



# SOLAR DECATHLON 2009



## Building for the Future



National Renewable  
Energy Laboratory

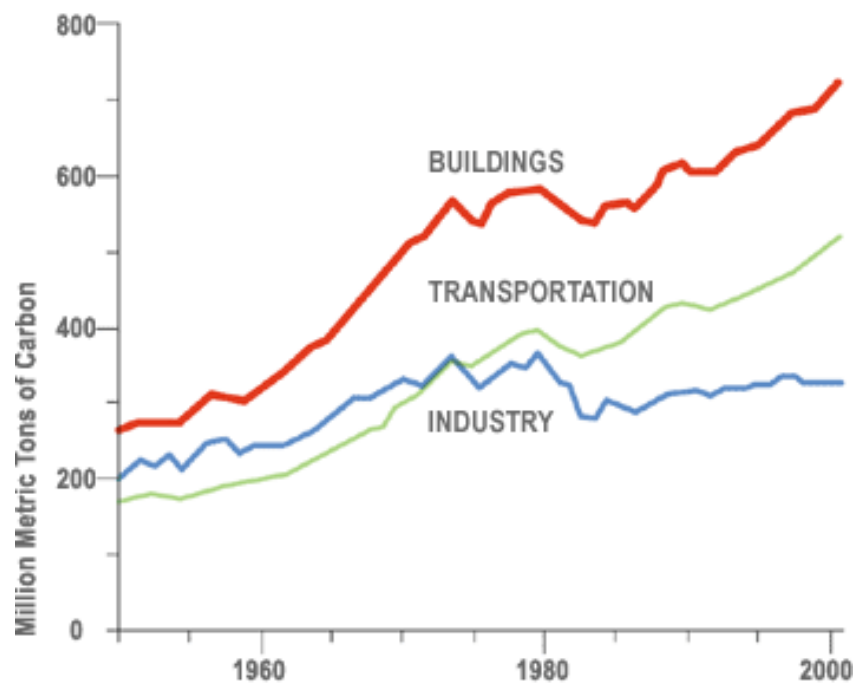
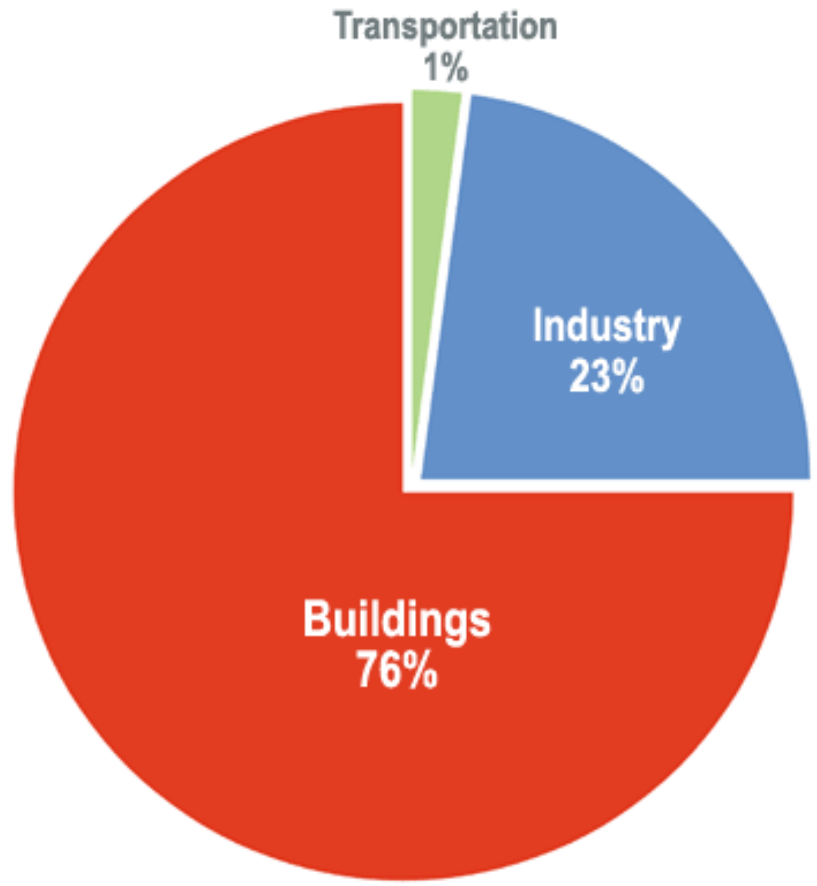
## Sustainable Home Design



John Quale, Assistant Professor and ecoMOD Project Director  
University of Virginia School of Architecture



## environmental impact of buildings



electricity usage

carbon emissions

source: [www.architecture2030.org](http://www.architecture2030.org)





## environmental impact of buildings

- 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

entire 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.





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**2002 UVA Solar Decathlon Team**





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# design

creating sustainable prefab housing units for affordable housing organizations



# ecoMOD

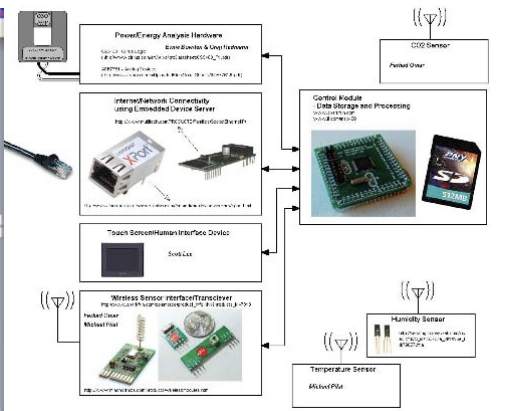
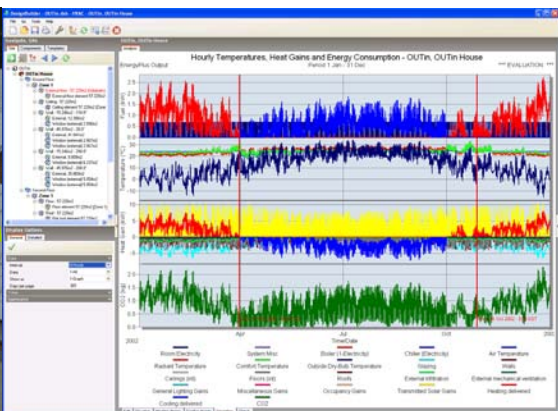
a multi-disciplinary collaborative research project



# 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*





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# 2

## design for your site

- *create a comfortable microclimate*
- *make good planting choices – native and drought tolerant*
- *reduce stormwater runoff*

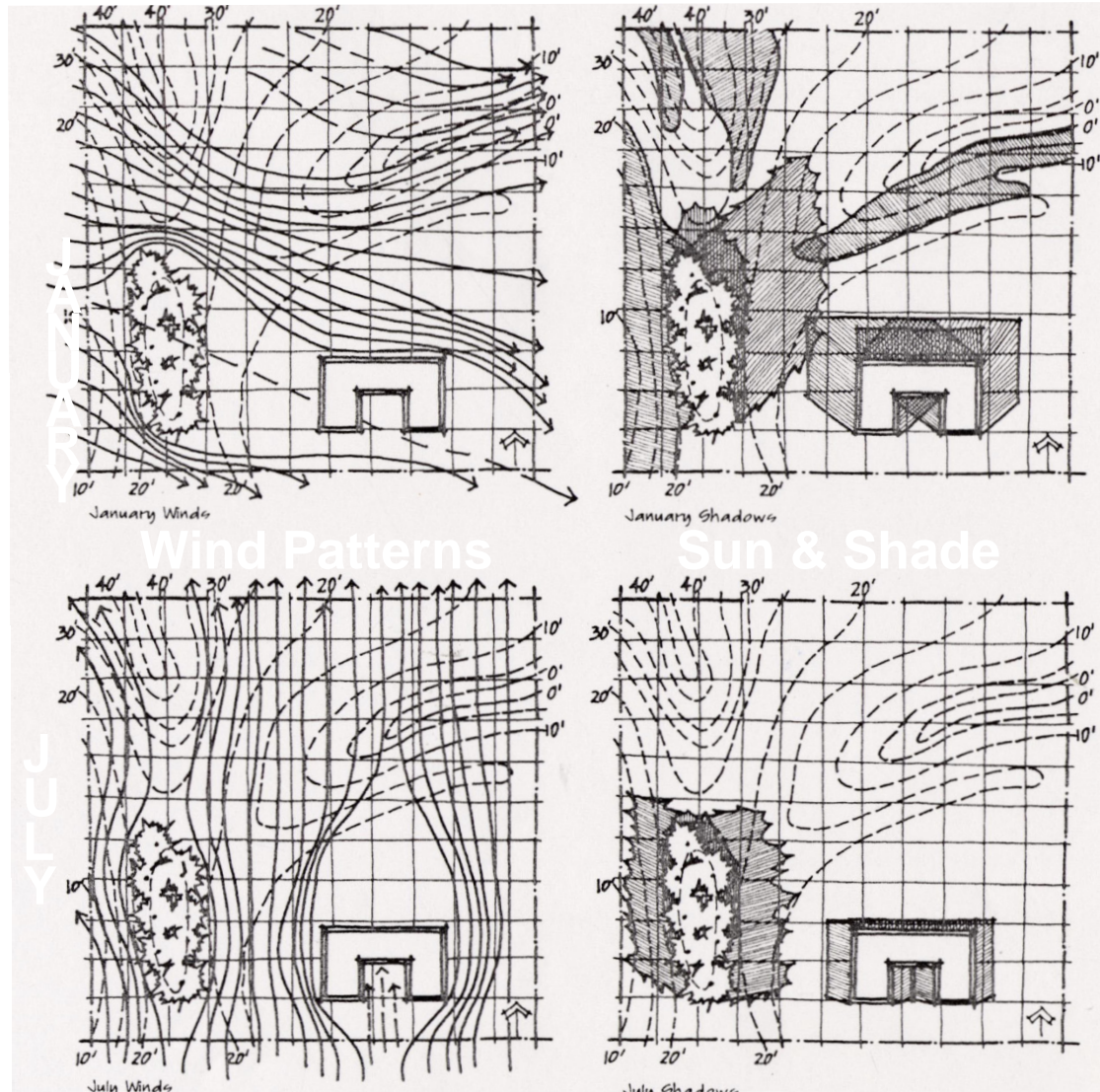


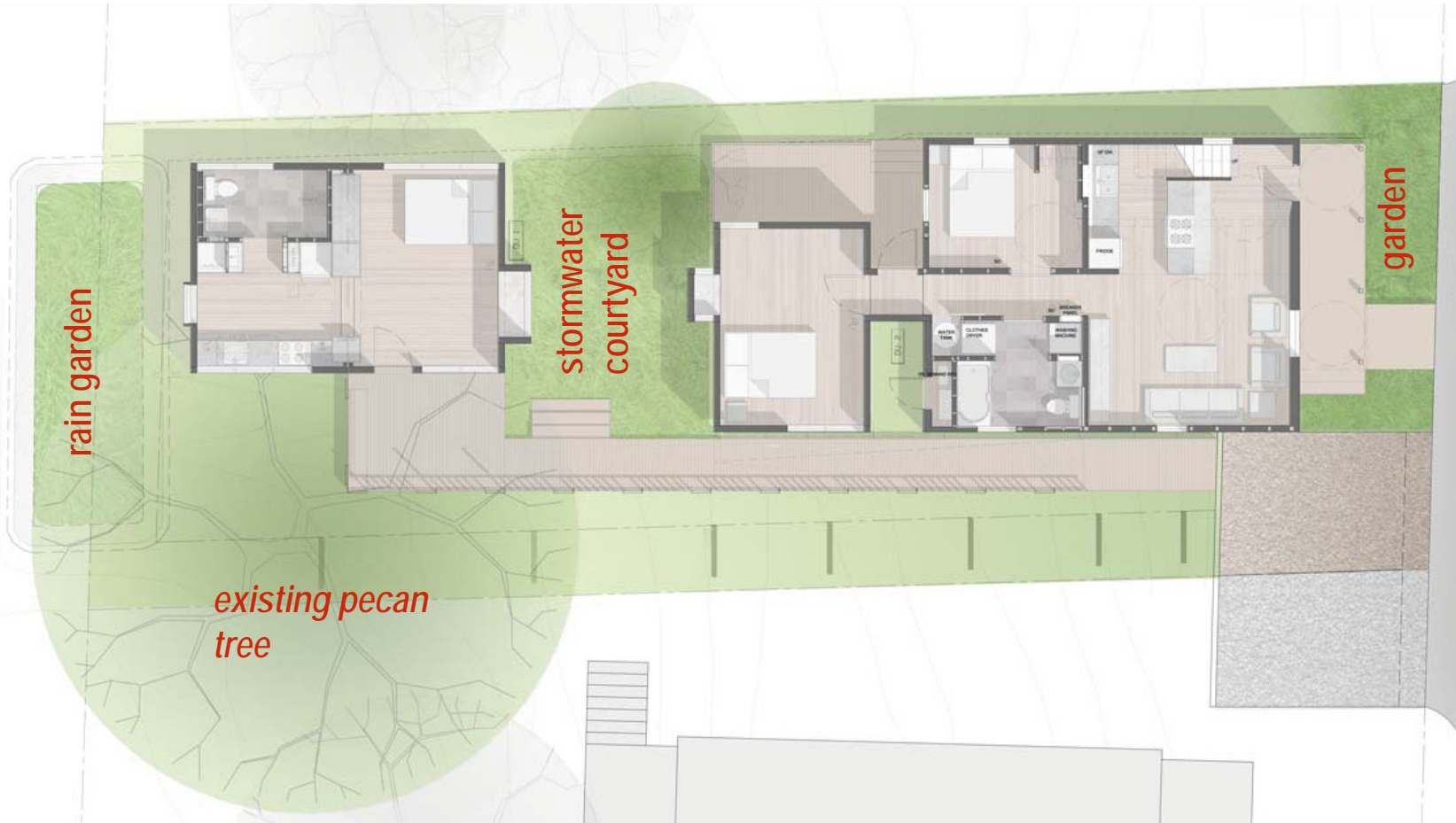


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- components of microclimate:
- *sun*
  - *wind*
  - *daylight*
  - *thermal comfort*
  - *topography*
  - *humidity*









## 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





## 3

### reduce water usage

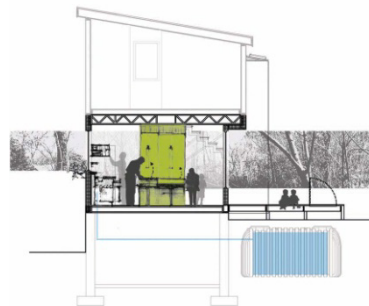
- *choose plumbing fixtures and appliances carefully*
- *use plumbing fixtures and appliances carefully*
- *collect rainwater for landscape use*
- *reuse greywater for landscape use*
- *collect rainwater and / or greywater for domestic (potable) use*





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# 4

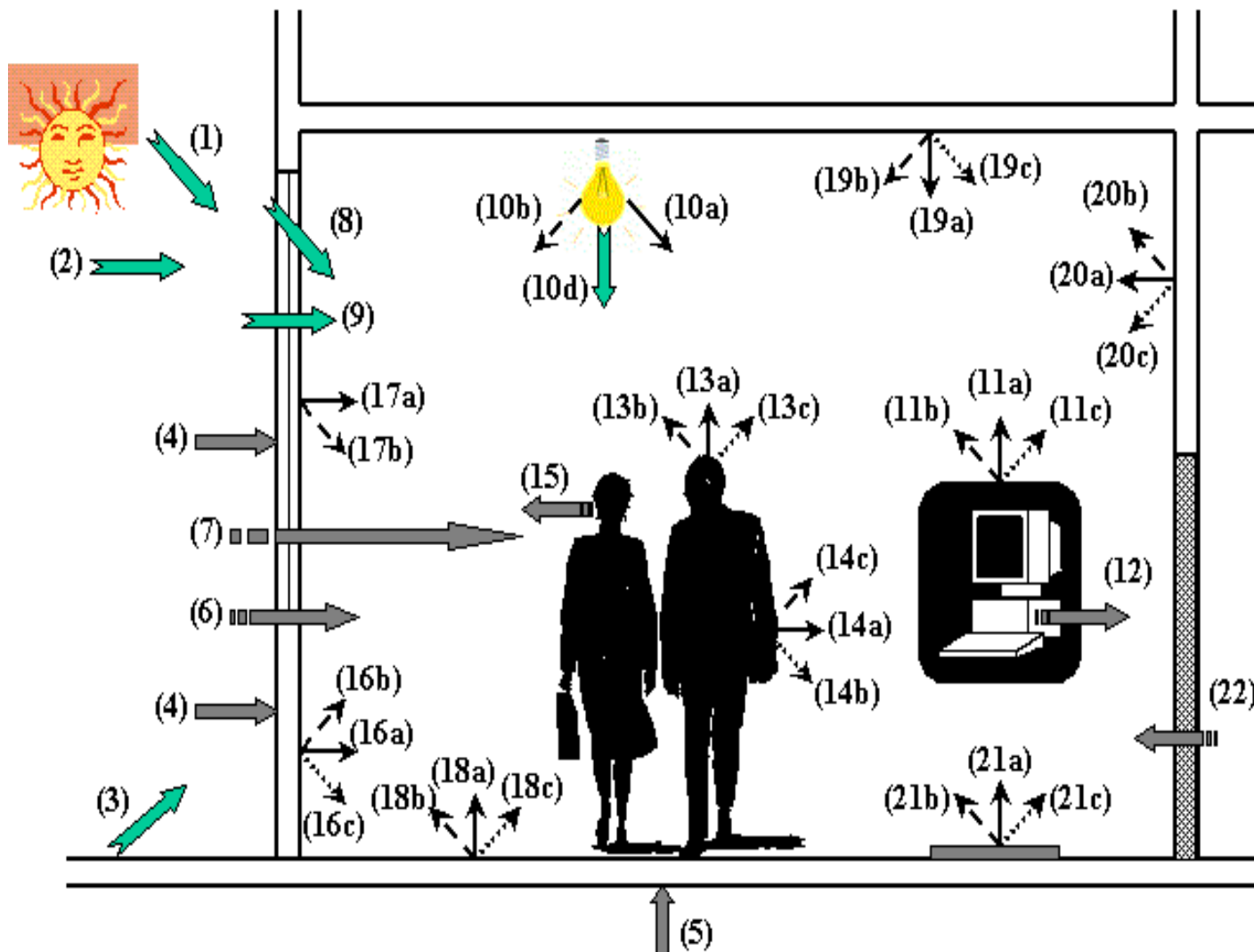
## don't waste energy

- *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*



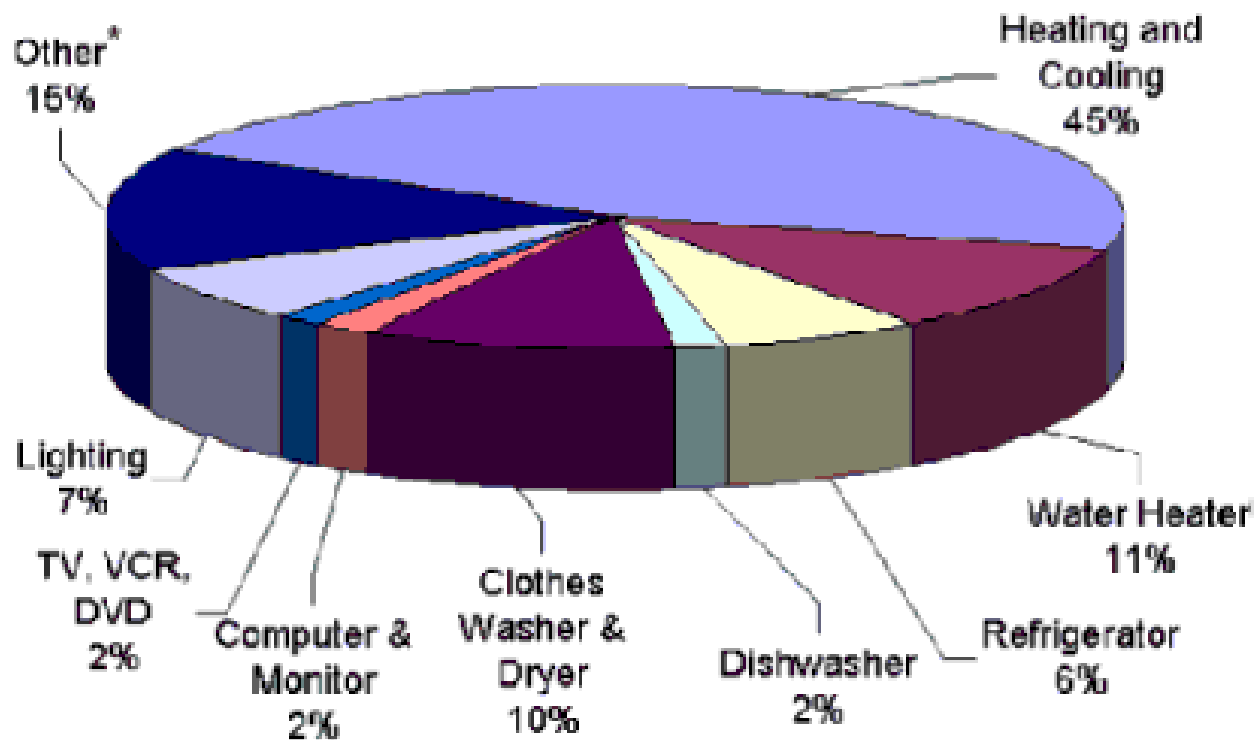


everything in the pre-design, design, and occupancy stage is going to effect the energy consumption





## WHAT THE AVERAGE US HOME ENERGY BILL PAYS FOR



Source:  
Energy Star

\* "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.





## why insulate? – it saves energy and money

Sources of Air Leaks breaks in You 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





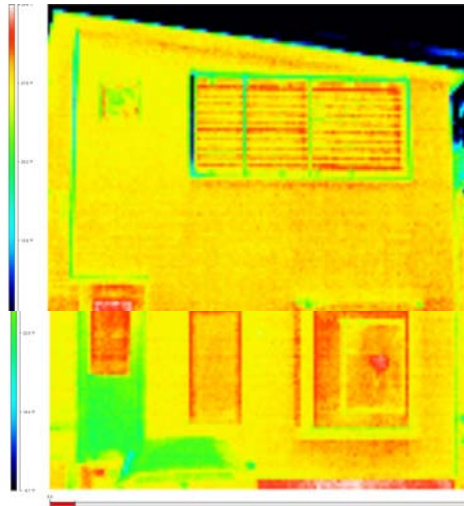


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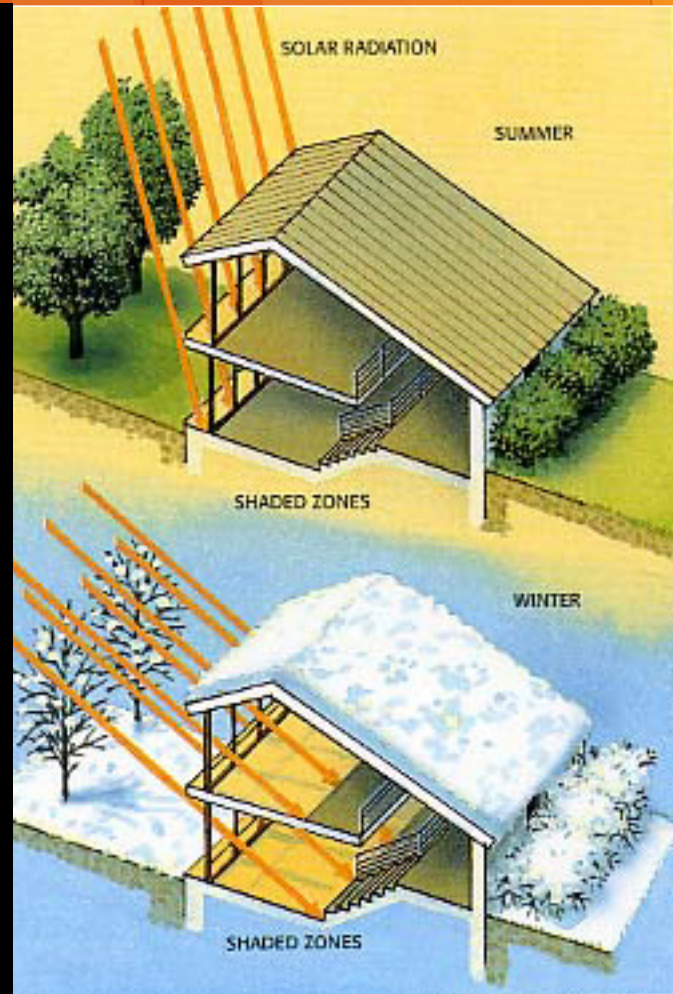
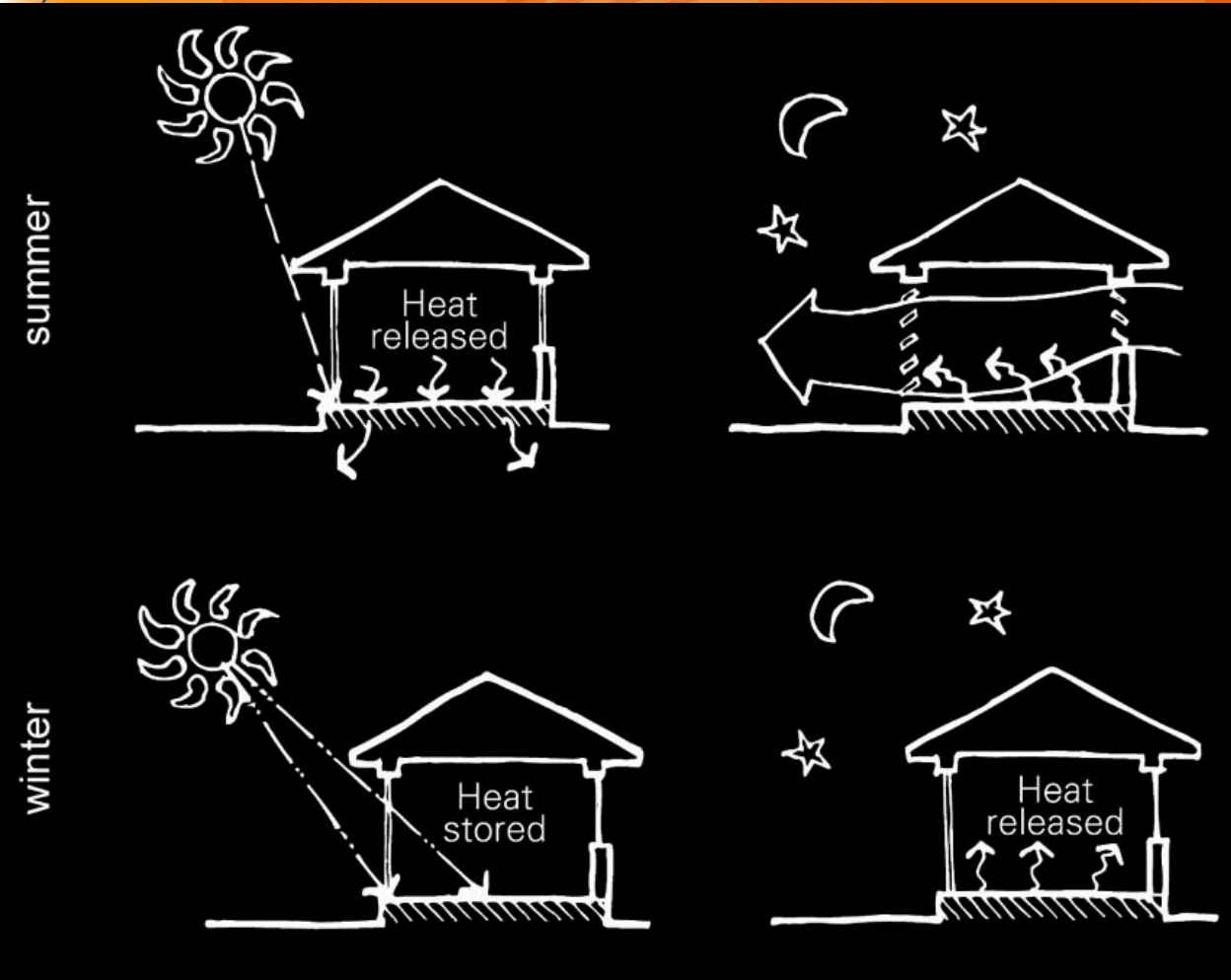


insulation



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passive heat gain and passive ventilation



heat gain using sun space

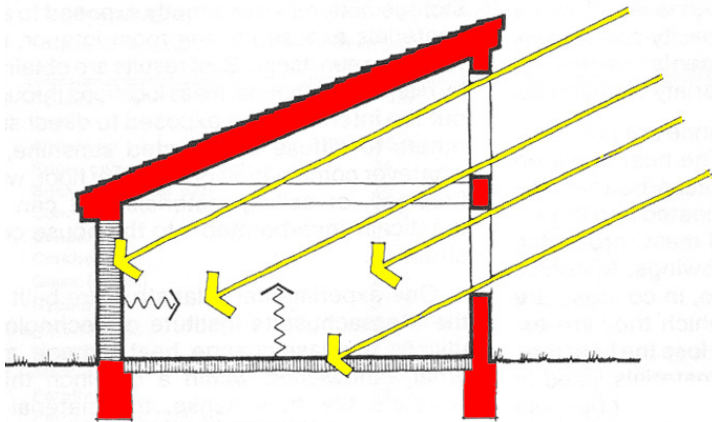


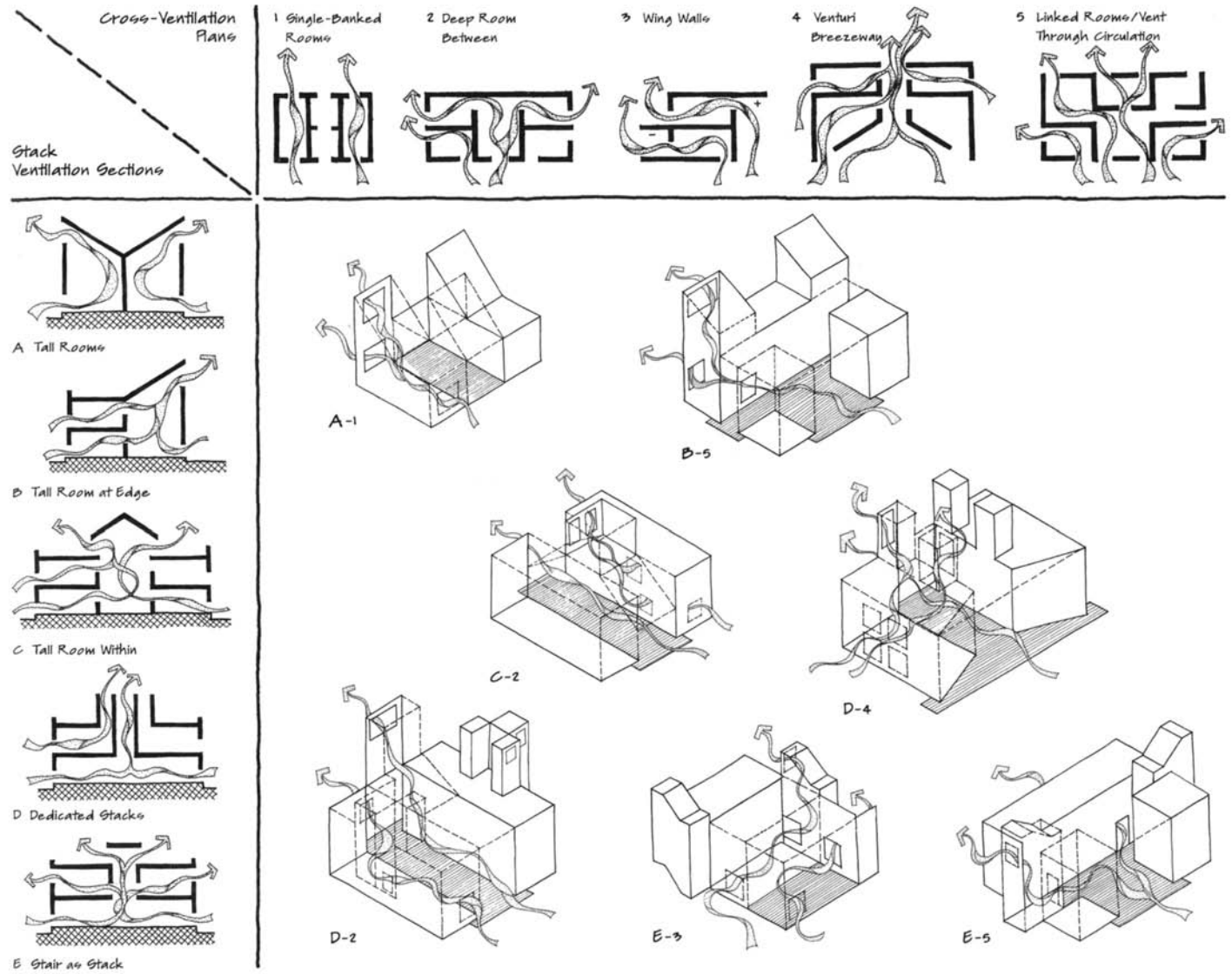
FIG. 19a. Direct Gain

heat gain using sun space





## natural ventilation



Room Organization Strategies That Facilitate Both Cross and Stack-Ventilation





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## PRECEDENTS IN ZERO-ENERGY DESIGN

ARCHITECTURE AND PASSIVE DESIGN IN THE  
2007 SOLAR DECATHLON

PRECEDENTS IN ZERO-ENERGY DESIGN  
Michael Zaretsky Foreword by John D. Quale



MICHAEL ZARETSKY  
FOREWORD BY JOHN D. QUALE





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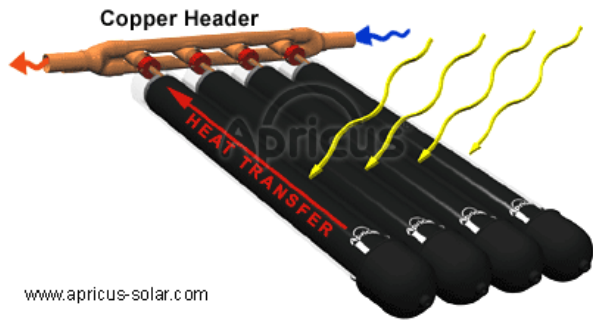
shading control







## solar hot water



[www.apricus-solar.com](http://www.apricus-solar.com)





## hydronic heating and cooling

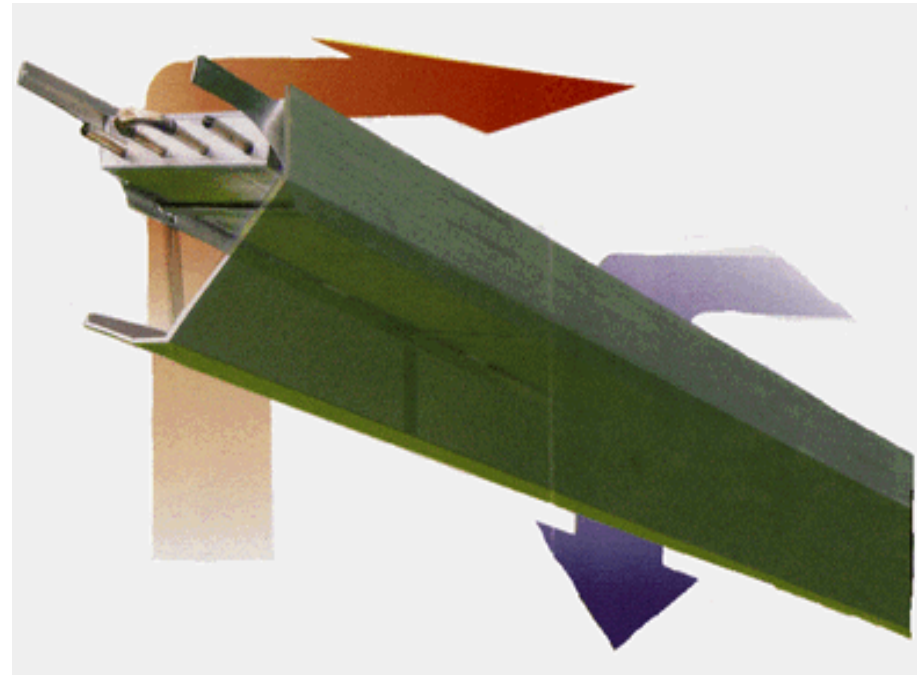
radiators



radiant floor



valance cooling

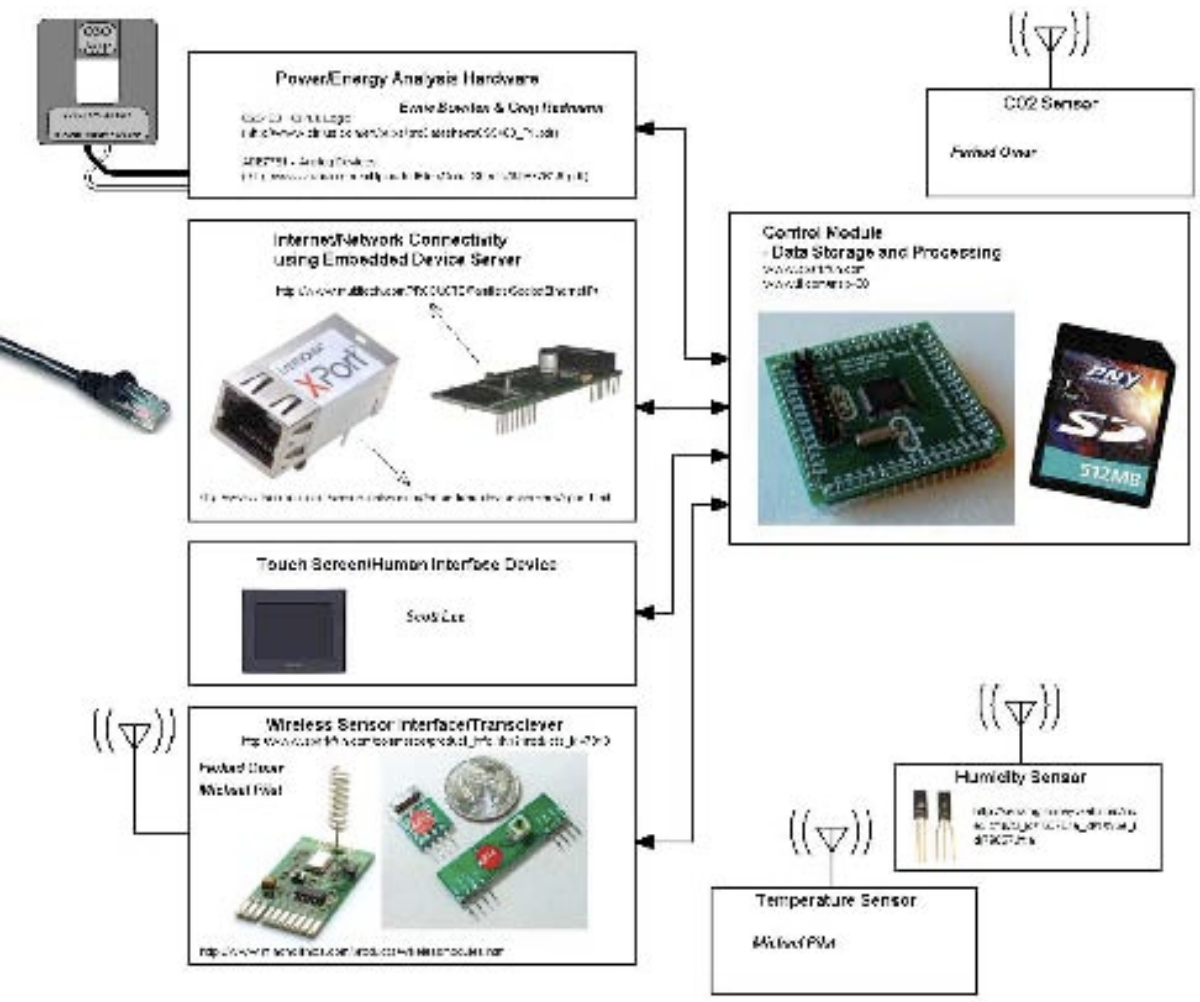




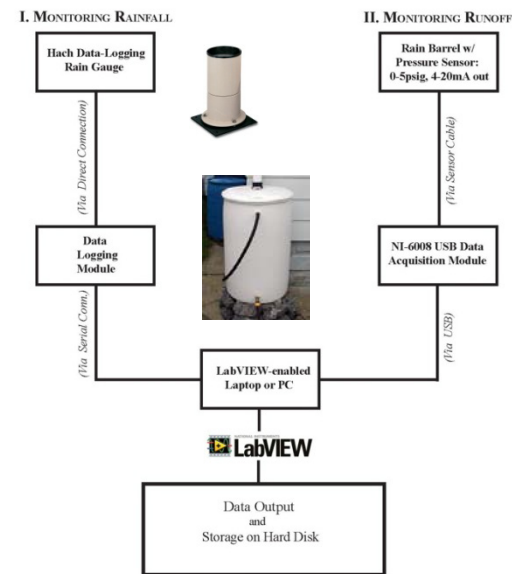


## photovoltaic systems





GREEN ROOF MONITORING SYSTEM: FLOW CHART





## 5

### choose materials wisely

- *increase thermal resistance*
- *reduce potential for moisture or mold problems*
- *source locally and regionally*
- *low maintenance*
- *reuse 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)*







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## 6

remember housing is about humans

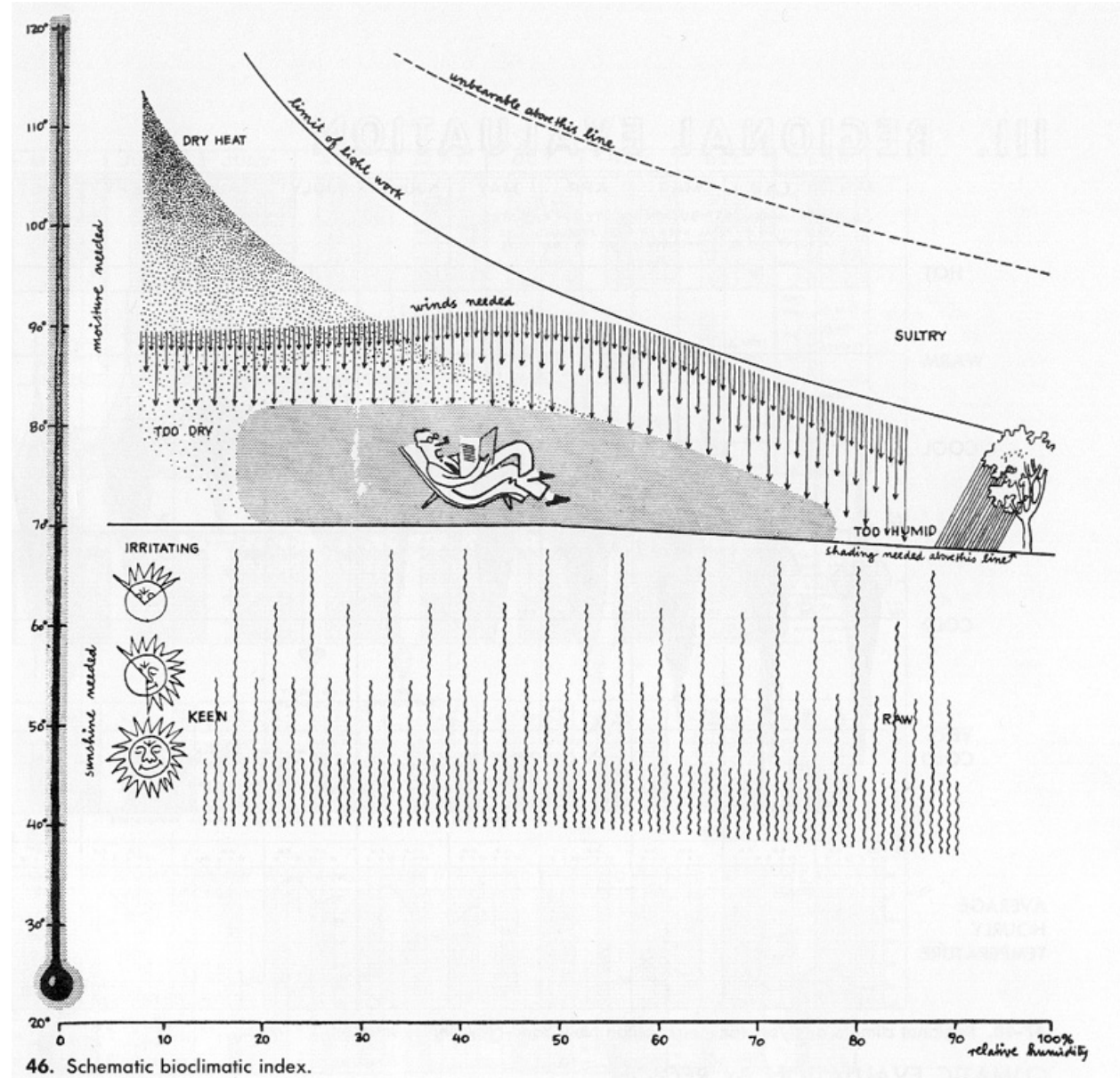
- *indoor air quality*
- *acoustics*
- *daylighting*
- *thermal comfort*
- *inspiration for occupants*
- *evaluate the results*





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## thermal comfort





daylighting





## daylighting

### considerations:

- *site location*
- *movement of the sun*
- *climate*

### design options:

- *sidelighting*
- *toplighting*
- *core daylighting*  
(collection, transportation,  
distribution)
- *atrium*

### design issues:

- *veiling reflections*
- *quantity*
- *glare*

### 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*





## daylighting



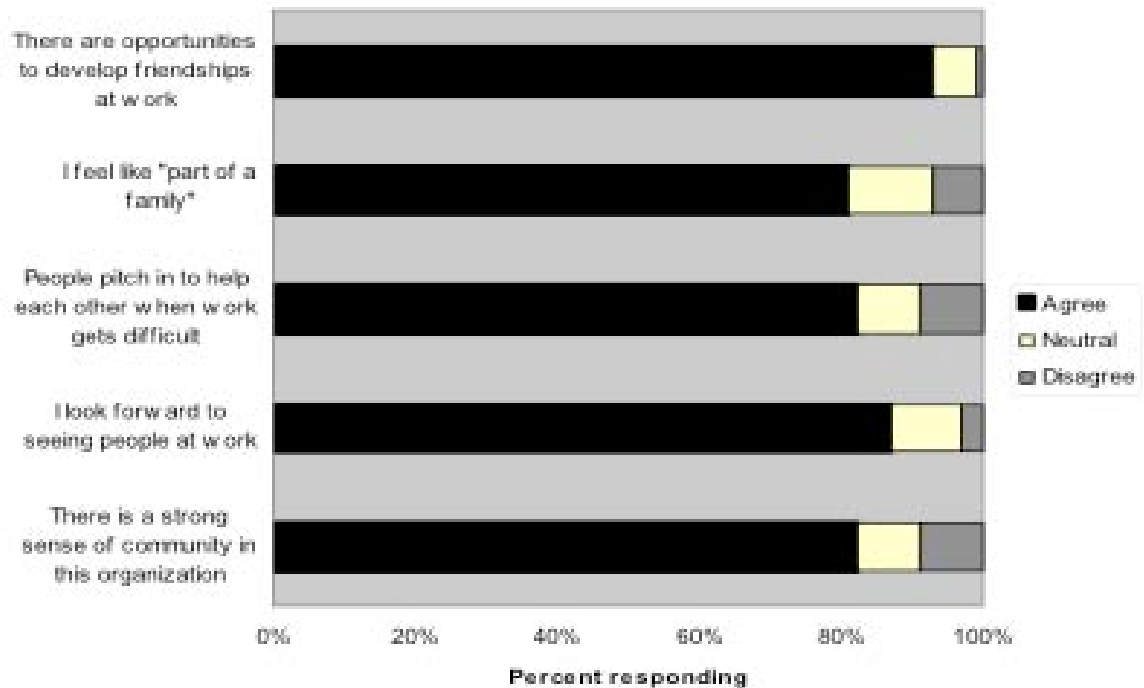


## post occupancy evaluation

### Chesapeake Bay Foundation Merrill Environmental Center



Fig. 9. Sense of Community and Belonging







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, 2<sup>nd</sup> 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](http://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](http://www.buildinggreen.com) (Environmental Building News)

[www.usgbc.org](http://www.usgbc.org)

[www.doe.gov](http://www.doe.gov)

[www.usablebuildings.co.uk](http://www.usablebuildings.co.uk)

[www.epa.gov](http://www.epa.gov)

[www.greenguard.org](http://www.greenguard.org)

[www.builditsolar.com](http://www.builditsolar.com)

