PRODUCT APPLICATION NOTE
MassEffekt-Thermal Energy Storage Solution (TESS) for Cold warehouse

PLUSS-DOC-407 Version No. R2, May-2023

PLUSS® TECHNOLOGY FOR A BETTER WORLD

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Technical specifications

System components -

1) Thermal battery stack with the appropriate structure – A Thermal battery stack consists of Phase Change Materials (PCM) modules with phase change temperature of 5 deg C. PCM used is sav*E*® OM 05P. The number of PCM modules is determined based on the size of the rack.
2) Fixtures to mount Thermal battery stack: A set of battery stack can be mounted using two standard fixtures depending upon the size of the rack.
3) Fans for air circulation with invertor backup during power failure

Schematic diagram of system -

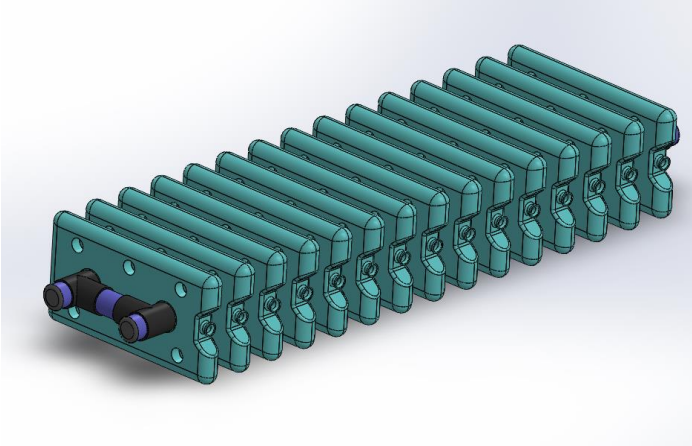

Figure 1: Representation of a Thermal battery stack.

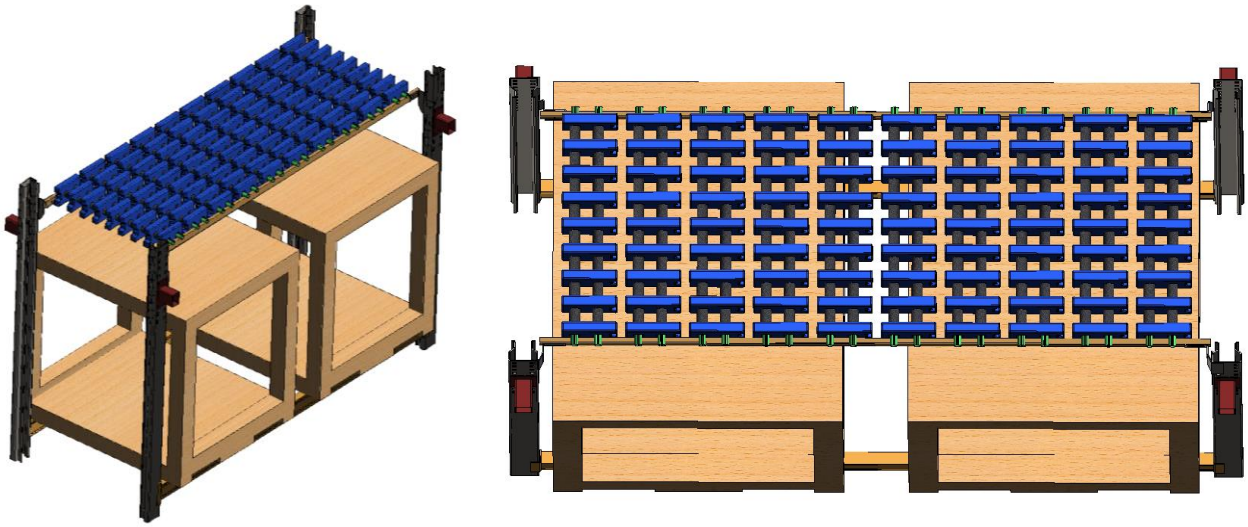

Figure 2: Representation of TESS system on racks (L) Isometric view (R) Top view.

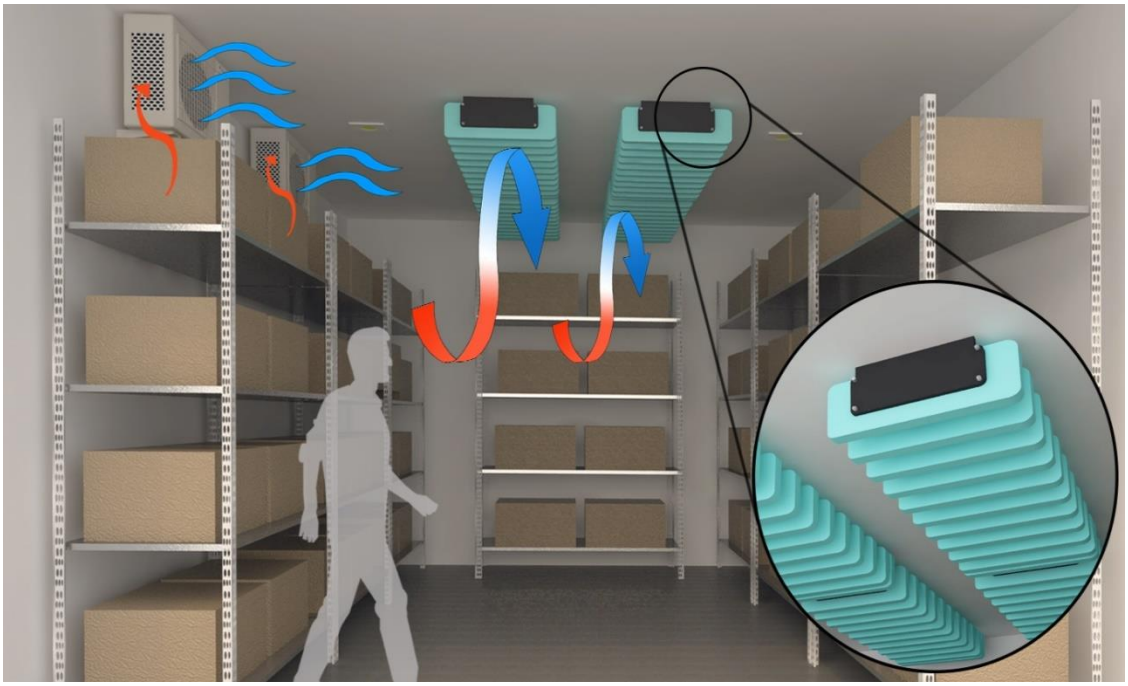

Figure 3: Representation of TESS system in a cold-room.

Operation of the system -

- When the refrigeration system turns on, the cold air temperature in the room should be maintained at a minimum of 3°C. The Thermal battery stack is charged during this period, i.e., the PCM changes phase from liquid to solid
- In the event of a power outage or other breakdown, when the refrigeration system turns off, the temperature of the air begins to rise. As the temperature rises beyond 5 °C and reaches around 8 °C the thermal battery begins to respond to the temperature increase. The PCM begins to melt due to the delta T and prevents the temperature of the room from increasing beyond 8 °C
- At all times, the fans are switched on for air circulation It is recommended that the fans be provided with invertor backup.

Note: The TESS heat exchanger system is a proprietary design of PLUSS®. The design ensures the efficient charging and discharging of the PCM. The system can be also designed for negative temperature cold-rooms with appropriate changes in the PCM and the thermal battery stack design.

Benefits:

- Reduces temperature fluctuations in the cold-room due to operational disturbances (like door opening).
- Provides backup cooling during power outages, reducing the need for DG backup.
- Reduces compressor cut-in/cut-off leading to lower power consumption and increased savings.

Case Study:

Tests were carried out on the CERP Rouen site - Mareuil Les Meaux, France. The system was installed in November 2022. In a room of 80 m³, 1120 kg of PCM thermal batteries (280 PCM batteries of 4kg each) were used and the test room was fitted with 30 sensors for temperature measurements. The operational conduct of the test was as follows:

Steps	Description	Day
1	Installation of TES System	0
2	Installation of monitoring sensors - setpoint at +4.5°C	1
3	Installation of the power logger	1
4	Check-in starts for 24:00 continuous period	1
5	Data recovery - re-installation of sensors	2
6	Installation of PCM Thermal Batteries - setting set to 0°C	2
7	Stabilization of the TES for 48h00	3
8	Temperature setting set to +4.5°C.	5
9	Check-in for 24h00 of consumption	5
13	End of test	8

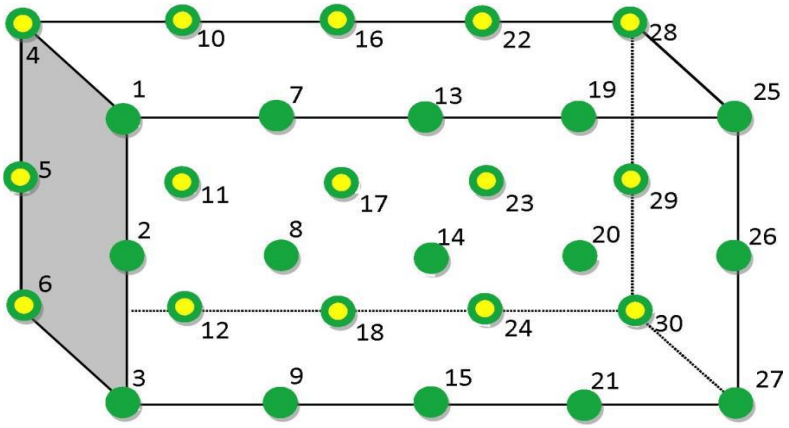

Figure 4: Placement of sensors in the test room

Performance Results:

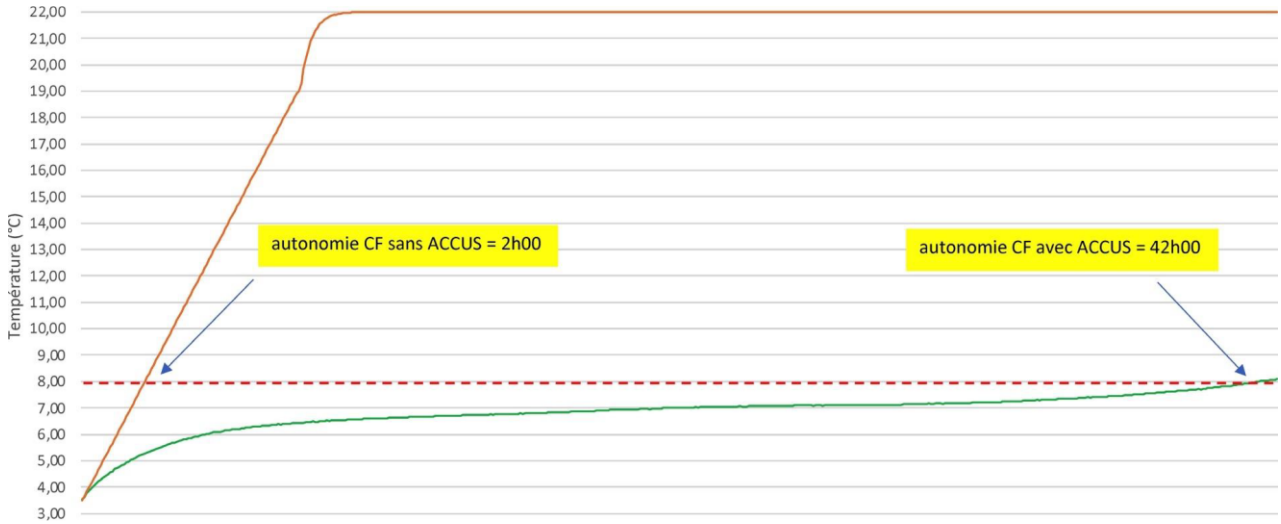

Figure 5: Cold-room temperature rise time with PCM (green colour) and without PCM (orange colour) after test room cooling switched off

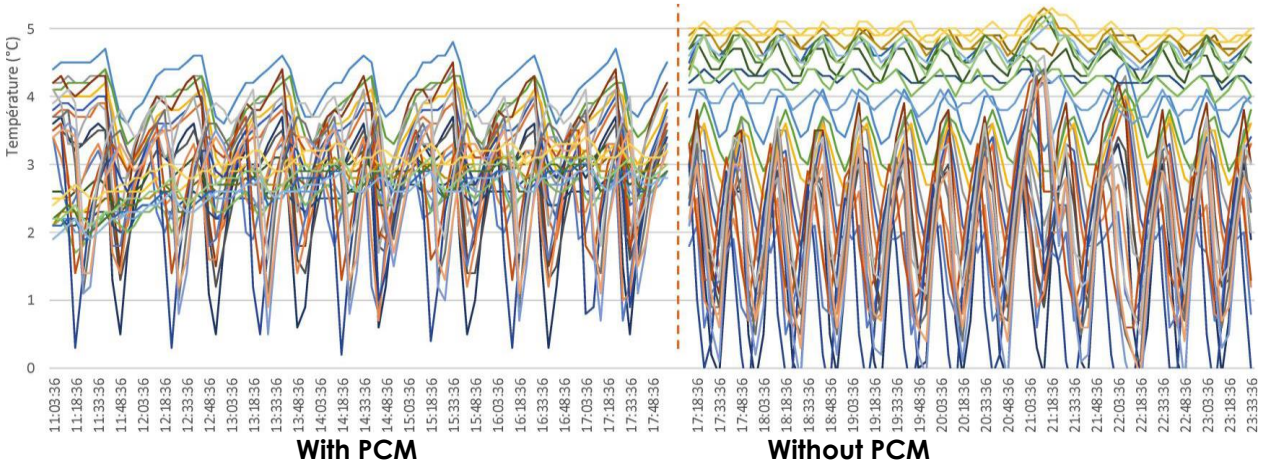

Figure 6: Cold-Room temperature profile at 30 different points with and without PCM.

Observations & Conclusions:

- As seen in Fig. 5, the cold room has a 4 °C temperature rise in 2 hrs without PCM while it takes 42 hours for the same temperature rise to happen with the presence of PCM Batteries.
- The measurement at 30 different points demonstrates the effectiveness of the TESS system in limiting temperature fluctuations as seen in Fig. 6.
- The number of compressor cut-in/cutoffs are reduced by 30%.
- This enables energy savings as follows:
    - Each refrigeration unit is 4.5 kWh
    - 2 refrigeration units per CF = 9 kWh or 108 kWh per day
    - Or 3240 kWh per month for normal operation

- The annual total energy consumed is 38,880 kwh or 5832 € / year (kWh valued at 150€/MWh)
- The annual savings generated by the addition of the TESS system is potentially 1944€/year per cold- room.

- This test was carried out with empty space. So, the performance of the system will certainly increase in case the space is filled with the material.