

# Heat on wheels concept

Enabling data centre waste heat use without  
direct district heating connection

8 October 2026, 11:00 – 12:30 CET

[www.thunderproject.eu](http://www.thunderproject.eu)



Funded by  
the European Union



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- Submit your questions using the Q&A box
- The recording of the webinar will be uploaded to:
  - [www.thunderproject.eu](http://www.thunderproject.eu)
  - Euroheat & Power's YouTube channel (THUNDER folder)
  - Sent to all the registered participants via email



# Stefano Barberis

Senior Mechanical Engineer  
University of Genova

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*Heat on Wheels concept for data centre  
waste heat recovery*

<https://tpg.unige.eu/>

**Established in 1998 - Staff: 30 people**

**Publications, Awards, Patents, Spin-off**

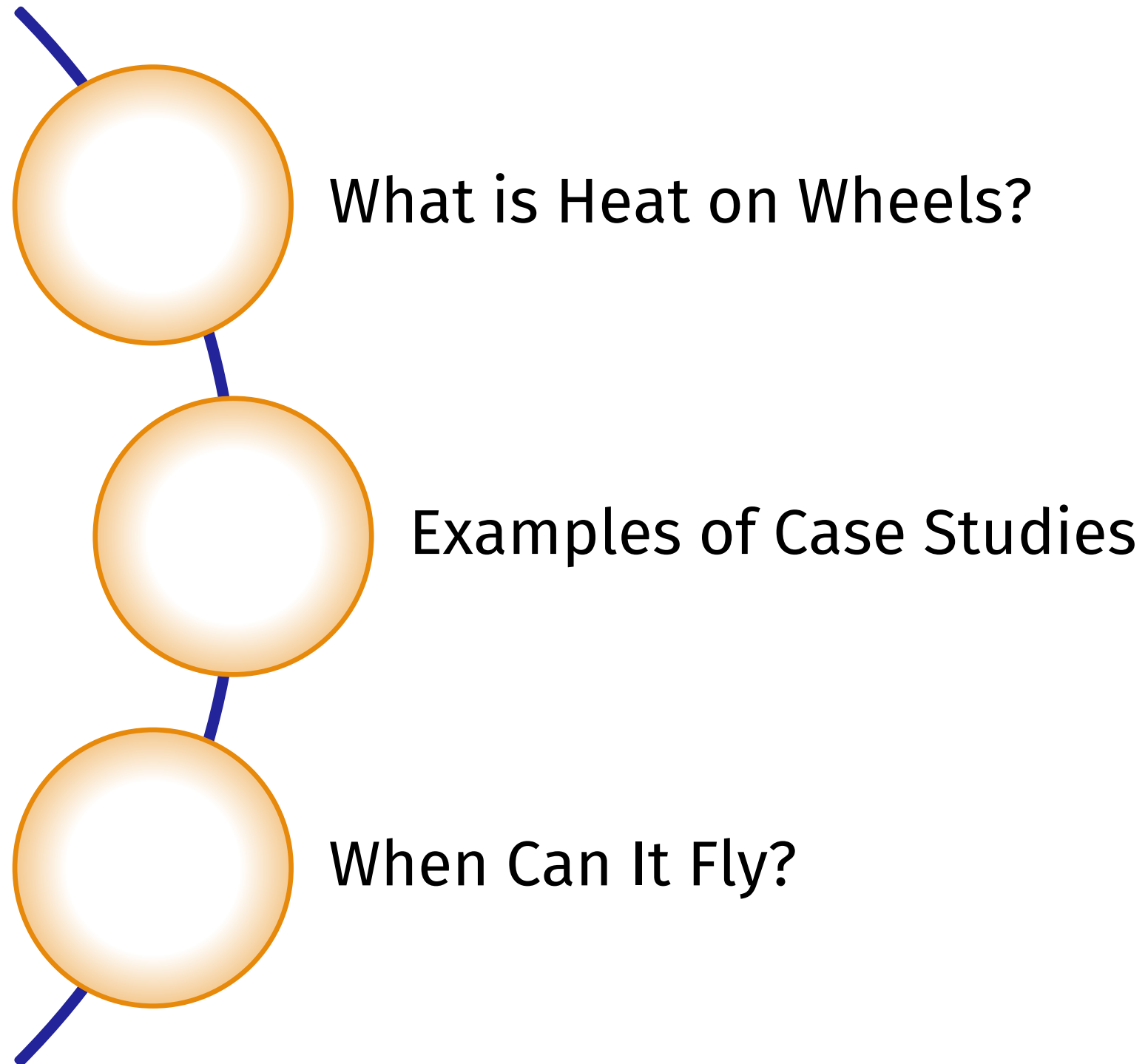
- >350 Papers, >250 Journals (1998-2023)
- 18 International Awards (1998-2023)
- 19 patents (1998-2020)
- 2 spin off companies (BluEnergyRevolution, SIT Technologies)



- Own modelling tools
- Experimental Facilities
- EU projects experience



# Table of contents





THUNDER

## — What is Heat on Wheels?

**Mobile Thermal Energy Storage (M-TES)** transports industrial waste heat in phase-change material (PCM) containers via truck, rail or ship — delivering it to buildings or district heating networks not connected to fixed pipelines.

Around **50% of industrial energy** in industrialised countries is lost as waste heat. At the same time, nearby buildings burn fossil fuels for heating. M-TES bridges this gap where a pipeline would be too expensive or impractical.

### ADVANTAGE

Avoids costly pipeline infrastructure · adds flexibility · serves isolated users

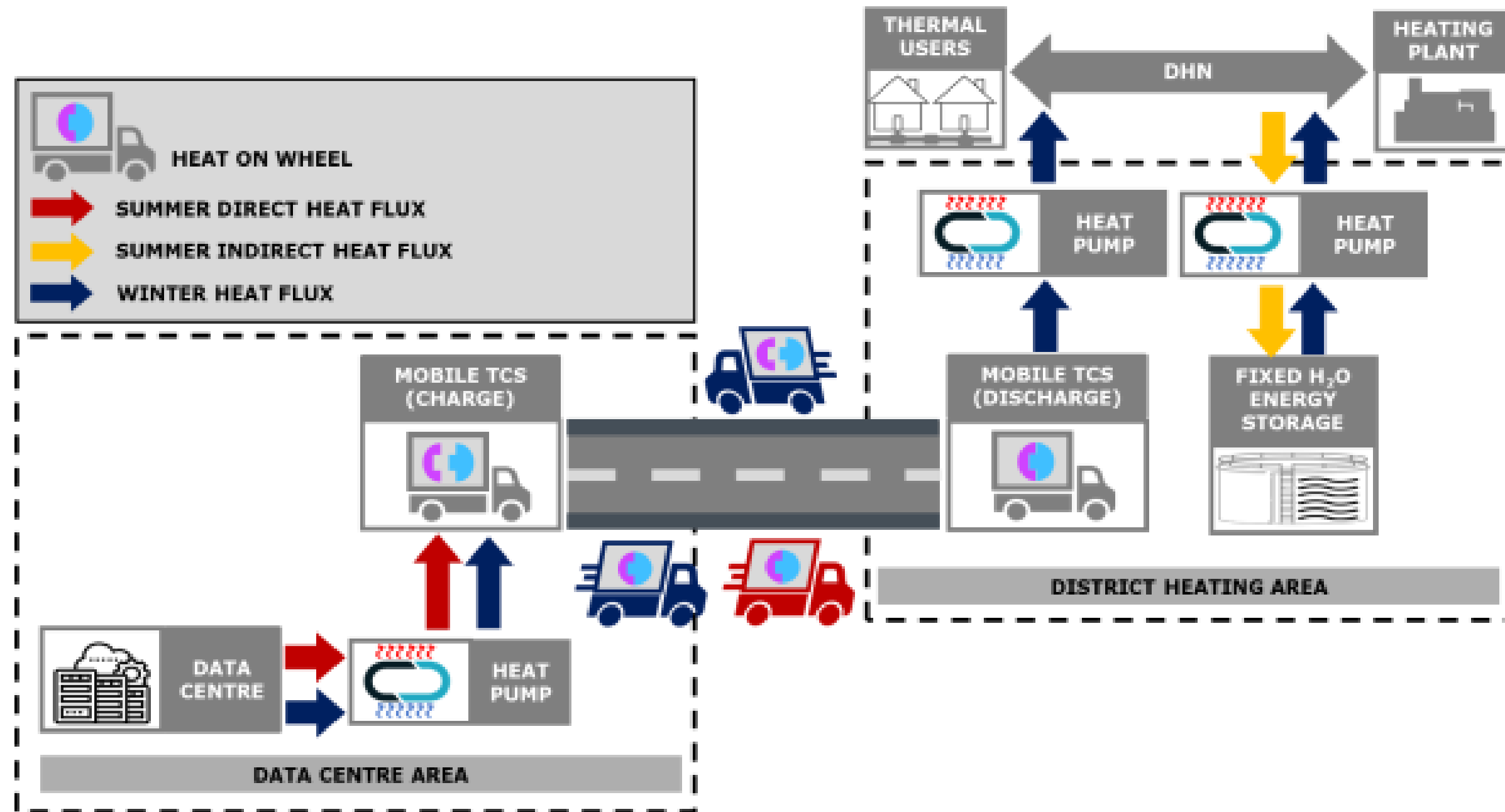
### IDEAL CONTEXT

Source and sink separated by topographic or urban constraints · short–medium distances

### THE CYCLE

- 1 **Charge:** hot fluid from industrial source melts the PCM in an ISO container
- 2 **Transport:** truck carries the charged container to the end user
- 3 **Discharge:** heating water flows through the container, extracts heat as PCM solidifies
- 4 **Return:** empty container goes back for the next charge cycle

## — Why Heat on Wheels in THUNDER?

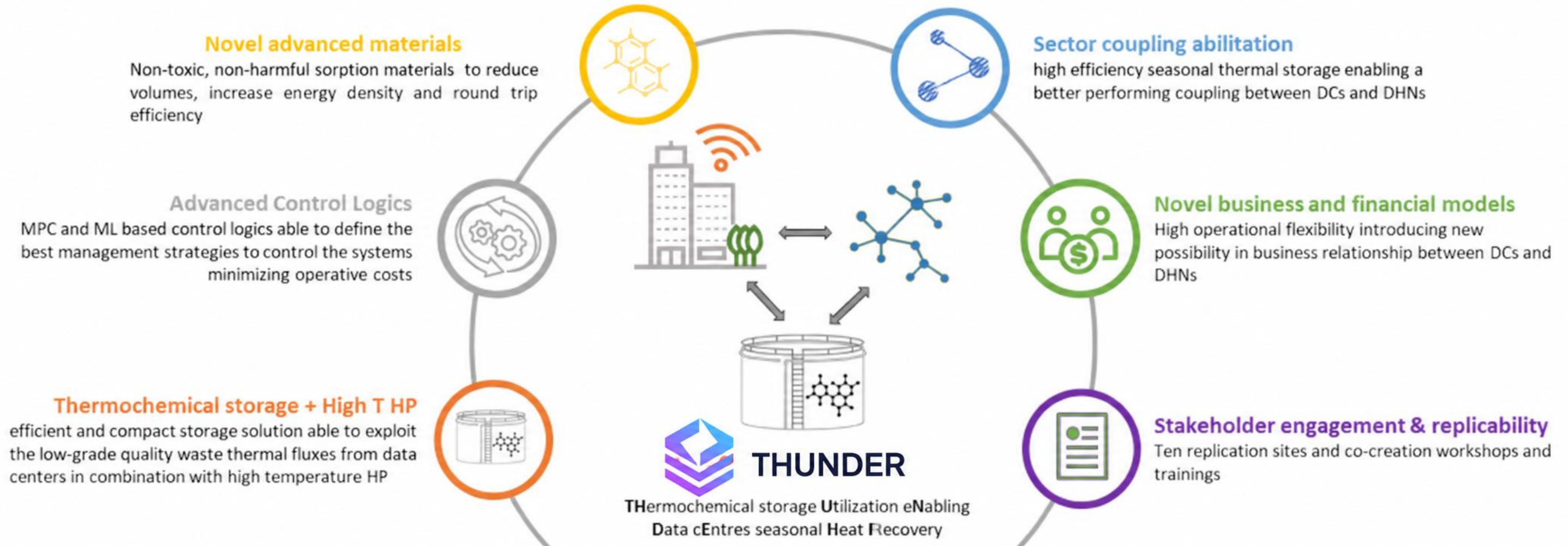


*WHEN YOU DO HAVE AVAILABLE CHEAP AND ABUNDANT WASTE HEAT BUT INTEGRATION CAN POSE CHALLENGES AT BUILDING/LOCAL DHN LEVEL*

# — WHAT IS THUNDER



THUNDER





# — What is Heat on Wheels? Storage materials & key numbers

## Three types of thermal storage

### Sensible (hot water)

~50 kWh/t · cheap & simple · economic only up to ~15 km

### Latent (PCM) ← HoW focus

100–130 kWh/t · 2–3× denser than water · economic up to ~30 km

### Thermochemical (TCM) ← HoW focus

Highest density · minimal transport losses · less mature technology

## KEY OPERATIONAL NUMBERS

|                              |             |
|------------------------------|-------------|
| Container capacity           | 1.5–4 MWhth |
| Standard container           | 20-ft ISO   |
| Average source–sink distance | 7.5 km      |
| Max economic (urban, diesel) | ~20 km      |
| Max economic (EV/RNG truck)  | up to 50 km |
| Transport energy loss        | ~3.5%       |

PCM/TCM capital cost + transport = **over 60%** of total system cost — the single biggest economic challenge.

## — Examples of Case Studies European Pioneers

### ● LaTherm – Dortmund (2009+)

**Source** Waste heat from a municipal swimming pool boiler plant

**PCM** Sodium acetate trihydrate (58.5 °C)

**Distance** ~9 km · 2.5 MWh per container

**Impact** First commercial delivery Nov 2009; launched the HoW commercial concept

*German school case: biomass boiler surplus heat → school district, ~10 km, similar PCM*



### ● TransHeat / Alfred Schneider

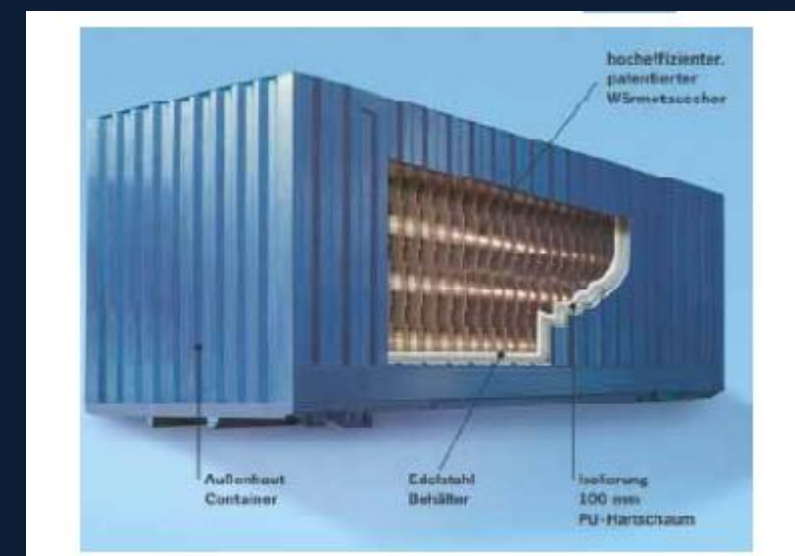
Industrial-grade containers supplied to food industry clients (incl. LSG Sky Chefs). Focused on **barium hydroxide octahydrate (78 °C)** as PCM — higher temperature, suited for industrial process heat.

Container types **6 sizes up to 40-ft**

Temperature range **58–120 °C**

Market focus **Food, hospital, agro sectors**

→ Demonstrated that different PCMs can expand the addressable temperature window



# — Examples of Case Studies Scandinavian Research Pilots

## ● KTH – Sandviken / Högbo (2013–15)

Swedish Energy Agency · "Heat on Wheels" project

**Source** Sandvik steel plant + Stora Enso Fors Bruk paper mill

**Sink** GävleEnergi district heating network

**PCM** Erythritol ( $C_4H_{10}O_4$ , melting 118 °C) — high-energy latent storage

**Distance** 7.6 km (Högbo route)

### LCOH RANGE

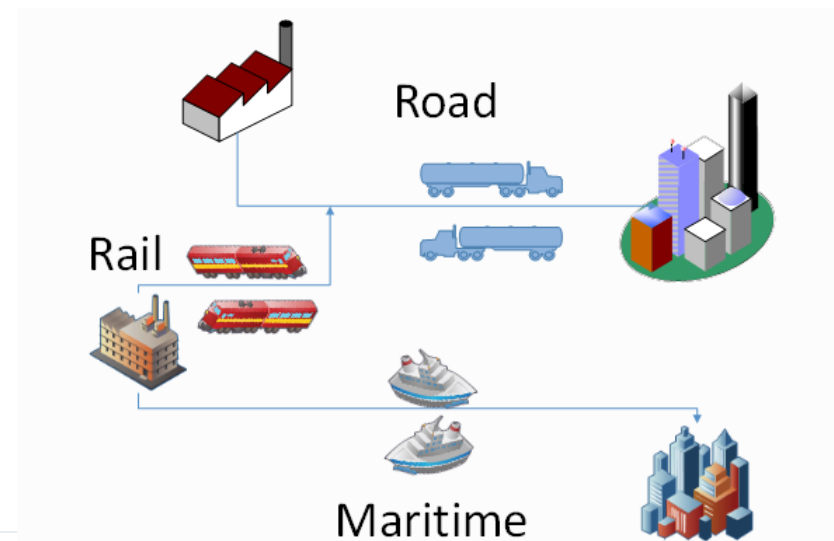
**470**

SEK/MWh (best)

**1 380**

SEK/MWh (worst)

Competitive when heat purchase price  $\geq 300$  SEK/MWh and containers  $> 5$  trips/week



## ● Wang / Mälardalen – Årila (2010)

PhD thesis · Mälardalen University

**Source** CHP district heating plant

**PCM** Polyethylene glycol (PEG) / expanded graphite composite — enhanced thermal conductivity

**Sink** Isolated buildings and small industrial users outside DHN coverage

### Key contributions

→ First systematic M-TES simulation model for distributed heating

→ Showed PEG/EG composite triples effective thermal conductivity vs pure PEG

→ Validated that M-TES is economic up to ~30 km with efficient heat loading

*Sweden alone estimates ~10 TWh/year of recoverable industrial waste heat*

**SCANDINAVIAN CASE STUDIES INTERESTING FOR LOW COST DHN THERMAL ENERGY**

# — Examples of Case Studies Japan, Canada & Italy

## Japan – Three National Demos (NEDO)

- I Sanyo → Aluminum factory • 20 km**  
PCM: erythritol • process heat recovery • first large-scale demo
- II Sewage sludge → Air conditioning • 2.5 km**  
Absorption chiller + M-TES • precursor of **Cold on Wheels**
- III Furnace → Neighboring factory • 3 km**  
Short-range industrial symbiosis • high utilisation rate



## SURREY BC, CANADA (2021)

Shehadeh et al. — integration of M-TES into local district energy network using diesel vs EV/RNG trucks

Distance range **15–45 km**

LCOTE (diesel) **\$42–\$110 CAD/MWh**

EV/RNG advantage **+20 km range & lower CO<sub>2</sub>**

## A2A Life Ventures (Italy)

First Italian integrated open-innovation company (launched 2025) backed by A2A multiutility — manages both district heating networks and industrial heat plants.

→ **Ideal HoW testbed: source + sink + logistics integration under one umbrella**

<https://www.sciencedirect.com/science/article/pii/S0378778822007083>



THUNDER

## — Cold on Wheels The cooling analogue of M-TES

### THE CONCEPT

Instead of transporting heat, transport **coldness**: containers charged with cold PCMs are delivered to cooling demand points — replacing or supplementing chiller installations.

### COLD STORAGE MATERIALS

- **Ice / water slurries** — 0 °C, highest latent heat (333 kJ/kg), lowest cost
- **Eutectic salt solutions** — -20 to -5 °C, food & pharma cold chains
- **Cold PCMs (organic)** — 4–15 °C range, district cooling injection

### Key applications & examples

#### Japan Demo II — Absorption Chiller

Sewage waste heat drives absorption chiller → cold stored in M-TES container → air conditioning delivery at 2.5 km. Proof-of-concept for "cold from waste heat."

#### Pharma & food cold chain

Companies (va-Q-tec, Cryoport) already commercialise insulated PCM containers for pharma logistics. M-TES extends this to bulk district-scale cold delivery.

#### District Cooling Networks

Urban areas with peak summer cooling demand. Mobile cold storage can top up district cooling networks without extending underground pipe infrastructure.

**LIMITED REAL CASES/EXPERIMENTAL SOLUTIONS**

Same success conditions as HoW — short distances, stable demand, low transport cost — plus refrigeration regulations for food-grade and pharmaceutical applications.

<https://www.sciencedirect.com/science/article/pii/S2352152X26009904>



## — When Can It Fly? 7 conditions that make or break the economics

### 1 Short source–sink distance

Economic limit: ~**20 km** (diesel), up to **50 km** with EV/RNG trucks. Beyond this, transport energy & cost outweigh savings. Average deployed: 7.5 km.

### 2 Continuous & predictable demand

Requires high utilisation (>5 trips/container/week). Seasonal or intermittent heating demand means stranded container capital cost.

### 3 PCM capital cost below threshold

PCM + transport = **>60%** of total system cost. Material prices must fall or system scale must increase enough for LCOTE to compete with gas or DH extension.

### 4 Adequate thermal conductivity

Most organic PCMs have low conductivity (0.1–0.3 W/m·K). Without enhancement (graphite, fins, foam), charge/discharge times become uneconomically long.

### 5 Low-carbon transport vehicle

Diesel trucks are viable but add CO<sub>2</sub>. EV and RNG trucks extend the economic range *and* preserve the low-carbon claim — essential in carbon-priced markets.

### 6 No cheaper low-carbon competitor

HoW fails if: a DH pipeline extension is cost-effective, green gas is cheap, or a heat pump can serve the sink locally. The niche disappears when alternatives close.

### 7 Enabling policy & pricing framework

Waste-heat valorisation policies, a fair price for industrial residual heat, and road-use regulations for heavy thermal containers are all needed. Without them, the business case cannot be bankrolled.

#### Bottom line

HoW is not universally applicable. It occupies a **well-defined niche**: short urban distances, stable industrial surplus heat, and no pipeline alternative — a niche that is **growing** as cities densify and decarbonise.

<https://www.mdpi.com/1996-1073/15/22/8713>

<https://www.mdpi.com/1996-1073/19/9/2112>

# Thank you for your attention!

Speaker: Stefano Barberis

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# Mirella Berry

Innovation Manager  
Water Horizon

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*Mobile TES for heat and cooling supply*



01/10/2026

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# Moving Heat 2 Cold

A mobile thermal battery by Water Horizon

Heat on Wheels webinar



THUNDER



## Key figures



# Water Horizon

Deliver low-carbon cooling from  
(distant) waste heat

Thermal battery • Circular economy  
Cooling as a Service • Decarbonization

[water-horizon.com](https://water-horizon.com)



### CREATION

**2017**

Student entrepreneur



### LOCATION

**Toulouse**

South-West of France



### TEAM

**39 people**

Mainly engineers & PhD



### FUNDRAISING ROUNDS

**5 M€**

Mar. 2022

**18 M€**

Nov. 2025



### INNOVATION

**4 projects**

National & EU-funded



### TECHNOLOGY PORTEFOLIO

**2 groups**

Move Heat 2 Cold Low Heat 2 Cold



### DEMONSTRATION

**2 running pilots**

More to come



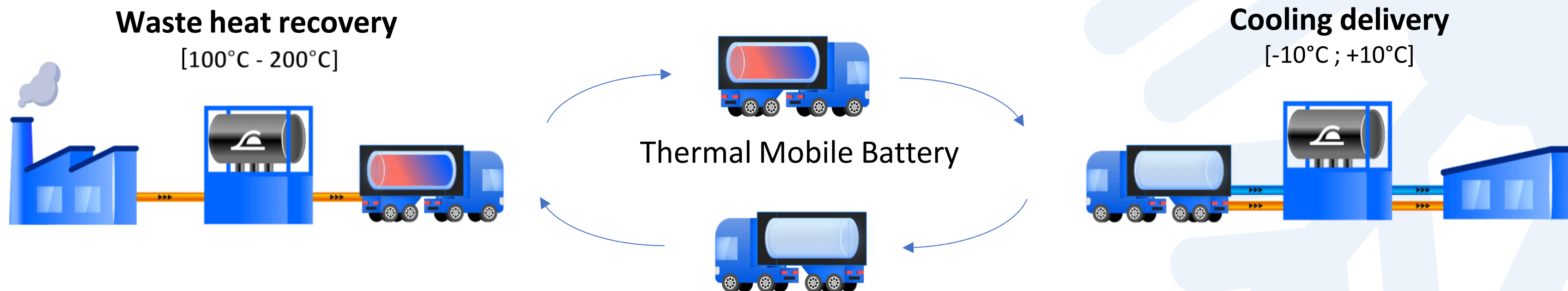
### COMMERCIAL TRACTION

**+200 leads**

In France and abroad



# We turns waste heat into transportable energy



LOW ELECTRICITY

**10x less**

Than conventional technologies



NO UPFRONT INVESTMENT

**0 CAPEX**

With Cooling-as-a-Service



SUSTAINABLE

**Only salt & water**

Operates in closed loop



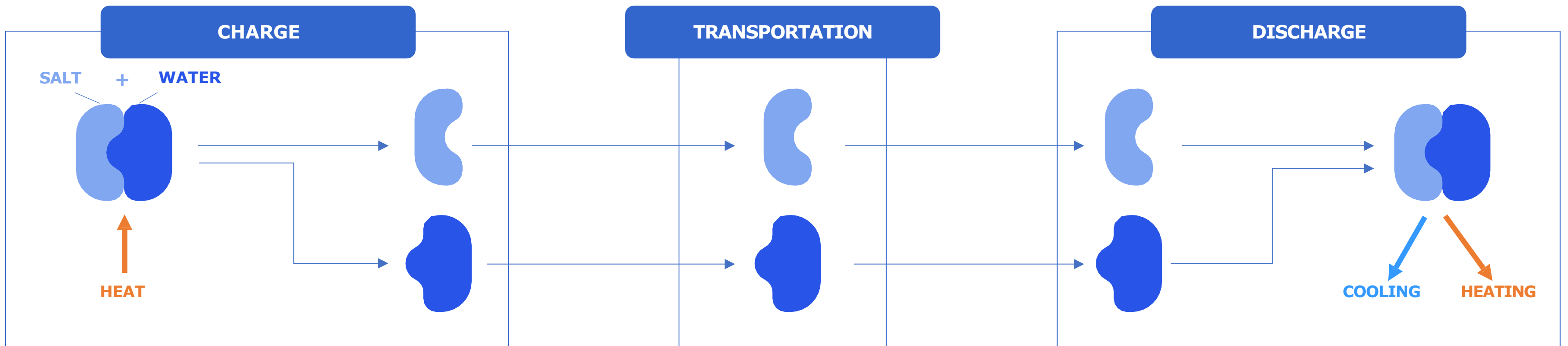
EFFICIENT

**100% reversible**

No loss over time



# Thermochemical reaction based on sorption





# MHC Innovation Fund project



European Commission



**INNOVATION FUND**  
Deploying innovative net-zero technologies for climate neutrality  
**WH: Water Horizon Renewable Energy Solution**

**Project Factsheet**

Water Horizon is a startup based in Toulouse, France, created in 2017. It develops innovative thermal storage technology (thermal battery). Water Horizon's vision is to value the heat lost by industries (waste heat). Water Horizon recovers the waste heat and stores it in its battery. Once the battery is charged, it is transported to distribute the stored energy to a distant consumer as renewable energy (heat and cold).

WH's project aims to perform a commercial demonstration of its Mobile Thermal Battery. WH will recover waste heat from an incinerator (in Toulouse), and will bring this stored energy to a sport complex 20 kilometres away to heat a swimming pool and cool an ice rink. WH thermal battery will substitute a gas boiler and a heat pump to deliver renewable heat and cold.

The objective of this demonstration is to prove the technical and economic viability of WH technology as well as the relevance of the thermal recovery model.

**COORDINATOR**  
WATER HORIZON

**LOCATION**  
France

**CATEGORY**  
Renewable Energy (RES)

**SECTOR**  
Other energy storage

**AMOUNT OF INNOVATION FUND GRANT**  
EUR 2,456,505

**EXPECTED GHG EMISSIONS AVOIDANCE**  
12,806 tonnes CO2 equivalent

**STARTING DATE**  
01 January, 2022

**FINANCIAL CLOSE DATE**  
31 August, 2023

**ENTRY INTO OPERATION DATE**  
30 September, 2025

**CALL NAME**  
InnovFund-SSC-2020

## Overcoming challenges

When the project began in 2022, the technology had only been validated through a 10-kilowatt prototype. Scaling it up a hundredfold within a short timeframe presented both technical and organisational challenges.

Three years later and with a €2.5 million grant from the Innovation Fund, the project has reached entry into operation and has been using two batteries since September 2025. This milestone marks the first full-scale deployment of the technology and a key step towards market uptake, helping build trust with current and future clients.

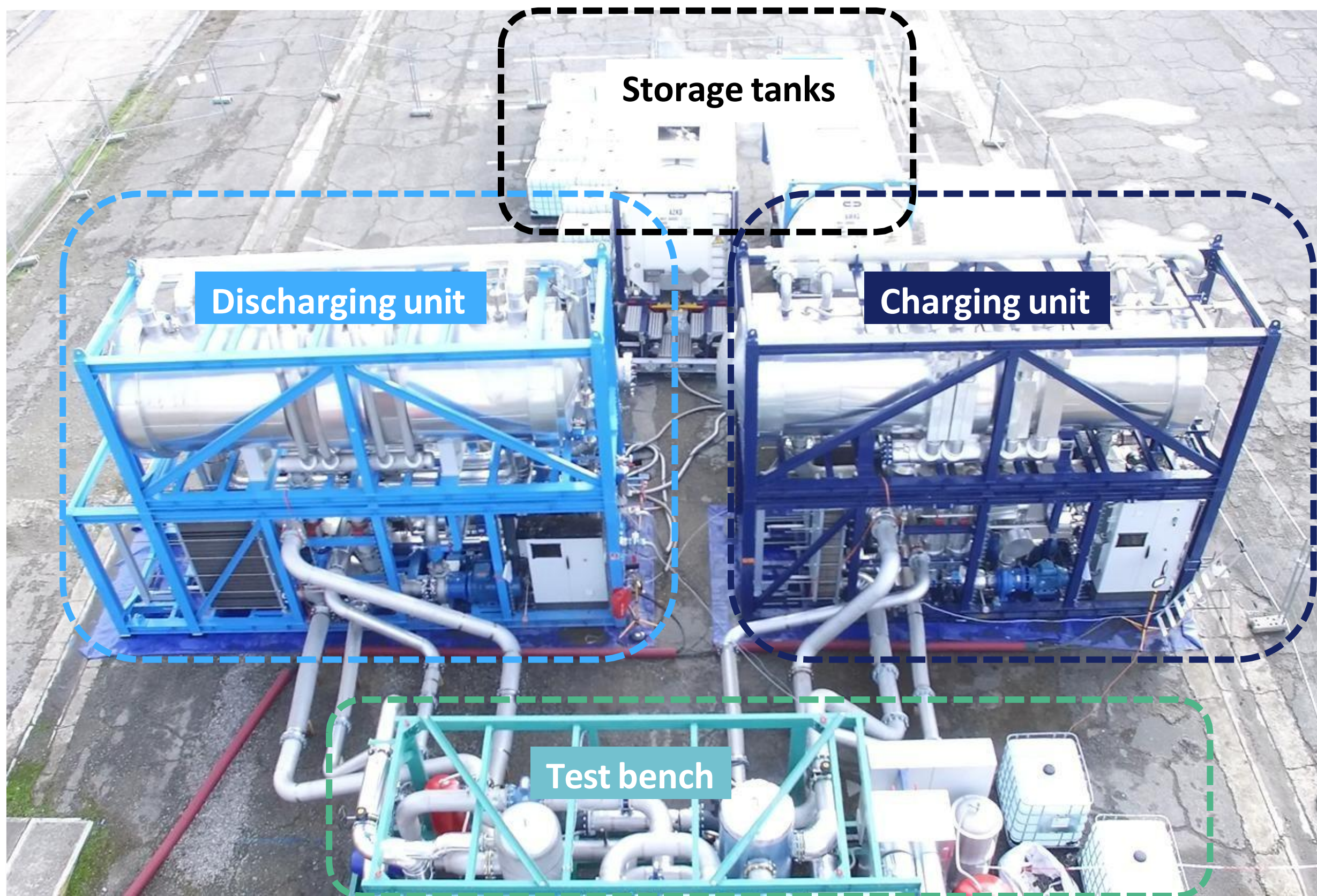
*Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.*



**Funded by the European Union**  
Emissions Trading System  
Innovation Fund



# Complete system





## Charging unit (incinerator)





# Mobile battery



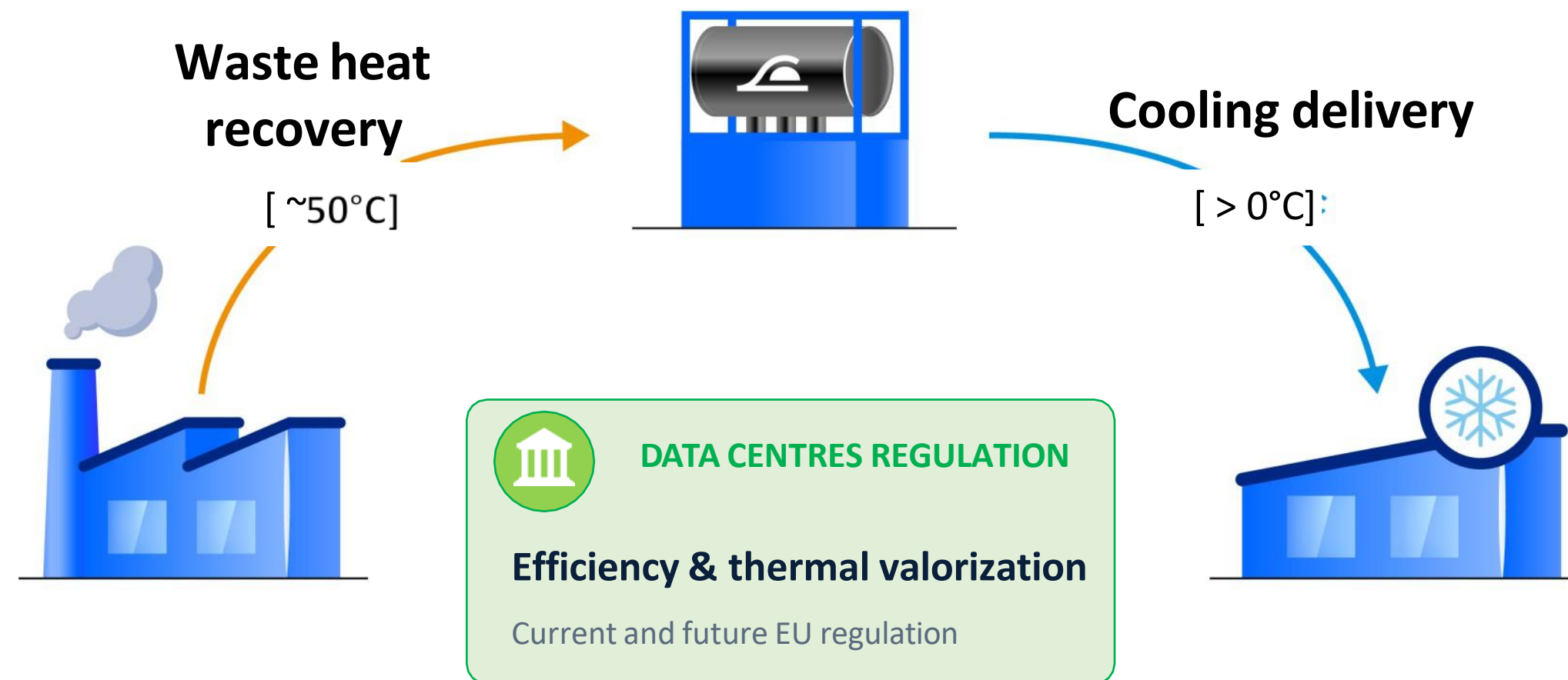


## Discharging unit (sport complex)





## We also turns waste heat low temp. into cooling



LOW ELECTRICITY

**10x less**

Than conventional technologies



NO UPFRONT INVESTMENT

**0 CAPEX**

With Cooling-as-a-Service



SUSTAINABLE

**Only salt & water**

Operates in closed loop



EFFICIENT

**100% reversible**

No loss over time



# Operating unit



Ce projet a été financé par l'État dans le cadre de France 2030 opéré par l'ADEME, et financé par l'Union européenne – NextGenerationEU.



Thank you



# Lucía Gallego Florencio

Energy Innovation Engineer  
Veolia Spain

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*Integration Assessment , Investment Relevance  
& Replication Potential Across Europe*

# Integration scenarios

## **A - Direct connection**

Data center and network are close. Heat flows from storage into the network by pipeline

## **B2 - Single Heat on Wheels, TCS hosted by DHN**

Trucks haul heat daily during summer to TCM storage at DHN. This is the Varna demonstrator.

## **B1 - Single Heat on Wheels, TCS hosted by DC**

Heat stored on site in summer PCM containers carry it to the network in winter.

## **C - Dual Heat on Wheels**

Storage sits away from both sides: one fleet charges it, another delivers to the network.

### **Why only PCM moves?**

The seasonal TCM storage needs charging temperatures up to 100 °C and vacuum or pressurised piping, which conflict with urban transport safety rules.

# Methodology for replicability analysis

## Definition of key parameters and site characteristics

| STEP 1: Define specific contexts based on a small number of key parameters. |                   |                            |                               |                                     |                           |
|-----------------------------------------------------------------------------|-------------------|----------------------------|-------------------------------|-------------------------------------|---------------------------|
|                                                                             | DC Size           | Temperature Thermal Demand | Distance between DC-heat sink | Mapped represented sites            | Preliminary Scenario      |
| Context 1                                                                   | (Small / Medium / | (Low / Medium /            | (Short / Medium /             | (List of grouped mapped facilities) | (Scenario A / Scenario B) |

- Data Centre Size (Available Thermal Capacity):** Determines the total volume of waste heat available for recovery.
  - Values:* Small (< 1 MW), Medium (1-10 MW), Large (> 10 MW).
- Temperature of Thermal Demand:** Represents the operating temperature of the existing District Heating Network (DHN) or the specific identified heat sink
  - Values:* Low (< 60 °C), Medium (60-80 °C), High (> 80 °C).
- Distance between DC and Heat Sink:** The primary spatial constraint that determines the logistical and economic feasibility of the integration pathway.
  - Values:* Short (0-2 km), Medium (>2-5 km), Long (> 5 km).

| STEP 2: Context cases characterised by the site characteristics framework. |                              |                                                |
|----------------------------------------------------------------------------|------------------------------|------------------------------------------------|
| Category                                                                   | Parameter                    | Value possibilities                            |
| <b>A. Waste heat characteristics</b>                                       | DC size                      | Small / Medium / Large                         |
|                                                                            | Waste heat continuity        | Continuous / Intermittent                      |
|                                                                            | Waste heat temperature level | Low-grade / Medium-grade                       |
| <b>B. Heat Demand Characteristics</b>                                      | Heat Demand Capacity         | Low / Medium / High                            |
|                                                                            | Heat Demand Temperature      | Low / Medium / High                            |
|                                                                            | Seasonal Demand Profile      | Strongly seasonal / Moderately seasonal / Flat |
| <b>C. Spatial and locational context</b>                                   | Spatial context              | Urban / Periurban                              |
|                                                                            | Distance DC–DH network       | Short / Medium / Long                          |
|                                                                            | Climate                      | Nordic / Continental / Mediterranean           |
| <b>D. Stakeholder &amp; organisational context</b>                         | Market maturity              | Mature / Emerging                              |
|                                                                            | Regulatory framework         | Mandatory WHR / Supportive / Lacking framework |

# Definition of methodology for replicability analysis

## Definition of replicability readiness dimensions

**Dimension 1: Technical Compatibility:** Assesses the fundamental thermodynamic and volumetric fit between the thermal "source" (DC) and the "sink".

**Dimension 2: Seasonal Storage Criticality:** This dimension is vital for validating the core THUNDER Thermochemical Material (TCM) technology.

**Dimension 3: Spatial, Logistical & Infrastructure Feasibility:** Evaluates the physical and operational viability of the integration pathway.

**Dimension 4: Market, Stakeholder & Regulatory Context:** Evaluates the external enabling environment, which is crucial for the business model's success.

| STEP 3: Based on the characterization, the Replicability Readiness Scoring is applied |                                       |                             |
|---------------------------------------------------------------------------------------|---------------------------------------|-----------------------------|
| Replicability dimension                                                               |                                       | Linked site Characteristics |
| Technical Compatibility                                                               | Temperature matching                  | A3, B2                      |
|                                                                                       | Capacity balance                      | A1, B1                      |
|                                                                                       | Continuity matching                   | A2, B3                      |
|                                                                                       | Subtotal                              |                             |
| Seasonal Storage Criticality                                                          | Temporal mismatch severity            | B1, B3, C1, D1              |
|                                                                                       | Temperature compatibility for storage | A3, B2                      |
|                                                                                       | Subtotal                              |                             |
| Spatial, Logistical & Infrastructure Feasibility                                      | Complexity feasibility                | A1, C1, C2                  |
|                                                                                       | Subtotal                              |                             |
| Market, Stakeholder & Regulatory Context                                              | Market maturity                       | D1                          |
|                                                                                       | Regulatory framework                  | D2                          |
|                                                                                       | Incentives availability               | D1, D2                      |
|                                                                                       | Subtotal                              |                             |

# Definition of methodology for replicability analysis

## Pathway configuration assessment

$$N_{trips} = E_{\{WH,day\}} / C_{pcm}$$

### Logistical Constraints Formulation (The "Truck-Trip" Limit):

For contexts lacking direct pipeline connections, the HoW logistical viability is dictated by:

#### A. Transport thermal capacity of the PCM containers.

- **0.045 MWh** (Current Pilot Scale)
- **0.904 MWh** (Future Commercial 20-ft)

#### B. Daily Recoverable Heat and Operational Window.

$$E_{\{WH,day\}} = P_{DC} * t_{recovery}$$

#### C. Thermal Charging Time

$$t_{charge} = C_{pcm} / P_{HP}$$

| DC Size Category       | $E_{\{WH,day\}}$ | Daily Trips ( $C_{pcm} = 0.045$ MWh)                                                     | Daily Trips (Future scale: 20-ft ; $C_{pcm} = 0.904$ MWh)                                |
|------------------------|------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Varna Pilot (16,55 KW) | ~ 0.1 MWh/day    | $N_{trips} \sim 2$ trips/day                                                             | $N_{trips} \sim 0.1$ trips/day<br><b>Unfeasible. Oversized.</b>                          |
| Small (< 1 MW)         | ~ 1 - 6 MWh/day  | For 100 KW<br>$N_{trips} \sim 12$ trips/day<br>For 1MW<br>$N_{trips} \sim 133$ trips/day | $N_{trips} < 7$ trips/day                                                                |
| Medium (1 - 10 MW)     | ~ 6 - 60 MWh/day | $N_{trips} > 133$ trips/day                                                              | For 1.8 MW<br>$N_{trips} \sim 12$ trips/day<br>For 10MW<br>$N_{trips} \sim 67$ trips/day |
| Large (> 10 MW)        | >60 MWh/day      | $N_{trips} > 1333$ trips/day                                                             | $N_{trips} > 67$ trips/day                                                               |

**Note:** Calculations based on 1 bay. If more bays are available, divide by the total number of bays.

# Definition of methodology for replicability analysis

## Pathway configuration assessment

### Investment Relevance: Direct Connection vs. HoW

**A. Direct Connection:** The maximum economically feasible **distance for laying a direct pipeline** ( $L_{\max}$ ) before the investment becomes unprofitable.

$$L_{\max} = E_{\{WH,year\}} * p_{\text{heat}} * PB / c_{\text{pipe}}$$

**B. Heat-on-Wheels:** The revenue generated by a single truck trip (Rev trip) must cover the transport OPEX. The maximum viable **transport distance** ( $L_{\max, HoW}$ ) is calculated as:

$$L_{\max, HoW} = (Rev \text{ trip} - c_{\text{fixed}}) / (2 * c_{\text{dist}})$$

| DC Size Category   | Scenario A: Direct Connection               | Scenario B: Single HoW                                                                                    |
|--------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Small (< 1 MW)     | For 1 MW<br>$L_{\max} = 25.4 \text{ km}$    | Valid if urban trenching is forbidden, with the commercial scale-up.                                      |
| Medium (1 - 10 MW) | For 10 MW<br>$L_{\max} = 254.04 \text{ km}$ | Valid if urban trenching is forbidden, with the commercial scale-up. Above 1.8 MW more than 1 bay needed. |
| Large (> 10 MW)    | For 20 MW<br>$L_{\max} = 508.08 \text{ km}$ | Logistically unfeasible due to extreme transport volume.                                                  |

Note: Assumed Baselines :  $p_{\text{heat}} = 58 \text{ €/MWh}$  ;  $PB = 10 \text{ years}$  ;  $c_{\text{pipe}} = 200 \text{ k €/km}$  ;  $c_{\text{dist}} = 0.03 \text{ €/km}$  ;  $c_{\text{fixed}} = 40 \text{ €} / N_{\text{trips}}$

# Potential Replication

## Bulgaria

**12**

Sites · 5 contexts  
Sofia, Montana, Ruse  
**0.13–9 MW**

## Southern

**15**

Sites · 7 contexts  
8 countries, Italy to  
Albania & Spain  
**1–70 MW**

## East-Central

**4**

Sites · 3 contexts  
Poland, Hungary,  
Moldova, Romania  
**0.18–3 MW**

## Northern

**4**

Sites · 3 contexts  
Sweden, Denmark  
**0.19–37 MW**

## West-Central

**5**

Sites · 3 contexts  
France, Belgium,  
Luxembourg,  
Germany  
**1.6–12 MW**

## Distances to the Heat Network

Distances range from **0 km to 15 km**, and so do the answers: some sites are ready for a short pipeline, while others face dense-city gaps of **5 to 8 km**.

## Key Drivers

**EU energy efficiency rules** and national decarbonisation targets push utilities to seek decarbonised heat, shifting replication barriers away from policy and towards physical infrastructure.

# Replication Sites

**10**

## Feasibility Studies across Europe

**Characterise**

Size, temperature, distance.

**Acid test**

Pipeline or Heat on Wheels.

**Investment case**

Costs, payback, ownership.

**Score readiness**

Technical, logistics, market.



# Thank you for your attention!

*Lucia Gallego Florencio*



Funded by the  
European Union



[www.thunder.eu](http://www.thunder.eu)



#THUNDER



# Burcu Ünlütürk

Project Manager, International Business  
IVL Swedish Environmental Research  
Institute

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*Business and Ownership models:  
Where does Heat on Wheels stand?*

# Agenda

**1**

## Why business models matter

- Key messages
- Two sectors, new dependencies
- The EU policy context
- How we built the business model

**2**

## Ownership

- Who controls the cooling?
- The value chain and the open ownership question

**3**

## Heat on Wheels in practice

- What it adds to the business model
- Contract elements to clarify

**4**

## Wrap-up

- Open questions
- Takeaways

## Key messages

### 01

#### **Business model and technical design were developed together**

Ownership discussions informed technical and logistics choices, alongside site and cost constraints.

### 02

#### **The data centre keeps control of its cooling**

The ownership boundary is placed at the heat exchanger.

### 03

#### **Ownership options are still being compared**

For both Heat on Wheels and a direct connection. The value of the heat is a key open question.

# Two sectors that never had to rely on each other



## Data centres

- Uptime and cooling reliability come first
- Heat is a byproduct, rarely priced
- Core business is IT services, not heat supply

**THUNDER**  
(Heat on Wheels +  
Seasonal Storage)



## District heating

- Demand peaks in winter, drops in summer
- Assets have long lifetime, regulated tariffs
- Needs heat at network temperature

# What the business model depends on

EU-level framework conditions that apply across European markets



## Energy Efficiency Directive

EED III: data centres above 1 MW must recover waste heat unless a cost-benefit analysis shows it is not feasible.



## Renewable Energy Directive

RED III: indicative target for heating and cooling networks to raise their share of renewables and waste heat.



## From directives to national rules

Member States transpose both directives into national law, so practical rules differ by country.



## EU co-funding

Instruments such as the Innovation Fund and LIFE can co-finance the investment.

**EU policy sets the direction; the business case is built on national implementation**

# How we built the business model



## Stakeholder interviews

Data centre, DH company,  
heat pump and storage  
manufacturer, system  
designer



## Ownership workshop

Who could own and operate  
which component?



## Business Model Canvas

Who creates value, for whom,  
and how costs and revenues  
are shared



## Contract design

ReUseHeat checklist

**M18 · June 2025**

First business model and  
contract design

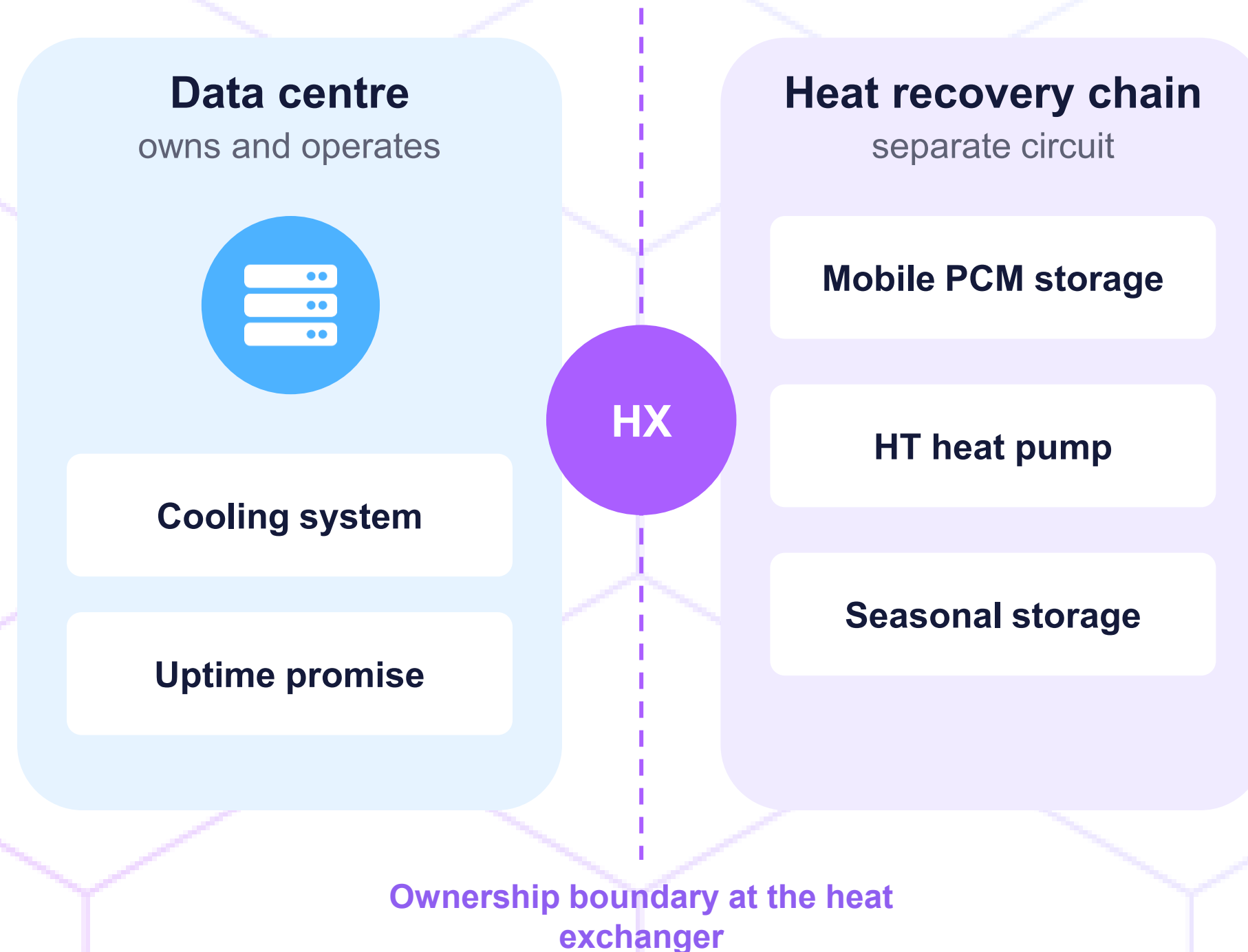
**M36 · Dec 2026**

Update on the business model  
and contract design

**M48 · Dec 2027**

Final business and contract  
models to support replication

# Lesson learned: who controls the cooling?



## What we assessed

‘Cooling as a service’: the heat off-taker runs the data centre’s cooling. Of interest to the DH operator.

## Why it did not fit

For a data centre, cooling is critical to ensuring uptime. Handing over control was not acceptable.

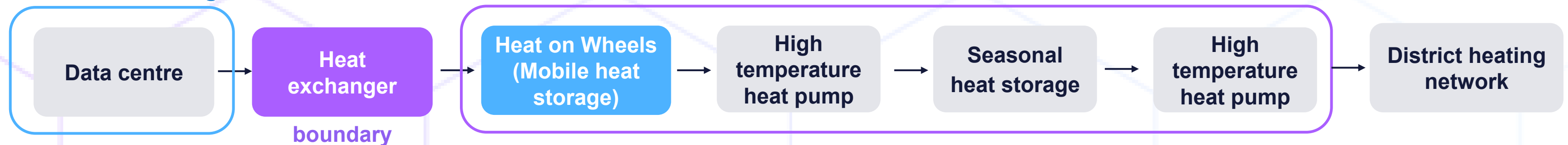
## What we agreed

Cooling stays with the data centre. When useful, heat passes through a heat exchanger to charge the storage; otherwise cooling runs as today.

# The value chain and the open ownership question

Data centre: keeps control of cooling

Recovery and storage chain: ownership under assessment



## Option I

### DH company owns the chain

- Recovered heat is integrated into its own system
- Carries investment and operation of the chain



## Option II

### A third party owns the chain

- For example an ESCO: buys heat from the data centre and sells it to the DH company or others
- Scalable and replicable; needs contracts on both sides

**Both options are being investigated, for Heat on Wheels and for a direct connection**

# Moving heat and shifting it in time



## Heat on Wheels bridges distance

From the data centre to the DH site, without a pipeline



## Seasonal storage bridges seasons

From summer, when heat is available, to winter, when it is needed

## What this means for the business model

1

### Value depends on timing

Without storage, the network can use only a small part of the heat recovered in summer.

2

### Two assets at two locations

Mobile units move between sites; the seasonal storage is fixed at the DH site. Each needs an owner and an operator.

3

### Contracts cover the whole chain

Metering, responsibilities and payment from charging at the data centre to winter discharge into the network.

# What Heat on Wheels adds to the business model



## A new partner

A logistics and transport provider becomes part of the value chain.



## New activities

Charging, transport, handover and discharging of PCM units, scheduled around both sites.



## New resources and costs

Mobile PCM units and electric vehicles, and transport costs, instead of a fixed pipeline.



## New questions

Who owns the mobile units? Could other customers be served?

**The ownership options apply with or without Heat on Wheels; what changes is the delivery chain and its contracts**

# Contract elements to clarify for Heat on Wheels



## Ownership boundary

At the heat exchanger. Asset ownership, location and access rights at both sites.



## Heat specification

Temperature and energy per PCM charge, metered at charging and discharging.



## Price formula

Is heat priced or free, and for how long?



## Logistics and handover

Who carries the risk in transit; schedules, site access, liability.



## Maintenance and failure

Separate O&M terms per asset; back-up when units are out of service.



## Change and exit

Volume drops, relocation or new owner. Mobile units can partly reduce relocation risk.

Selected from the ReUseHeat checklist of 15 contract elements for urban waste heat recovery (Lygnerud, 2022)

# Open questions we are working on



## What is the heat worth?

Today closer to a byproduct than a traded commodity. The answer affects every price formula.



## Who carries the investment?

Heat pumps, seasonal storage and mobile units are capital-intensive; co-funding is still part of the case.



## Which customers beyond DH?

Buildings off the network, industry and low-temperature users.



## Heat on Wheels or a pipe?

For the decided ownership structure, we look at both delivery options.

**Next:** Updated business and contract models at M36; final versions to support replication at M48

# Takeaways for practitioners

**1**

## **Start the ownership conversation early**

It affects the technical design as well as the contract.

**2**

## **Respect each party's core operations**

For data centres cooling is crucial. A clear boundary at the heat exchanger helps.

**3**

## **Make the price of heat explicit**

Including whether it is free, and for how long.

**4**

## **Include logistics in the contract**

Heat on Wheels adds transport, handover and metering per charge.

## A question for you



**In your context, who would you expect to own the mobile storage units?**

**A**

**The data centre operator**

**B**

**The district heating company**

**C**

**A third party, e.g. an ESCO**

**Answer A, B or C in the chat, or tell us why later**

Thank you for your attention!

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