ABOVE-CEILING PCM STUDY SUMMARY

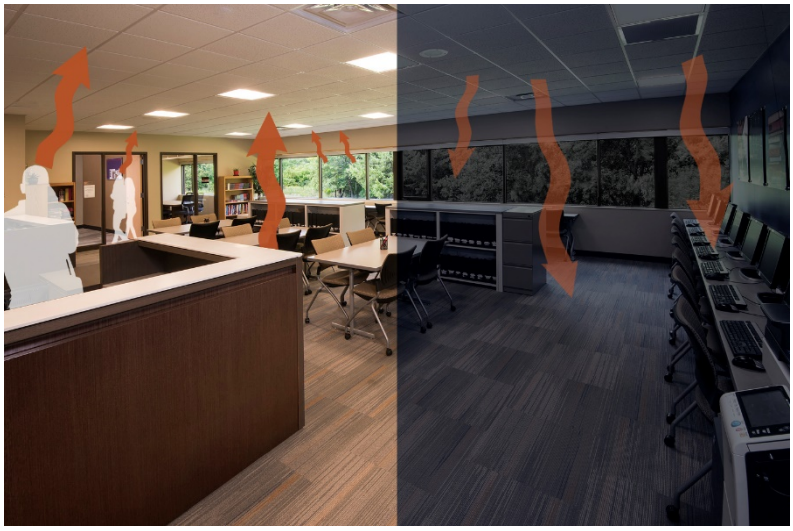
What is a phase change material?

A phase change material (PCM) is any material that uses the latent energy potential of a phase change to store and release thermal energy. In buildings, PCMs are used to stabilize indoor air temperatures, decrease energy consumption, and shift peak energy loads.

How do PCMs work?

Phase change materials are more common than you might think! The most common form of PCM is water. Just like the ice in your cooler, PCMs in buildings slowly melt as the indoor temperature rises. When a frozen PCM reaches its melting point, it absorbs heat without rising in temperature. PCMs used in buildings are engineered to melt at the desired room temperature. Once the temperature drops below the PCM's freezing point – typically at night – the PCM will begin to solidify, releasing the thermal energy stored throughout the day back into the space (Figure 1).

Figure 1. Phase Change Material Diagram



What are the benefits of PCMs?

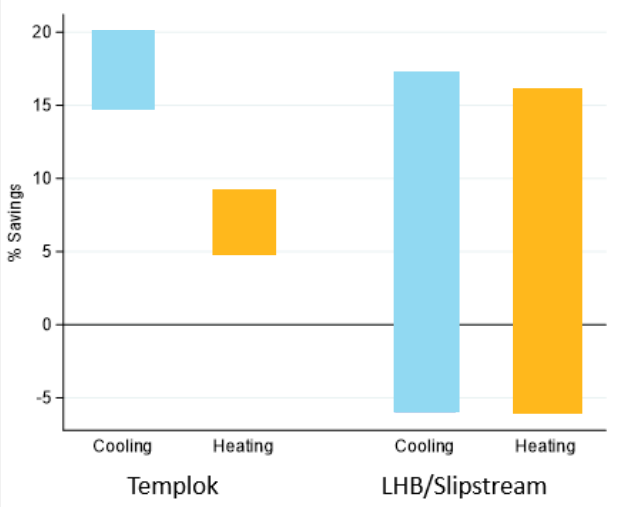
Using PCM to passively regulate indoor air temperature in buildings has the potential to:

- Reduce annual energy consumption, along with its associated costs and greenhouse gas emissions.
- Reduce peak demand for electricity and shift demand to off-peak hours.
- Improve the thermal comfort of building occupants.
- Reduce energy demand on existing HVAC systems, lowering operating costs and wear on the equipment.[1]
- Increase resilience and passive survivability by maintaining safe thermal conditions when power is unavailable.

Figure 2. Installing Above-Ceiling PCM

Building products include PCM encapsulated within flexible blankets or rigid panels that can easily be installed above suspended ceilings. In 2024, Armstrong released a new product - a PCM panel integrated with an acoustic ceiling tile.

Figure 3. Energy Savings – Above-Ceiling PCM



Though overlapping with the energy savings results of a study by the manufacturer of the Templok PCM product, the LHB/Slipstream field study has more uncertainty. These savings estimates have been adjusted to isolate the impacts of the PCM from the nighttime temperature setbacks.

Table 1. Life Cycle Cost Results

Scenario	Net Savings ($)
Bloomington site	$219
Shakopee site	-$2,027

The life cycle cost analysis compares the initial cost of the PCM to the annual energy cost savings, along with the residual value of the PCM at the end of 25 years. Using Minnesota's average retail energy prices, the analysis shows positive net savings at the Bloomington site, but not at the Shakopee site. These results are consistent with the findings from the LHB/Slipstream simulation study conducted in 2020: PCM is likely to be cost-effective in some scenarios, but not others.

Can PCMs save energy in Minnesota?

The first phase of LHB and Slipstream's PCM research included a simulation study that concluded PCM can cost-effectively reduce energy use and peak demand in Minnesota buildings. This validated the need for a field study to understand the technology's real-world application. From 2021-23, LHB and Slipstream tracked energy use before and after retrofitting two bank buildings with above-ceiling PCM "Templok" panels.

The findings did not provide conclusive evidence that installing PCM resulted in heating or cooling energy savings. This is due to several uncontrolled variables that made the PCM's impact difficult to isolate. Although PCM is a passive technology, the study found that well-controlled HVAC systems are an important tool in optimizing PCM performance. The study sites did achieve energy savings; however, the savings are attributed both to the PCM and the nighttime temperature setbacks in place.

What did the PCM study conclude?

Although the field study energy savings results were not conclusive, overall, the study found that:

- Installing PCM in buildings is broadly applicable in Minnesota.
- PCM is easily installed in spaces with suspended ceilings.
- Building controls are important for achieving energy savings with PCM.
- There is not enough evidence to recommend that utilities develop incentive programs at this time.
- There is high potential for PCM in the future as manufacturers invest in R&D of new products.
- PCM's potential benefits make it a technology worthy of further exploration.

[1] Cabeza, Luisa F. and Alvaro de Gracia. September 2015. "Phase Change Materials and Thermal Energy Storage for Buildings." *Energy and Buildings.* Vol 103. pp 414-419.

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