Building for the Future
Sustainable Home Design

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environmental impact of buildings

- Buildings: 76%
- Industry: 23%
- Transportation: 1%

Electricity usage and carbon emissions:

Source: www.architecture2030.org
• the U.S. generates and uses more energy than any other nation; more than half is used in the construction or operation of buildings
• the U.S. is the world's largest generator of greenhouse gas emissions
• the average single-family home in the U.S. emits more than 22,000 pounds of carbon dioxide each year (from the electricity generated by utilities to run the home, and oil or gas powered appliances and equipment in the home) this is more than twice the amount emitted by the typical American car
• each day the sun directly radiates more than 10,000 times the amount of energy required in the world
• less than 10 percent of single-family residences are designed by architects; of those, most are for the wealthy
what is green design?

design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants in five broad areas:

- site
- water
- energy
- materials
- comfort
how is it measured?

energy and water use monitoring
utility bills
life cycle analysis / assessments
post occupancy evaluations
carbon neutrality assessments
certification processes such as LEED or Energy Star or Earthcraft
who is responsible?

clients
architects
engineers
landscape architects
planners
contractors
policy makers
government officials
advantages of green housing design

homes designed using rigorous sustainable design strategies can:

• save you money -- reduced operating costs
• run on smaller (less expensive) heating and cooling equipment
• have increased home value and return on investment
• are healthier indoor environments with reduced risk of health problems
• use less water -- saving money and helping your local ecosystem
• participate in a national effort to reduce carbon emissions and overall damage to our environment
how do you succeed?

convene a team and start cost estimating and life cycle costing immediately --

set clear financial and environmental goals

etire team must understand the goals from the beginning to get full financial benefit of green design strategies
with no more than 5% more in construction costs, sustainably designed housing units use 30 to 50% less energy and 10 to 20% less water.

Costs and Benefits of Green Affordable housing, New Ecology Inc.
U.S. Department of Energy

SOLAR DECATHLON

2009

2002 UVA Solar Decathlon Team
design
a multi-disciplinary collaborative research project
creating sustainable prefab housing units for affordable housing organizations
build
evaluate
1

make good choices before you start

- **the most sustainable building is the one that already exists** – so renovate before starting new

- **good design is cheaper than high technology** – focus on design before anything else
design for your site

- *create a comfortable microclimate*
- *make good planting choices – native and drought tolerant*
- *reduce stormwater runoff*
components of microclimate:
- sun
- wind
- daylight
- thermal comfort
- topography
- humidity
rain garden
- reduced storm water runoff
- rainwater filtration
- creation of green space
green roof
- reduced storm water runoff
- rainwater filtration
- creation of green space
- reduced roof maintenance costs
- types of plants: grasses, herbs, sedums
reduce water usage

- choose plumbing fixtures and appliances carefully
- use plumbing fixtures and appliances carefully
- collect rainwater for landscape use
- reuse greywater for landscape use
- collect rainwater and/or greywater for domestic (potable) use
don’t waste energy

- super-insulate all buildings
- use passive design to minimize need for heating and cooling
- carefully select appliances, equipment and lighting
- carefully use appliances, equipment and lighting
- choose renewable energy technologies with the shortest payback for your climate and building
everything in the pre-design, design, and occupancy stage is going to effect the energy consumption
WHAT THE AVERAGE US HOME ENERGY BILL PAYS FOR

- Heating and Cooling: 45%
- Refrigerator: 6%
- Dishwasher: 2%
- Clothes Washer & Dryer: 10%
- Computer & Monitor: 2%
- TV, VCR, DVD: 2%
- Lighting: 7%
- Other*: 16%

* "Other" represents an array of household products, including stoves, ovens, microwaves, and small appliances. Individually, these products account for no more than about 2% of a household's energy bills.

Source: Energy Star
why insulate? — it saves energy and money

Sources of Air Leaks breaks in Your Home:

1. Dropped Ceiling
2. Recessed light
3. Attic entrance
4. Electric wires & box
5. Plumbing utilities & penetration
6. Water & furnace flues
7. All ducts
8. Door sashes & frames
9. Chimney penetration
10. Warm air register
11. Window sashes & frames
12. Baseboards, coves, interior trim
13. Plumbing access panel
14. Electrical outlets & switches
15. Light fixtures
insulation
passive heat gain and passive ventilation
heat gain using sun space
heat gain using sun space
natural ventilation

Room Organization Strategies That Facilitate Both Cross and Stack-Ventilation
PRECEDENTS IN ZERO-ENERGY DESIGN
ARCHITECTURE AND PASSIVE DESIGN IN THE
2007 SOLAR DECATHLON

MICHAEL ZARETSKY
FOREWORD BY JOHN D. QUALE
shading control
• CFL and LED lighting
• Energy Star appliances and equipment
• programmable thermostats
• occupancy sensors to turn off lights
• high efficient heating and cooling
• heat recovery systems
solar hot water
hydronic heating and cooling

radiators

valance cooling

radiant floor
photovoltaic systems
monitoring systems
choose materials wisely
- *increase thermal resistance*
- *reduce potential for moisture or mold problems*
- *source locally and regionally*
- *low maintenance*
- *reused materials when possible*
- *recycled or rapidly renewable*
- *resource efficient, energy efficient and non-toxic*
- *manufacturing process*
- *consider indoor air quality*
- *use simple, natural materials where possible*
(*garbage in, garbage out*)
remember housing is about humans
- indoor air quality
- acoustics
- daylighting
- thermal comfort
- inspiration for occupants
- evaluate the results
thermal comfort

46. Schematic bioclimatic index.
daylighting
daylighting

considerations:
- site location
- movement of the sun
- climate

design options:
- sidelighting
- toplighting
- core daylighting
(collection, transportation, distribution)
- atrium

strategies:
- maximize external surface area
- allow penetration high in a space
- “effective aperture” (window to wall ratio)
- bounce or reflect daylight within a space to increase brightness
- slope ceilings to direct light
- use direct sun cautiously

design variables:
- site elements
- sky conditions
- external obstructions

design issues:
- veiling reflections
- quantity
- glare
SOLAR DECAHLON 2009

daylighting
post occupancy evaluation
in other words:

“Design with nature, or else I’ll grind you up for dog food!”

Ian McHarg
ecoMOD awards:

2009 World Habitat Award, Finalist
2009 National Idea-to-Product Competition for Social Entrepreneurship, 2nd Place
2008 U.S. Green Building Council Excellence in Green Building Curriculum Award
2008 National Collegiate Inventors and Innovators Alliance (NCIIA) Advanced E-Team Grant Award
2007 NCARB Grand Prize
2007 AIA Education Honor Award
2007 ACSA Collaborative Practice Award
P3 Award Grant from the U.S. EPA
Best Residential Project for 2006, Virginia Sustainable Building Network
Best Residential Project for 2008, Virginia Sustainable Building Network
Go Green Honor Award, James River Green Building Council
Go Green Grant Award, James River Green Building Council

www.ecomod.virginia.edu
some useful resources:

books:
The Green Studio Handbook by Alison G. Kwok And Walter T. Grondzik
Sun, Wind & Light by G.Z. Brown and Mark DeKay
Ecohouse 3: A Design Guide by Sue Roaf
The New Ecological Home by Daniel D. Chiras
Sustainable Landscape Construction by J. William Thompson and Kim Sorvig
The Builder's Guide To Mixed Climates by Joseph W. Lstiburek
Green Building Materials by Ross Speigel
Healthy House Building for the New Millennium by John Bower
Trojan Goat: A Self Sufficient House by John Quale
Precedents in Zero-Energy Design by Michael Zaretsky

websites:
www.buildinggreen.com (Environmental Building News)
www.usgbc.org
www.doe.gov
www.usablebuildings.co.uk
www.epa.gov
www.greenguard.org
www.builditsolar.com