Task 39: Large Thermal Energy Storage for District Heating

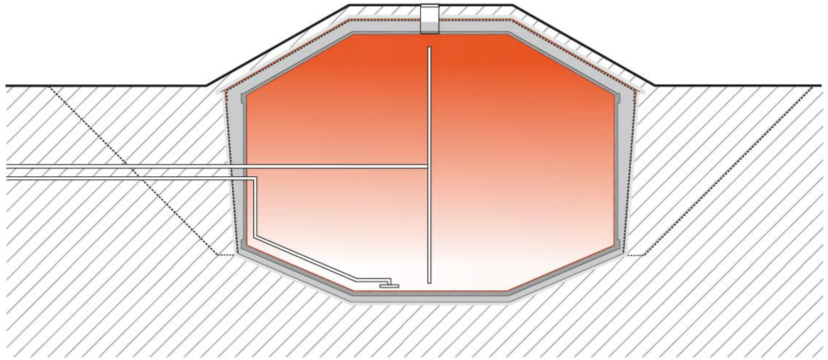
Eurosun workshop
27 September 2022

Wim van Helden

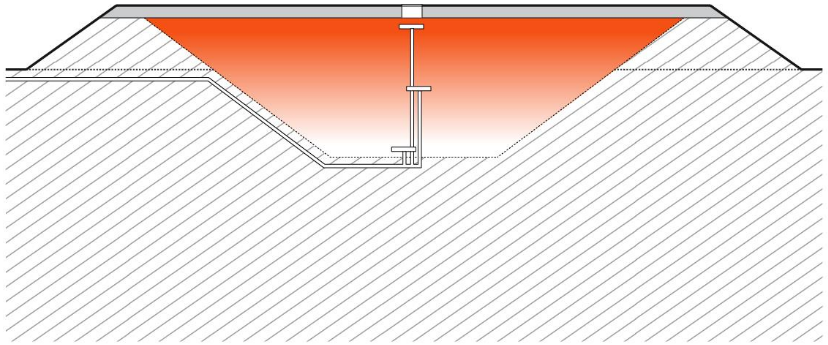
Where is the Large Thermal Energy Storage?

Scope

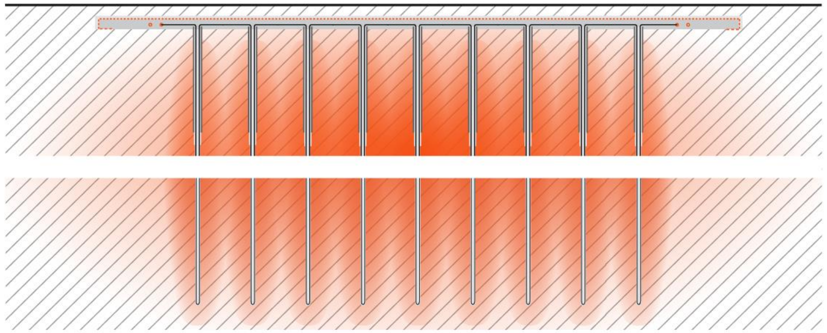
Tank thermal energy storage (TTES)



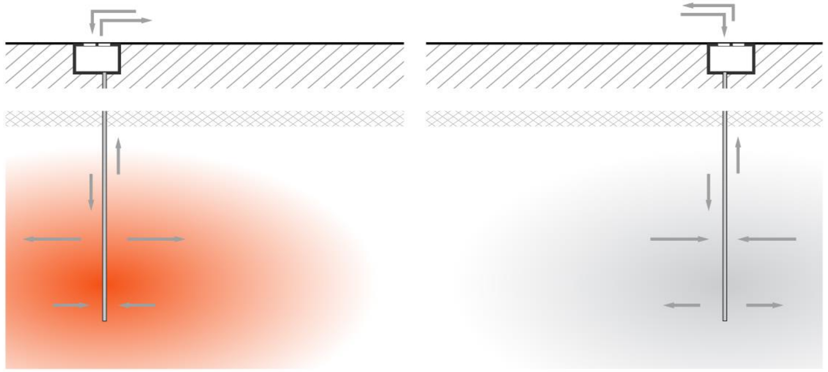
Pit thermal energy storage (PTES)



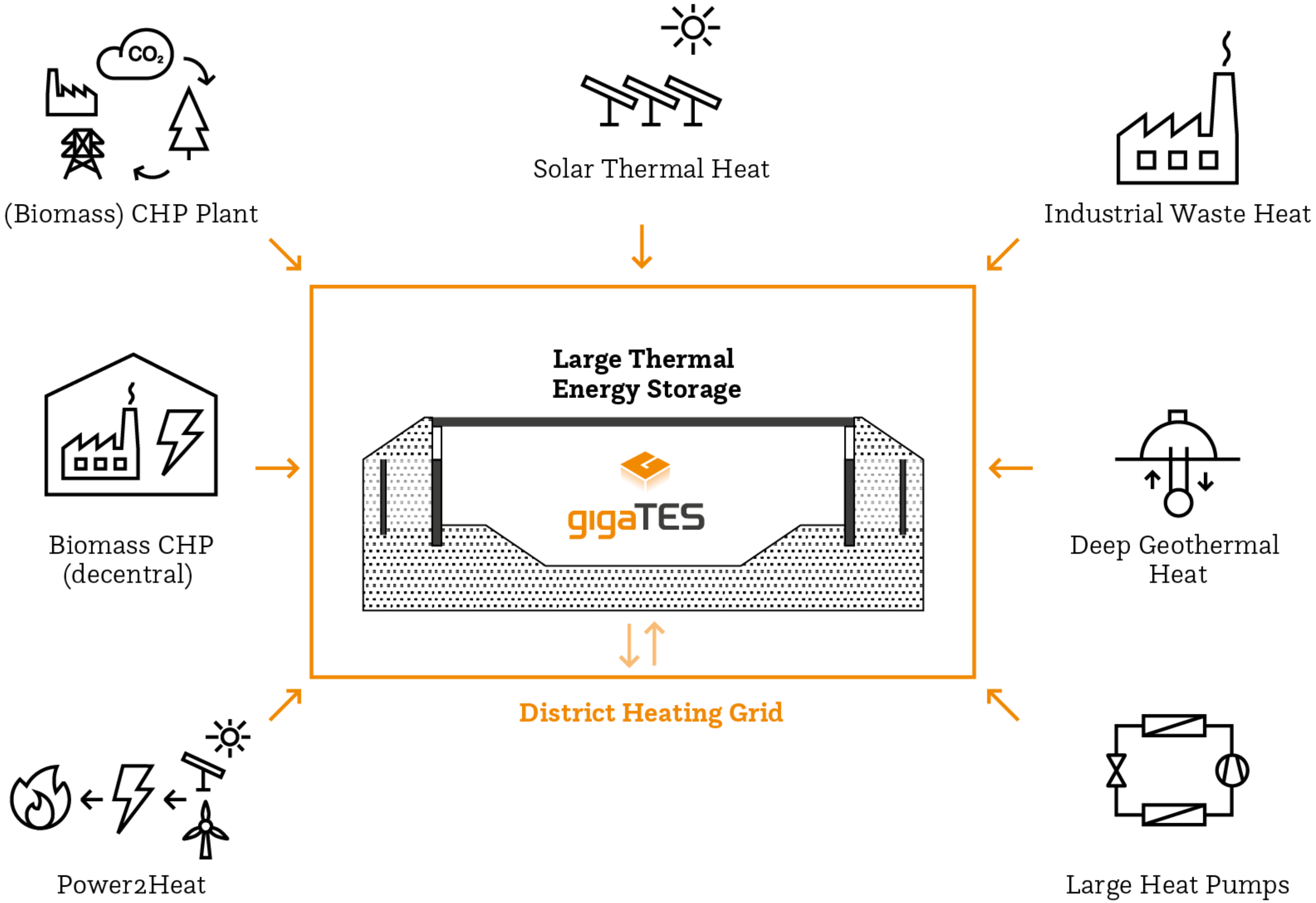
Borehole thermal energy storage (BTES)



Aquifer thermal energy storage (ATES)



The LTES as flexibility enabler



Why Large Thermal Energy Storages for District Heating?

Target for 100% renewable energy generation;

<u>LTES provide:</u>

- 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

<u>Larger storages are needed:</u>

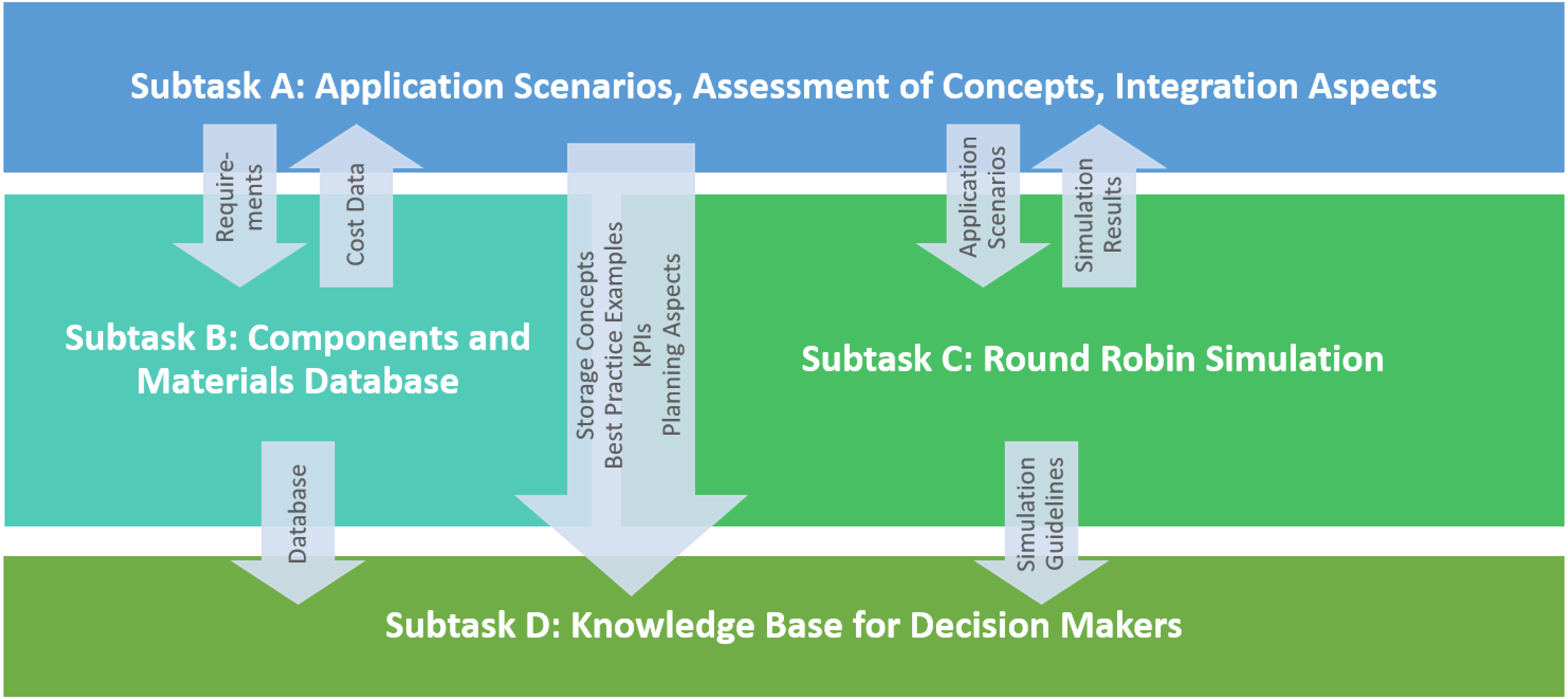
- To serve DH systems and other large applications
- To further reduce specific costs

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

Subtasks and their interdependencies



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

AEE INTEC

energy storage
IEA Technology Collaboration Programme

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

DH-network related	Unit	Storage related	Unit	Economics	Unit
Increase of RES share in DH-Network	MWh/y , %/y	Storage Capacity	MWh	LCOH – See Discussion Below	€/MWh
Comments:		**Comments:** Defines the energy stored in the system and depends on the storage process, the medium and the size of the system (Ioan Sarbu, 2018)		**Comments:** See Discussion Below	
Reduction of DFF (dependency on fossil fuel) of DH-network	MWh/y , %/y	Storage Capacity related to site	MWh/m³	Storage Volume Cost	€/m3
Comments:		**Comments:** 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)* *) water equivalent volume: $V_{WE} = V_{SM} \cdot \frac{\rho_{SM} \cdot c_{p,SM} \cdot \Delta T_{SM}}{\rho_W \cdot c_{p,W} \cdot \Delta T_W}$ SM: storage medium W: water ΔT: usable temperature difference		**Comments:** SVC = COS/SV COS: the cost, considering the storage medium, container, and charging and discharging device SV: Storage volume (Tianrun Yang, 2021)	
Reduction of peak load in DH-network	MW, %	Max. charge performance	MW	Storage Capacity Cost	€/MWh
Comments:		**Comments:** defines how fast the energy stored in the system can be charged (Ioan Sarbu, 2018)		**Comments:** SCC = COS/SC COS: cost, considering storage medium, containe reactor, and charging and discharging device SC: Storage capacity (energy) (Tianrun Yang, 2021)	

Subtask B: Materials and Components

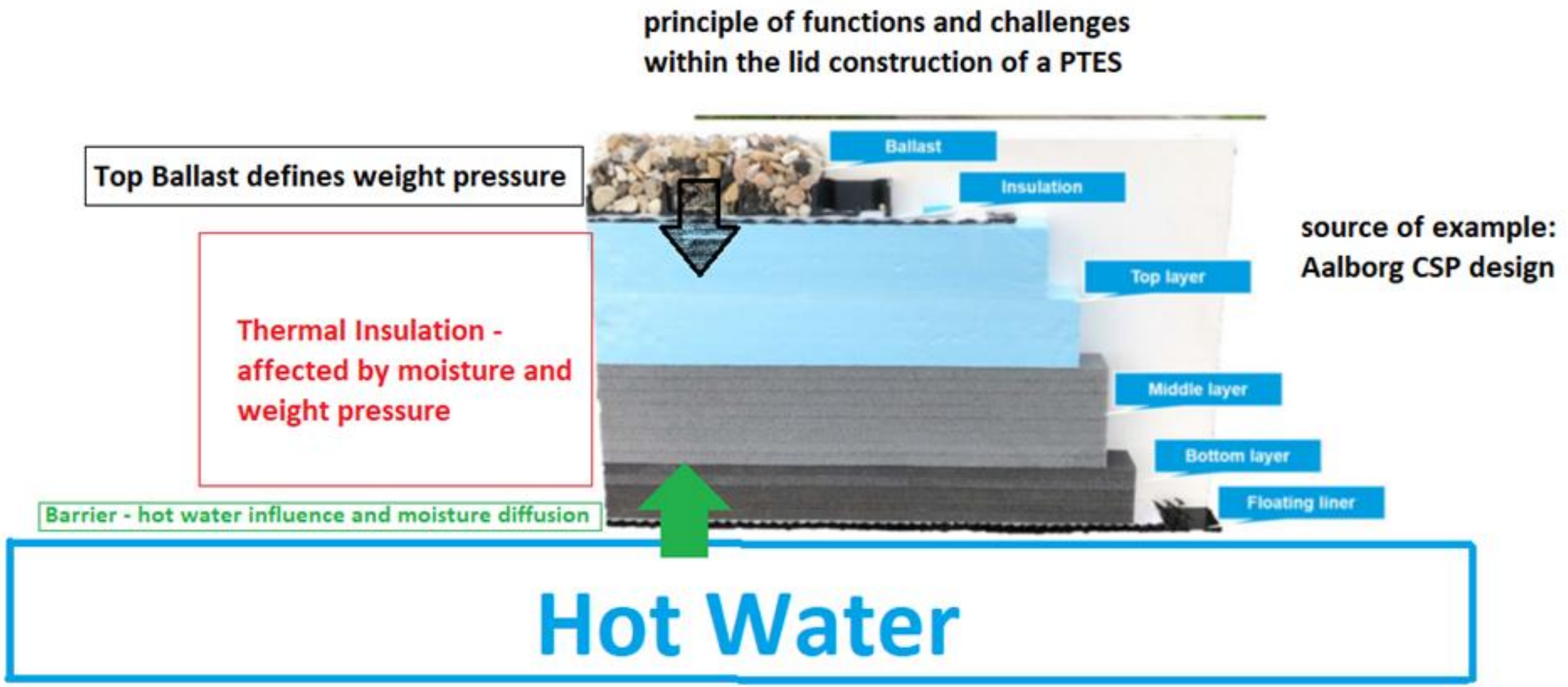
Subtask B manager: Bijan Adl-Zarrabi, Chalmers University, Sweden

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 (now mainly electricity storage)

Subtask B: Material properties

- Functionalities of materials in LTES components described to arrive at relevant material properties



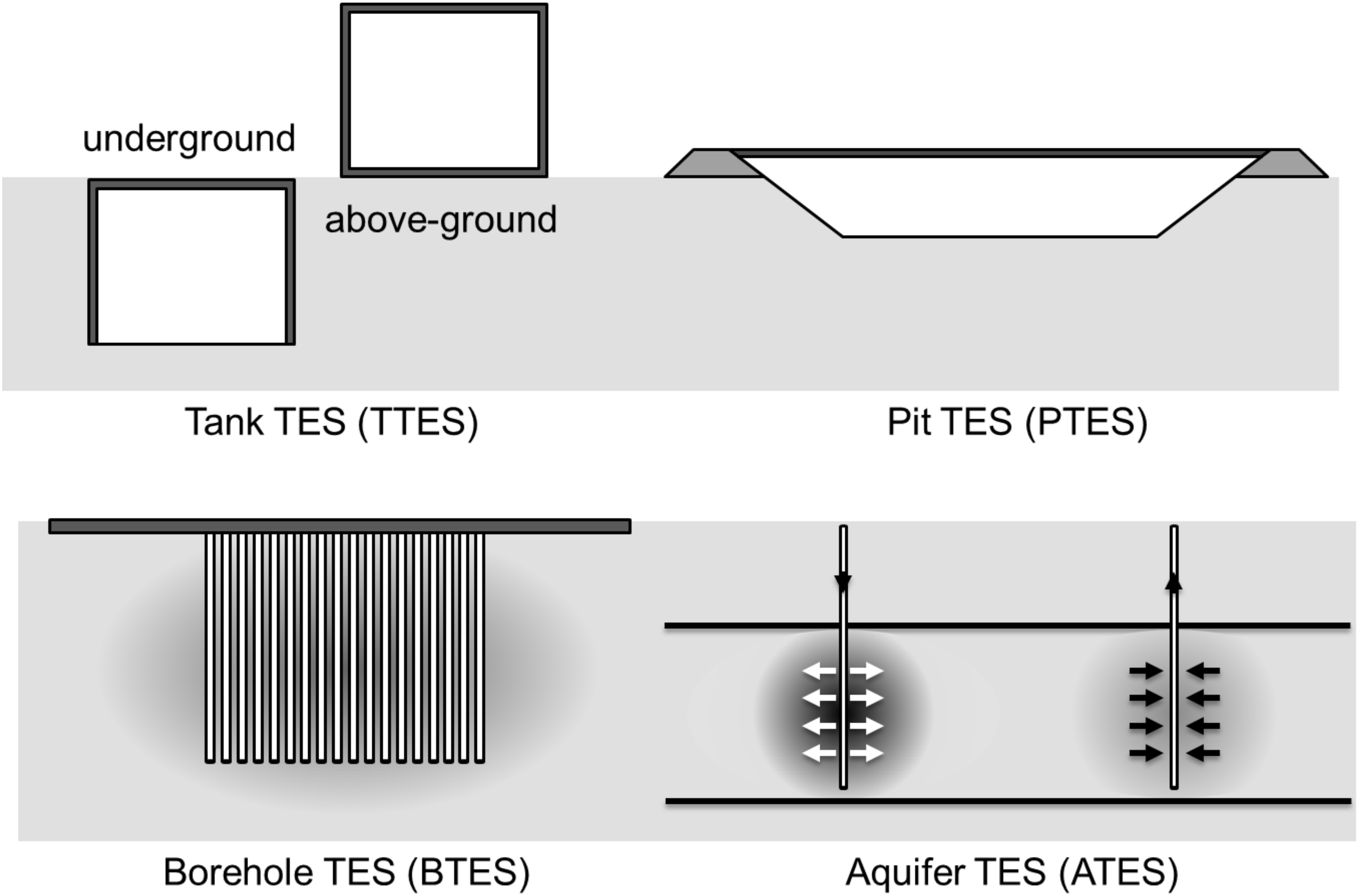
Subtask C: Round Robin Simulation

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; Geometries chosen for round robins



Subtask D: Knowledge Base for Decision Makers

Subtask D manager: Geoffroy Gauthier, PlanEnergi, Denmark

Goal: Generate information packages and disseminate to decision makers

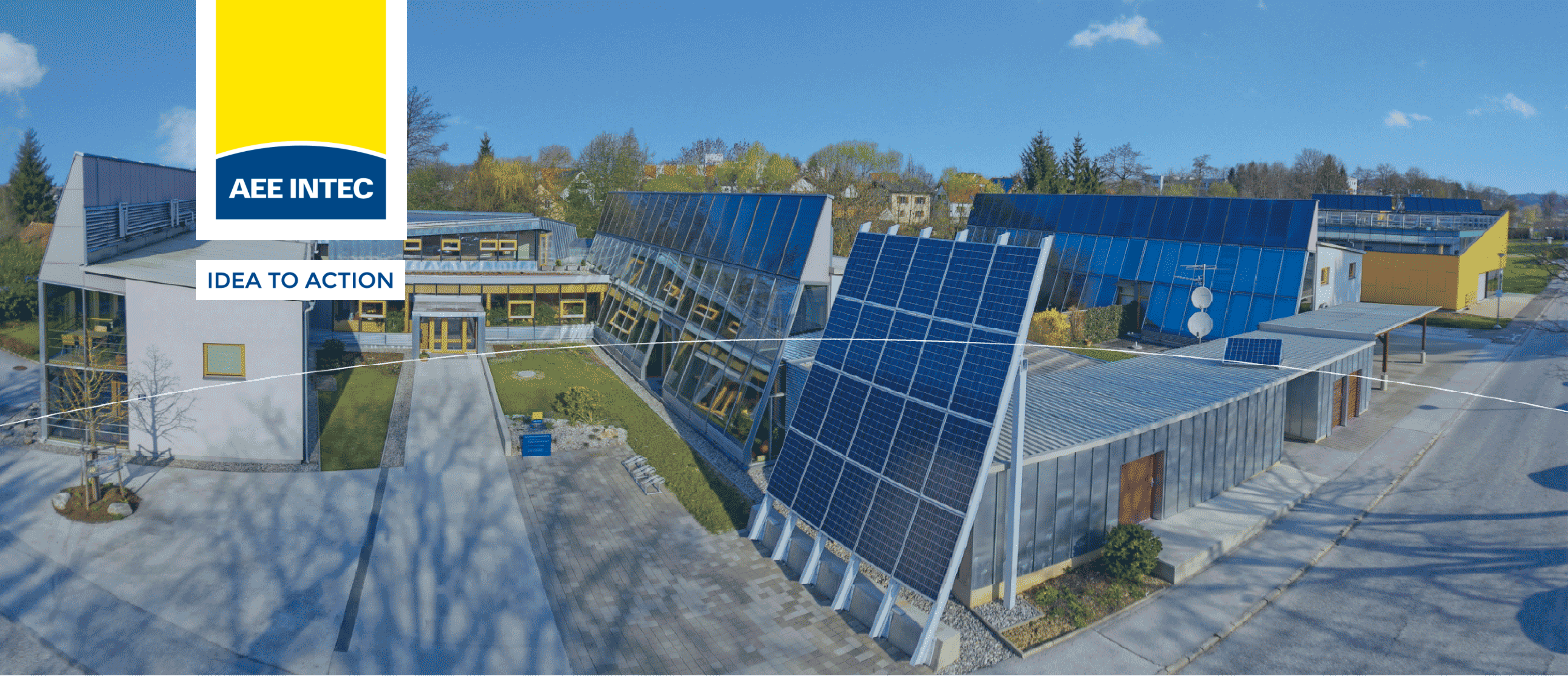
Online questionnaire for decision makers

- 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

Experts Meetings

City	Country	Date	# Participants
Online	-	27 October and 3 November 2020	27
Online	-	10+11 May 2021	33
Online	-	2+3 November, 2021	34
Graz	Austria	8 April 2022	24
Aalborg	Denmark	15 and 16 September 2022	

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



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https://iea-eces.org/annex-39/