Fraunhofer Center for Sustainable Energy Systems

PCMs in Building America Projects - Roof Retrofit Technology with Use of the PCM Heat Sink

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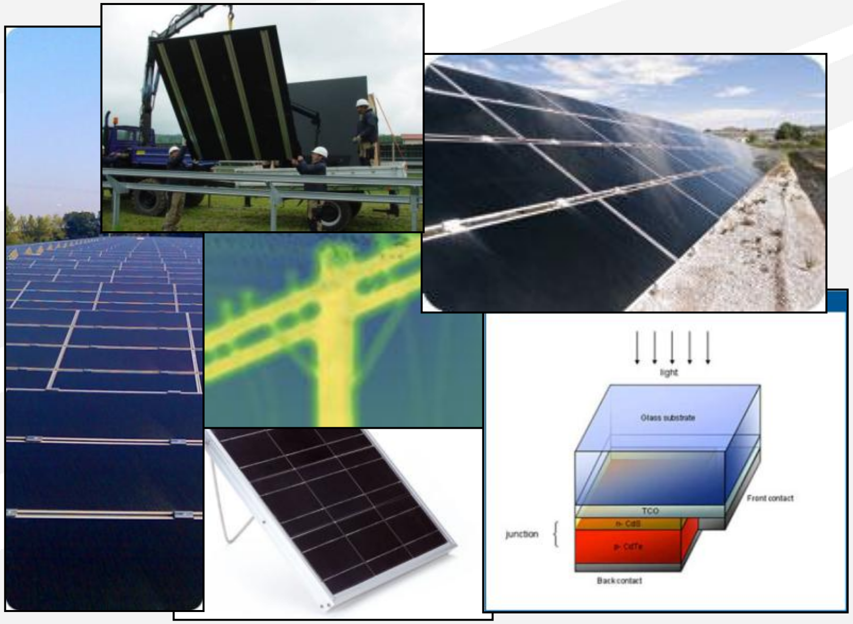


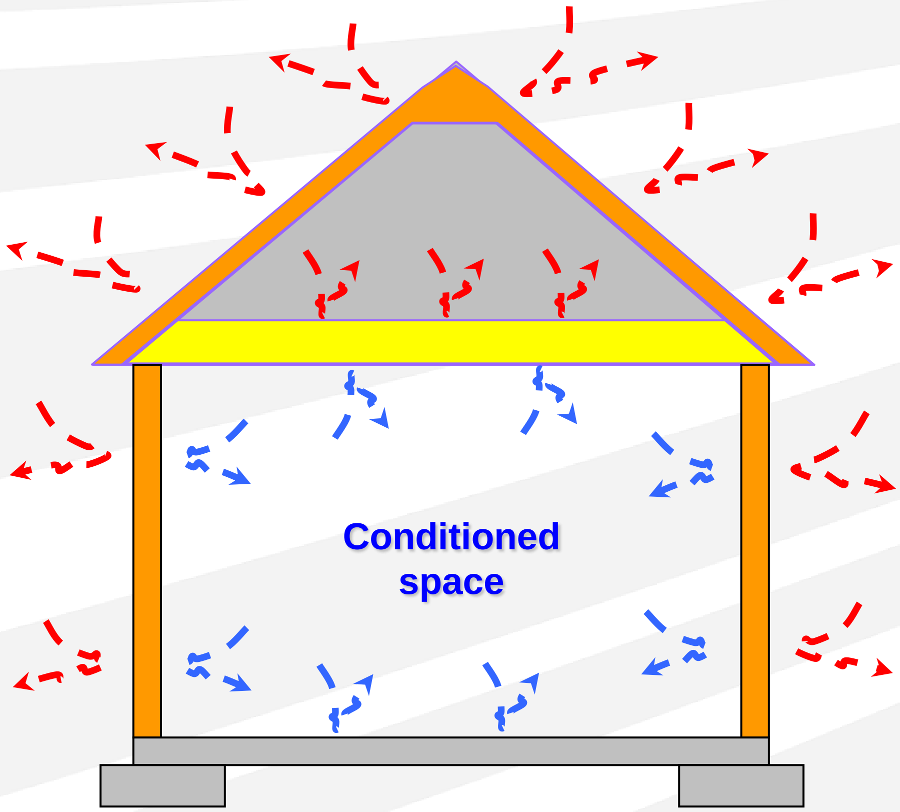
IV Thermal Mass Workshop
Dec. 05, 2010

Fraunhofer USA

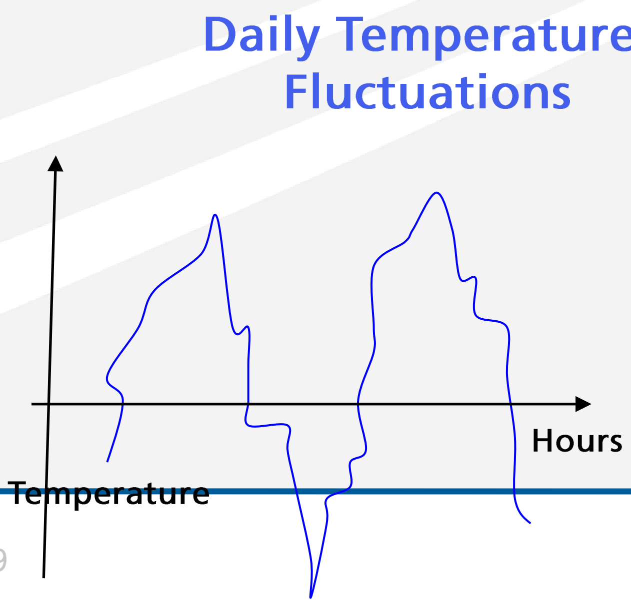
Overview

- A new paradigm for building enclosures has been introduced by the Fraunhofer CSE for Building America Projects
- Between 2008-2010 a consortium of commercial companies led by MCA and ORNL designed and constructed a series of commercial test roofs utilizing metal roofing panels with cool roof coatings, ventilated cavities, PV laminates, reflective insulations, and PCM heat sinks.
- Most of these assemblies are still being tested
- Some of findings from this study were adopted by the Building America team led by the Fraunhofer CSE for application in new residential buildings and residential retrofits
- This presentation is showing an example of utilization of the PCM heat sink technology for residential roof retrofit with use of the metal roofing panels.

Current Paradigm for Thermal Design of Buildings doesn't Recognize Dynamic Exterior Processes



SUN & WIND



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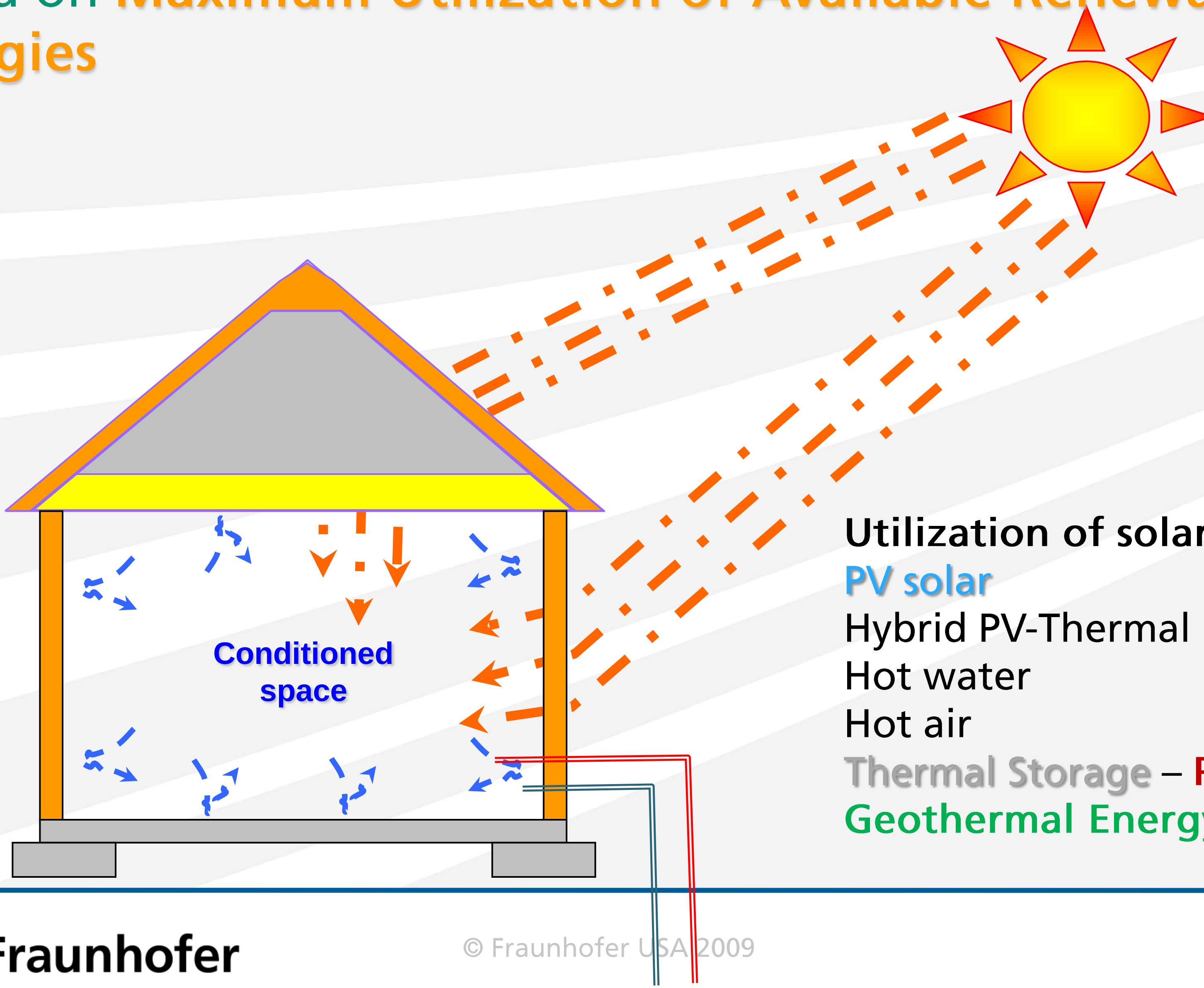
A New Paradigm Introduced by Fraunhofer CSE is Based on Maximum Utilization of Available Renewable Energies

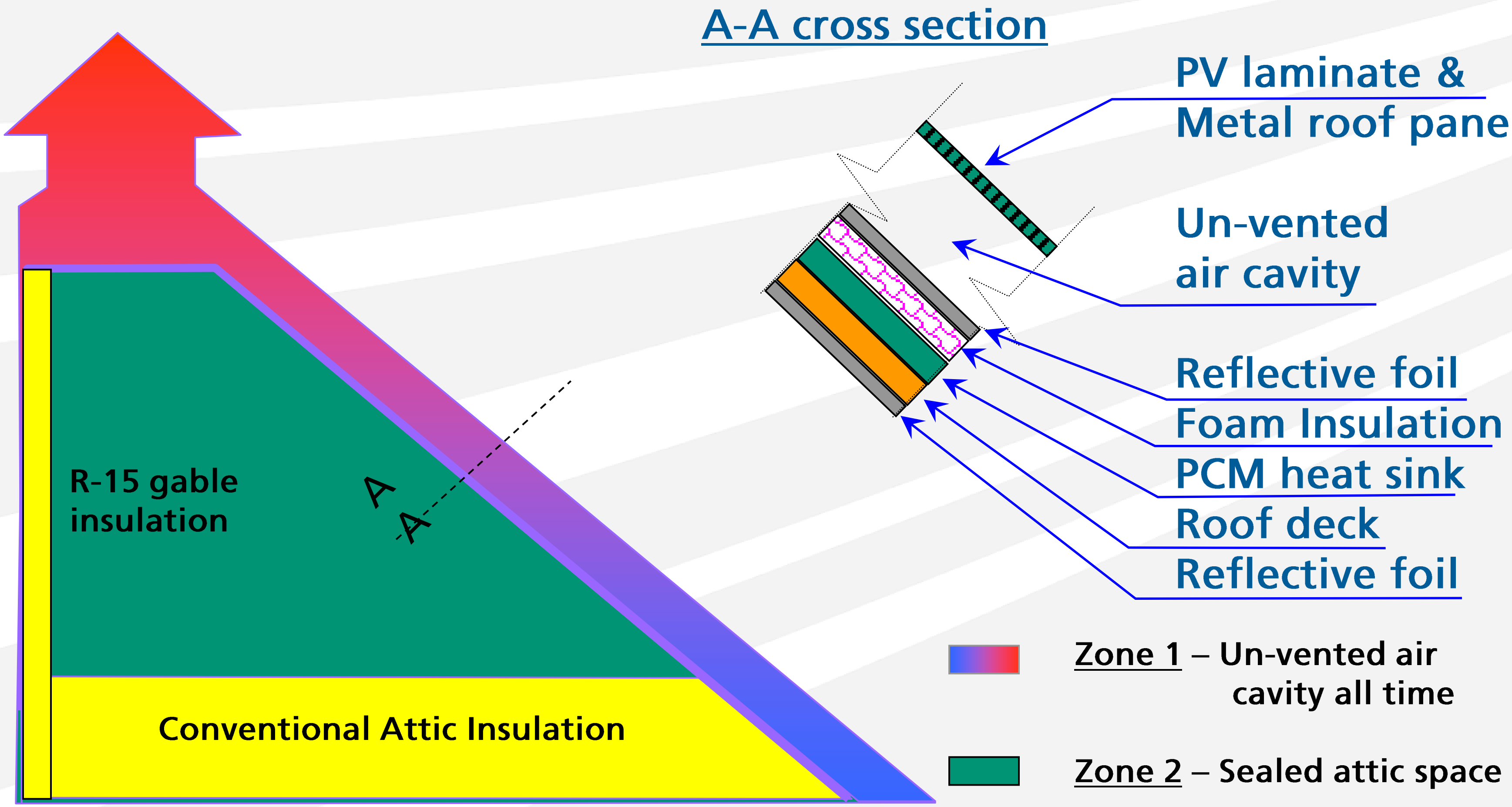


Utilization of solar energy:

PV solar
Hybrid PV-Thermal
Hot water
Hot air
Thermal Storage – PCMs
Geothermal Energy

Past Performance Study of Metal Roofing Assembly Containing PCM Heat Sink

First Concept of the PCM Attic - 2007 J. Kosny, W. Miller



Metal Roof Systems Validated during MCA-ORNL Project

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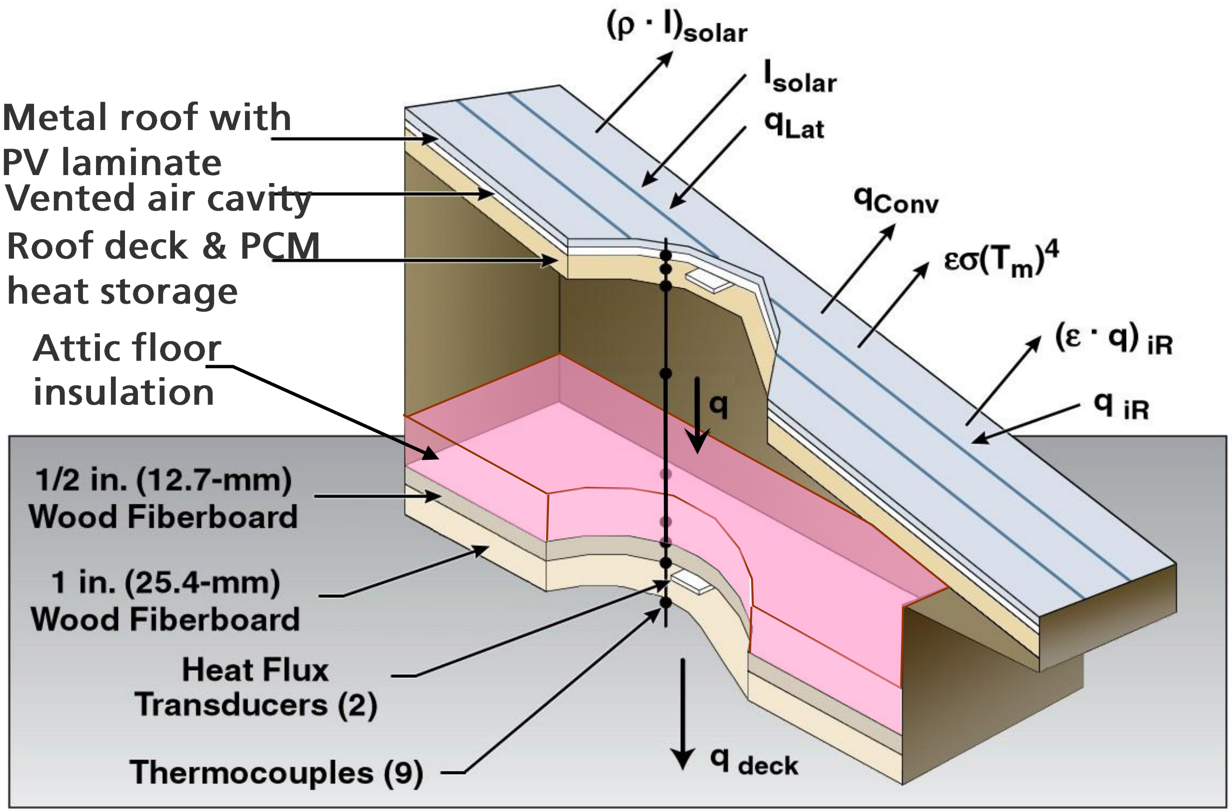
Schematic of the Test Attic with PCM Heat Sink



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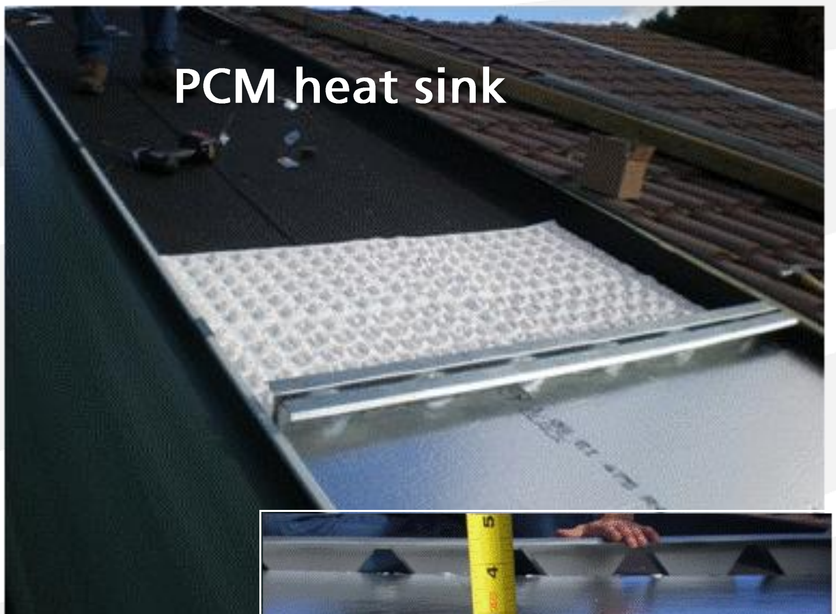
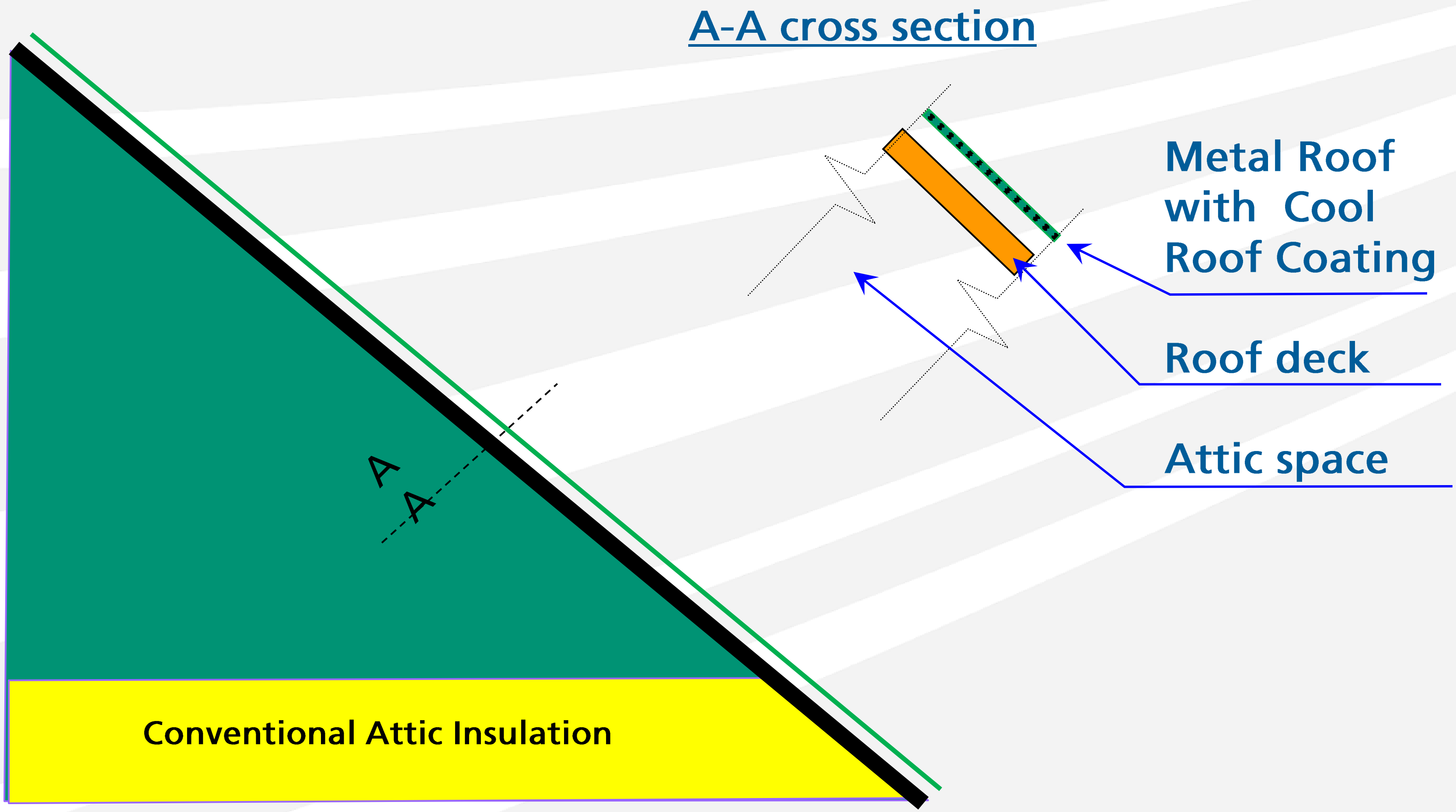
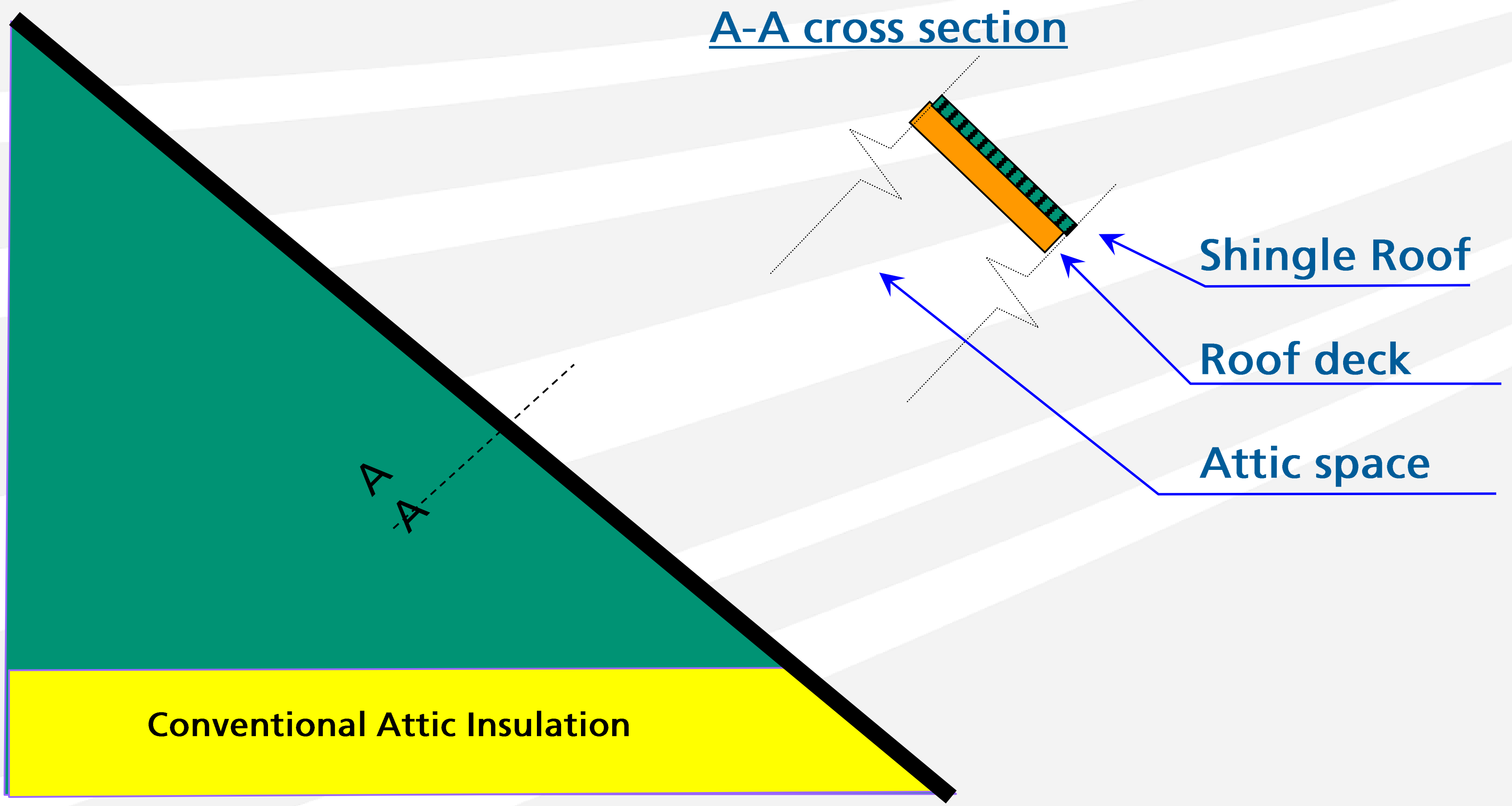
Ventilated roof-over-the-roof assembly;
PCM Attic – Configuration Details – July 2009



Conventional Attic Using Cool Roof Coating – Nov. 2009



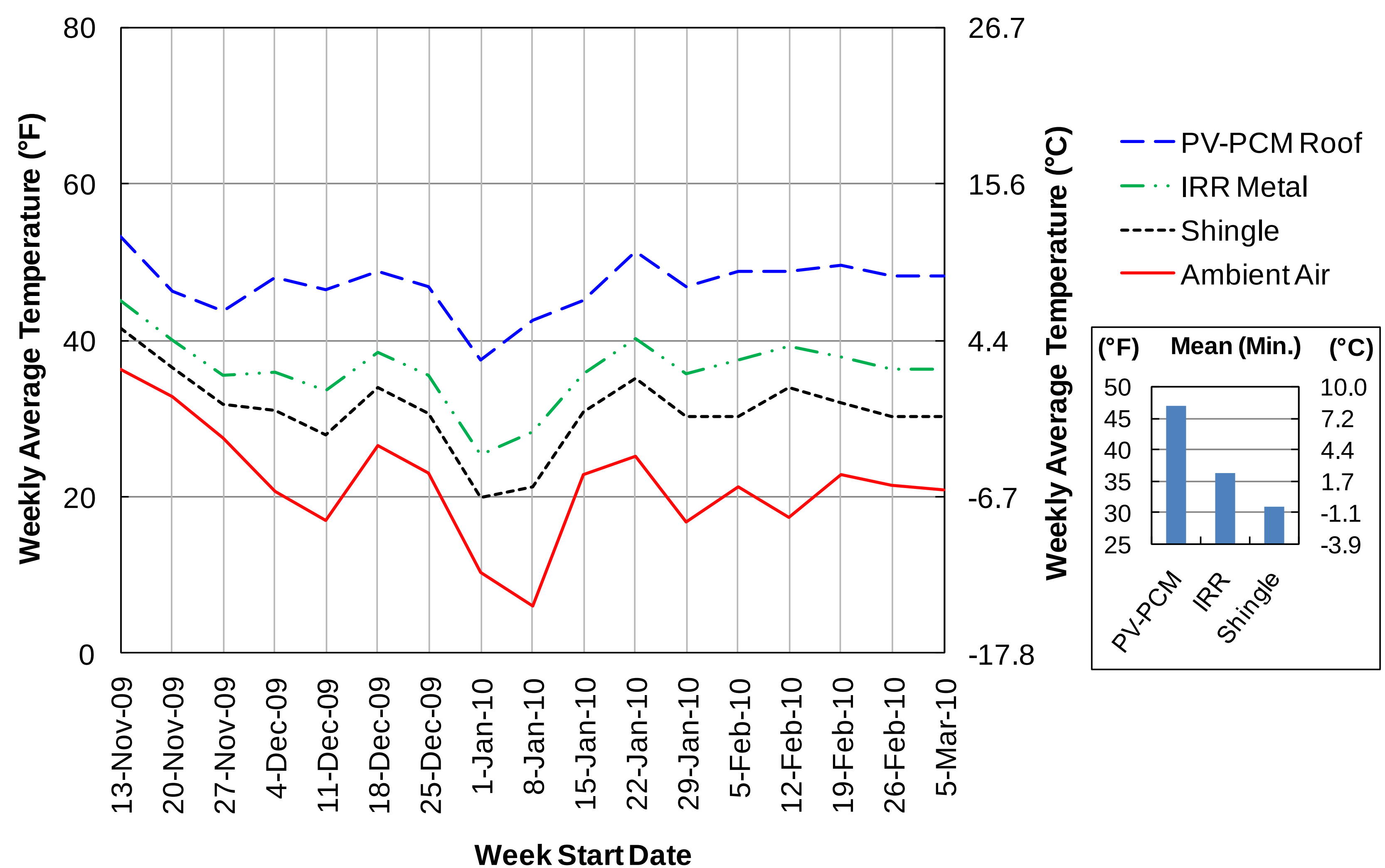
Comparative Basic Attic Assembly Using Asphalt Shingles – Nov. 2009



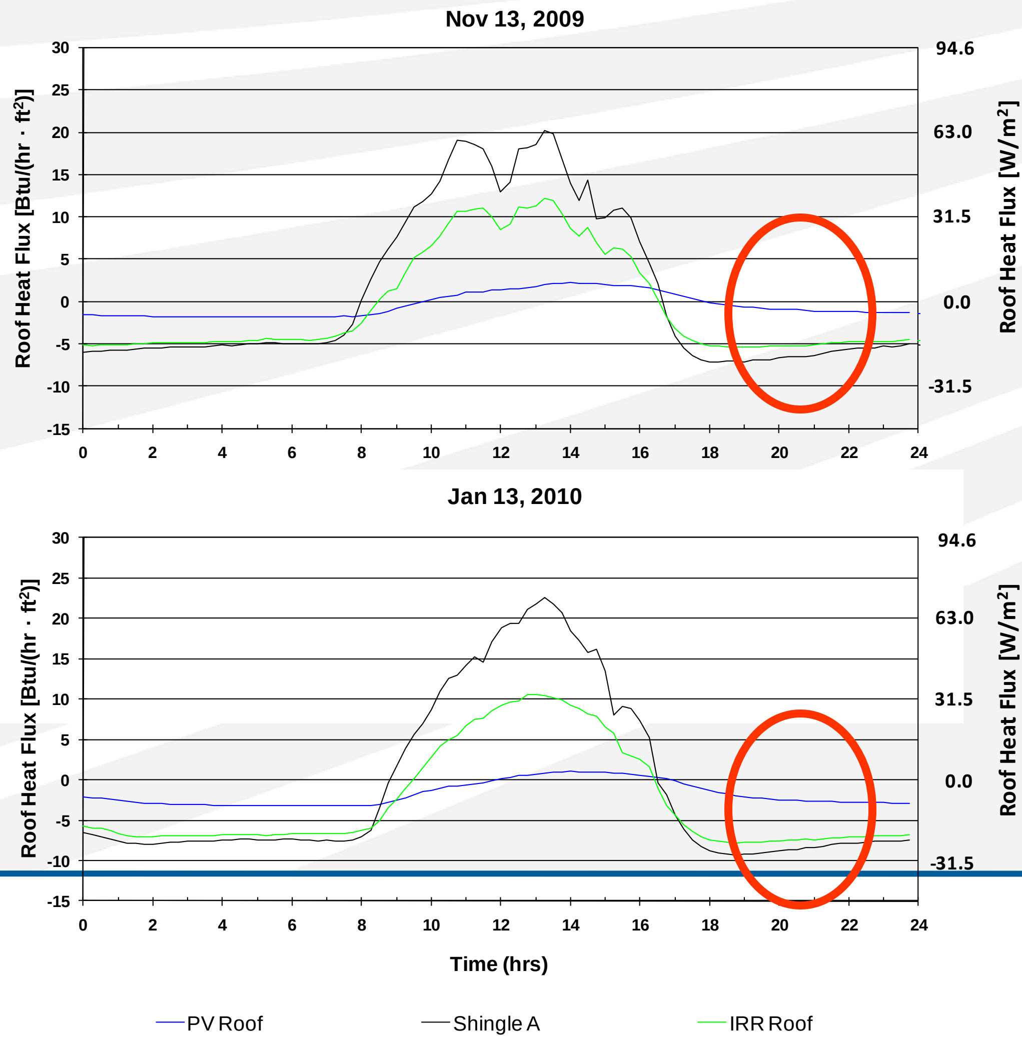
Results from the Dynamic Envelope Study performed at the ORNL campus

WINTER TEST DATA

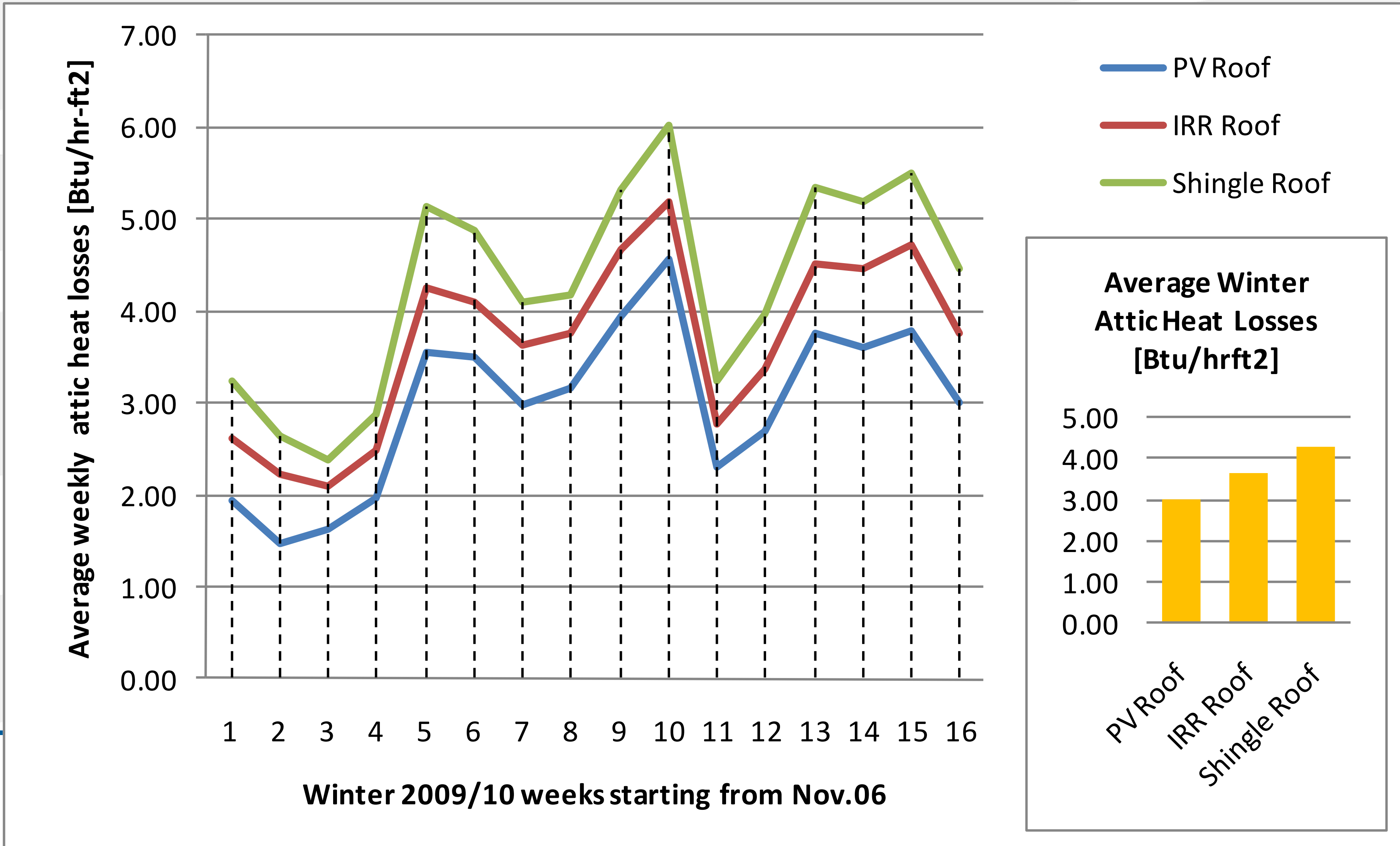
Night Attic Air Temperatures in PV-PCM Attic are Highest about 16 degF– lowest night heat losses



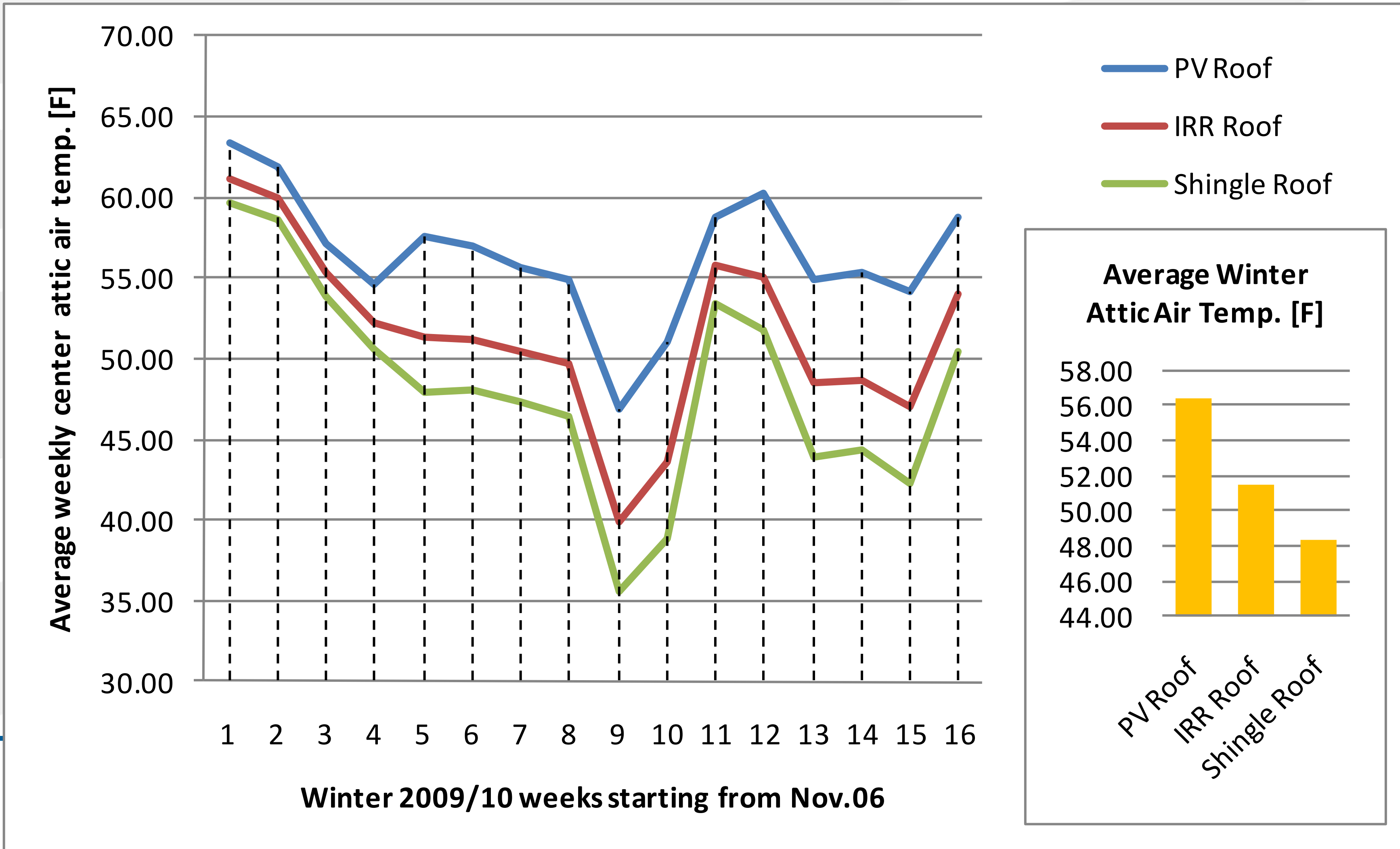
Night Heat Flows in the PV-PCM attic were ~75% lower from the other attics



Significantly lower winter heat losses in the PV-PCM Attic



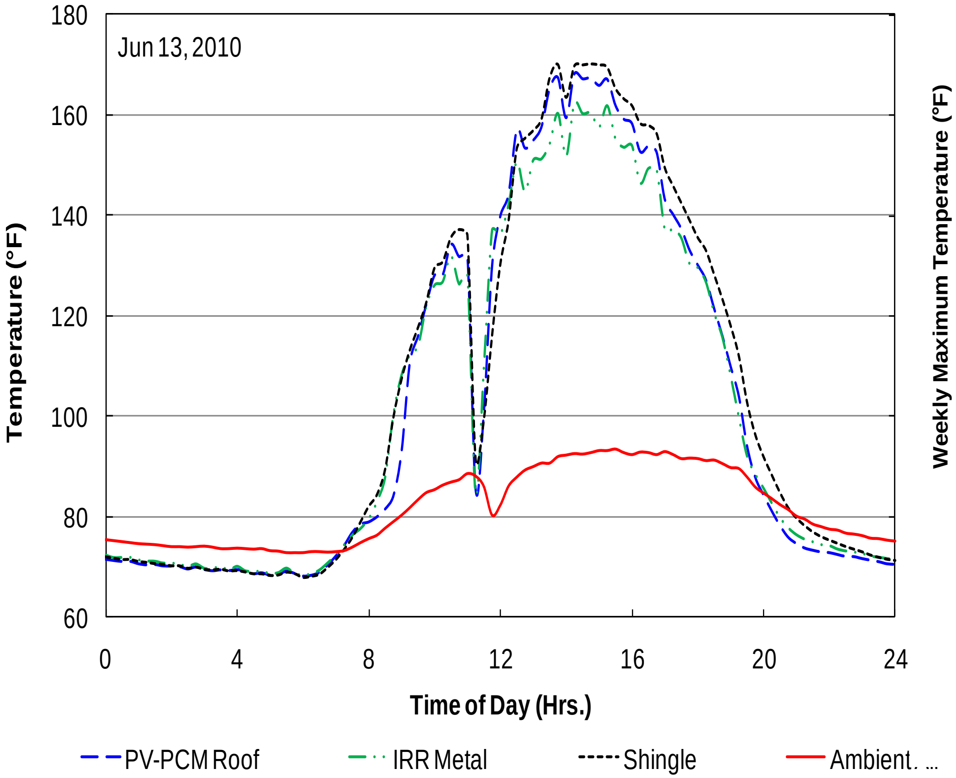
Much Higher Center of the Attic Temperature ~ 8degF

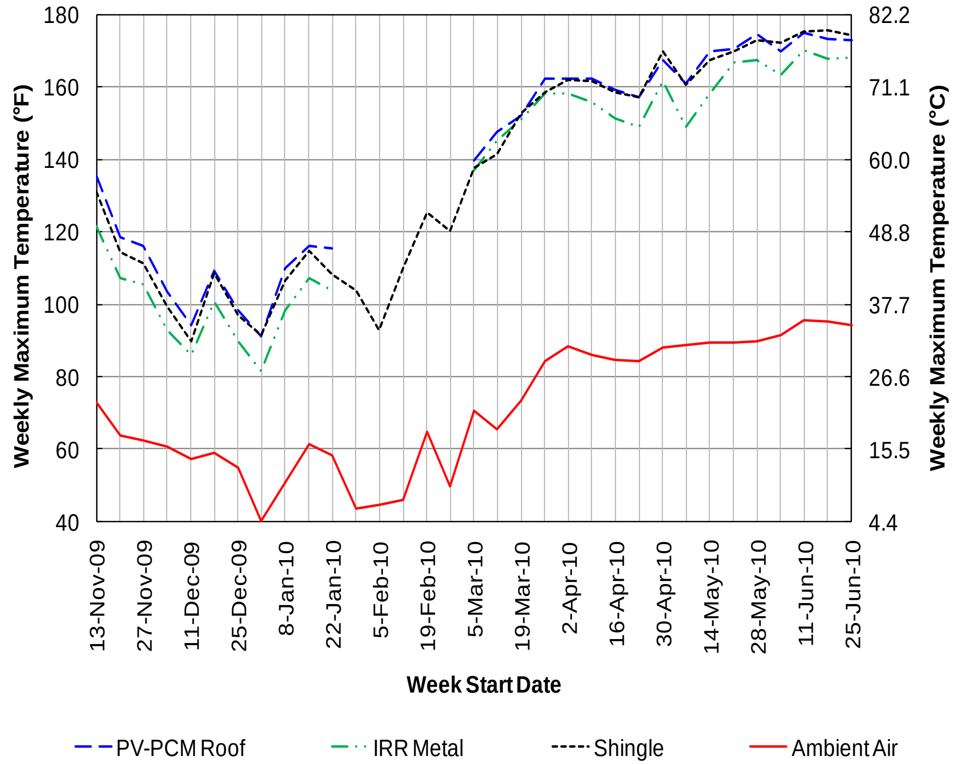


Results from the Dynamic Envelope Study performed at the ORNL campus

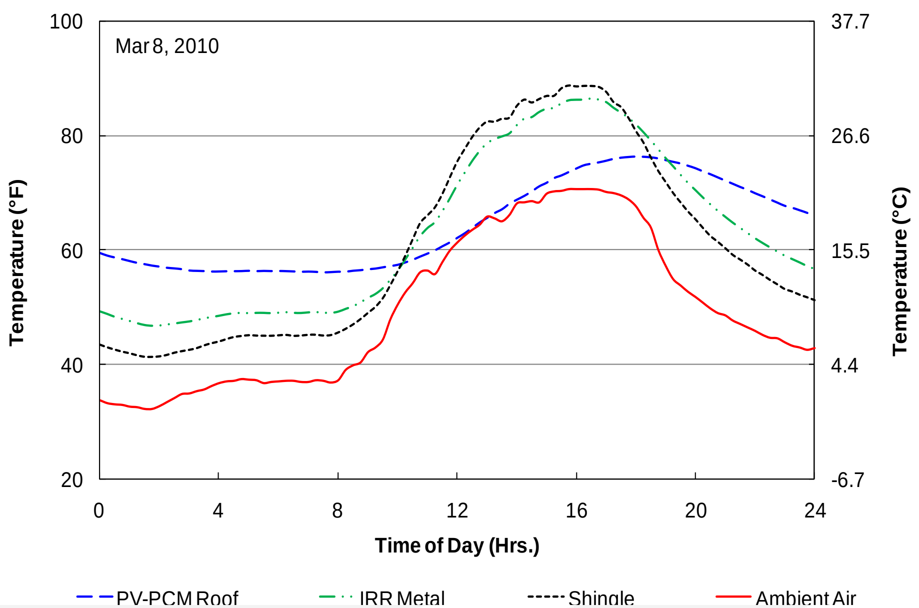
SUMMER TEST DATA

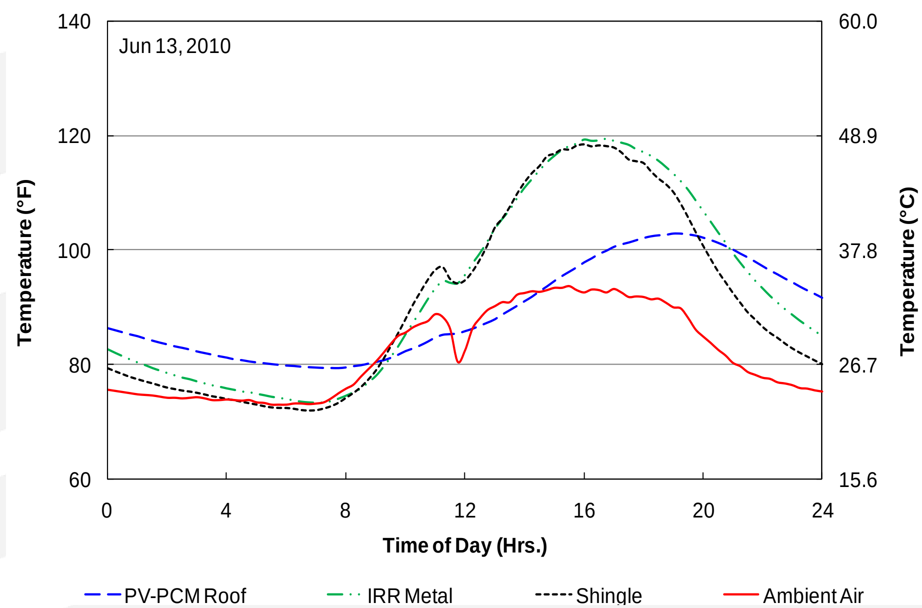
Great Potential for Harvesting Solar Heat - Summer Roof Surface Temperatures in PCM Attic can reach 170 degF



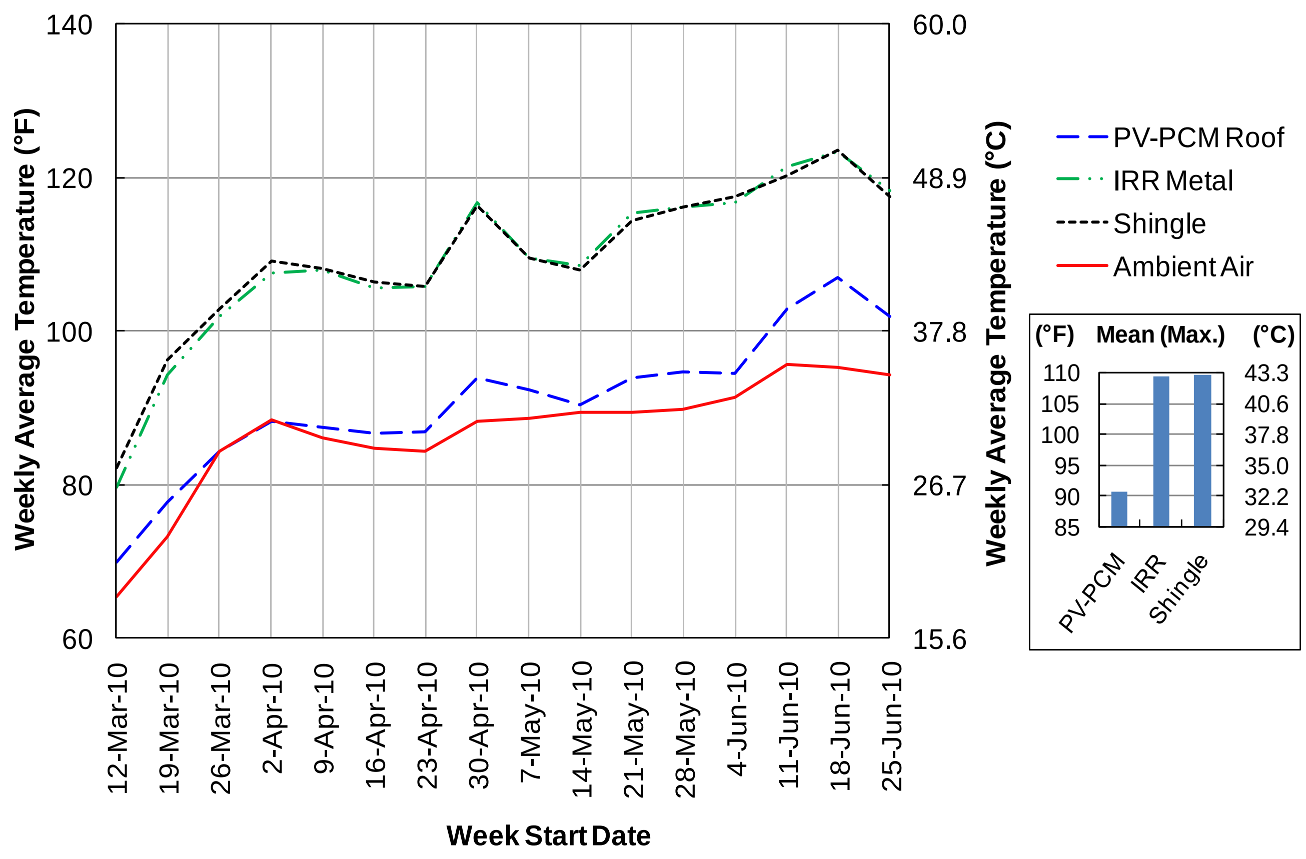


PCM Moderates Greatly Attic Air Temperature in Spring and Summer in average over 7.5 deg F difference

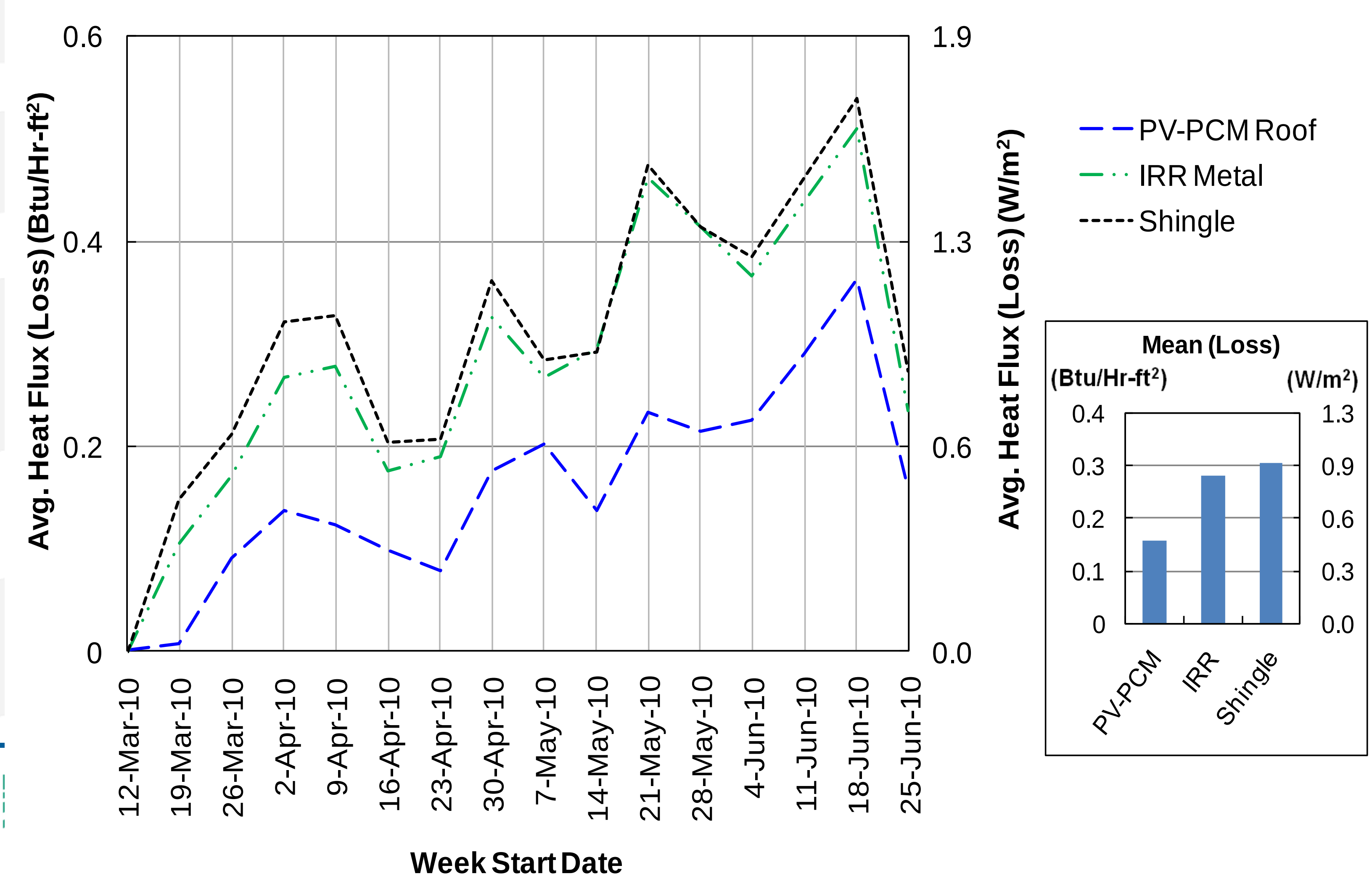




In Summer Average PV-PCM Attic Air Temperatures were almost identical as the Ambient Air Temperature



Average weekly heat flux lost by the attic to the conditioned space (Cooling Load) during spring-summer period – about 50% difference



Green Roofing Technology Ready for Full-Scale Application in Building America Projects

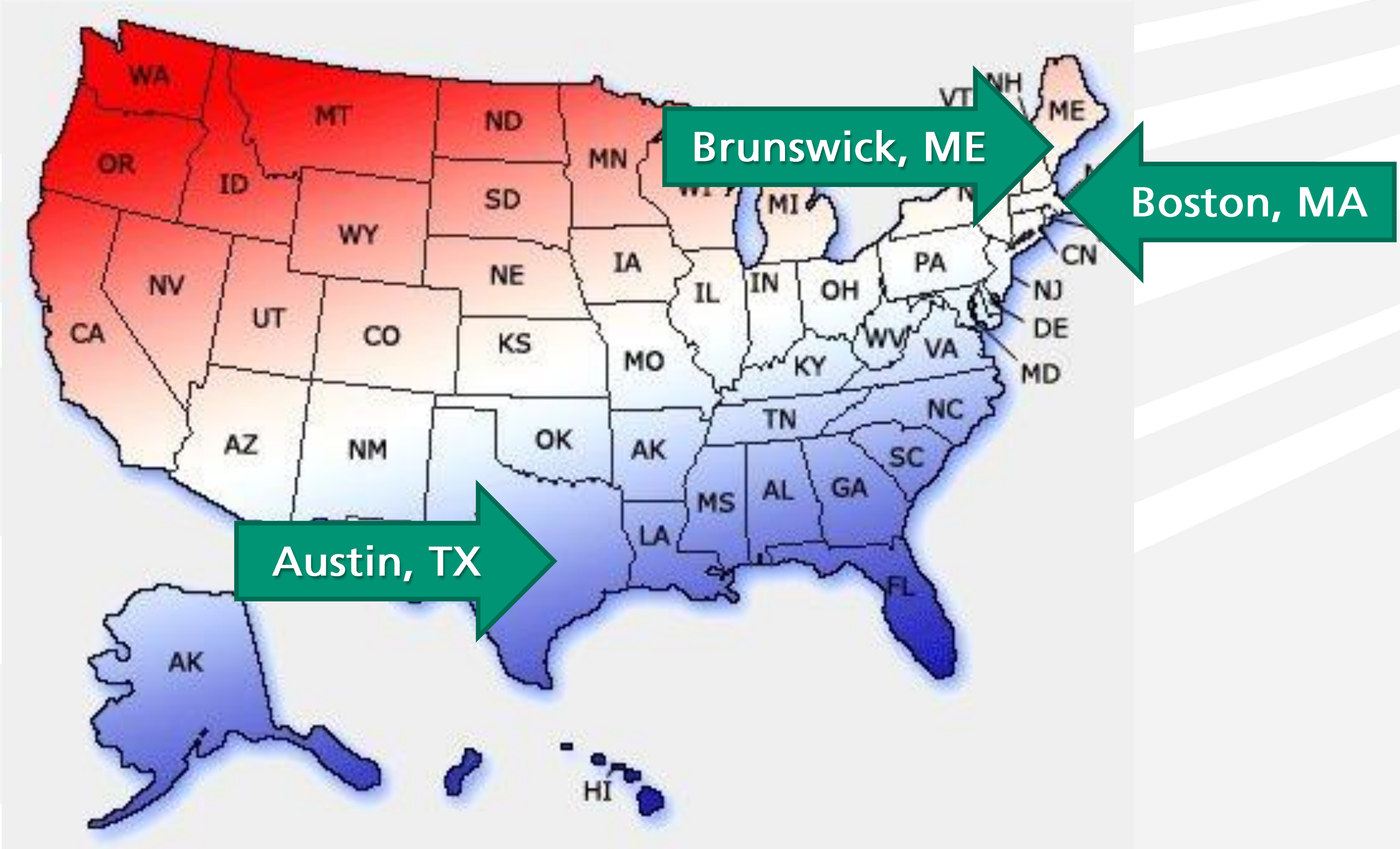
Fraunhofer Center For Sustainable Energy Systems is leading one of the largest Building America teams

- In 2010 – Fifteen Building America Teams Were Selected by DOE
- List and of Current Enclosures Research Areas for Fraunhofer-CSE Building Enclosure Research Team
- Three Building America Project Locations Considered by the Fraunhofer CSE
- New PCM Thermal Storage Technologies proposed by the Fraunhofer-CSE for Building America Program

Fraunhofer Center For Sustainable Energy Systems – Building Energy Efficiency Group – Core Activities:

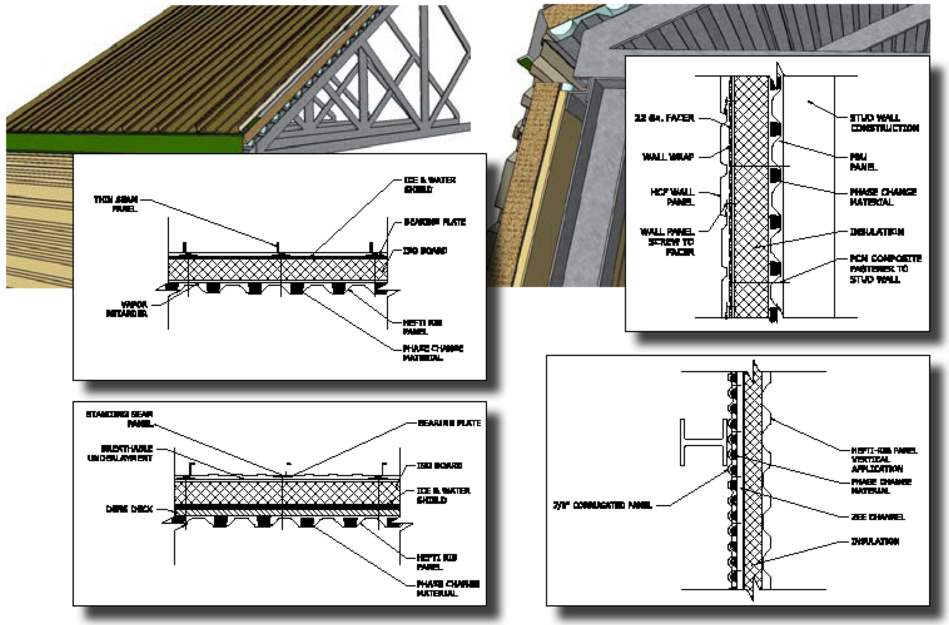
- Test, evaluate, and demonstrate the performance of energy-saving building technologies
- Apply novel materials to energy-efficient building components and systems
- Model and simulate advanced building systems
- Develop breakthrough, cost-effective energy retrofit technologies and processes
- Adapt high-performance European building technologies to North American markets and climates and vice versa

Fraunhofer Center For Sustainable Energy Systems – Building America Team – Core Geographic Locations:



Integration of the PCM Heat Sink Technology into the Metal Roofing and Wall Systems - Fabral

Fabral LEED compliant roofing and wall systems

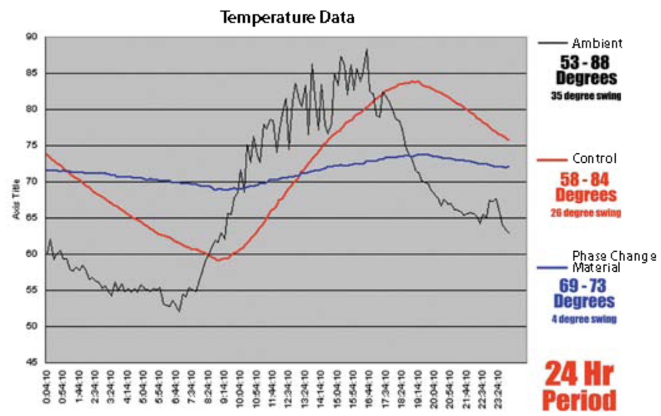


For the complete integrated roofing and wall system offerings, review the Fabral Phase Change technical manual.

Proof of Performance

Third Party Testing
Confirms Energy Savings

Energy savings from Phase Change materials enables smaller, more efficient heating and cooling units to be installed. Some climates can completely eliminate air conditioning. Third party public utility testing confirms up to 30% overall energy savings when Phase Change materials are installed. Direct savings are realized by reduced electric and gas utility bills and lower heating and cooling costs.



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PCM Heat Sink- A Green Energy Solution – Fabral and Phase Change Energy Solutions

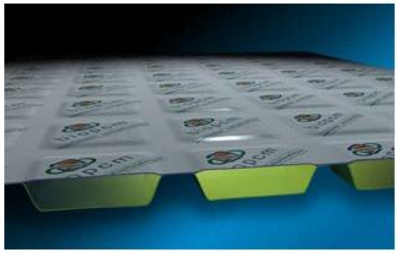
Thinking beyond insulation. We all know traditional insulation works as a simple barrier that slows the transfer of heat. That's a good start, but we have now gone beyond insulation to develop Phase Change material technology that absorbs and releases excess heat as needed. The result? Buildings that want to stay at a prescribed temperature throughout the day, consuming less energy and keeping room temperatures more constant.

How It Works

Phase Change materials absorb and release heat at pre-set temperatures. It is engineered around a fundamental property of nature: the natural tendency of materials to absorb heat when they melt (phase change from solid to liquid) and to release heat when they solidify (phase change from liquid to solid). All materials exhibit this behavior, however there are some in particular that go through this phase change at or near room temperature, absorbing and releasing heat in the process.

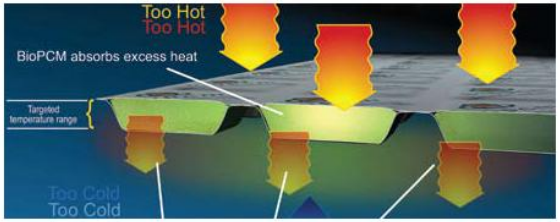
When these Phase Change materials are placed in quantity into the structure of a building, they absorb heat during the day and then release it at night. This makes the entire energy cycle more efficient. Less Kwh are used to heat and cool buildings while Phase Change material intelligently captures and releases otherwise wasted energy.

By absorbing
AND
releasing heat, structures can
AND WILL
maintain a constant and
comfortable
building temperature.



Phase Change materials increase the comfort, safety and efficiency of buildings by:

- reducing indoor temperature fluctuation
- reducing need for heating and cooling
- reducing greenhouse gas emissions
- reducing overall energy use
- shifting energy usage away from peak demand



*** CONCLUSSIONS ***

- A new paradigm for building enclosures has been introduced. It will be used by the Fraunhofer CSE team for Building America projects
- Over the winter and spring, the PV-PCM attic showed a **30% reduction in the heating load** compared to the conventional shingle attic.
- On average, the maximum day time temperatures were lower by about 15% in the PV-PCM attic compared to the shingle attic; this difference was higher in the late-spring and summer months.
- In average weekly **Attic Cooling Load in case of the PV-PCM attic was ~50% lower** comparing to the shingle attic - during spring-summer period.
- Continued evaluation through the months of July and August can provide better metrics for comparing the hot-weather performance of the PV-PCM roof strategy to the shingle roof.
- The new sustainable way of reroofing with the PV-PCM technology not only improves overall performance of existing roofs, but in addition will generate inexpensive solar electricity.

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Thank You!

ANY QUESTIONS?

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