Task 39: Large Thermal Energy Storage for District Heating

IEA ES TCP OnSeminar
21 July 2022

Wim van Helden
Why Large Thermal Energy Storages for District Heating?

Target for 100% renewable energy generation;

LTES provide:

- More flexibility in DH Systems
- Higher share of renewables and waste heat
- Peak shaving, P2H (sector coupling)
- Large variation of operational conditions: short term, long term, middle to very large district heating systems

Larger storages are needed:

- To serve larger DH systems and other large applications
- To further reduce specific costs
Goal and objectives

**Goal:** Determine the aspects that are important in planning, design, decision-making and realising very large thermal energy storage for integration into district heating and for industrial processes.

**Objectives:**

- Definition of a number of representative application scenarios, the connected boundary conditions and Key Performance Indicators
- Improve LTES materials and materials performance measurement methods
- Prepare guidelines for obtaining proper water quality
- Compare the performance and accuracy of simulation models for LTES
- Derive validation tests for LTES simulation models
- Generate information packages and disseminate to decision makers
Scope

- Water or soil
- Volumes > 50,000 m³
- LTES in DH or in industries
- Seasonal storage, daily storage and multifunctional storage will be included
- Dissemination is targeted to decision makers in policy, municipalities, utilities and DH heating companies
Subtasks and their interdependencies

Subtask A: Application Scenarios, Assessment of Concepts, Integration Aspects

Subtask B: Components and Materials Database

Subtask C: Round Robin Simulation

Subtask D: Knowledge Base for Decision Makers
### Participation

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- **11** countries
- **13** Industry/platform
- **33** Organisations
- **18** R&D
Subtask A: Application Scenarios, Assessment of Concepts, Integration Aspects

Subtask A manager: Pierre Delmas, NewHeat, France

Goal: Definition of a number of representative application scenarios, the connected boundary conditions and Key Performance Indicators

- Drafting the lists of system level and storage level Key Performance Indicators (KPIs)
  - System level: CO2 savings, Primary energy savings
  - Storage level: Cycles/year, storage efficiency, thermal losses, specific storage capacity costs, …

- Site-specific indicators: geological conditions, legal aspects, …
### Subtask A: part of drafted KPI Table

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<th>DH-network related</th>
<th>Unit</th>
<th>Storage related</th>
<th>Unit</th>
<th>Economics</th>
<th>Unit</th>
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<td>Increase of RES share in DH-Network</td>
<td>MWh/y, %/y</td>
<td>Storage Capacity</td>
<td>MWh</td>
<td>LCOH – See Discussion Below</td>
<td>€/MWh</td>
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<td>Reduction of DFF (dependency on fossil fuel) of DH-network</td>
<td>MWh/y, %/y</td>
<td>Storage Capacity related to site</td>
<td>MWh/m³</td>
<td>Storage Volume Cost</td>
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<td>Reduction of peak load in DH-network</td>
<td>MW, %</td>
<td>Max. charge performance</td>
<td>MW</td>
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**Comments:**
- Increase of RES share in DH-Network: Defines the energy stored in the system and depends on the storage process, the medium and the size of the system (Ioan Sarbu, 2018)
- Reduction of DFF (dependency on fossil fuel) of DH-network: Use "equivalent water m³" to become comparable? Ref: Design Aspects for Large-Scale Aquifer and Pit Thermal Energy Storage for District Heating and Cooling (Storage cost plot from Solites)
  \[ V_{WE} = (\frac{V_{SM} \cdot P_{W} \cdot SM - \Delta T \cdot W_{T}}{P_{W} \cdot SM \cdot S_{W}}) \]
  \[ SM: \text{storage medium} \]
  \[ W_{T}: \text{water} \]
  \[ \Delta T: \text{usable temperature difference} \]
- Reduction of peak load in DH-network: Defines how fast the energy stored in the system can be charged (Ioan Sarbu, 2018)
- Storage Capacity Cost: SVC = COS/SV
  COS: the cost, considering the storage medium, container, and charging and discharging device
  SV: Storage volume
  (Tianrun Yang, 2021)

**Economics**
- LCOH – See Discussion Below
- Storage Volume Cost
- Storage Capacity Cost
Subtask B: Materials and Components

Subtask B manager: Bijan Adl-Zarrabi, Chalmers University, Sweden

Goals: Improve LTES materials and materials performance measurement methods

Prepare guidelines for obtaining proper water quality

- Database for LTES materials through Supergen project [https://ukesto.supergenstorage.org](https://ukesto.supergenstorage.org) (now mainly electricity storage)
Subtask B: Material properties

- Functionalities of materials in LTES components described to arrive at relevant material properties
Subtask B: Corrosion related water quality requirements

Example: Gathering practical experience for PTES

Corrosion effect of water chloride content on carbon steel (Aalborg CSP experience)
Subtask C: Round Robin Simulation

Subtask C manager: Thomas Schmidt, SOLITES, Germany

Goals: Compare the performance and accuracy of simulation models for LTES
Derive validation tests for LTES simulation models

- Target TES sizes (BTES, PTES), inlet and outlet temperatures determined
- Simulation round robins in a 2-stage procedure;
  - Simple operation, Multiple storage cycles
  - Seasonal storage operation, Multiple storage cycles)
- Discussion on challenges in simulation model, e.g. thermal bridges between lid and wall in PTES
Subtask C; thermal bridge problem

Problem:

Possible Solutions:

- similar top thermal losses
- wrong ground temperatures at the surface

- correct top thermal losses
- correct ground temperatures at the surface
Subtask C; Geometries chosen for round robins

- Tank TES (TTES)
- Pit TES (PTES)
- Borehole TES (BTES)
- Aquifer TES (ATES)
Subtask D: Knowledge Base for Decision Makers

*Subtask D manager: Geoffroy Gauthier, PlanEnergi, Denmark*

**Goal:** Generate information packages and disseminate to decision makers

**Online questionnaire for decision makers**

- Distributed and available since start of the year
- 54 reactions up to now; first analysis
  - 24 LTES in planning or realisation
  - System perspective KPIs, Technical aspects, Financial aspects seen as most interesting
  - Project feasibility and planning not seen as interesting (but this actually is in experience of experts) → dissemination focus needed
Subtask D; representation in questionnaire

Which kind of organization do you represent?

- Utility/Energy company
- Authority and/or politician - National level
- Authority and/or politician - Regional level
- Authority and/or politician - Municipality
- Authority and/or politician - Energy agency
- NGO (non-governmental organization)
- Local housing association (or similar)
- Academia
- Consultancy
- Contractor of construction projects
- Manufacturer
- Research institute
- Association (district heating, solar)
Experts Meetings

- Planned meetings:
  - 15 and 16 September 2022; Aalborg, Denmark (in conjunction with Smart Energy Systems conference)

- If you are interested in participating, contact Task Manager or your national IEA ES TCP delegate (see [https://iea-es.org/](https://iea-es.org/))

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