Radical | Green

Arch 125: Introduction to Environmental Design
Winter 2014

"The world will not evolve past its current state of crisis by using the same thinking that created the situation."

– Albert Einstein

…the world of DESIGN needs some Radical thinking!

Being less BAD is not GOOD enough

Radical CONFLICT!??

#1 – GLOBAL WARMING – too much CO_2

#2 – RUNNING OUT OF OIL (oil causes CO_2)

POLLUTION IS AN ACT OF DESIGN

Remember, EVERYTHING that is called 'disposable' was DESIGNED from day one to be garbage--as its PRIMARY and overriding design consideration."


EVEN THIS BUILDING!
GATE 1
NO PARKING

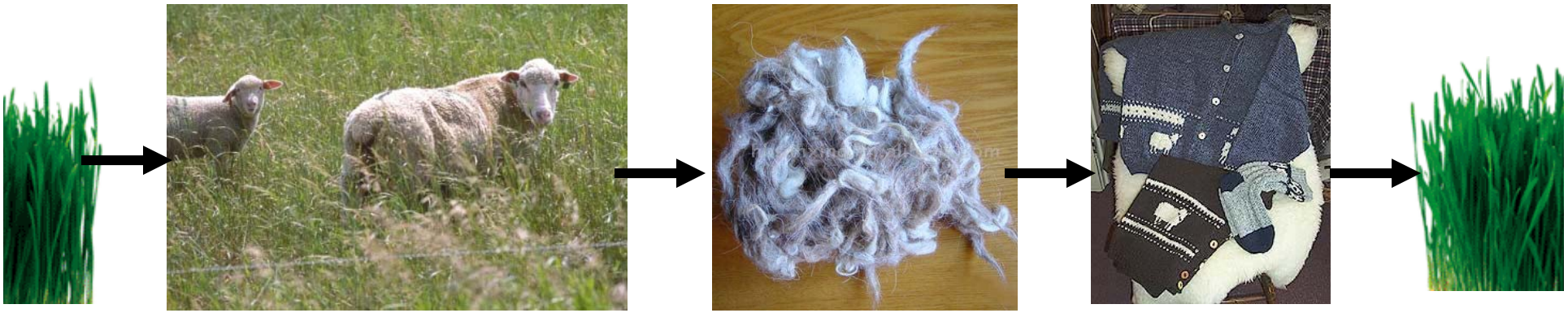
Radical PHILOSOPHY!??

WASTE = FOOD

(the human race is the only species to DESIGN things with the INTENTION that they become GARBAGE!)

MIMIC NATURAL CYCLES

Design for a closed loop where WASTE becomes FOOD and FEEDS back into a healthy cycle….



compostable end product

Radical PROPOSITION!??

DESIGN FOR DISASSEMBLY

So that we can take things (even buildings!) apart and easily repair or reuse them

REUSE MEANS LESS ENERGY THAN RECYCLE

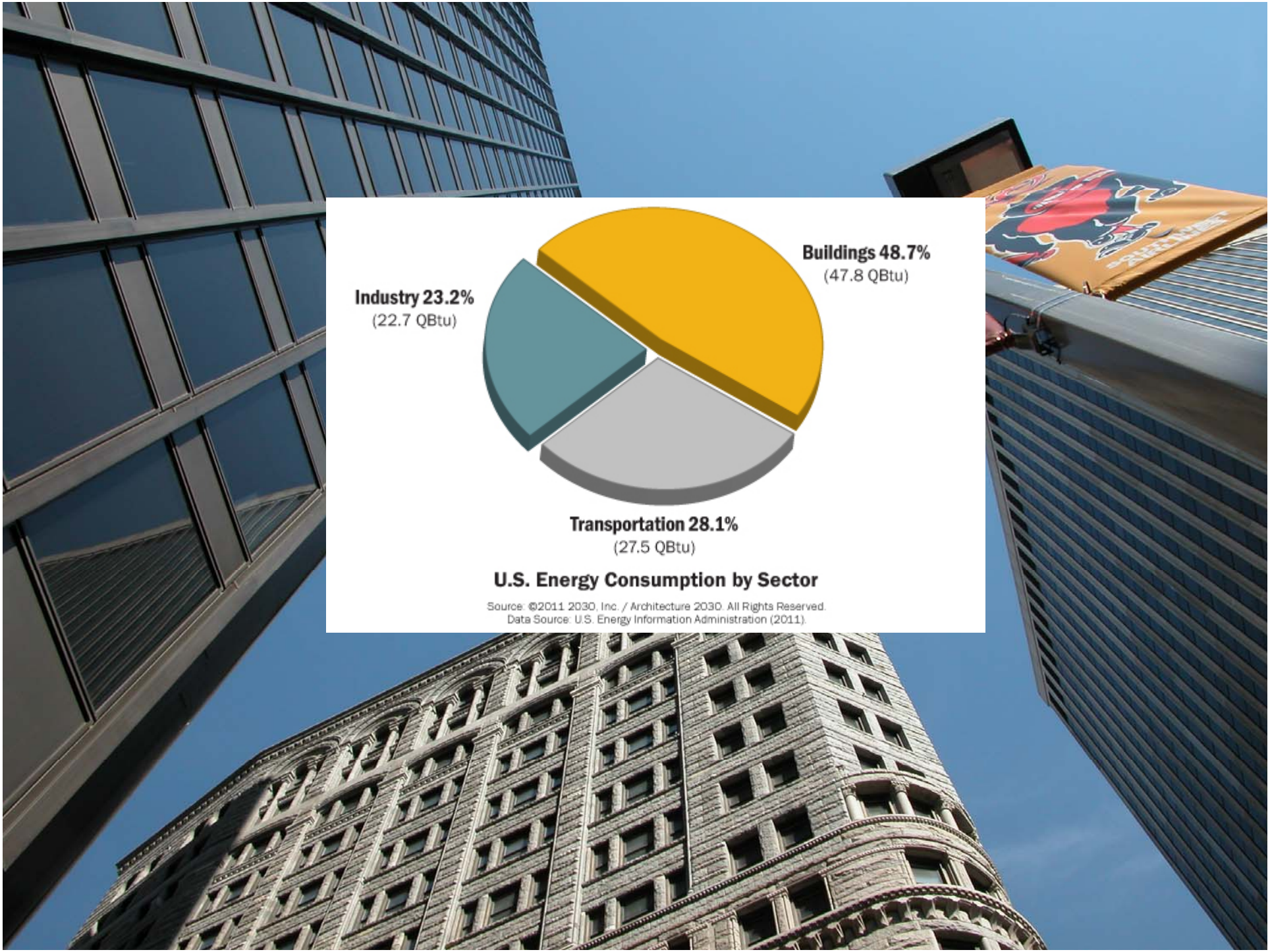
MIMIC OTHER INDUSTRIES

DESIGN BUILDINGS TO COME APART SO THAT THEY CAN BE REPAIRED, REUSED AND RECYCLED – EASILY!

Inconvenient TRUTH

BUILDING BETWEEN

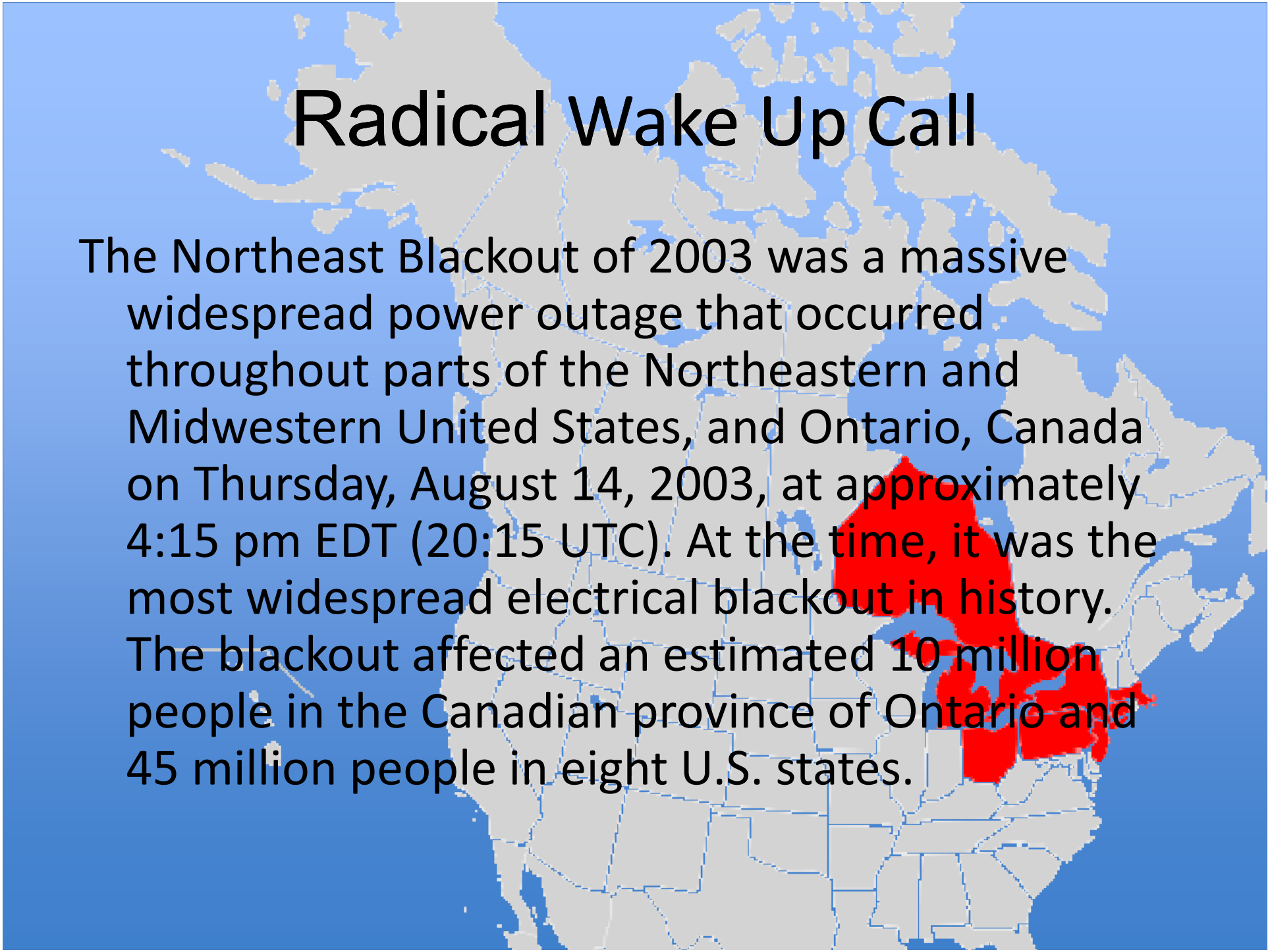
40% TO 7 MISSIONS


Buildings 48.7%
(47.8 QBtu)
Industry 23.2%
(22.7 QBtu)
Transportation 28.1%
(27.5 QBtu)
U.S. Energy Consumption by Sector
Source: ©2011 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: U.S. Energy Information Administration (2011).

Do you remember August 14, 2003?

Radical Wake Up Call

The Northeast Blackout of 2003 was a massive widespread power outage that occurred throughout parts of the Northeastern and Midwestern United States, and Ontario, Canada on Thursday, August 14, 2003, at approximately 4:15 pm EDT (20:15 UTC). At the time, it was the most widespread electrical blackout in history. The blackout affected an estimated 10 million people in the Canadian province of Ontario and 45 million people in eight U.S. states.



Do you remember December 21, 2013?


ICE STORM = NO POWER = NO HEAT

Radical PROBLEM!

- No power…
- Hot August weather… or
- Cold December temperatures…
- *Hooked* on electricity, heat and A/C
- What buildings/environment/systems "worked"?
- What buildings/environment/systems "didn't" work?


SEALED BUILDINGS CANNOT BREATHE
ELEVATORS AND LIGHTS NEED POWER

Radical AWAKENING!

- Grid and energy dependent buildings/environment/systems DID NOT WORK!
- OPERABLE WINDOWS WORKED!
- NATURAL VENTILATION WORKED!
- SHADE WORKED!
- SUNLIGHT WORKED!
- DAYLIT SPACES WORKED!
- WALKABLE NEIGHBOURHOODS WORKED!
- BICYCLES WORKED!

Radical THOUGHT!??

MAYBE WE SHOULD BEGIN TO DESIGN OUR BUILDINGS/ENVIRONMENTS IN REVERSE!

Start with a basic UNPLUGGED building

Radical Steps!

#1 - *start* by UNPLUGGING the building

Then…

#2 – heat only with the sun

#3 – cool only with the wind and shade

#4 – light only with daylight

USE the ARCHITECTURE first, and mechanical systems only to supplement what you cannot otherwise provide.

#5 – USE RENEWABLE CLEAN ENERGY BEFORE HOOKING UP TO NATURAL GAS, OIL OR THE REGULAR ELECTRICAL GRID (with all of its nastiness – including CO_2)

Radical IS Passive…

PASSIVE DESIGN is where the building uses the SUN, WIND and LIGHT to heat, cool and light

ARCHITECTURALLY

Carbon Reduction: The Passive Approach

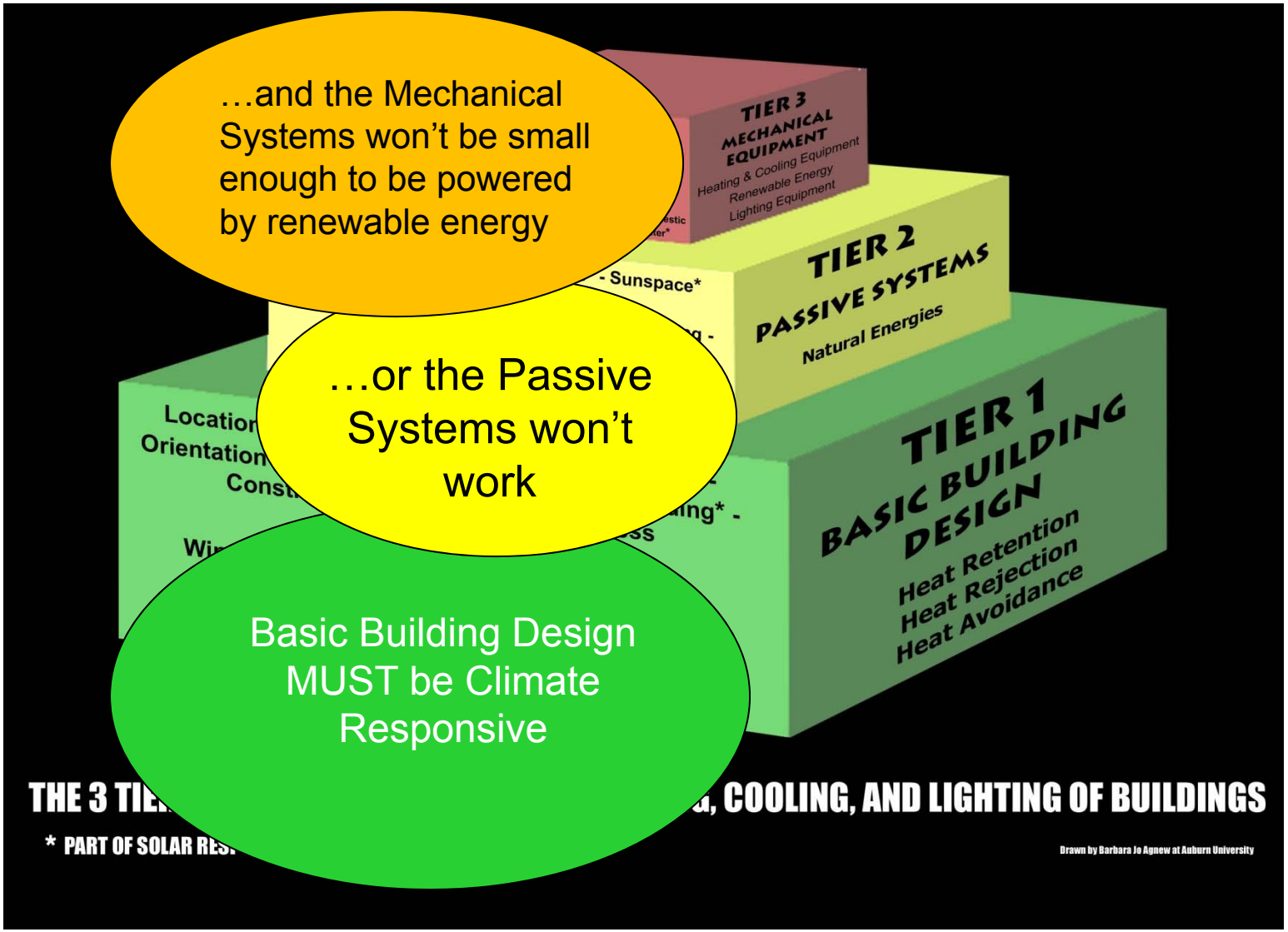


Image: Norbert Lechner, "Heating, Cooling, Lighting"

Radical Thought – Smaller is Better!

- ***Simple!***…**less** building results in **less** embodied carbon; i.e. **less** carbon from materials used in the project, **less** requirements for heating, cooling and electricity….

- Re-examine the building program to see what is *really* required

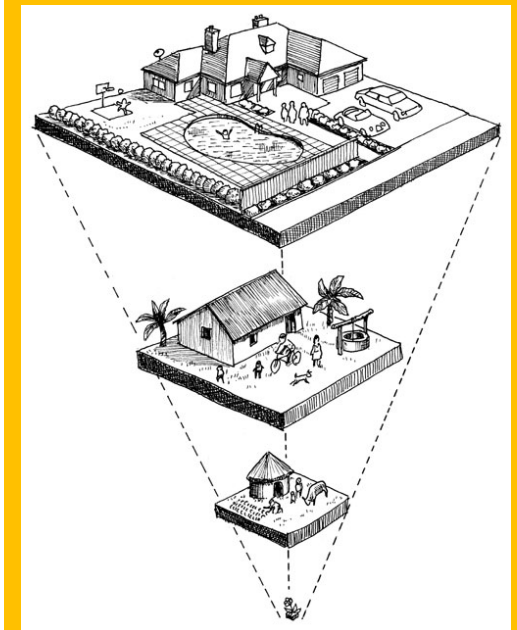
- How is the space to be used?

- Can the program benefit from more inventive double uses of spaces?

- Can you take advantage of outdoor or more seasonally used spaces?

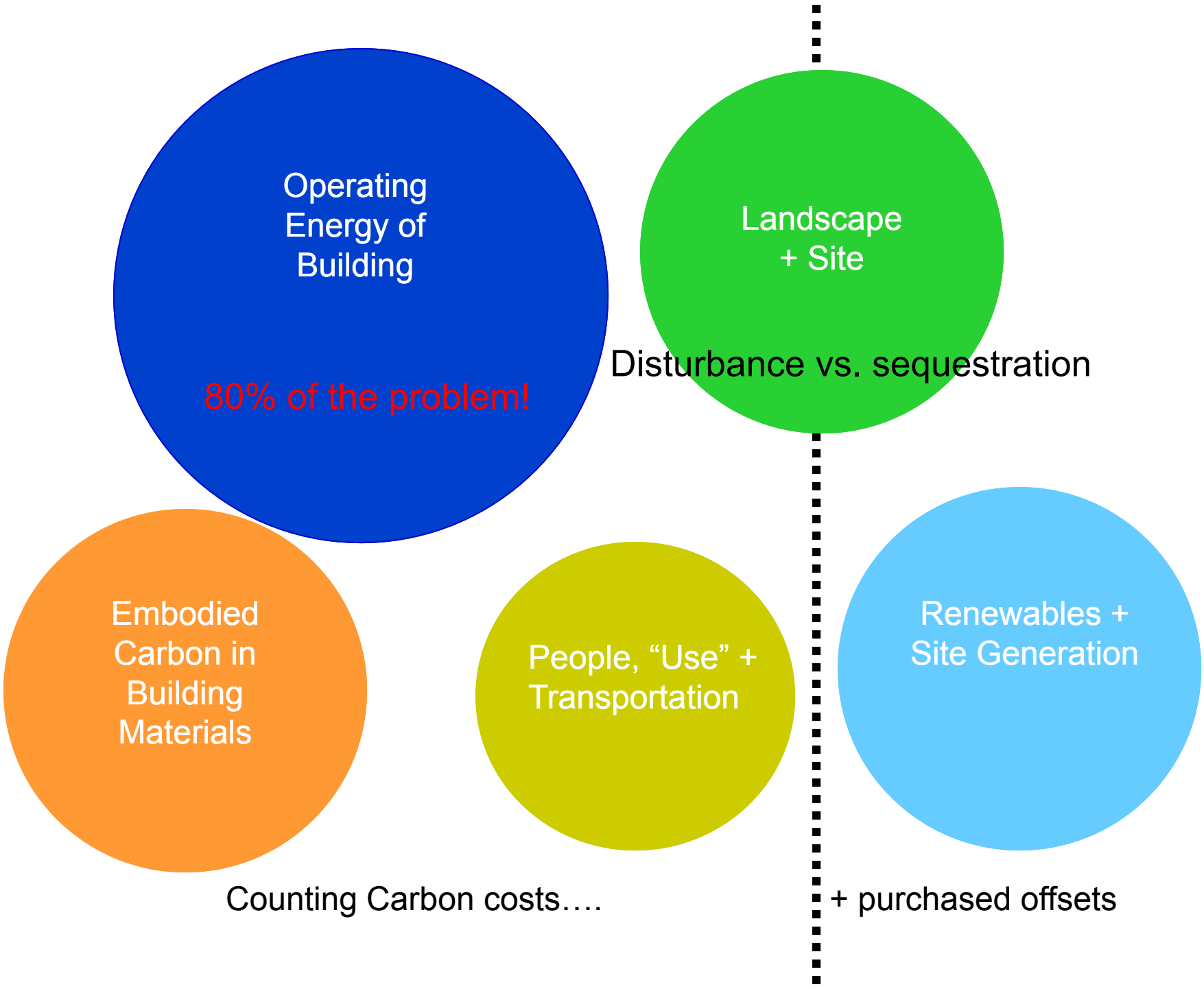
- **How much building do you *really need?***

- **Inference of LIFESTYLE changes**



Calculating your "ecological footprint"

… can naturally extend to an understanding of your "carbon footprint"


Operating Energy of Building
80% of the problem!
Landscape + Site
Disturbance vs. sequestration
Embodied Carbon in Building Materials
People, "Use" + Transportation
Renewables + Site Generation
Counting Carbon costs….
+ purchased offsets

Radical REALIZATION

#1 - OUR NORTH AMERICAN LIFESTYLE OF CONSUMPTION IS NOT SUSTAINABLE

#2 – DEVELOPING COUNTRIES (WITH ZILLIONS MORE PEOPLE THAN WE) ARE STRIVING TO BE *JUST LIKE US….*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Radical TOUGH QUESTION:

IS EVERYONE IN THE WORLD ENTITLED TO LIVE LIKE US?

IS EVERYONE IN THE WORLD ENTITLED TO WASTE RESOURCES LIKE WE DO?

MUST WE SHARE – IF IT MEANS LOSS OF LIFESTYLE?

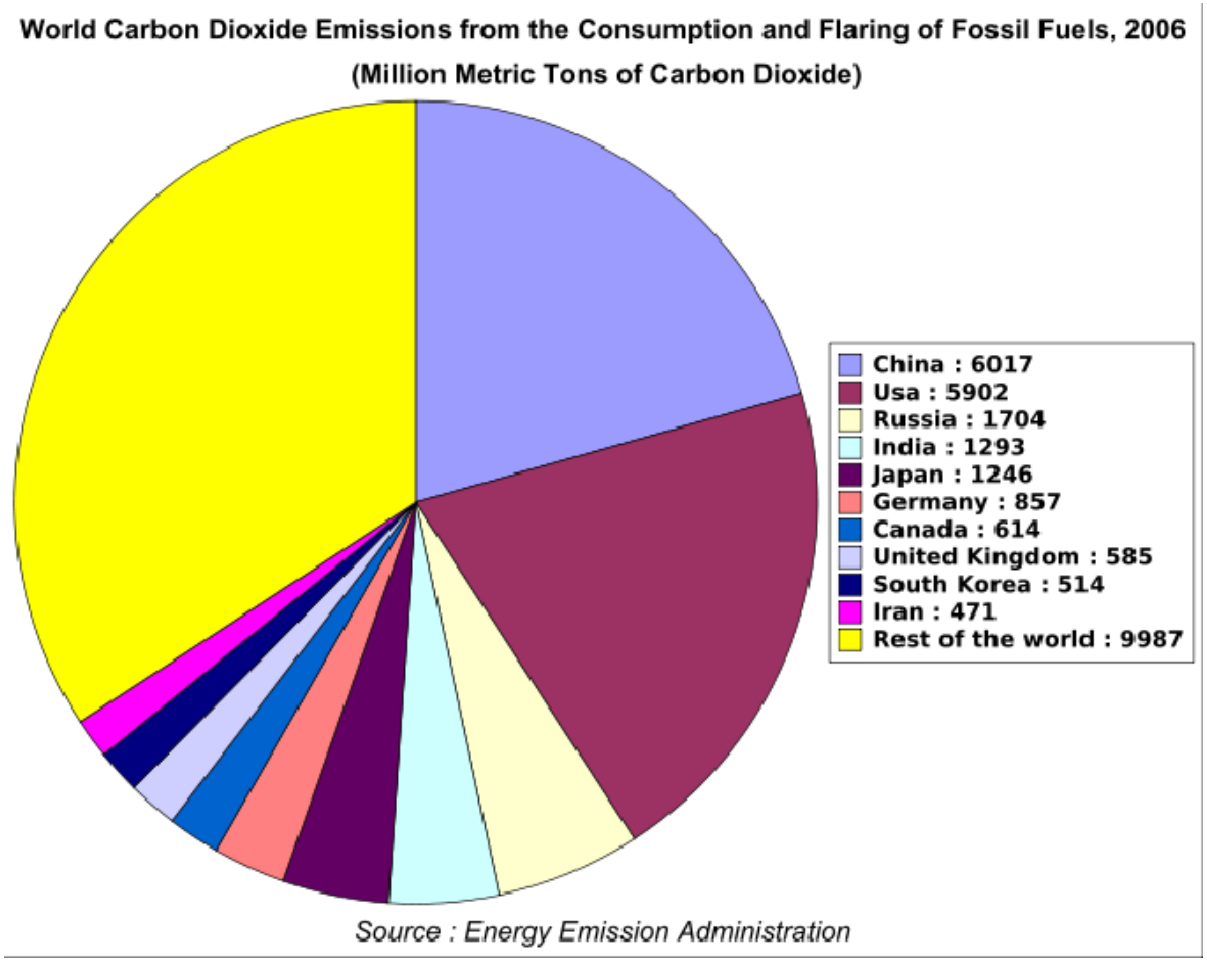
CO_2 Production by Country in 1997

Country	CO_2 Produced Total (millions)	(tonnes of carbon) Per Capita	
U.S.	**1,489.6**	**5.48**	Radical Problem here!
China	913.8	**0.75**	
Russia	390.6	2.65	
Japan	316.2	2.51	
India	279.9	**0.29**	
Germany	227.4	2.77	
UK	142.1	2.41	
Canada	**133.9**	**4.42**	Radical Problem here!
Italy	111.3	1.94	
Ukraine	100.4	1.97	

Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Tennessee

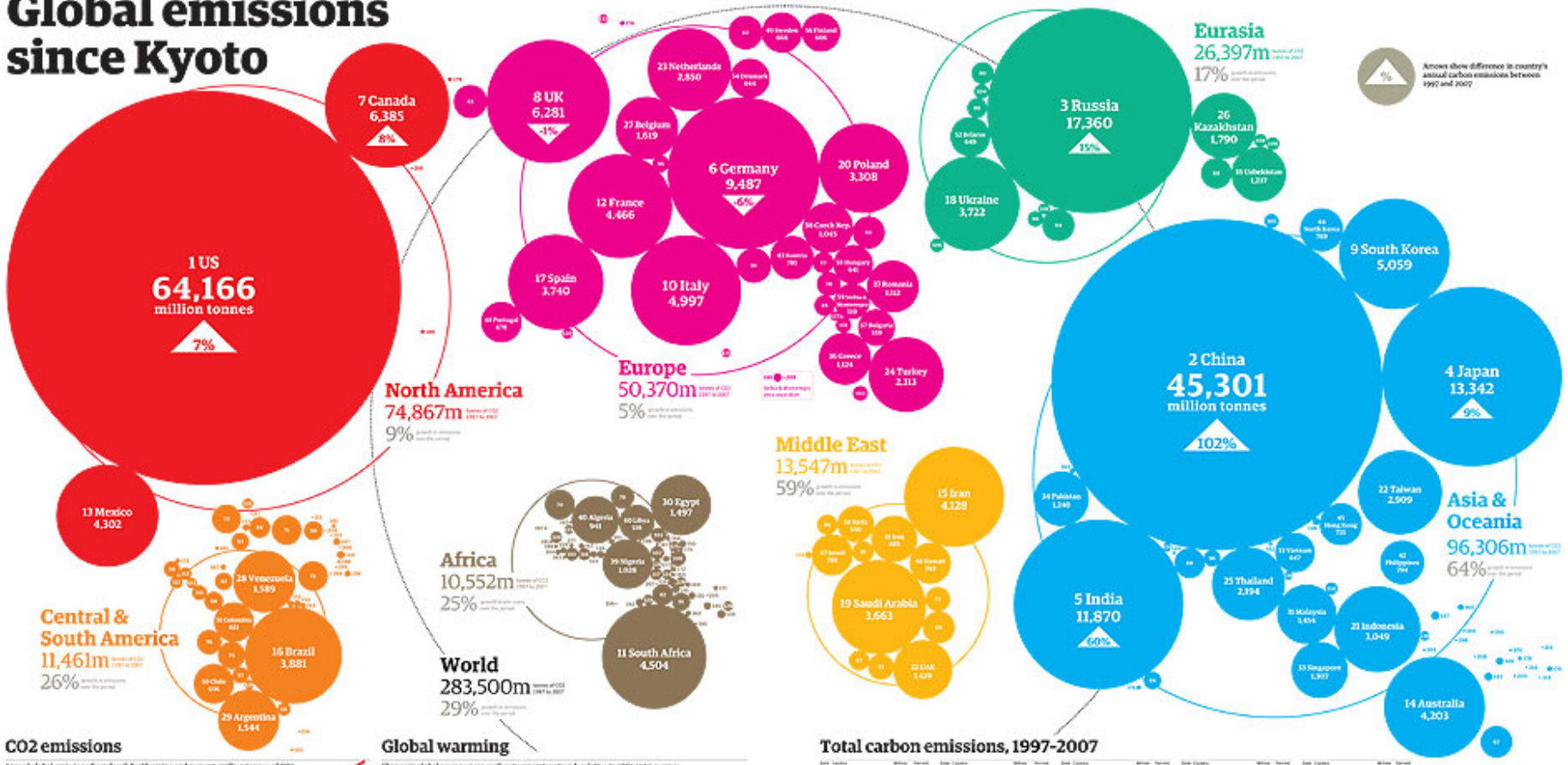
And can you even IMAGINE how bad this might be if everyone in India and China lived like we do???

CO_2 Production by Country in 2006



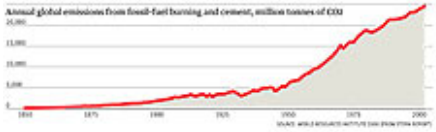
China is catching up!!!???

Global emissions since Kyoto



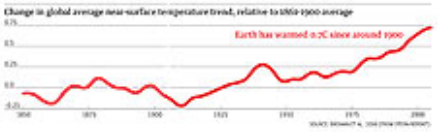
CO2 emissions

Annual global emissions from fossil-fuel burning and cement, million tonnes of CO2

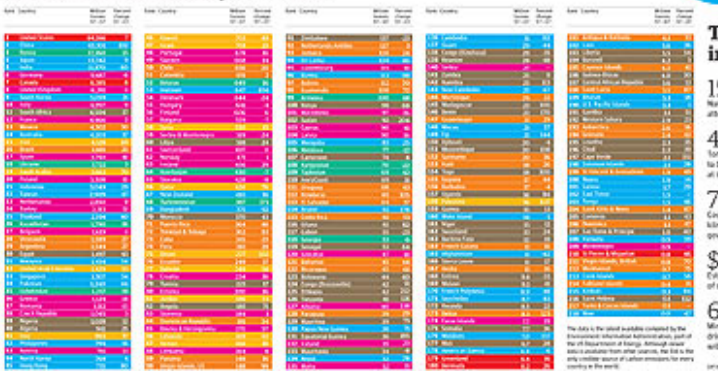


Global warming

Change in global average near-surface temperature trend, relative to 1850-1900 average



Total carbon emissions, 1997-2007



The key issues at Copenhagen

1 Cut carbon in rich world

Scientists say cuts of 25-40% by 2020 are needed, relative to 1990 levels, rising to 80-95% by 2050. Developed countries have grown rich on fossil fuels and still emit vast amounts of CO2 per person, so have a responsibility to make deepest cuts.

2 Curb carbon in developing world

Emissions from fast-growing economies such as China and India are surging, yet their citizens have small carbon footprints and millions live in poverty. So they'll argue they need to be allowed to pollute for a while yet as they improve their citizens' lives.

3 Pay the price for climate change

All agree that the poorest nations need urgent aid, having done nothing to pollute the atmosphere. It will also cost a bit to create the clean technology essential for slashing global emissions. In both cases, rich nations will be expected to pick up the tab.

4 Keep tabs on funds and emissions

Poorer nations want to continue Kyoto's top-down approach, with clear responsibilities placed on rich countries. Developing nations also want climate funds distributed by the UN, whereas developed countries would prefer the World Bank.

5 Slow the speed of deforestation

About 17% of the carbon emitted by human activity comes from razing forests. But paying people not to fell trees soon becomes complex... Who really owns them? Were they actually going to be chopped down? How do you verify the whole process?

6 Clean technology

Paying for clean technology is just the start, as the products and services required must be developed and deployed rapidly and efficiently all over the globe. But nations differ on whether a strong international body is needed, or just an advisory one.

Checklist of success

- ☐ Rich nations commit to a combined reduction in greenhouse gases of 25-40% by 2020. **Chance of success: Middling**
- ☐ Developing nations commit to a 15-30% cut on the emissions levels expected in 2020. **Chance of success: Good**
- ☐ Richer nations commit to funding poorer ones, and clean technology, to tune of $100bn+ per year. **Chance of success: Low**
- ☐ Deal done on who monitors countries' carbon emissions and distributes the money. **Chance of success: Low**
- ☐ Agreement which delivers cash to forested nations, meaning far fewer trees are cut down. **Chance of success: Good**
- ☐ Deal that delivers a radical overhaul in the deployment of clean technology. **Chance of success: Fair**

The summit in numbers

15,000
Number of delegates expected to attend official Copenhagen summit

40,500
Tonnes of carbon dioxide predicted to be emitted by those delegates while at the summit

700,000
Cost in euros of replacing outdated brick kilns in Bangladesh, paid for by Danish government to offset those emissions

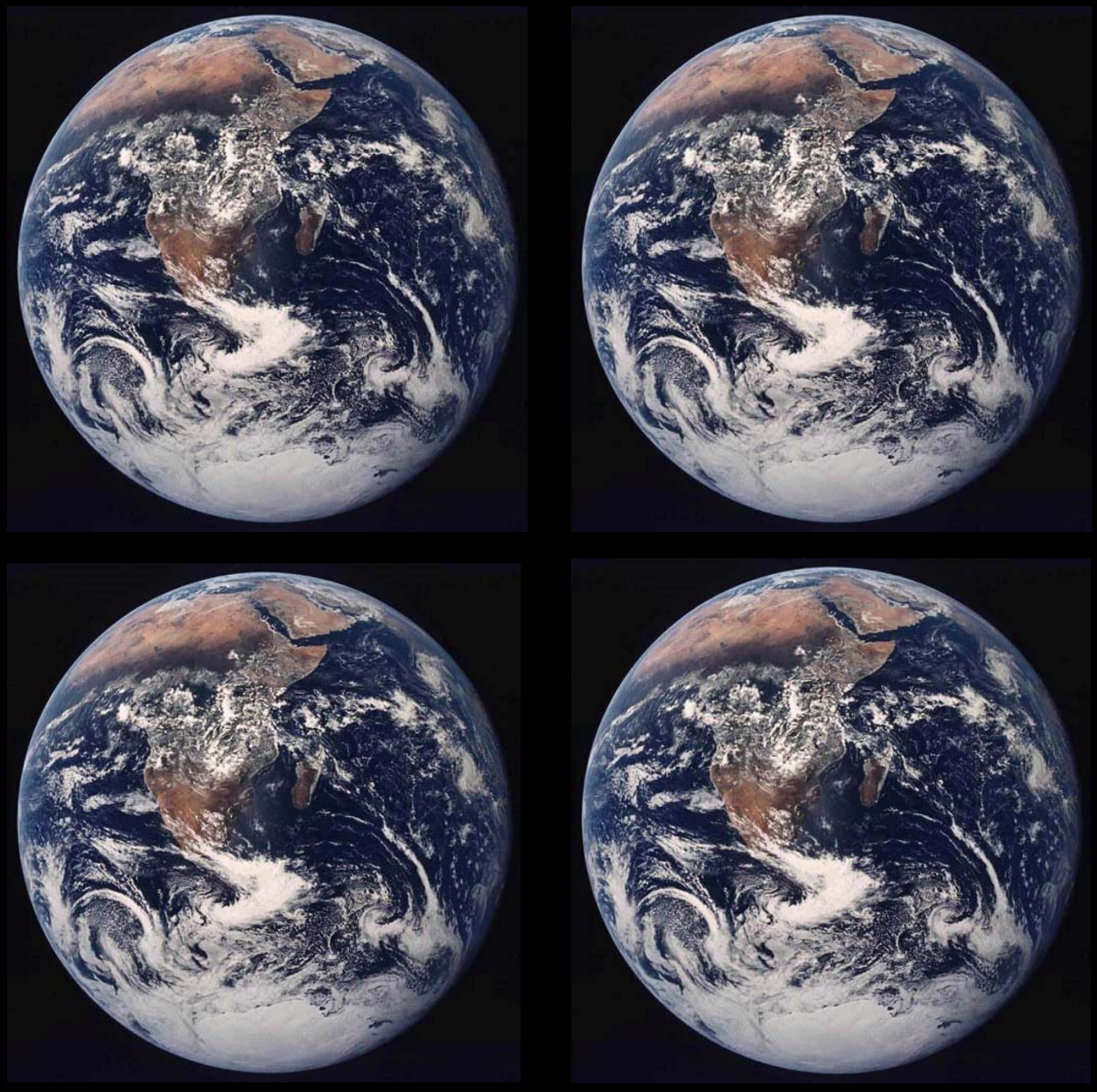
$62m+
Estimated cost to Danish government of staging the event

65%
Minimum proportion of food and drink provided to delegates that will be organic

Radical PROBLEM:

MUST WE SHARE – IF IT MEANS LOSS OF LIFESTYLE?

AVERAGE ONTARIAN NEEDS 4 PLANETS TO SUPPORT LIFESTYLE….



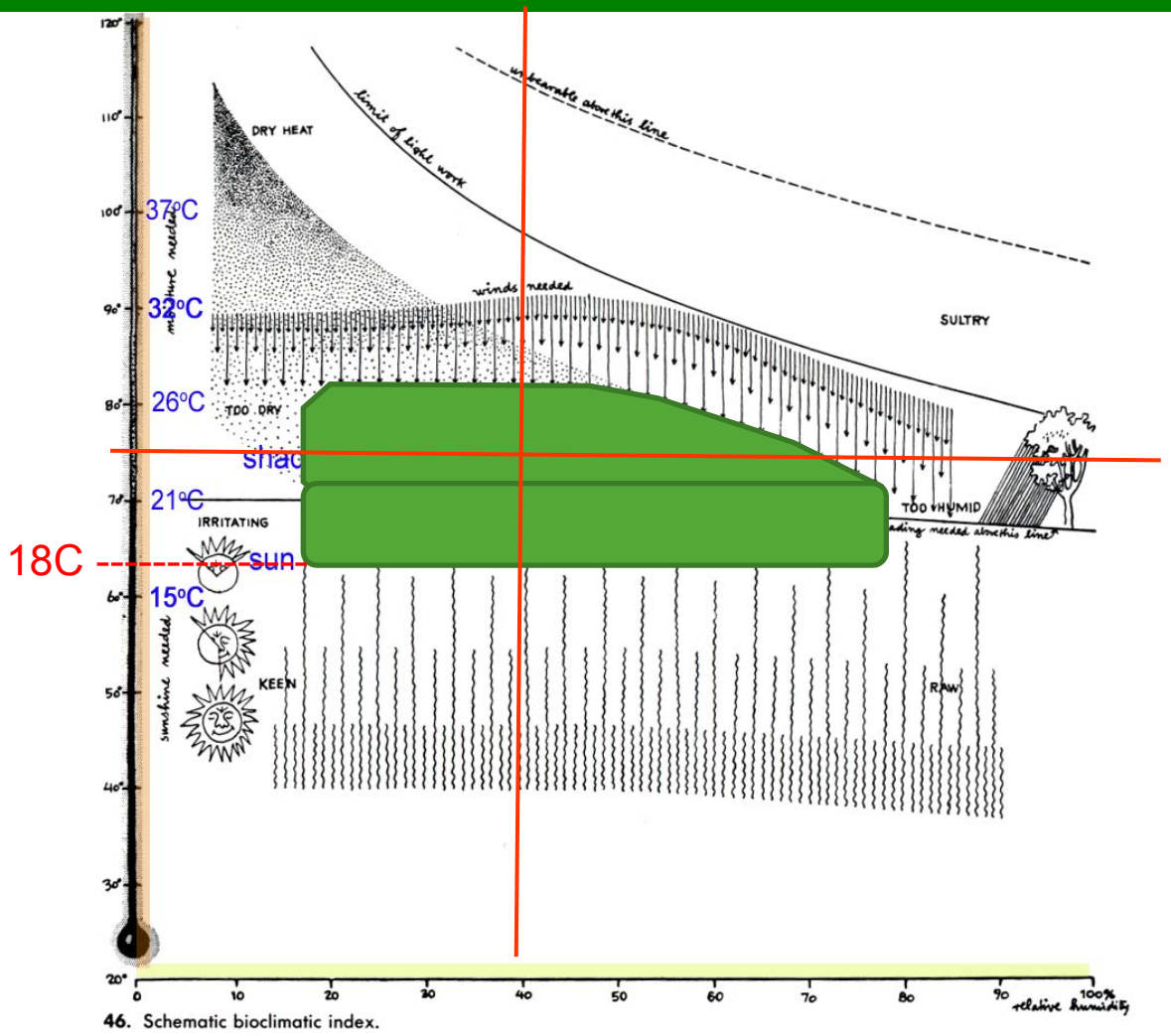
Radical POTENTIAL!!

COMFORT ZONE

WHAT IS IT?

WHAT DOES IT HAVE TO DO WITH GREEN BUILDING?

Where is your Comfort Zone?



46. Schematic bioclimatic index.

This famous illustration is taken from “Design with Climate”, by Victor Olgyay, published in 1963.

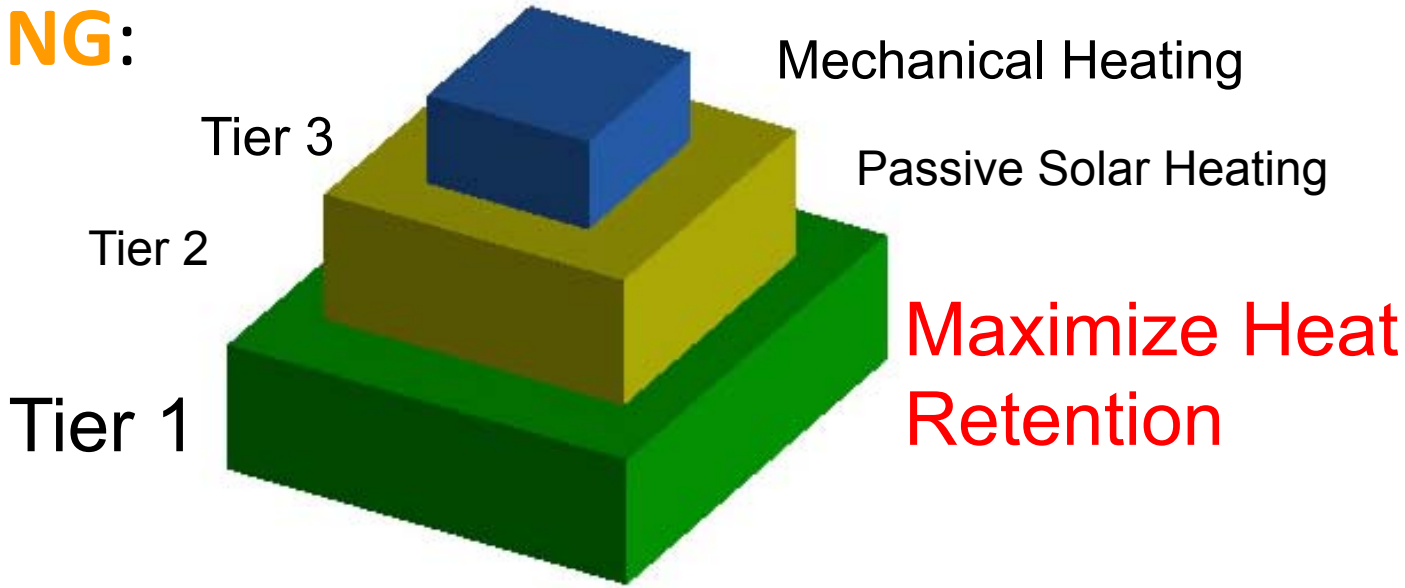
This is the finite point of expected comfort for 100% mechanical heating and cooling.

To lower our energy consumption, we must work within the broader area.

AND move this line DOWN to 18C (point of heating or cooling in degree day calculations.

PASSIVE Strategies - HEATING

The tiered approach to reducing carbon for **HEATING**:



First reduce the overall energy required, then maximize the amount of energy required for mechanical heating that comes from renewable sources.

Source: Lechner. Heating, Cooling, Lighting.

PASSIVE Strategies - HEATING

MAXIMIZE HEAT RETENTION:

1. Super insulated envelope (*as high as **double** current standards*)
2. Tight envelope / controlled air changes
3. Provide thermal mass **inside** of thermal insulation to store heat (COMPLETE OPPOSITE OF REGULAR WOOD FRAME CONSTRUCTION!)
4. Top quality windows with high R-values – up to **triple glazed** with argon fill and low-e coatings on two surfaces

Premise – what you don't "lose" you don't have to create or power…. So make sure that you keep it! *(…NEGAwatts)*

PASSIVE Strategies - HEATING

PASSIVE SOLAR HEATING:

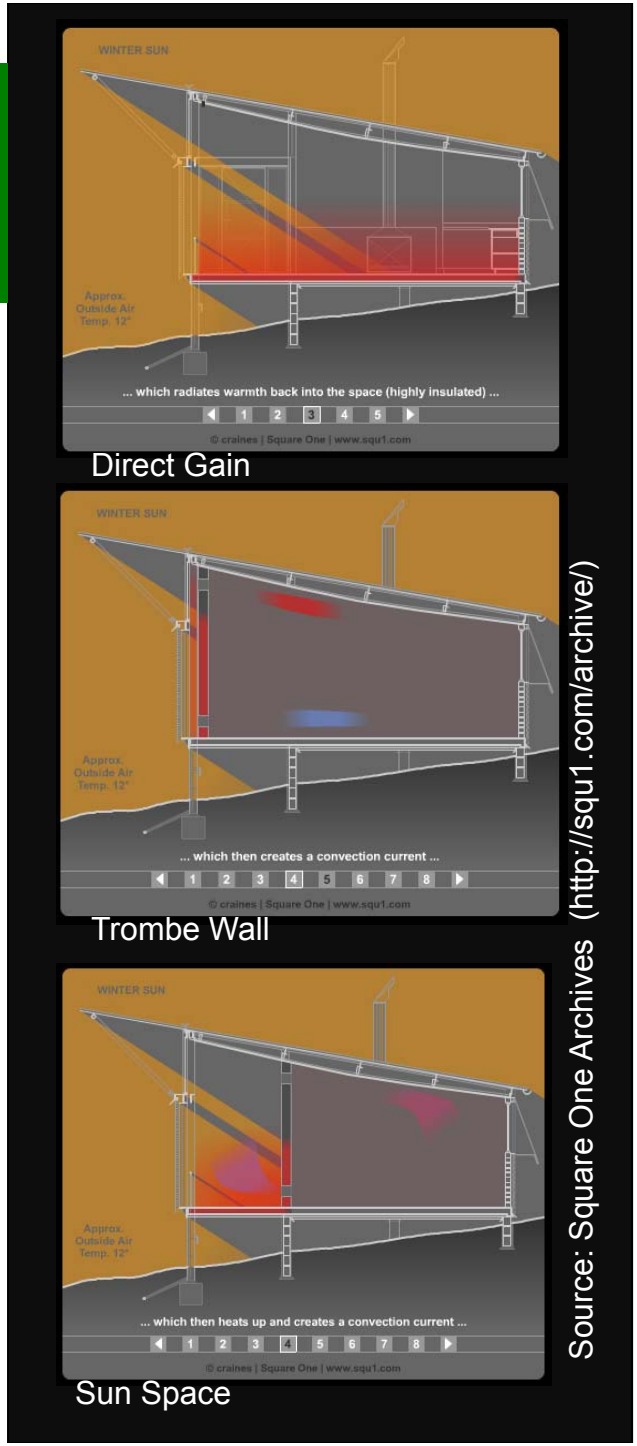
1. primarily south facing windows
2. proportion windows to suit thermal mass and size of room(s)

3 MAIN STRATEGIES:

Direct Gain

Thermal Storage Wall

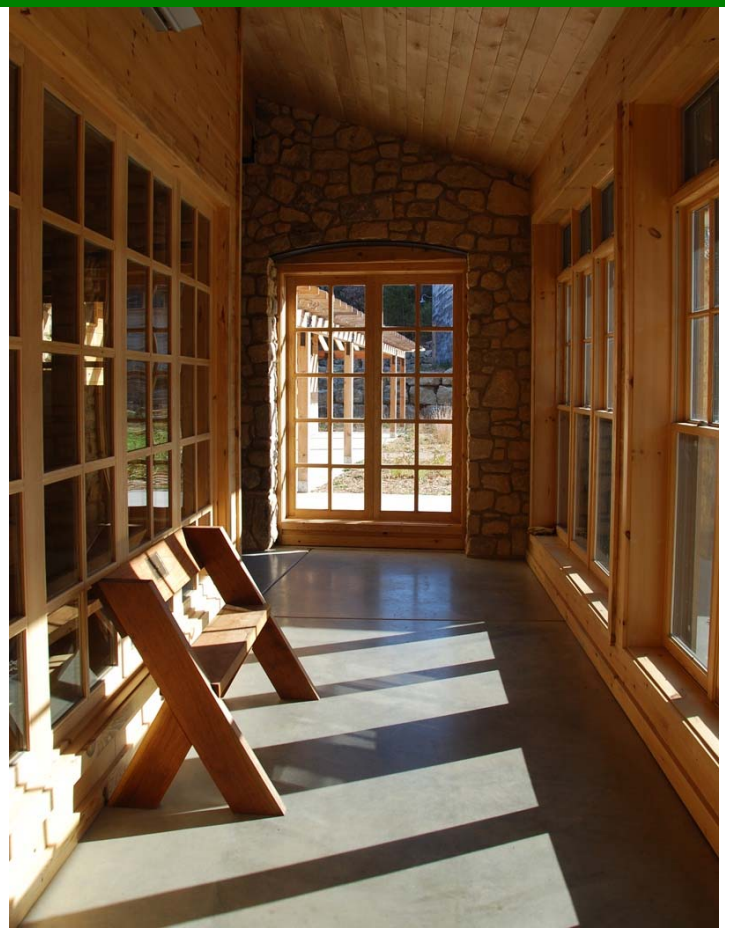
Sunspace



Thermal Mass is Critical

- To ensure comfort to the occupants….
- People are 80% water so if they are the only thermal sink in the room, they will be the target.

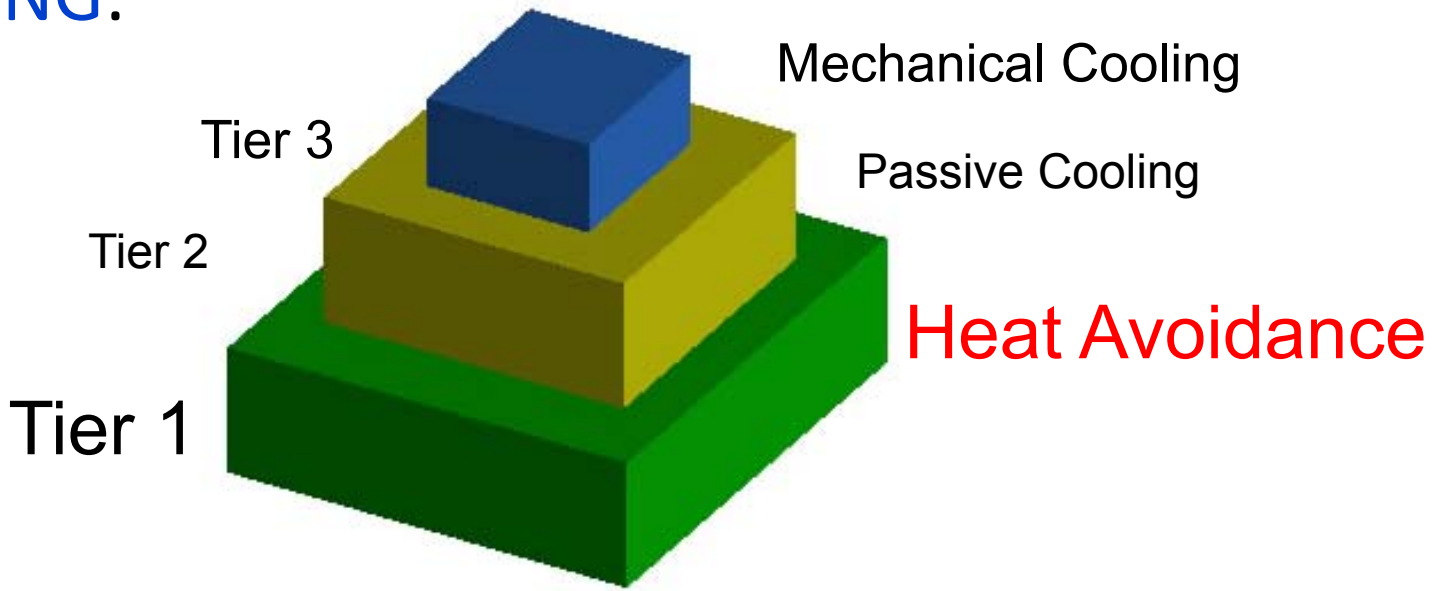
- And to store the FREE energy for slow release distribution….



Aldo Leopold Legacy Center: Concrete floors complement the insulative wood walls

PASSIVE Strategies - COOLING

The tiered approach to reducing carbon for COOLING:



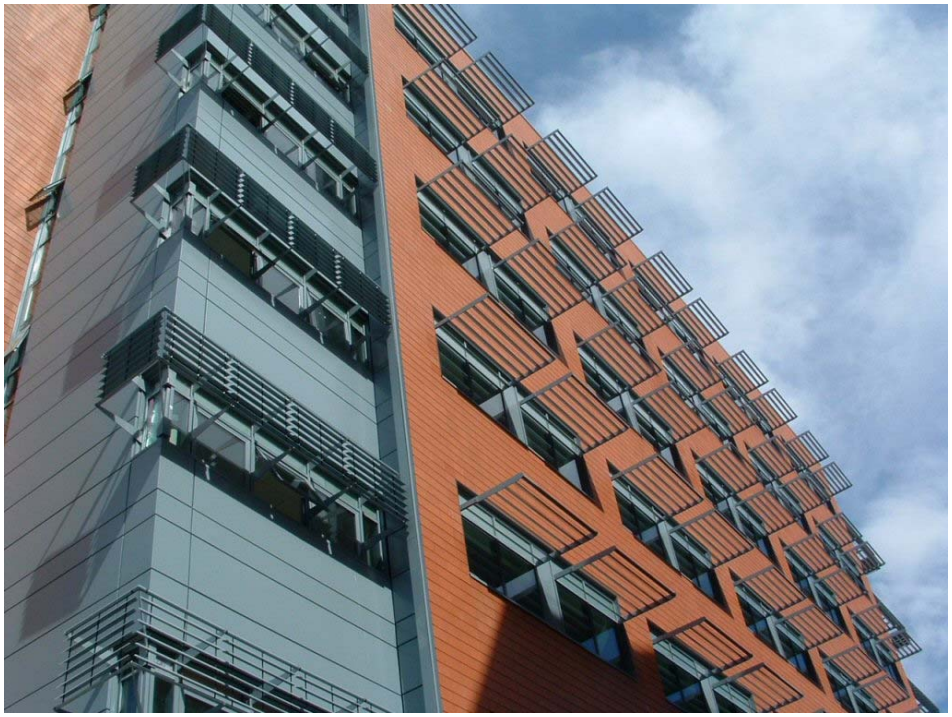
Maximize the amount of energy required for mechanical cooling that comes from renewable sources.

Source: Lechner. Heating, Cooling, Lighting.

PASSIVE Strategies - COOLING

HEAT AVOIDANCE:

1. shade windows from the sun during hot months
2. design materials and plantings to cool the local microclimate
3. locate trees and trellis' to shade east and west façades during morning and afternoon low sun

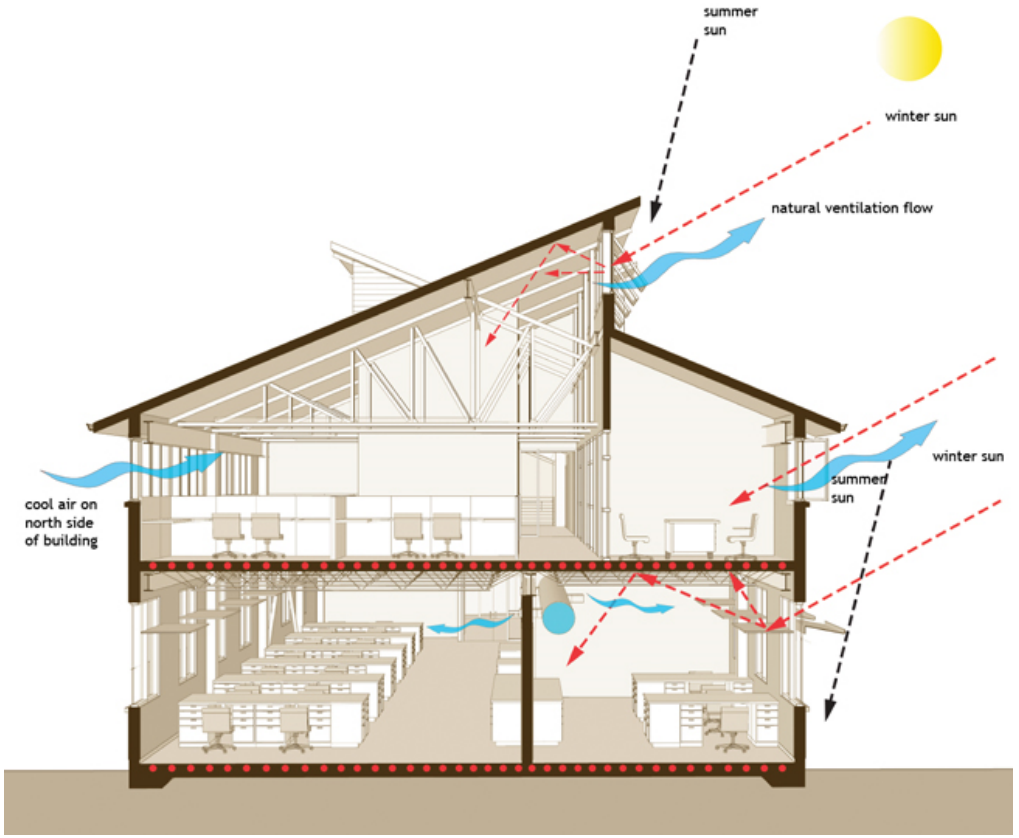


If you don't invite the heat in, you don't have to get rid of it…..

PASSIVE Strategies - COOLING

NATURAL VENTILATION:

1. design for maximum ventilation
2. keep plans as open as possible for unrestricted air flow
3. use easily operable windows at low levels with high level clerestory windows to induce stack effect cooling



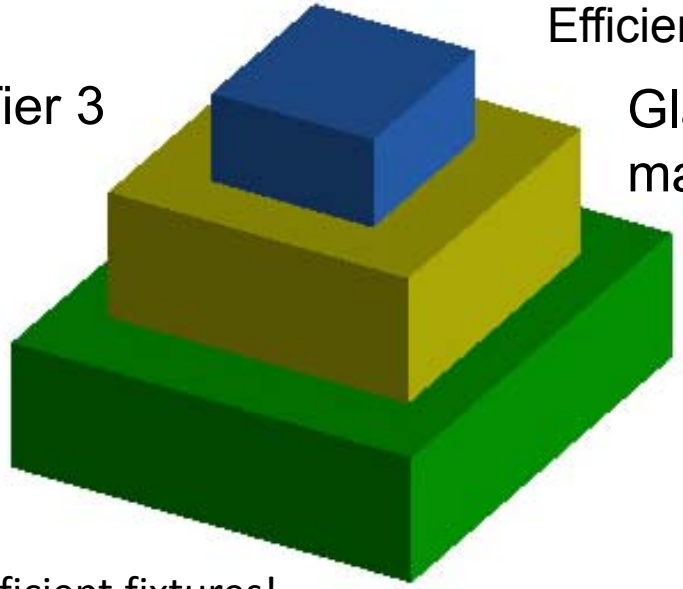
PASSIVE Strategies - COOLING

INNOVATION:

1. wind cowls
2. solar chimneys
3. water features

PASSIVE Strategies - DAYLIGHTING

The tiered approach to reducing carbon with **DAYLIGHTING**:



Efficient artificial Lighting w/ sensors

Glare, color, reflectivity and material concerns

Orientation and planning of building to allow light to reach maximum no. of spaces

Use energy efficient fixtures!

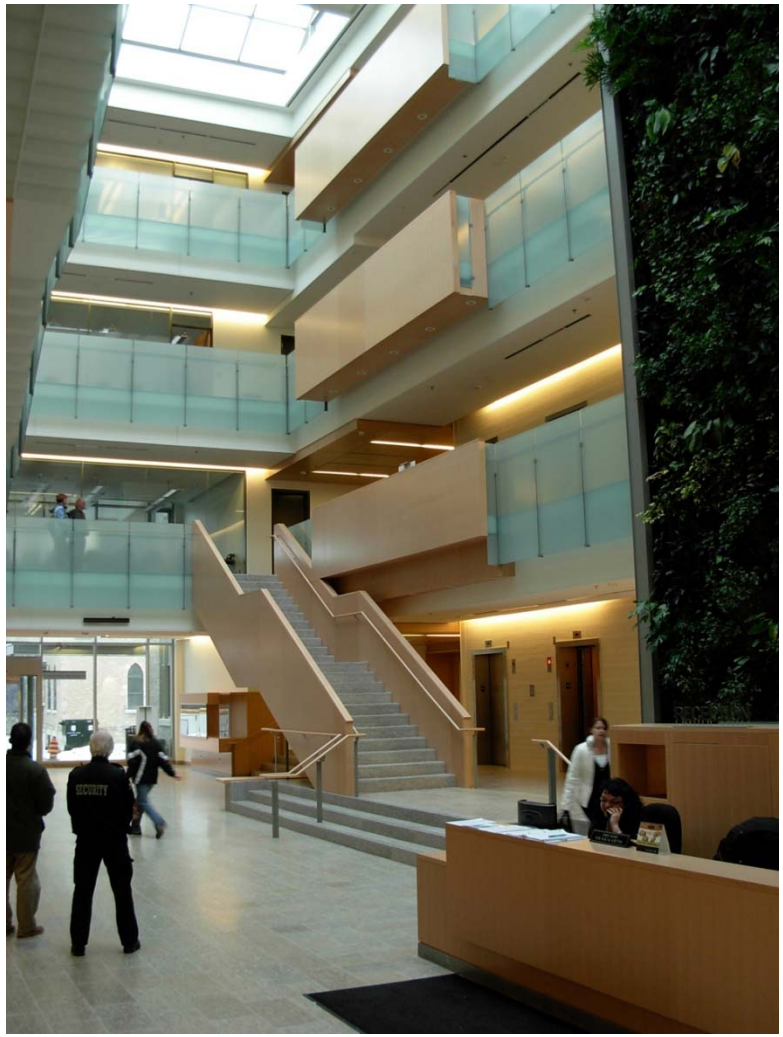
Maximize the amount of energy/electricity required for artificial lighting that comes from renewable sources.

Source: Lechner. Heating, Cooling, Lighting.

PASSIVE Strategies - DAYLIGHTING

GLARE, COLOUR, REFLECTIVITY, MATERIALS:

- incorporate light dynamics
- avoid glare
- understand the function of material selection; ie. reflectivity and surface qualities
- balance color and reflectivity with amount of daylight provided



PASSIVE Strategies - DAYLIGHTING

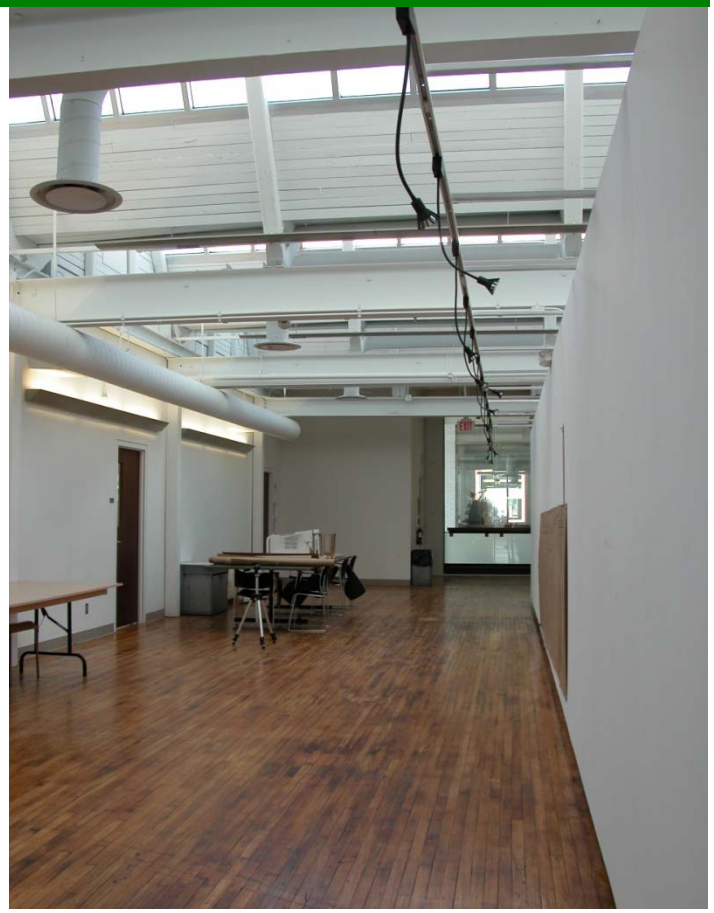
ENERGY EFFICIENCY AND RENEWABLES:

- use energy efficient light fixtures (and effectively!)

- use occupant sensors *combined with light level sensors*

- aim to only have lights switch on only when daylight is insufficient

- provide electricity via renewable means: wind, PV, CHP



Lights on due to occupant sensors when there is adequate daylight – WASTES ENERGY!

Radical RETHINKING:

DESIGN FOR YOUR LOCAL CLIMATE!

ERADICATE

"MacDonald's Type Architecture"

PASSIVE – BIO CLIMATIC DESIGN

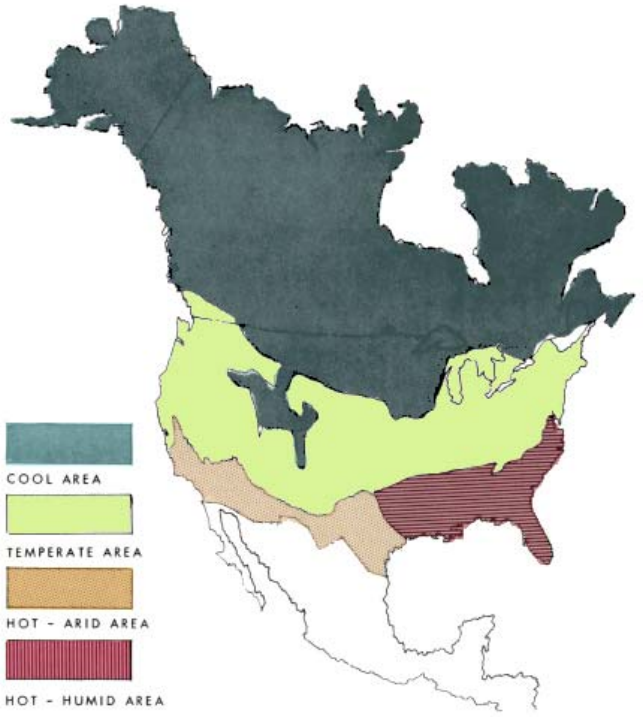
Design must first acknowledge regional, local and microclimate impacts on the building and site.

COLD

TEMPERATE

HOT-ARID

HOT-HUMID



11. Regional climate zones of the North American continent.

Image: 1963 “Design With Climate”, Victor Olgyay.

Bio-climatic Design: COLD

Where **WINTER** is the dominant season and concerns for conserving heat predominate

RULES:

- **First INSULATE**
- *exceed* CODE requirements
-build tight to reduce air changes
- **Then INSOLATE**
- ORIENT AND SITE THE BUILDING PROPERLY FOR THE SUN
- maximize south facing windows for easier control
- fenestrate for DIRECT GAIN PASSIVE
- apply THERMAL MASS to store the FREE SOLAR HEAT
- create a sheltered MICROCLIMATE

YMCA Environmental Learning Centre, Paradise Lake, Ontario

Bio-climatic Design: HOT-ARID

Where **very high summer temperatures** with great fluctuation predominate with **dry conditions** throughout the year.

RULES:

- Solar avoidance : keep DIRECT SOLAR GAIN out of the building
- avoid daytime ventilation
- promote nighttime flushing with cool evening air
- achieve daylighting by reflectance and use of LIGHT non-heat absorbing colours
- create a cooler MICROCLIMATE by using light / lightweight materials
- respect the DIURNAL CYCLE
- use heavy mass for walls and DO NOT INSULATE

Traditional House in Egypt

Bio-climatic Design: HOT-HUMID

Where **warm to hot** stable conditions predominate with **high humidity** throughout the year.

RULES:

- SOLAR AVOIDANCE : large roofs with overhangs that shade walls and to allow windows open at all times
- PROMOTE VENTILATION
- USE LIGHTWEIGHT MATERIALS that do not hold heat
- use STACK EFFECT to ventilate through high spaces
- use of COURTYARDS and semi-enclosed outside spaces
- use WATER FEATURES for cooling

House in Seaside, Florida

Bio-climatic Design: TEMPERATE

The summers are hot and humid, and the winters are cold. In much of the region the topography is generally flat, allowing cold winter winds to come in form the northwest and cool summer breezes to flow in from the southwest. **The four seasons are almost equally long.**

IslandWood Residence, Seattle

RULES:

- BALANCE strategies between COLD and HOT-HUMID

- maximize flexibility in order to be able to modify the envelope

- understand the natural benefits of SOLAR ANGLES that shade during the warm months and allow for heating during the cool months

Radical GREEN

IS POSSIBLE!

RIGHT NOW!

Radical | Green

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