

Phase Change Energy Solutions, Inc.



PHASECHANGE
energy solutions

www.phasechange.com

Our BioPCM™ products address one of the most pressing problems of our time...

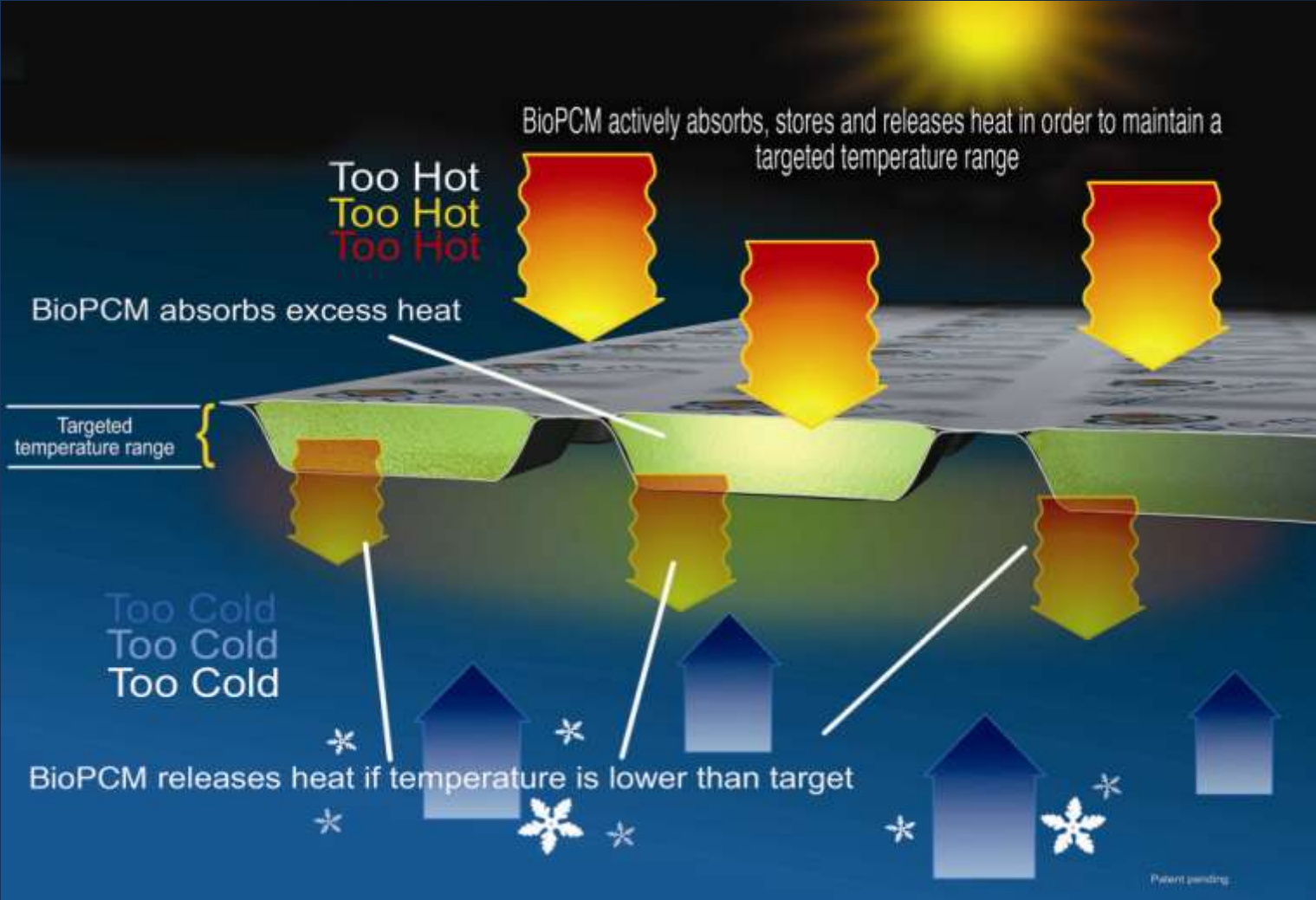
*the increasing demand for energy
and the limited global resources to fulfill that need.*



What Are Phase Change Materials(PCMs)?

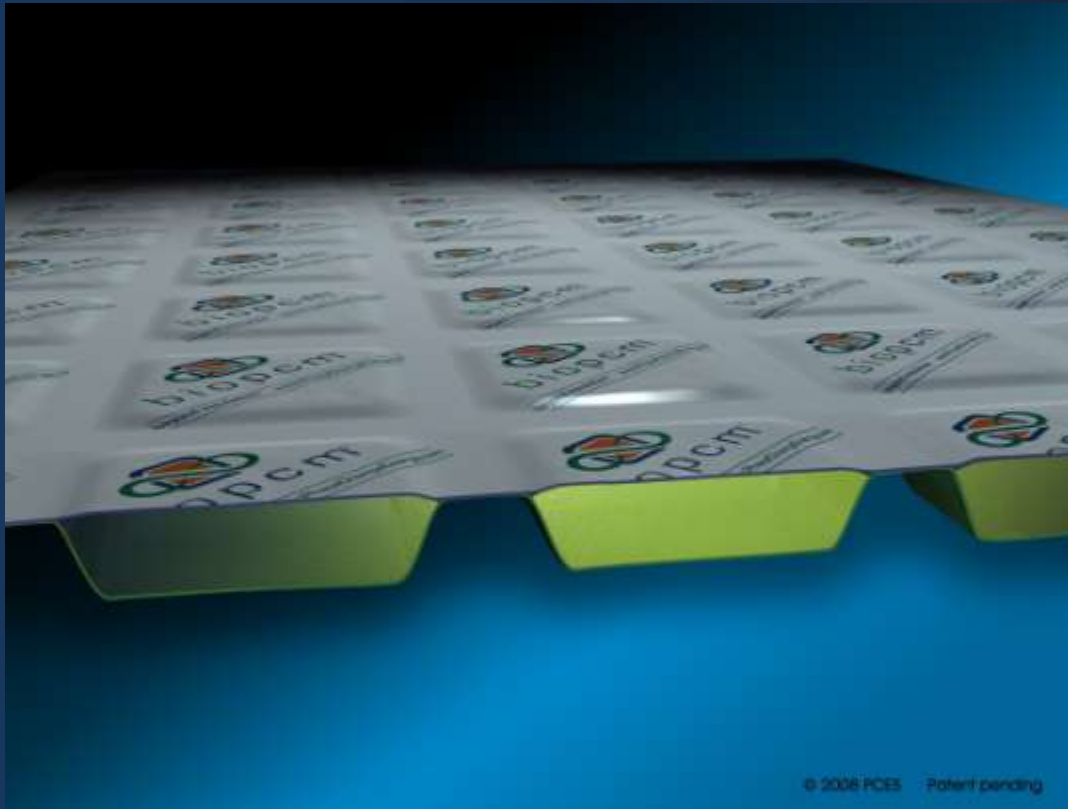
- *PCMs are materials which take advantage of a fundamental property of nature; the natural tendency of materials to absorb heat when they melt (change phase from a solid to a liquid) and to release heat when they solidify (change phase from a liquid to a solid).*
- *PCMs can store tremendous quantities of heat per unit of mass through these transitions. When phase change materials are placed in quantity into the structure of a building, they will absorb heat (air condition) in the building as temperatures rise and release heat (heat) in the building when temperatures drop.*

How BioPCM Works



Our Current Family of Products

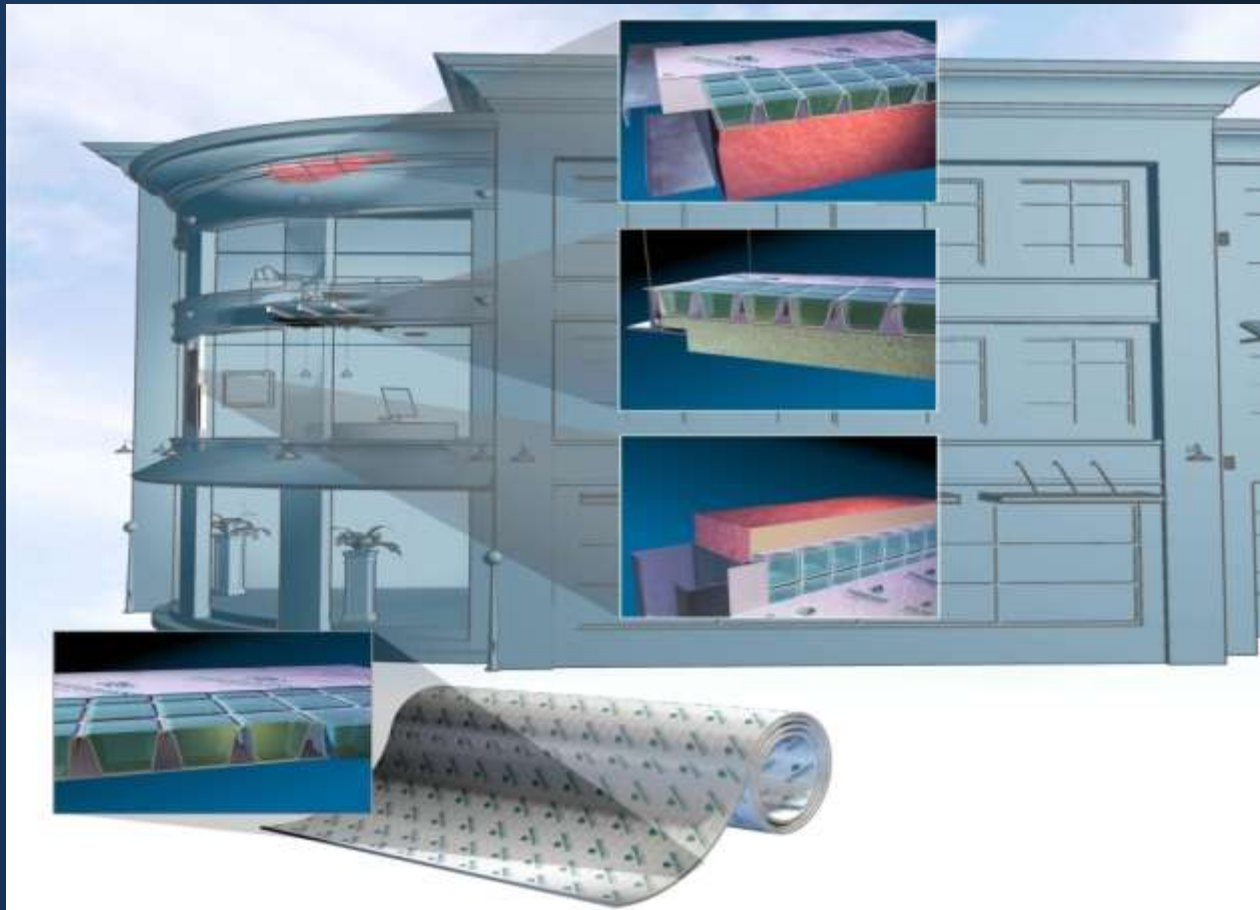
BioPCmat™



Available in:

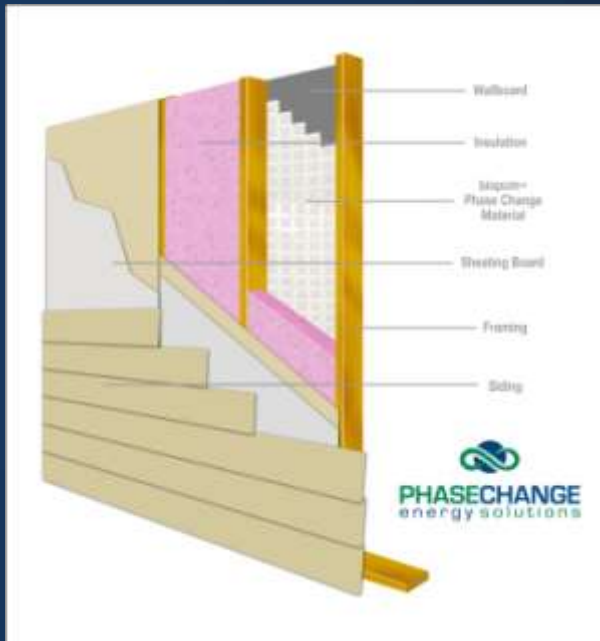
- 23, 25, and 29 degree Celsius melt point (custom temperatures available)
- .3lb (M27), .56 lb (M51), 1 lb (M91), 2lb (M182) active component per sq. ft.
- approx. 180 – 200 j/g latent heat
- Solid to gel transition
- Class A and Class C fire rating
- Permeable, non-permeable and vapor retarding available

BioPCM™ Installations Methods and Energy Savings



Underneath Wallboard

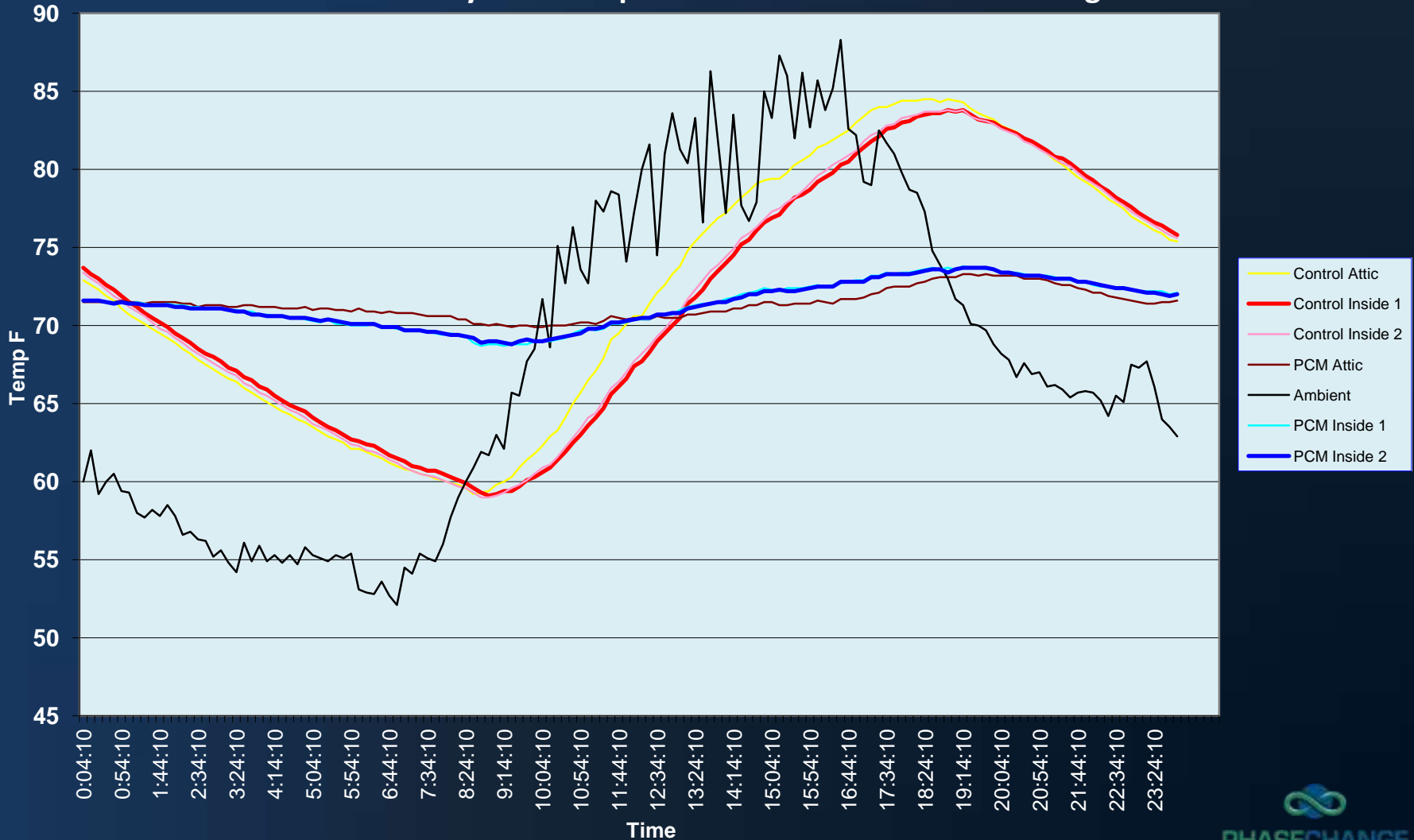
- installed behind wallboard
- reduces peak demand and heat flux through walls
- helps balance out temperature differences throughout building
- staple, screw or glue to metal or wood studs



Korea – BioPCM™ has been installed into multifamily homes in Seoul Korea.

Field Test Results

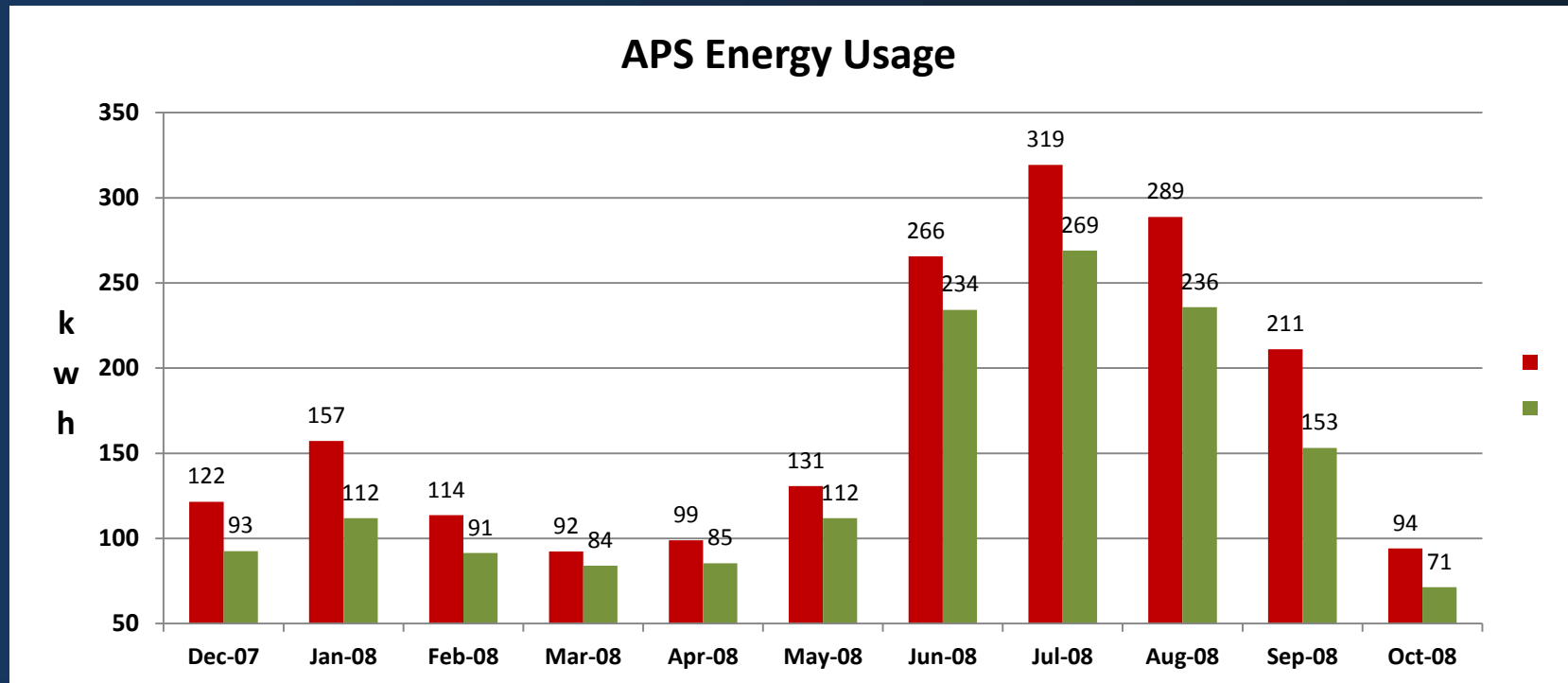
BioPCM™ vs. Control in Unconditioned Space
Side by Side Comparison of two residential buildings



Annual Energy Savings

STAR Test Facility – Arizona

Two Identical Residential Buildings Except One Has bioPCmat™ added



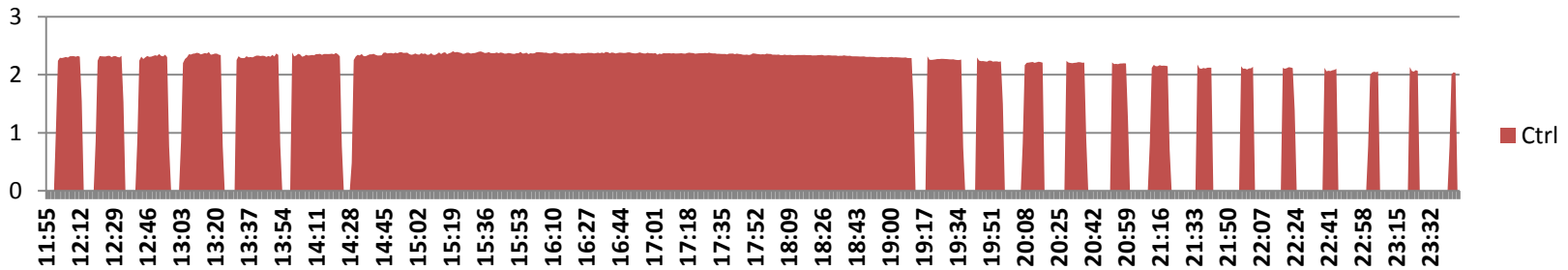
test building (green) vs. control (red)

Test HVAC Run Times

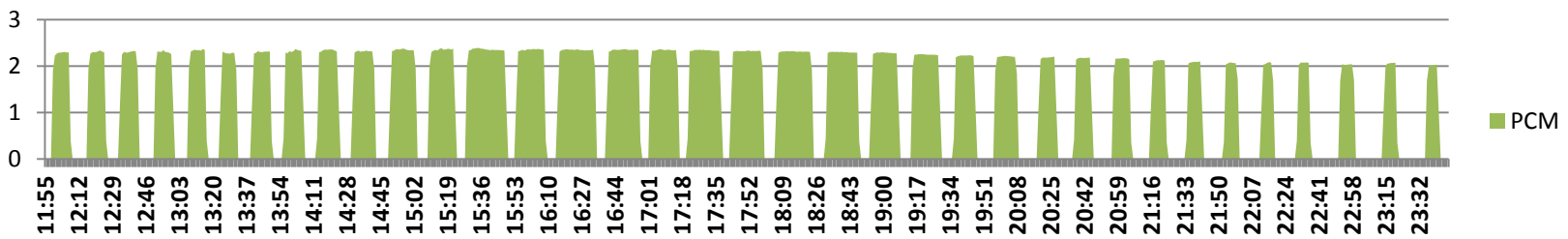
STAR Test Facility – Arizona

Two Identical Buildings Except One Has bioPCmat™ added

Ctrl HVAC Run Times



PCM HVAC Run Times

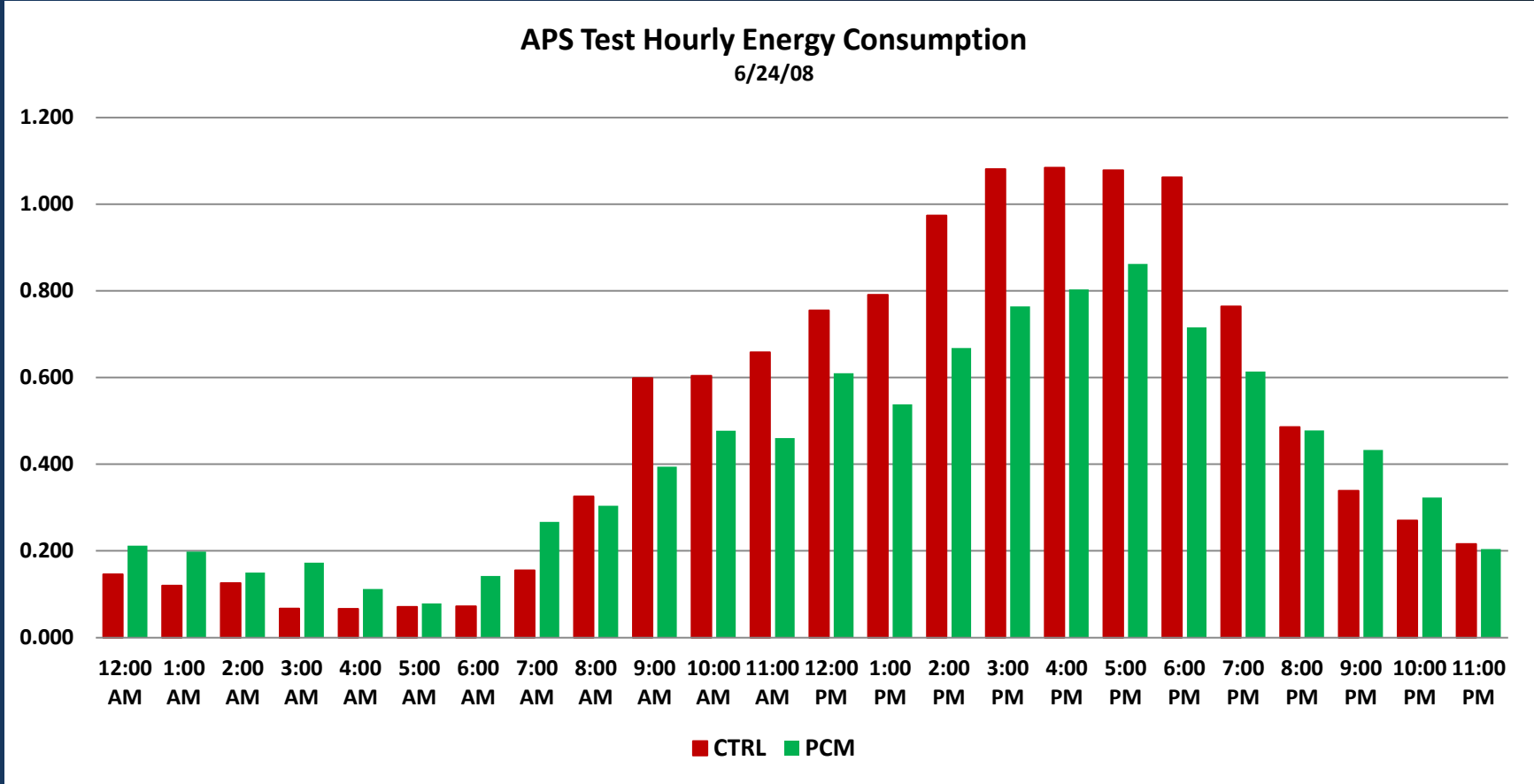


test building (green) vs. control (red)

Measured Energy Savings for a Typical Day

STAR Test Facility – Arizona

Two Identical Buildings Except One Has bioPCmat™ added



test building (green) vs. control (red)

PCM's can greatly enhance building envelope performance

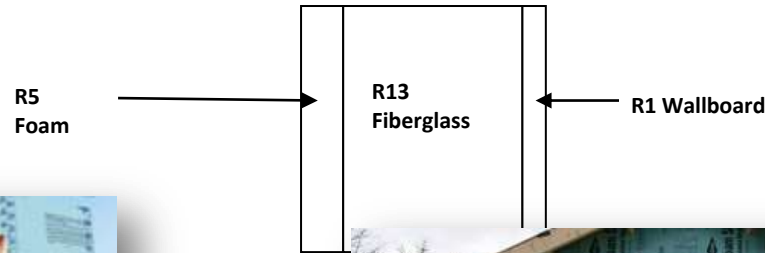
Calculating the effect of BioPCM™ using the Steady State Heat Transfer method

Using Empirical units

The simplified equation for calculating steady state heat transfer is as follows $k = \frac{T_{outside} - T_{inside}}{R_{Value}}$

Using steady state heat transfer equation,

if Outside temperature is 90 ° F and Inside Temperature is 71° F the Heat Flux = $k = \frac{90 - 71}{19} = 1$ btu per hour per sq. foot

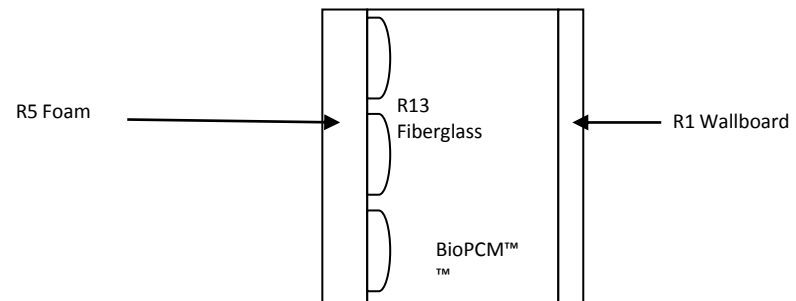
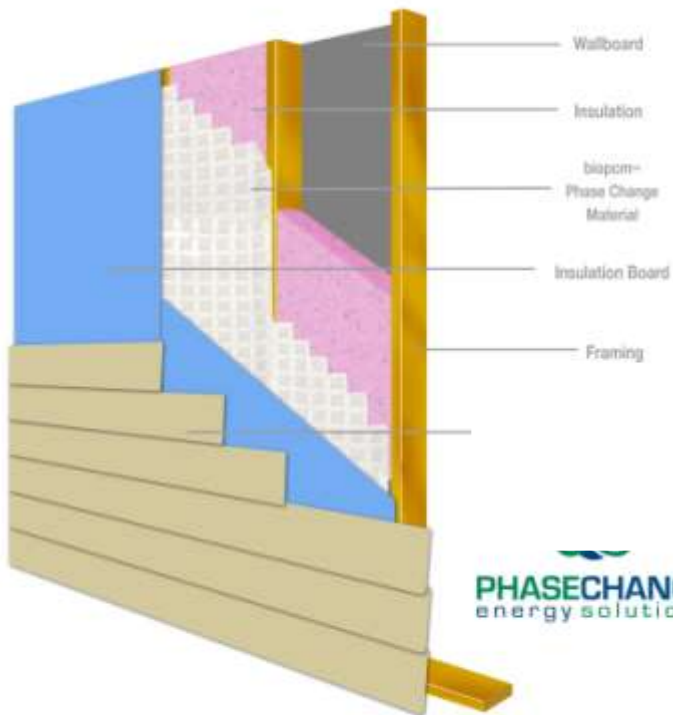


The Science Behind How PCM's Work

Same dimension Wall Section with 73° F melting point BioPCM™

Using steady state heat transfer equation,
if a layer of BioPCM™ set to 73 ° F is installed as below and Inside Temperature is 71° F then the Heat Flux into the building is =

$$k = \frac{73-71}{14} = .143 \text{ btu per hr. per sq. foot}$$



This is equivalent to an R value of 133

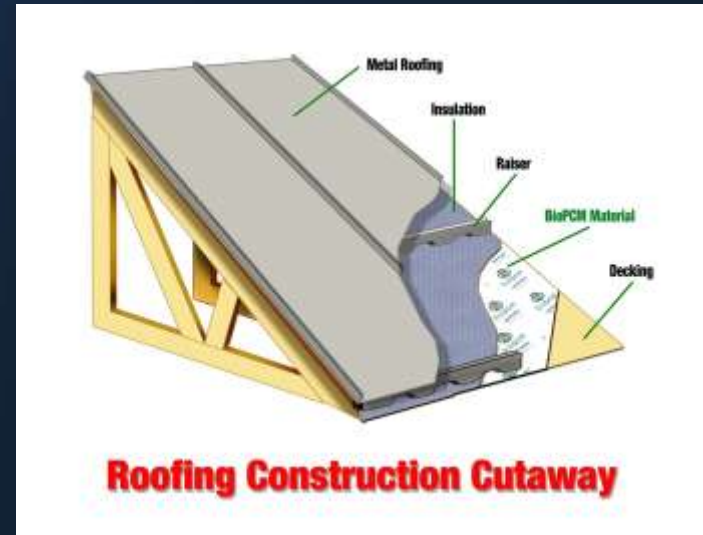
To get the same performance with only fiberglass insulation you would need a wall 36" thick!!!

BioPCM™ Metal Roofing

Department of Energy – Metal Construction Association

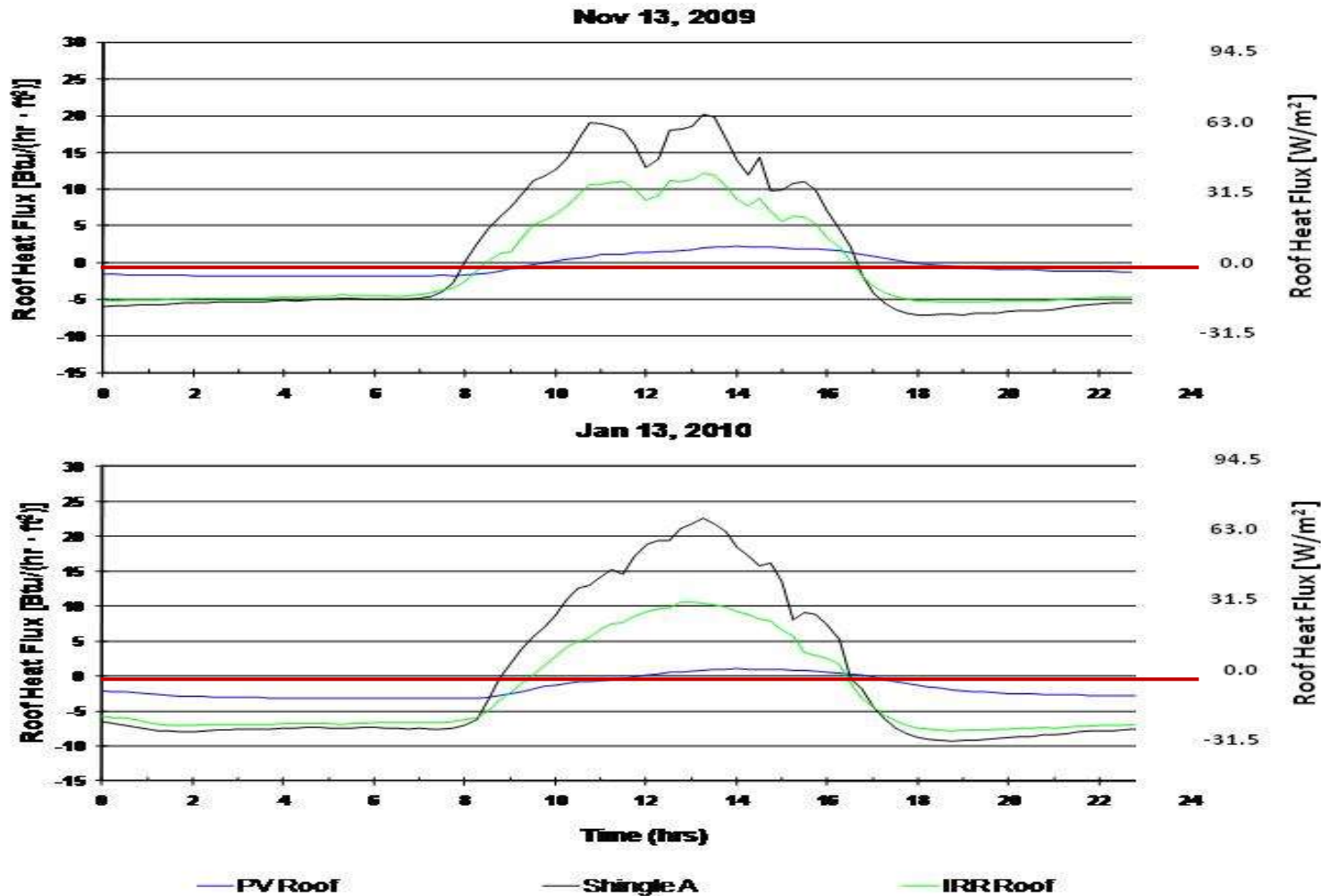
BioPCM™ Cool Roof Design

- Developed by Oak Ridge National Lab, funded by MCA
- Showed 30% reduction in Heating Load, 50% reduction in Cooling Load and 75% reduction in nighttime heat loss
- System is commercially available from Fabral & PCES, Inc.
- Simple Retrofit over existing roofing shingles without tear off
- Easy non invasive method to retrofit buildings with sloped roofs.
- Great new roof design.

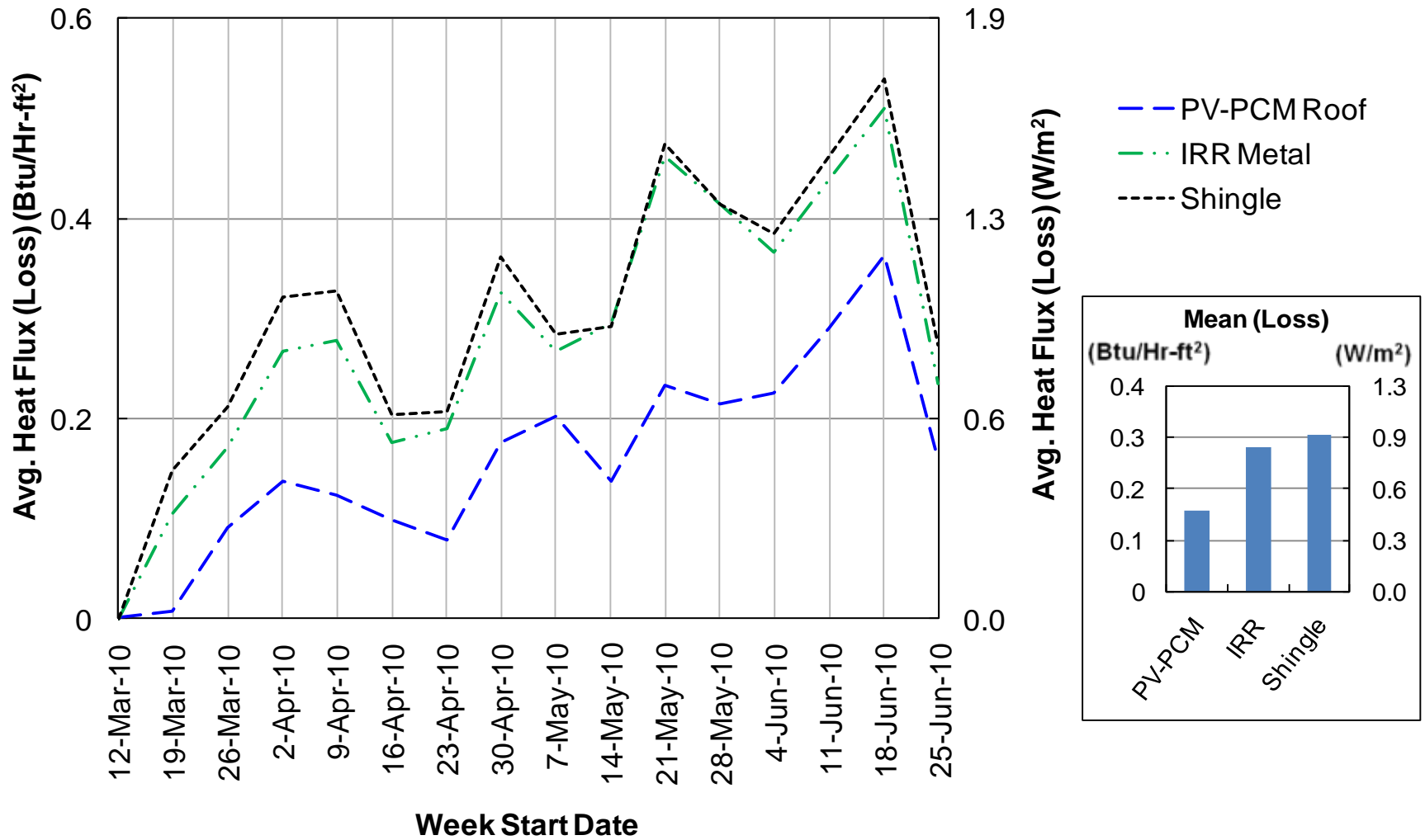


DOE – MCA roof dramatically reduces heat flux

Oak Ridge National Laboratory Test Results

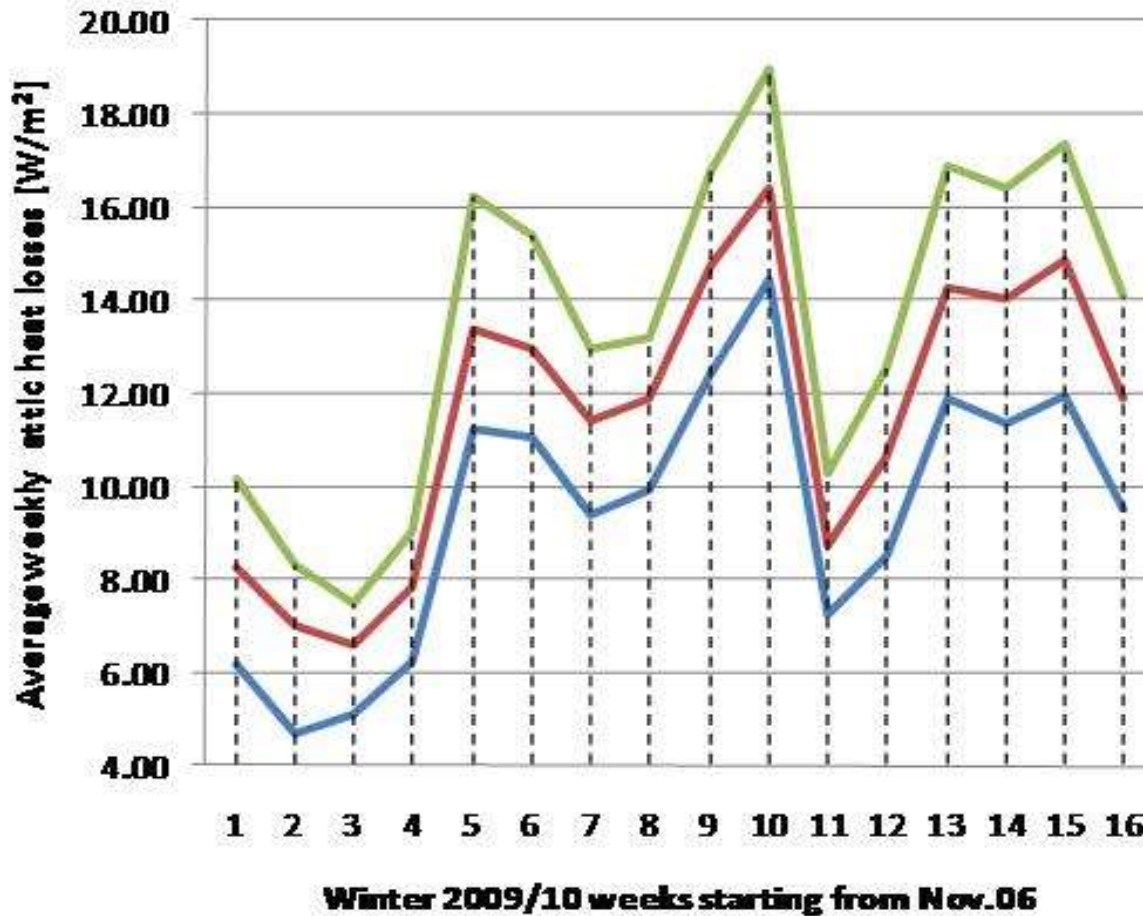


Oak Ridge National Laboratory Test Results



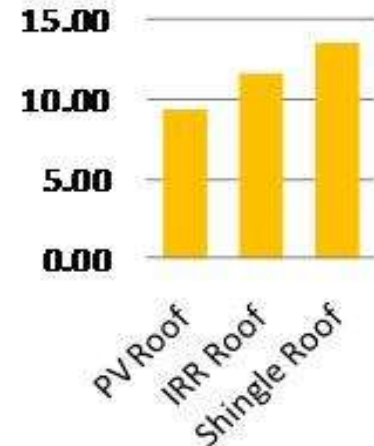
Oak Ridge National Laboratory Test Results

bioPCmat™ under metal roofing



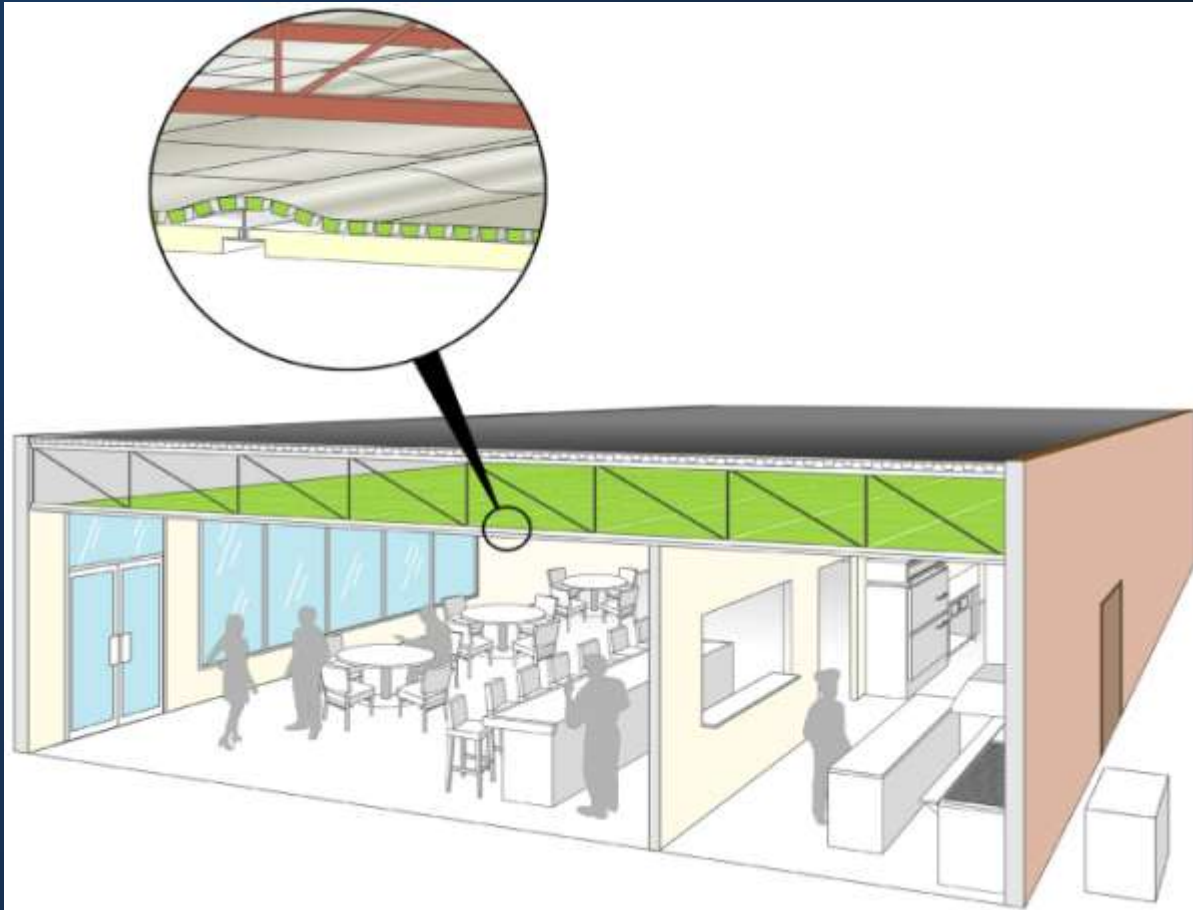
— PV Roof
— IRR Roof
— Shingle Roof

**Average Winter
Attic Heat Losses
[W/m^2]**



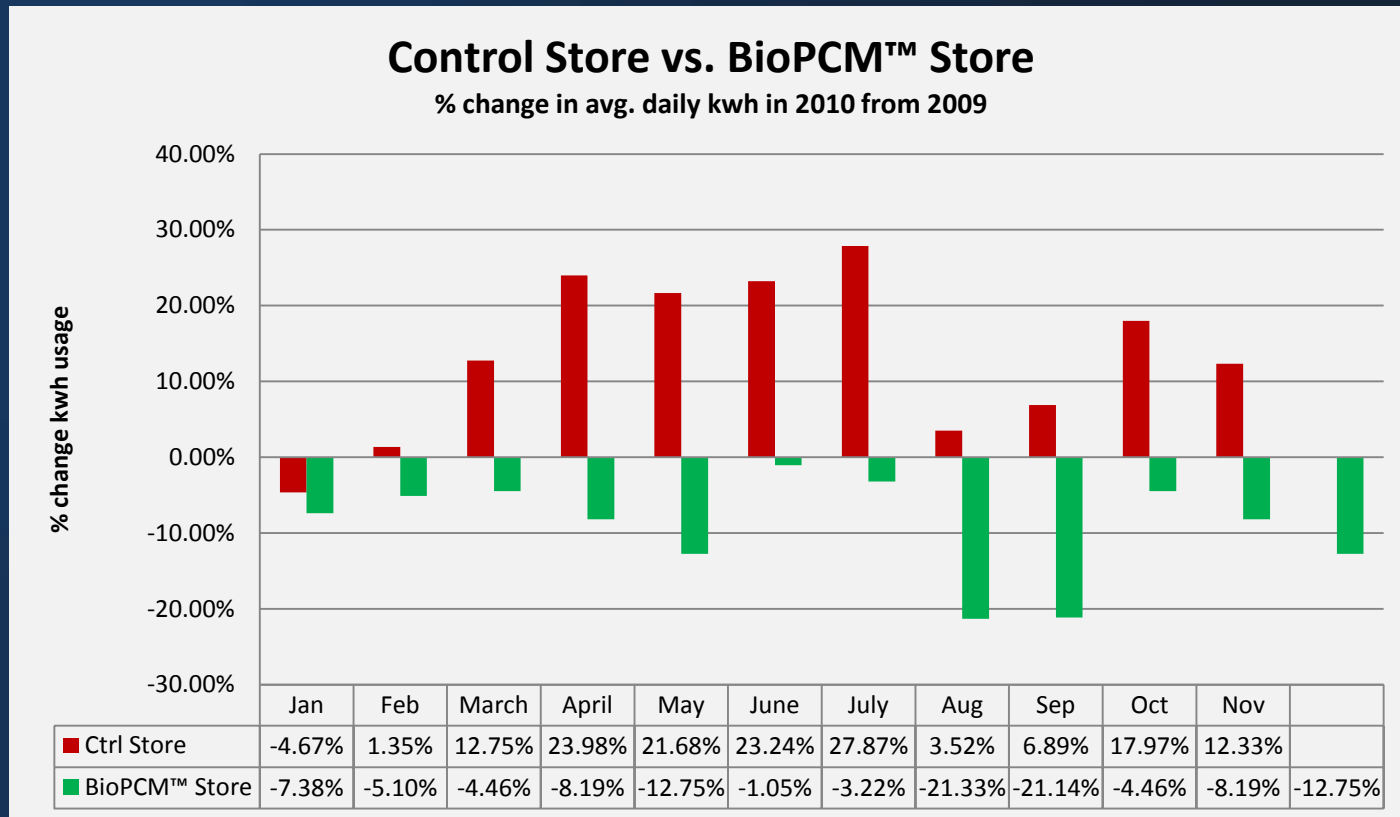
Easy Restaurant Retrofit

bioPCmats™ are placed above ceiling tiles



This application has a very fast return on investment... 18 to 30 months
Typical savings average greater than 12 percent on total energy

Simple Restaurant Retrofit yields substantial savings

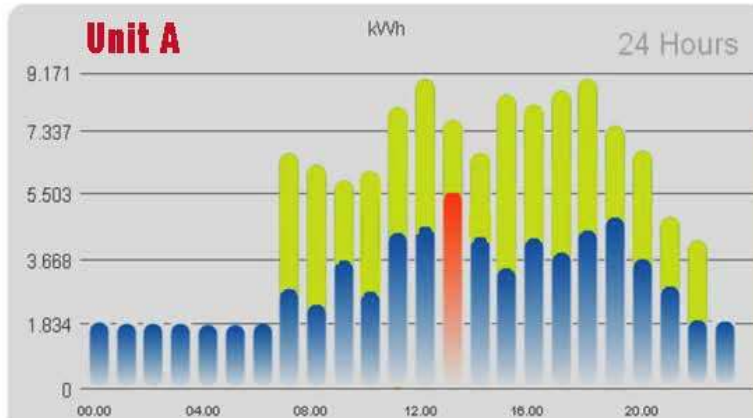


GREEN = BioPCM™ restaurant total 2010 vs. 2009 monthly energy usage

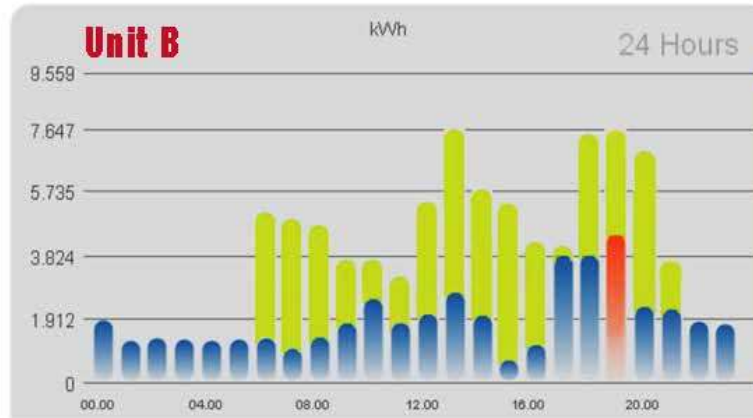
RED = Control restaurant total 2010 vs. 2009 monthly energy usage

Taiwan BioPCM™ Restaurant Savings

6-18% Savings



Unit A
Before Installation: 114.1 KWH
After PCM Installation: 76.2 KWH
Savings Difference: 37.9 KWH



Unit B
Before Installation: 83.3 KWH
After PCM Installation: 48.32 KWH
Savings Difference: 35 KWH

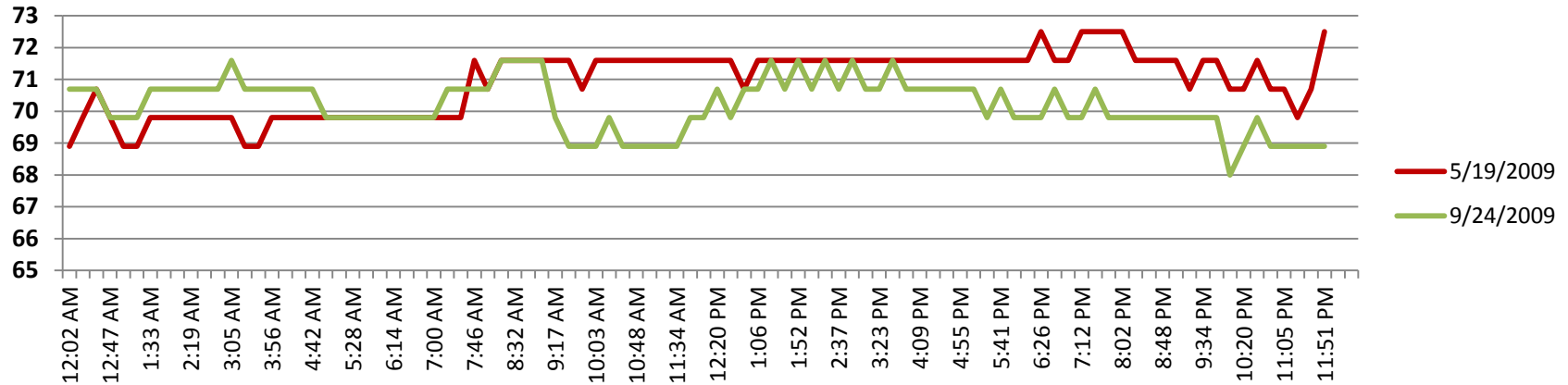
■ Before PCM ■ After PCM ■ Peak Demand

10% Savings Overall

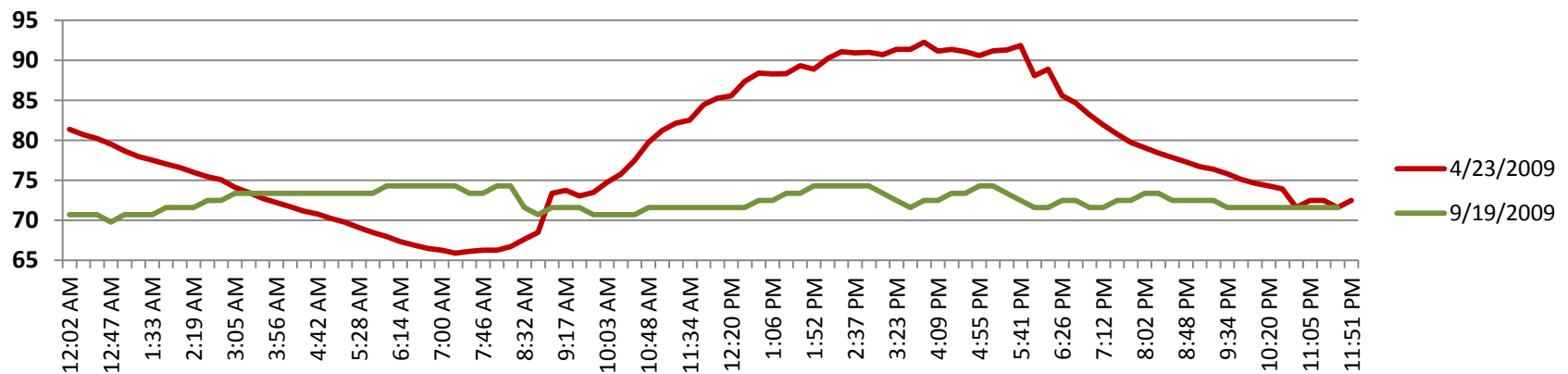
BioPCM™ “Before and After” Field Test

Comfort Level Is Improved Along With Costs

Dining Area



Kitchen Temp



With BioPCM™(green) vs. control (red)

Why This is an Exciting Product Offering

- Our products are economically viable today, without tax credits or other government incentives. The ROI is estimated to be between 6 months and 5 years depending on application. In certain new builds, savings by downsizing HVAC will more than pay for the installation of our material.

Current BioPCM™ Projects



Modular Life Styles Net-Zero Homes



“my entire electric bill for the past year, including home heating and air conditioning, was about \$15”

- Bill Haff, Ojai, CA

Modular Life Styles receives SCE Advanced Energy Rating with only R11 walls and BioPCM™

Homes are currently installed in 5 CA climate zones
Homes have 1.1KW of PV and sell surplus into grid



Peak Summer Internal
Temperatures reduced
from 95F to 79F

15 Hour cool down
reduced to 3 Hours

Energy Usage is
currently being
measured. First two
months of data show a
savings of
approximately 50%



Sunset Avenue Church of God- Asheboro, North Carolina



CHEMEKETA COMMUNITY COLLEGE

YAMHILL VALLEY CAMPUS PHASE 1 BLDG

59,000 sq. ft., three-story building, housing registration and administration offices, classrooms, science labs, faculty offices, library, food service, and support spaces.



Building will use 128,000 BTU's of BioPCM™ Capacity to supplement HVAC



The University of Washington

Molecular Engineering Building



- Designed by Zimmer Gunsul Frasca Architects
- Construction began 2009 with Completion scheduled for 2012
- Building will use BioPCM™ for passive energy storage
- Energy Design by Affiliated Engineers Seattle Washington





HARVARD Graduate School of Education

Monroe C. Gutman Library Renovation



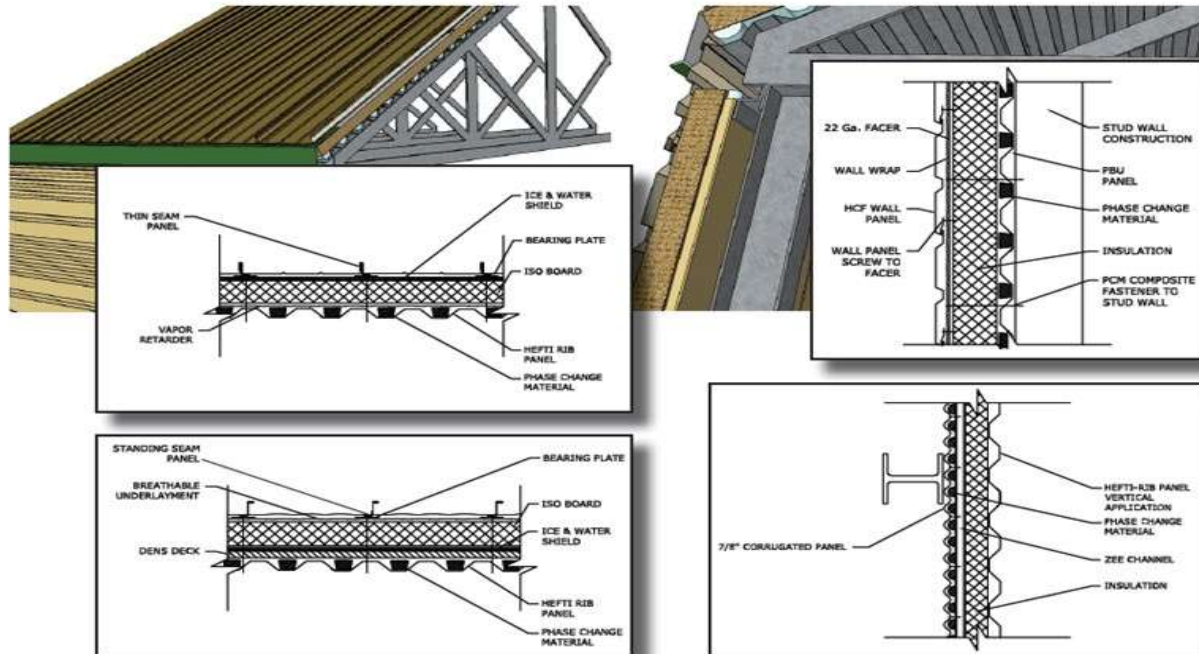
Ongoing renovation of the Monroe C. Gutman Library will utilize BioPCM™ on multiple floors to help reduce energy costs and increase occupant comfort

BAKER DESIGN GROUP

Current Partners

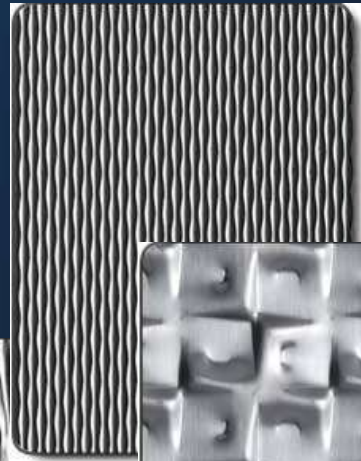
A key strategy for our company is to jointly work with other manufactures to jointly make phase change products to take to market

Fabral LEED compliant roofing and wall systems



For the complete integrated roofing and wall system offerings, review the Fabral Phase Change technical manual.

- Euramax which owns Fabral had \$812 million in sales in 2009
- Offering our product in conjunction with their metal roofing
- Will begin near-term testing in modular housing in Europe



Are designing interior
metal panels that include
our bioPCmat™

Coming to Greenbuild 2011



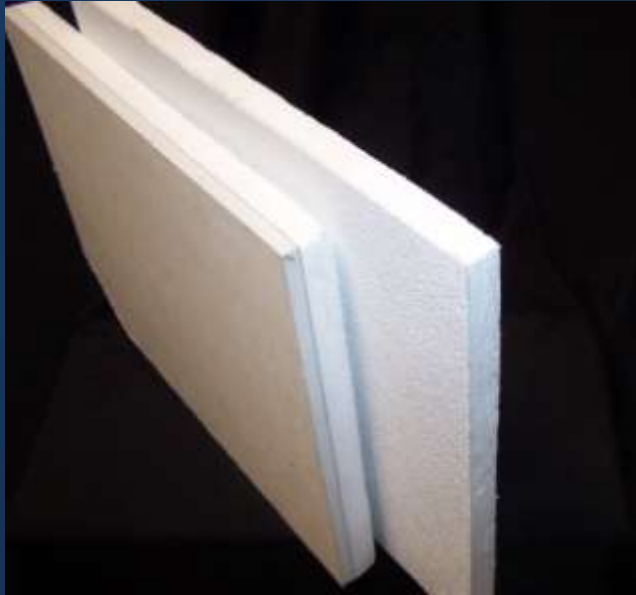
Atlas Roofing

Major manufacturer of roofing materials including insulation and shingles
Privately held company
Estimated sales in the range of \$1 billion

- Jointly applied for provisional patent on three panels that contain their insulation and our bioPCmat™ product.
- Product should be ideal for placing under flat roof PV, and under shingles in high energy efficient homes and buildings.



Retrofit Wall Panels



- Can be installed over existing walls
- Gypsum board outer layer can be finished with traditional methods
- FRP class A or class C fire rating available

Insulated Concrete Panel Construction



Energy Models Which Can Handle PCM's

Extensive work is underway this year to make the modeling user friendly...

- TRNSYS
- Energy Plus
- eQuest
- EDSL Tas Building Designer
- Carrier
- PCM Energy
- RemDesign (release date 11/2011)

BioPCM™ model for TRNSYS

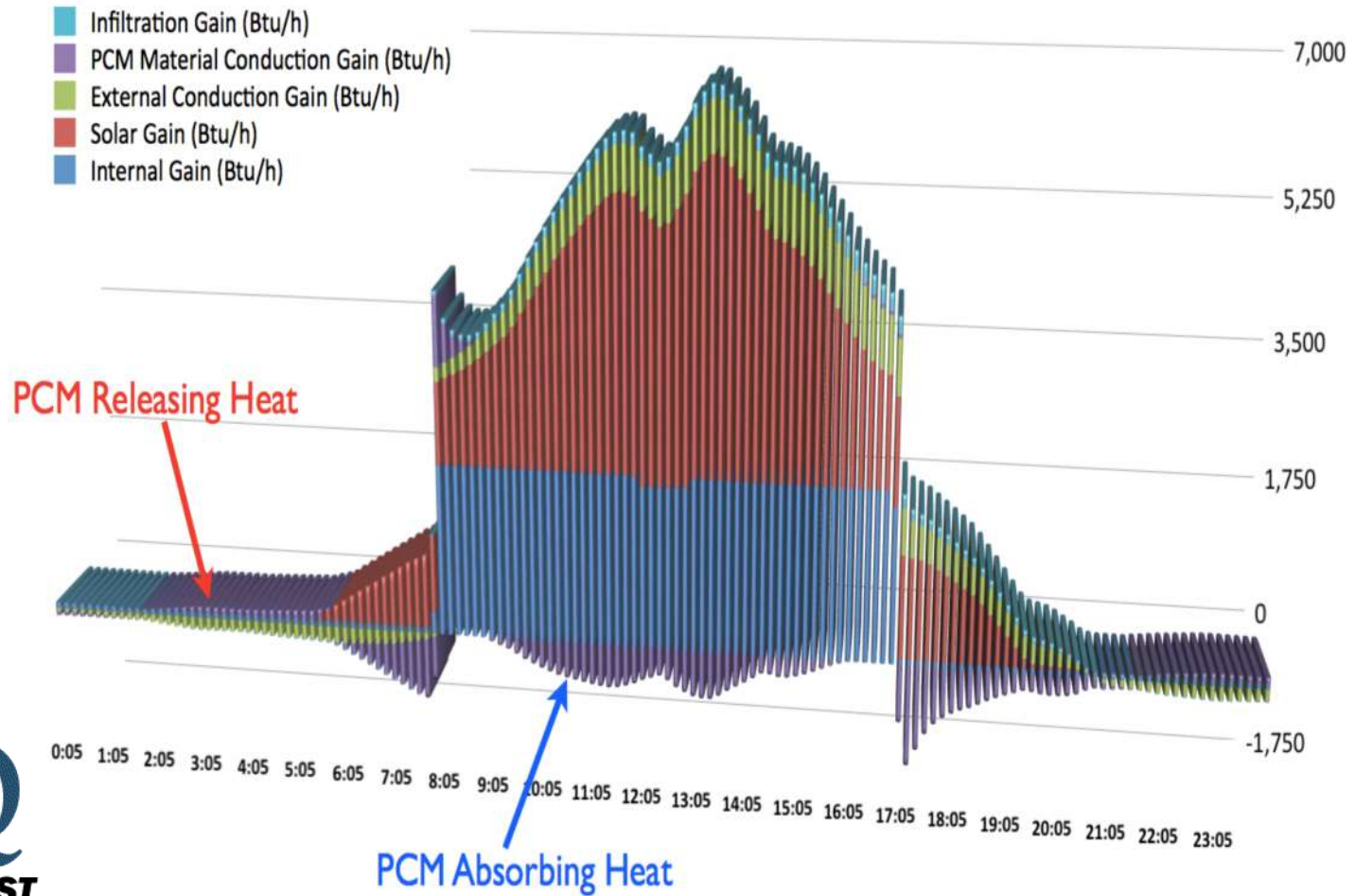
rev 16 or 17

Developed for the Korean Institute of Construction Technology
To evaluate BioPCM™ for
600+ Meter Lotte Super Tower 123

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d.bradley@tess-inc.com <http://www.tess-inc.com> <http://www.trnsys.com>

Room Peak Cooling Load Profile

Modeled with eQuest



Potential LEED Certification Contributions

- Improved Energy Usage
 - Optimize Energy Performance
 - On-site Renewable Energy
- Reduce Carbon Dioxide Emissions
 - Enhanced Refrigerant Mgmt
- Minimize Cost of Increased Ventilation
- Facilitate Increased Thermal Comfort of Occupants
 - Thermal Comfort– Design

...Other Credits May Also Apply such as Innovations in application

“Within twenty years you will see phase change materials being installed in virtually every application where thermal insulation is used today. Smart Thermal Mass™ is the future of economic, energy conservation for this generation.”

Jim McColgin – CEO Phase Change Energy Solutions

