



# BEYOND FIRE

## Cost-Competitive Zero Energy Building Methods

Presented by:

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# Overview

- How to go “zero energy” for about the same cost as conventional?
- Smartboard phase change heating & cooling system (5 years old)
- Passive solar principles (2300 years old)
- Ultra-sealed and insulated assemblies using new techniques
- Ventilation & humidity controls
- Triple hot water efficiency (not solar thermal, heat pumps)

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# What's Unique About the Stern Residence

- Passive solar features are on second floor, made possible by integrating phase-change material into floor assembly. (2" thick = 14" concrete slab)
- Heat gain mechanical room optimizes efficiency of heat pump hot water tank, (300% to 500% efficiency) requires only three panels, cheaper & more durable than solar thermal systems.





# Heating Requirements

(These variables independent of passive solar and phase change material)

- Energy modeling indicates that 1400sf. house needs only 3200 BTUs per hour. (About a tenth of the average house)
- R-33 walls and R-60 ceilings with R-7 insulation under first floor slab
- Very well air-sealed (below .10ACH, about a fifth of the leakage of the average house).

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# Wall Assembly

- Three moisture barriers
- Super air-tight, but has ventilated wall assembly to let vapor drive out.

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# Insulation

- 3" Foam in ceiling below roof deck (R-21) plus 5" to 6" of Optima (R-23)
- All walls R-33
- Vaulted ceilings are R-60
- Attic has R-38 ceiling and floor.
- Batt insulation is ineffective.
- Blown adds only 1% to cost

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# Roof Assembly

- Insofast foam used on roof is far cheaper than SIPS panels, allows condensate drain.
- Not labor intensive
- Must use exterior foam if ceiling is unvented.
- Foam prevents mold
- Double roof membrane

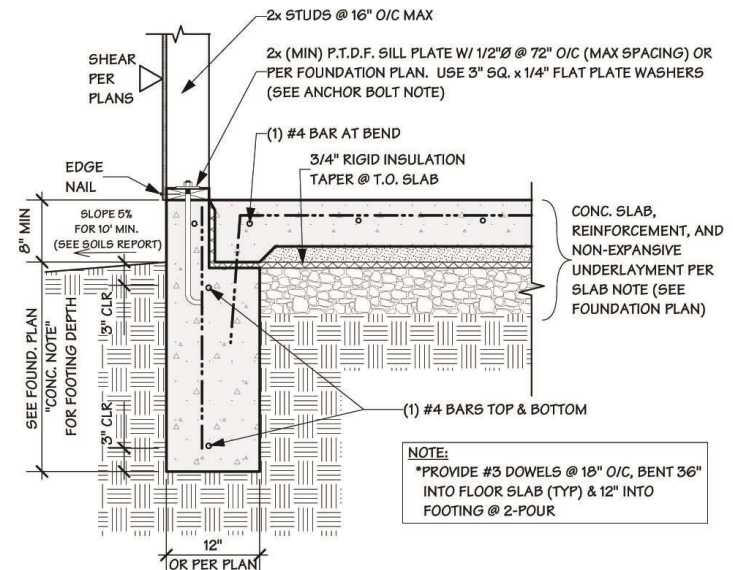




# Slab Insulation

- R-7 Dow “Blue Board” under slab.

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## 1-STORY EXTERIOR FOOTING

NO SCALE





# Critical Passive Solar Features:

(Method of letting the sun warm house in the winter and not in the summer)

- Orientation within 15° of south.
- Eave length (min. 3' to 4' for 8' tall wall)
- 15% to 20% glass on south wall.
- Hard floor surfaces at south wall.
- R10 insulation under slab.
- Above average air sealing and insulation.

NOTE: Passive solar features must be designed in to new construction at the beginning of design process!!

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# Passive Solar Advantages

- Slab insulation allows slab thermal mass to retain heat for days.
- Eave length (3' for 8' tall wall): prevents sun from hitting slab during summer.
- Passive design costs 1% more to build (\$2/sf for slab insulation), but advanced framing saves \$1500 to \$2000 (\$1/sf)
- Reduces heating cost by 50%.

NOTE: Passive solar features must be designed in to new construction at the beginning of design process!!

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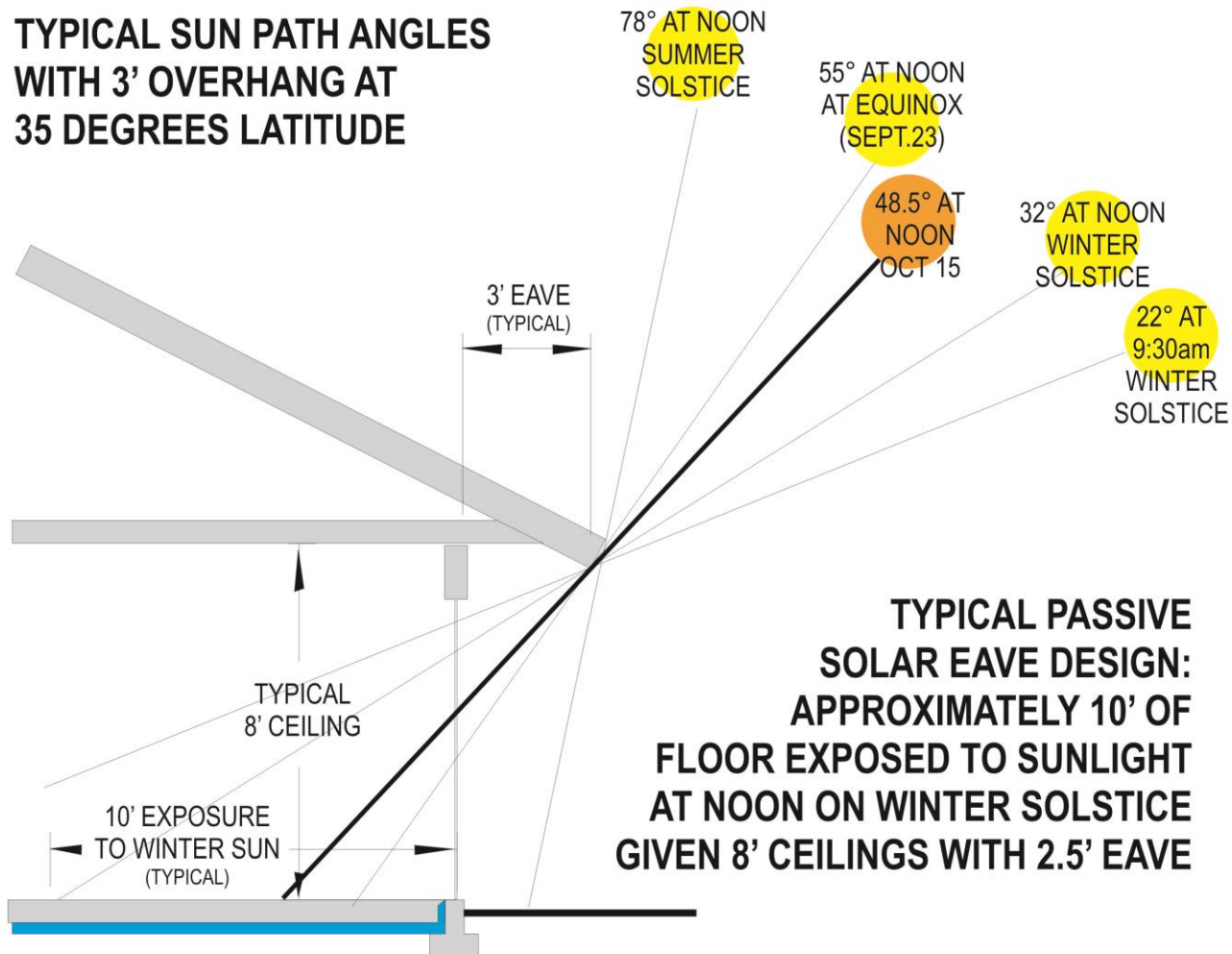
# Typical Passive Solar Eave Design

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**NOTE:**  
Basic principles used by the Greeks and Romans and then we entered the Dark Ages.

## TYPICAL SUN PATH ANGLES WITH 3' OVERHANG AT 35 DEGREES LATITUDE



**TYPICAL PASSIVE SOLAR EAVE DESIGN: APPROXIMATELY 10' OF FLOOR EXPOSED TO SUNLIGHT AT NOON ON WINTER SOLSTICE GIVEN 8' CEILINGS WITH 2.5' EAVE**





# Passive Solar Features Reinvented

(Heat home faster & retain heat for longer periods during winter)

- Longer than typical south overhang (5.5'-6') prevents noon sun from hitting second floor until late fall (Oct 1).
- Twice the glazing: 30% glazing on south wall.
- More thermal mass concentrated on second floor in direct winter sun (on floor).
- Insulated at 5 times the R-value of first floor slab.
- Phase change material prevents overheating.

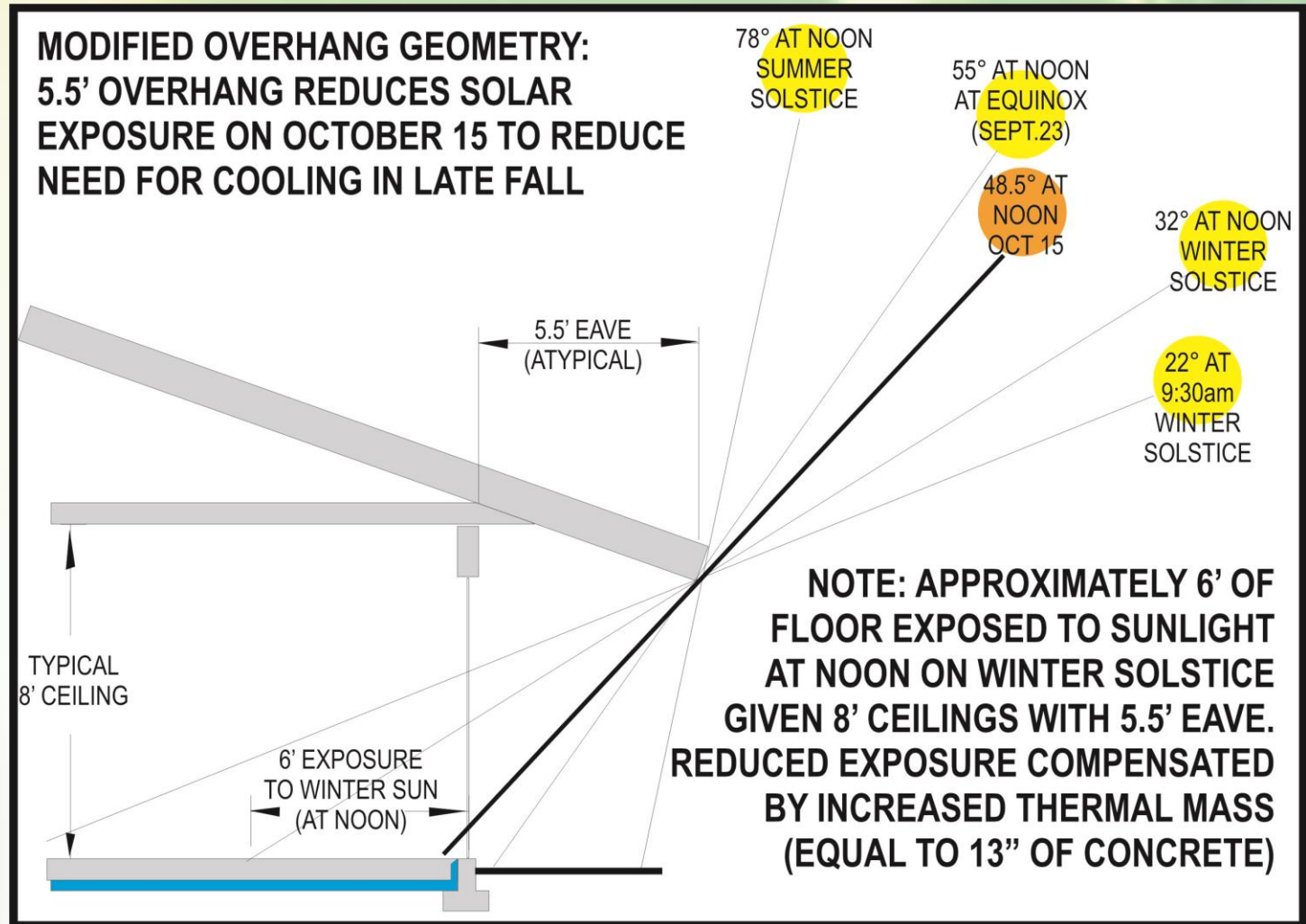
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# What is Phase Change Material?

- Materials that change phase from solid to liquid or liquid to gas have unique properties.
- Example: 1 BTU to move 1lb. of water 1° F until 212 °. Then 976 BTUs to go 1 ° more degree.
- It takes energy to break molecular bonds.
- Phase change material in micro-bubbles in the drywall allows ½” material to absorb and store same heat energy as 3.25” of concrete.  
(See Micronal Smart-board at BASF website)

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# Energy Recovery Ventilators

- Dedicated source of fresh air.
- Meet minimum ventilation requirement.
- Humidity sensors kick into higher speed above 60%.



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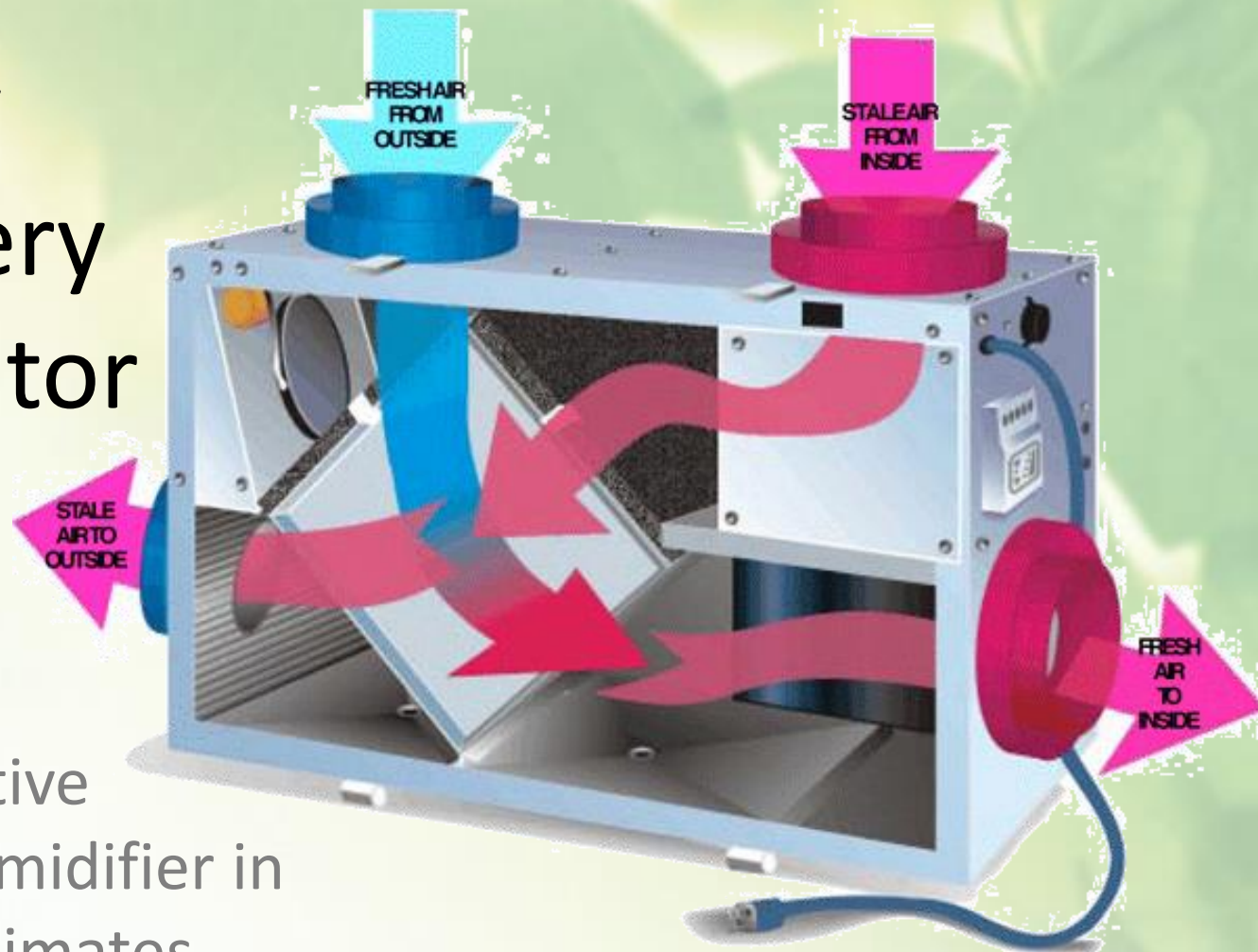


# Energy Recovery Ventilator

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Effective  
dehumidifier in  
dry climates



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# Bath Fan Humidistats

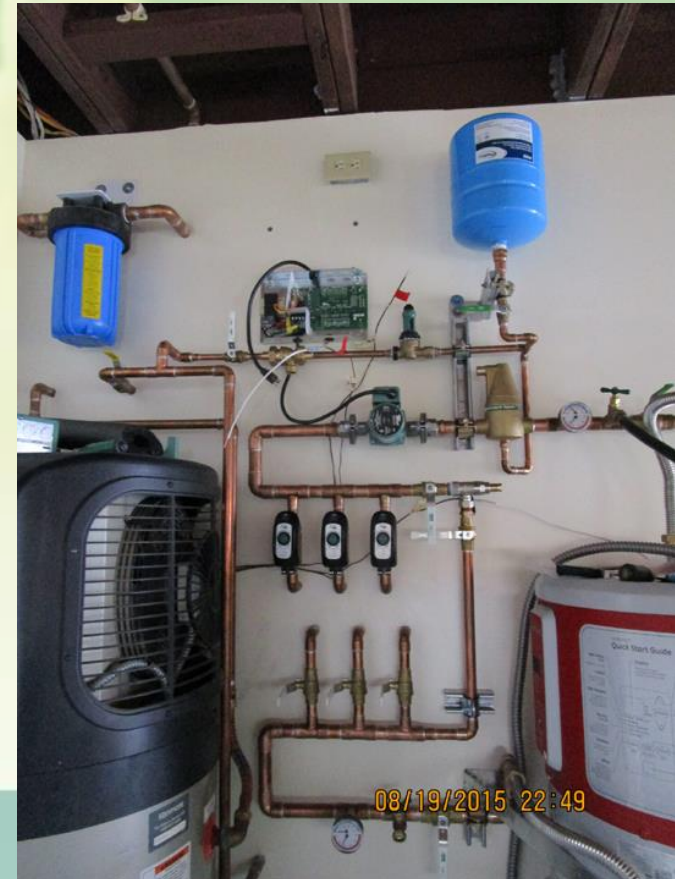
- Fans turned on by timers set at 15 minutes.
- Humidistats keep fans on past timer setting if humidity exceeds 70%.





# Maximizing Hot Water Efficiency

- GE GeoSpring is only heat pump hot water heater with WIFI interface.
- This system has new smart phone app to program water heater to go on only during the heat of day.

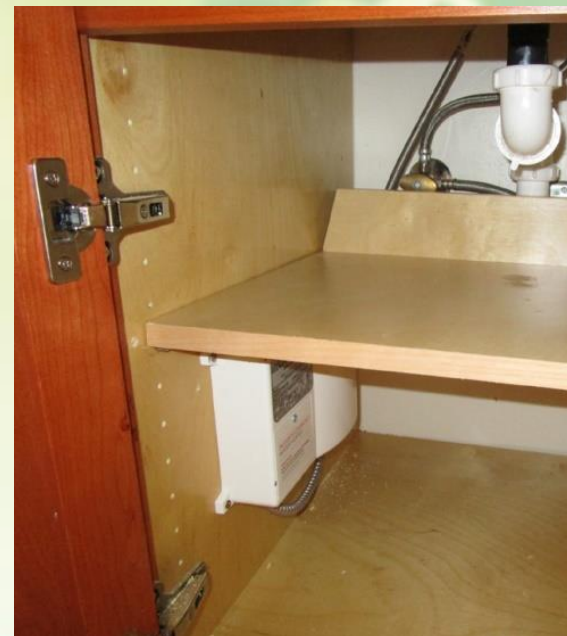




# Water Saving Devices

- Foot pedal control at kitchen sinks.
- Short, super-insulated pipe runs.
- Mini on-demand hot water heaters feed bath sinks.

NOTE: Recirc systems waste energy! They are heat radiators!



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## Passive Solar & Smartboard Beats FAU

- Passive solar with 2x6 framing is \$1-\$2/sf more to build but saves \$650/year in energy costs with ROI of around 30%.
- Smartboard combined with passive solar eliminates HVAC equipment for \$2/sf (cost in mass production).
- Forced air system for 2000sf home costs \$8k to \$12k (\$4-\$6/sf) and costs \$1000-\$2000 per year to operate. (Initial cost difference, plus energy cost plus replacement in 20 years = \$50k higher cost than Smartboard in first 20 years).

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# Questions?

Please email follow-up  
questions to:

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