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Call: HORIZON-CL5-2026-02-D3-05: Demonstration of thermal energy storage solutions for solar thermal plants and systems

Demo Concept — PCM-Enhanced Thermal Flexibility for a Solar-Heat-Pump Building

Existing System

Since 2023, the Solimpeks Factory-I headquarters building in Konya, Türkiye (~1,630 m^2) has operated a hybrid solar-heat-pump system. The system consists of 59 kW PV/T, 21 kW PV, three 50 kW air-source heat pumps, and twelve 1,000-L hot-water tanks. It reliably supplies space heating in winter, cooling in summer, and domestic hot water to the building. The installation is continuously monitored, including temperature differentials, flow rates, and other operating points.

Owner Profile: Solimpeks is a leading Turkish solar technology manufacturer, specializing in solar thermal systems, PV/T modules, and thermal energy storage solutions. The company combines R&D and in-house production with demonstration activities at its own facilities. As a technology provider, Solimpeks not only develops and manufactures innovative components but also acts as an early adopter, testing and validating cutting-edge solutions such as PCM-based TES, digital twin tools, and integrated hybrid systems.

New Concept: PCM TES and Digital Twin

The proposed demo upgrades this proven platform with **phase-change-material (PCM) thermal energy storage** and a **digital twin** to shift both heating and cooling loads beyond daylight hours. Two pathways are possible:

- **Simulation-only**: Integrating PCM virtually through the digital twin using real operational data.
- **Selective real PCM installation**: Limited in-situ integration of PCM modules to validate their performance physically.

How PCM Storage Works

- **Hot storage (40–65 °C PCM):** During sunny, off-peak hours, PV/T and heat pumps charge the PCM by melting it. After sunset, as the PCM solidifies, it releases stored heat at a stable temperature to cover space heating and domestic hot water, reducing evening electricity demand.
- **Cold storage (12–18 °C PCM):** During the day, solar electricity powers the heat pumps to freeze the PCM. In the evening or night, the PCM melts and absorbs heat from building circuits, delivering cooling without running compressors.

By combining hot and cold storage cycles, the building can shift its thermal demand, extend the use of on-site solar, and smooth equipment operation.

Flexibility to the Grid

The building becomes a **flexible prosumer**, able to adapt its electricity use to grid conditions. Flexibility means:

- Charging TES during sunny or off-peak hours.
- Discharging after sunset to avoid evening peaks.
- Absorbing surplus PV to reduce curtailment.
- Providing smoother demand profiles and reducing grid congestion.

Partner Roles

- **Sabancı University (SU):** Coordinator; performs technoeconomic analysis, quantifying CAPEX/OPEX, payback/ROI, and the value of flexibility.
- **Unda Engineering:** Develops the digital twin and optimal operating strategies for TES charging/discharging.
- **Solimpeks:** Provides the pilot site and monitoring data, and integrates PCM TES modules in-house if agreed.
- **OEDAŞ (DSO):** Evaluates grid impacts, including peak reduction, congestion relief, and increased renewable self-consumption.

Alignment with Call Requirements

The Horizon CL5-2026-02-D3-05 call supports **demonstration of innovative thermal energy storage for solar thermal heat and/or cold**. The demo addresses this by:

- Integrating **solar thermal energy (PV/T)** with **PCM TES** for both heating and cooling storage.
- Delivering **substantial improvements** in performance (latent storage density, dual heat/cold storage, optimized dispatch), cost-effectiveness (greater solar self-consumption, reduced evening electricity use), and equipment lifespan (smoother compressor operation).

Sabancı Üniversitesi

İşletme çatısında;

PV/T: 59 kW

PV: 21 kW kurulu güç

İşletme 110,44 ton CO_2-e olan emisyonunu 37,54 ton CO_2-e seviyesine düşürmüştür.

İklimlendirme için

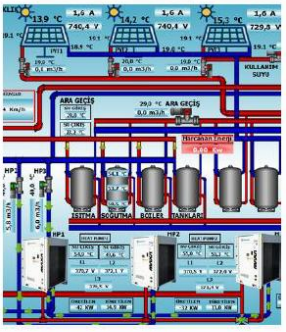
3 x 50 kW Isı Pompası

İşletmede doğalgaz kullanımından kaynaklı 118,44 ton CO_2-e emisyonunun önüne geçilmiştir.

Termal Enerji Depolama için

12 x 1000 L boyler

İşletme termal enerji fazlasını depolamış ve bu sayede 72,90 ton CO_2-e emisyonun önüne geçmiştir.



SCADA Sistemi

İzleme için

Sabancı Üniversitesi

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