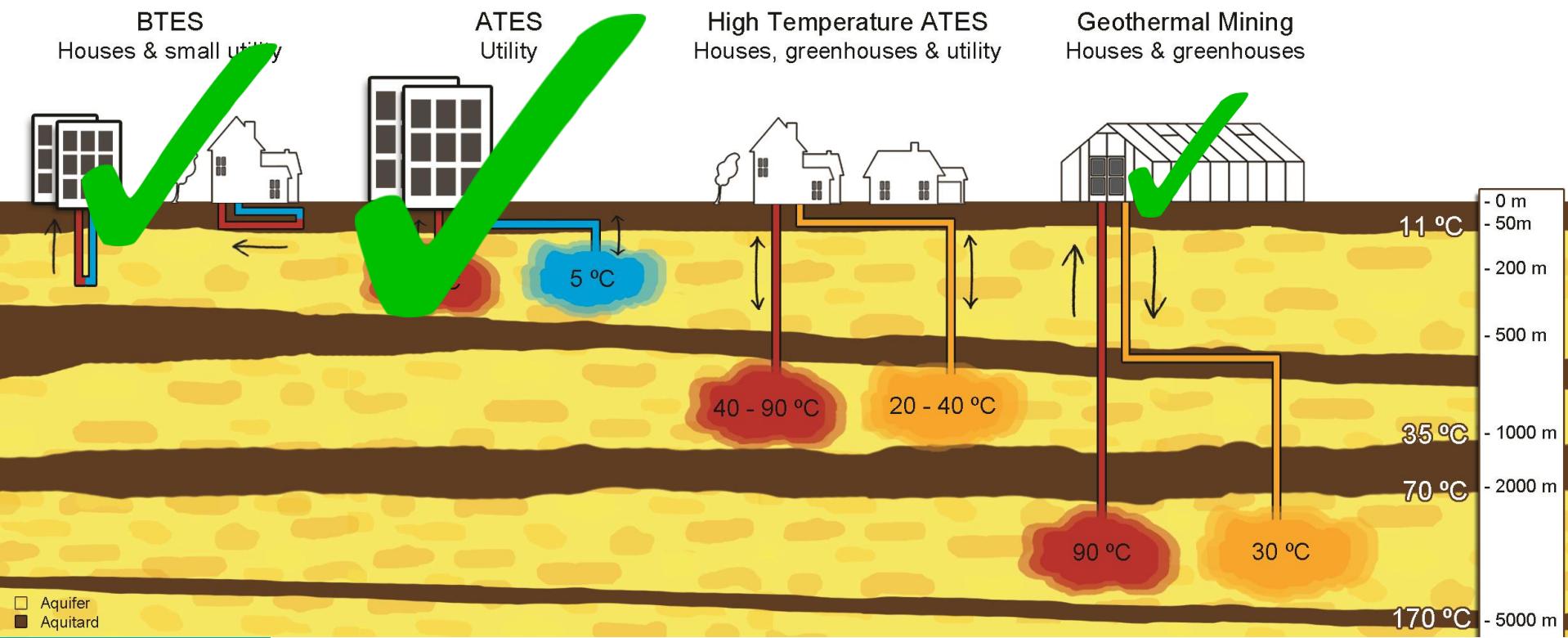


Opportunities and challenges for large scale HT-ATES systems

Martin Bloemendaal
2019-03-12



Geothermal Energy in NL





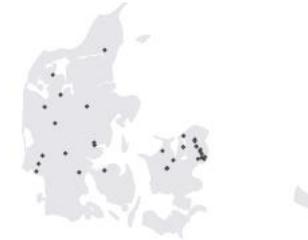
Netherlands & Belgium



China & Japan



Denmark



Great Britain



ATES

- 0
- 1-2
- 3-5
- 6-10
- 11-20
- 21-100
- 101-500
- >2000
- Implemented ATES

CA: 4
US: 2

DK: 55

GB: 12
NL: 2500
BE: 30
DE: 4

SE: 220
NO: 8

TR: 1

JP: 2
CN: 6

Sweden & Norway



North America



Germany

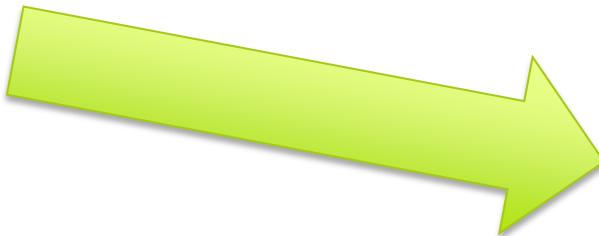


Turkey

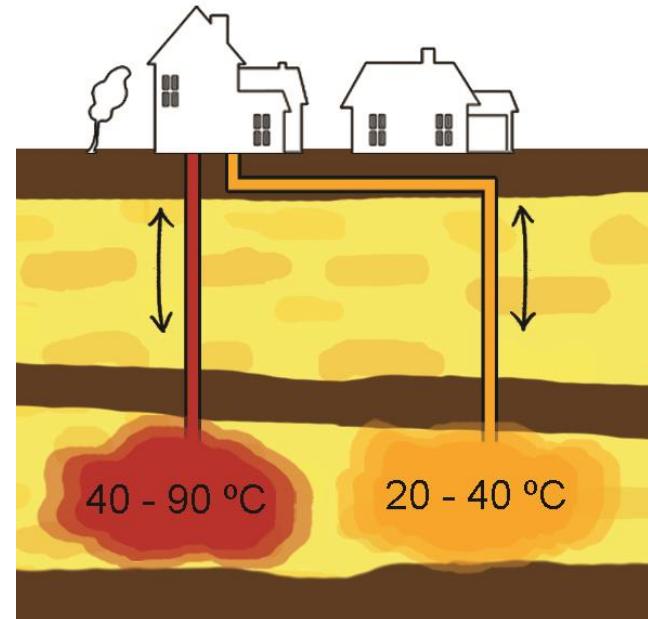


HT-ATES

- $>25^{\circ}\text{C}$
- Currently permitted as “pilot-projects”

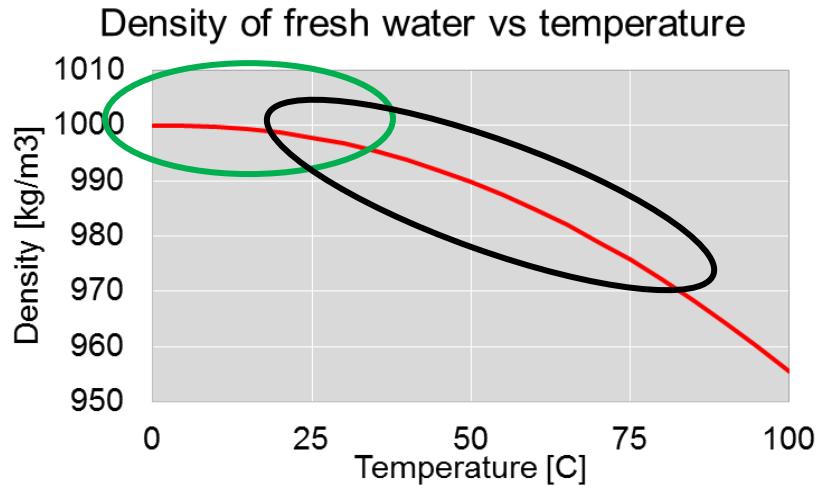


High Temperature ATES
Houses, greenhouses & utility

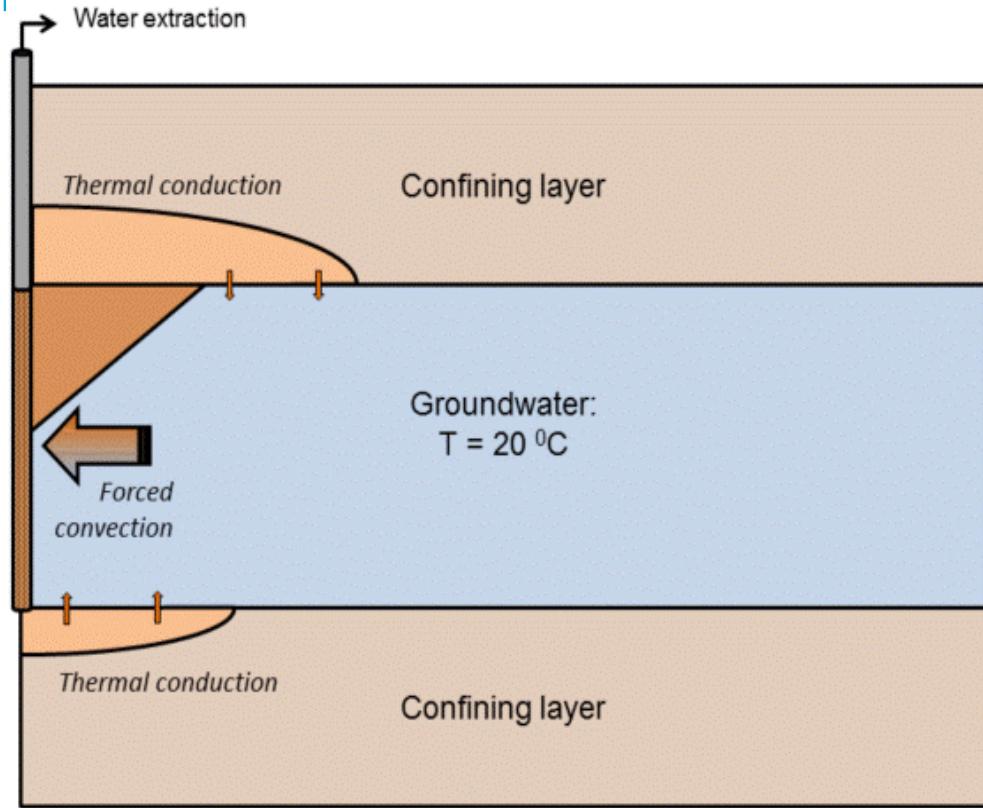
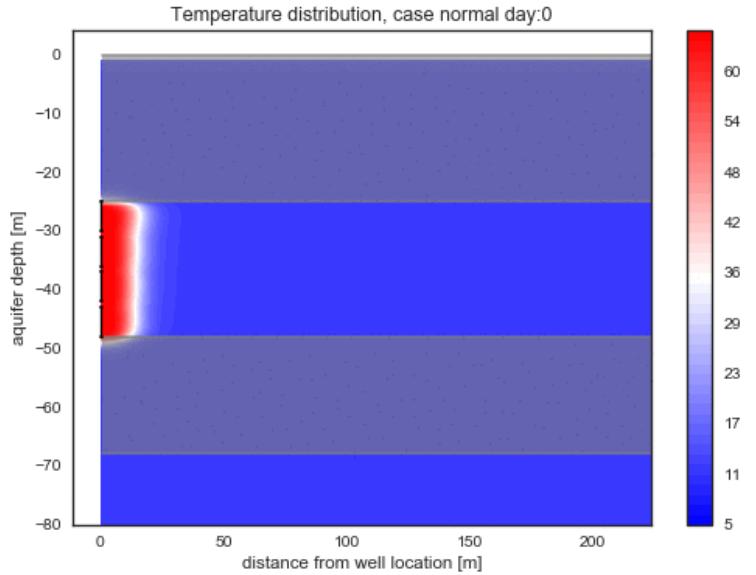


Challenges

- Chemical & micro biological effects
- Clogging e.g. Deposition of CaCO_3
- Buoyancy flow

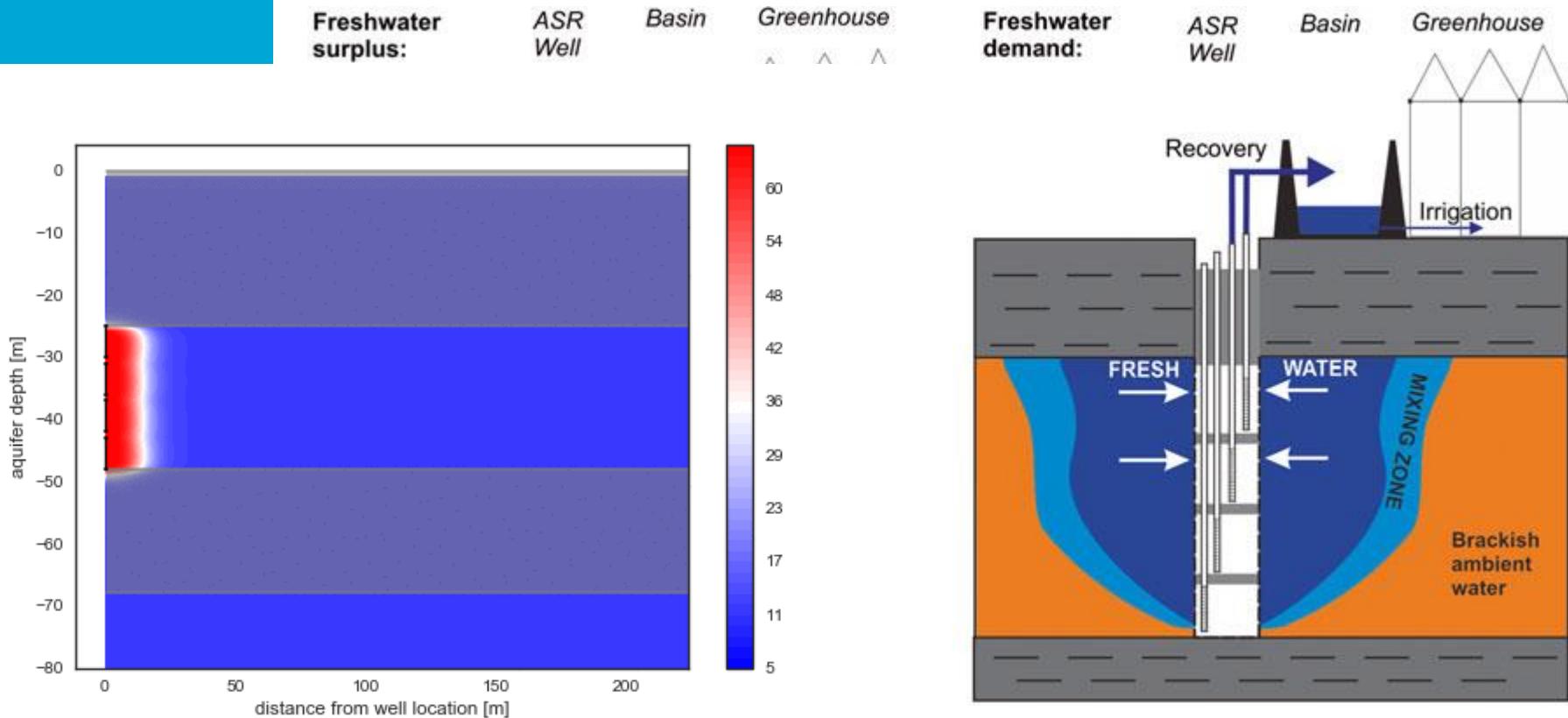


HT-ATES → Rinnovancy



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*.

Multi partially penetrating wells

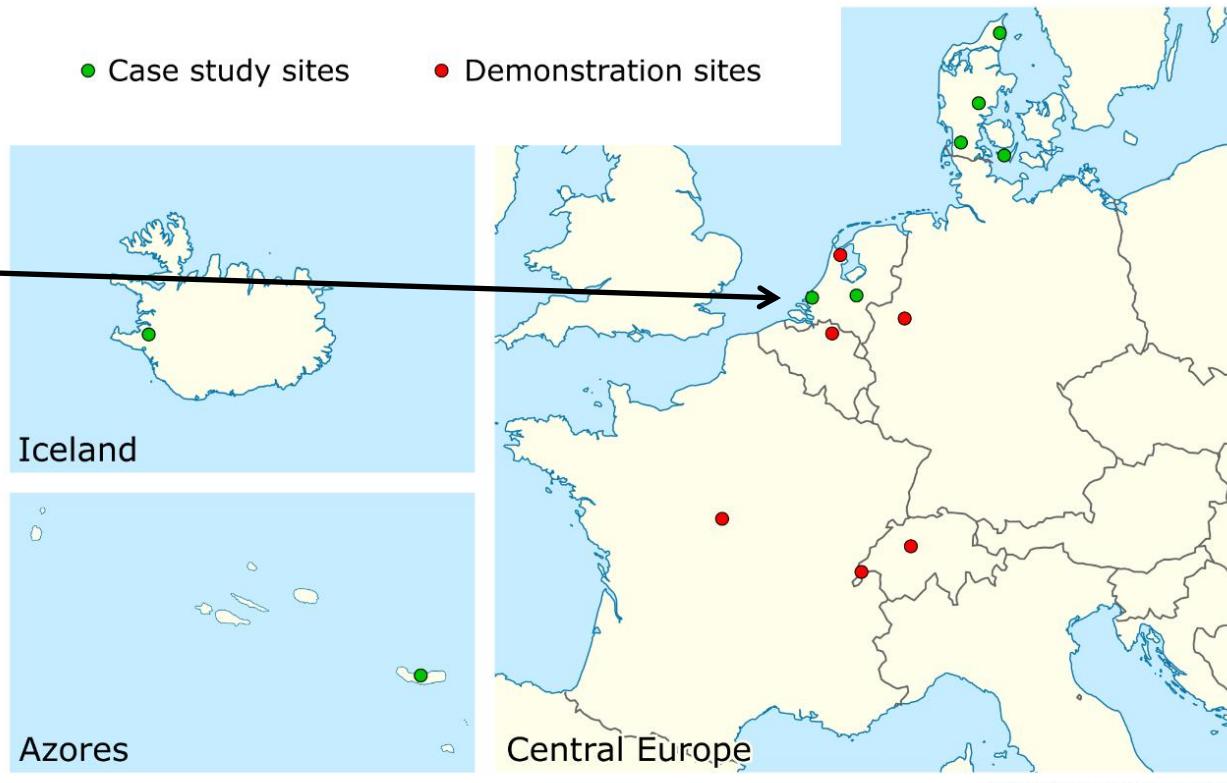


Effects
Efficiency
GW-quality

EGC 19
field-trip

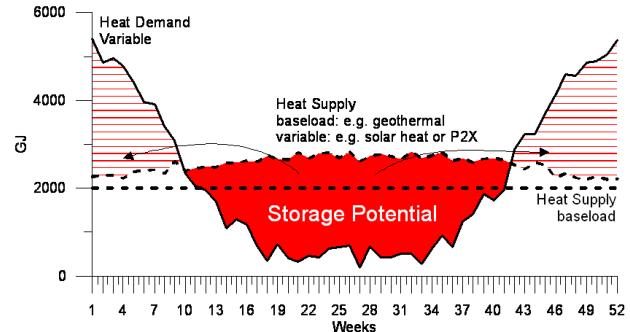
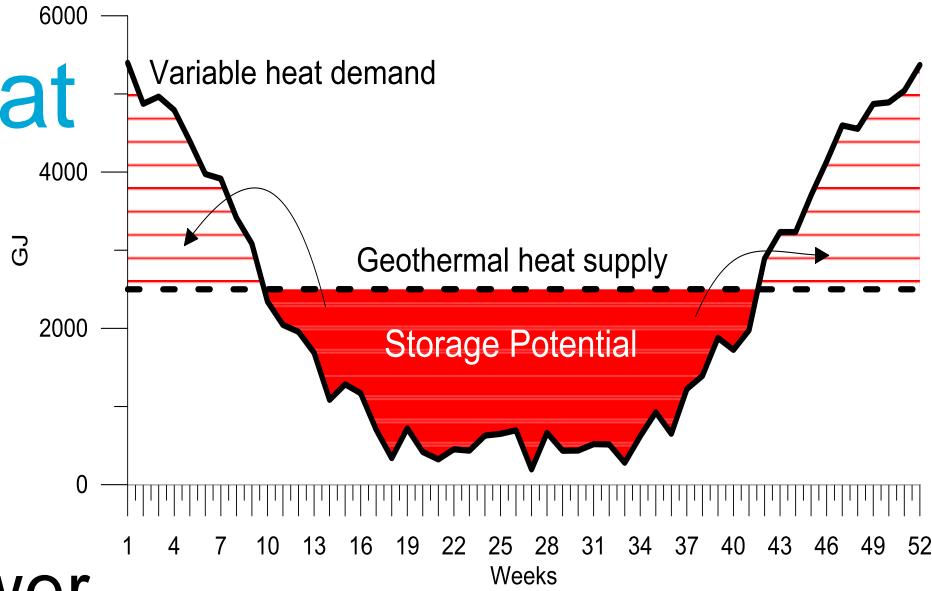
HEATSTORE

(geothermica funding)



Sources of heat

- Geothermal
- Waste heat
- Solar heat
- Solar / wind power

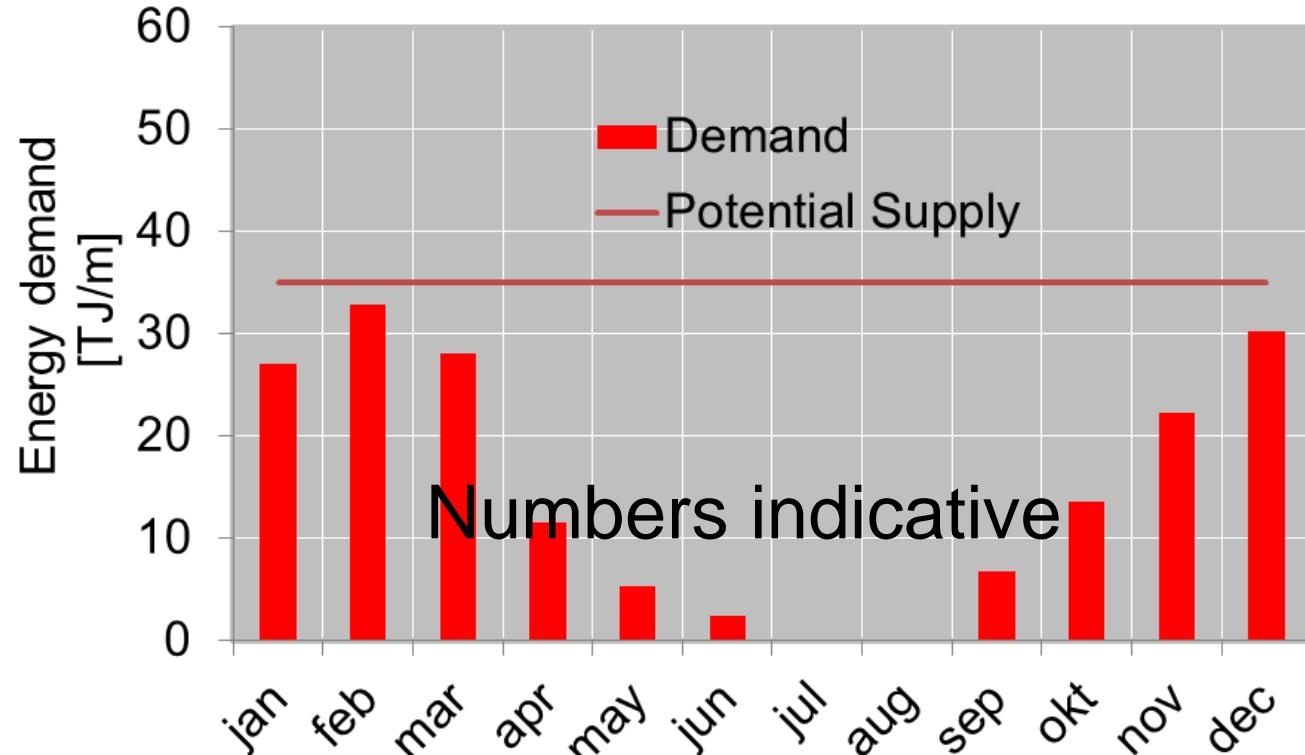


Demand:
180 TJ/y

Direct from
DAP-well :
180TJ/y

Potential
DAP well:
>400TJ/y
(p50)

HT-ATES @ TU Delft



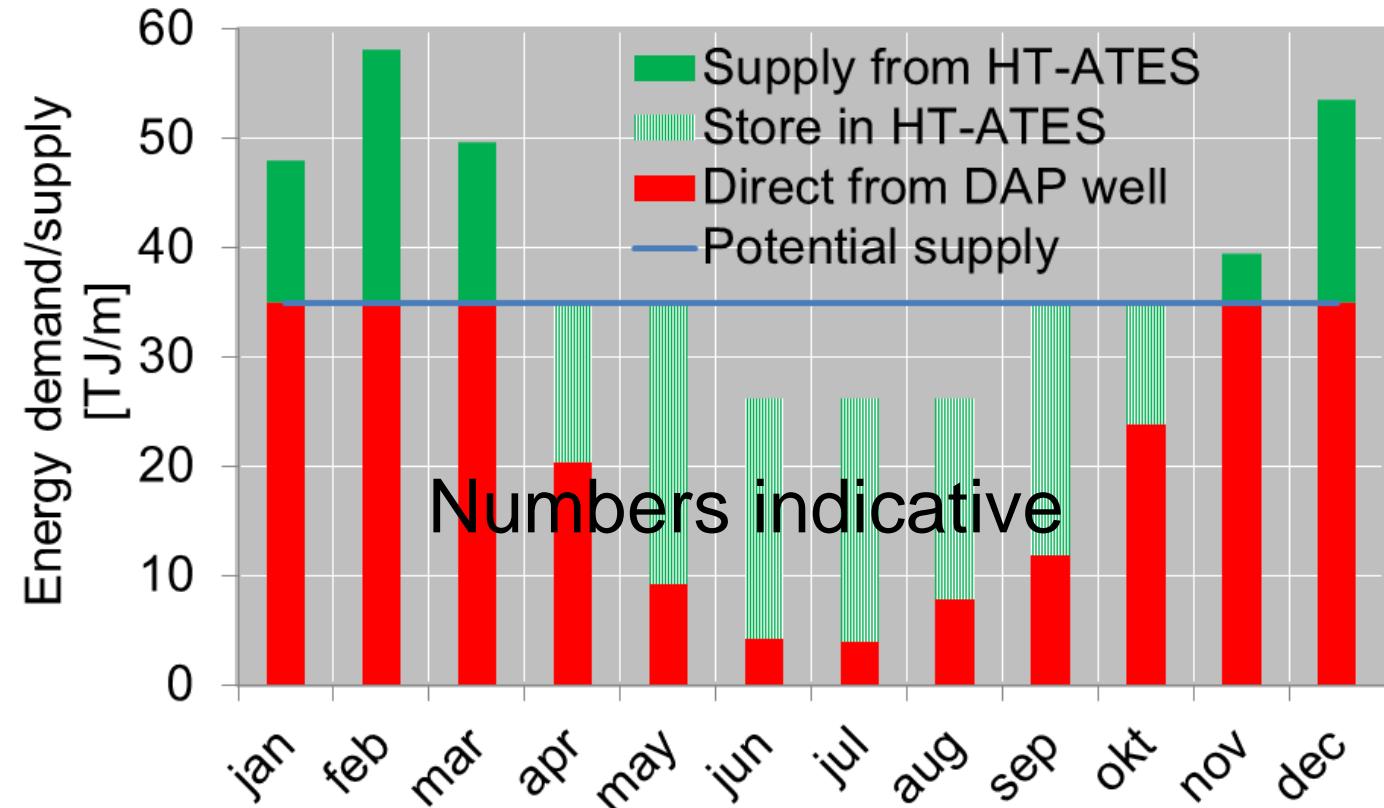
Add 15,000 houses to
Demand:
330 TJ/y

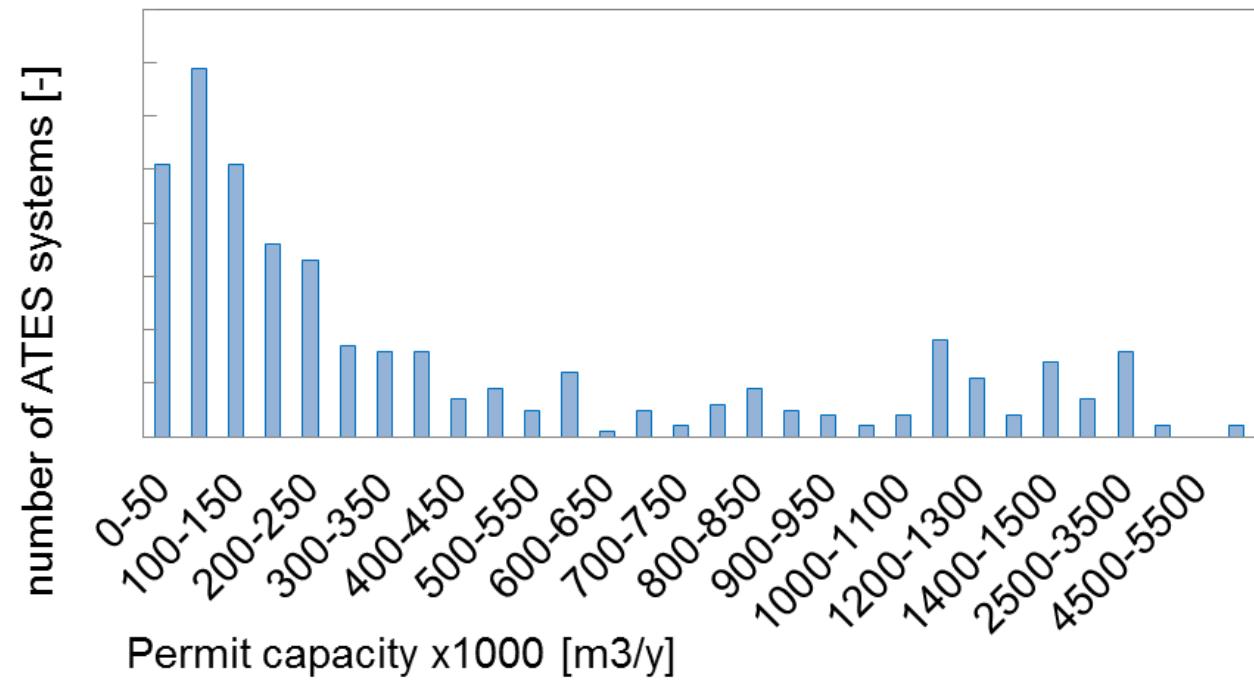
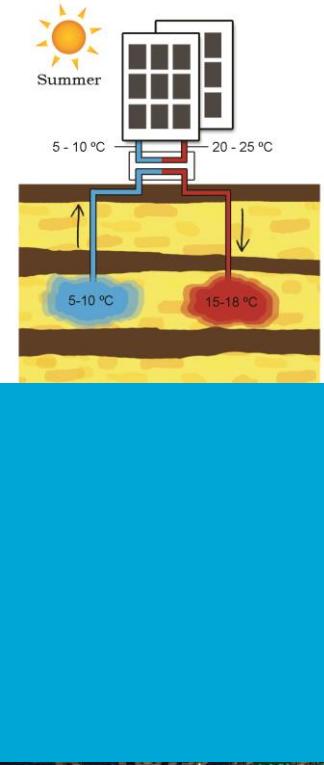
BACK-UP/
redundancy

Store:
~100TJ

~750,000 m³

HT-ATES @ TU Delft





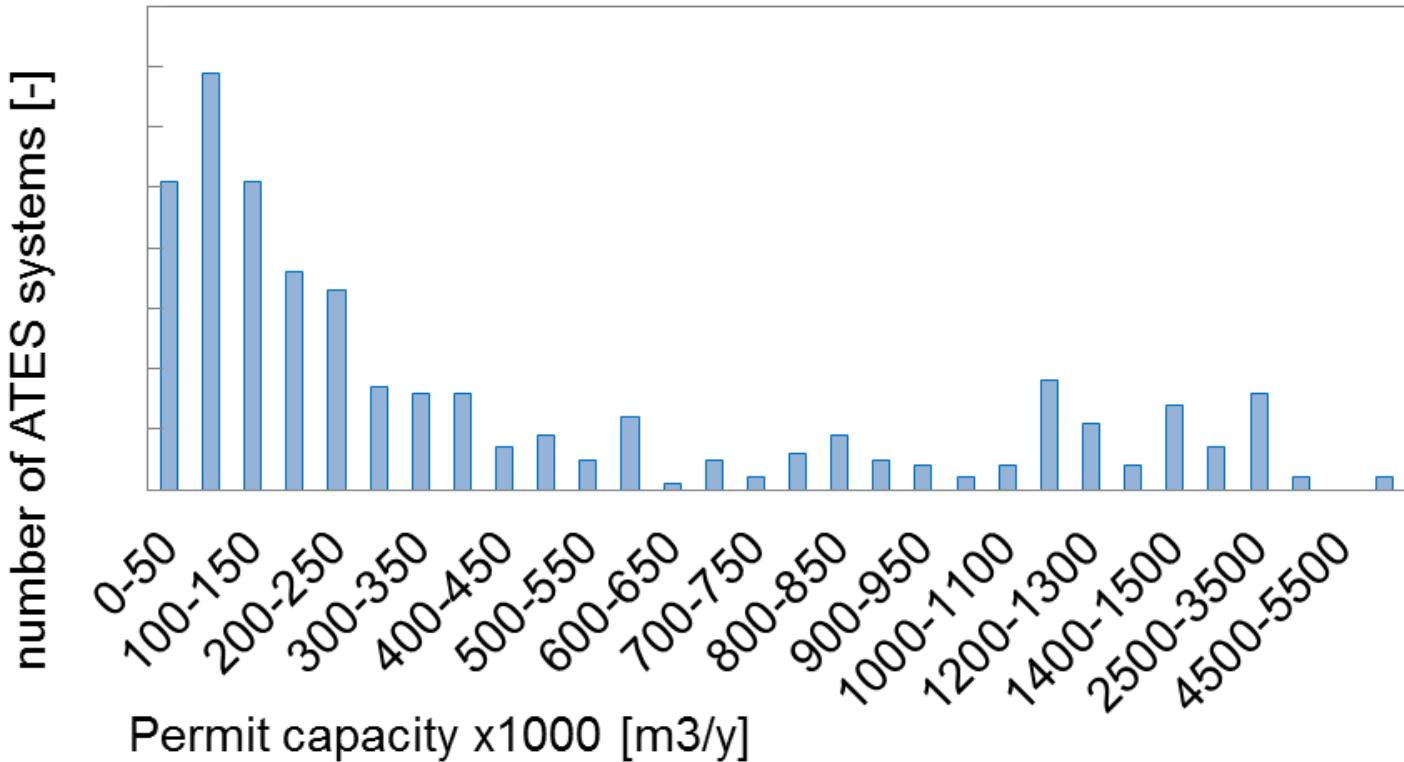
Bloemendaal, M. and N. Hartog (2018). "Analysis of the impact of storage conditions on the thermal recovery efficiency of low-temperature ATES systems." Geothermics 17(C): 306-319.

20 --- 100 ----- 2000

10TJ ----- **100 TJ** ----- **1PJ**



Heat storage for district heating of Amsterdam



Take home message

- Some challenges to tackle, but:
- Aquifers = Time & Space
- HT-ATES is complementary to geothermal systems
- HT-ATES offers back-up/redundancy
- NL = ATES

Opportunities and challenges for large scale HT-ATES systems

DAP symposium 2019-03-12
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