source control & dilution

BUILDING MATERIALS HIGHLIGHTS: PROTECTION

BUILDING MATERIALS HIGHLIGHTS: LOW-EMITTING MATERIALS

Urea Formaldehyde-free Composite Wood

MDF & Particleboard

CRI GREEN LABEL
 Certified "Green" Carpeting

APA THE ENGINEERED WOOD ASSOCIATION
 A-C GROUP 1
 EXTERIOR
 000
 PE 1-02
 Plywood

CPA
 COMPANY LOCATION PRODUCTION STATEMENT

INDUSTRIAL PLYWOOD
 CONFORMS TO REQUIREMENTS

GREENWOOD PLYWOOD & VENEER ASSOCIATION
 INDUSTRIAL PLYWOOD CONFORMS TO REQUIREMENTS

GREENWOOD
 TYPE 1
 ANSI/PVA HP-1-2004

GREENGUARD
ENVIRONMENTAL INSTITUTE

Green Guard
GREENGUARD Certification Standards for Low-Emitting Products
<http://www.greenguard.org/>

Green Seal

Green Seal provides science-based environmental certification standards that are credible, transparent, and essential in an increasingly educated and competitive marketplace.
<http://www.greenseal.org/>

CRI
THE CARPET AND RUG INSTITUTE

Carpet & Rug Institute
Green Label Plus, for carpet and adhesives, sets an even higher standard for IAQ and ensures that customers are purchasing the very lowest emitting products on the market.
<http://www.carpet-rug.org>

SCS
SCIENTIFIC CERTIFICATION SYSTEMS

floor score

SCS FloorScore

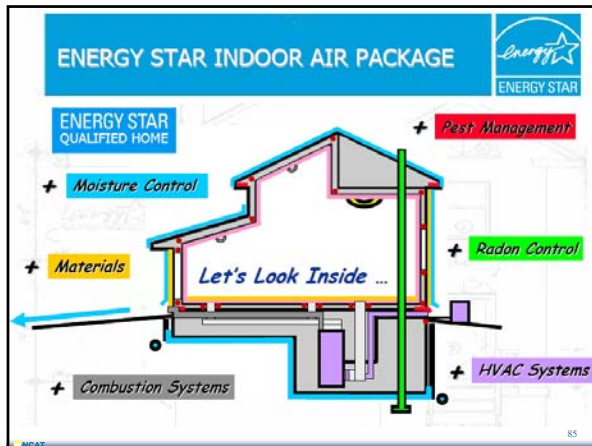
The FloorScore program, developed by the Resilient Floor Covering Institute (RFCI) in conjunction with SCS tests and certifies flooring products for compliance with indoor air quality emission requirements adopted in California. Flooring products include vinyl, linoleum, non-PVC resilient flooring, wall base, and associated sundries.
<http://www.scs-certified.com>

Moisture



- Water related to 90% of building and material failures (ASHRAE)
- Estimated \$9 Billion/year in repairs

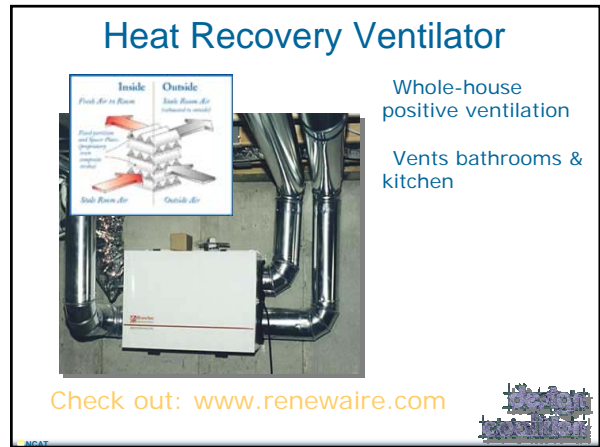




Infiltration versus Mechanical Ventilation

	Infiltration	Mechanical Ventilation
Reliable appropriate quantity of air	NO	Yes
Air delivered to appropriate spaces	NO	Yes
Can be shut off if house is unoccupied	NO	Yes
Quality of air good as outdoor air	NO	Yes

Note: This assumes mechanical system is properly designed.



Mechanical Ventilation

REM/RATE assumes ASHRAE 62.2-2003

Requires continuous whole-building* mechanical ventilation based on conditioned floor area and # of bedrooms

7.5 cfm/bedroom +1 plus 1 cfm/100 SF

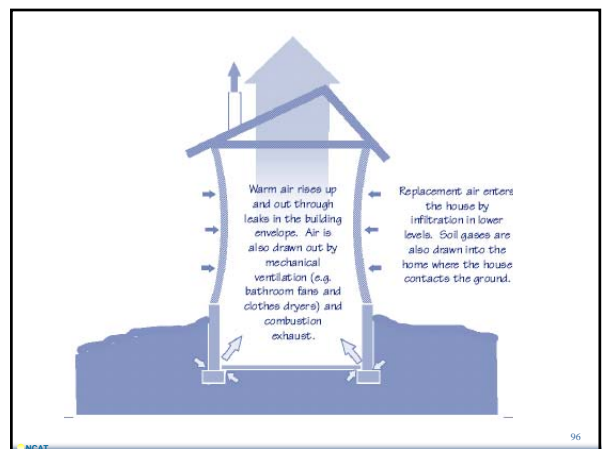
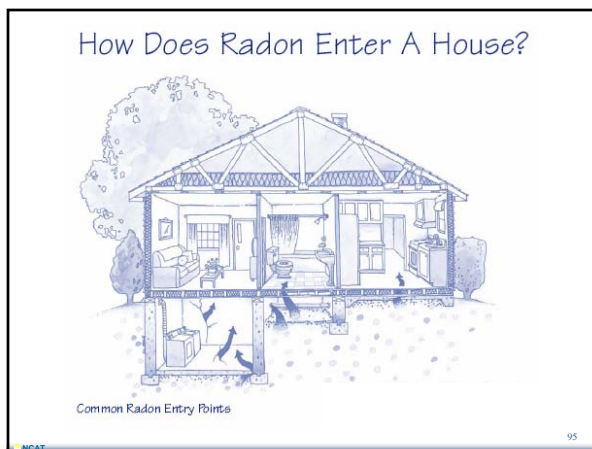
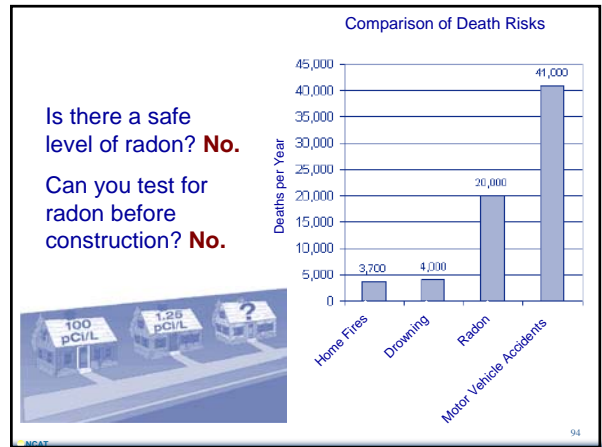
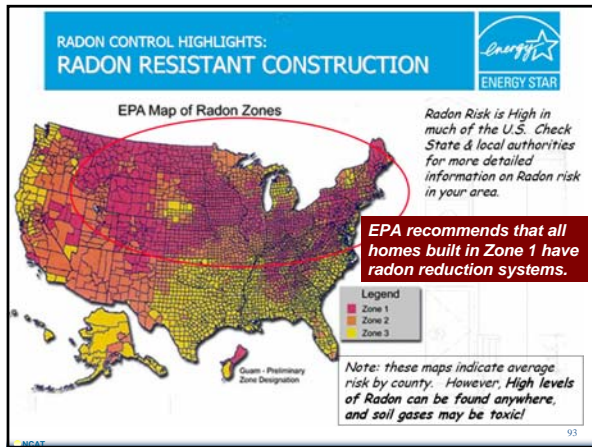
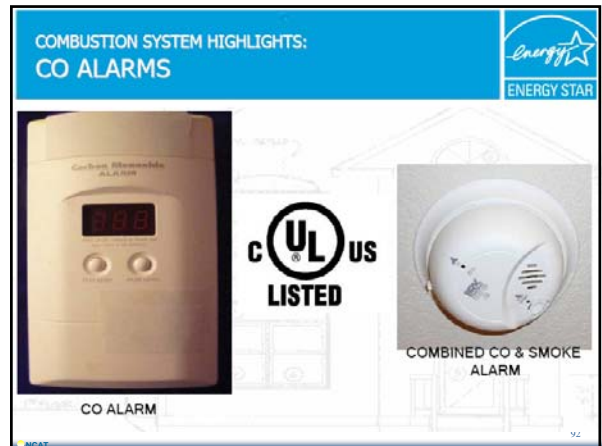
Example: 3-bedroom 2400 SF house

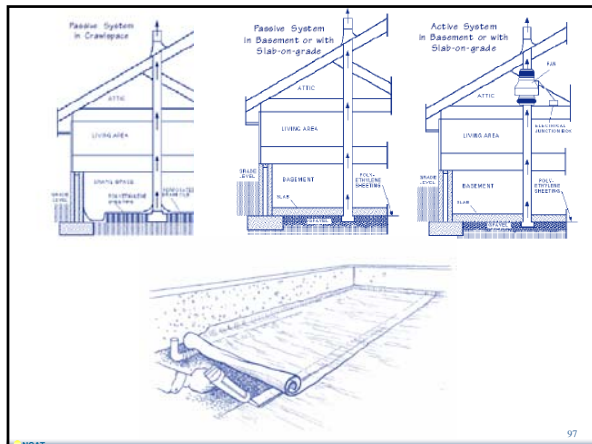
$(7.5 \text{ cfm} \times (3+1)) + (2400/100) = 54 \text{ cfm}$

* - Mech exhaust system may include local exhaust fans.

Residential Energy's BTL is out-of-date







97

A joint project of
Bay Area Low Income Support Coalition and Build it Green

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

98

Green Communities Criteria 2008

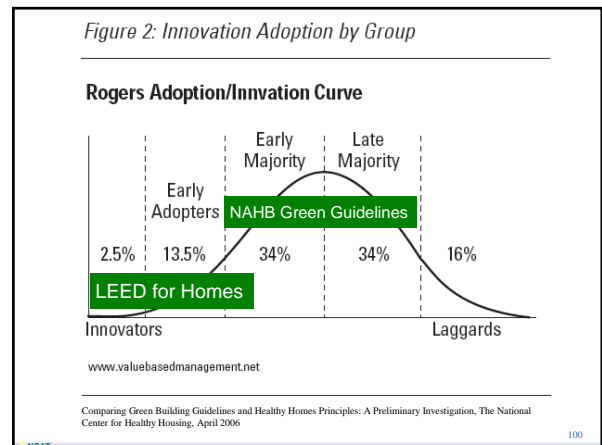
"...make 'green' criteria the normal way everyone builds affordable housing, because it makes so much sense, both economically and environmentally,"

Bart Harvey, Enterprise Foundation's chairman and CEO

- Recognizes that low-income families are disproportionately impacted by housing related health problems
- Includes focus on affordable existing housing

<http://www.greencommunitiesonline.org>

99



100

What is LEED?
 Leadership in Energy & Environmental Design

LEED for Homes is a floating point rating system with 4 Certification Levels.

This scale slides per a calculation which considers the square footage of the house per bedroom ratio. For a 4 bedroom 2,600sf Home the scale is:

- Platinum: 90 – 129
- Gold: 75 – 89
- Silver: 60 – 74
- Certified: 45 – 59


Materials and information can be found at - www.usgbc.org

101

Green Building Strategies

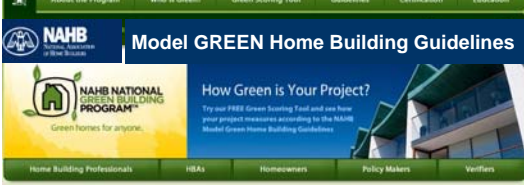
- Integrated Design
- Location/Site
- Water Efficiency
- Energy Efficiency
- Materials & Resources
- Healthy Indoor Air
- O&M/Education
- Verification/Testing

102



LEED for Homes Points

	No. Prereq. Measures		Min. No. Pts Required		Max. No. Pts. Available	
Innovation and Design Process	4	22%	0	0%	9	7%
Location and Linkages	0	0%	0	0%	10	8%
Sustainable Sites	2	11%	5	31%	21	16%
Water Efficiency	0	0%	3	19%	15	12%
Energy and Atmosphere	1	6%	0	0%	38	29%
Materials and Resources	3	17%	2	13%	14	11%
Indoor Environmental Quality	7	39%	6	38%	20	15%
Awareness and Education	1	6%	0	0%	3	2%
	18	100%	16	100%	130	100%



Model GREEN Home Building Guidelines

How Green is Your Project?
Try our FREE Green Scoring Tool and see how your project measures according to the NAHB Model Green Home Building Guidelines.

Home Building Professionals HBA's Homeowners Policy Makers Verifiers

	Green	Silver	Gold
Lot Design, Preparation, and Development	9	10	12
Resource Efficiency	44	60	77
Energy Efficiency	37	62	100
Water Efficiency	6	13	19
Indoor Environmental Quality	32	54	72
Operation, Maintenance, and Homeowner Education	7	7	9
Global Impact	3	5	6
Obtain additional points from sections of your choice	100	100	100

*If the home does not have a ducted distribution system for space heating and cooling, deduct 15 points from the number of points required in the Energy Efficiency section.

- ### Green Rehab Basics
- Construction Waste Management Plan
 - Construction IAQ Plan
 - Perform Energy Analysis
 - Test for Lead and Asbestos

 - Reuse Building Materials
 - Use ENERGY STAR Equipment (HVAC, appliances)
 - Use ENERGY STAR Lighting (CFLs, T8 lamps)
 - Use Recycled or Salvaged Materials
 - Use No or low VOCs (paints, adhesives, sealants)
 - Avoid Formaldehyde (pressed wood products, flooring, insulation)
 - Replace Cement with Fly Ash
 - Install Crawl Space Moistures Barrier
 - Radon Testing and Mitigation
 - Tighten Building Envelope and Test
 - Attic Insulation

 - Water Heater and Pipe Insulation
 - Low Flow Toilets, Fixtures, and Aerators
 - HVAC Controls (Programmable Thermostats)
 - Performance Testing
- www.ncat.org
Go to "Sustainable Energy" then "Presentations/Downloads"