

CARBON REDUCTION STRATEGIES

ZERO ENERGY, WITH "ZERO BTU"

DOING A MORE "PASSIVE" HOUSE :USING THE BUILDING MASS TO STORE ENERGY.

WHAT IS THERMAL MASS?

It is the ability of materials to absorb, store and release energy. It is determined by a material's "Specific Heat Capacity" AKA Thermal Inertia (or Thermal Lag) and its "Thermal Conductivity"

Matl	Density	Specific Heat	Thermal Conductivity
Timber	37 lb/ft ³	31 Btu/(lb.F)	0.081 Btu/h.ft.F
Concrete	137 lb/ft ³	20 Btu/(lb.F)	0.90 Btu/h.ft.F
Brick	106 lb/ft ³	13 Btu/(lb.F)	0.29 Btu/h.ft.F
Stone	194 lb/ft ³	13 Btu/(lb.F)	2.00 Btu/h.ft.F
Water	62 lb/ft ³	79 Btu/(lb.F)	0.34 Btu/h.ft.F

PCM Tile 86 Btu/lb* 1.35 Btu/(lb.F) 0.26~0.66 Btu/h.ft.F (*LATENT HEAT)

Thermal Storage capacity of materials: Density X Specific Heat (Btu/h.ft³.F)

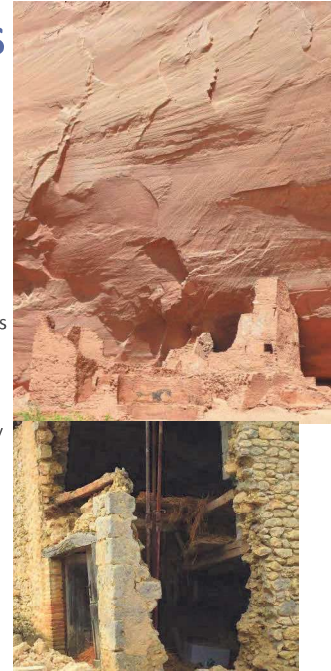
Concrete: 137 x 20 = 2,740 Btu/h.ft³.F

CTPH Conductivity determines the rate of heat transfer



Passive solar heat has been used for thousands of years

30" thick 18th century stone walls: night time ventilation cooling (8hr lag time)



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TRADITIONAL THERMAL MASS OPTIONS:

- FLOOR & WALL TILES SET IN A "MUD BED" OR CEMENT BOARD
- LATH & PLASTER OR STUCCO WALL & CEILING FINISH
- CMU (BARE) WALLS INSIDE THE ENVELOPE
- WATER FILLED CONTAINERS (WITH A DARK DYE)

THERMAL MASS CHALLENGE:

Designing the thermal mass for Maximum energy storage:

Materials absorb heat from the air by convection.

The surface area and difference of Temperature are critical:

A 55 gal. tank absorbs heat more slowly than 37, 1.5 gallon containers

Note: The process occurs in reverse when the ambient temperature is lower than the that of the thermal mass.

The rate of heat transfer can create a time lag in the building envelope similar to the effect of insulation materials



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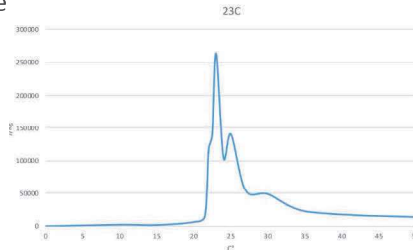
DOING A MORE "PASSIVE" PASSIVEHOUSE:
EXPERIMENTING WITH PCM (Phase Change Materials) For the last four months

- PANEL MATERIAL:** Thermoplastic 20 mil Top & Bottom
- PANEL WIDTH:** 23.75" OR 16" (603mm or 406mm)
- PANEL LENGTH:** 23.75" (603mm)
- GENERAL PANEL THICKNESS:** 0.25" (6.3mm)
- MAX CENTER RIDGE THICKNESS:** 0.16" (mm)
- THERMAL CAPACITY** +100btu/sf ; [2,496 J/m2]
- PHASE CHANGE MATERIAL** Mineral Based/Inorganic
- TEMPERATURES** 65F(18C), 72F(22C), 77F(25C), 80F(27C)
- LATENT HEAT** -86 btu/lb; [-200 j/g]
- SPECIFIC HEAT** 1.35 btu/lb; [3.14 j/g]
- THERMAL CONDUCTIVITY** -0.15 W/ft/K Liquid, -0.38 W/ft/K Solid
- WEIGHT** 1.3 lbs/sf [5.7 kg/m2]
- FLAMMABILITY** ASTM E84|UL723 - CLASS A FIRE RATED



TEMPLOK PCM Tiles
4 x 100 btu 12x12 PCM tiles
FOUR PHASE CHANGE OPTIONS
65 F, 72 F, 77 F, 84 F. (+ custom)

CREDIT: INSOLCORP Co.



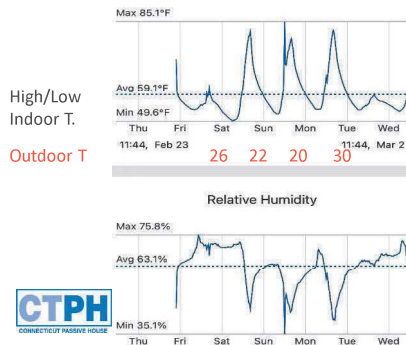
ADVANTAGES OF PHASE CHANGE MATERIALS:

- STRAIGHTFORWARD BTU CALCULATIONS
- EASY TO INTEGRATE IN EXISTING BUILDINGS
- EASY TO INSTALL. (MODULAR)
- SCALABLE INSTALLATION
- LOW \$/ Btu (\$0.035/Btu)
- MULTIPLE PHASE CHANGE OPTIONS:
Heat: 65 F & 72 F Cool: 77 F & 84 F

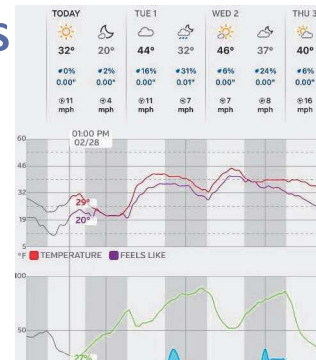
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PHASE 1: A MINI SOLAR GREENHOUSE

6'x8' with 5/8" R1.6 double plexiglass
R10.6 North wall (1-1/2" Polyiso)
Ceramic tile floor in sand bed & R7 timber base
40 PCM tiles on cement board (=4,000 BTU) maintained interior Temp 29°F above nighttime low of 20 °F
Cost: \$140 + installation



Local weather data



- 1 1/2" POLYISO
- 3/4" CEMENT BD
- PCM TILES



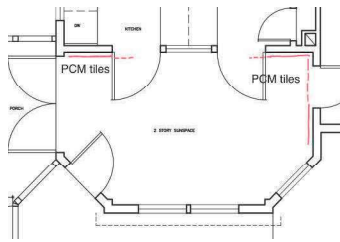
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STEP II: 6,800 BTU of PCM Tiles

No heating. 1 Ceiling fan running 24Hs @ low speed



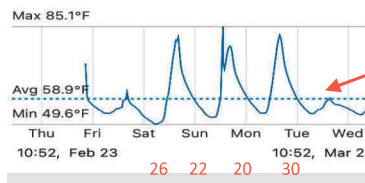
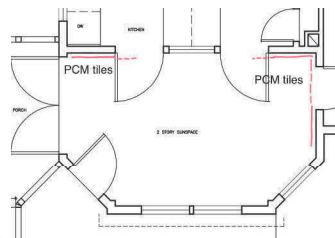
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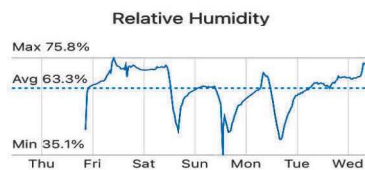
STEP II: 68 12x12 PCM tiles = 6,800 BTU

No heating. 1 Ceiling fan running 24Hs @ low speed



INTERIOR DOORS OPENED

COST: PCM tiles: \$240.00 + Labor & 2 (4'x8') sheets of plywood



ROOFS
WALLS
WINDOWS



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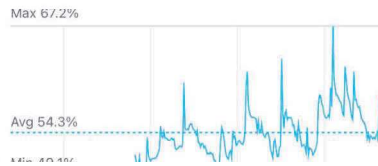
ZERO ENERGY, STEP III PASSIVEHOUSE RETROFIT

24 12x12 PCM tiles = 2,400 BTU Cost: \$84.00 + labor
Finished Passivehouse Remodeling with Mini-split HVAC

(T-stat set at 50°F)
Zehnder ERV @ low speed,
24Hs/DAY



Relative Humidity



There are 10 tiles
(12x11) in this room

