TU Delft Subsurface urban energy lab

Full-scale application and development of seasonal heat storage

Dr.ir. M. Bloemendal
2023-11-7
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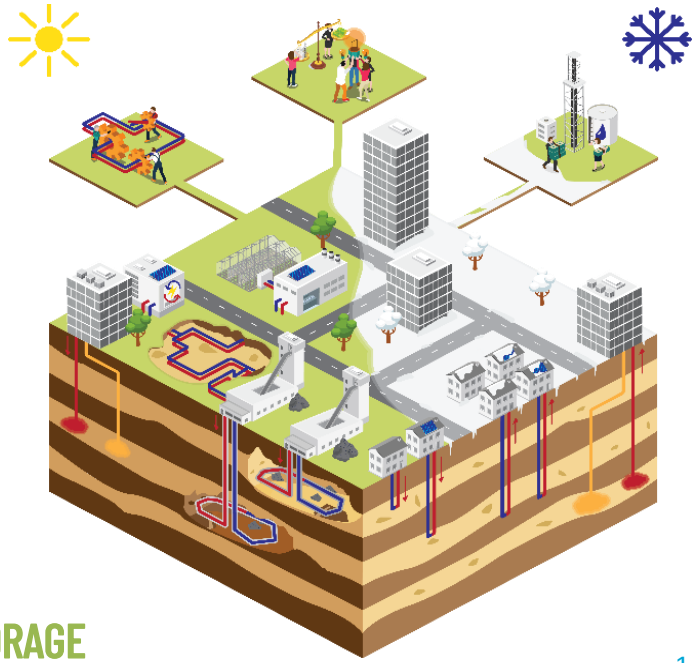
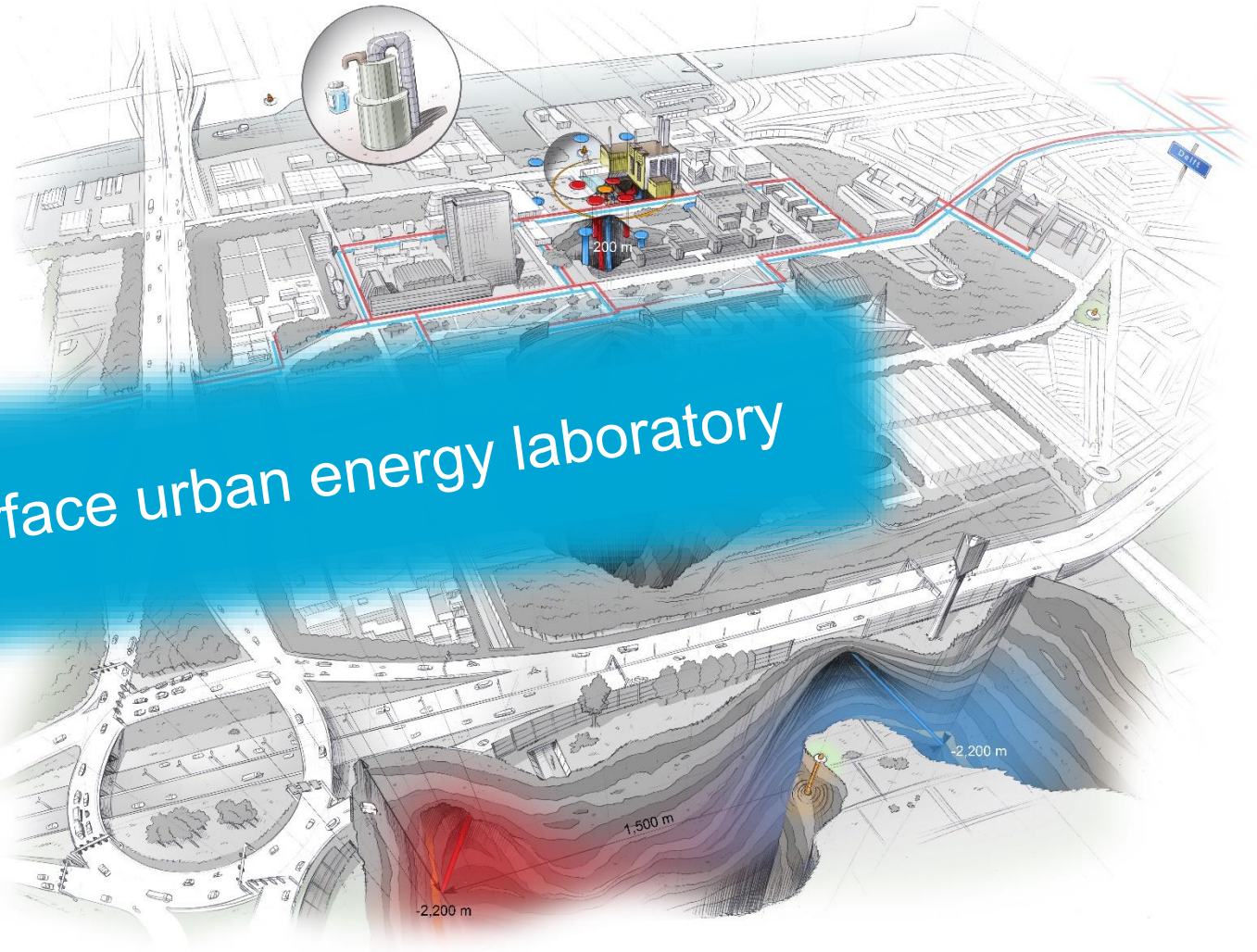


Co-funded by the European Union

Workshop in Utrecht
APPLICATIONS FOR INDUSTRIAL THERMAL ENERGY STORAGE

Delft Subsurface urban energy laboratory



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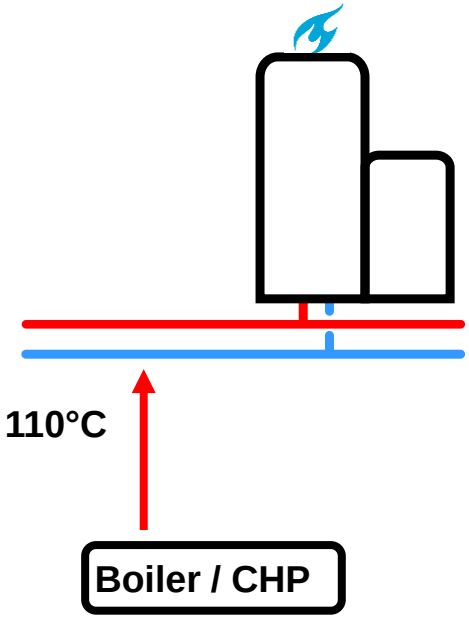
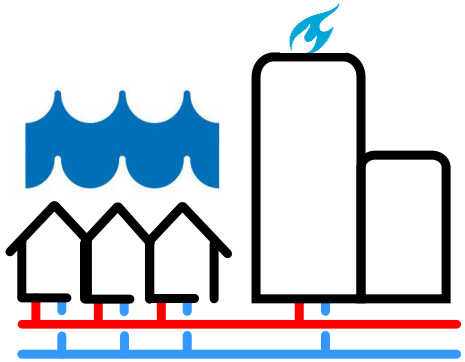
Current



~2024



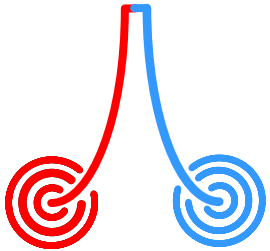
Also deliver to city

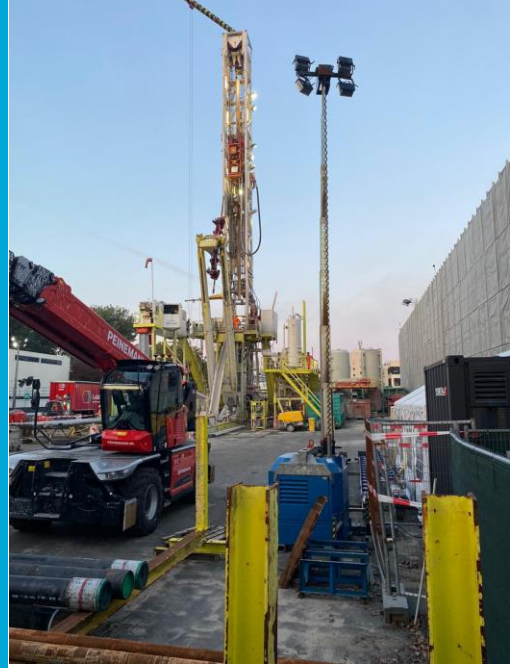
Maximise power
Minimise injection temp

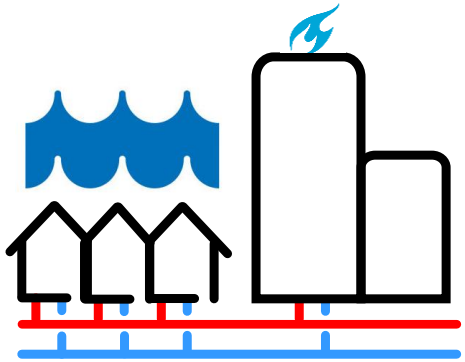
HPC

Boiler / CHP

Backup for peaks





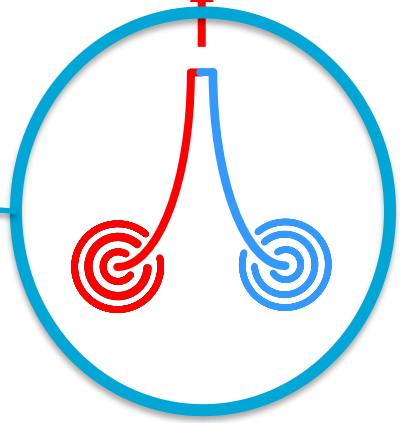


HPC

Boiler / CHP

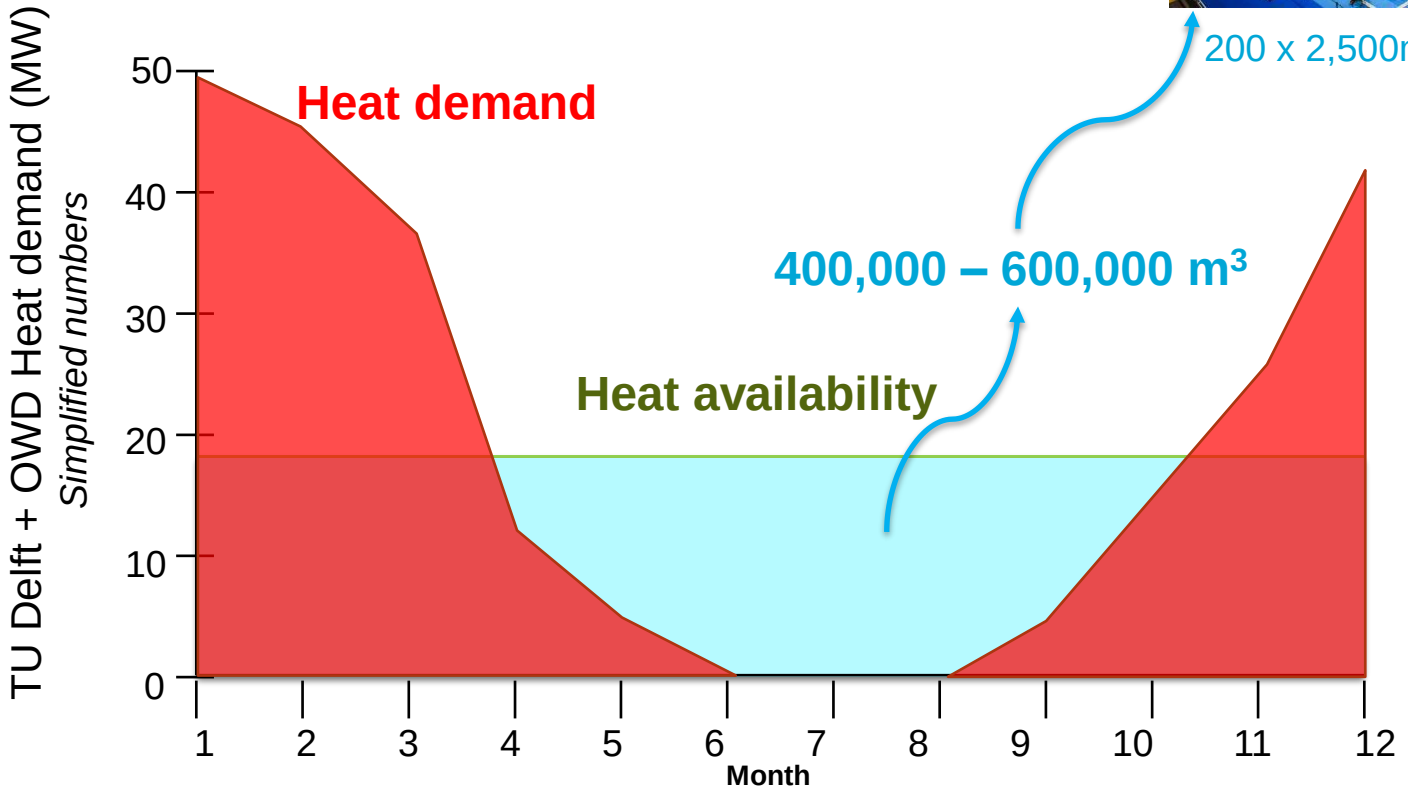
Backup for peaks

EGW
Nov.9 – 9:00



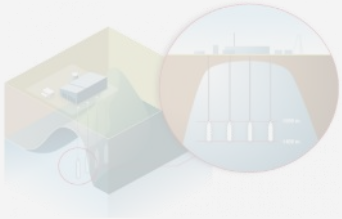
The need for heat storage

200 x 2,500m³



Large scale – seasonal heat storage ? → **Sensible heat storage**

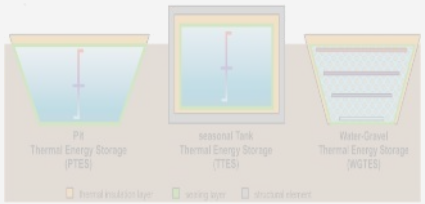
MINES/ CAVERNS



- Salt deposits in mines/caverns can be used to store energy.

- Availability is limited
- Losses can be high

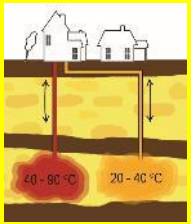
TANKS/PITS



- Offers good insulation and flexibility

- Expensive & limited capacity
- Not always possible in dense urban settings

Underground



- No space requirement above ground
- Large capacities

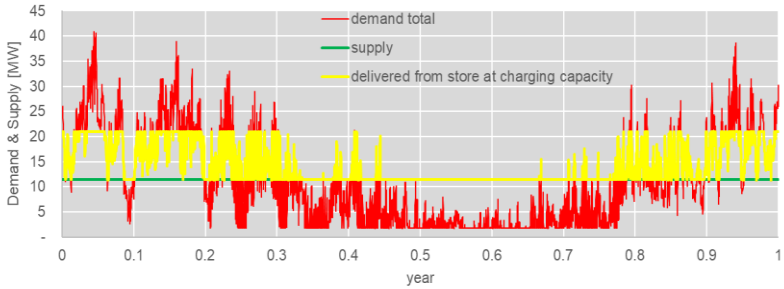
- Subsurface infrastructure needed
- Dependent on local geological conditions

Fossil energy use in DHN

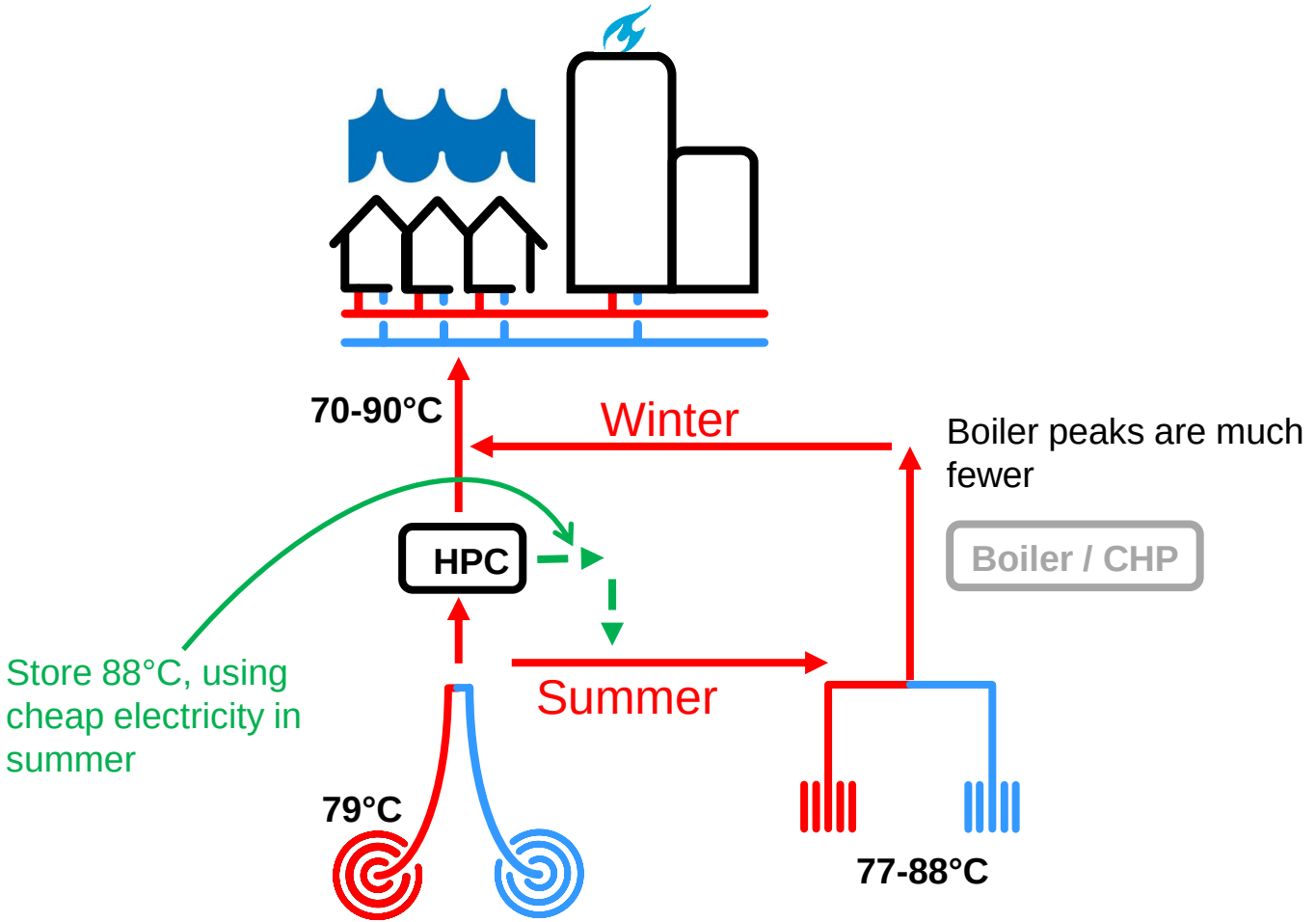
100% - Gas fired boiler

40% - Geothermal

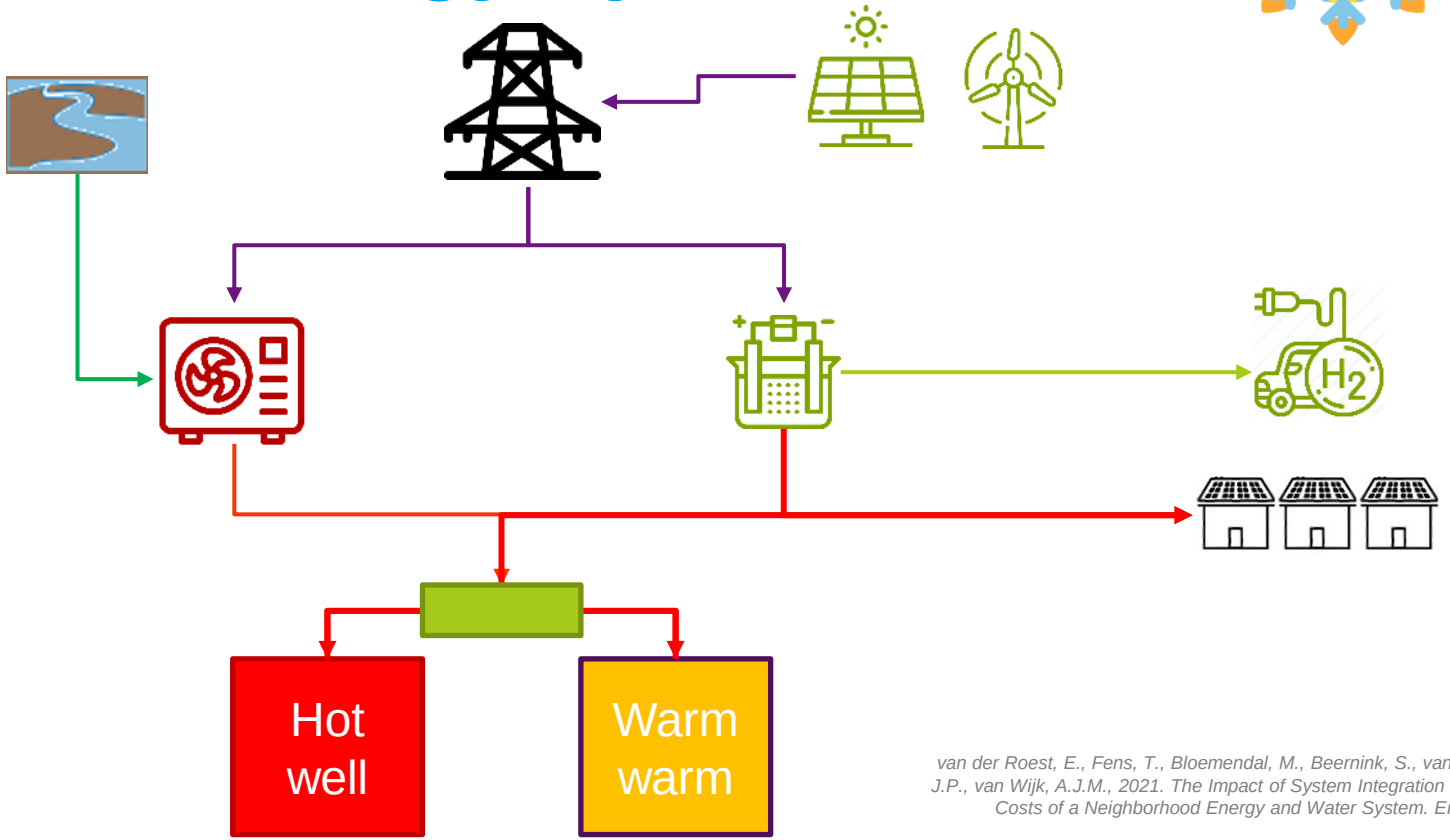
5-10% - Geothermal + heat storage



>2025


70-90°C
Winter
Boiler peaks are much fewer
HPC
Boiler / CHP
Store 88°C, using cheap electricity in summer
Summer
79°C
77-88°C

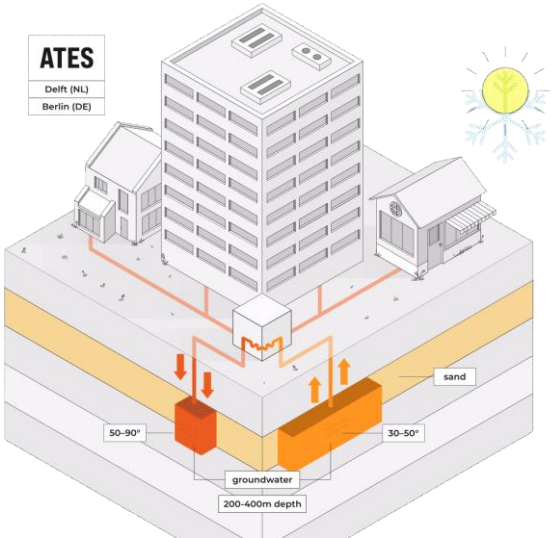
Multi energy systems



van der Roest, E., Fens, T., Bloemendal, M., Beernink, S., van der Hoek, J.P., van Wijk, A.J.M., 2021. The Impact of System Integration on System Costs of a Neighborhood Energy and Water System. Energies 14.

ATES legality

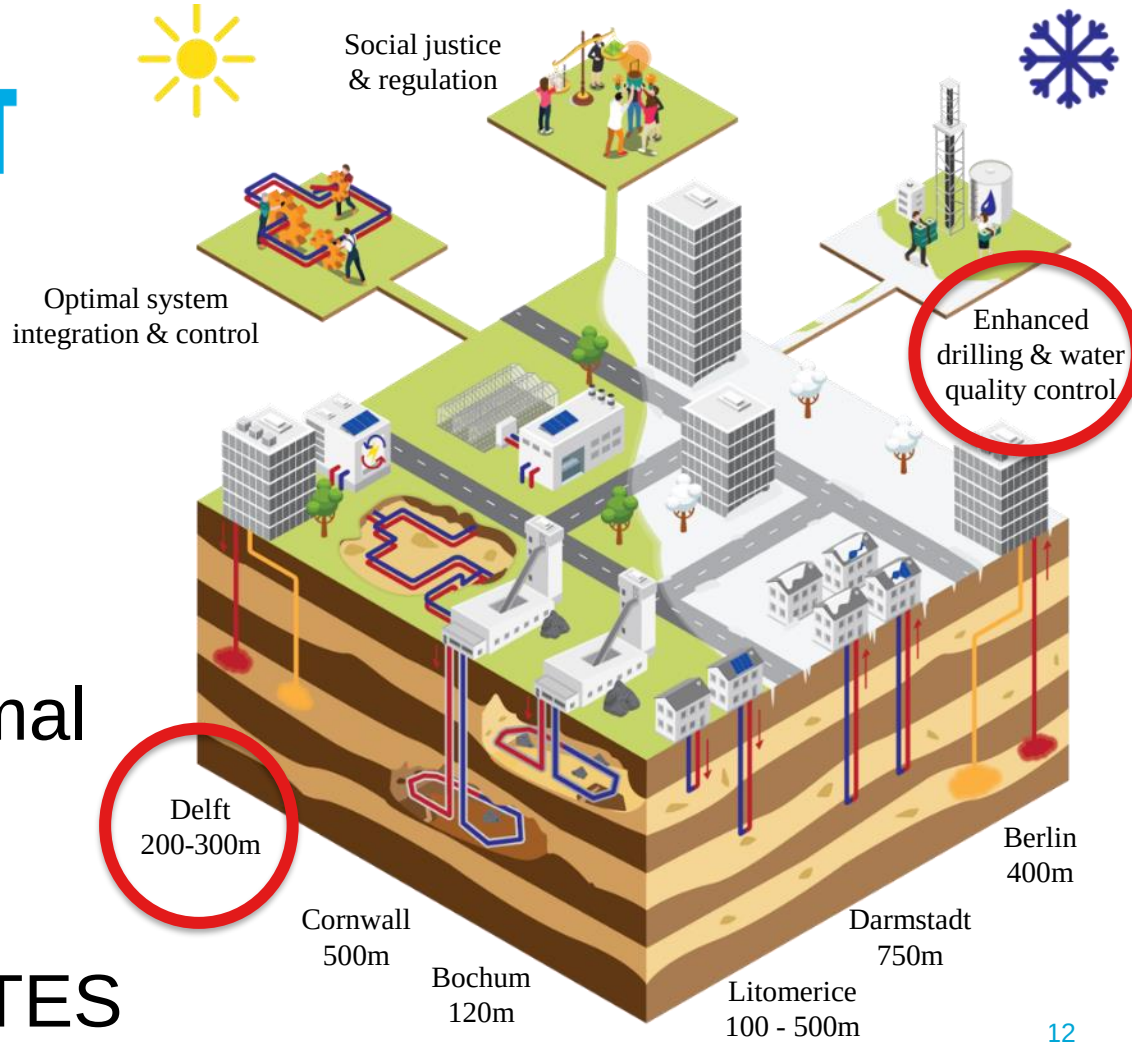
- <25°C standard regulatory framework
- >25°C Permitted by provincial board (GS)
  currently as pilot / research projects



PILOTING UNDERGROUND SEASONAL HEAT STORAGE

IN GEO-THERMAL RESERVOIRS

PUSH IT



- up-to 90°C
- In geothermal reservoirs
- ATES, BTES & MTES

European Commission

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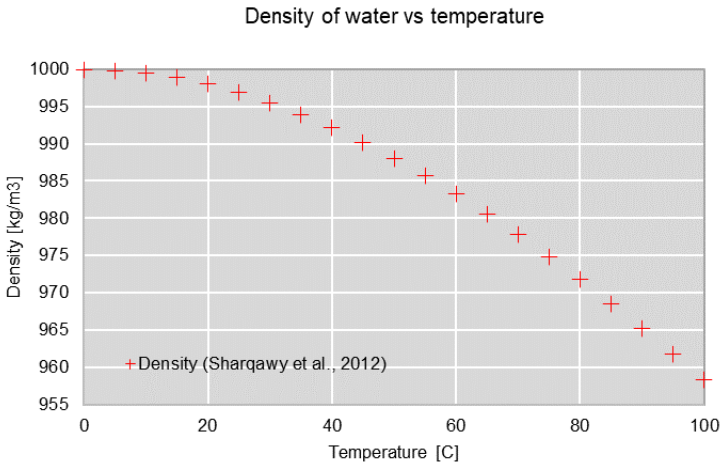
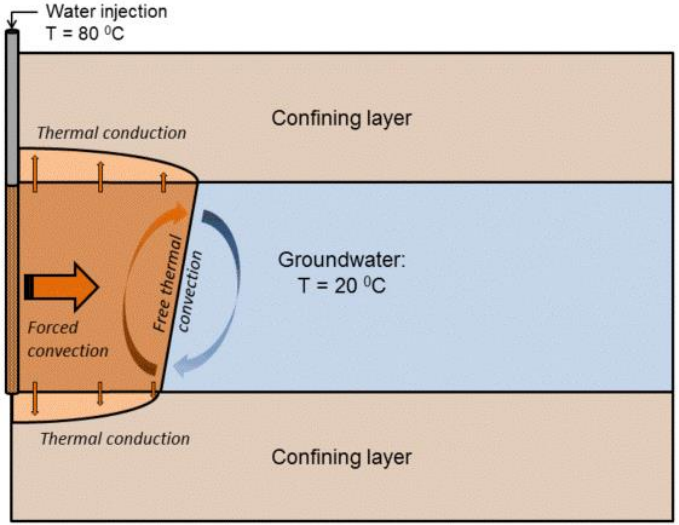
Innovation Highlights

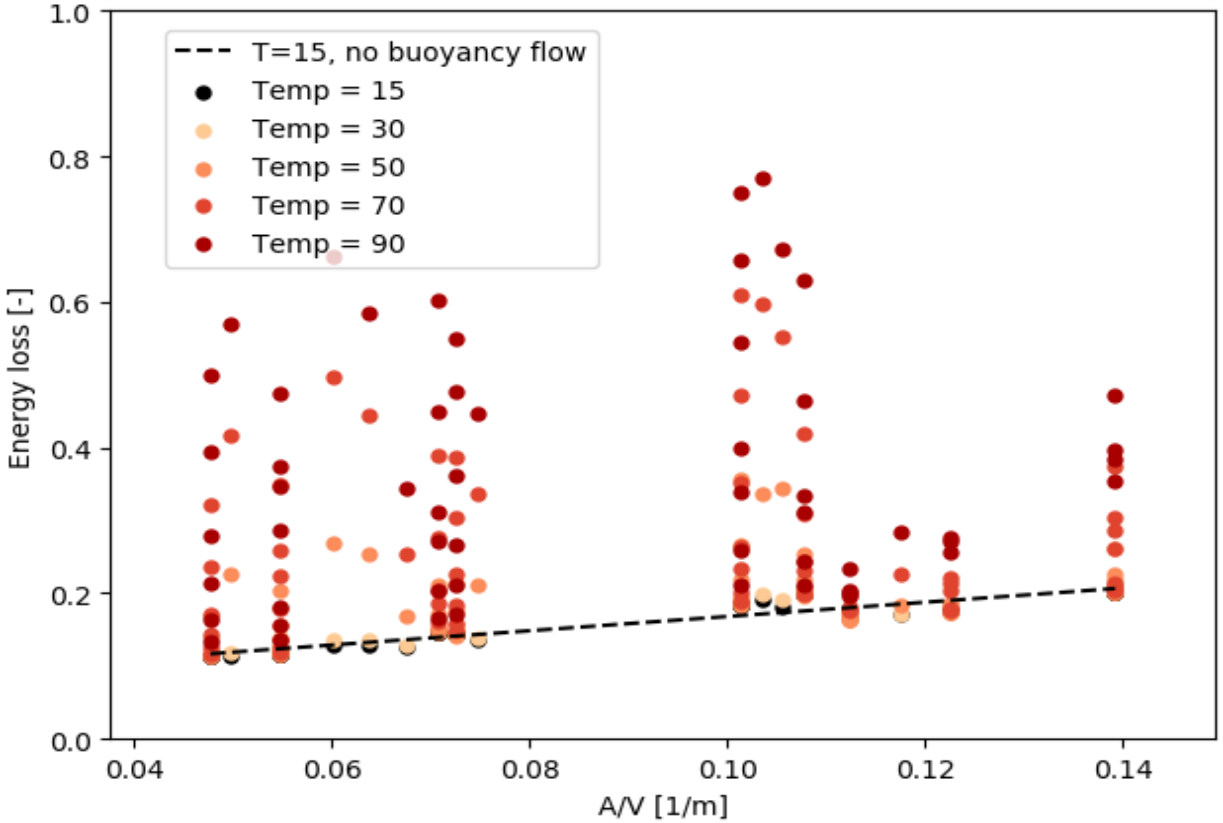
1. Impact & performance
   - Heat distribution / losses
   - Aquifer characterisation



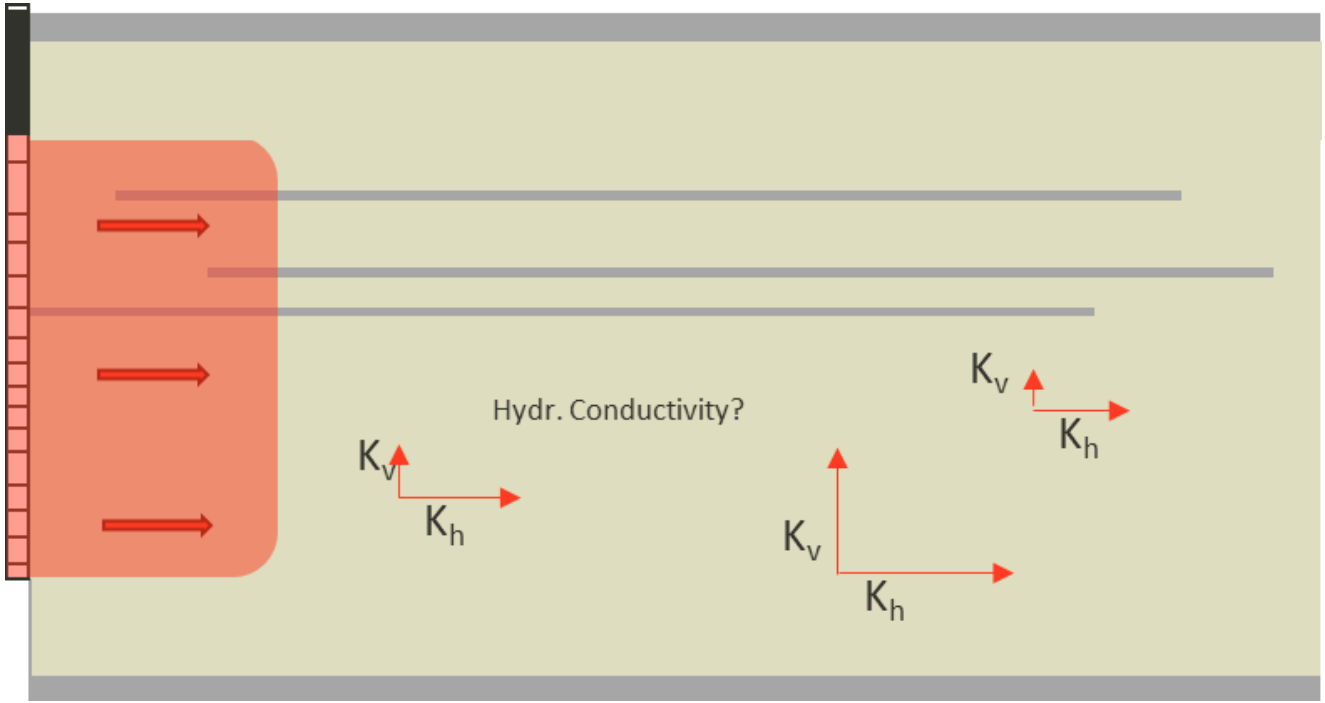


Lopik, J. H. v., N. Hartog and W. J. Zaadnoordijk (2016). "The use of salinity contrast for density difference compensation to improve the thermal recovery efficiency in high-temperature aquifer thermal energy storage systems." Hydrogeology Journal.

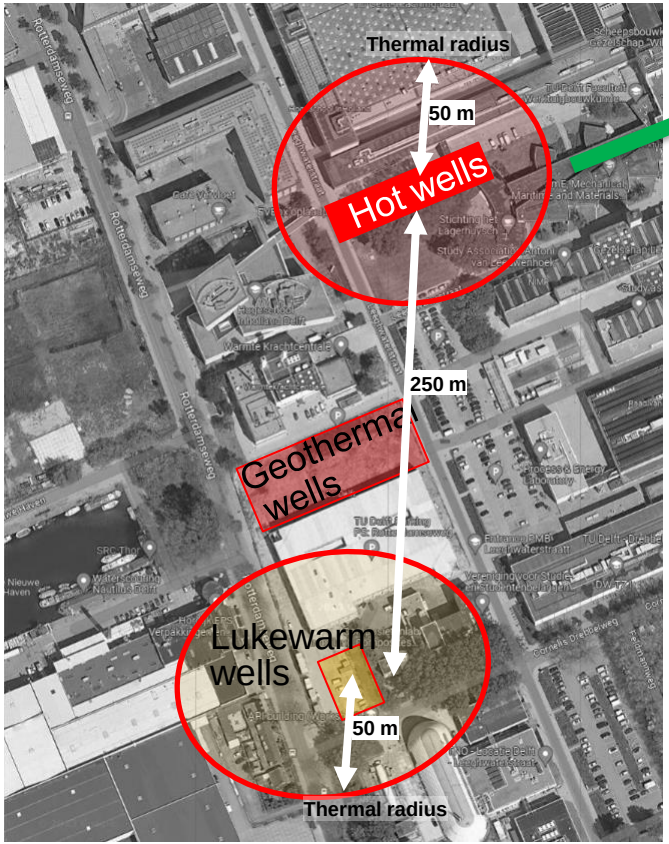
Buoyancy and conduction losses

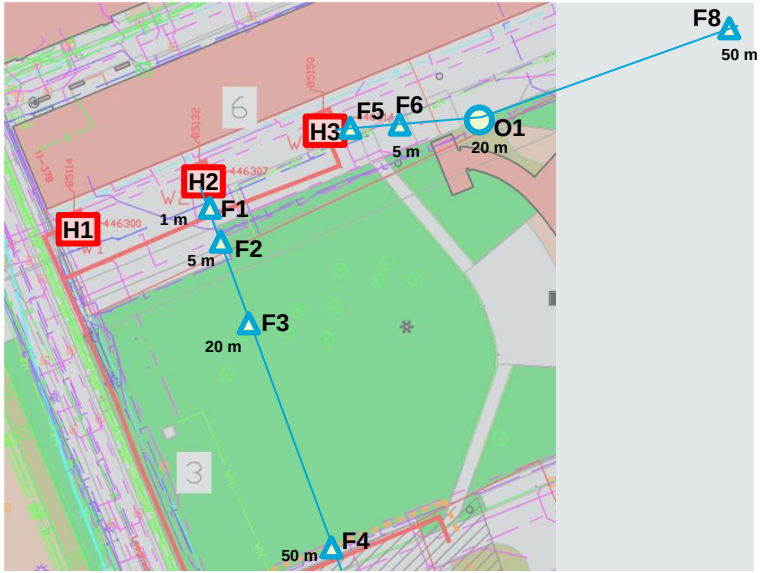


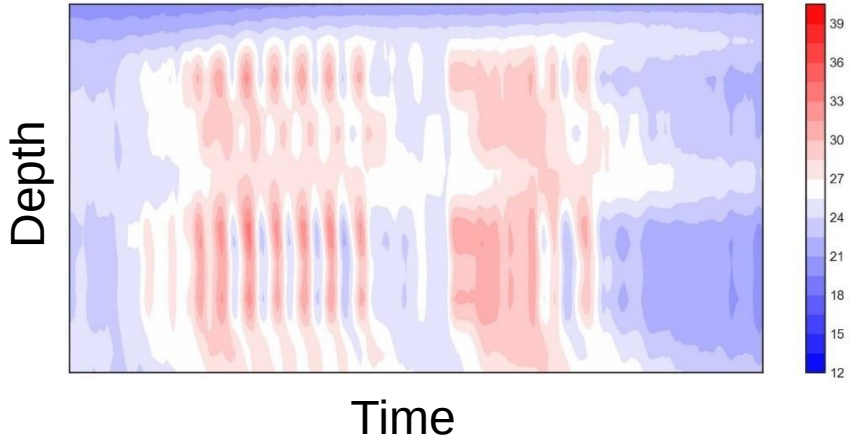
HT-ATES → aquifer conditions



Temperature distribution







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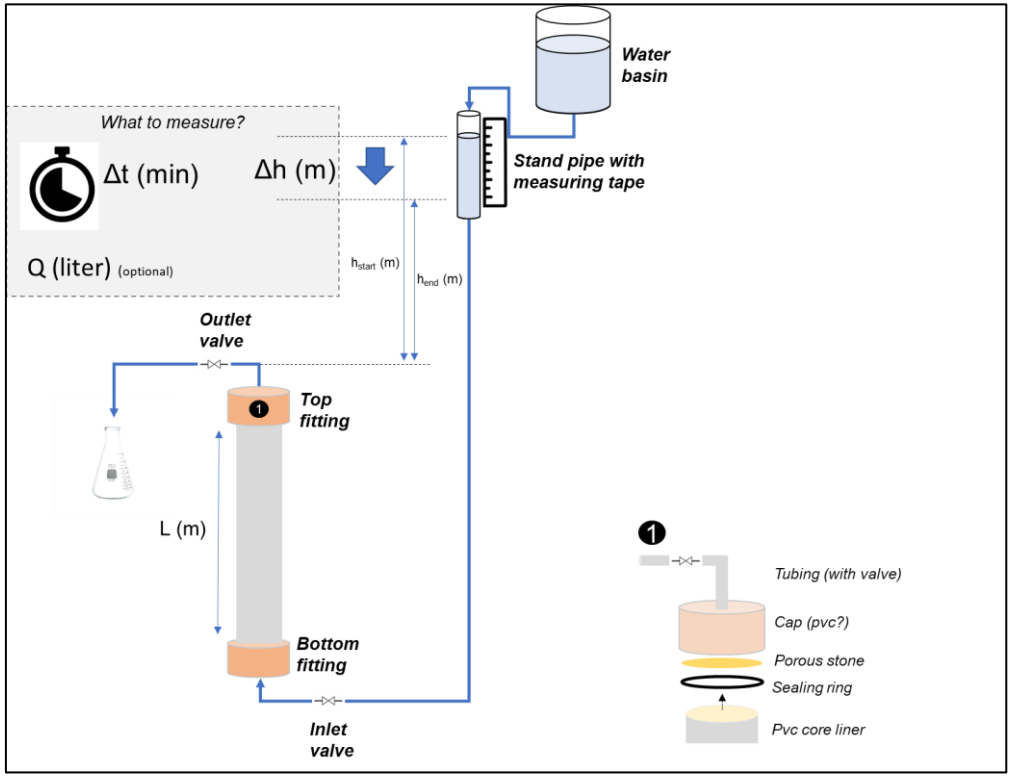
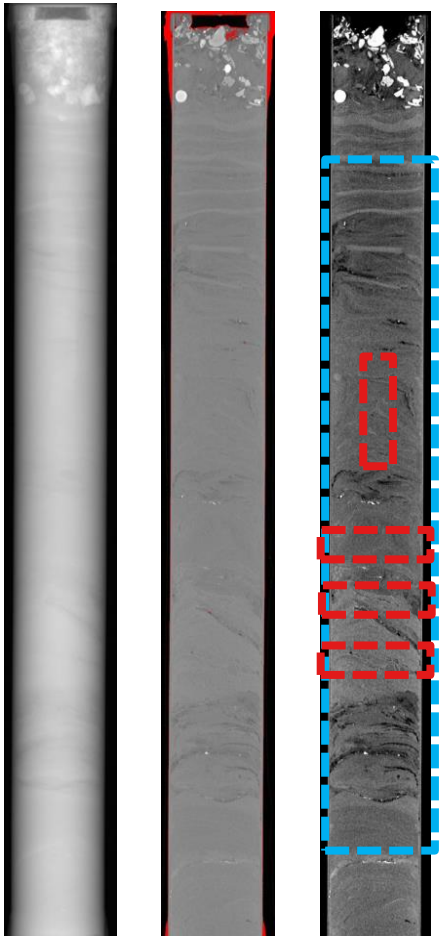
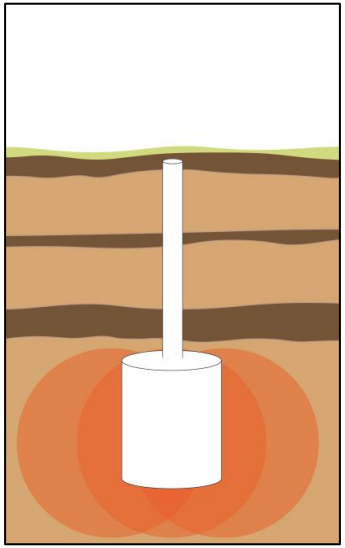
Core analysis and tests



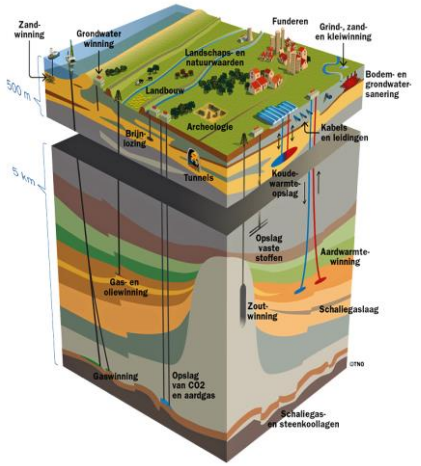


Innovation Highlights

1. Impact & performance
   - Heat distribution / losses
   - Aquifer characterisation
2. Wells
   - Well design and Drilling method



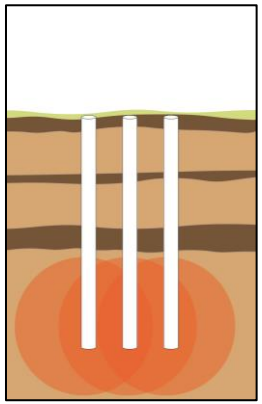
Problem

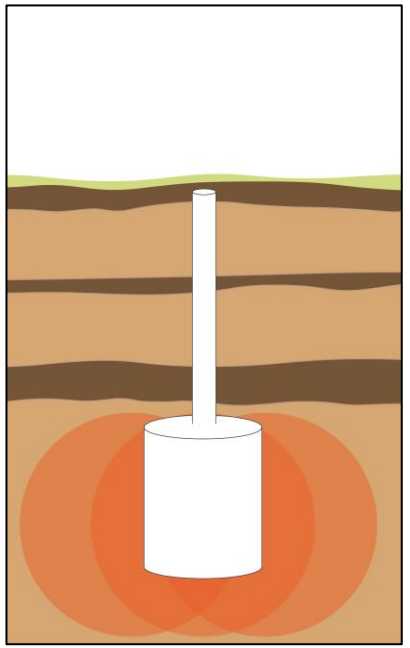


- Busy in the underground
- Utilise more “challenging” aquifers
  i.e. thin, fine grained, deep
- Capacity, clogging and costs are an issue

Expand borehole diameter at depth

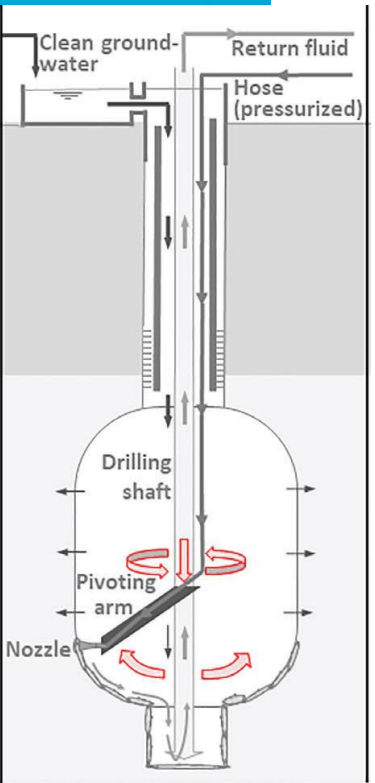
- Potential benefits
  - Reduce drawdown i.e. pumping costs
  - Reduce mechanical clogging
  - Reduce drilling costs





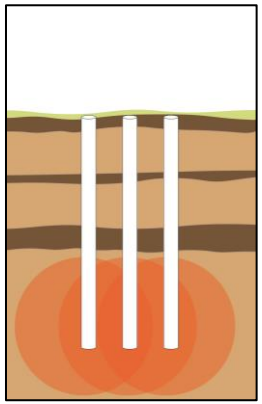
Expand borehole diameter at depth

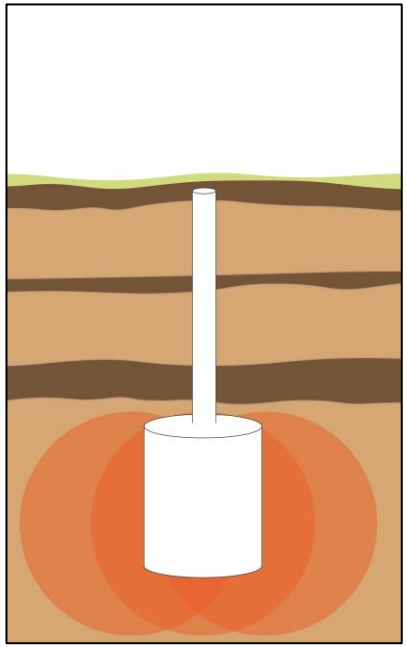
Under reaming by Jetting



Potential benefits

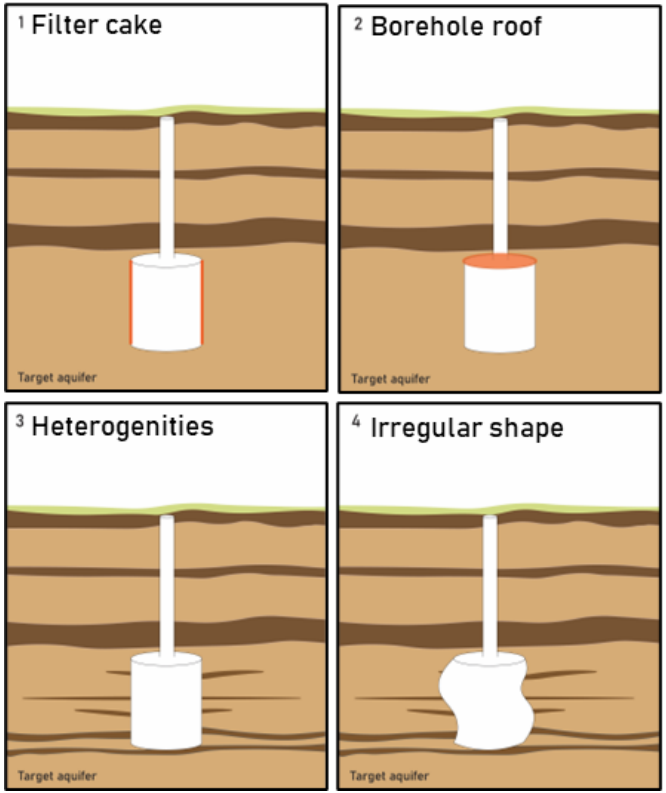
- Reduce drawdown i.e. pumping costs
- Reduce mechanical clogging
- Reduce drilling costs

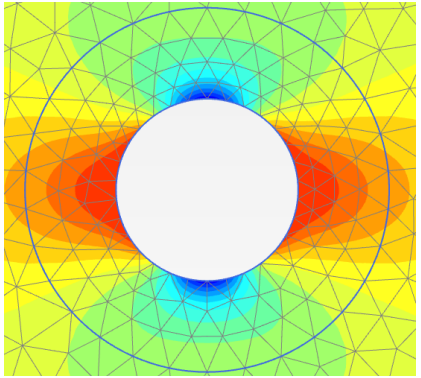




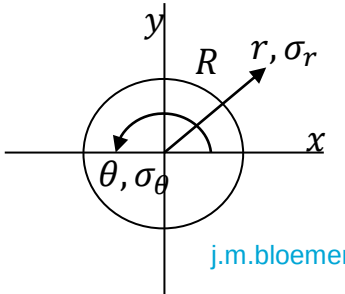
Method suitable for
Expansion of borehole in unconsolidated formations

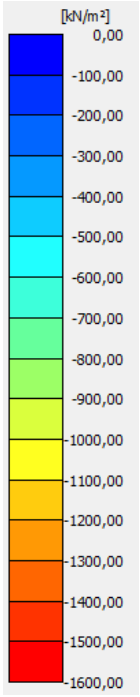
Expanded Diameter Gravel Well (EDGW) Principles and Challenges → wellbore stability





σ_y for R=1 m

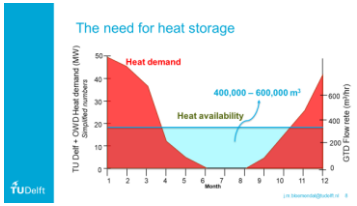




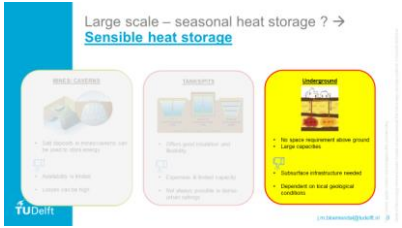
Innovation Highlights

1. Impact & performance
2. Wells
3. System integration and control
4. Societal

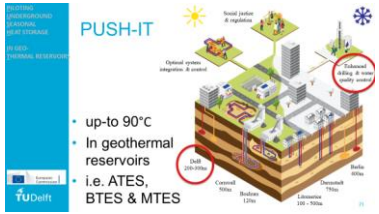
Take home

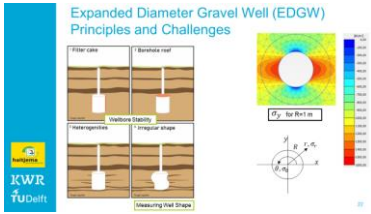


- Large scale seasonal heat storage is needed
- Underground accommodates capacity for seasonal storage



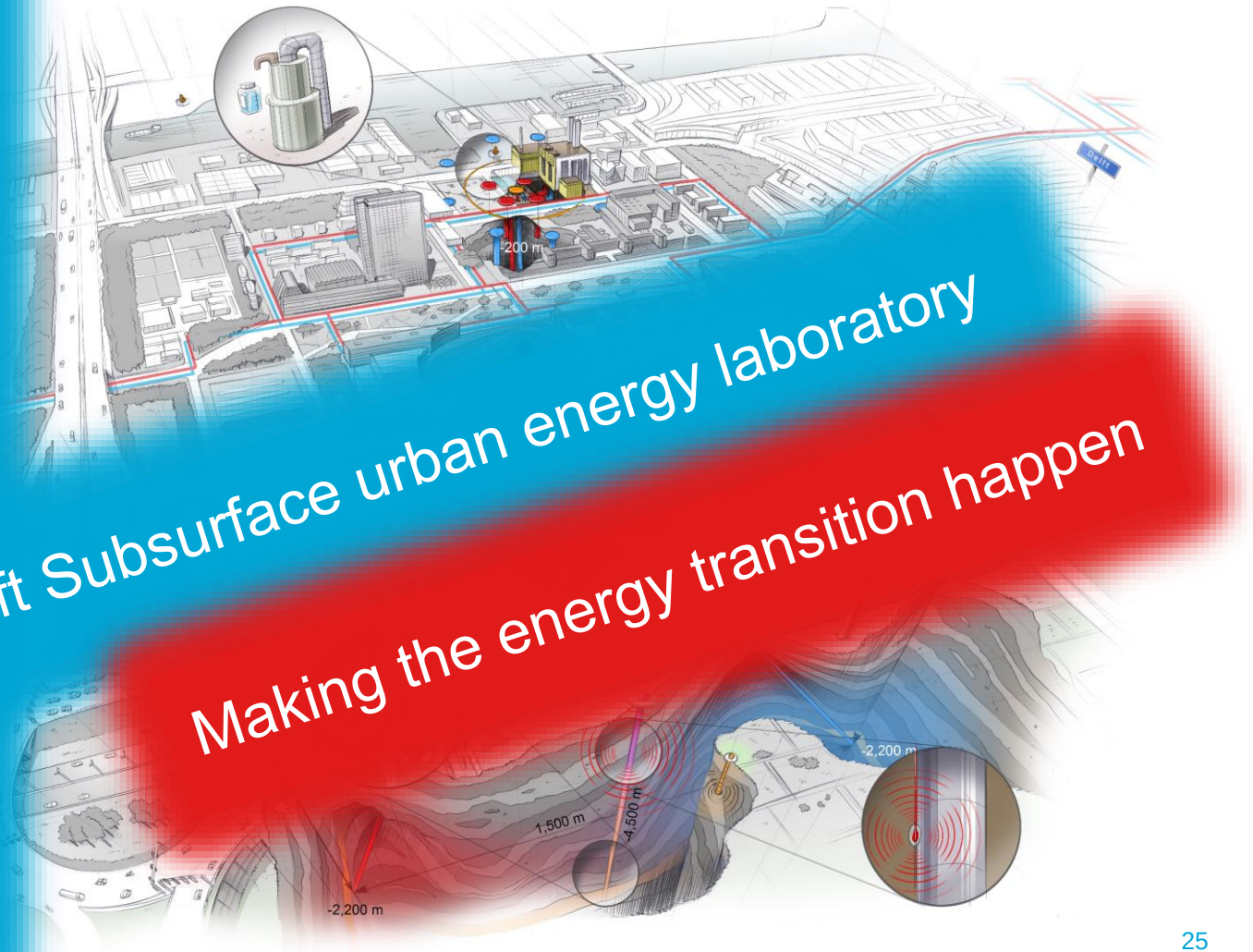
- Via fundamental research at demos towards cheap and robust seasonal heat storage in the underground





Novel combination of geothermal & HT-ATES

World-wide unique research & education infrastructure



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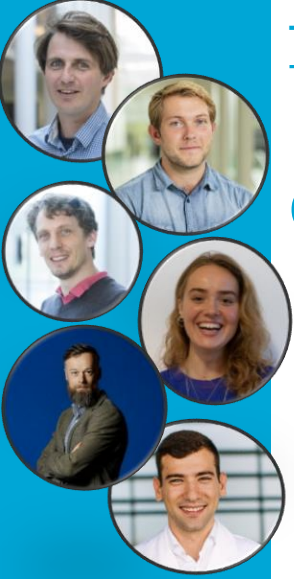

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Full-scale application and development of seasonal heat storage

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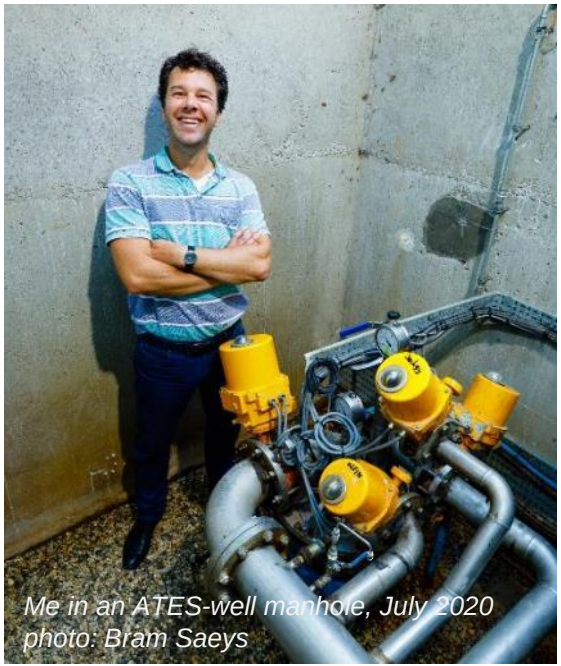
PUSH IT
www.push-it-thermalstorage.eu

Contributions from:
Tessel Grubben, Alexis Koulidis, Stijn Beernink, Martin v.d. Schans, Phil Vardon, Niels Hartog


Me in an ATES-well manhole, July 2020
photo: Bram Saeys

Co-funded by the European Union

TU Delft

Workshop in Utrecht
APPLICATIONS FOR INDUSTRIAL THERMAL ENERGY STORAGE