**Summer 2025 Pilot Proposal**

**Back-of-Panel Phase-Change Cooling for Silicon PV at Lehigh**

**Purpose & Audience** — The Thermosolar group is seeking support from the Lehigh Sustainability Office, Facilities, and Energy groups to run a Summer 2025 rooftop pilot testing phase-change material (PCM) cassettes mounted behind silicon photovoltaic (PV) panels.

**Quick definitions (plain language)**
• **Silicon PV**: the standard solar panels on campus; silicon cells turn sunlight into electricity but lose power as they get hot.
• **Phase-Change Material (PCM)**: a substance that melts and freezes at a chosen temperature, absorbing or releasing large amounts of heat during that change of phase.
• **STC** (means for standard test conditions): lab rating point for panels (1,000 $W/m^2$, 25 °C cell temperature, clear spectrum).

**Problem statement**
Silicon PV output typically drops about 0.4–0.5% per °C rise in cell temperature. On hot, still afternoons, cell temperatures can run 30–40 °C above STC, silently erasing a meaningful share of peak-hour production—the very hours when campus demand and grid emissions are highest.

**Our proposal (Why PCM?)**
*To mitigate this heat buildup, we propose using a PCM because it can "clamp" temperature right where panels start to lose the most efficiency.* We will mount a small, sealed cassette of calcium chloride hexahydrate ($CaCl_2 \cdot 6H_2O$) behind the panel. This salt-hydrate PCM melts around 24–29 °C (tunable by formulation). As it melts during midday heat spikes, it absorbs latent heat without a large temperature rise. When temperatures drop, it re-solidifies and releases that heat harmlessly to ambient air.
**Why this PCM?** It is non-flammable, low-cost, widely available, and offers high latent heat in the right temperature window compared with paraffins.

**Design concept**
• A compact cassette (≤ 5 kg per panel) using corrosion-resistant housing (e.g., HDPE/PP or coated aluminum) and welded inner pouches to prevent leaks.
• Non-penetrating brackets or adhesive pads to avoid warranty-risking roof or panel penetrations; cassette sits behind the backsheet with a thin aluminum spreader for good thermal contact.
• Retrofit-friendly; no electrical changes to the array.

**Measures of success (with data plan)**

1. **Temperature reduction: 5–10 °C** drop in backsheet/cell temperature between **12–3 pm** on clear, hot days.
2. **Power recovery: ~2–5%** instantaneous gain (versus matched control panels) during peak heat.
3. **Reliability:** no leaks or visible corrosion after summer cycling; mounting remains secure.
   **Instrumentation:** panel-mounted thermocouples/RTDs, irradiance (pyranometer), inverter telemetry/I-V tracing. All methods, raw data, and analysis will be made public.

**Risks & mitigations**
• **Supercooling / incomplete crystallization:** use a **stabilized salt-hydrate** with **nucleating agents** to ensure reliable freeze–melt cycling.
• **Phase separation / water loss:** select a **gelled or thickened formulation** and fully sealed pouches; secondary containment within the cassette.
• **Corrosion:** avoid dissimilar-metal contact; use **polymer housings** or **coated aluminum**, plus desiccant and barrier films where needed.
• **Added mass / wind loads:** keep per-panel mass under 5 kg; confirm racking load margins with Facilities.
• **Maintenance & winter behavior:** system is passive; in cold months the PCM remains solid and benign.

**Value beyond kilowatt-hours**
This pilot is **cheap (≈ $5–10k)**, **fast**, and **interdisciplinary**.
• **EE students**: quantify temperature coefficients, uncertainty, and performance uplift.
• **ME/Materials students**: design heat-transfer cassettes and packaging.
• **Policy/Finance students**: analyze time-of-day benefits, emissions impact, and payback.
Regardless of outcome, the result is **open campus data** and a **publishable case study** on passive PV thermal management.

**Schedule (high-level)**
Spring 2025: design/fabrication and safety review.
Summer 2025: 8–10 weeks of rooftop testing and public reporting.
Fall 2025: analysis, publication, and go/no-go on scale-up.

**Call to action**
Approve a Summer 2025 rooftop pilot led by the student Thermosolar team with a budget

under \$10k and full public reporting. We already paid for the photons—let's keep our panels cool enough to use them.

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