The Advantages of Installing BioPCM Sheet
vs.
Increasing Insulation Quantity

BioPCM sheet provides energy savings by increasing the thermal mass of the building. Insulation derives savings by increasing thermal resistance. Understanding the difference between these two properties is a necessity when comparing the two.

Thermal Resistance is a measurement of a structures resistance to heat flow. Increasing a structures thermal resistance increases the time it takes heat to flow (thermal conduction) from inside a building to the outside and vice versa. Increasing thermal resistance reduces thermal conduction resulting in energy savings.

Thermal Mass is defines as a structures resistance to temperature change. Increasing a buildings thermal mass reduces temperature fluctuations within the structure. A good illustration of this is to compare an unheated/cooled steel utility shed with a medieval stone cathedral. Both structures are constructed with materials which have minimum thermal resistance, however the stone cathedral will stay much cooler in the summer and much warmer in the winter months due to its much larger thermal mass.

As you can see, both of these properties can be used to increase energy efficiency, however since modern construction methods already adequately address thermal resistance while neglecting thermal mass, the majority of energy efficiency improvements can only be obtained by manipulating the later.

Let us compare the required increases in thermal resistance necessary to receive comparable energy savings to those achieved from a standard application of BioPCM sheet.

PCM Annual Savings for Standard US Home[i]:

Using the National Home Builders Association data, the standard US Home built in 2005 can be defined as follows:

2,434 sq. ft multi level home with unfinished basement equal to 30% of finished space.
Natural gas powered furnace (66% of homes)
Electric central air conditioner (89% of homes)
Electricity generated by a coal powered power plant (60%+ of homes)
R-13 insulation in 2” x 4” 16” OC Stud walls with vinyl siding.
R-30 attic insulation

The standard home will have approximately 3077 sq ft of Wall and Ceiling space, which could accommodate BioPCM sheet

Historical Data from existing buildings constructed with similar densities of PCM per sq. ft as PCES PCM Sheet indicate that 30% heating and cooling energy savings are realistic. Assuming this 30% savings, the annual energy savings for a standard home located in a moderate climate would be as follows:

Standard 2,434 sq ft house with 730 sq ft Basement, Gas Furnace, Central Air-conditioning

Heating and cooling cost per yr. Location: Louisville KY[ii]	
1643 therms Natural Gas @ average retail price of $1.30 per therm[iii]	$2136.00
10623 kWh @ average retail price[iv] 9.45	$1004.87
Yearly Total	$3140.87
Monthly expenditure	$ 262.67

PCM 2,434 sq ft house with 730 sq ft Basement, Gas Furnace, Central Air-conditioning

Heating and cooling cost per yr. Location: Louisville KY	
1150 therms Natural Gas @ average retail price of $1.30 per therm[v]	$1495.00
7436 kWh @ average retail price[vi] 9.45	$702.70
Yearly Total	$2197.70
Monthly expenditure	$ 183.14

Yearly Energy Savings for home with PCES BioPCM =$ 943.17

Insulation requirements to receive comparable savings

Insulation is a material designed to slow down the flow of heat by increasing thermal resistance. In the building envelope, the primary function of insulation in most North American regions and the generally its largest contribution to energy savings is to keep heat in (reduce heating costs)

The United States Department of Energy has come up with an equation to estimate average annual energy savings from reduction in heating costs achieved by adding insulation to an existing structure.

Formula

AREA (sqft) x (1/Initial R-value - 1/Final R-value) x 24 x HDDZ x Cost/Unit of Heating Fuel / Btu/Unit of Heating Fuel / Heating System Efficiency = Annual Dollars Saved

Variables Defined

Area = Length x Width of area to be insulated
Initial R-Value & Final R-Value = Figure out based on R-Value Table.
HDDZ = Heating Degree Days. See HDDZ Table.
Heating Fuel Cost = Get from your bill by dividing units / cost.
Btu/Unit = Get from Fuel Btu Table.
Heating System Efficiency = Get from Heating System Efficiency Table

When we use this formula to calculate energy savings from adding additional insulation to our previous standard home model we find the following:

If we added an additional 9 inches (R30 fiberglass mat) to the existing walls and attic our annual savings will equal approximately $199.58

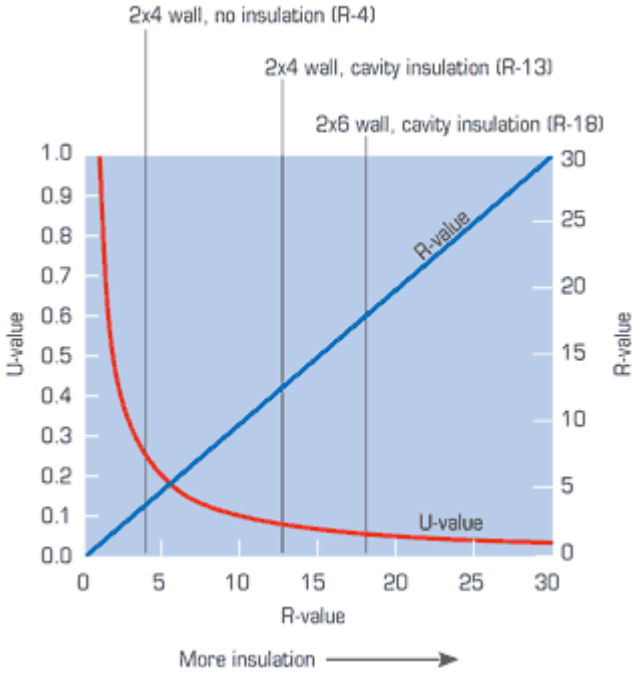
Adding an additional R100 (+32 inches) = $262.46

Adding R1000 (an addition 26 *FEET* of fiberglass) = $293.35

Why is this? Because while the R-value is the most common measure of the resistance to heat flow (thermal resistance) used in the U.S. and a great marketing tool, it is it's reciprocal, the U-value (the amount of heat that moves through the material for each degree Fahrenheit difference in temperature) which determines energy savings. Unlike the R-values of different components which can be added (all the different layers of a wall, for example); U-values cannot be directly added.

"Energy savings obtained from adding additional insulation must follow the law of diminishing R-eturns (**Figure 2**): Each additional unit of R-value contributes less energy savings than the previous one. As the graph shows, the U-value curve quickly flattens as R-value continues to climb. In practical terms, this means that adding R-10 insulation to a wall that already has R-20 insulation will save very little additional cooling energy. Economic analyses that account for the cost of energy saved can help in determining the most cost-effective level of insulation. As a general rule of thumb, one could never recoup the cost of additional insulation when insulation thickness exceeds an average of 7 inches.

Figure 2: The law of diminishing R-eturns



Source: Reliant Energy www.reliant.com

While high R-values sound attractive, the real effect of insulation—the U-value—diminishes with each additional inch of insulation. For example, an insulated 2 x 4 wall has an R-value of 13 and a U-value of .077. Upgrading to a 2 x 6 wall adds 5 points of R-value (18-13) but only drops the U-value by .022 (.077-.055). Adding another 5 points of R-value would lower U-value even less—by only .011."[vii]

In conclusion, even if we double these savings to include savings from cooling, we can clearly conclude that we can NEVER reach the 30% energy savings we get with the addition of BioPCM sheet.

Some Additional Benefits from the use of BioPCM sheet:

- Tax benefits
- Lower cost for HVAC equipment
- Lower construction costs
- Energy Efficient Mortgage
- Reduced energy costs

Tax Benefits:

Over the last few years, the federal government and most state governments have implemented tax credits for energy efficient homes. These averages out to approximately $2500 per home as long as the home can show a 50% energy savings over the minimum home built to 2003 IECC standards. This 50% should be easily achieved by combining BioPCM Sheet with "normal" home construction. (i.e. Double Pane windows, Tyvex house wrap).

Gross cost:	$ 7696.00
Less avg. $2500.00 Tax Credit	$ 5196.00

HVAC equipment savings:

The introduction of phase change materials into building construction dramatically reduces temperature peaks within the home. Historically these peak reductions have been in the neighborhood of 30% to 40%. Assuming a corresponding 30% reduction in HVAC requirements, an additional equipment cost savings of approximately $1500 should be achievable.

Gross cost:	$ 7696.00
Less avg. $2500.00 Tax Credit	$ 5196.00
Less $1500 equipment cost savings	$ 3696.00

Lower Construction Costs (2x6 to 2x4 wall):

Discussions with builders have brought another cost saving to our attention. Many builders are dramatically increasing R-values of exterior walls by adding additional

insulation in order to meet new energy efficiency requirements. This additional insulation requires greater wall thickness requiring builders to change from 2x4 to 2x6 wall construction. This adds approximately $2500 to the construction of the average new home as well as drastically increasing lumber demands. The addition of BioPCM Sheet will allow builders to discontinue this practice, saving an average of $2500 per home as well as saving forests.

Gross cost:	$ 7696.00
Less avg. $2500.00 Tax Credit	$ 5196.00
Less $1500 equipment cost savings	$ 3696.00
$2500 avg. lower framing costs	***$ 1196.00***

Energy Efficient Mortgage (EEM):

HUD developed the energy efficient mortgage program in 1995. EEMs recognize that reduced utility expenses can permit a homeowner to pay a higher mortgage to cover the cost of the energy improvements on top of the approved mortgage. FHA EEMs provide mortgage insurance for a person to purchase or refinance a principal residence and incorporate the cost of energy-efficient improvements into the mortgage. The borrower does not have to qualify for the additional money and does not make a down payment on it. The mortgage loan is funded by a lending institution, such as a mortgage company, bank, or savings and loan association, and the mortgage is insured by HUD.

EEMs make it easier for a homebuyer to purchase a "Green" home. They also allow a homebuyer to qualify for a higher cost home. In addition, many environmentally conscious mortgage companies offer lower interest rates for EEMs. These rate deductions usually average .25%. This savings can be substantial over the lifetime of the loan.

2005 Average Home Price[viii]		$297,000	with PCES PCM Sheet	$298,196
Less 3% down payment ($8945) Min for FHA EEM		$288,055	with PCES PCM Sheet	$289,251
Average mortgage rate 3/07 6.25%	monthly payment[ix]	$1,773.60	EEM with .25% rate decrease	$1,734.21

Yearly Mortgage Savings for home with PCES PCM Sheet $ 472.68

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[i] http://www.nahb.org/fileUpload_details.aspx?contentID=59066 National Association of Home Builders
[ii] http://lge.apogee.net/rescalc/ Kentucky State University
[iii] http://www.eia.doe.gov/neic/brochure/oil_gas/natgas06/natgas.html Energy Information Administration
[iv] http://www.eia.doe.gov/cneaf/electricity/epa/epat7p4.html Energy Information Administration
[v] http://www.eia.doe.gov/neic/brochure/oil_gas/natgas06/natgas.html Energy Information Administration
[vi] http://www.eia.doe.gov/cneaf/electricity/epa/epat7p4.html Energy Information Administration
[vii] http://www.reliant.com
[viii] http://www.nahb.org/fileUpload_details.aspx?contentID=59066 National Association of Home Builders
[ix] http://www.mortgage-calc.com/mortgage/simple.php Quicken Loans Mortgage Calculator