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PHASING INTO SAVINGS WITH PCM

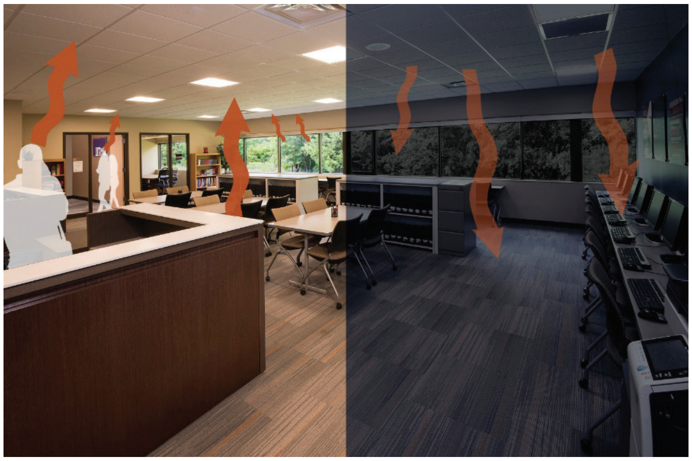
What is a phase change material?

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 begins to absorb heat without rising in temperature. This heat is called latent energy, which is the amount of energy required to change the material from a solid to a liquid. PCMs used in buildings – which are typically comprised of paraffins, salt hydrates, or organic substances – are engineered to melt at the desired room temperature. The room does not rise above this temperature until all the PCM has melted.[1] Once the room's 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



PCMs absorb heat during the day and release it at night. Available building products include a flexible PCM mat that can easily be installed above suspended ceilings.

Can PCMs save energy in Minnesota?

A simulation study conducted by LHB and Slipstream in 2020 found significant energy savings potential for commercial buildings in Minnesota. As shown in Figure 2, PCM applications achieved savings up to 15% of cooling energy, 50% of heating electricity, and 17% of heating natural gas. This amounts to a 5% reduction in total building energy, with a peak electricity demand reduction of 4-7%.

Figure 2. Modeled Energy Savings from PCM

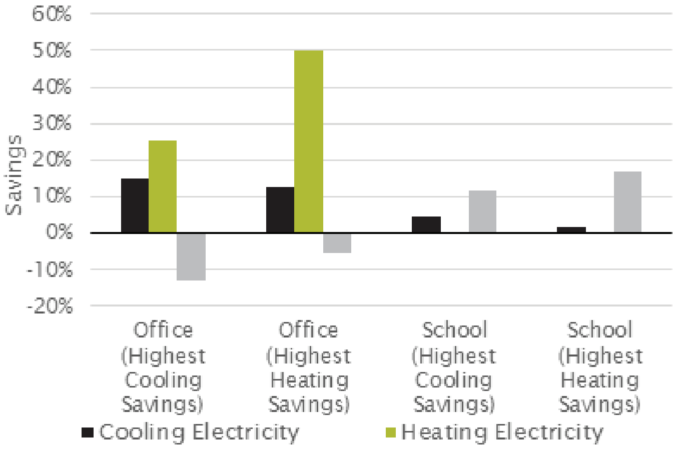
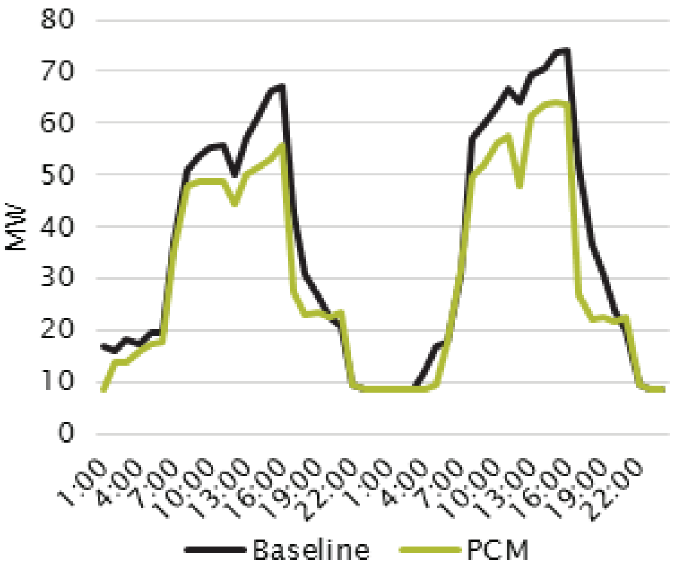


Figure 3. Electric Loads Over Two Days (Office)



The sample two-day span in April in Figure 3 shows PCM's potential to reduce both overall electricity consumption as well as peak loads.

Table 1. Life Cycle Cost Results

Scenario	**Net Savings ($)**
Office (Highest Cooling Savings)	$8,820
Office (Highest Heating Savings)	$5,748
Shool (Highest Cooling Savings)	-$1,612
Shool (Highest Heating Savings)	-$4,220

Using Minnesota's average energy rates, the modeled office scenarios achieve net cost savings over a 25-year study period. The modeled school scenarios are not cost-effective within this timeframe since heir energy reductions are primarily from natural gas (a relatively inexpensive energy source).

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. This helps balance electricity supply and demand and results in lower energy rates where peak demand pricing applies.
- Improve the thermal comfort of building occupants, which can increase productivity and satisfaction.
- Reduce energy demand on existing HVAC systems, lowering operating costs and wear on the equipment.[2]
- Eliminate the need for installing costly HVAC equipment (e.g. air conditioning) in existing buildings by passively improving thermal comfort.[3]
- Increase resilience and passive survivability by maintaining safe thermal conditions when power is unavailable.

Where should PCM be used?

PCM will provide benefits in buildings that have constant daytime occupancy and high internal loads, such as offices, computer labs, and data centers. Other beneficial applications for PCM are older buildings with poorly performing thermal envelopes that operate HVAC systems at peak capacity to maintain interior temperature setpoints. PCM can be installed within wall, roof, or ceiling assemblies in new construction. The results shown here are based on PCM installed above suspended ceilings, which can be done through a non-invasive retrofit.

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[1] *Childs, Kenneth and Therese Stovall. March 2012. "Potential Energy Savings due to Phase Change Material in a Building Wall Assembly: An Examination of Two Climates." Energy and Transportation Science Division. pp 1-35.*

[2] *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.*

[3] *Auzeby, Marine; Chen, Chao; Buswell, Richard; Ling, Haoshu; Ng, Bobo; Pan, Song; Tindall, Jess; Underwood, Chris; Wei, Shen. 2017. Using phase change materials to reduce overheating issues in UK residential buildings." Energy Procedia. Vol 105. pp 4072-4077.*

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