

Radical | Green

Arch 126: Environmental Building Design
Winter 2019

“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 CO₂
- #2 – RUNNING OUT OF OIL (oil causes CO₂)



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!



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....



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
40% TO 7



BETWEEN
MISSIONS

Industry 23.2%
(22.7 QBtu)



Buildings 48.7%
(47.8 QBtu)

Transportation 28.1%
(27.5 QBtu)

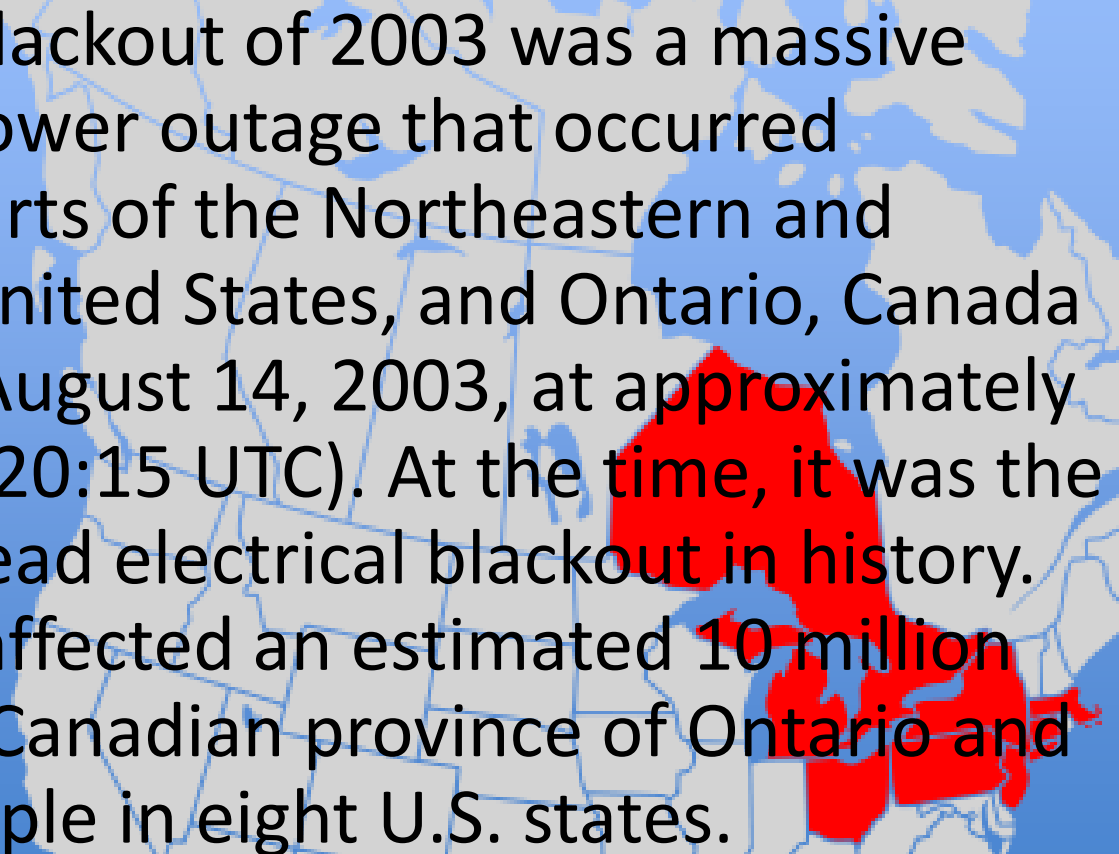
U.S. Energy Consumption by Sector

Source: ©2011 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: U.S. Energy Information Administration (2011).

You might not 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.

A map of North America with the affected regions of the 2003 Northeast Blackout highlighted in red. The red area covers Ontario, Canada, and eight U.S. states: Michigan, Ohio, Pennsylvania, New York, New Jersey, Connecticut, Massachusetts, and Vermont.

You might 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?

A photograph of a city skyline at dusk or dawn. Several tall skyscrapers are visible, including one with 'UNTRIN' signage at the top. The buildings are illuminated, and their reflections are visible on the water in the foreground. A bridge spans across the river. The sky is a mix of blue and orange.

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 CO₂)

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

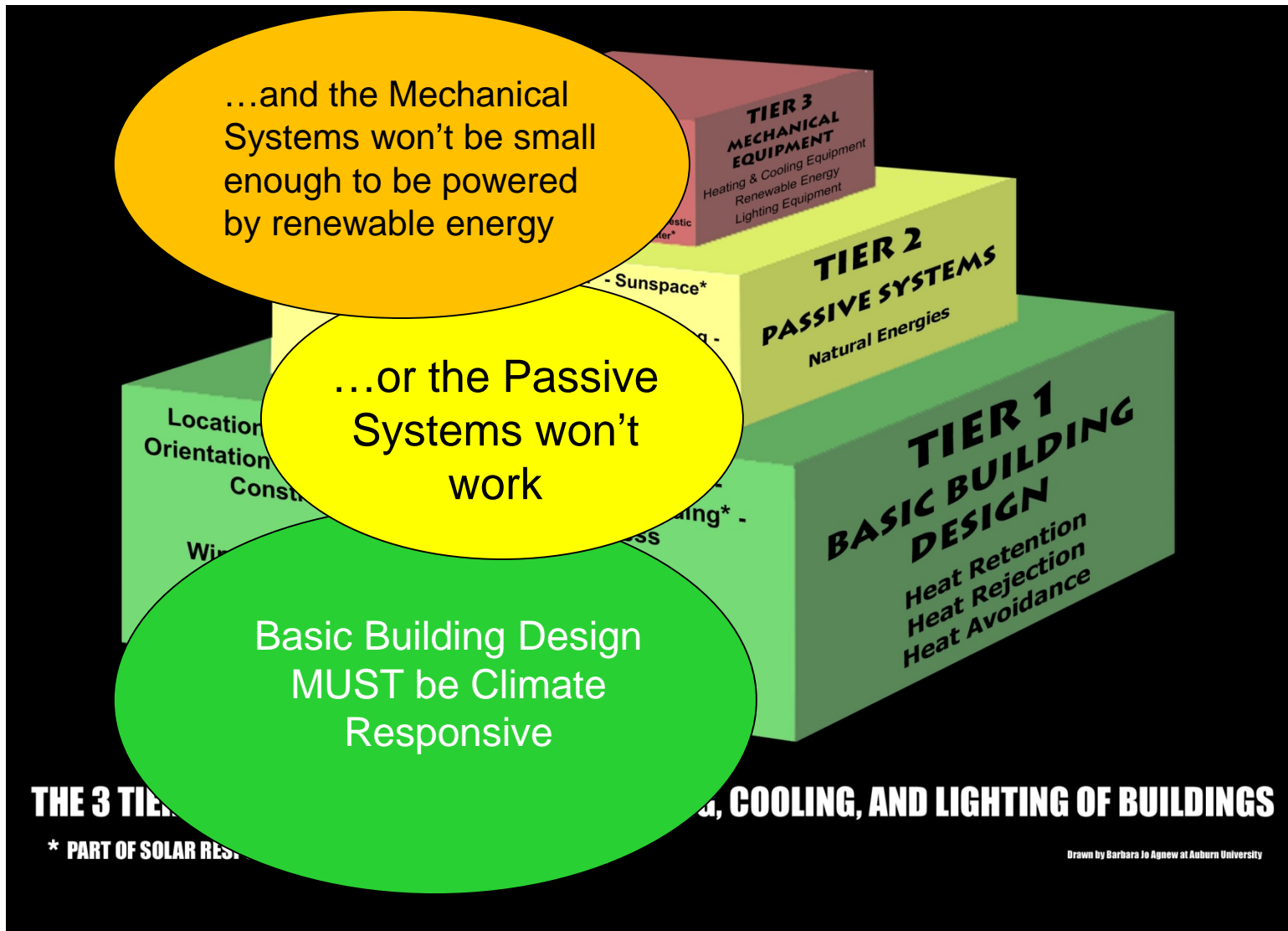
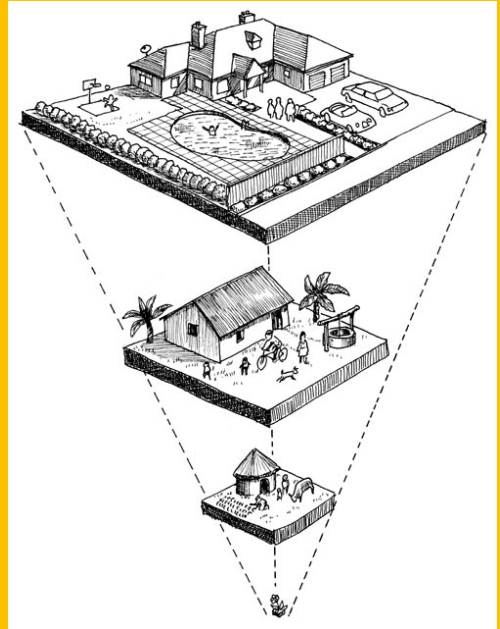


Image: Norbert Lechner, "Heating, Cooling, Lighting"

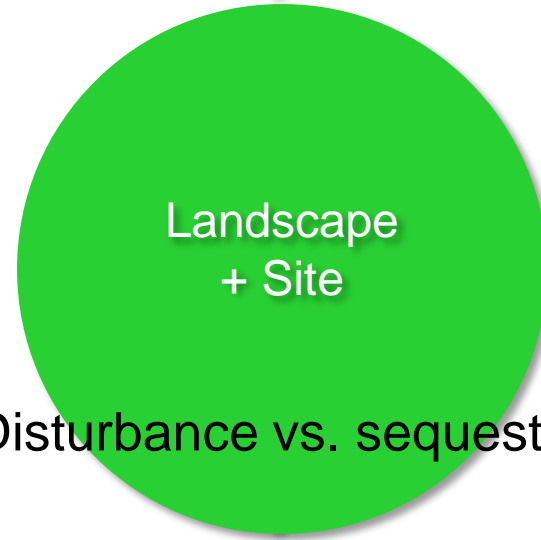
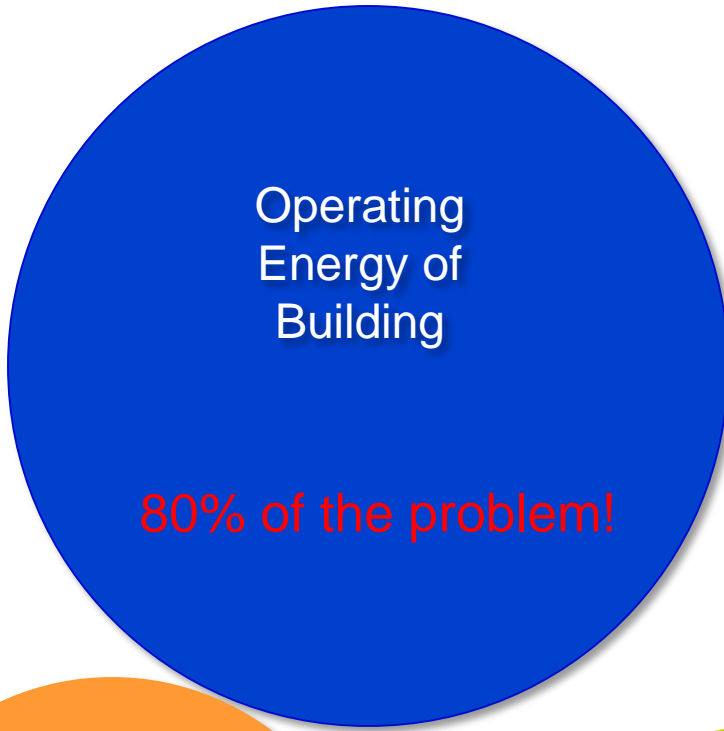
Radical Thought – Smaller is Better!

- **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**

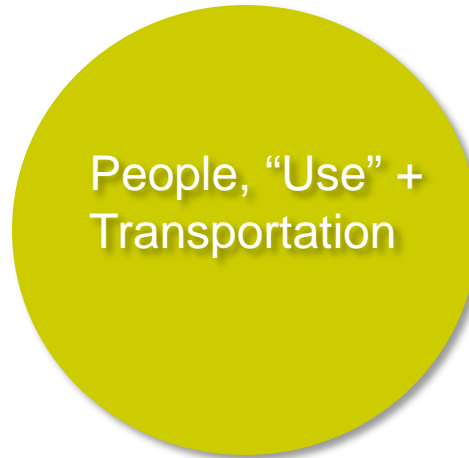


Calculating your
“ecological footprint”

... can naturally extend to
an understanding of your
“carbon footprint”



Disturbance vs. sequestration



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....



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?



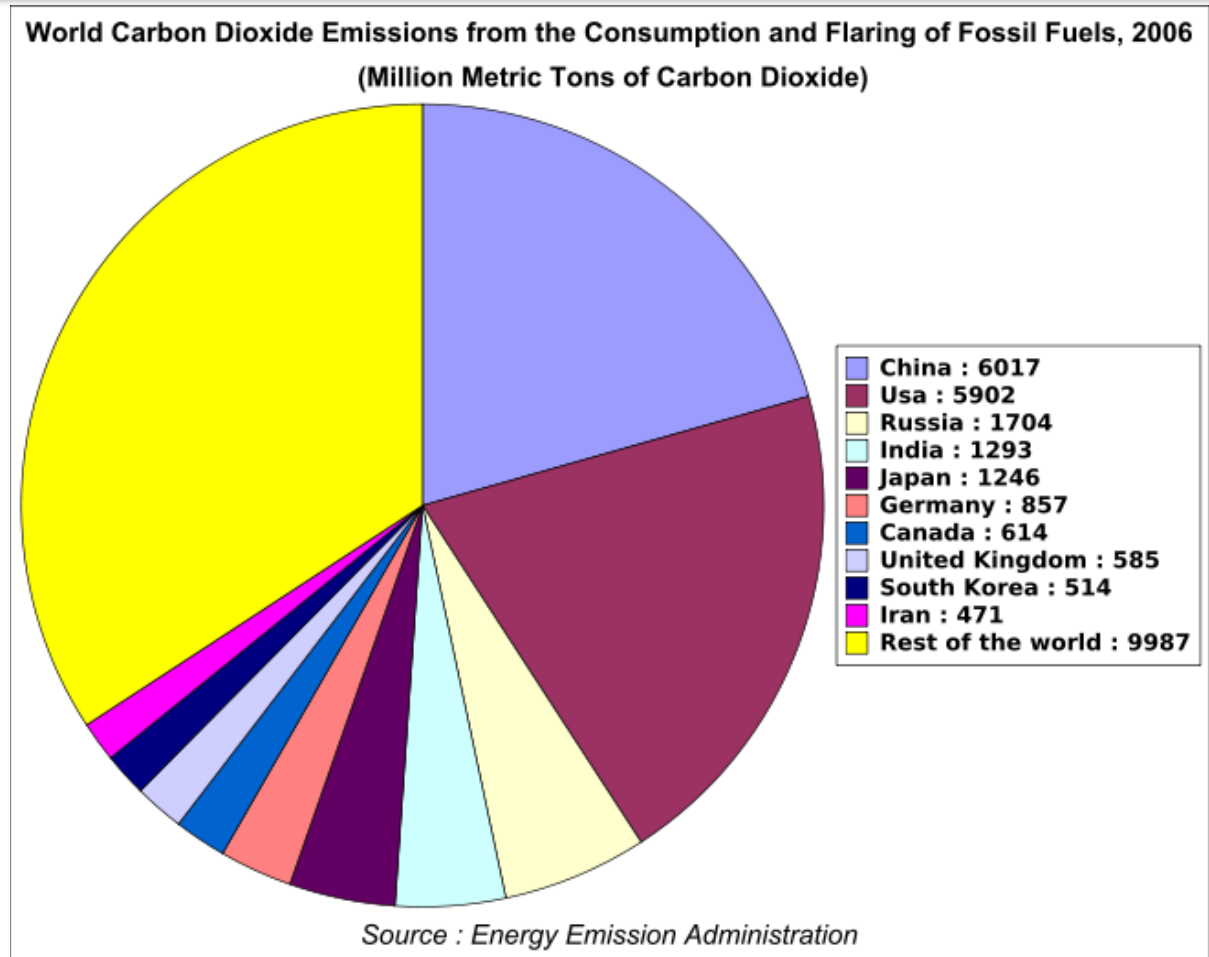
CO₂ Production by Country in 1997

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

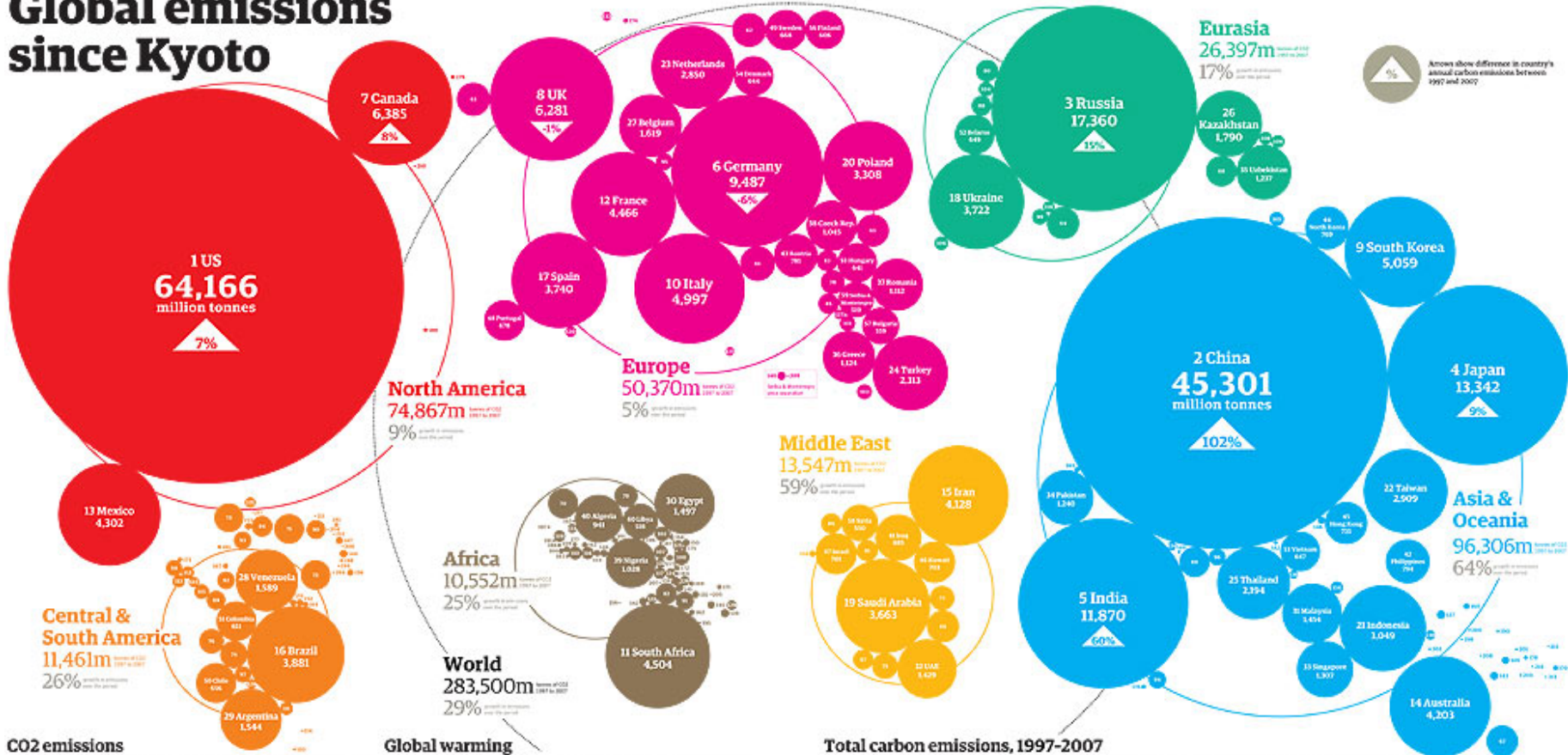
And can you even IMAGINE how bad this might be if everyone in India and China lived like we do???

CO₂ Production by Country in 2006

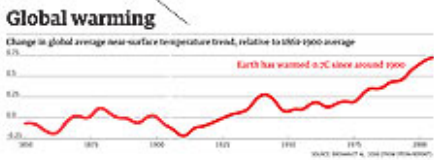
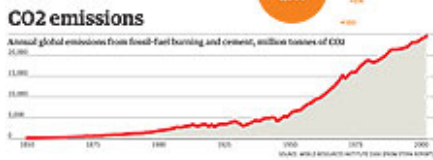


China is catching up!!!???

Global emissions since Kyoto



Arrows show difference in country's annual carbon emissions between 1997 and 2007



Total carbon emissions, 1997-2007

Rank	Country	1997	2007	Change
1	USA	12,682	17,047	+33%
2	China	1,371	13,342	+870%
3	Russia	17,360	17,360	0%
4	Japan	13,342	13,342	0%
5	India	11,870	11,870	0%
6	Germany	9,487	9,487	0%
7	Canada	6,385	6,385	0%
8	UK	6,281	6,281	0%
9	South Korea	5,059	5,059	0%
10	Italy	4,997	4,997	0%
11	South Africa	4,504	4,504	0%
12	France	4,466	4,466	0%
13	Mexico	4,302	4,302	0%
14	Australia	4,203	4,203	0%
15	Iran	4,128	4,128	0%
16	Brazil	3,881	3,881	0%
17	Spain	3,740	3,740	0%
18	Ukraine	3,722	3,722	0%
19	Saudi Arabia	3,663	3,663	0%
20	Poland	3,308	3,308	0%
21	Taiwan	2,909	2,909	0%
22	Netherlands	2,850	2,850	0%
23	Thailand	2,314	2,314	0%
24	Turkey	2,313	2,313	0%
25	Venezuela	1,889	1,889	0%
26	Kazakhstan	1,790	1,790	0%
27	Algeria	1,619	1,619	0%
28	Indonesia	1,649	1,649	0%
29	Argentina	1,544	1,544	0%
30	Egypt	1,497	1,497	0%
31	Pakistan	1,476	1,476	0%
32	UAE	1,476	1,476	0%
33	South Korea	1,476	1,476	0%
34	South Africa	1,476	1,476	0%
35	South Korea	1,476	1,476	0%
36	South Korea	1,476	1,476	0%
37	South Korea	1,476	1,476	0%
38	South Korea	1,476	1,476	0%
39	South Korea	1,476	1,476	0%
40	South Korea	1,476	1,476	0%

The summit in numbers

- 15,000 Number of delegates expected to attend official Copenhagen summit
- 40,500 Tons 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 their emissions
- \$62m+ Estimated cost to Danish government of staying the event
- 65% Proportion of food and drink provided to delegates that will be organic

The key issues at Copenhagen

- 1 Cut carbon in rich world**
Scientists say cuts of 21-40% by 2020 are needed, relative to 1990 levels, rising to 50-95% 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 deep cuts.
- 2 Curb carbon in developing world**
Emissions from fast growing economies such as China and India are soaring, 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 need a bid to create the clean technology essential for tackling global emissions. In both cases, rich nations will be expected to pick up the tab.
- 4 Keep tabs on funds and emissions**
Poor 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 tropical forests. But saving people need to tell trees, have better alternatives... Who really saves them? More than 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 agreed to a combined reduction in greenhouse gases of 21-40% by 2020. **Chance of success: Middling**
- Developing nations agreed to a 15-30% cut in the emissions levels expected in 2020. **Chance of success: Good**
- Richer nations committed to funding poorer ones, and sharing technology, to tune of \$500bn per year. **Chance of success: Low**
- Deal done on who monitors countries' carbon emissions and also audits the money. **Chance of success: Low**
- Agreement which delivers cash to funded nations, meaning for trees from trees are cut down. **Chance of success: Good**
- Deal that delivers a radical overhaul in the deployment of clean technology. **Chance of success: Fair**

Source: World Bank, IPCC, UNEP, Reuters

Radical PROBLEM:

MUST WE SHARE – IF IT MEANS LOSS OF
LIFESTYLE?

AVERAGE ONTARIAN NEEDS 4 PLANETS TO
SUPPORT LIFESTYLE....



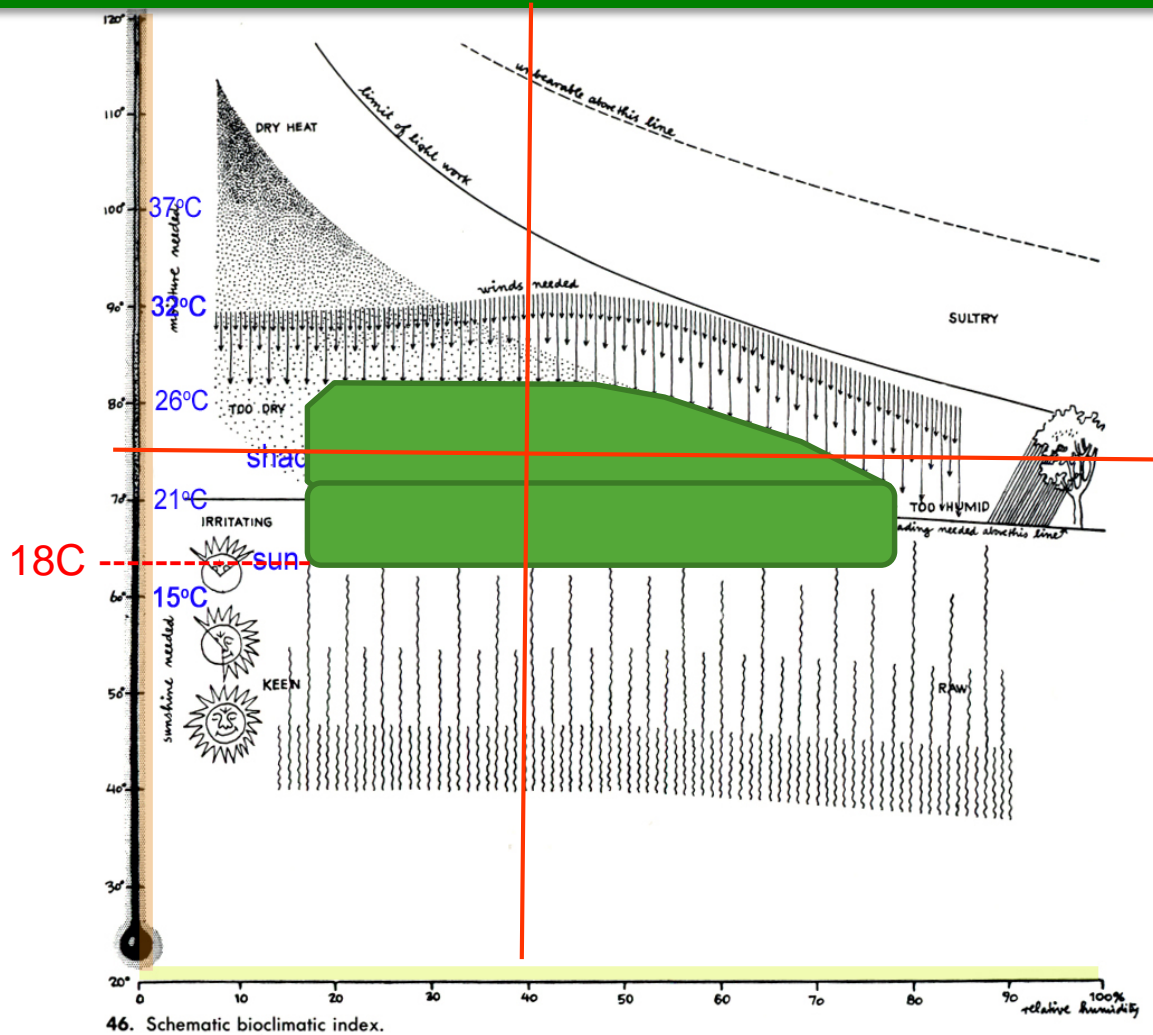
Radical POTENTIAL!!

COMFORT ZONE

WHAT IS IT?

WHAT DOES IT HAVE TO DO WITH
GREEN BUILDING?

Where is your Comfort Zone?



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.

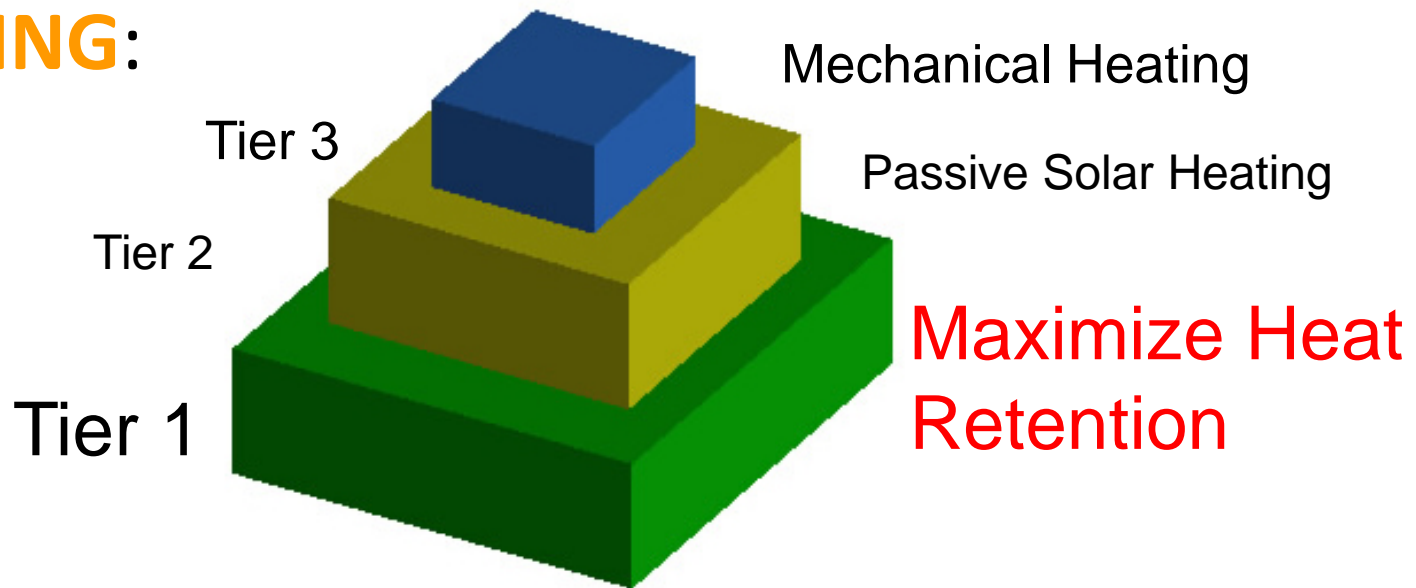
To lower our energy consumption, we must work within the broader area.

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:

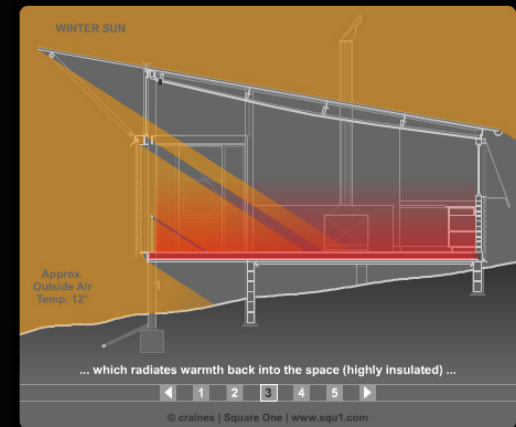
1. primarily south facing windows
2. proportion windows to suit thermal mass and size of room(s)

3 MAIN STRATEGIES:

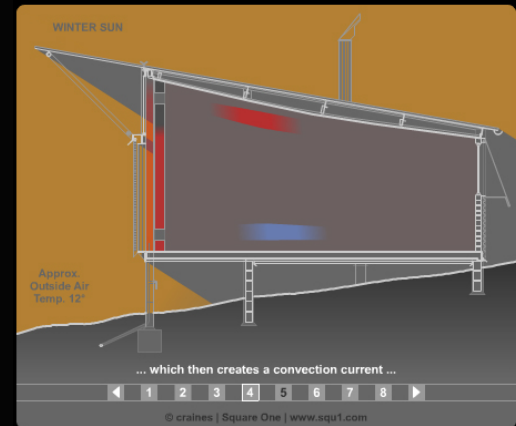
Direct Gain

Thermal Storage Wall

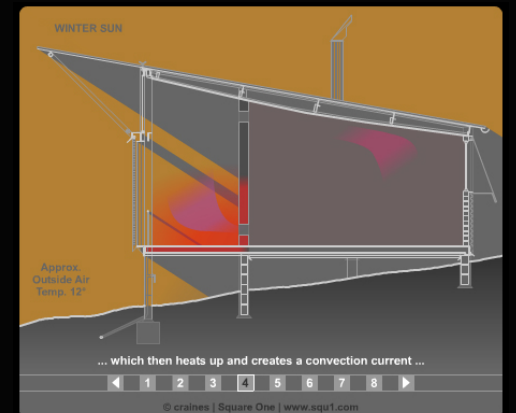
Sunspace



Direct Gain



Trombe Wall



Sun Space

Thermal Mass is Critical

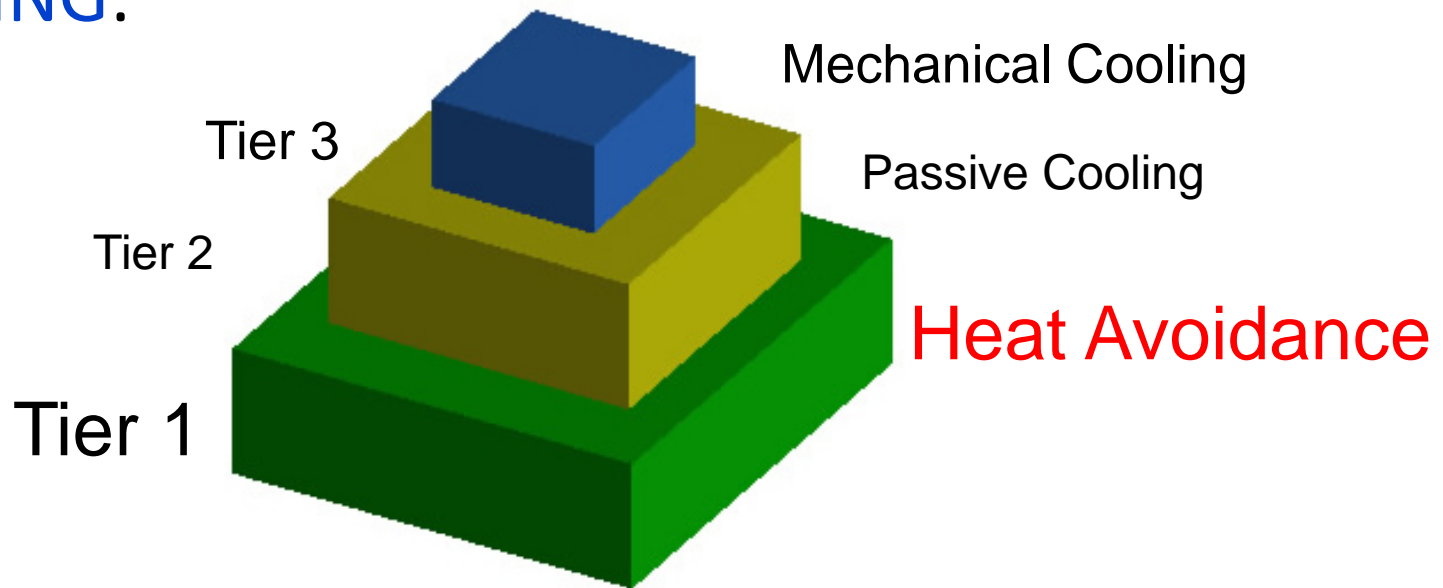
- To ensure comfort to the occupants....
- People are 80% water so if they are the only thermal sink in the room, they will be the target.
- And to store the FREE energy for slow release distribution....



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

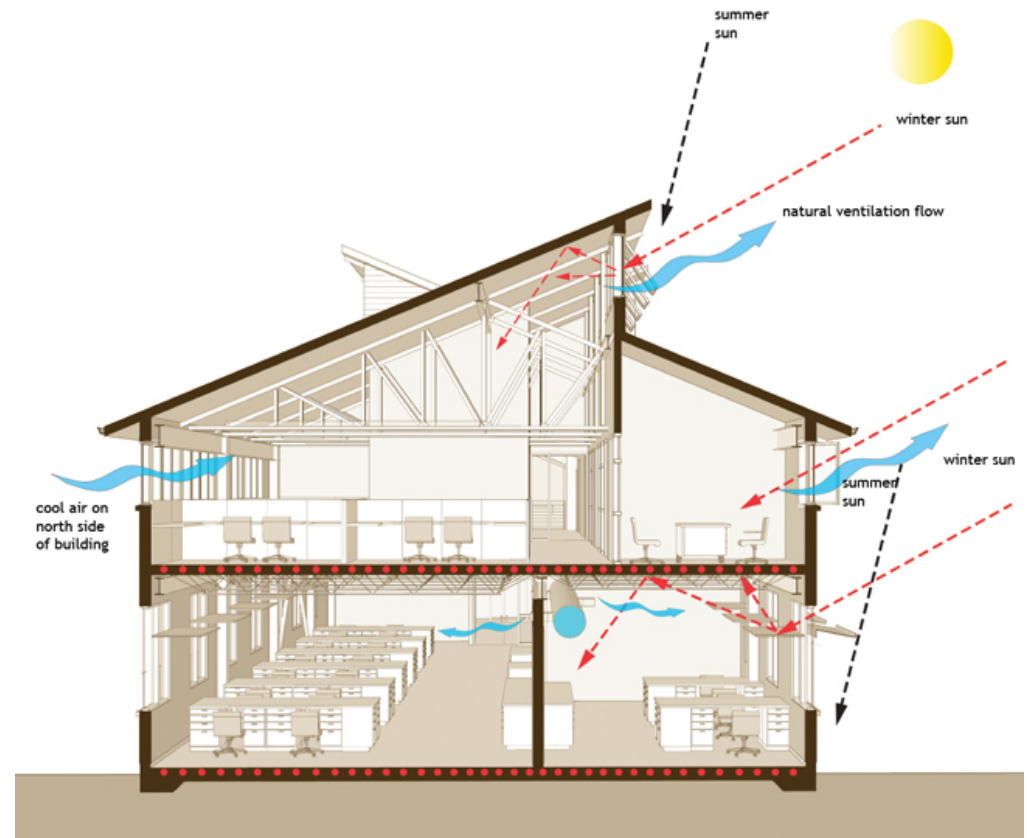


If you don't invite the heat in, you don't have to get rid of it.....

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

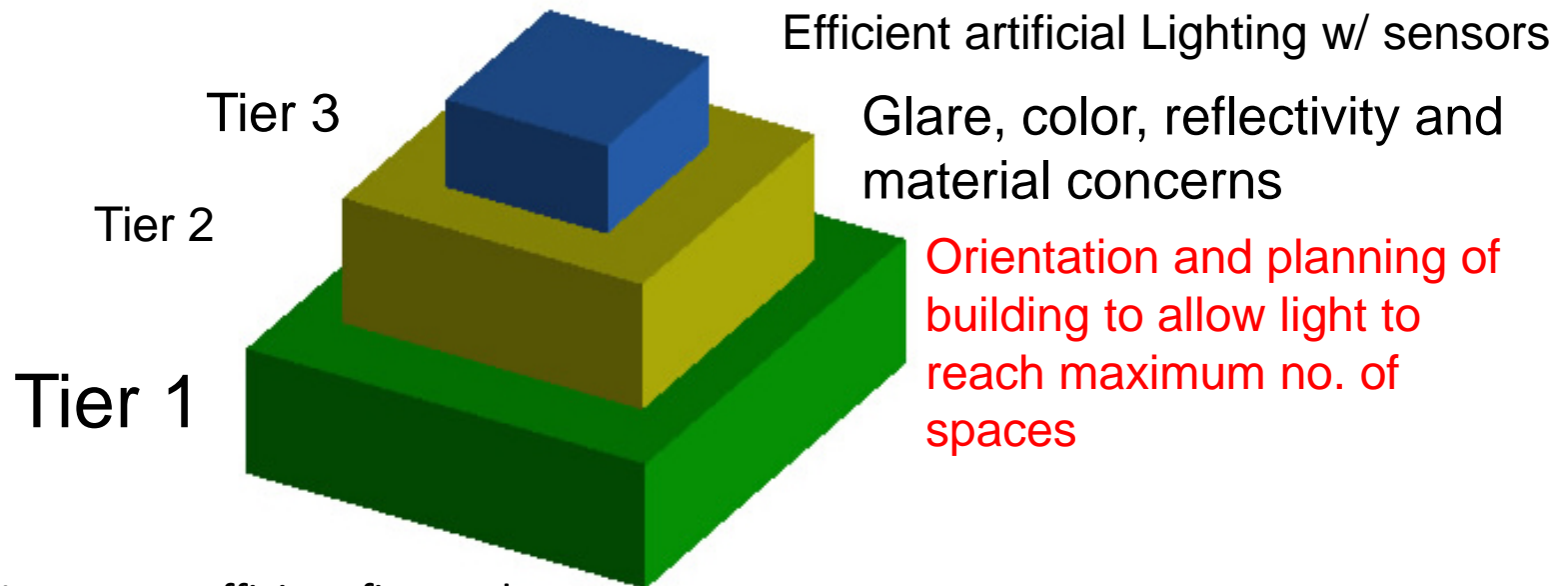
INNOVATION:

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



PASSIVE Strategies - DAYLIGHTING

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



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:

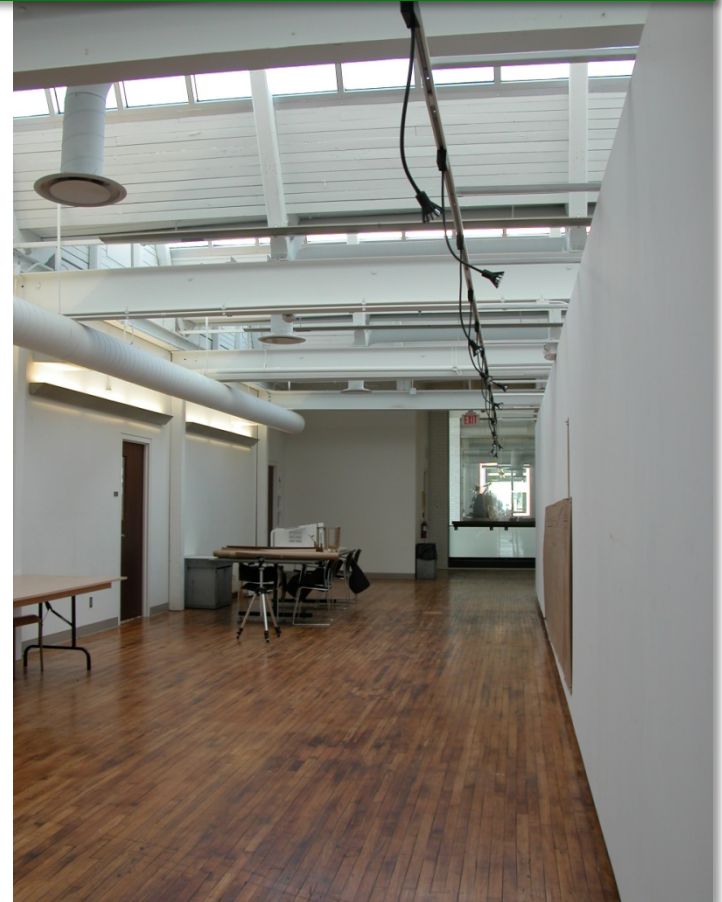
- incorporate light dynamics
- avoid glare
- understand the function of material selection; eg. reflectivity and surface qualities
- balance color and reflectivity with amount of daylight provided



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

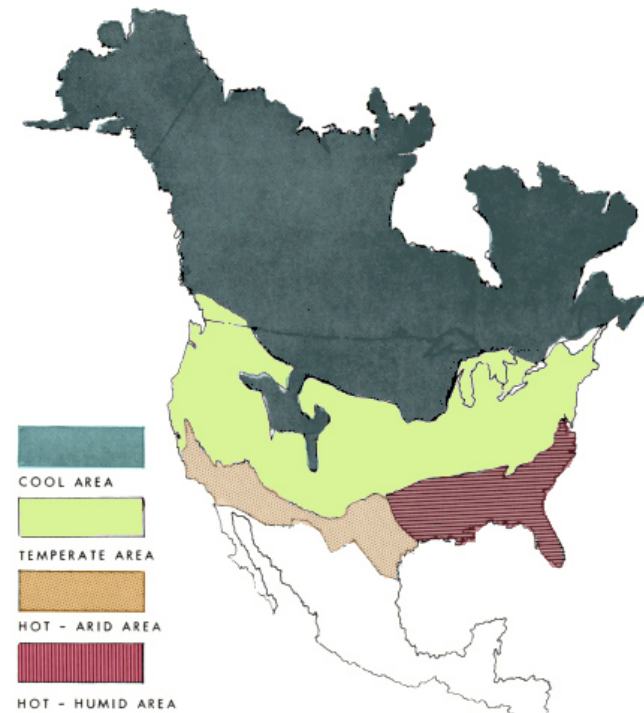
Design must first acknowledge regional, local and microclimate impacts on the building and site.

COLD

TEMPERATE

HOT-ARID

HOT-HUMID



11. Regional climate zones of the North American continent.

Image: 1963 "Design With Climate", Victor Olgay.

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**



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
- respect the **DIURNAL CYCLE**
- use heavy mass for walls



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



House in Seaside, Florida

Bio-climatic Design: TEMPERATE

The summers are hot and humid, and the winters are cold.

The four seasons are almost equally long.

RULES:

- BALANCE strategies between COLD and HOT-HUMID
- maximize FLEXIBILITY in order to be able to modify the envelope



IslandWood Residence, Seattle

Radical GREEN

IS POSSIBLE!
RIGHT NOW!

Radical | Green

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