The 6th Low Emission Advanced Power (LEAP) Workshop
U.S. Department of Energy
National Energy Technology Laboratory

Storage in Heat Pump and Heat Management Systems

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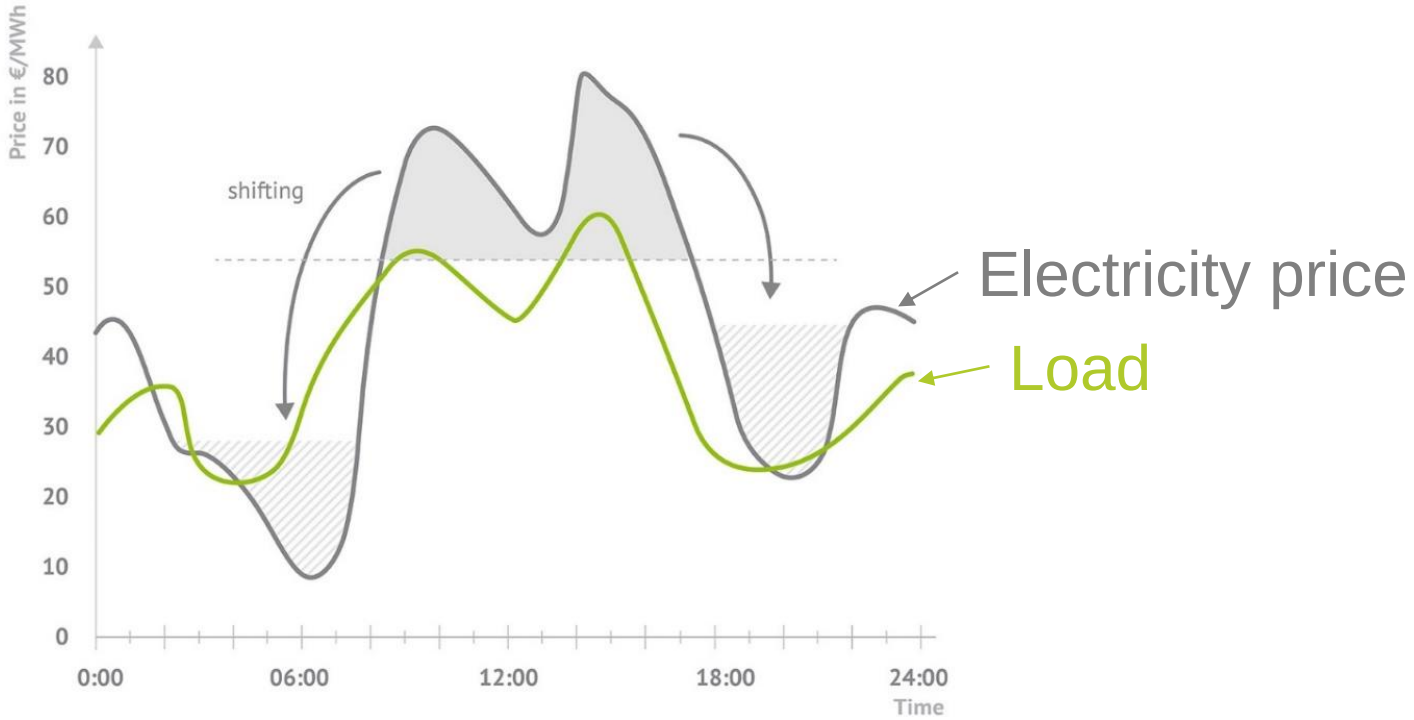
2021 Nov 2nd

Horizon 2020 Programme

Table of Content

1. Motivation

Demand-Side Load Shifting Needs **Energy Storage**

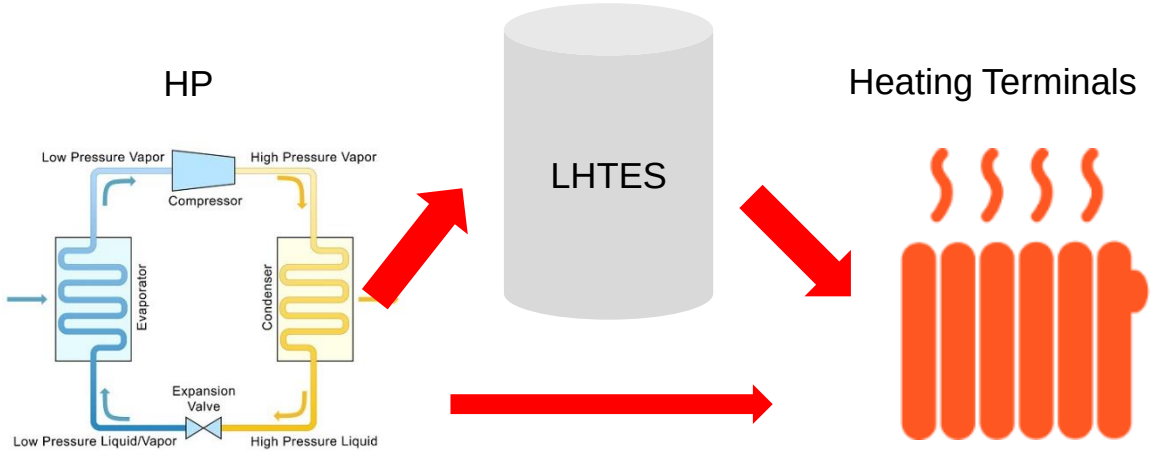


Source: https://www.next-kraftwerke.com/knowledge/what-is-peak-shaving

1. Motivation

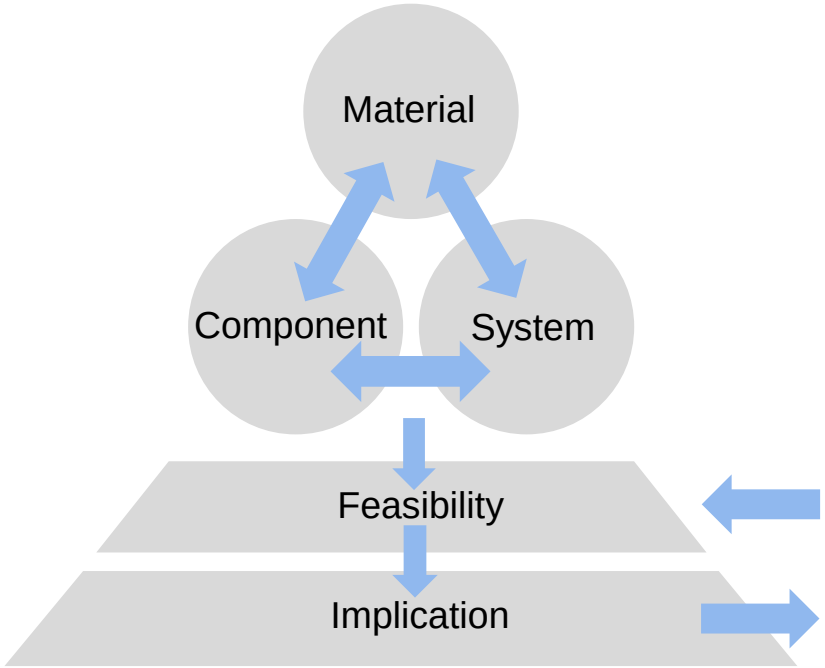
Active Latent Heat Thermal Energy Storage (**LHTES**) + Heat Pump (**HP**) for space heating and domestic hot water supply

- Compact storage component with Phase Change Material (**PCM**)



2. Latent Heat Thermal Energy Storage integrated Heat Pump Systems

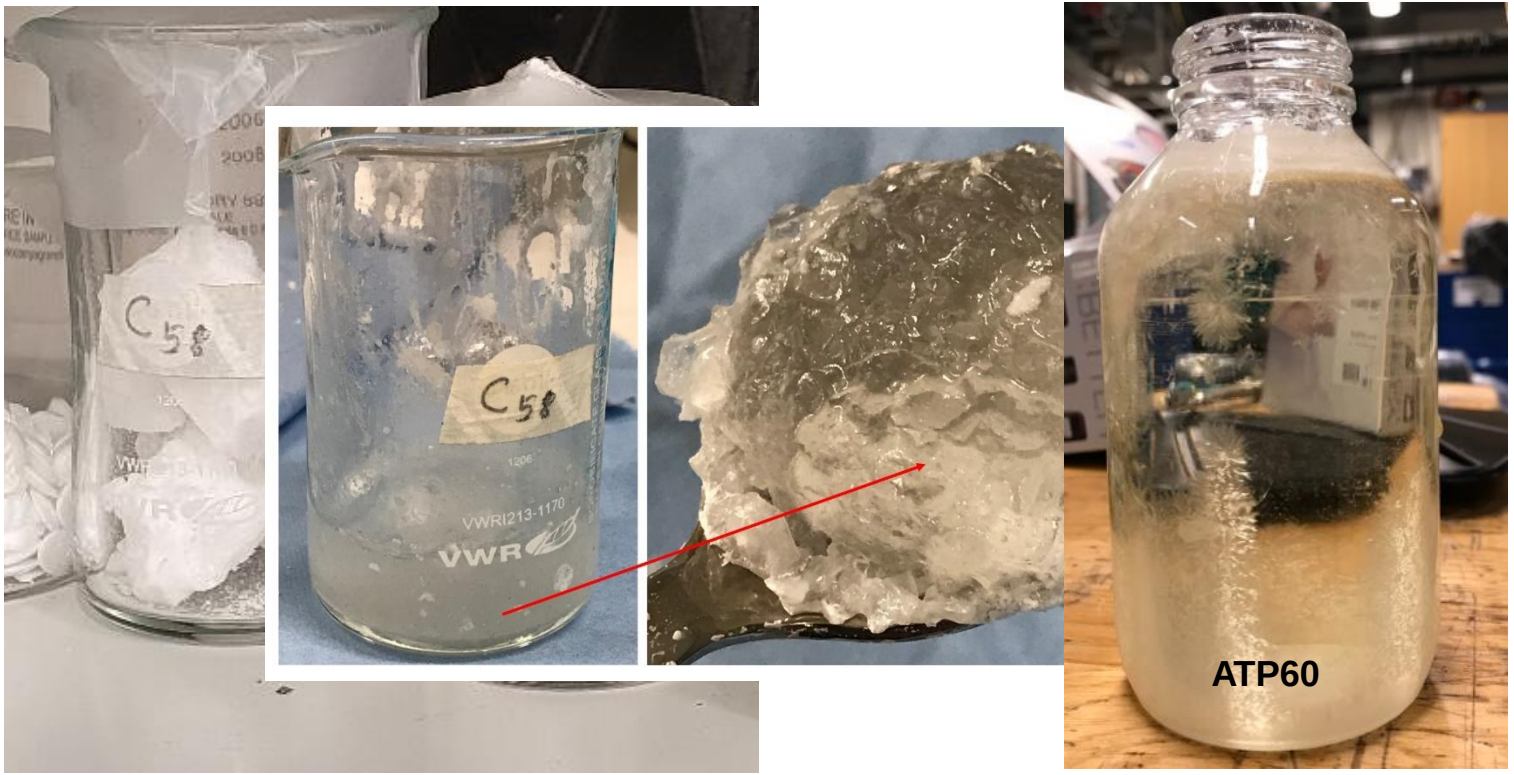
Demonstrate a technical and economic feasibility evaluation



Scenario: HP-based residential heating systems in Sweden

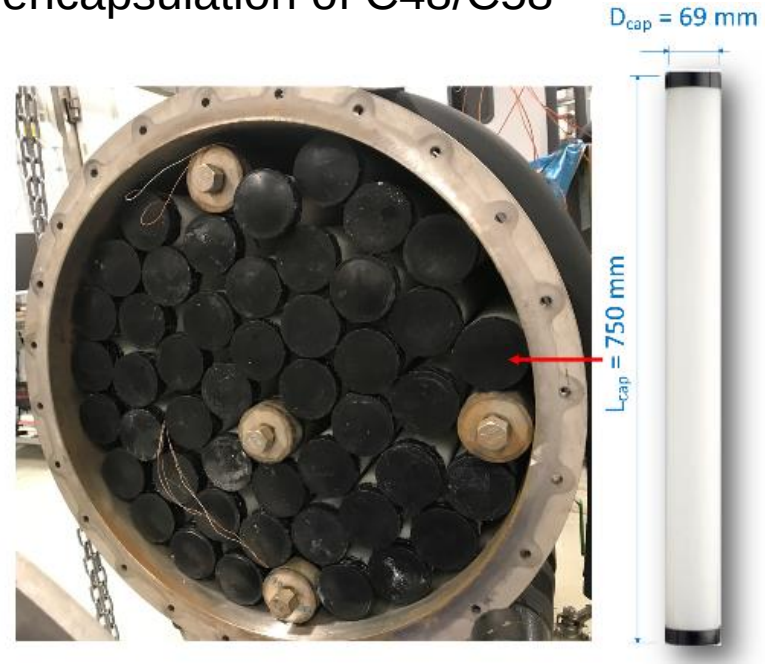
Improving measures for LHTES-HP load shifting solutions

2. Latent Heat Thermal Energy Storage integrated Heat Pump Systems



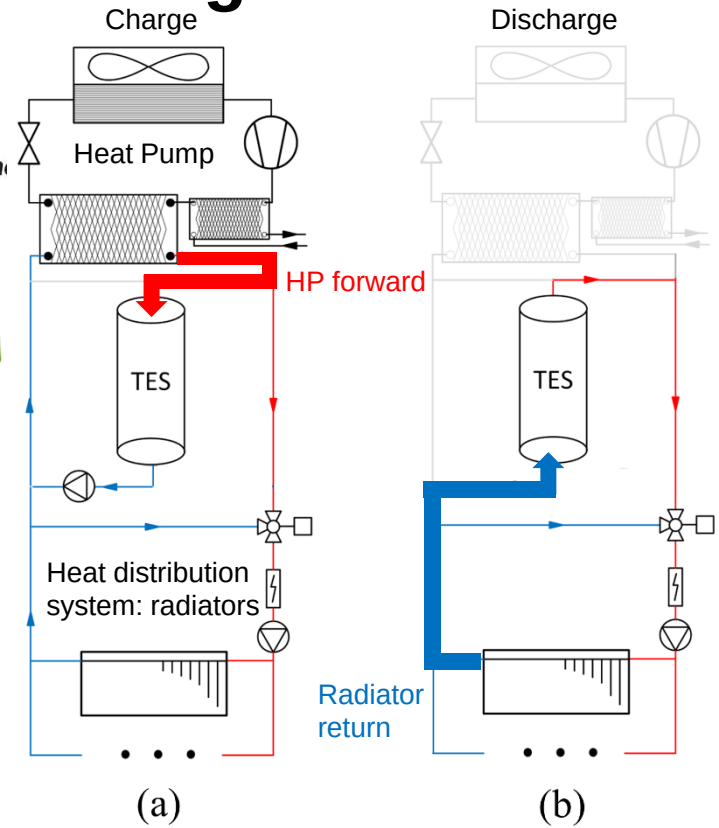
2. Latent Heat Thermal Energy Storage integrated Heat Pump Systems

Component 1+2: cylindrical encapsulation of C48/C58



Component 3: ellipsoidal encapsulation of ATP60

3. System Design with Latent Heat Storage



'The most direct application of PCMs for space heating is their implementation in a tank heated by the heat pump condenser.'

---- Pardinas et al. *State-of-the-art for the use of phase-change materials in tanks coupled with heat pumps*

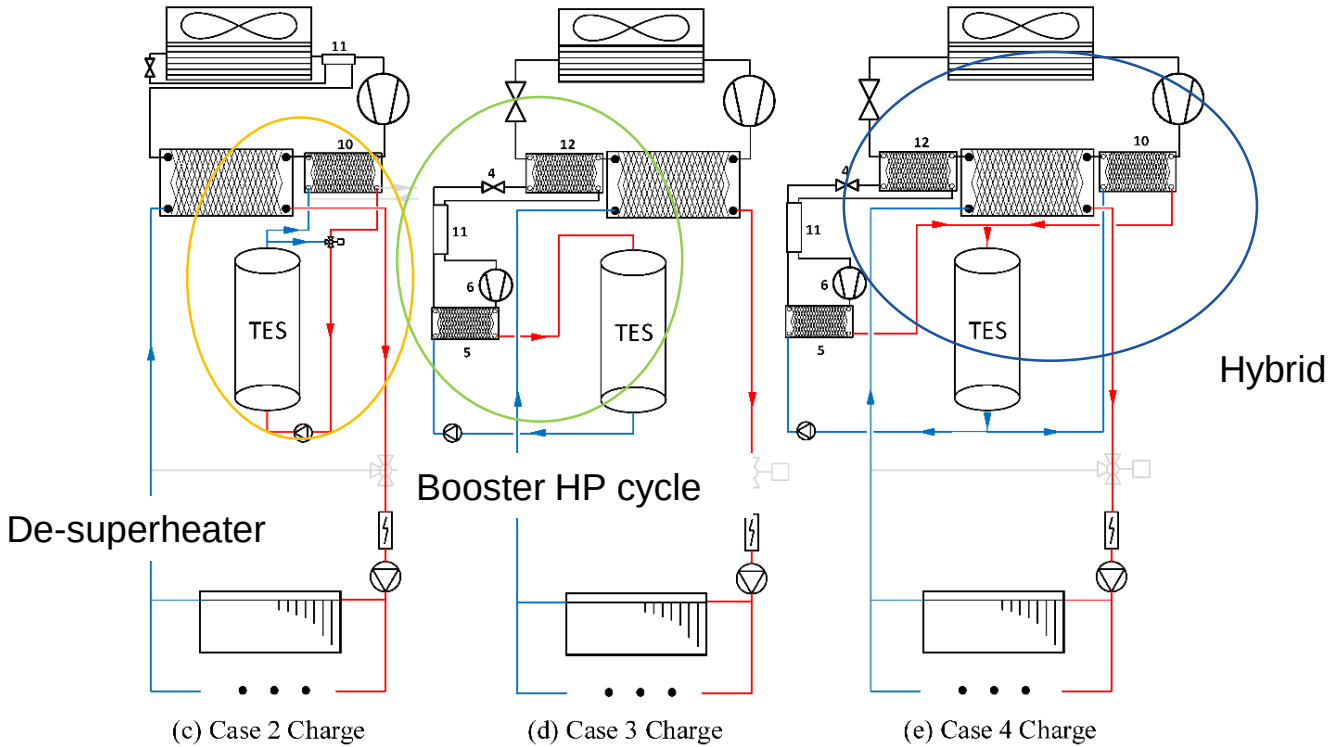
However, increase in condensation temperature → COP decreases

We propose here:

- new LHTES+HP layouts without sacrificing COP
- technical, economic, and environmental analyses

Pardiñas, Ángel Á., et al. "State-of-the-art for the use of phase-change materials in tanks coupled with heat pumps." *Energy and Buildings* 140 (2017): 28-41.

3. System Design with Latent Heat Storage



Conclusion

- Weekly Analysis: Week 1 2019
  - Fixed-time charge-discharge strategy:
- A three-story multi-family building in Stockholm with an R290 heat pump
- Performance indicators
  - Technical: $WPF = \frac{\sum_{t=1}^{n} \dot{Q}_b(t)}{\sum_{t=1}^{n} P_{tot}(t)}$
  - Economic: $OPEX_{el} = \sum_{t=1}^{n} P_{tot}(t) \cdot Pri_{el}(t)$

    $CAPEX_j < \mathrm{n} \cdot Sav_w \cdot a$
  - Environmental: $E_{CO_2,tot} = \sum_{t=1}^{n} P_{tot}(t) \cdot \mathrm{CO_{2\ eq}}(t)$

- Discussion:
  - new integrating layouts:
    - > 22%-26% higher WPF
    - > 34%-38% reduced CO_2 emission
    - > 2%-5% saving in OPEX vs. without storage
  - Justifiable CAPEX

  .
- Opportunities:
  - Potential in future electricity pricing scenarios.

5. Future Outlook

Latent heat thermal energy storage

- High storage density
- Small temperature swing
- Suitable temperature range

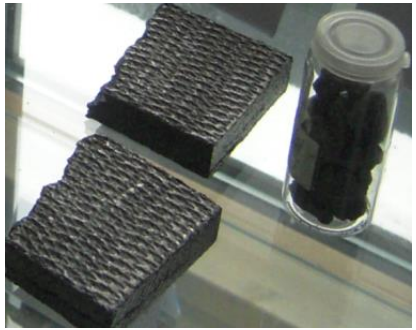
But

- Low thermal conductivity
- Phase separation
- Non-steady thermal power
- Economic feasibility
- Environmental impact
- Too few experimental validations

Possible Solutions

Encapsulation

Heat Exchanger



Impregnation

Thank You for Your Attention

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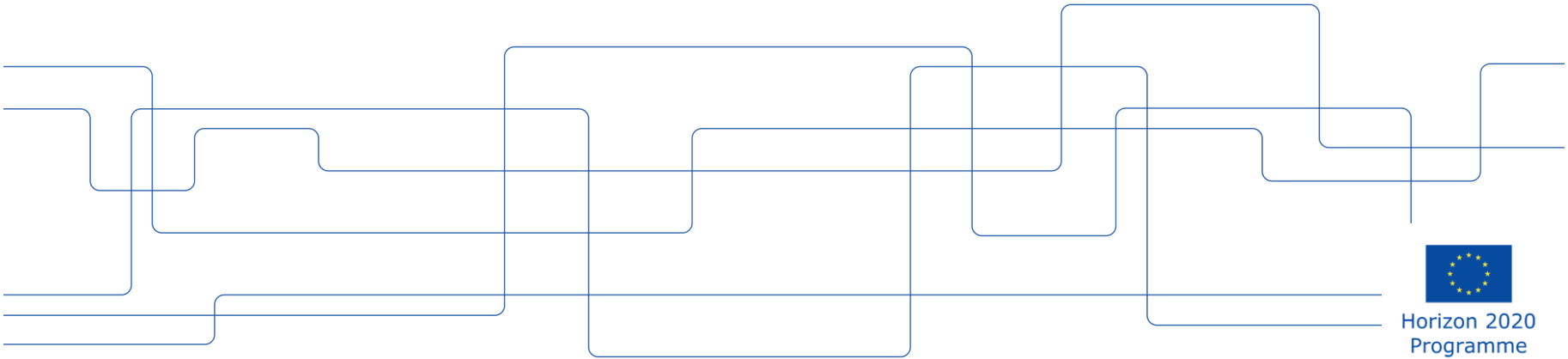

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