

Passive First:

- Passive Solar Heating
- Passive Cooling

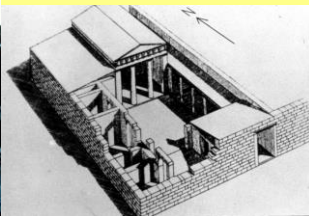


SOLAR ENERGY.

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Greek and Roman solar buildings featured vast, unglazed south-facing apertures.



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Introduction to Passive Strategies

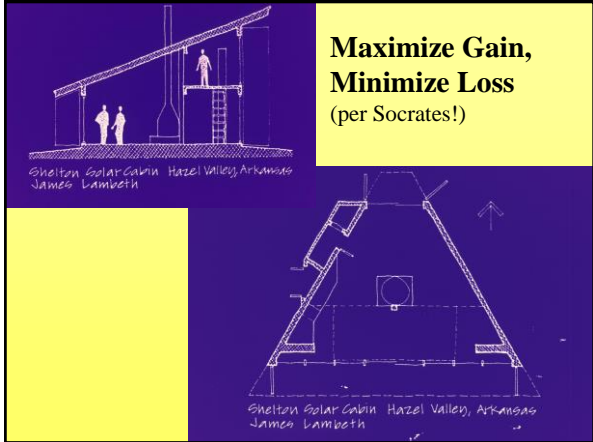
"Again when he (Socrates) said about houses that beauty and utility were the same, he was giving a lesson in the art of building houses as they ought to be. He approached the problem thus:

'Is it not true that to have the right house it should be both useful and pleasant to live in.'

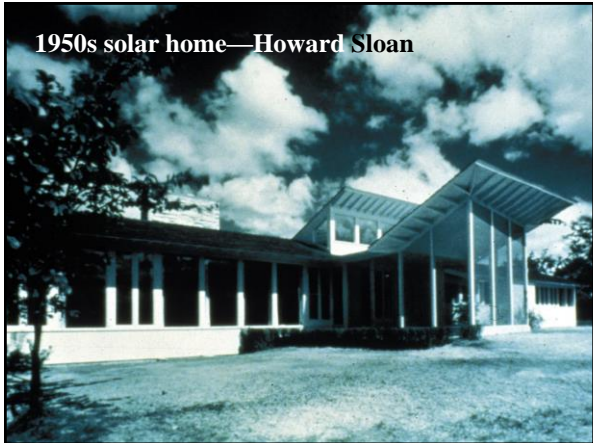
And this being admitted: "is it pleasant," he asked, "to have it cool in summer and warm in winter."

And when they agreed with this also, "Now in houses with a southern exposure, the sun's rays penetrate the porticos in winter but in summer being less inclined, they afford us shade. If then, this is the best arrangement, we should build the south side loftier to get the winter sun, and the north side lower to keep out the cold winds."

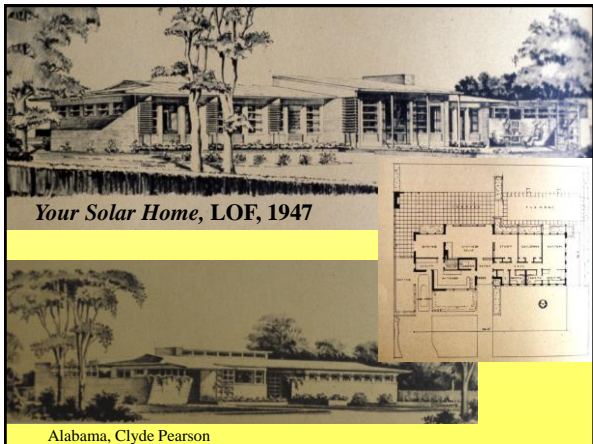
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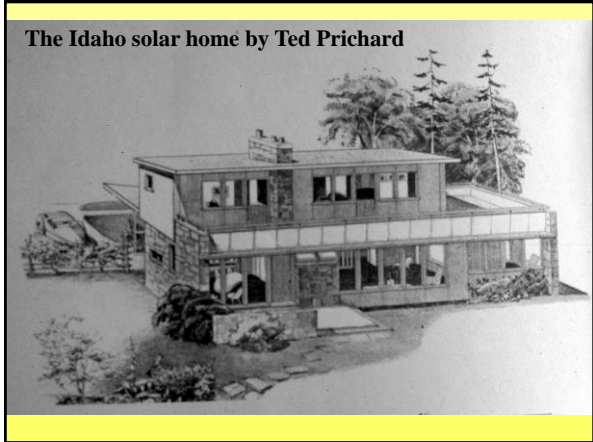
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A PASSIVE SOLAR HEATING OR COOLING SYSTEM IS ONE IN WHICH THE THERMAL ENERGY FLOW IS BY NATURAL MEANS.

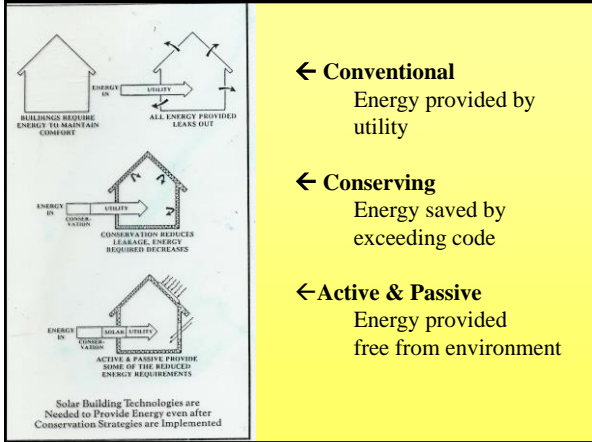
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Solar Knowledge Comparison Chart

Year	Cats' Solar Knowledge	Peoples' Solar Knowledge
1980	1 cat = 100 people	100 people = 1 cat
2000	1 cat = 100 people	100 people = 1 cat

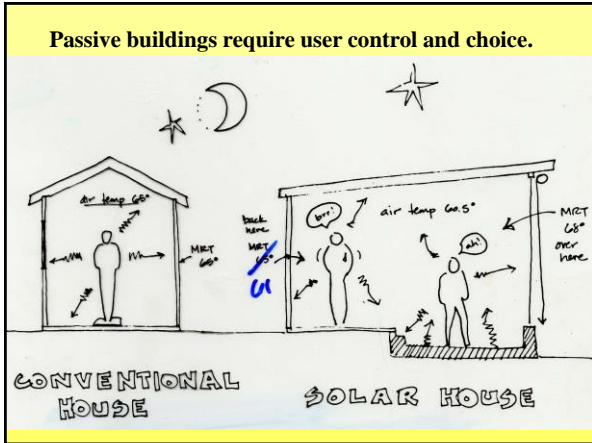
Figure 1.11 Comparison of total world-wide solar knowledge at the release of the Solar Cat Book in 1980 and in 2000, twenty years later. [Using very good polling techniques.]

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- ← **Conventional**
Energy provided by utility
- ← **Conserving**
Energy saved by exceeding code
- ← **Active & Passive**
Energy provided free from environment

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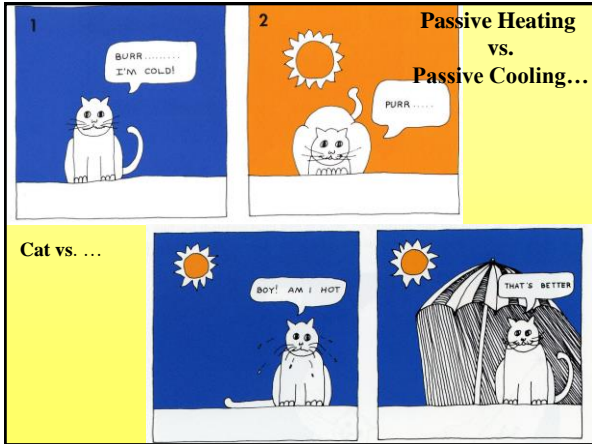
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Passive Goals

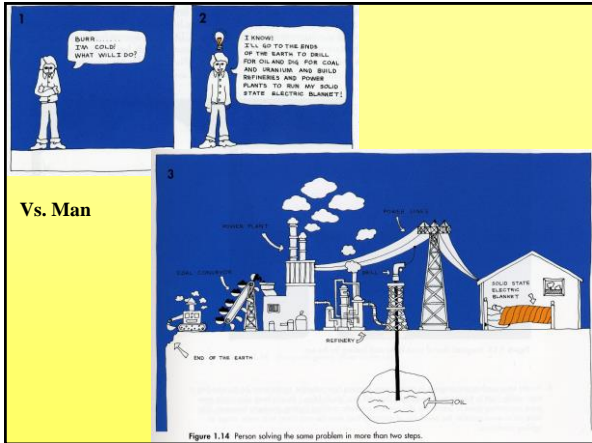
Heating Season	Cooling Season
1. Optimize solar gain	1. Minimize solar gain
2. Minimize skin heat loss	2. Minimize skin and internal gains

Can a single design do both?

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COMPONENT	SOLAR THERMAL CAT		SOLAR THERMAL SYSTEMS MADE BY PEOPLE	
	ACTIVE	PASSIVE	ACTIVE	PASSIVE
COLLECTOR				
STORAGE				
HEAT TRANSFER MECHANISM				
CONTROL				
CATABOLISM			NOT APPLICABLE	NOT APPLICABLE

Figure 2.3 Chart comparing cats' and peoples' solar thermal systems.

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Passive Strategies

Cooling	Heating
Direct Loss	Direct Gain
Indirect Loss	Indirect Gain
Isolated Loss	Isolated Gain
Avoiding Gain	Avoiding Loss
Lowering Internal Gain	No conserving parallel

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DIRECT LOSS

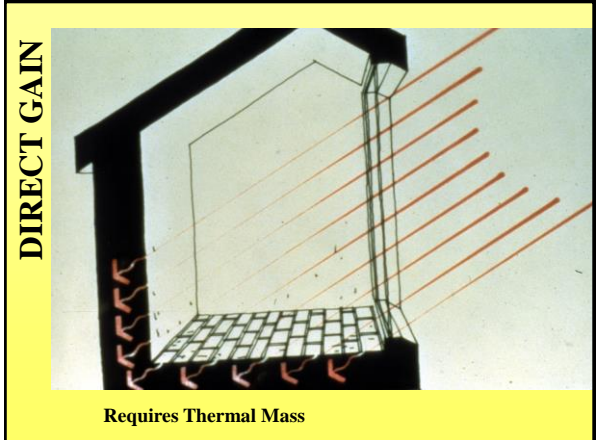
Night - Open - Day - Closed
 Lose heat directly via night radiation
 NIGHT-AIR COOLING
 Day - Closed - Night - Open
 NIGHT-SKY RADIATION

Requires apertures with switches.
Reverse diurnal operation to provide heating.

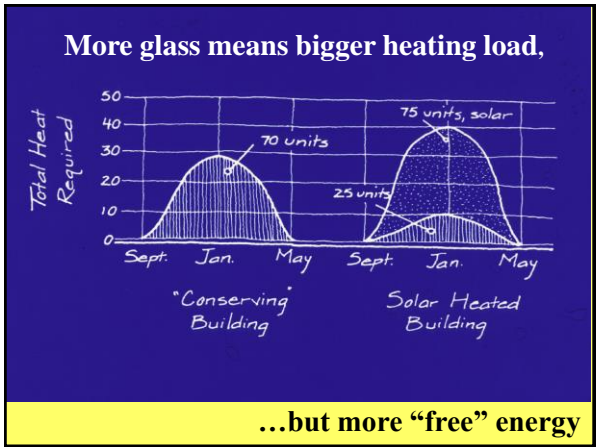
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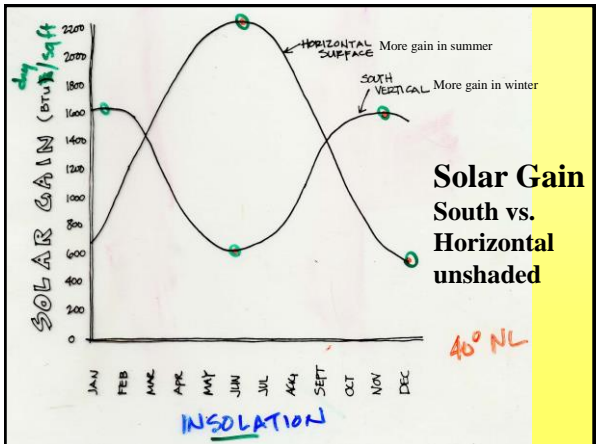
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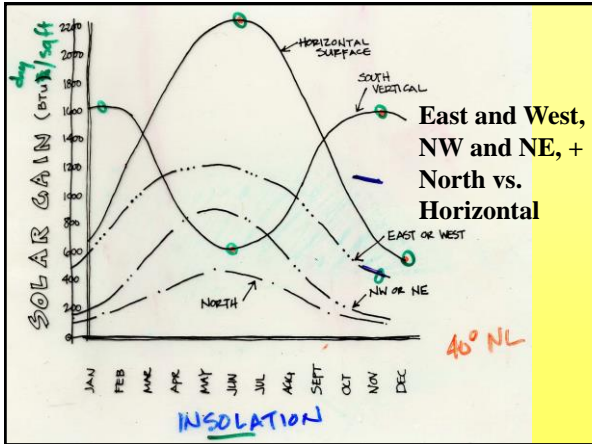
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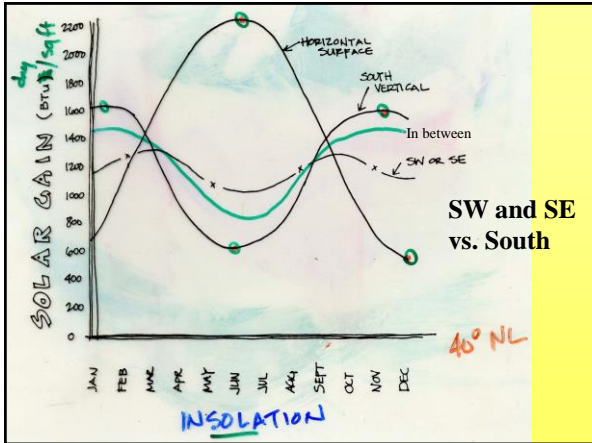
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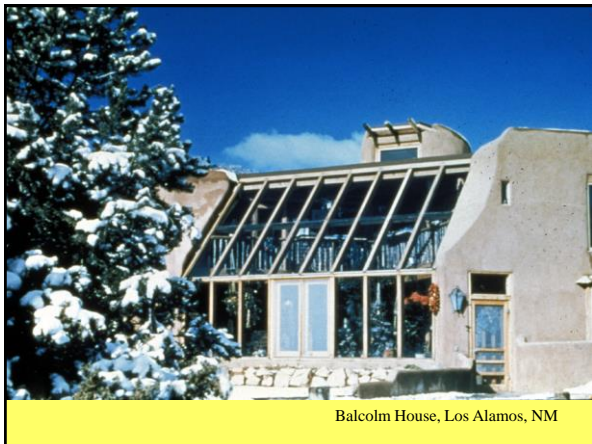
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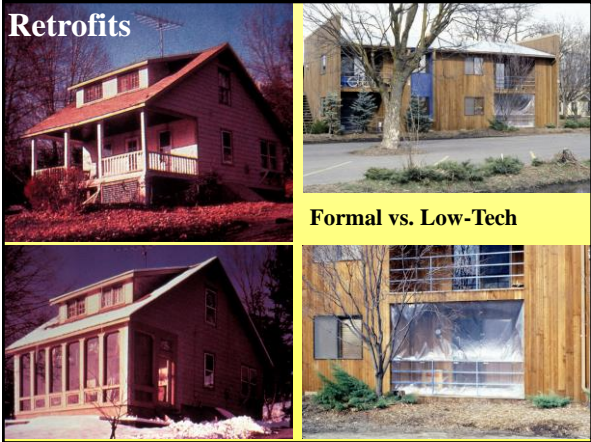
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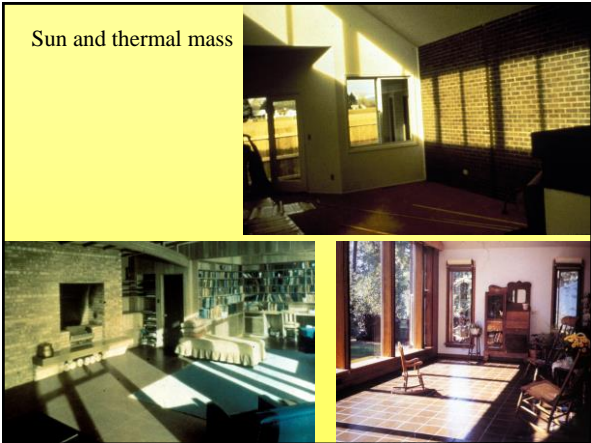
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Retrofits

Formal vs. Low-Tech

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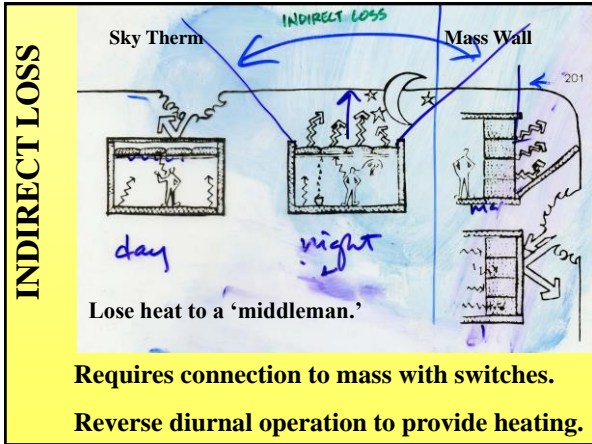


Sun and thermal mass

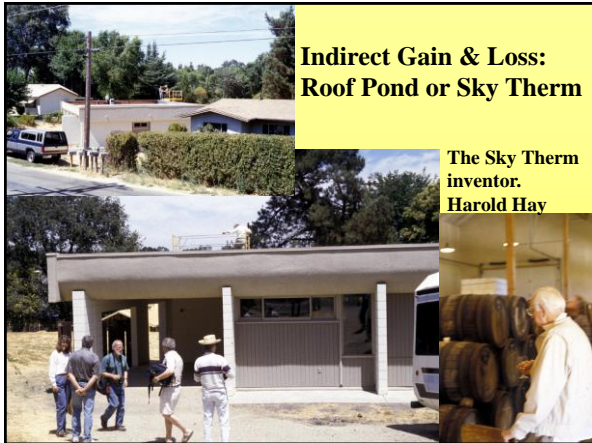
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Phase change materials
can replace thermal mass

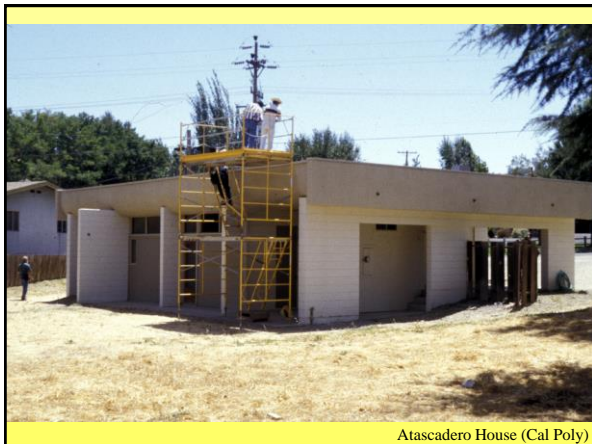
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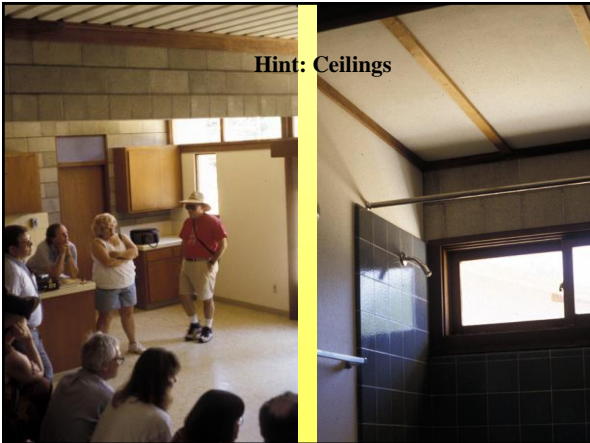
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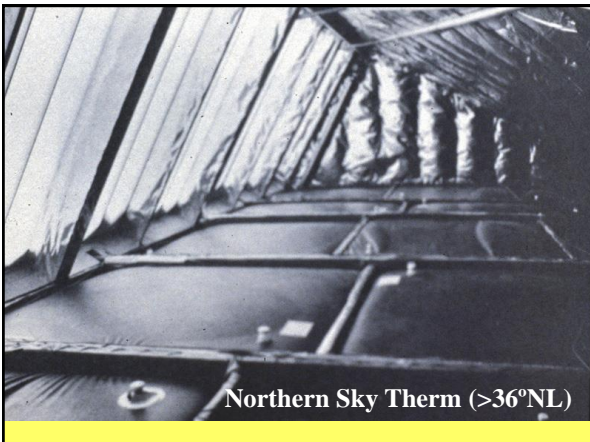
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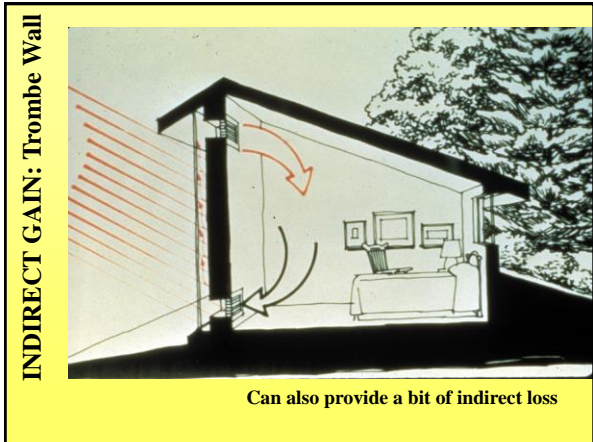
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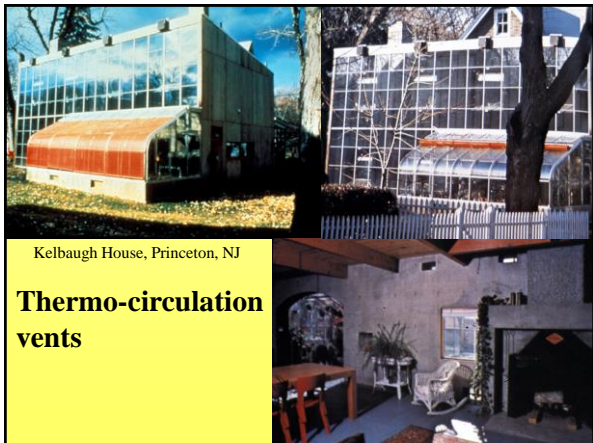
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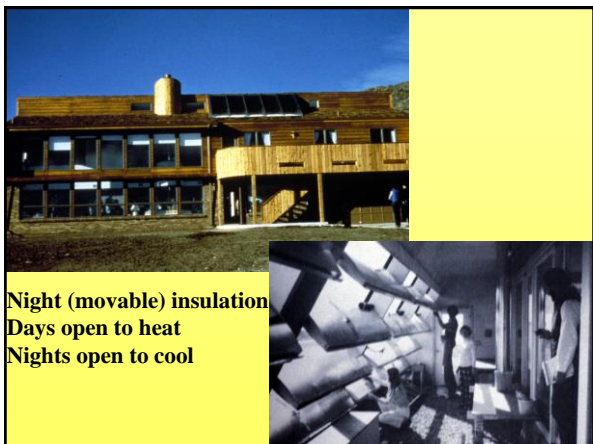
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Selective glazing—view not required

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Street barrier, Berkeley, CA

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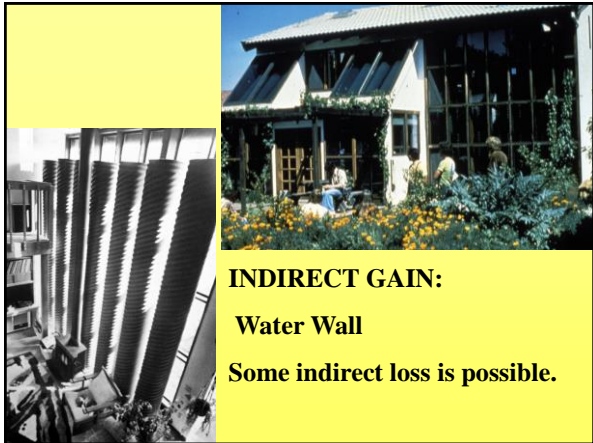
**Hybrid system:
Trombe wall for heating/cooling
Windows for light and view, Girl Scout House, NJ**

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Retrofit



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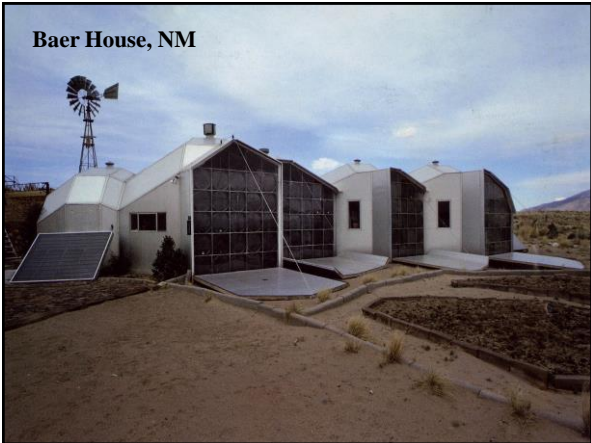
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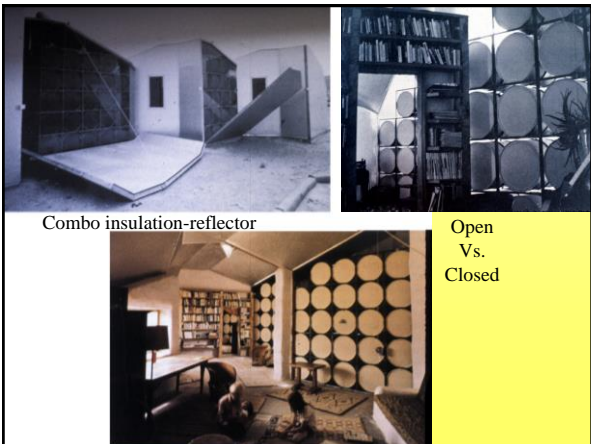
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ISOLATED LOSS

Lose heat via a remote system.

Requires remote apertures.
To provide heating requires a different system.

Isolated gain

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**INDIRECT LOSS:
Earth Tubes**

Sainsbury's passive grocery store North Greenwich

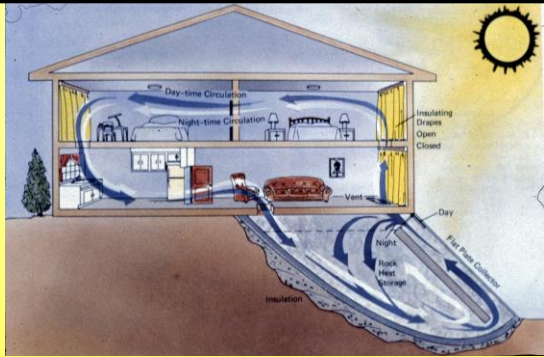
Daylighted & Earth Tube Cooled

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Epilog

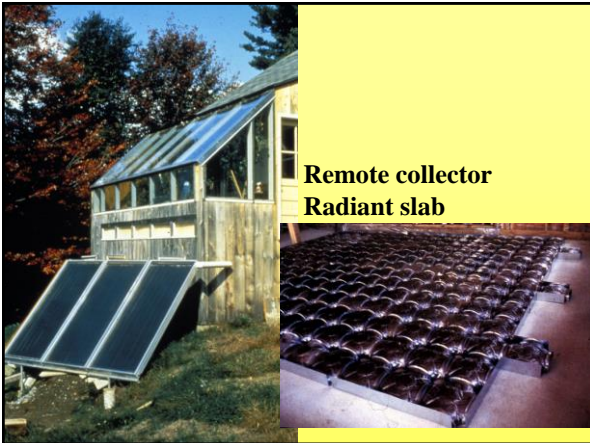
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ISOLATED GAIN: Thermosiphons



Air-based Collector with Rock Bed Storage

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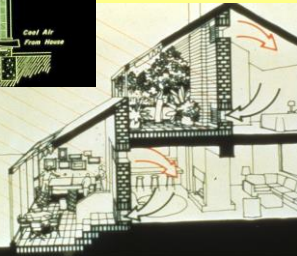
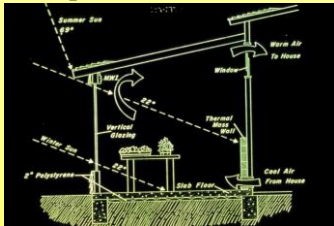


**Remote collector
Radiant slab**

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ISOLATED GAIN

Sun Spaces (Greenhouses)



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Retrofit and Low-tech



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Problem?

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AVOIDING GAIN/LOSS

INSULATING

SHADE ROOF

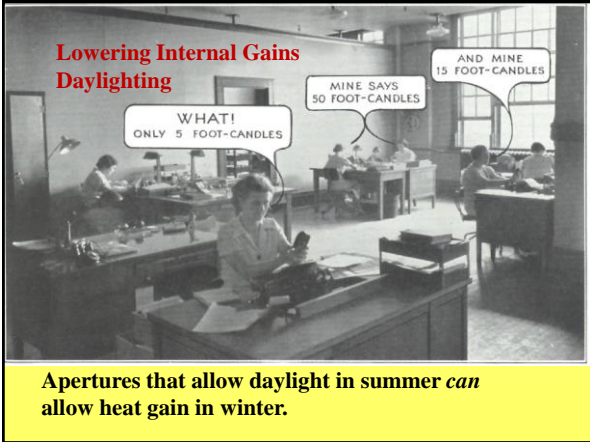
SHADING

AVOIDING = GAIN!

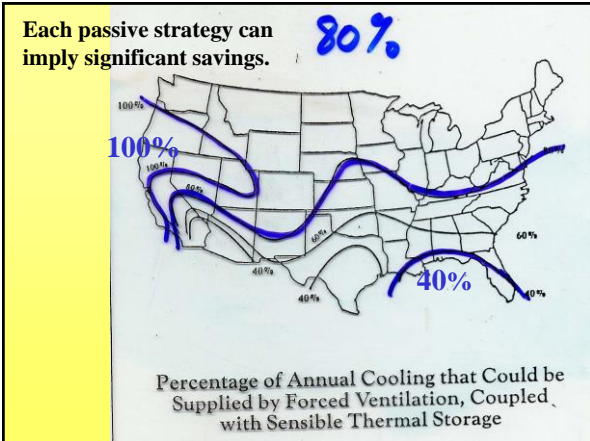
Well-designed shading avoids summer gain and promotes winter gain.

Insulation always reduces heat flow, so less gain in summer and less loss in winter.

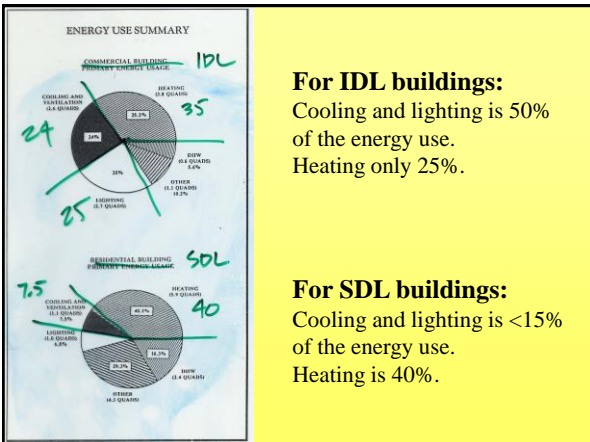
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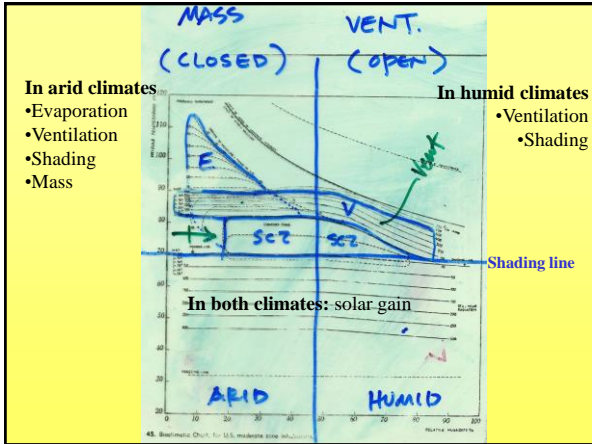
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US DOE insists that 80% of potential energy savings Occurs during the schematic design phase.

BP Solar Showcase, Arup Associates

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Design for difficult sites

Davis Cabin, VA

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Stair-step house, Karen Terry, AZ

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