Borehole Thermal Energy Storage (BTES) – developing of high temperature BTES

Kirsti Midttømme,

NORCE Norwegian Research Centre

kimi@norceresearch.no

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BTES - Borehole Thermal Energy Storage

- Volumetric heat capacity of rock or /and soil is used to store heat or cold
- The heat is injected or extracted by circulating fluid in u-tube pipes installed in a closely spaced boreholes (BHEs).
- Heat usually utilized using Ground Source Heat Pump (GSHP).
- Cooling needs can be covered by direct cooling in the Nordic countries.
- +Large storage capacity
- Storage periode: hours to years

BTES at Postterminal building, Lørenskog, Norway

BHEs field → BTES

- BHEs field: only for heating purpose (ex.apartment buildings)

- BTES «light»: mainly for heating but also used for cooling (ex schools, office buildings)
- BTES: balanced heat and cooling needs, or storage of additional heat from solar, grey water, waste heat (hospitals)

- HT-BTES: storage of solar or waste heat

  BTES temp > 25 °C

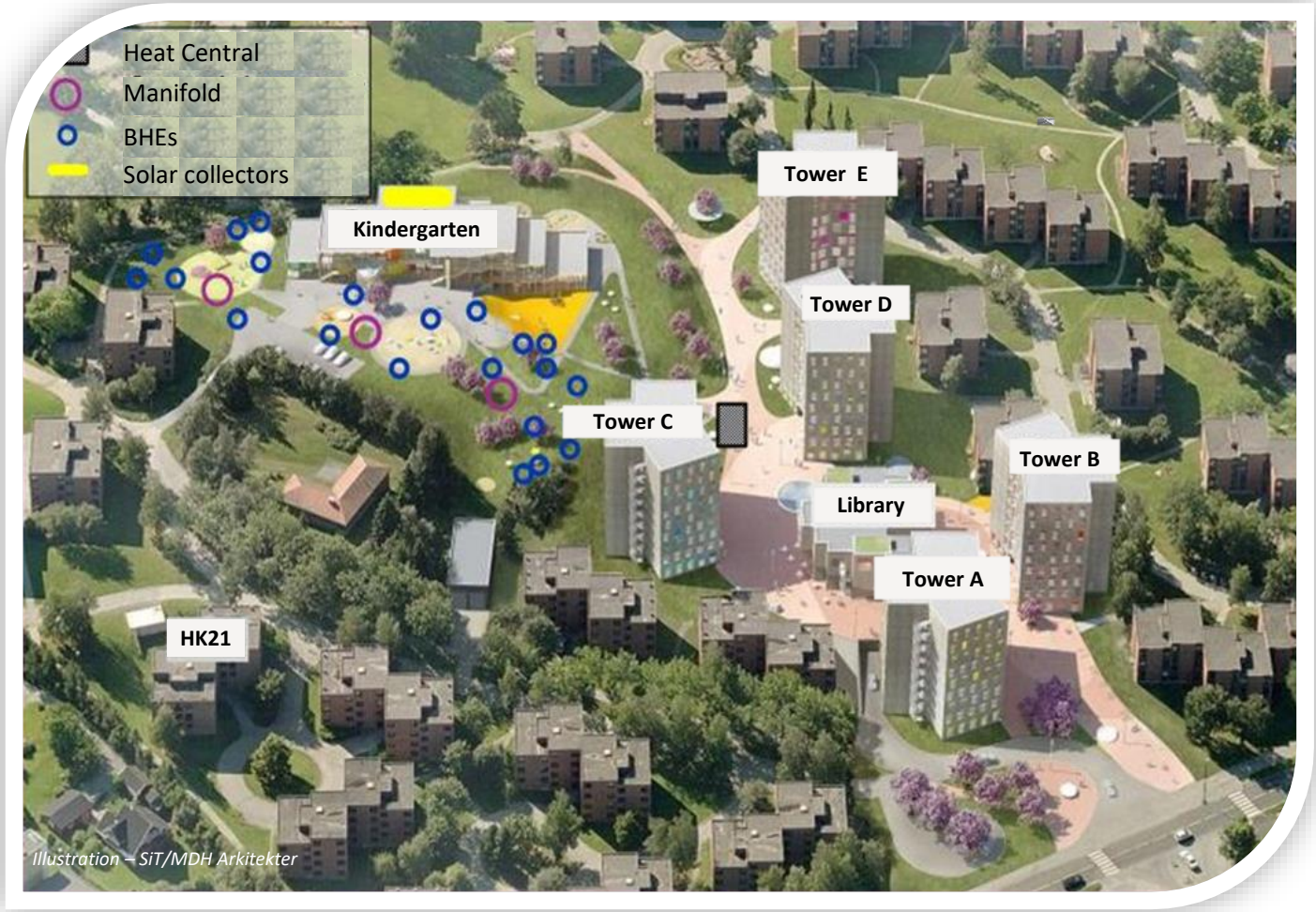
Norway: >800 BHEs fields/ BTES with 8 or more BHEs

Standard BTES (2004 – 2015)

Akershus University hospital (Ahus), Norway

- Operation from 2008
- 137 000 m^2
- 228 BHEs of 200 m
- Heat pump 8 MW
- Energy production
  - Heat 26 GWh
  - Cooling incl free cooling 8 GWh
- Investment cost BTES 10MEuro

Moholt 50|50, Trondheim – District Heating and Cooling (2017)

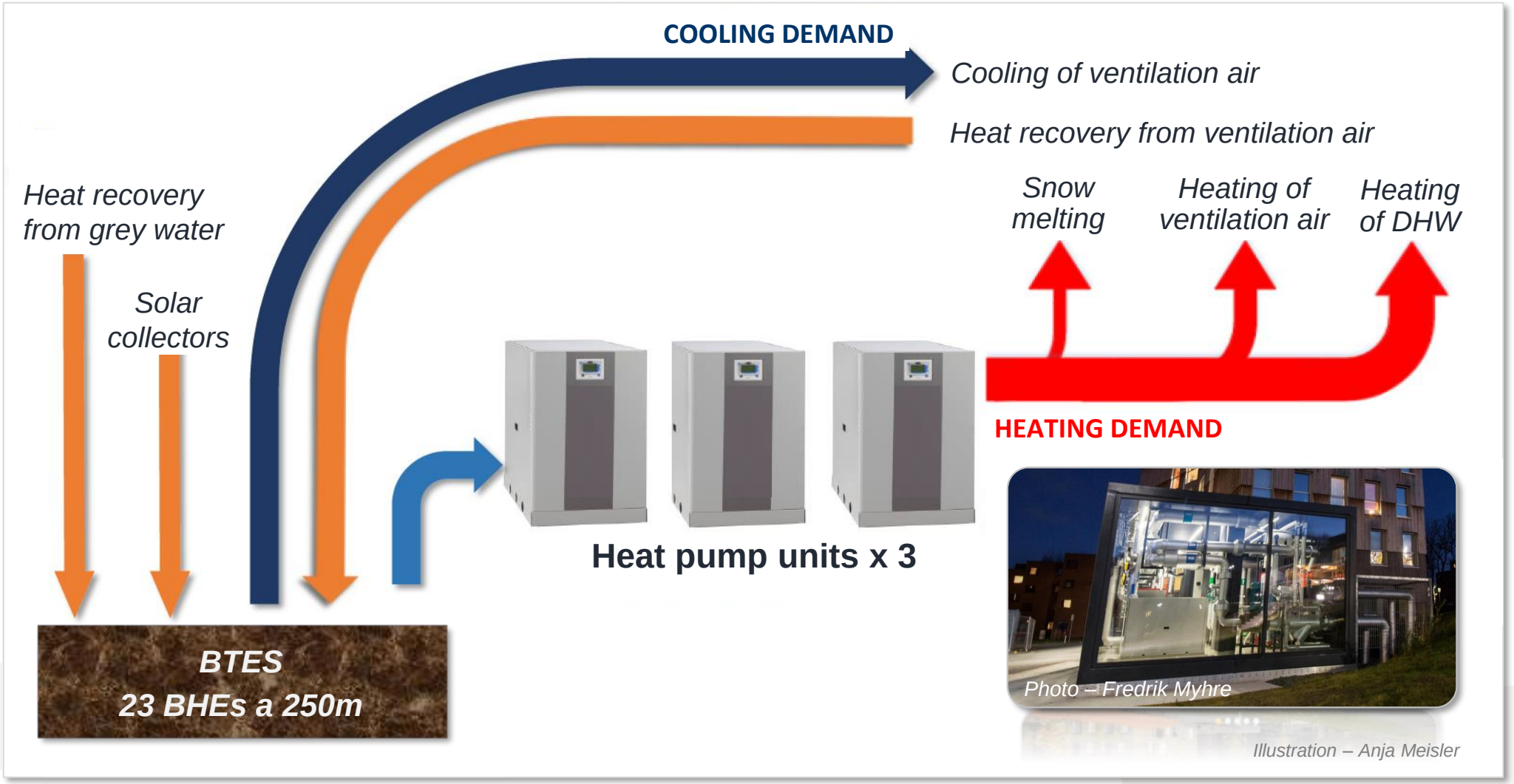


- Expansion of Moholt student town in Trondheim.
- 5 new apartments buildings.
- Passive house standard – 25,000 m^2

- BTES/GSHP – small-scale district heating/cooling.
- DHW heating, heating of ventilation air and snow melting.
- Thermal charging of BTES – solar, grey water and ventilation air

REF: Jørn Stene, COWI / Anja Meisler NTNU

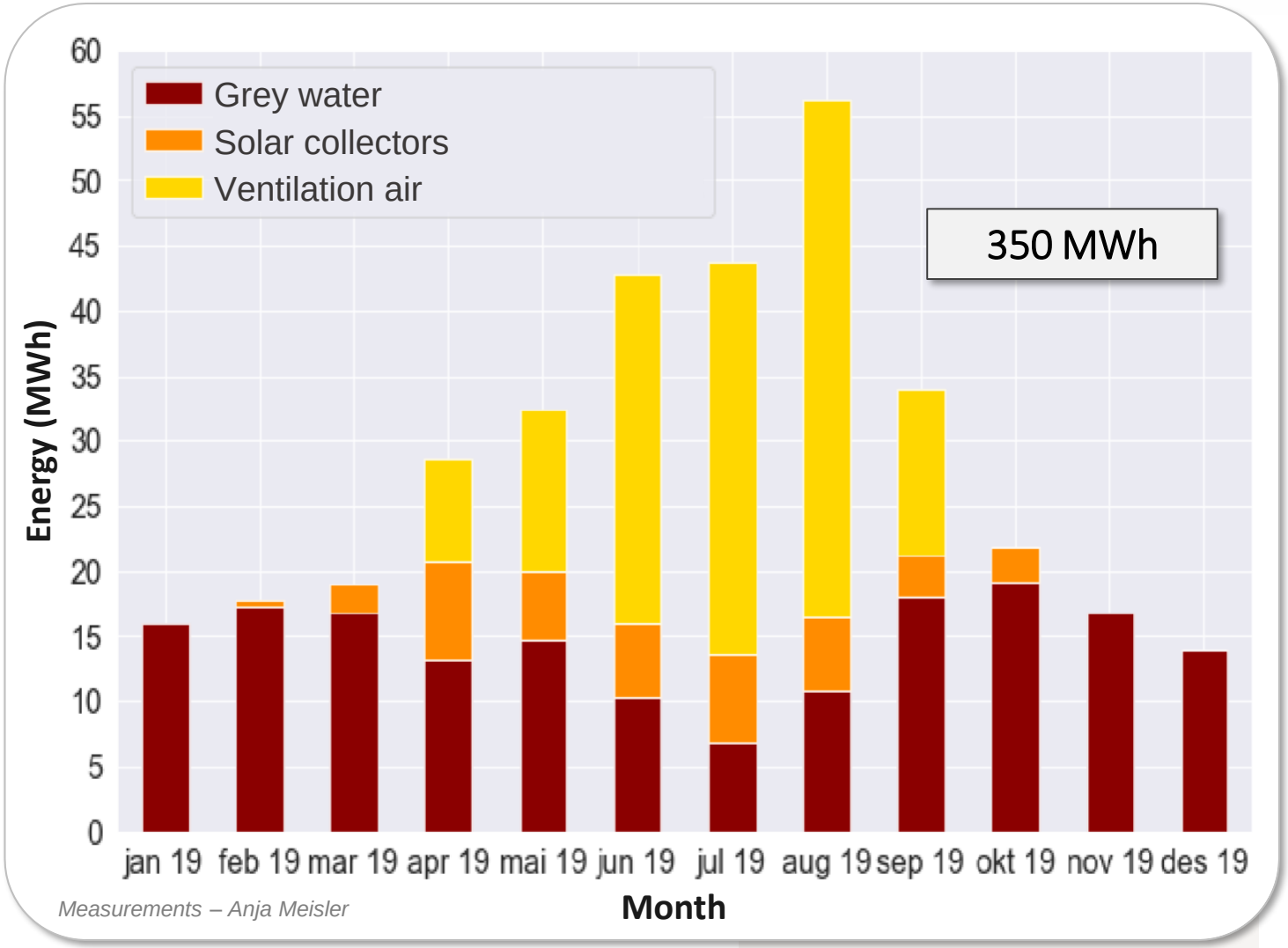
Moholt 50|50 – Principle Energy Flow Diagram



IEA HPT Annex 52, 2020 – Jørn Stene

Measurements – Thermal Charging of BTES

- 1) Grey water
  - Moderate temperature
  - Heat supply the entire year
  - 175 MWh in 2019 – 50 %
- 2) Ventilation air
  - Low temperature
  - Heat supply April to Sept.
  - 130 MWh in 2019 – 38 %
- Solar collectors
  - High temperature
  - Heat supply Feb. to Oct.
  - 40 MWh in 2019 – 12 %



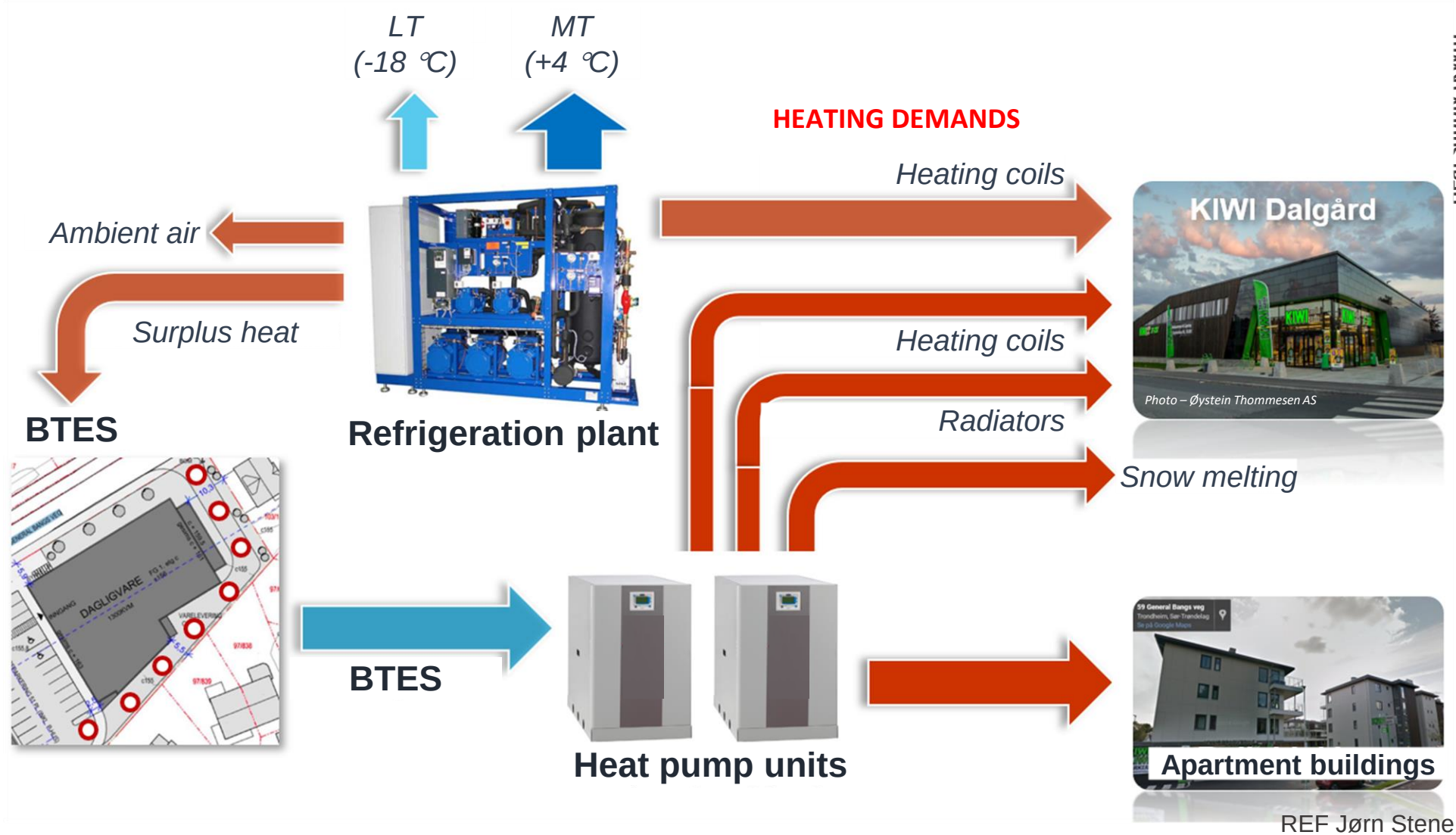
Ref: IEA HPT Annex 52, 2020 – Jørn Stene

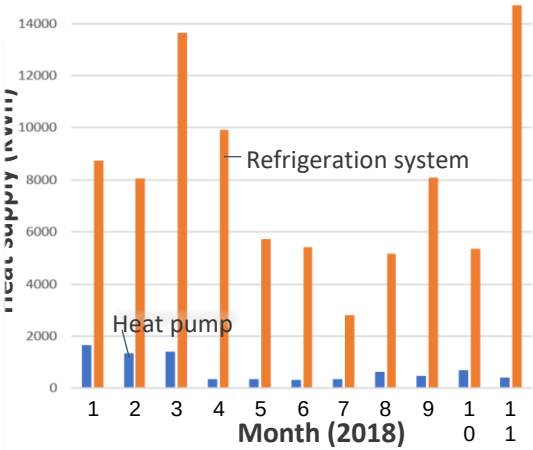
KIWI Dalgård, Trondheim – Supermarked (2017)

- Passive house standard – 1250 m^2
- Solar panels (PV), 560 m^2 + battery storage
- GSHP 2 units x 38 kW
- BTES – 8 BHEs total 2110 m – 15 m distance

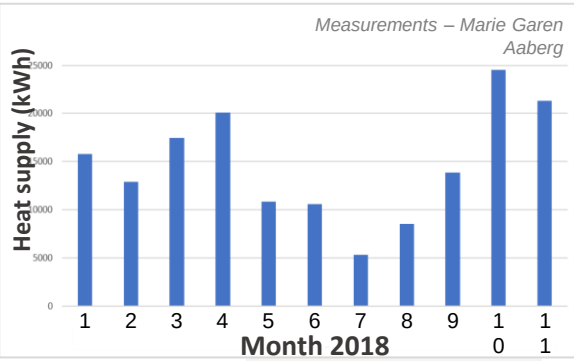
REF Jørn Stene COWI / Marie Garen Aaberg, NTNU

Refrigeration/Heat Pump Plant – Thermal Energy Flow





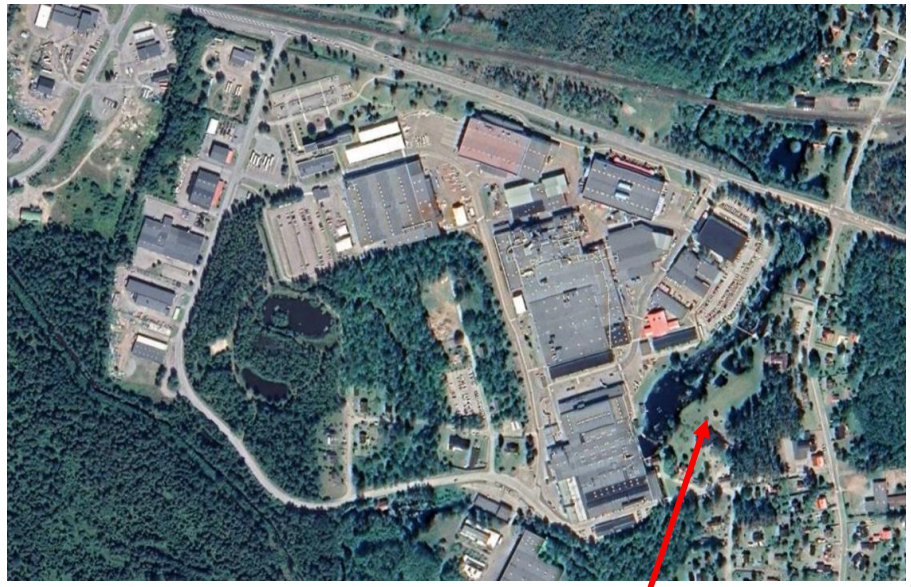
Measurements – Marie Garen Aaberg



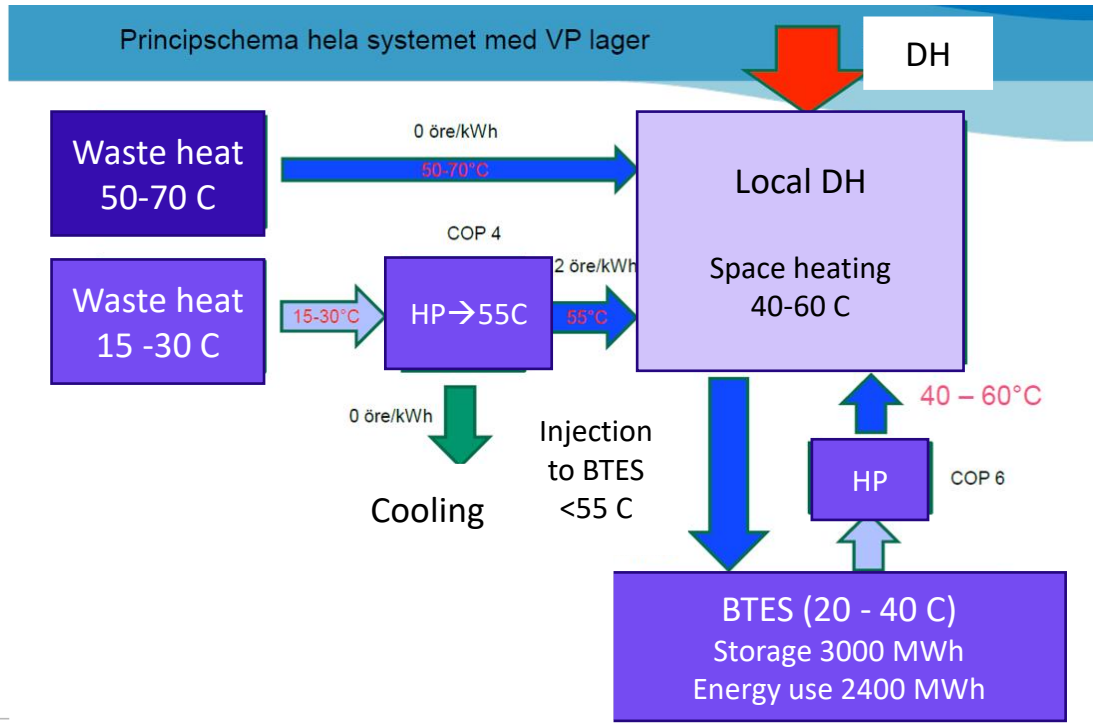
REF Jørn Stene COWI / Marie Garen Aaberg, NTNU

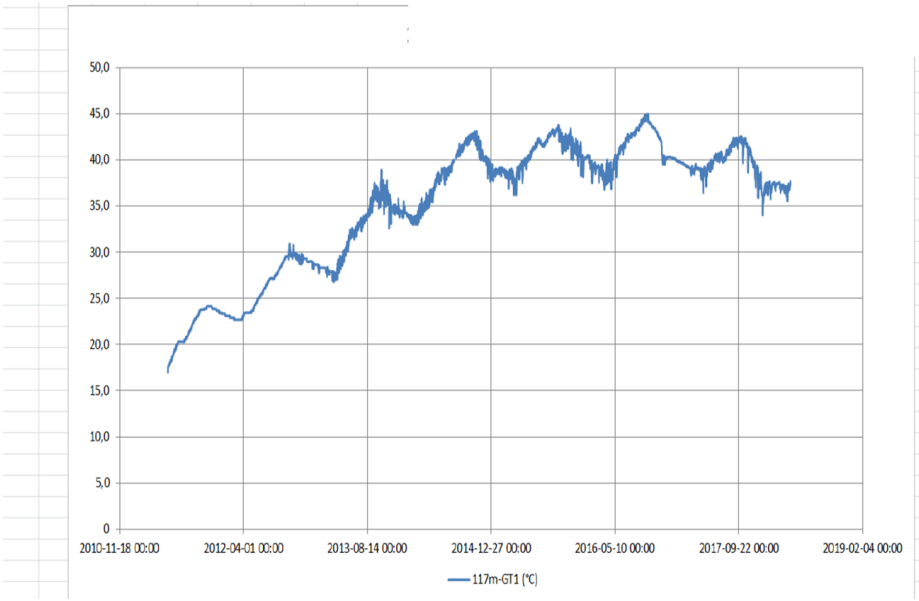
Thermal storage of industrial waste heat

Xylem, Emmaboda, Sweden



HT- BTES 140 BHE’s a 150 m

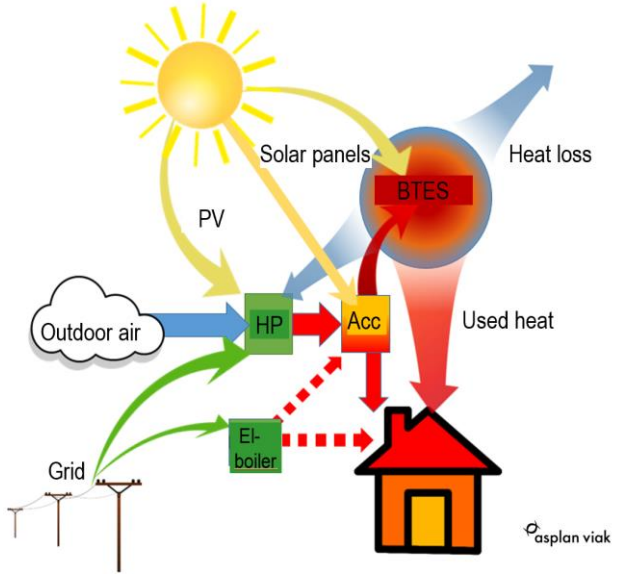




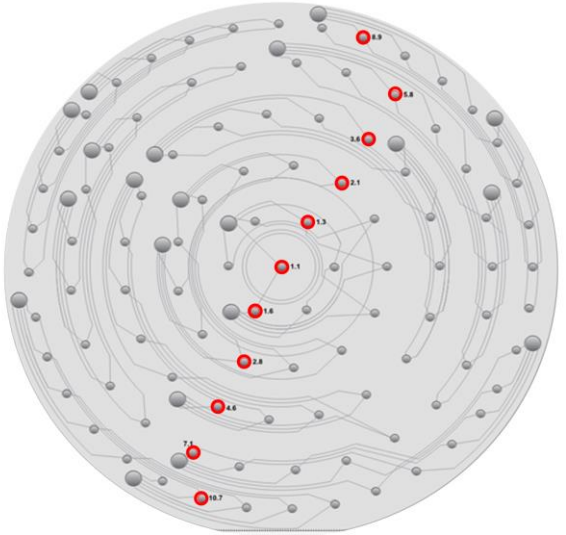
REF. Oluf Andersson,

HT BTES GeoTermos – Fjell2020, Drammen (2020)

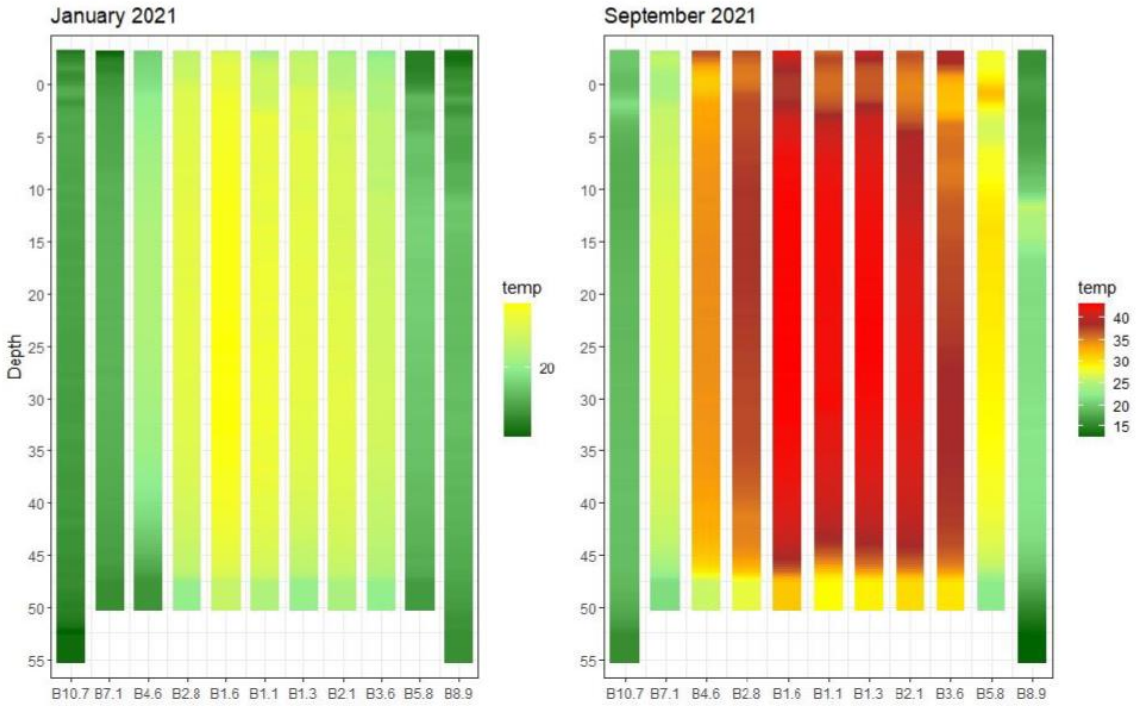
- Fjell School, Drammen 10000 m^2
- Injection of solar energy by use of air source heat pump and PVs
- Direct heating of the school, by 30 °C water-based underfloor heating system

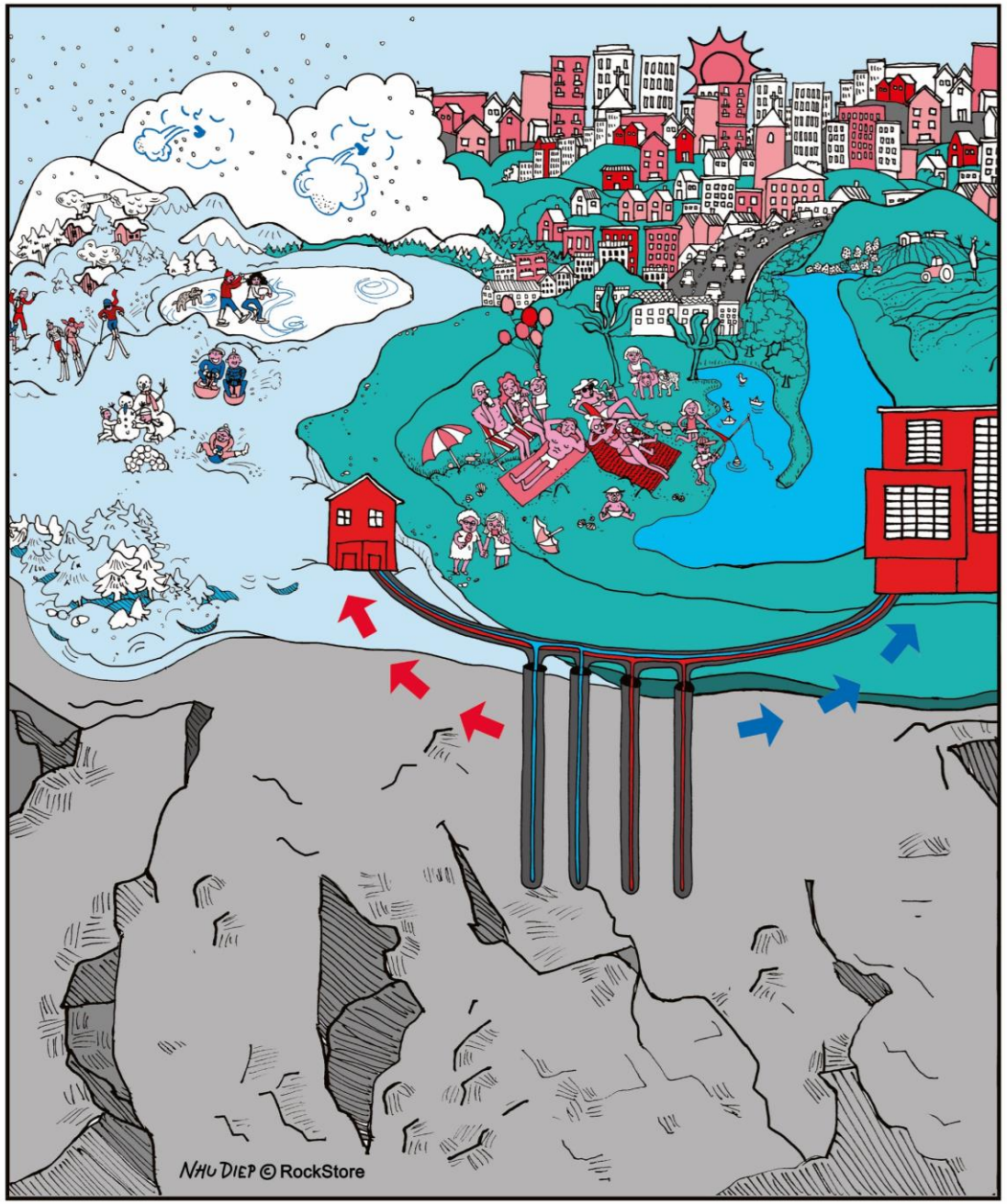


HT-BTES GeoTermos



- 100 BHEs a 50 m (55m)in a circle configuration.
- Fibre for distributed temperature sensing installed in 11 of the BHEs
- Granite covered with <15 of marine clay no/low groundwater flow
- Injection of heat started April 2020
- Temperature Sept 2021 <43°C
- Reservoir temperature: 25-50°C
- (8°C undisturbed)
- Injection temperature: 50-60°C
- Utilization temperature: >32 °C





SUMMARY

The ground offers a huge thermal store that can bank heat energy in times of surplus and be drawn upon in times of need. It allows us to match heating and cooling demand with natural resources over short or longe periodes

Thank you for your attention!