BUILDING GREEN AND SMART HOME

from personal experience

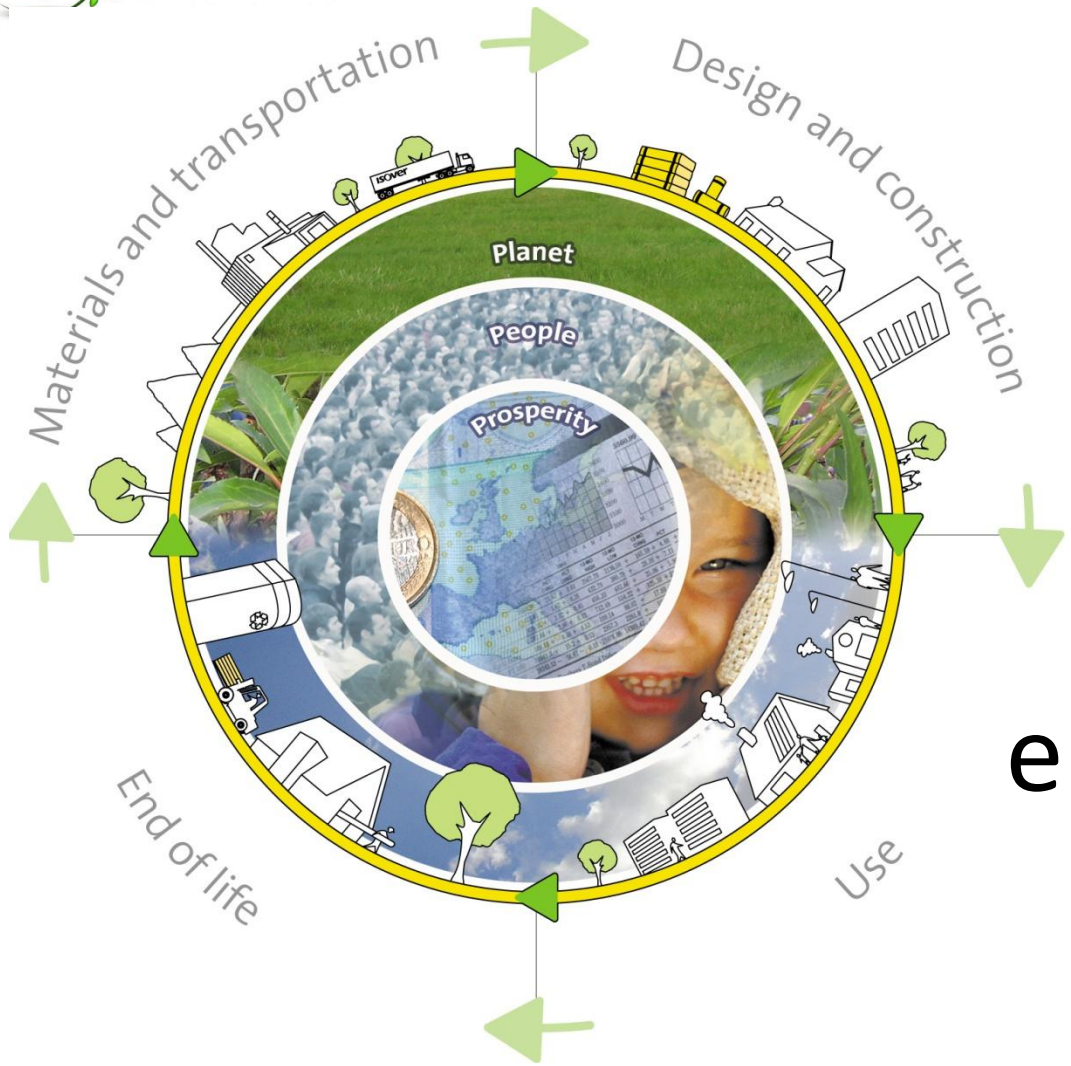
Nenad Uzelac, G&W Electric

What is Green Building?

A structure and process that is **environmentally responsible** and **resource-efficient** throughout a building's life-cycle:

Design – Construction –Operation – Maintenance – Renovation – Demolition

Green Objective:



Reduce environmental footprint!

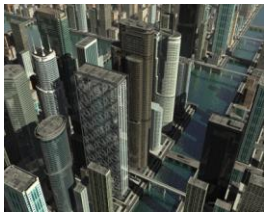
Low impact homes

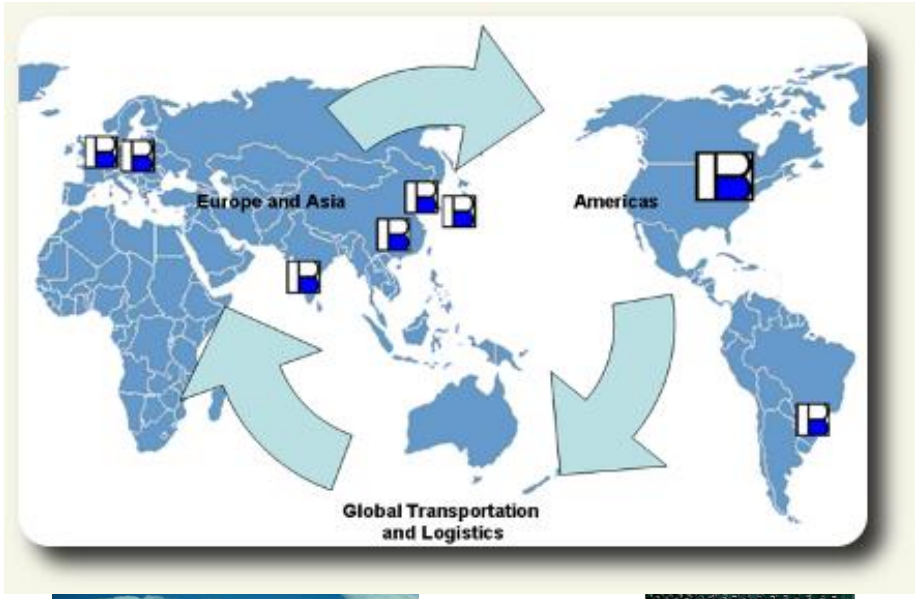
Don’t have to look like this !

They come in any style:

Social Transformation

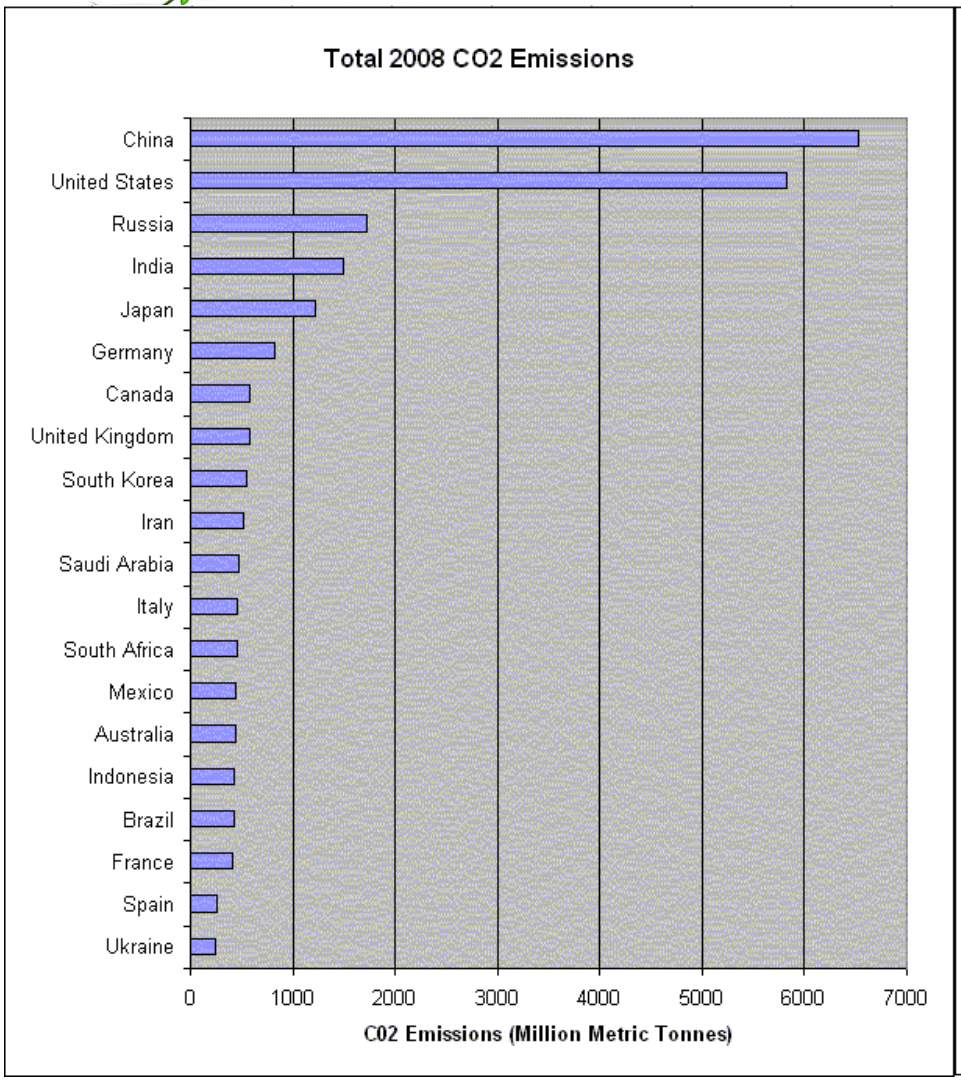
LOCAL

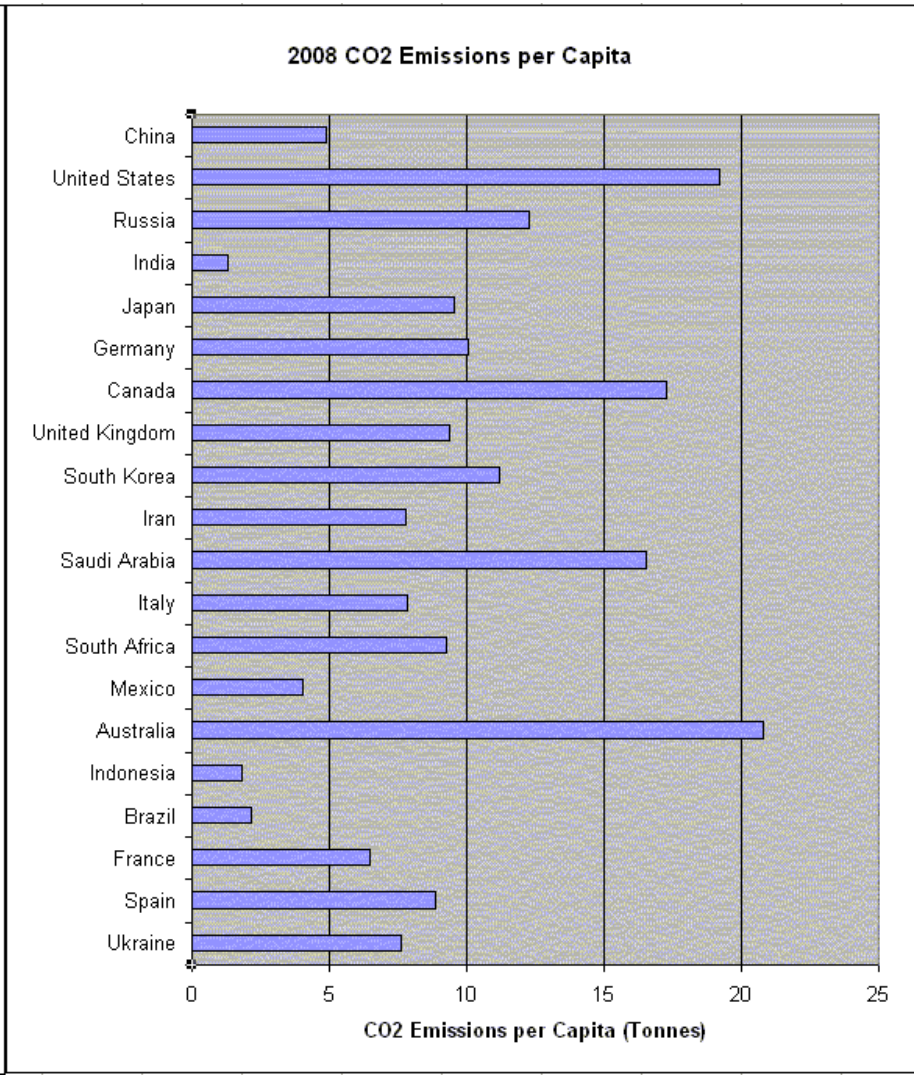




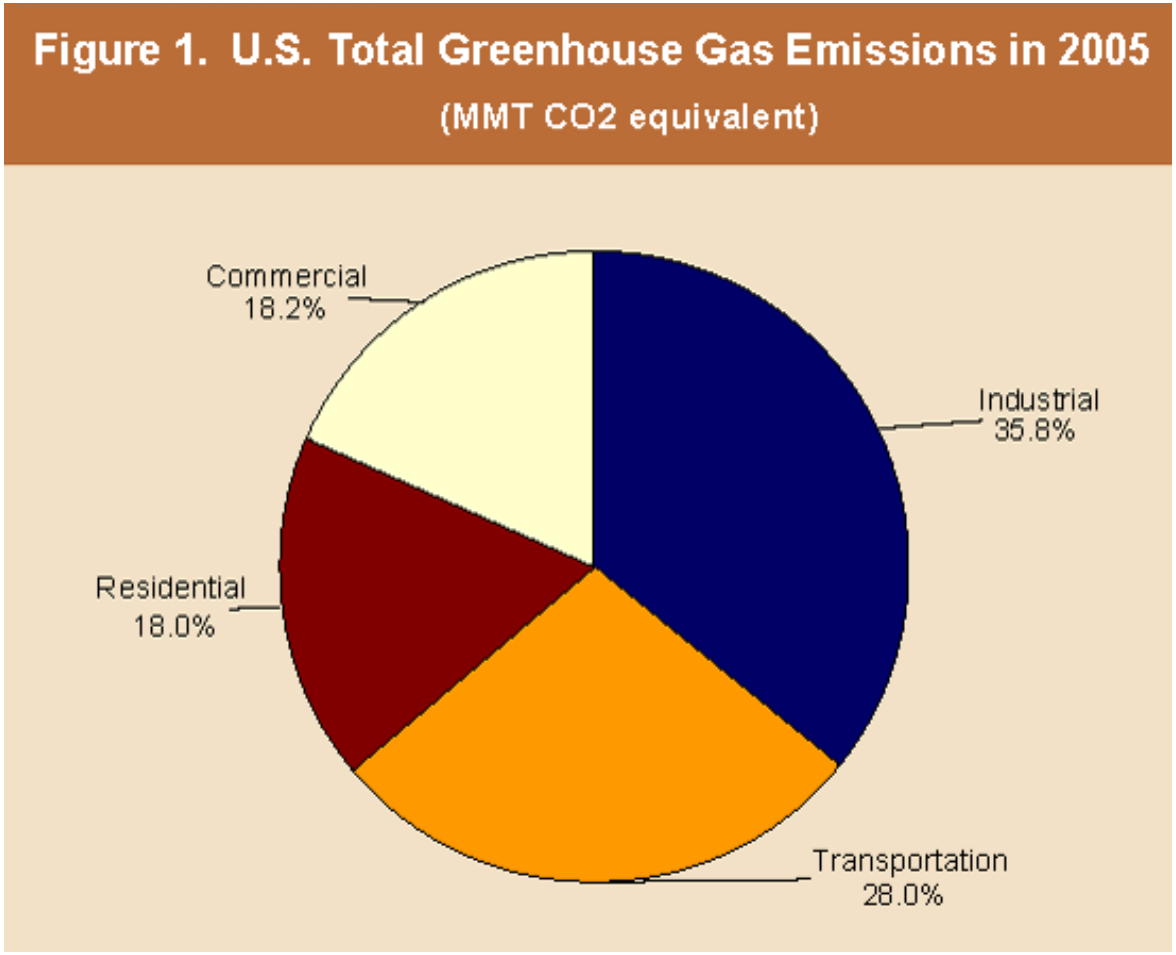
GLOBAL

Total CO2 emissions:





US Greenhouse emissions



Based on annual consumption

40% from buildings!

http://www.nahb.org/generic.aspx?genericContentID=75563

Bad CO2

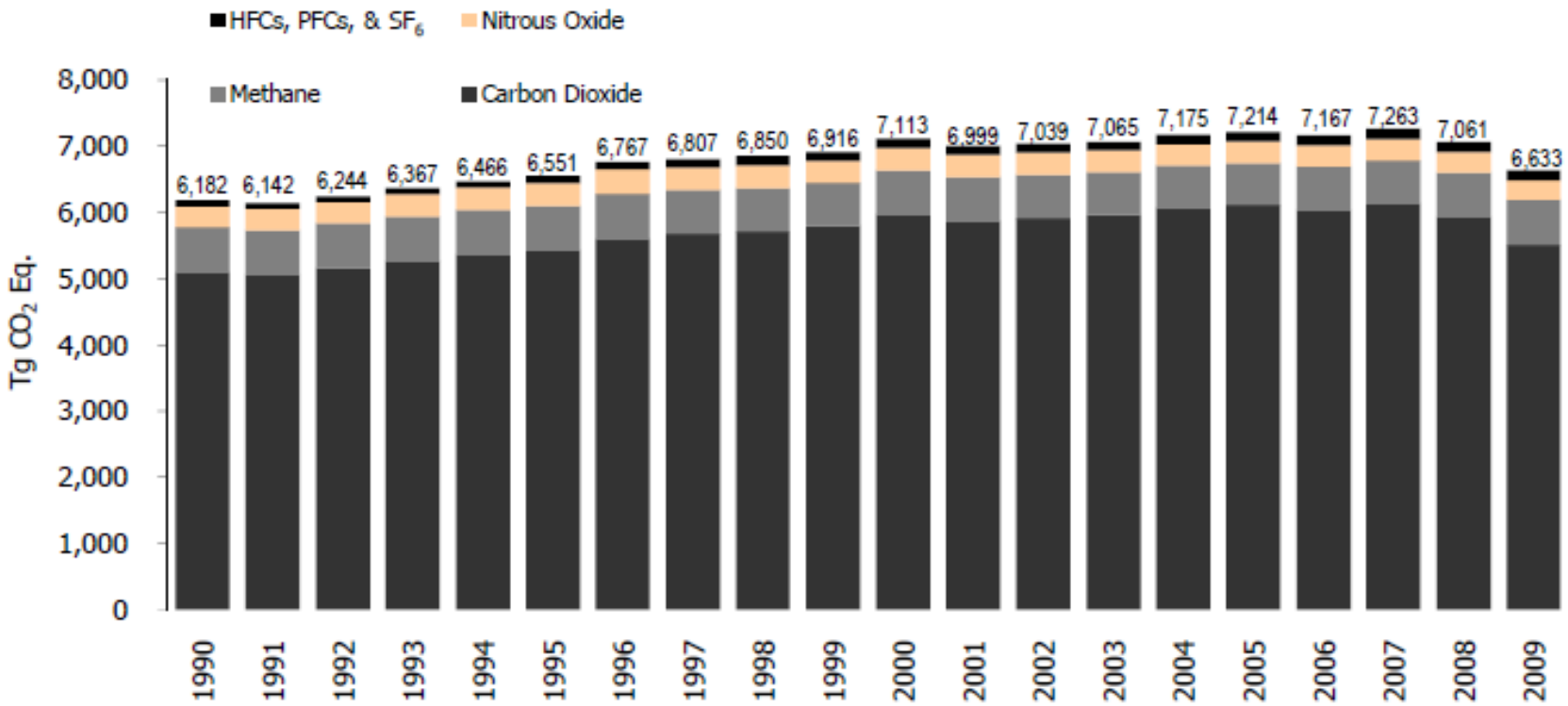


Figure ES-1: U.S. Greenhouse Gas Emissions by Gas

http://www.epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Executive-Summary.pdf

House lifecycle – energy usage

2,450 ft^2 residential home built in Ann Arbor, Michigan was analyzed to determine total life cycle energy consumption of materials fabrication, construction, use and demolition over a 50 year period

Lifecycle Energy distribution:

- 6.1% - construction phase
- 93.7% - use phase
- 0.2% - end of life phase

15,455 GJ

Total life cycle energy consumption:
(2,525 barrels of crude oil)

Green Standards

2 main standards in USA:

Better suitable for residential homes

NAHB NATIONAL GREEN BUILDING PROGRAM™

Approved by ANSI

Better suitable for commercial building homes

U.S. GREEN BUILDING COUNCIL
LEED
USGBC

NAHB Green

Green Building Categories			Performance Point Levels (1) (2)			
			BRONZE	SILVER	GOLD	EMERALD
1.	Chapter 5	Lot Design, Preparation, and Development	39	66	93	119
2.	Chapter 6	Resource Efficiency	45	79	113	146
3.	Chapter 7	Energy Efficiency	30	60	100	120
4.	Chapter 8	Water Efficiency	14	26	41	60
5.	Chapter 9	Indoor Environmental Quality	36	65	100	140
6.	Chapter 10	Operation, Maintenance, and Building Owner Education	8	10	11	12
7.		Additional Points from any category	50	100	100	100
		Total Points	222	406	558	697

Green Home Benefits:

- Economic Benefits:
  - Reduced energy / water consumption
  - Lower maintenance cost (durable materials)
- Health Benefits:
  - Improved indoor quality (nonvolatile organic and non-toxic materials, ventilation, far fewer problems with mold or mildew)
- Environmental Benefits:
  - Reduces environmental footprint

Goals:

- Obtain GOLD level of NAHB green standard
- Consume no more energy then previously owned 1500 sq ft condo
- Guidelines:
  - Quality before Quantity
  - Functionality before Formality
  - Efficiency before Spaciness
  - Comfort and Character

1) Resource efficiency:

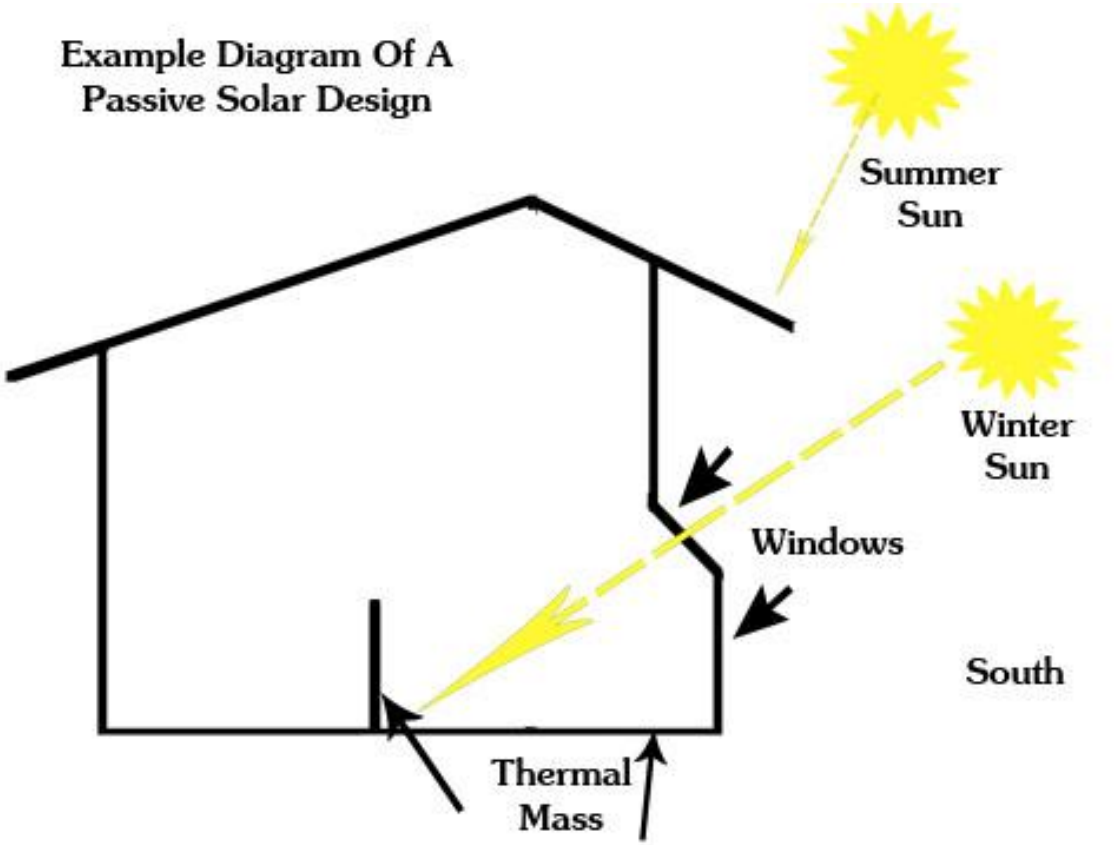
- Reduce the quantity of material used and waste
  - Efficient floor plan, pre-cut joists
- Enhance durability and reduce maintenance
  - Covered entry, roof overhands, flashing details
- Use recycled content material
  - Recycled insulation, countertops, tiles…
- Use renewable materials:
  - Bamboo, FSC wood (forestry stewardship council)

2) Energy efficiency

a) Passive solar design
b) Use daylight to preserve energy
c) Use appropriate windows
d) Insulate and airtight building envelope
e) Use efficient HVAC design
f) Use efficient equipment and monitor consumption
g) Install house automation system

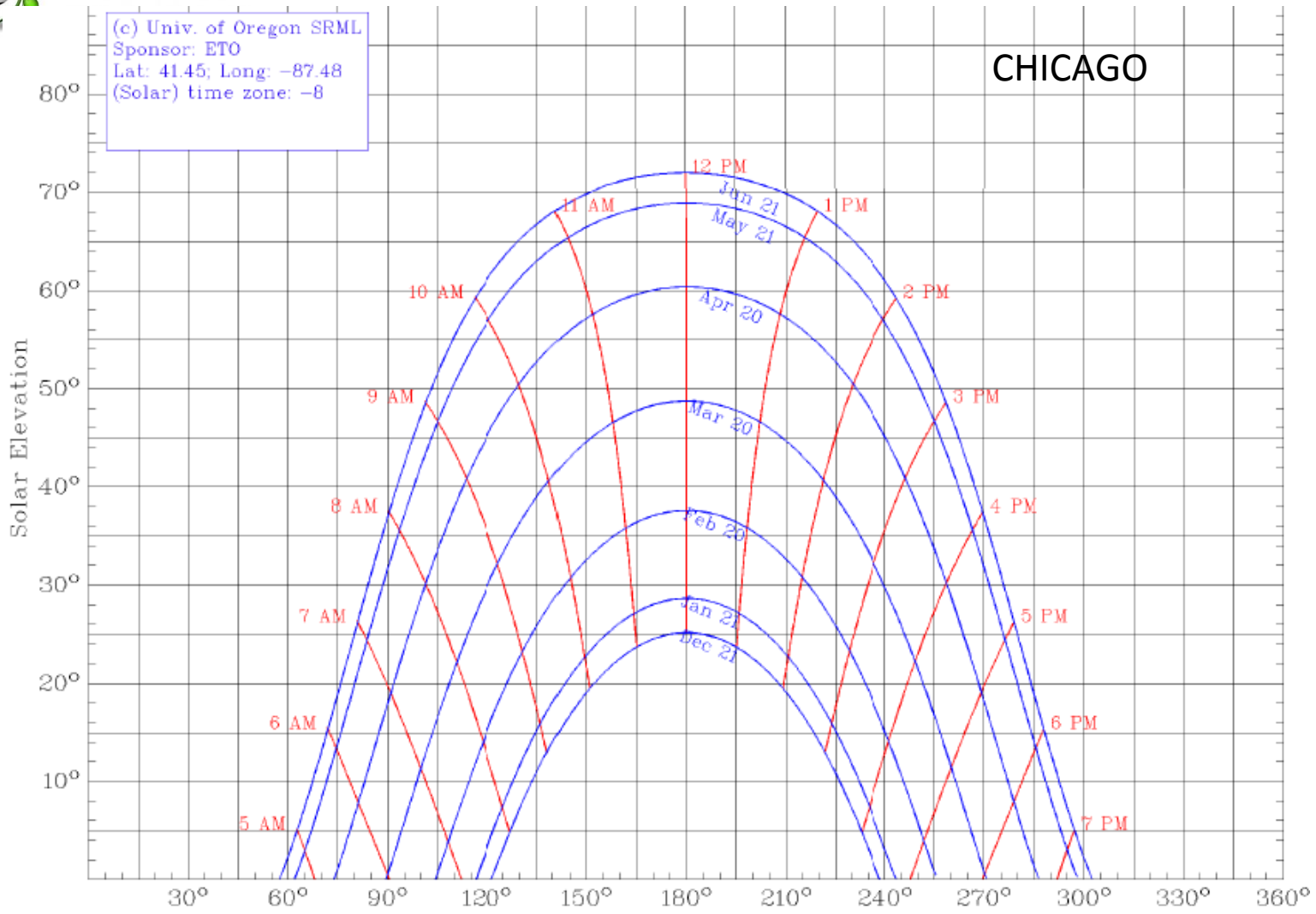
2a

Passive solar design

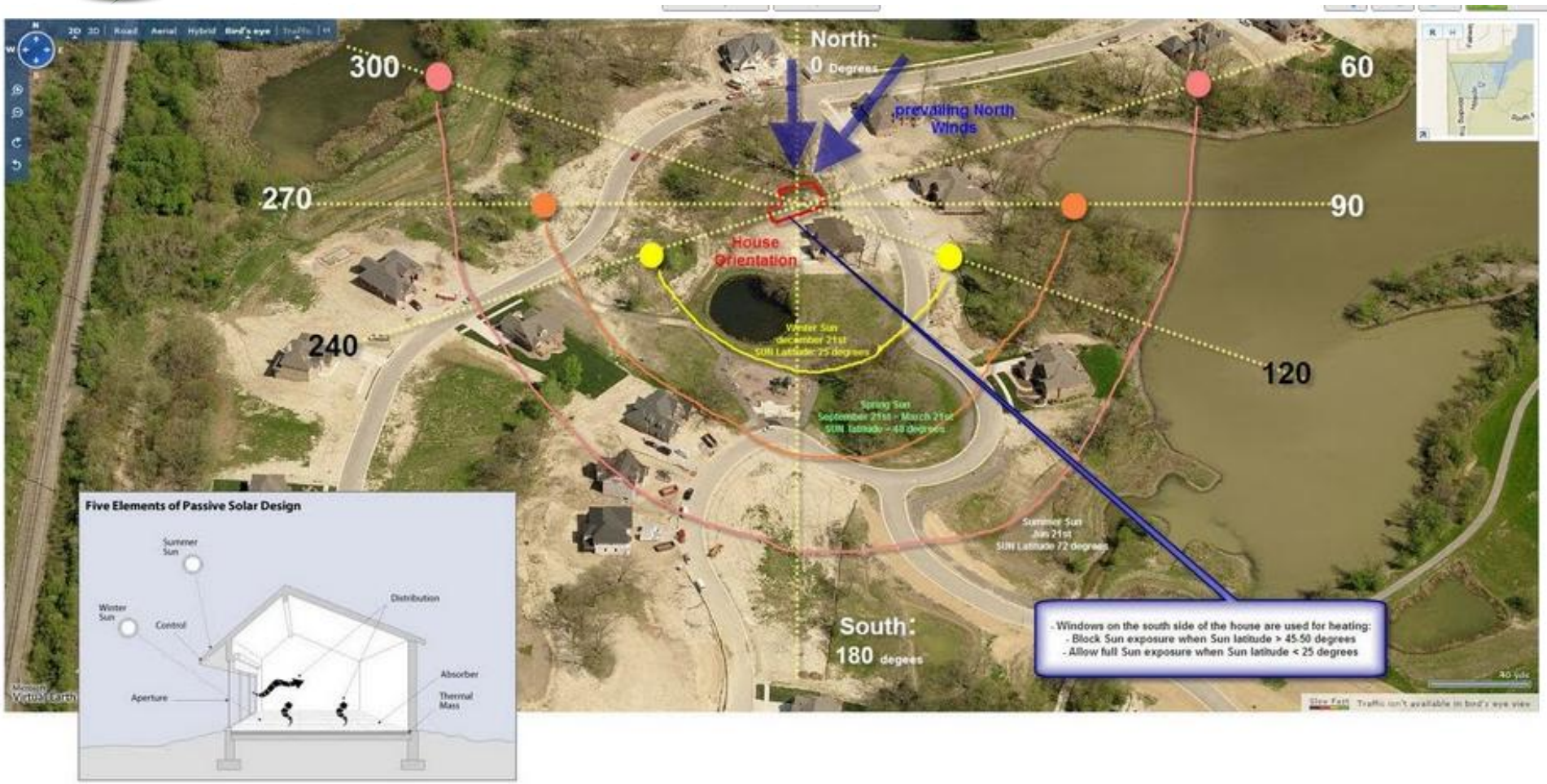


- Way of harnessing Sun energy
- No active components
- Concept used for centuries (Roman bathtubs)

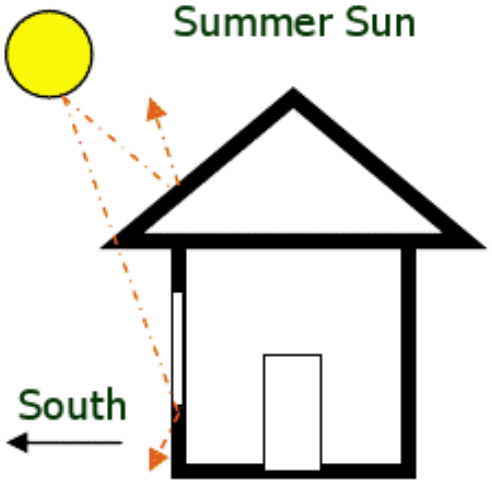
Sun Chart:

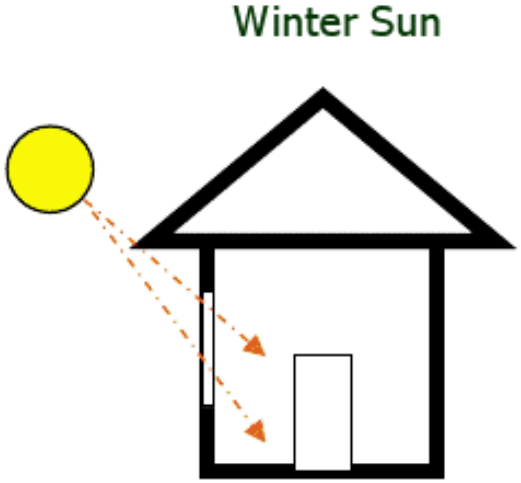

(c) Univ. of Oregon SRML
Sponsor: ETO
Lat: 41.45; Long: -87.48
(Solar) time zone: -8
CHICAGO
Solar Elevation
80°
70°
60°
50°
40°
30°
20°
10°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
360°
12 PM
11 AM
1 PM
10 AM
2 PM
9 AM
3 PM
8 AM
4 PM
7 AM
5 PM
6 AM
6 PM
5 AM
7 PM
Jun 21
May 21
Apr 20
Mar 20
Feb 20
Jan 21
Dec 21

2a Sun chart over Site location



Passive solar (cont)

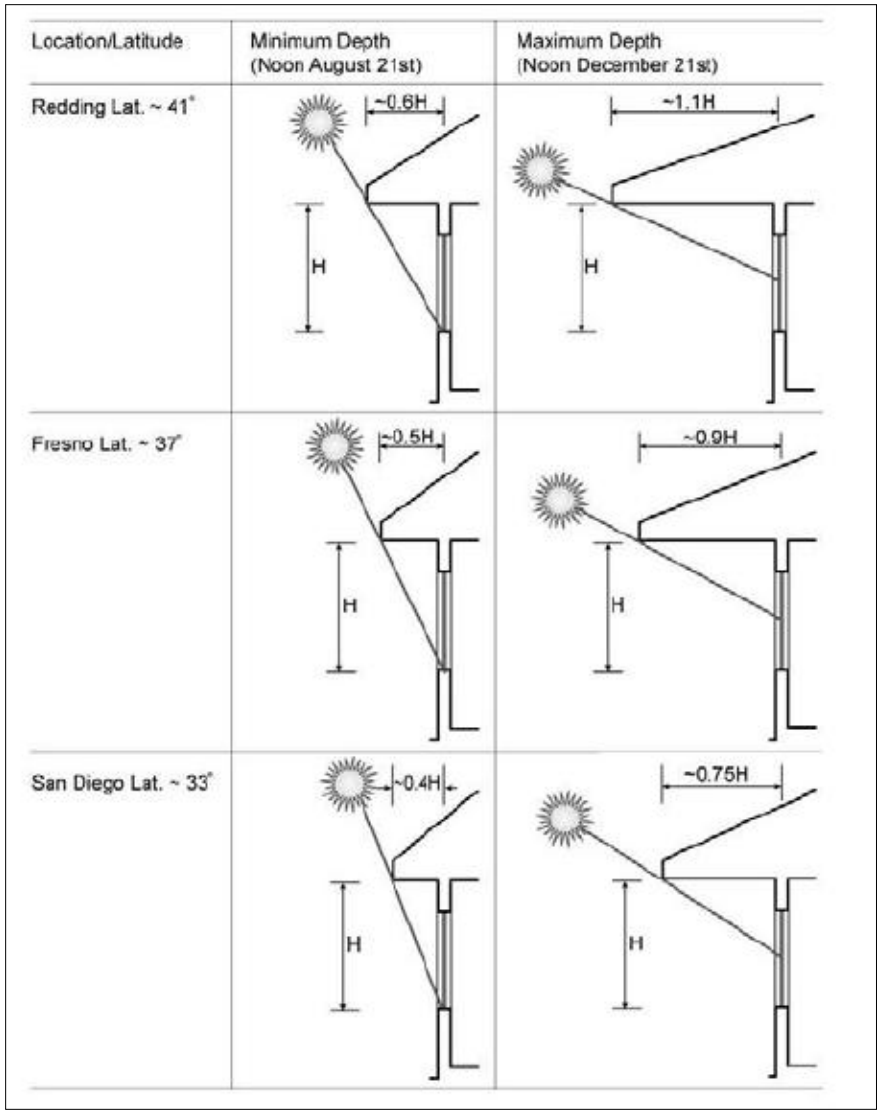




South window surface: 7 – 12% of the sq ft of conditioned area

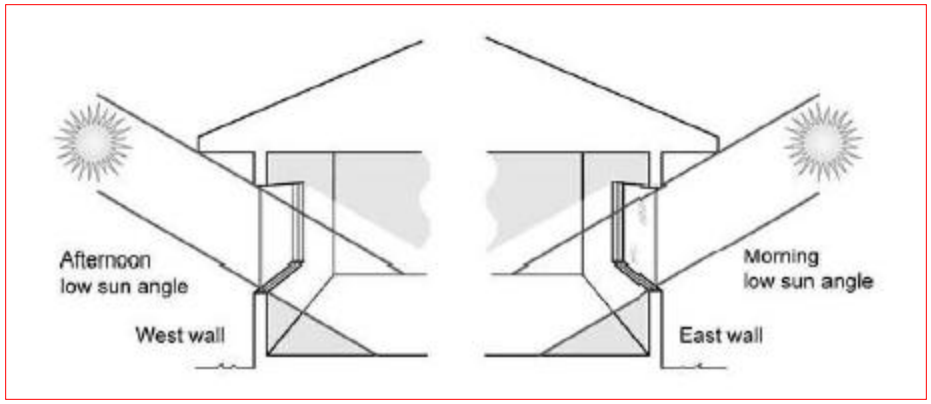
Passive solar (cont)

Depth of overhangs depends of the latitude

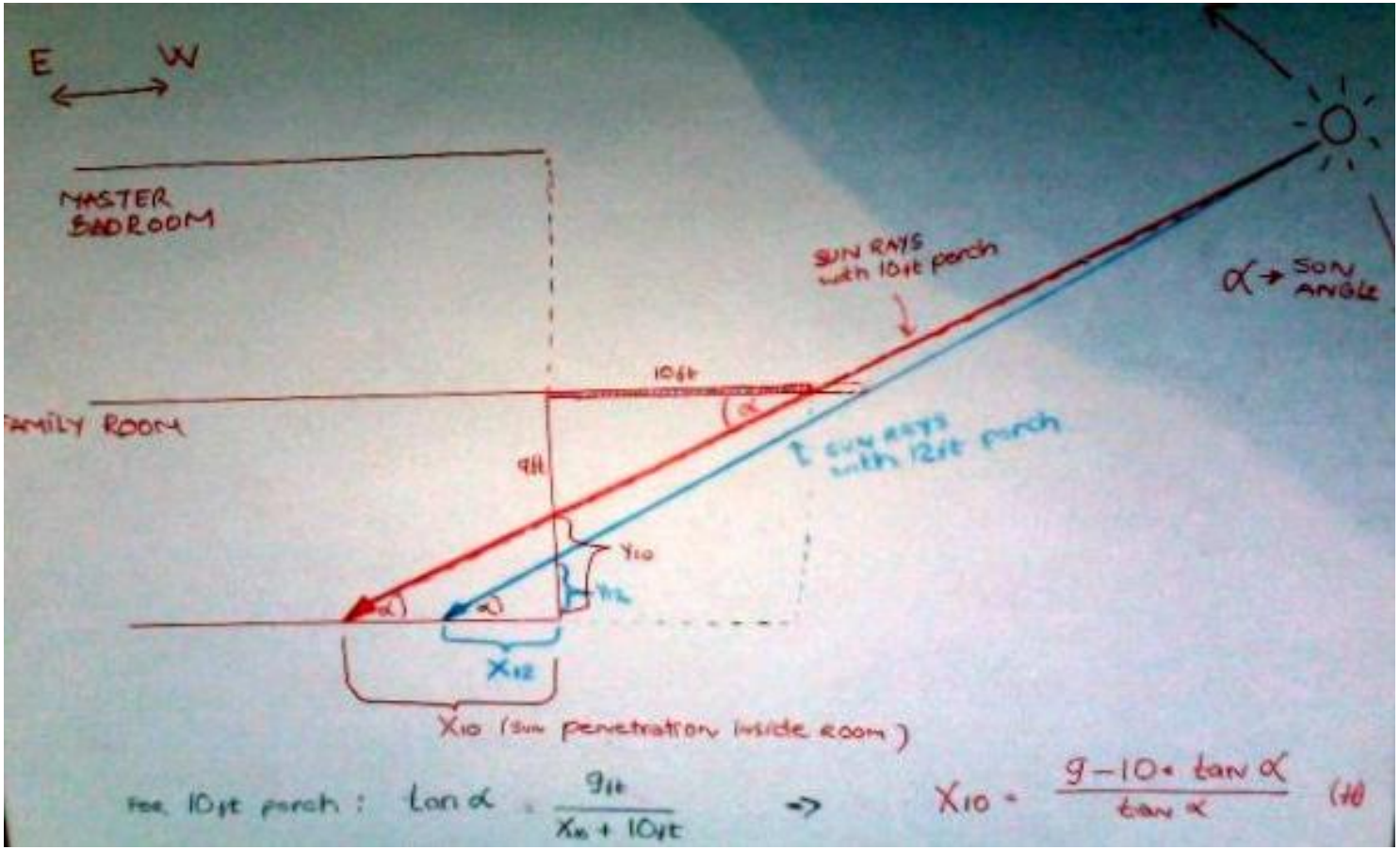


West side windows < 2% of sq ft

North + East windows < 4% of sq ft



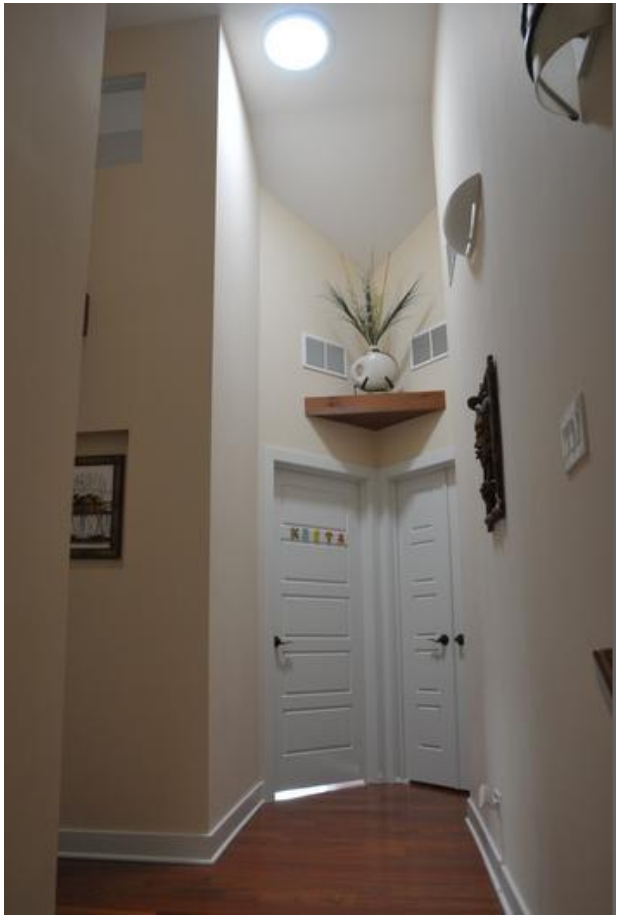
Passive solar (cont)

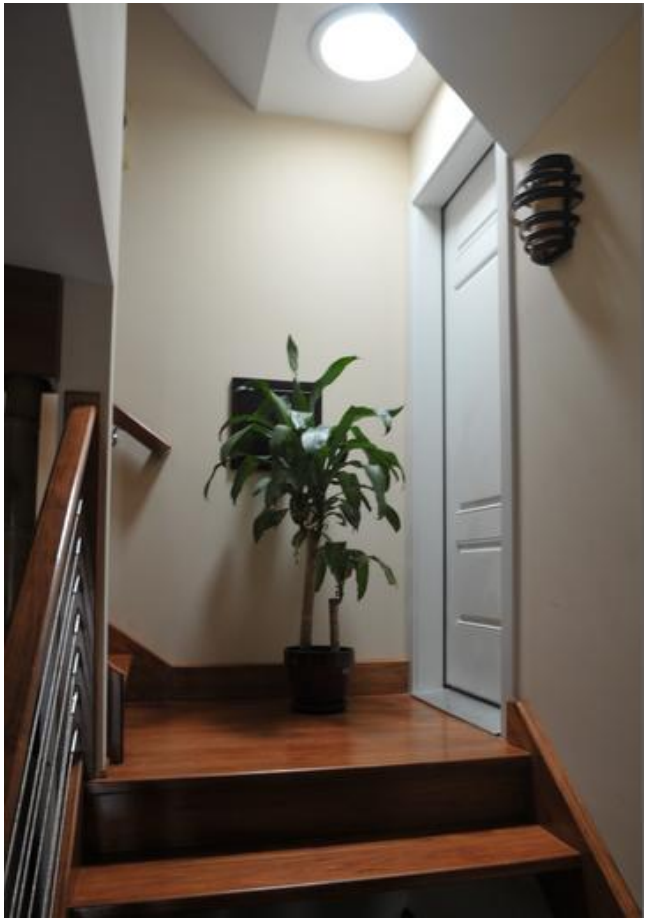


2a It works in Chicago Winter!

-20F outside on the Sunny day heating turned off.

b) Daylight





Well insulated light tubes bring in light without compromising insulation

b) Daylight (cont)

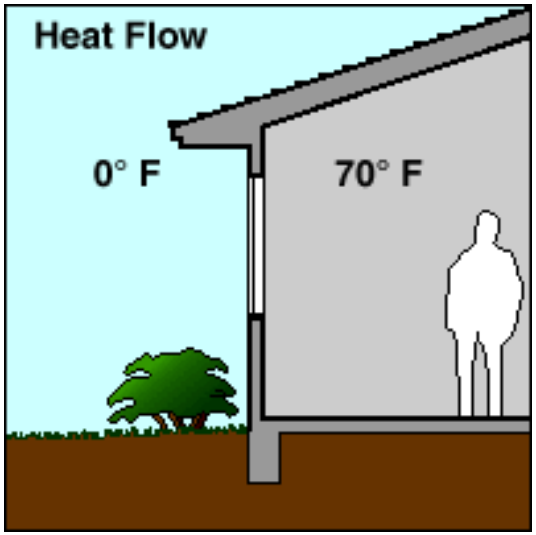
Enough light during an overcast day

2c c) Use appropriate windows

U factor – rate of heat loss

U = 1/R

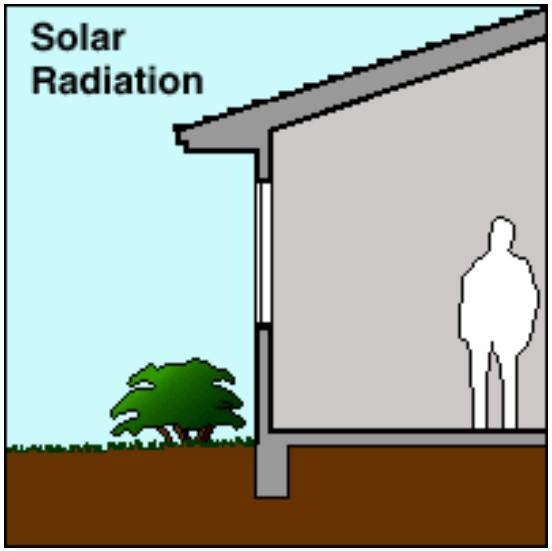
Low U (< 0.31) most important in heating dominating areas



SHGC - solar heat gain coeff

Range (0 – 1)

Use low SHGC in south, and high SHGC in north climates



http://www.efficientwindows.org/energystar.cfm

d) Improve building envelope

- Insulate, Insulate, Insulate
- Add external insulation to prevent thermal bridging and reduce/prevent condensation in the exterior walls

Thermal bridging

Yellow areas indicate the greatest heat loss through uninsulated wood studs.

Cavity Insulation with OSB Sheathing

Blue indicates minimal heat loss.

Cavity Insulation with OSB and R-5 Insulated Sheathing

Insulation

Ceiling - R50: Bat and spray foam insulation

Walls - R32 : cellulose insulation inside + rigid foam outside

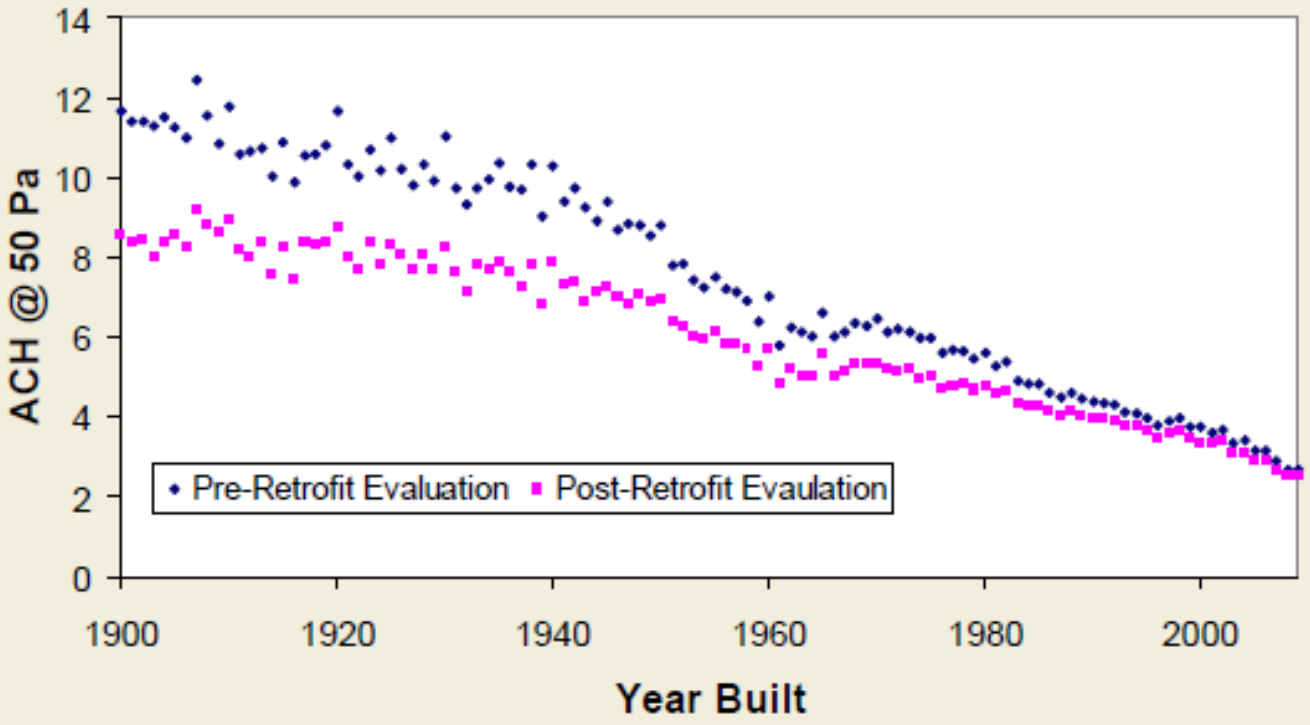
Make house Airtight!

2e Airtight building envelope (cont)

- Old houses can loose as much heat through air leakage as through building envelope conduction.
- Moisture, condensation..
- Door blower test
- Mechanical ventilation system may be required, if ACH (air exchange per hour) < 0.35

2e Air leakage in Canadian homes

Air Leakage by Year



12

Efficient HVAC design

- Properly size the equipment (Heat loss calculation, ACCA “Manual J” for residential homes
- Bigger is not Better. Oversized equipment leads to:
  - Higher energy bills
  - Higher initial cost
  - Uncomfortably cold/hot spots
  - Indoor humidity

SEER rating

- Higher SEER (Seasonal energy efficiency ration) means better efficiency

SEER	1 Ton	1.5 Ton	2 Ton	2.5 Ton	3 Ton	3.5 Ton	4 Ton	5 Ton
8	$ 270	$ 405	$ 540	$ 675	$ 810	$ 945	$ 1,080	$ 1,350
9	$ 240	$ 360	$ 480	$ 600	$ 720	$ 840	$ 960	$ 1,200
10	$ 216	$ 324	$ 432	$ 540	$ 648	$ 756	$ 864	$ 1,080
11	$ 196	$ 295	$ 393	$ 491	$ 589	$ 687	$ 785	$ 982
12	$ 180	$ 270	$ 360	$ 450	$ 540	$ 630	$ 720	$ 900
13	$ 166	$ 249	$ 332	$ 415	$ 498	$ 582	$ 665	$ 831
14	$ 154	$ 231	$ 309	$ 386	$ 463	$ 540	$ 617	$ 771
15	$ 144	$ 216	$ 288	$ 360	$ 432	$ 504	$ 576	$ 720
16	$ 135	$ 203	$ 270	$ 338	$ 405	$ 473	$ 540	$ 675
17	$ 127	$ 191	$ 254	$ 318	$ 381	$ 445	$ 508	$ 635
18	$ 120	$ 180	$ 240	$ 300	$ 360	$ 420	$ 480	$ 600
19	$ 114	$ 171	$ 227	$ 284	$ 341	$ 398	$ 455	$ 568
20	$ 108	$ 162	$ 216	$ 270	$ 324	$ 378	$ 432	$ 540
21	$ 103	$ 154	$ 206	$ 257	$ 309	$ 360	$ 411	$ 514
22	$ 98	$ 147	$ 196	$ 245	$ 295	$ 344	$ 393	$ 491
23	$ 94	$ 141	$ 188	$ 235	$ 282	$ 329	$ 376	$ 470
24	$ 90	$ 135	$ 180	$ 225	$ 270	$ 315	$ 360	$ 450
25	$ 86	$ 130	$ 173	$ 216	$ 259	$ 302	$ 346	$ 432
26	$ 83	$ 125	$ 166	$ 208	$ 249	$ 291	$ 332	$ 415

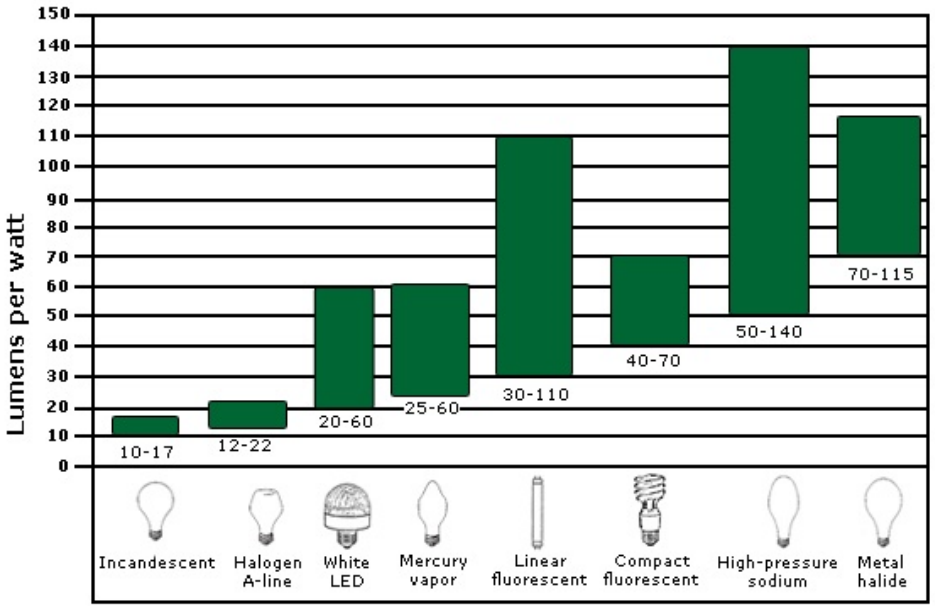
Base on 9 cent a KW and 2000 cooling hours

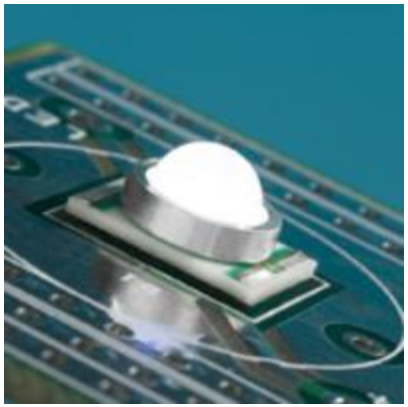
Efficient El. Equipment:

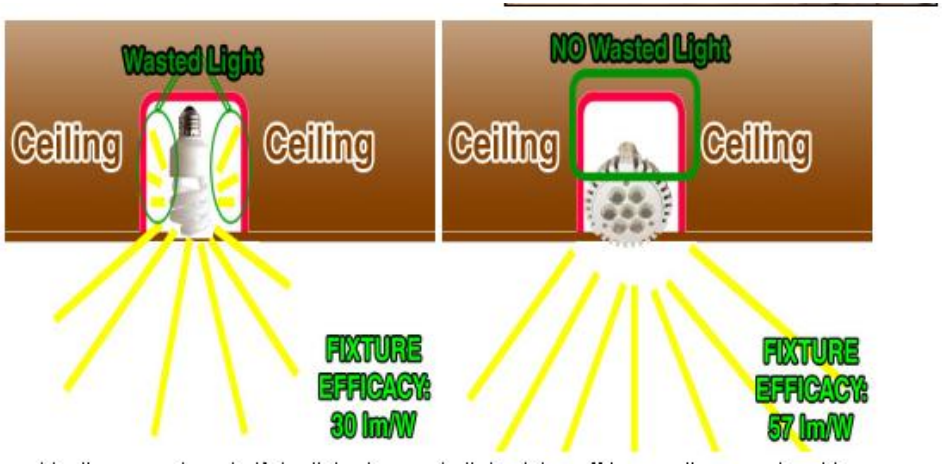
Energy star appliances

Compact Fluorescent Lights

Lumens per Watt







In 2011 CREE developed white LED (4500K) that has 231 lumens / watt !

CASE 1: warm white LED strips

5M 500CM Warm White 3528 SMD LED Strip Lights 300 leds

Like

On Ebay:

300 LEDs, 15ft, 12Vdc, 0.4A,
250 lumens

Use with 12Vdc power supply

Warm white LED strips

Warm white LED strips

Cove light
(30ft = 10W)

Under cabinet light – using 2 strips mounted parallel

Kick toe light

CASE 2: multi color LED strip

New 5M 5050 RGB LED Strip 44key Controller Power Supply

LED strip + Remote + Controller + 12Vdc Power supply=

Multi Color LED strip

CASE 3: LED downlight

120Vac, MR16 light fixture

LED downlight

Halogen

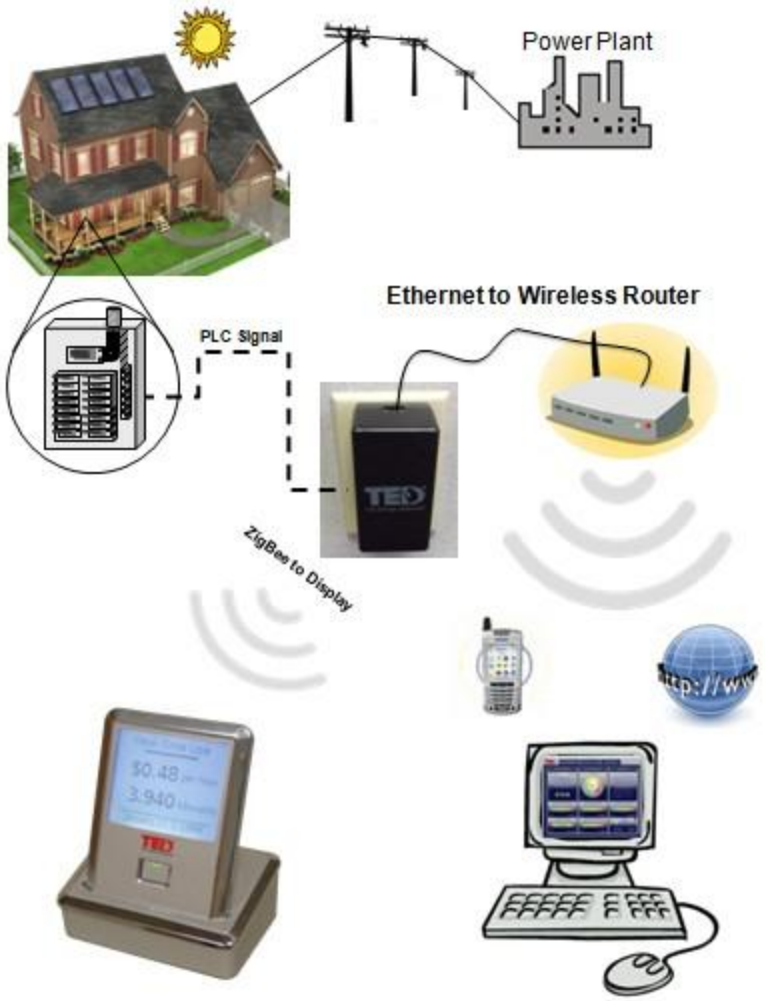
LED

LED downlight

3 Halogen lights

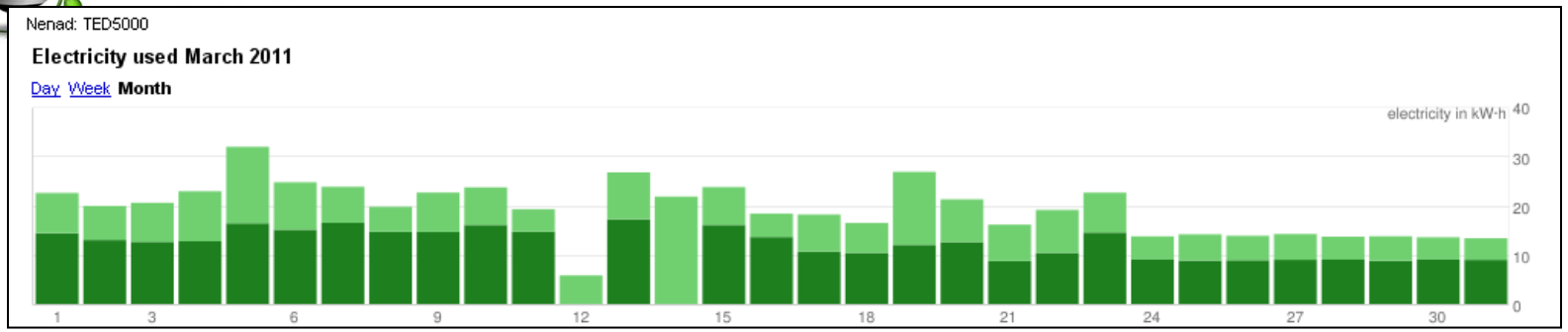
3 LED lights

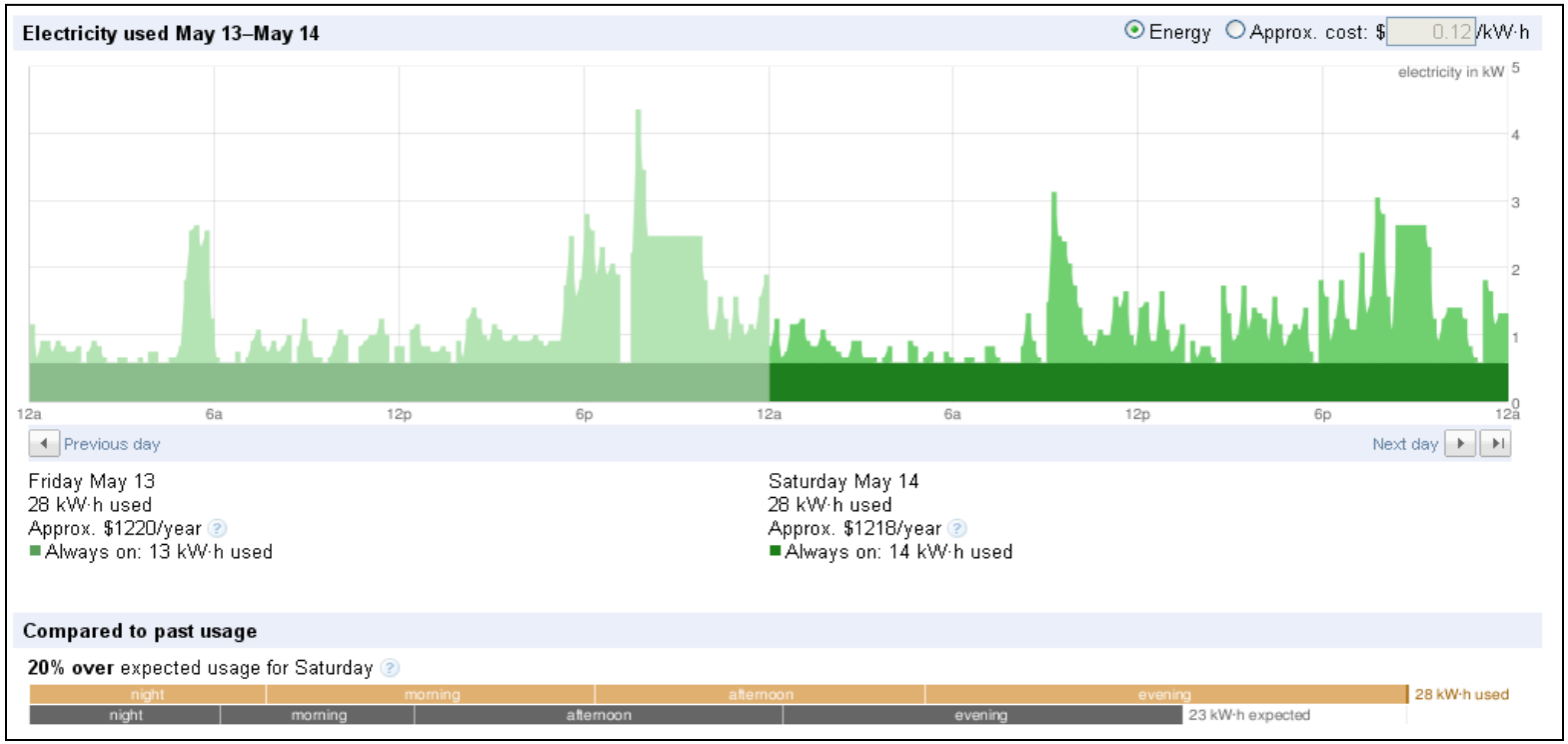
Monitor Power Consumption



- TED 5000 energy detective
- Real time monitor power consumption
- Record data in GOOGLE power module
- See it on computer, smart phone, Ipod

Power consumption data:





House automation system

Criteria:

- Reliable
- Secure
- Affordable
- Scalable
- DYI

2 wireless systems:

Z-WAVE	ZigBee Control your world
Developed by Zensys	IEEE 802.15.4
900 MHz	2.4 GHz (global)
Up to 30m range	10 – 100m range
Lower cost	

Zwave components:

keylock

thermostat

remote

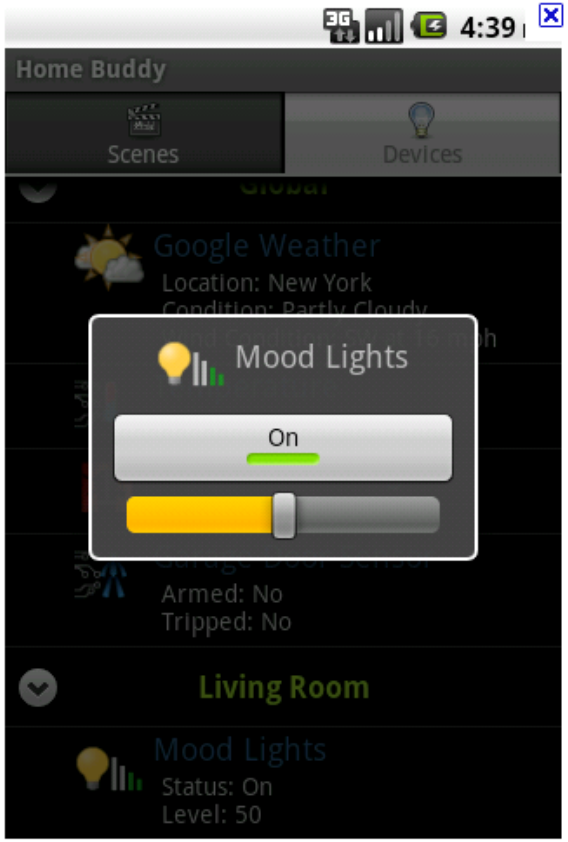
Appliance switch

Motion/temp sensor

router

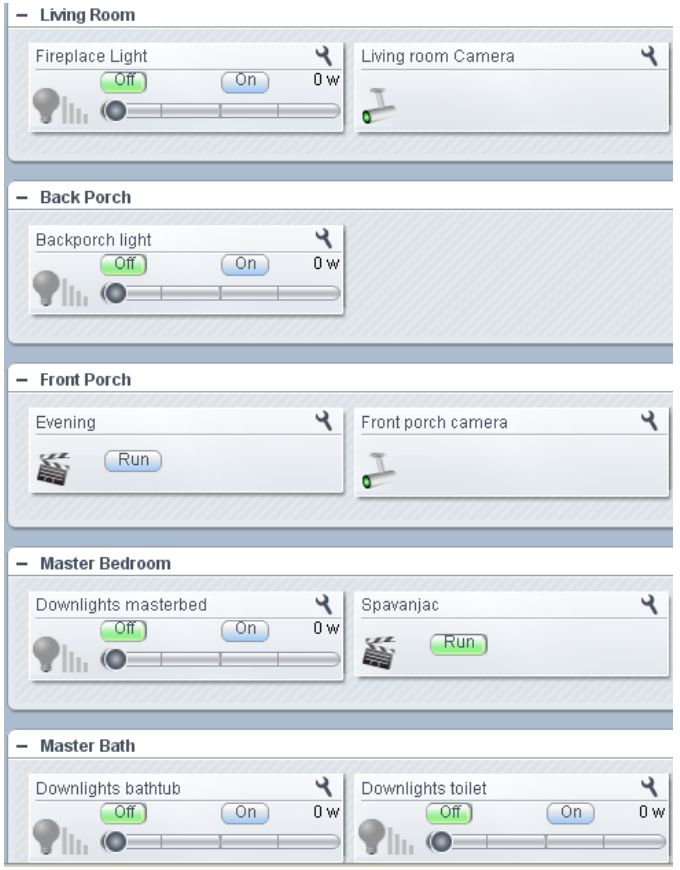
dimmer

Remote/local access:



Android phone

Iphone



PC/MAC browser

Applications:

- Automatically turn on/off lights when on vacation
- Turn off all loads when leaving the house
- Adjust thermostat from the bed, or away from home
- Automatically turn off selected lights during Sunny day
- Receive a text message when someone rings the door bell
- Receive an email with photo when camera with armed sensor detects motion
- Turn on the lights in bedroom during severe weather

Integration:

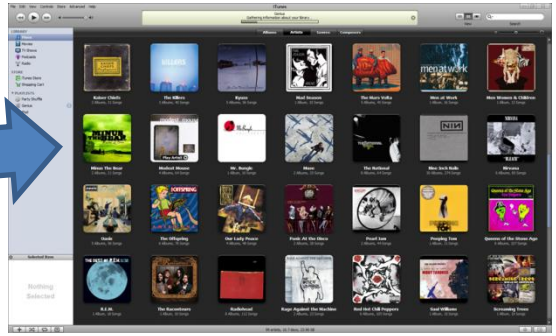
light

Alarm system

surveillance

TV / movies

tablet



music

Home automation

Operate everything in the house with one device

Irrigation

Water Efficiency

Touch faucet

Low flow rate shower

Drip irrigation system

Indoor air quality

- No Carpets
- Low VOC paint / stain
- Direct vent fireplace
- Tightly sealed doors to garage
- MERV9 filter
- Whole house ventilation system

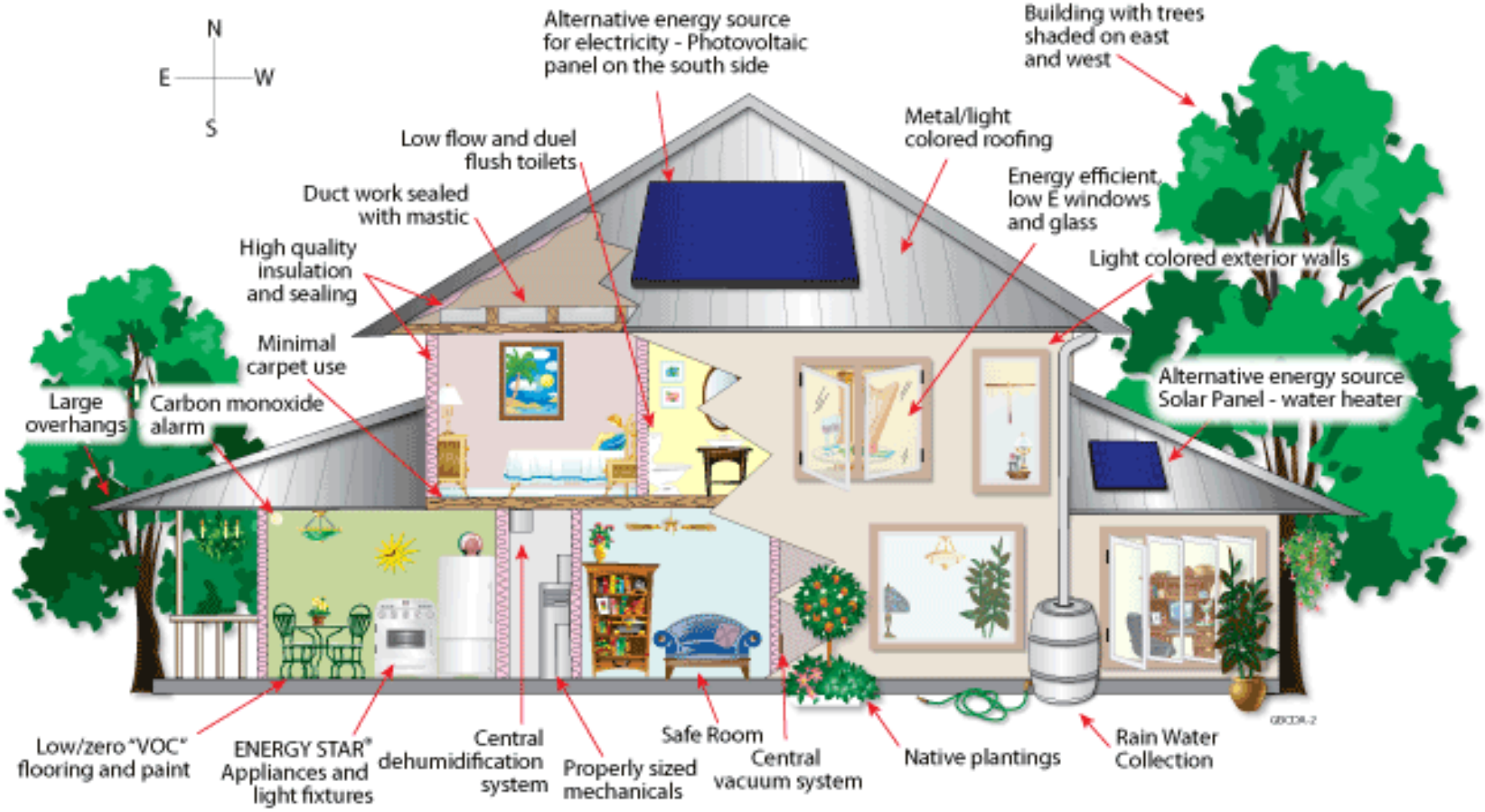
Lesson learned:

- Installing 5 occupancy sensors = 20 points
- Passive solar feature of the house = 10 points
- Carbon reduction is not proportional to number of points.
- Go for QUALITY, NOT QUANTITY (smaller, more functional, more durable, less cleaning, less maintenance)
- Use standard as a guideline, not Bible.
- MINIMIZE ENERGY consumption.
- Don’t forget to have FUN in the process!

References:

- Passive solar design: “The sun inspired house” http://www.sunplans.com/store/book
- Bigger is not better “Not So Big House”: *http://www.notsobighouse.com/*
- Sun Charts: *http://solardat.uoregon.edu/cgi-bin/SunChart.cgi*
- Misc solar tools: *http://www.builditsolar.com/References/SunChartRS.htm*
- Overhang design: *http://www.susdesign.com/overhang/*
- Building science: *http://www.buildingscience.com/index_html*
- Perfect Wall design: *http://www.buildingscience.com/documents/insights/bsi-001-the-perfect-wall*
- Supported ZWAVE devices: *http://wiki.micasaverde.com/index.php/Supported_Hardware*
- NAHB Green standard: *http://store.builderbooks.com/cgi-bin/builderbooks/874*

QUESTIONS?


N
E
W
S
Alternative energy source for electricity - Photovoltaic panel on the south side
Building with trees shaded on east and west
Metal/light colored roofing
Low flow and duel flush toilets
Energy efficient, low E windows and glass
Duct work sealed with mastic
High quality insulation and sealing
Light colored exterior walls
Minimal carpet use
Alternative energy source Solar Panel - water heater
Large overhangs
Carbon monoxide alarm
Low/zero "VOC" flooring and paint
ENERGY STAR® Appliances and light fixtures
Central dehumidification system
Properly sized mechanicals
Safe Room
Central vacuum system
Native plantings
Rain Water Collection