Thermal, Solar Ice and PCM Storage

1 Solar Ice Storage

1.1 Technical introduction

- Thermal energy storage (TES) to bridge the gap between supply and demand of renewable energies
- Uses the phase change from liquid to solid (frozen) to store and release latent heat
- Reversible process that enables cooling aswell

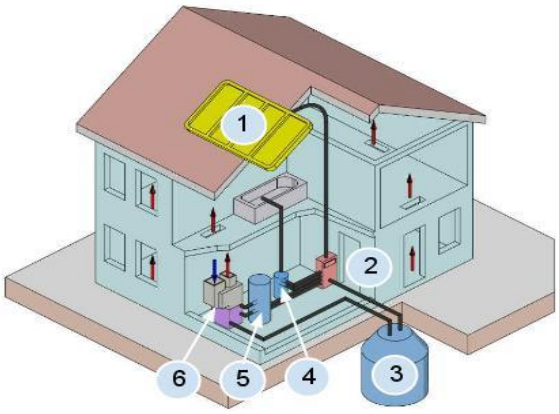

Figure 1: Solar ice storage concept diagram. Source: U.S. Army Installation Management Command [1]

1.2 Components

Solar air absorbers (1)

- Open, unglazed collectors - uses sun radiation and air temperature
- Regenerates the ice storage and is a direct heat source for the hot water storage (4)
- Works more efficiently with low temperatures and cloudy winter days

Ice storage unit (3)

- large cement unit installed in the garden underground
- no insulation needed due to storage temperature of 0°C to 30°C
- filled with water and heat exchange pipes (fig.2)
- Controlled freezing process, no damage due to volume increase

Figure 2: Empty solar ice storage unit with heat exchange pipes. Source: ZEBAU GmbH [2]

Heat pump (6)

- Connects the storage unit to the heating system
- Extracts heat from the water until frozen, phase change enables latent heat potential
- Transfers and distributes the heat directly or into the heating systems buffer tank (5)
- The control unit (2) helps regulating the heat distibution

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1.3 Conclusion

Solar ice storages can be a good TES solution to make the most of the renewable energy sources.

- High efficiency for sites with low sun radiation
- Expensive installation, space requirements and solar installation on the roof
- Multiple use – cooling systems "charge" for the next heating period
- Good COPs (Coefficient Of Performance) for heat pumps
- PCMs can be expensive, but can support the efficiency of diverse systems
- A lot of different options for implementation

2 PCM Storage – Phase change materials

- Temporary storage using latent heat during phase change
- Reversible process!
- Less common as storage units than the solar ice storage (water)
- Can be solid or liquid
- Can be organic, inorganic or both
- Embedded in a heat transfer liquid (HTF)
- Used in walls, ceiling boards, and others for passive temperature regulation

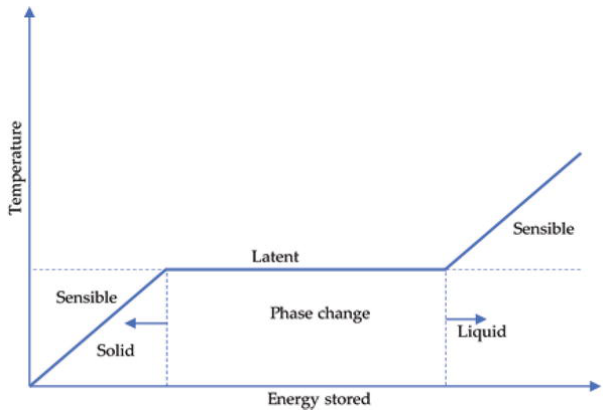

Figure 3: Latent heat during phase change. Source: G. Hailu [3]

3 Implementation

Pilot projects

District heating with seasonal thermal storage:

- Drake Landing Solar Community, Canada

Solar ice storage for Hotel Riva, Germany

- Large heating and cooling demand - 80m² Solar panels, 175m³ storage unit

PCM storage for industry and public buildings

- University of Life Sciences, Norway - 200m³ tank to cover peak loads

  Airport Bergen, Norway - four 60m³ tanks for Terminal 3 cooling demands

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4 References

- [1] U.S. Army Installation Management Command. U.S. Army Installation Management Command, Volume 4 (2013). https://ufdcimages.uflib.ufl.edu/AA/00/06/22/99/00055/10-2013.pdf
- [2] ZEBAU GmbH. Own photograph.
- [3] Getu Hailu (2018), Seasonal solar thermal storage: https://www.intechopen.com/books/thermal-energy-battery-with-nano-enhanced-pcm/seasonal-solar-thermal-energy-storage

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