

# Underground Thermal Energy Storage

## Lessons learnt from the IEA Geothermal co-sponsored events

- Aquifer Thermal Energy Storage Workshop, Netherlands 2023;
- Underground Thermal Energy Storage Symposiums, Germany 2024;
- Mine Water Geothermal Energy Symposium, Scotland 2024.

<https://iea-gia.org/workshop-presentations/>

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IEA Geothermal



To achieve the Energy Transition, globally we need to decarbonize the Heating & Cooling Sector

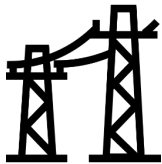
EU countries are active in Underground Thermal Energy Storage

**50%**

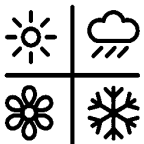
Total Energy demand in EU



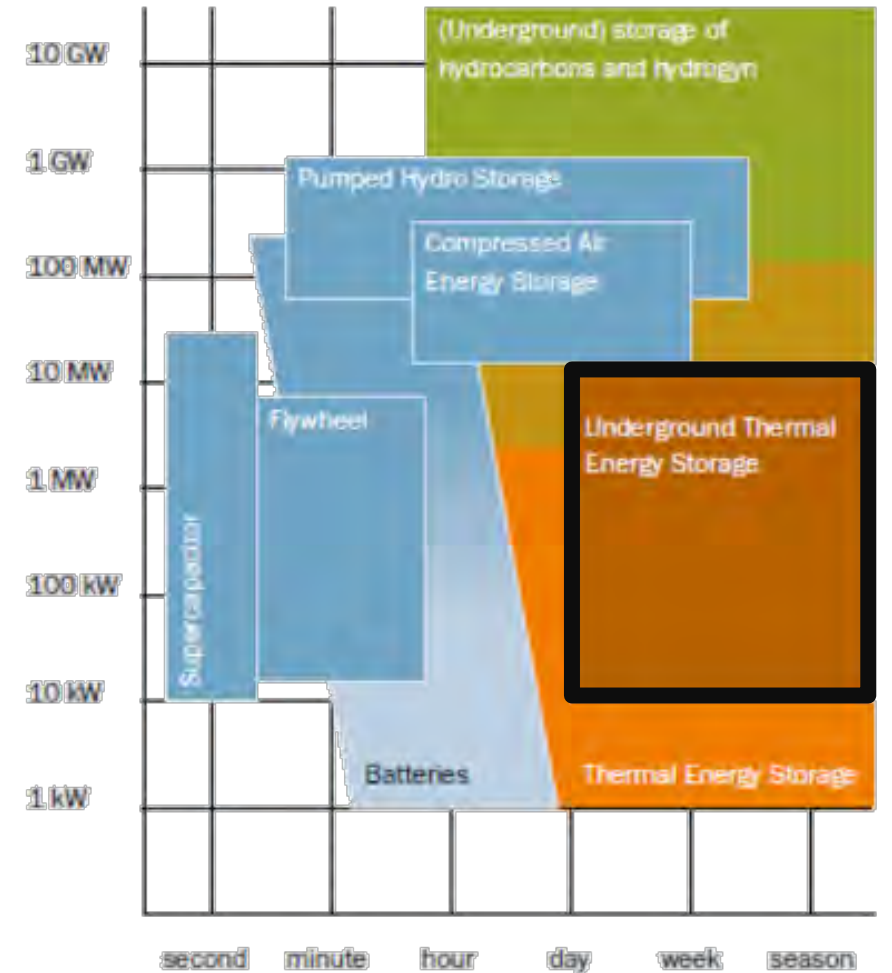
Cooling demand



Grid Congestion Issues



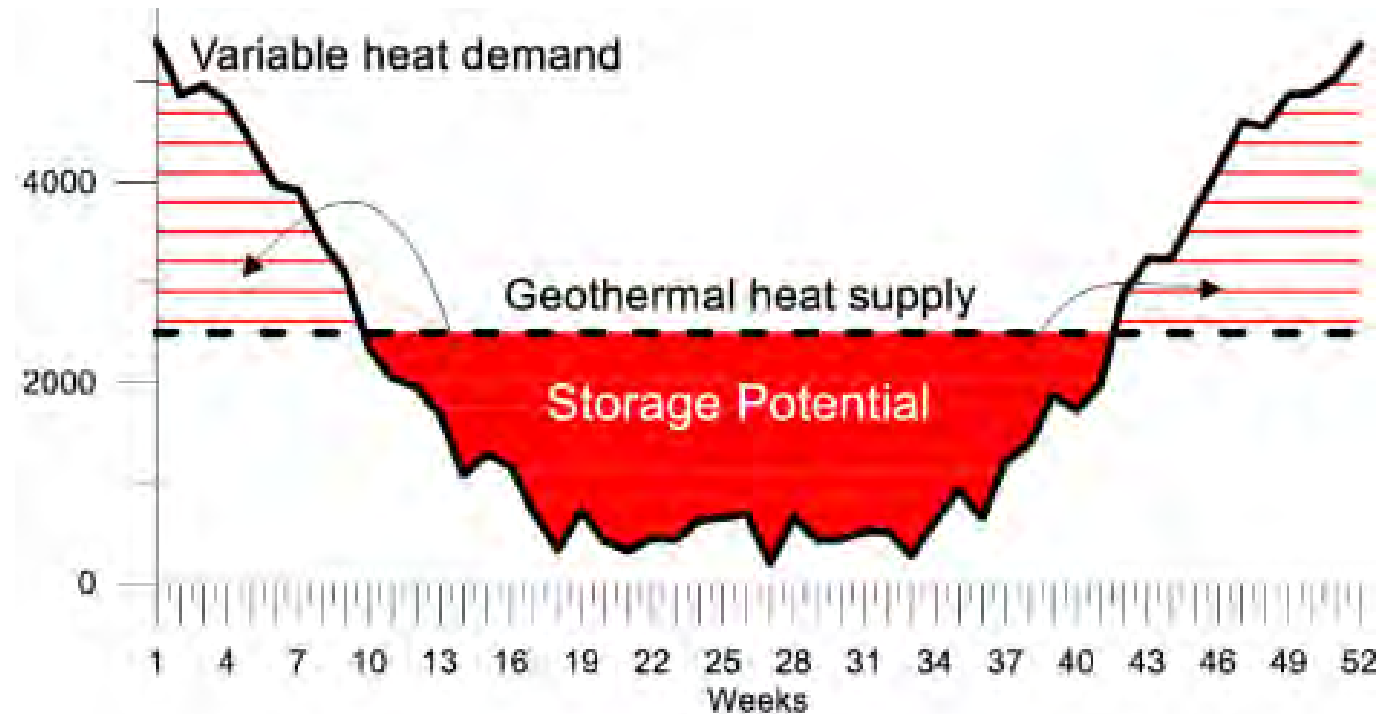
Variable Demand/Supply



[TNO-2020-R12006.pdf](#)

**Underground Thermal Energy Storage (UTES) has a role to play**

- **The Underground as a Thermal Battery**
- **Balancing the Heat Demand/Supply over time**
- **Add in Heat:**
  - Waste Heat
  - Excess Power
    - Renewable electricity to heat
  - Storing collected solar thermal



- **Different systems for different needs:**

- Daily, Weekly, Seasonal storage
- Small to Large Scale depending on application
- Low to Medium temperature
- Open or closed systems
- Shallow / Deep

- **Proven technology**

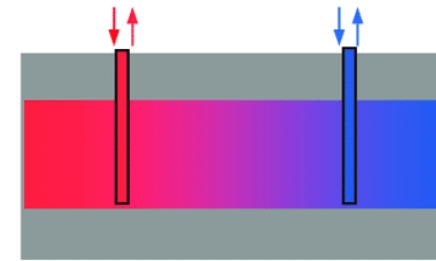
- Known R&D and operations in Europe, USA, and Asia

3000 ATES systems in the Netherlands

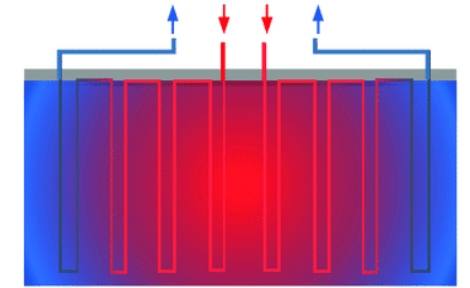
Mine Water Energy growing rapidly in the UK

- **Applications:** Utility (Office buildings), Hospitals, University campuses, Greenhouses, Airports, Datacentres, Shopping Malls, Residential areas

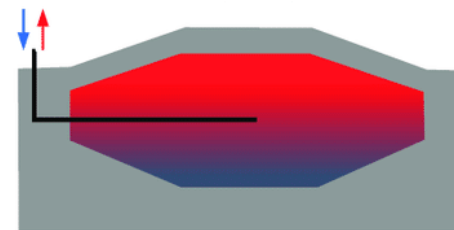
ATES: Aquifer Thermal Energy Storage



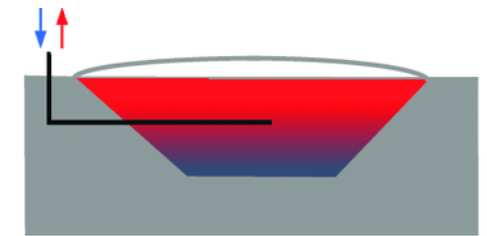
BTES: Borehole Thermal Energy Storage



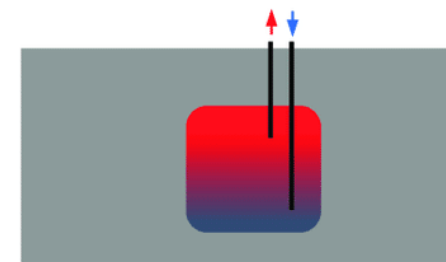
TTES: Tank Thermal Energy Storage



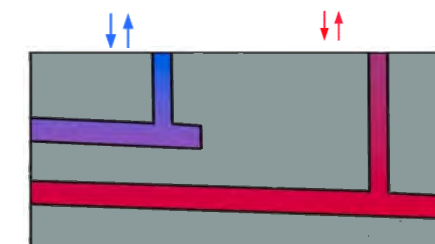
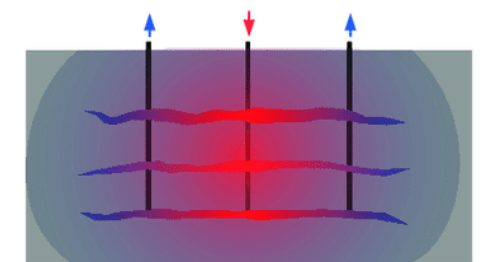
PTES: Pit Thermal Energy Storage



CTES: Caver Thermal Energy Storage

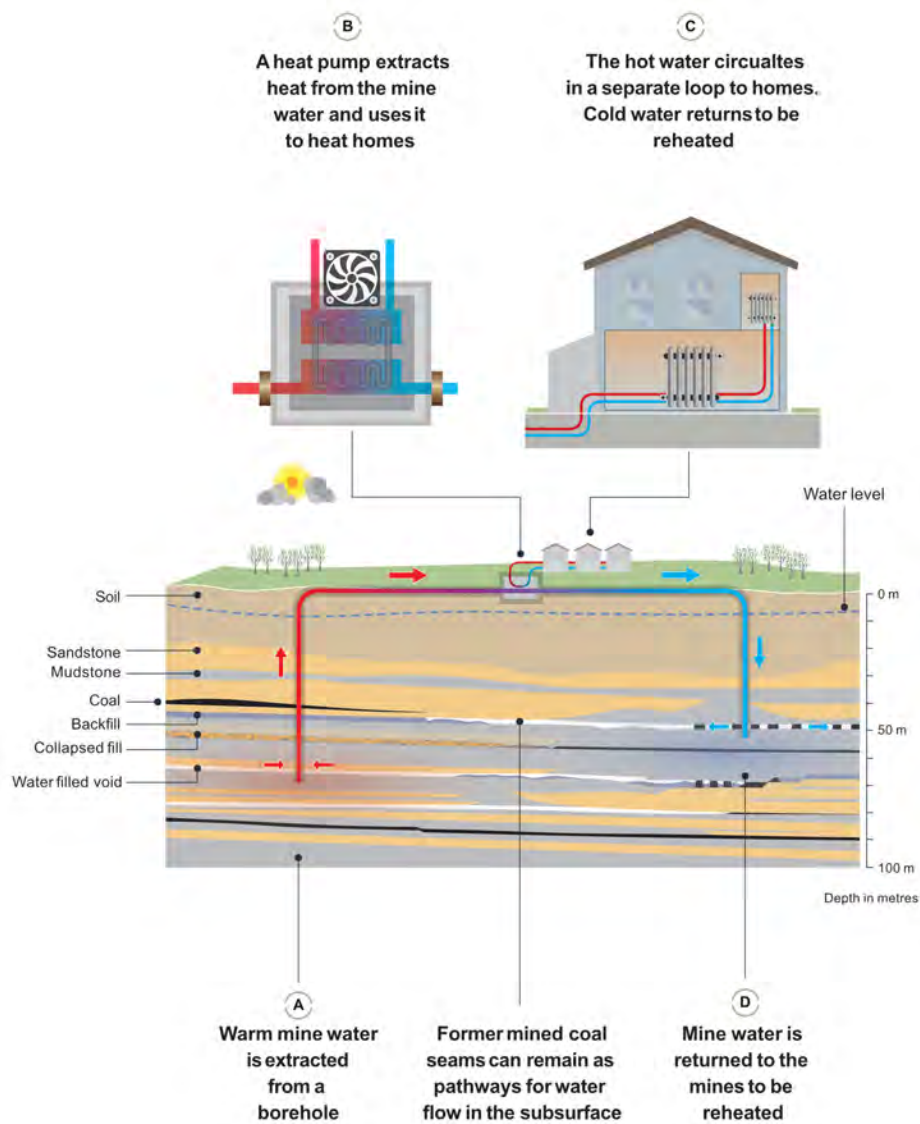


FTES: Fractured Thermal Energy Storage

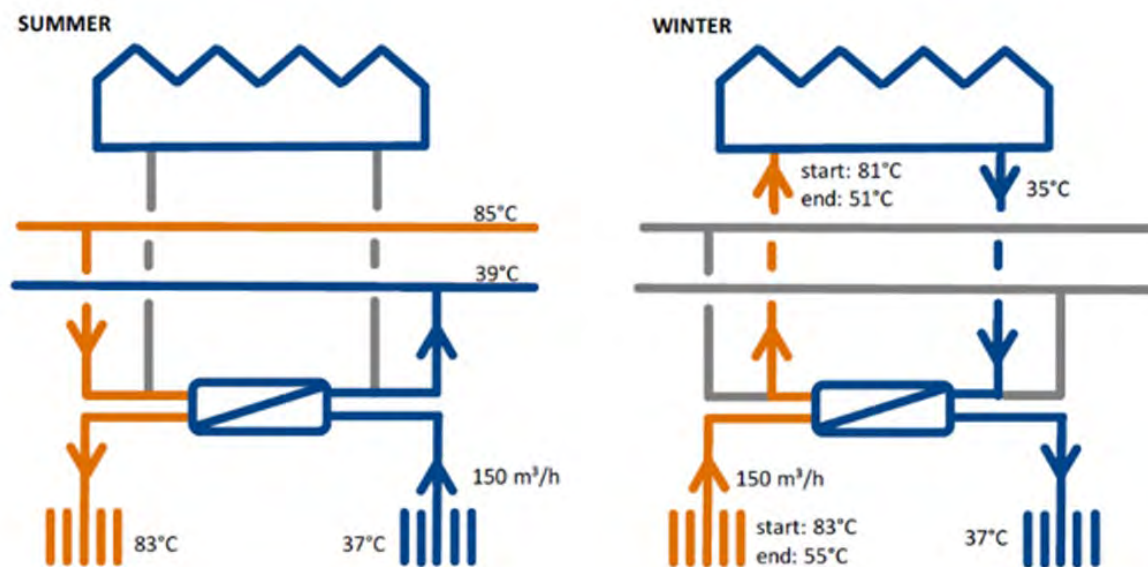
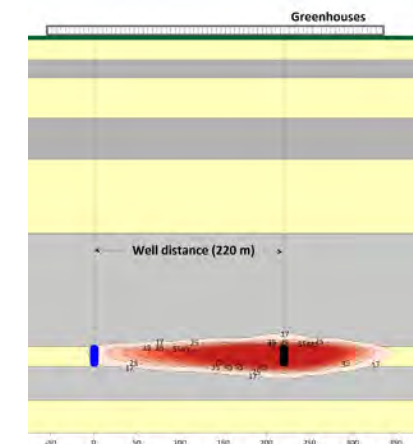


MTES: Mine Thermal Energy Storage

## MTES – Glasgow Observatory



## HT-ATES, ECW Middenmeer, the Netherlands





## 1- Demand:

- Climate requiring Heating and Cooling over time
- End Users

## 2- Supply: Excess Heat available

- Cheap source of energy locally

## 3- Suitable subsurface

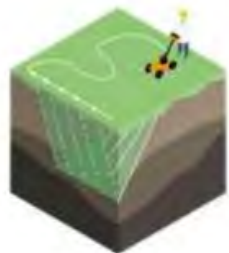
- Data availability
- Good confined aquifers or reservoirs
- Minimal heat loss and useable temperature

## 4- Regulations

- Clear regulations for the various technologies, depth, T°
- Treat heat as a commodity

## 5- Managing Effects and impacts

- Mitigations of risks (e.g. drilling, well performance)
- Acceptable surface and sub-surface effects
- Monitoring



Characterization  
of UTES



Modeling subsurface  
dynamics



System integration & UTES  
design optimisation



Demonstration



System performance  
monitoring



Fast track market uptake

- **Security of supply of Heat**

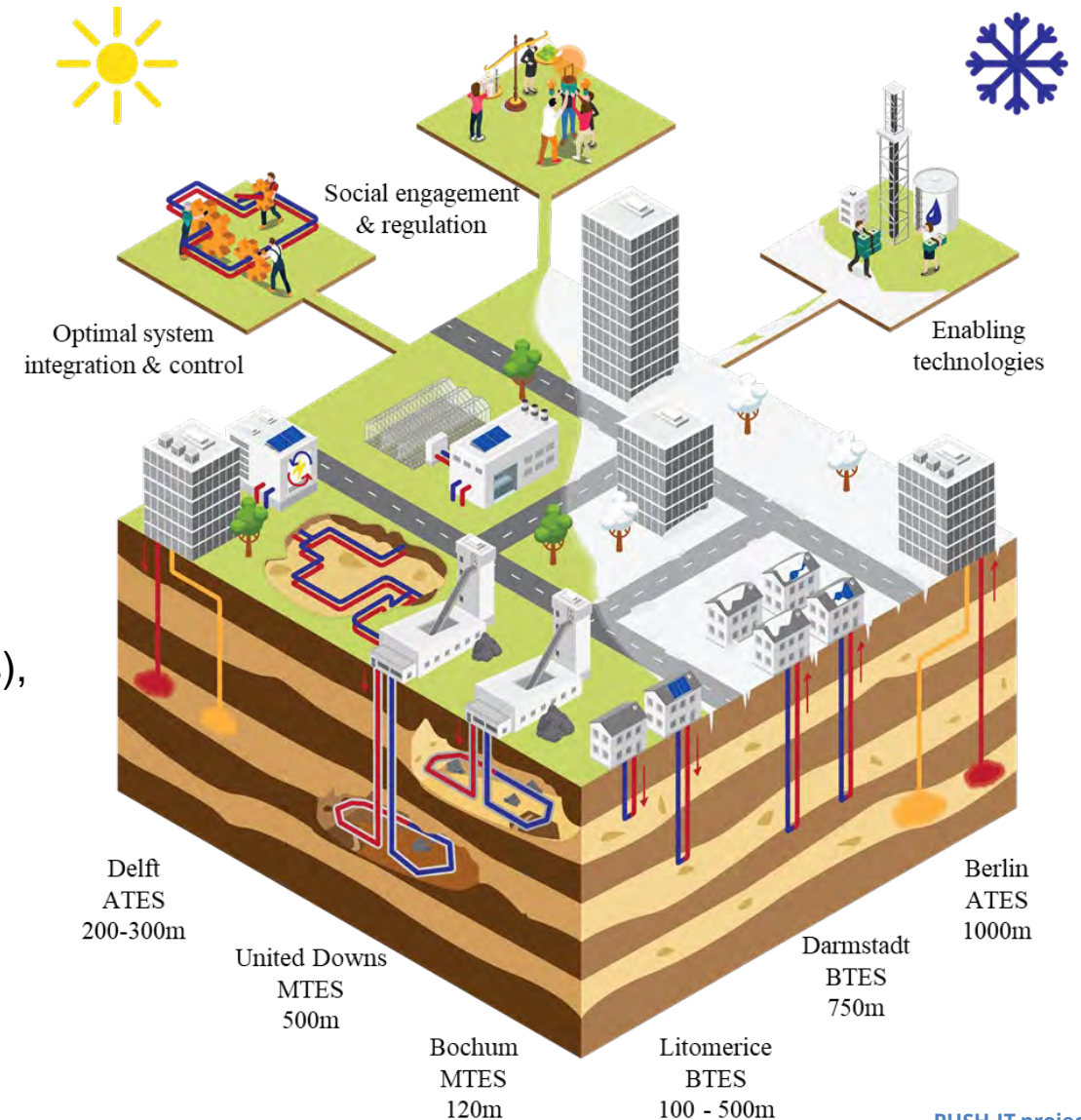
- Reduce electric load
- Local baseload energy source
- Large storage capacity
- Diversification possible with hybrid systems

- **Affordable**

- Efficient systems, Heating AND cooling
- CO<sub>2</sub> emissions savings
- Integrated system (District Heating and Cooling Networks),
- Sharing infrastructure and capital cost

- **Sustainable**

- Year-round solution
- Small footprint, no smell, no noise
- Resilient



# Take Home messages

- Heat has a key role to play in the energy transition
- Various technologies to suit local needs
- Applies to all sectors from industrial to residential
- UTES will help reduce load on electrical grid
- **Energy Security, Energy Sustainability, Energy Affordability**
- Large investments and developments in the world, why not in New Zealand?

What are we waiting for?

**Mine Water Heat Network, UK**  
 CLIMATE ZONE: Average monthly temperature 4°C - 16°C  
 ENERGY SYSTEM: 80% Heating Energy, 0% Cooling

**Gateshead Energy Storage**  
 CLIMATE ZONE: Average monthly temperature 2.5°C - 16.4°C  
 ENERGY SYSTEM: 100% Heating Energy

**Mine Water Geothermal**  
 CLIMATE ZONE: Average monthly temperature 0°C - 24°C  
 ENERGY SYSTEM: 82% Heating Energy, 4.8% Cooling

**Heerlen District Energy Scheme**  
 CLIMATE ZONE: Average monthly temperature 5°C - 21°C  
 ENERGY SYSTEM: 100% Heating & Domestic Hot Water

**Eco-subdivision heating network - Cadaujac**  
 CLIMATE ZONE: Average monthly temperature 5°C - 21°C  
 ENERGY SYSTEM: 100% Heating & Domestic Hot Water

**Domaine le Moulin sustainable and carbon-free innovative energy technology**

**In Brief**  
 Location: Heerlen, Netherlands  
 Owner / Operator: Mijwater Energy BV  
 Four interconnected energy clusters  
 Mine water wells: 2 at 700m, > 28°C; 2 at 250m, < 18°C; 1 at 500m  
 Flow Rate: Total well flow rate 400 m³/hour  
 Heat Pump Capacity: 9.9 MW heating, 8.8 MW cooling, 1.1 MW sanitary hot water  
 82 heat pumps for heating / cooling, 232 heat pumps for hot water  
 Operating: 12 years (in 2023)  
 2022 CO2 reduction: 2000 ton for heating, 1600 ton for cooling  
 Total Cost: 50 million €  
 Funding: 25 million €

**In Brief**  
 Location: Cadaujac, France  
 Owner / Operator: DTEC  
 60 boreholes, 15m deep, spaced 2m apart, through granite 10,000m  
 Heat energy data: Total 100 MW/year, Peak Heating Mode: 10 MW/year, Heat Pump Capacity: 360 MW/year (Geothermal COP: 14)  
 Energy Efficiency of BTES: 70% (due to the thermal inertia and user energy demand to integrate Solar Heating Panels)  
 Solar Heating Panels: Under Solar Collector by 240000 m²  
 Short Term Thermal Storage: 1000m³ above ground tank  
 BTES Heat pump: HeatPump - Addressed: 70 MW District compressor  
 District Heat Network: Domaine le Moulin, Domaine de la Vallée  
 Degree days: 3966  
 Operational: September 2022  
 Cost: 1.6 Million €  
 ADAME Subsidy: 910 000 €

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**We know the potential is massive.**

**Working collectively on this journey is the key.**

**We do not know the outcome of today but let's work together on the future:**

- **To find out if who would be interested in working on specific areas**
- **To be able to collate our collective learnings from today and share it with you all and your organisations**

**This is time to generate some actions and progress.**

**2 + 2 → Infinity**