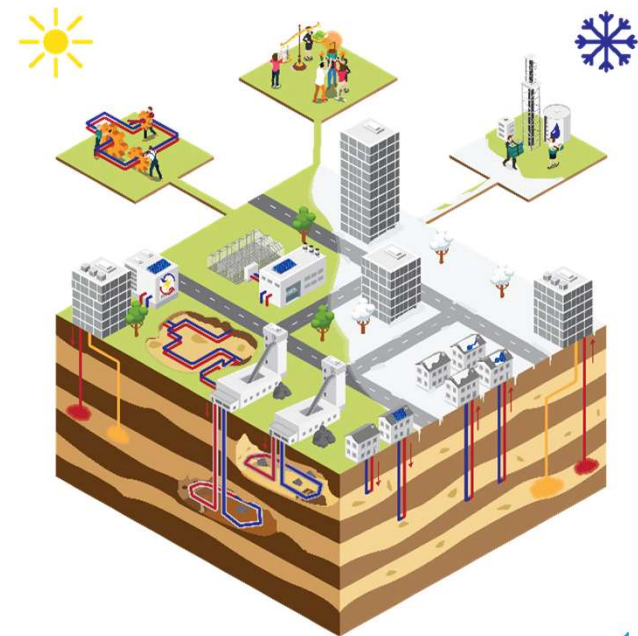


Onderzoek, innovatie en onderwijs op het gebied van bodemenergie op de TU Delft

2022-11-03
Gebruikersplatform bodemenergie

Dr.ir. M. Bloemendal
j.m.bloemendal@tudelft.nl



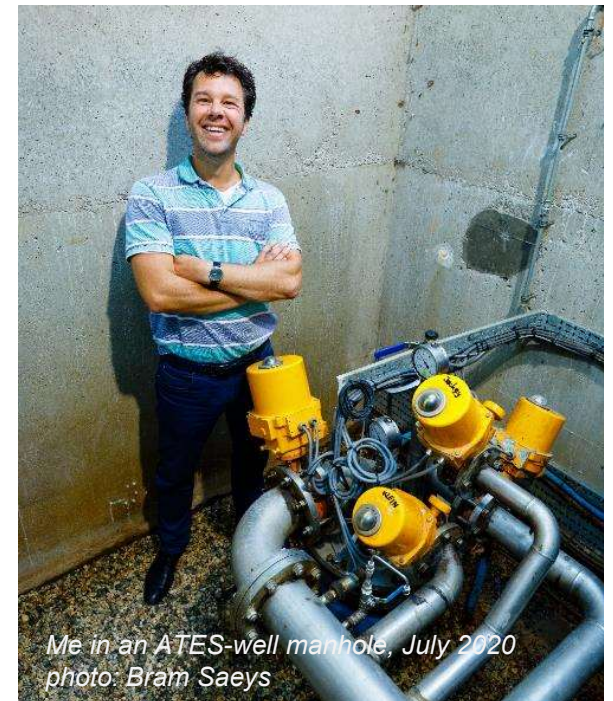
Dr.ir. Martin Bloemendal

Assistant professor UTES / bodemenergie

- TU Delft & KWR
- MSc Civil engineering
- 15 years experience in UTES practice
- >10 years UTES research
- PhD in ATES
- Water resources department
= grondwater & oppervlakte water

KWR

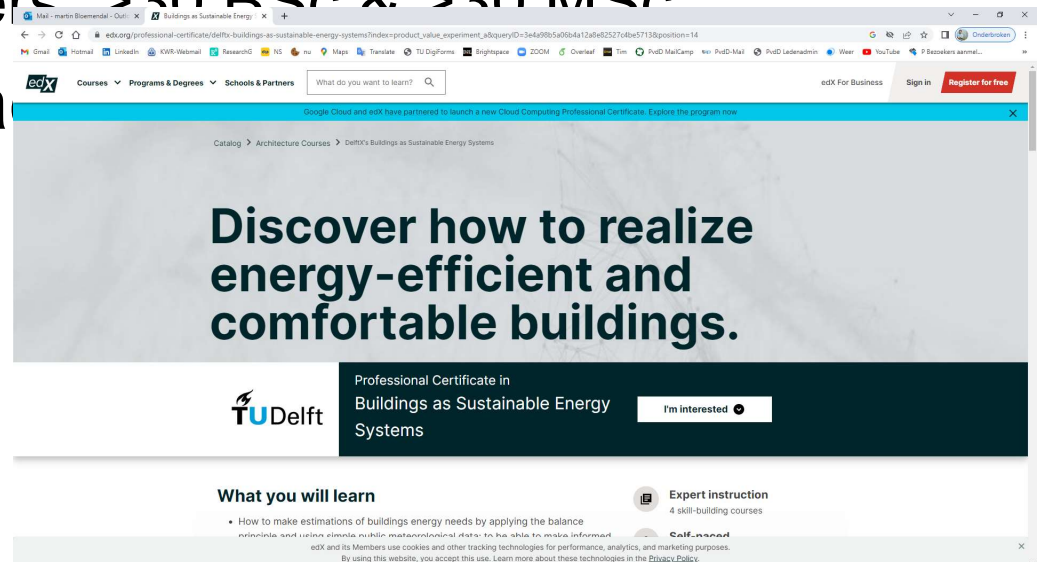
TU Delft



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

Education

- Online education
- Within MSc programmes
 - Afstudeerders: >30 BSc & >30 MSc
- SET Heat tra



Sustainable energy technology = Multi-disciplinary programme

- Multiple renewable energy sources needed to supply world energy demand
- Generation, transport, storage, and societal aspects
- **MSc SET** covers **all** these topics
- Similar programmes **TU/e** and **UT** within **4TU**.Education

MSc SET programme



Wind Energy



Solar Energy



Comb. Heat &



Storage



Power



Economics &
Society



Electric Mobility

Only about electricity!!

MSc SET programme: two tracks!

Electrical Energy



Wind Energy



Solar Energy



Comb. Heat &



Storage



Power



Economics & Society



Electric Mobility

Heating and Cooling



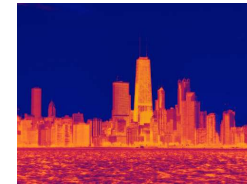
Heat Sources



Large scale heat



Comb. Heat &



Heat in Buildings and Processes



Power



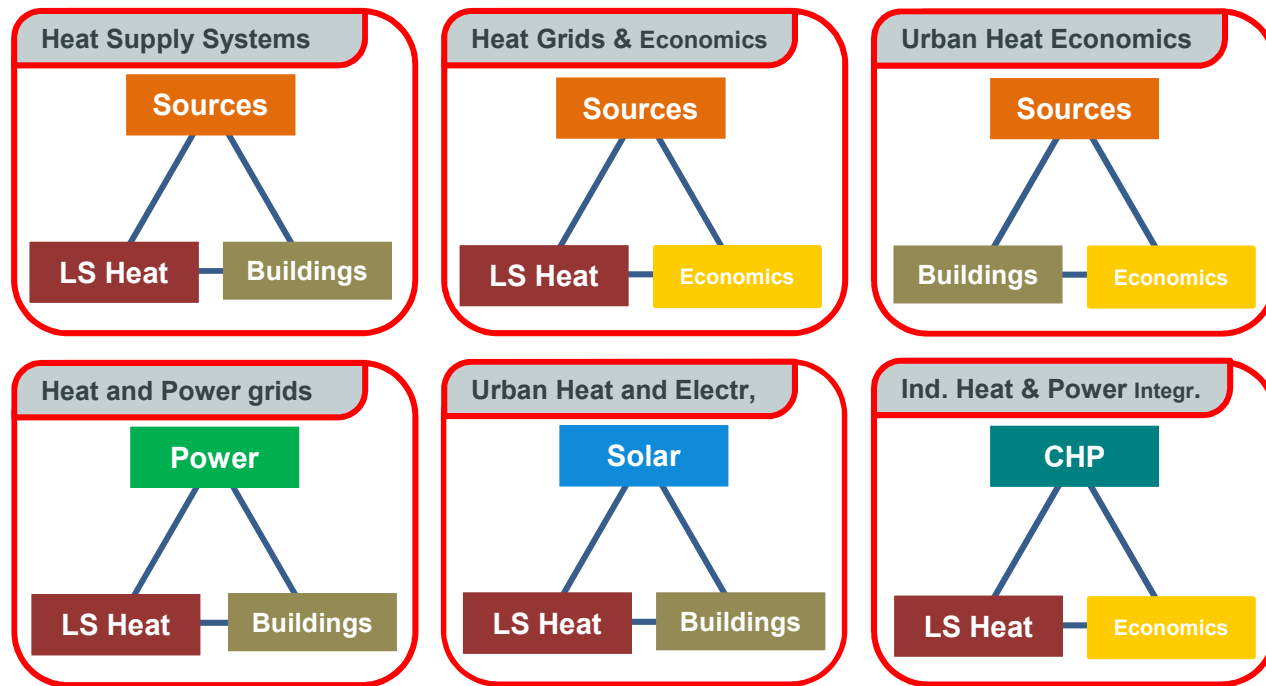
Economics & Society



Solar Energy

Profile Clusters

Track *Heating and Cooling*



Sustainable Energy Technology

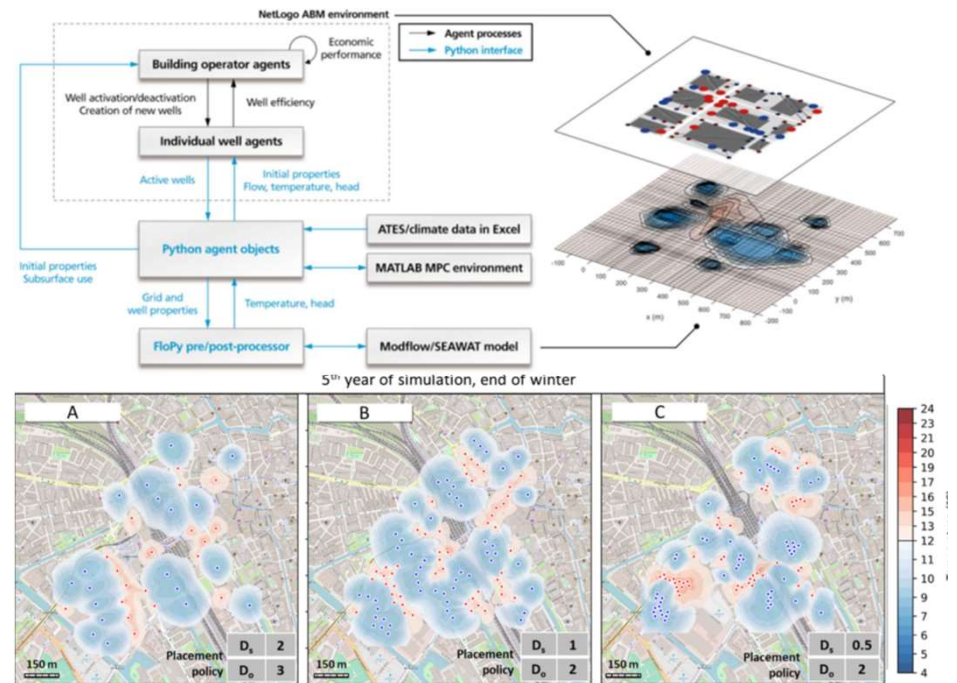
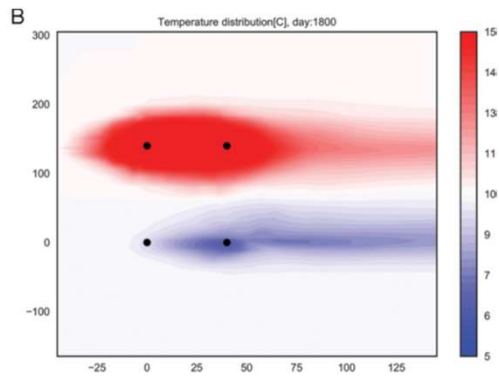
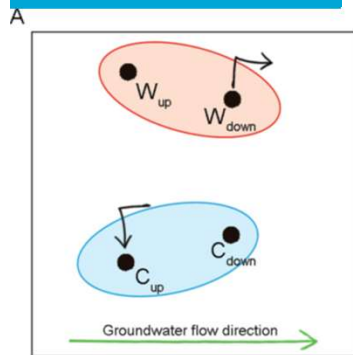
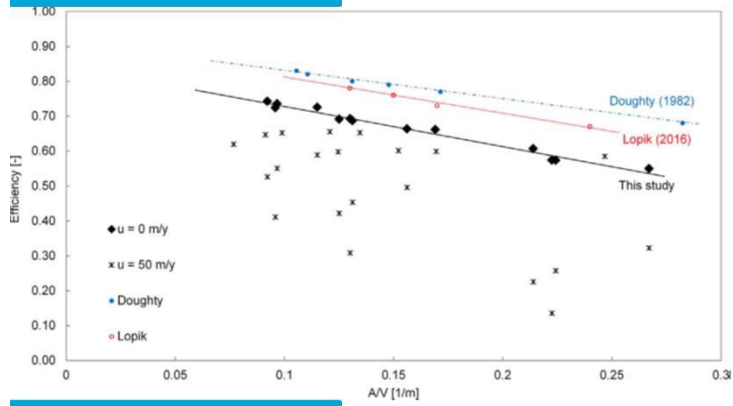


- **Electrical Engineering, Mathematics and Computer Science (EEMCS)**
- **Aerospace Engineering (AE)**
- **Applied Sciences (AS)**
- **Architecture (ABE)**
- **Civil Engineering and Geosciences (CEG)**
- **Mechanical, Maritime and Materials Engineering (3mE)**
- **Technology, Policy and Management (TPM)**
- **Industrial Design Engineering (IDE)**

Onderzoek & innovatie

- Bodemenergie
- Geo-energy structures
- Aquathermie
- Boor/bron technieken
- Warmte opslag

Bodemenergie



GEO-structures (1)



The green Village



GEO-structures (2)



Aquathermie

Max Kasteel / CRE

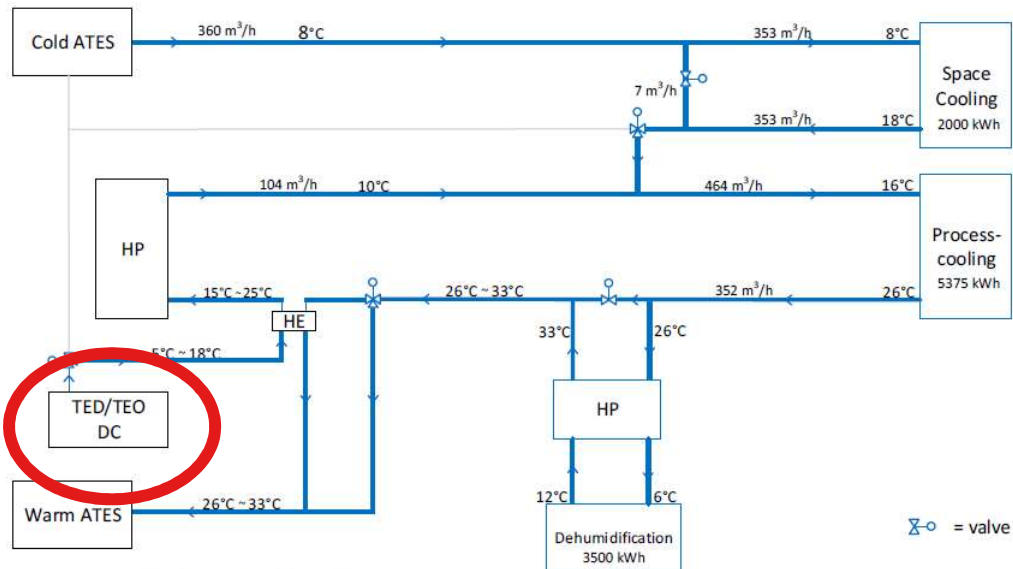
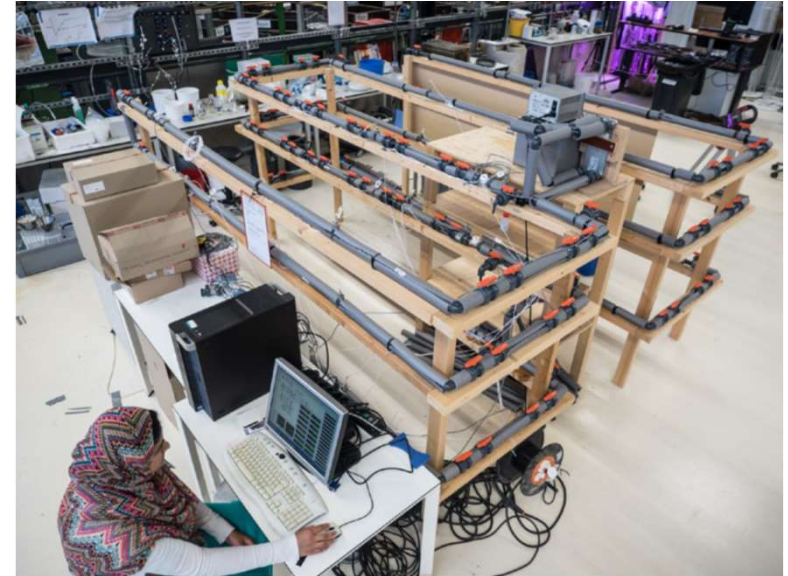


Figure 22 Coolina scheme – high demand

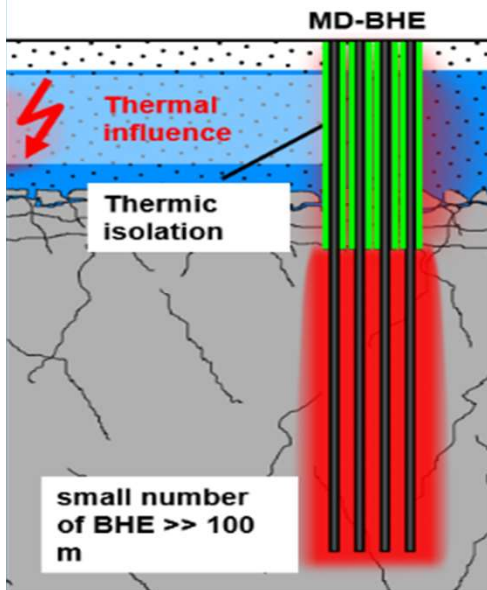
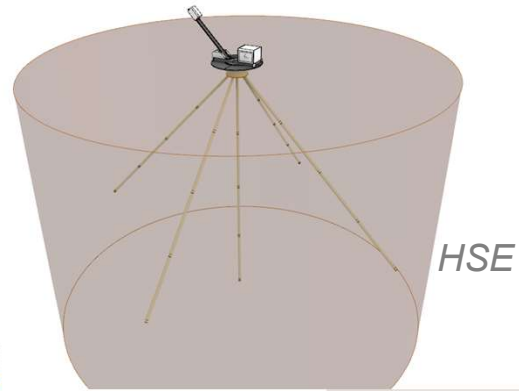


Waternet

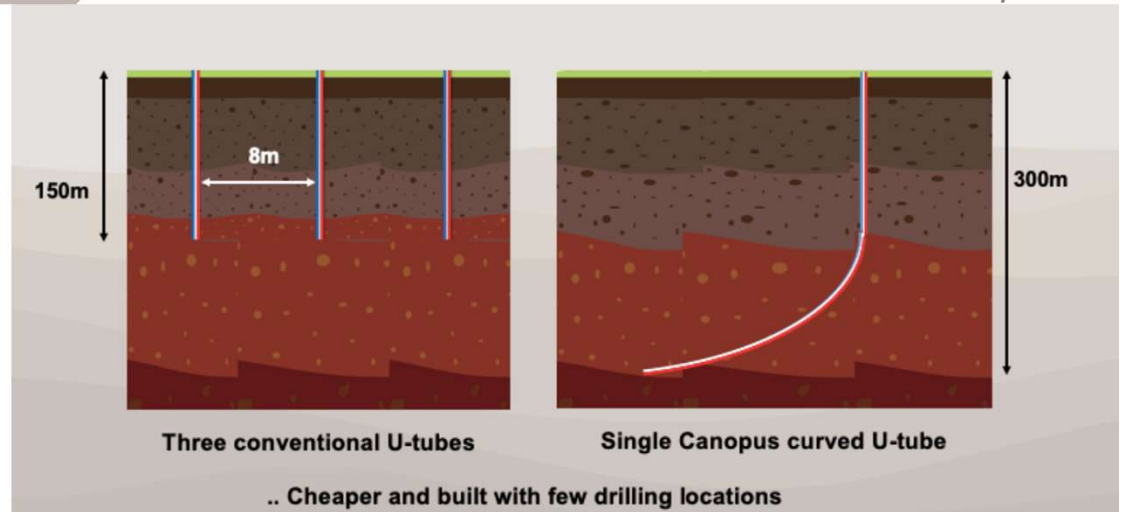


Boortechnieken – GBES

TU Darmstadt

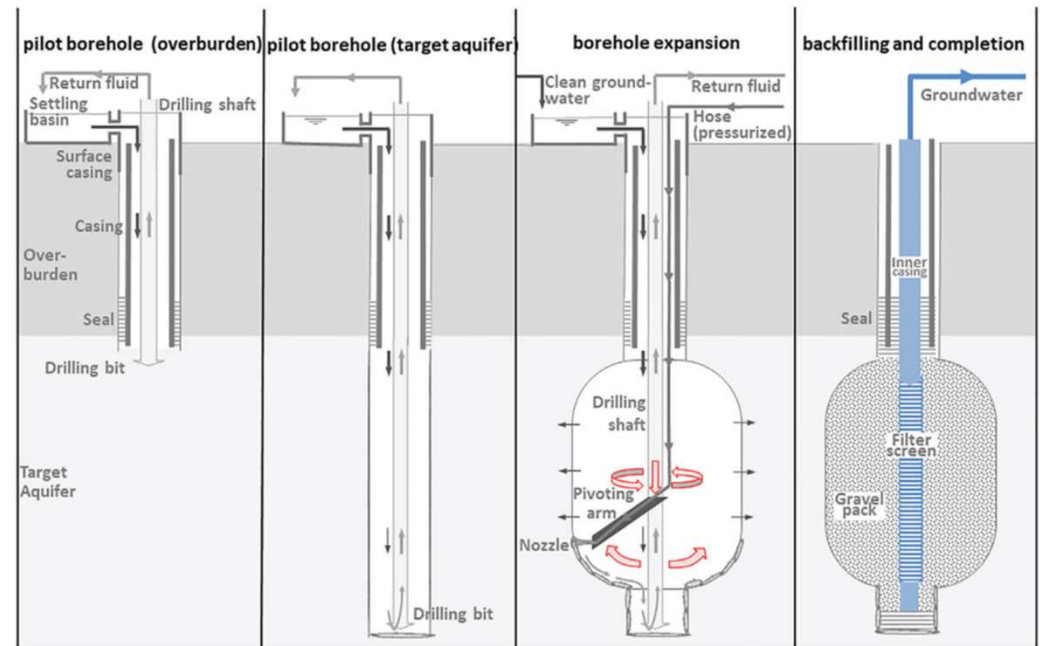


Canopus



Boortechnieken – OBES

- Drilling
 - EDGW
- Completion
 - GRE
 - SS
 - Vacuum



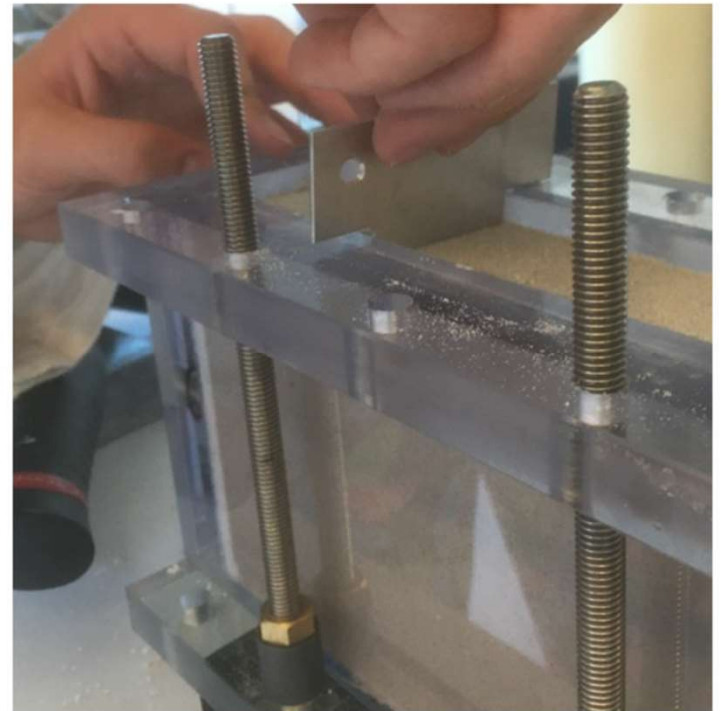
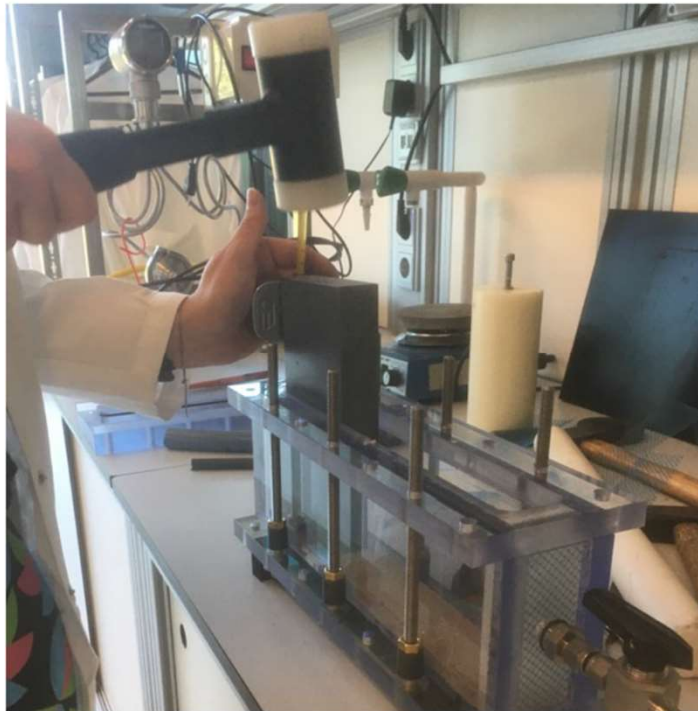
Schans, M.v.d., Bloemendal, M., Robot, N., Oosterhof, A., Stuyfzand, P.J., Hartog, N., 2022. Field Testing of a Novel Drilling Technique to Expand Well Diameters at Depth in Unconsolidated Formations. *Groundwater*

KWR

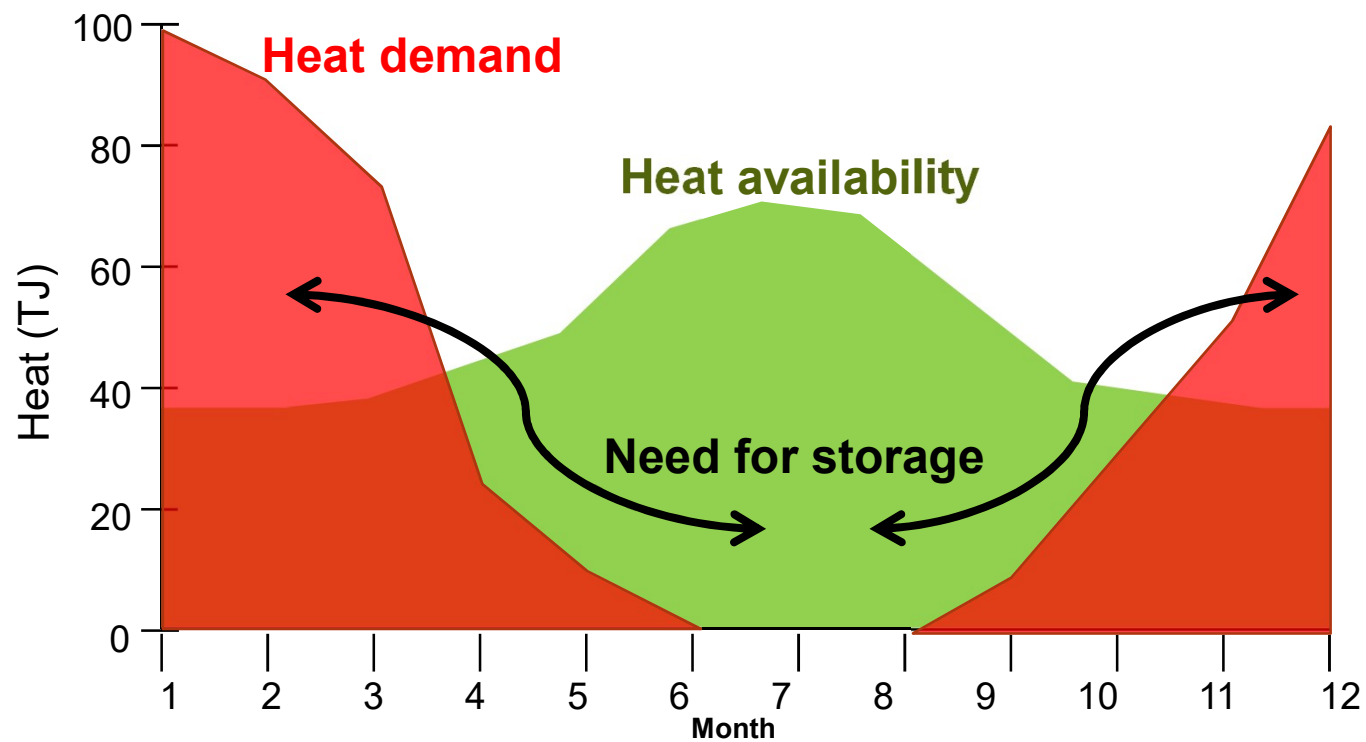
TU Delft

Bron Techniek - OBES

Noor van Eimeren, KWR



Warmte opslag

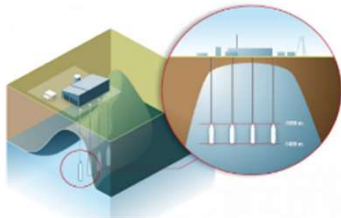


Heat demand and availability at Northern hemisphere j.m.bloemendal@tudelft.nl 17

Large scale – seasonal heat storage → Sensible heat storage

PCM & TCM
Small scale and short cycle storage

MINES/ CAVERNS

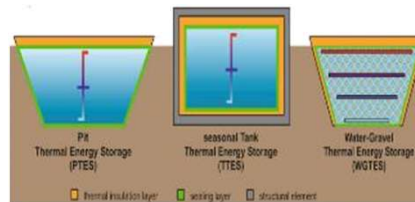



- Salt deposits in mines/caverns can be used to store energy.



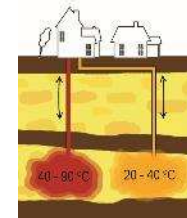
- Availability is limited
- Losses can be high


TANKS/PITS



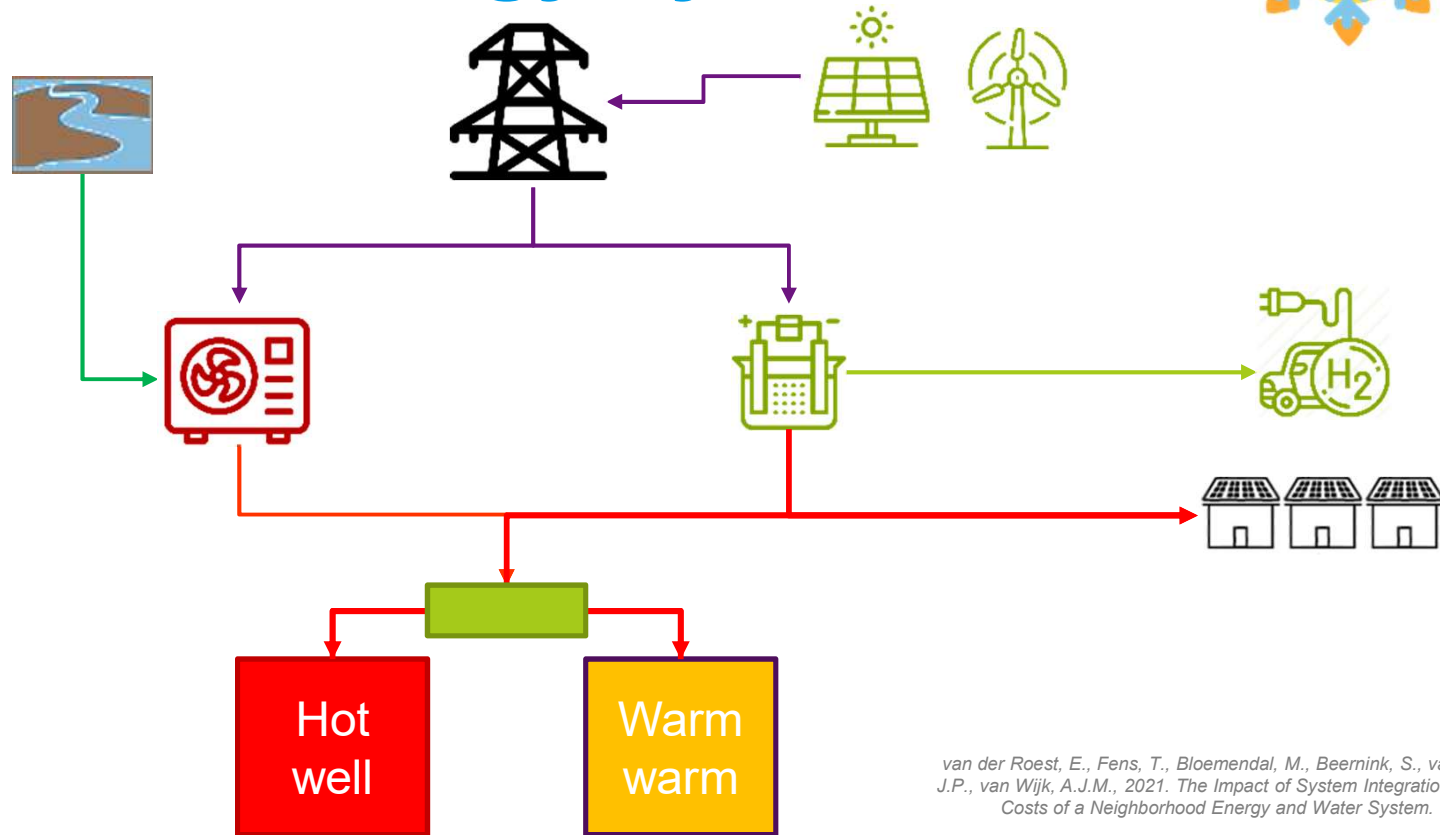
- Offers good insulation and flexibility
- 
- Expensive & limited capacity
 - Not always possible in dense urban settings

Underground



- No space requirement above ground
 - Large capacities
- 
- Subsurface infrastructure needed
 - Dependent on local geological conditions

Multi energy systems



van der Roest, E., Fens, T., Bloemendal, M., Beerink, 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.

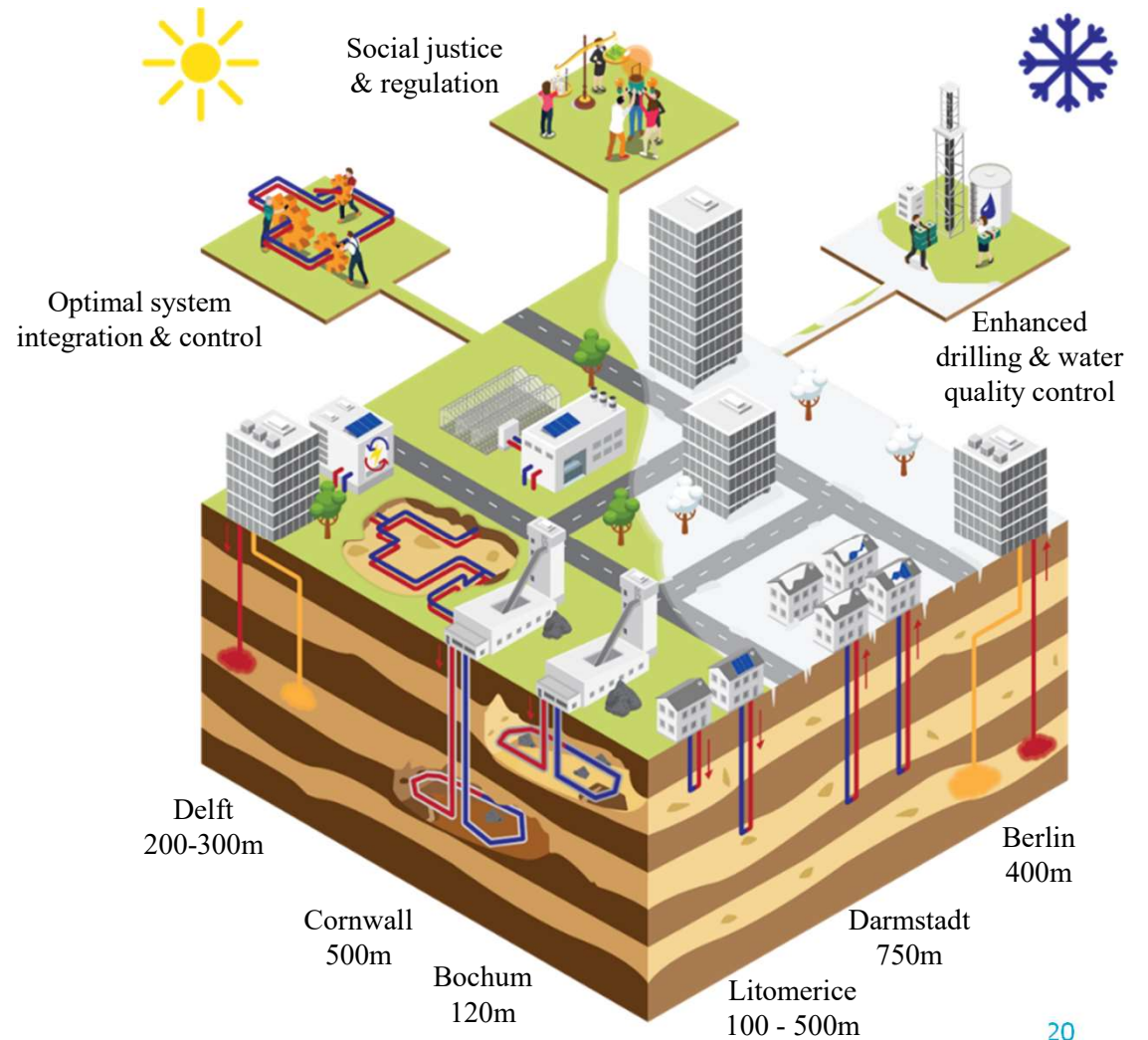
j.m.bloemendal@tudelft.nl 19

PILOTING
UNDERGROUND
SEASONAL
HEAT STORAGE

IN
GEO_THERMAL
RESERVOIRS

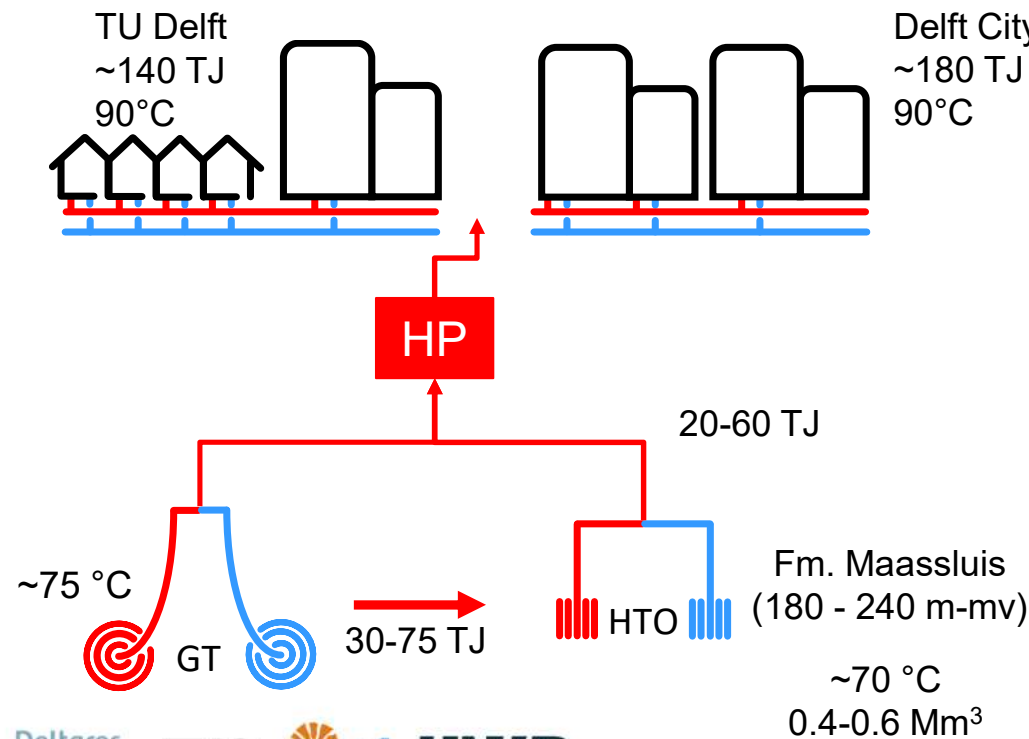


PUSH-IT



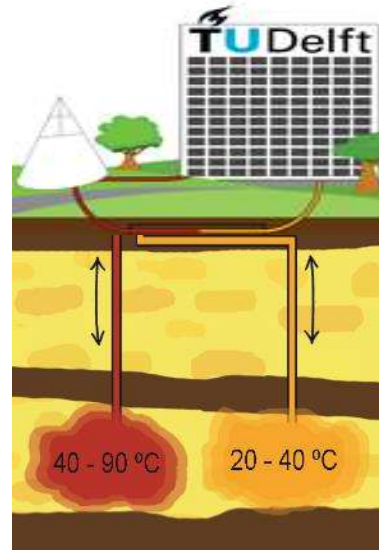
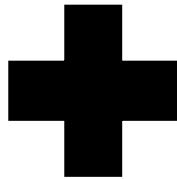
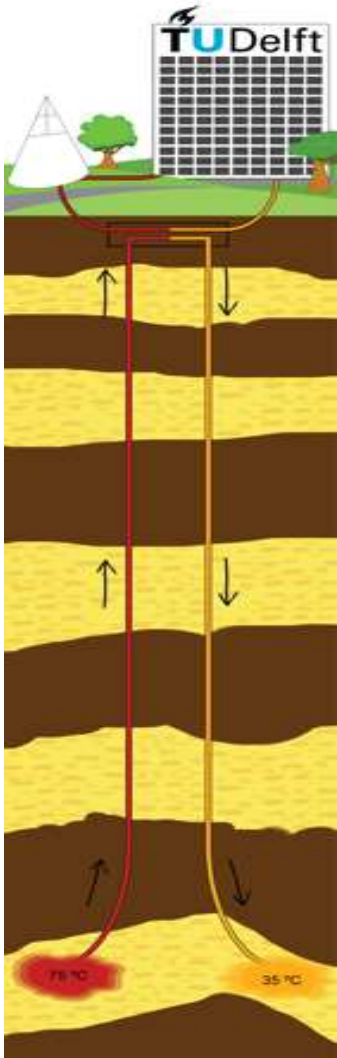


HT-ATES Delft – Lay-out/concept



- + Wells at own premises
- + In potential large demand
- + Also research and education

- Integration with Heat pump under development
- Development OWD uncertain
- Complex stakeholder landscape



Novel combination of
geothermal energy and HT-ATES
&
World-wide unique research infrastructure

Onderzoek, innovatie en onderwijs op het gebied van bodemenergie op de TU Delft

2022-11-03
Gebruikersplatform bodemenergie

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