GEBRUIKERSPLATFORM bodemenergie

Nationaal Symposium Bodemenergie 2026

Donderdag 28 mei 2026 | 12.30 – 17.30 uur
a.s.r. Nederland, Archimedeslaan 10, Utrecht

Programma

12.30	Ontvangst met koffie, thee en water
13.00	Opening door dagvoorzitter Henk van Zoelen
13.10	Welkomstwoord en visie – Martin Bloemendal (TU Delft & TNO)
13.20	Uitreiking WKO Duurzaamheid Award
13.45	Bodemenergie in ontwikkeling – Martin Bloemendal (TU Delft & TNO)
14.20	**Pauze | WKO-tool & kaartlaag Indicatieve energieprestaties OBEs**
15.00	**Parallelsessies in drie zalen (3 × 25 min, 5 min wisseltijd)**
16.35	**Plenaire terugkoppeling en afsluiting – Henk van Zoelen**
16.45	**Netwerkborrel**
17.30	Einde programma

From invisible asset to energy infrastructure backbone:

Het success van bodemenergie, what is next?

Dr.ir. M. Bloemendal

Nationaal symposium Bodemenergie

2026-05-28

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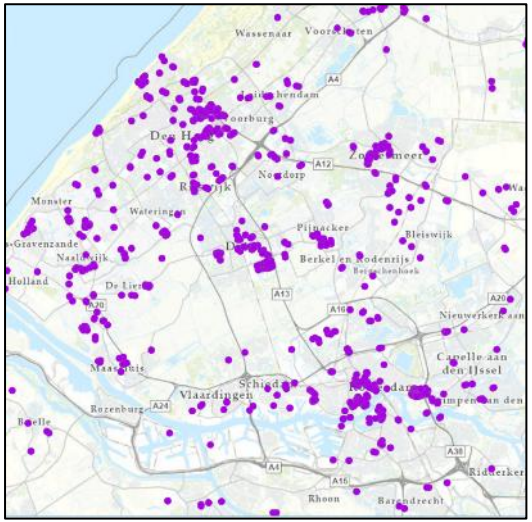
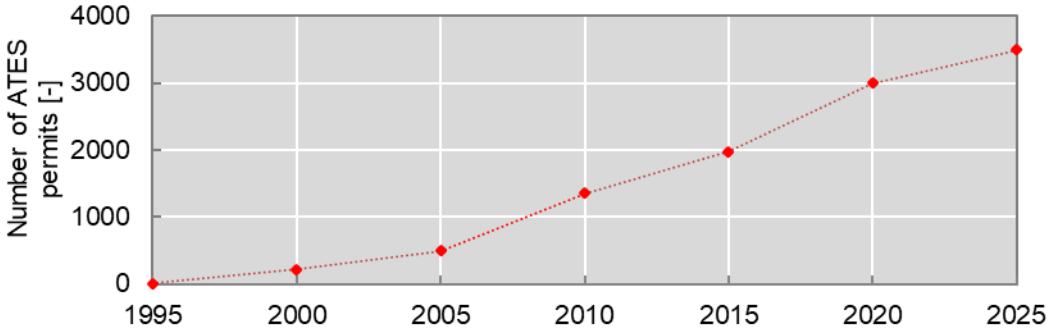
From innovation to the standard

- Proven technology
- High efficiency
- CO_2-reduction
- Reliable





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Transition phase to other roles

Newly built

Individual systems

Existing buildings

Scarcity in subsurface space

More complex subsurface conditions

Collective systems

Limited E-availability

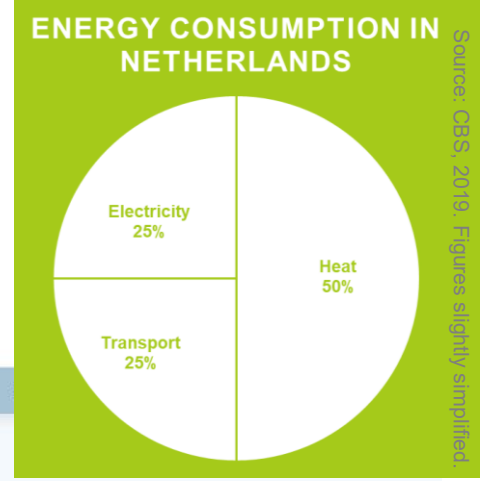
Increasing cooling demand

Transition phase to other roles

- ✅ Seasonal buffering of LT heat

- 🔥 Hybrid systems with higher temperatures
- ❄️ Key technology for cooling
- 🔌 Flexibility for E-grid

Heat storage, a hot topic!



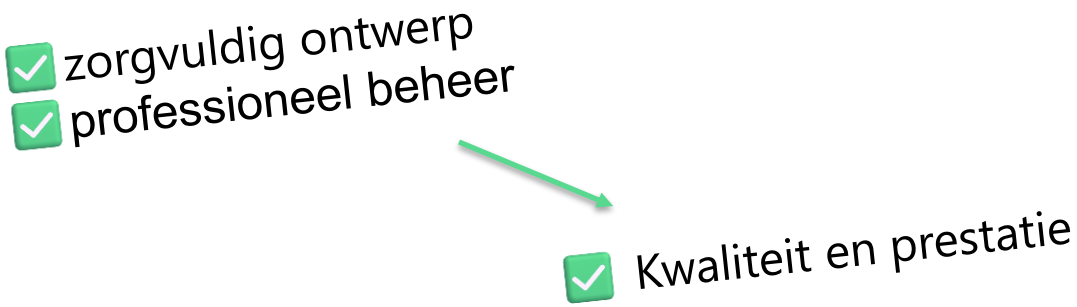
Challenges 

- Optimal and sustainable use of subsurface
  → Planning & governance
- Integration in wider energy system
  → control and robustness
  → link with building facilities and distribution
- Technology development

The proof in the pudding

De toekomst van bodemenergie wordt niet alleen bepaald door ambities en innovaties maar door systemen die daadwerkelijk presteren.

- Jaar in, jaar uit
- Aantoonbaar



GEBRUIKERSPLATFORM bodemenergie

WKO Duurzaamheid Award 2026

Criteria

- Gemiddelde injectietemperatuur:
  - koude bron ≤ 9 graden;
  - warme bron ≥ 15 graden;
- Gemiddelde dT over het jaar is tenminste 6 graden;
- OBES levert >70% van de jaarlijkse warmte- en koude behoefte
- Thermische balans
- >2 jaar draaien, met monitoring.
- SPF?

GEBRUIKERSPLATFORM bodemenergie

Genomineerd voor de WKO Duurzaamheid Award 2026

D-Pier Schiphol

Dang Nguyen, technical expert bij AMS Schiphol
Siem Opschoor, adviseur bij DWA

GEBRUIKERSPLATFORM bodemenergie

Genomineerde WKO Duurzaamheid Award 2026: D-Pier Schiphol

GEBRUIKERSPLATFORM bodemenergie

Genomineerd voor de WKO Duurzaamheid Award 2026

Rijksmuseum Amsterdam

Lester Bonn, **hoofd gebouwenbeheer en techniek bij het Rijksmuseum**
Sabine de Bijl, **contractmanager bij Kuijpers**

GEBRUIKERSPLATFORM bodemenergie

Genomineerde WKO Duurzaamheid Award 2026: Rijksmuseum Amsterdam

GEBRUIKERSPLATFORM bodemenergie

Genomineerd voor de WKO Duurzaamheid Award 2026

En de winnaar is…

GEBRUIKERSPLATFORM bodemenergie

Rijksmuseum Amsterdam

Lester Bonn, **hoofd gebouwenbeheer en techniek bij het Rijksmuseum**

Sabine de Bijl, **contractmanager bij Kuijpers**

Unlocking UTES for the next phase of the energy transition

Dr.ir. M. Bloemendal

Nationaal symposium Bodemenergie
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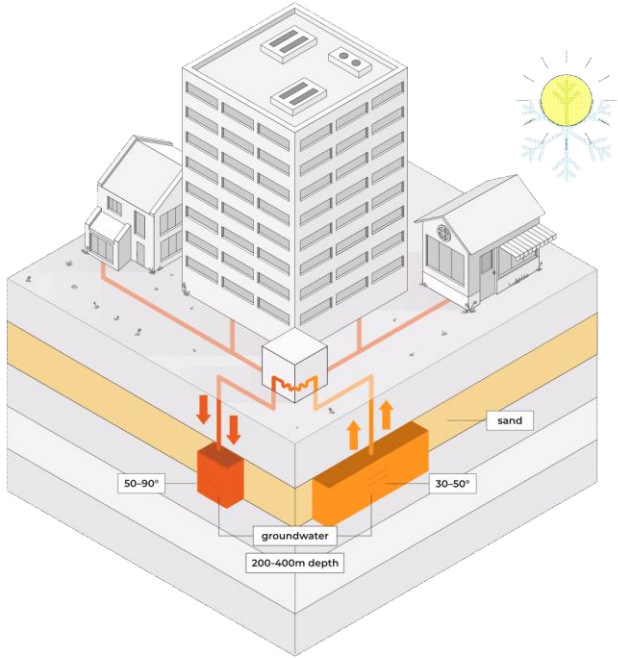


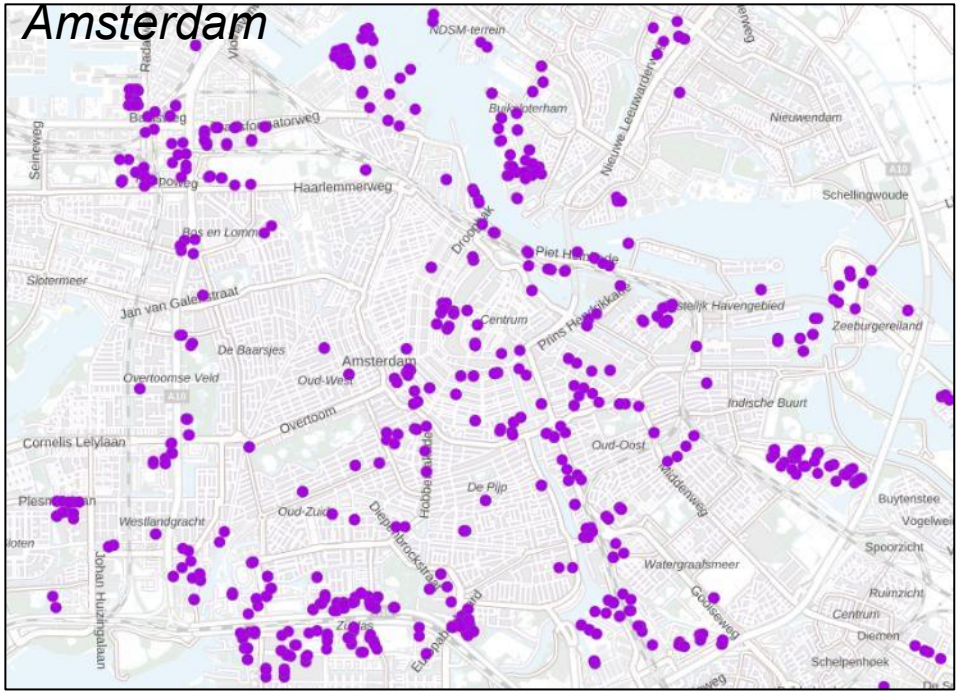
Challenges 

- Optimal and sustainable use of subsurface
  → Planning & governance
- Integration in wider energy system
  → control and robustness
  → link with building facilities and distribution
- Technology development

Optimal and sustainable use of the subsurface

The Crowded Subsurface

ATES systems in Amsterdam



In 2025: *LGR*

~3 000 ATES

In 2050: *CE Delft, PBL, Min BZK*

>100 000 ATES

The Crowded Subsurface

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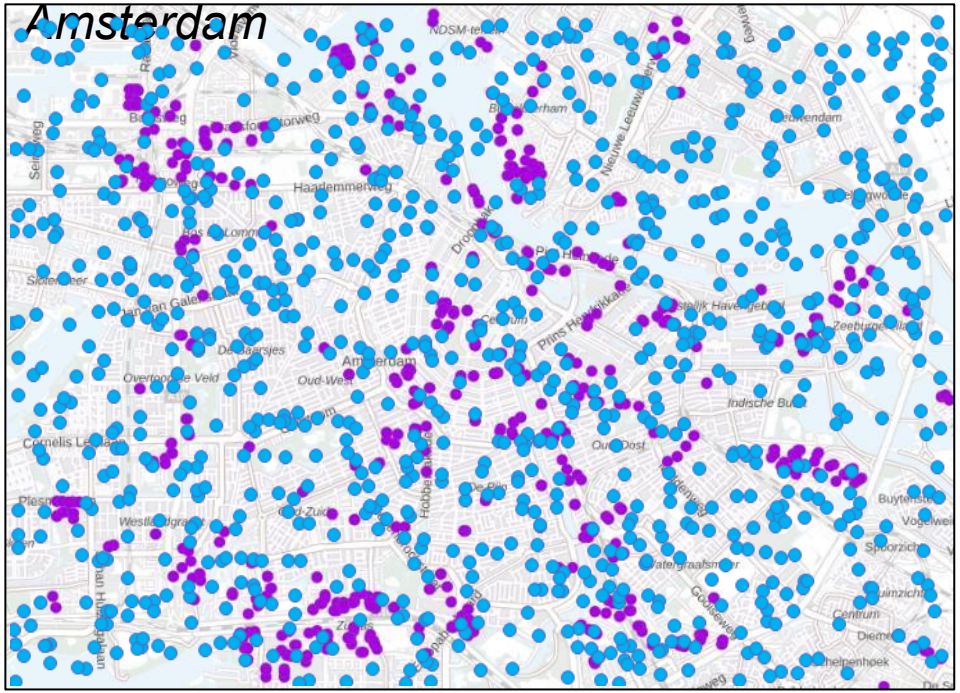


In 2025: *LGR*

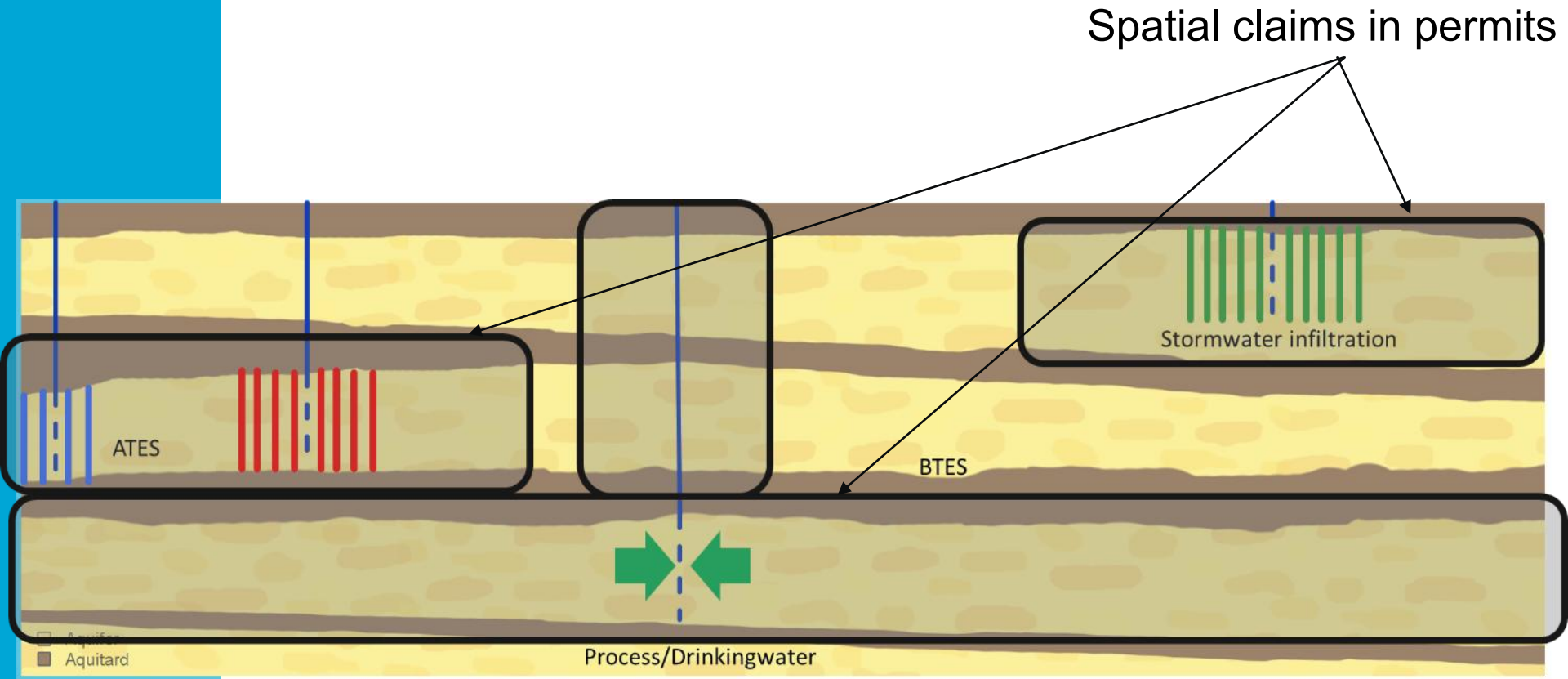
~3 000 ATES

CE Delft, PBL, Min BZK

In 2050:

>100 000 ATES

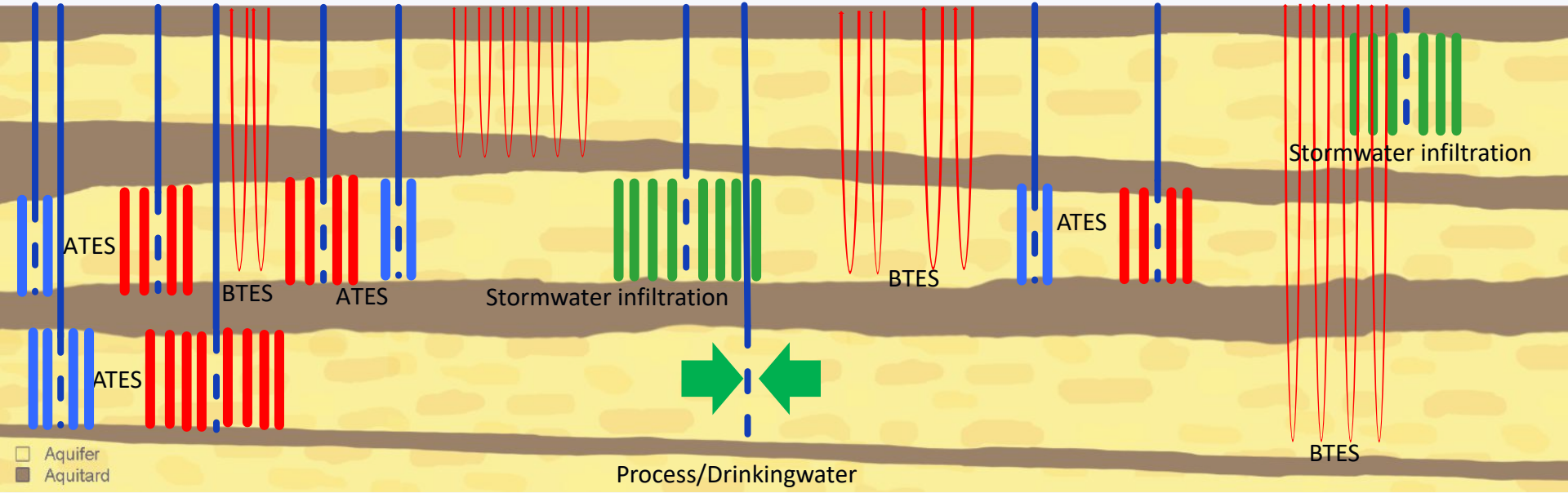
The paradox: scarcity by design



Vision: from separation to co-existence
→ Sustainable dense subsurface space use

- Vertical stacking of functions
- Lateral placement in same layer
- Temporal Sequencing for Reuse

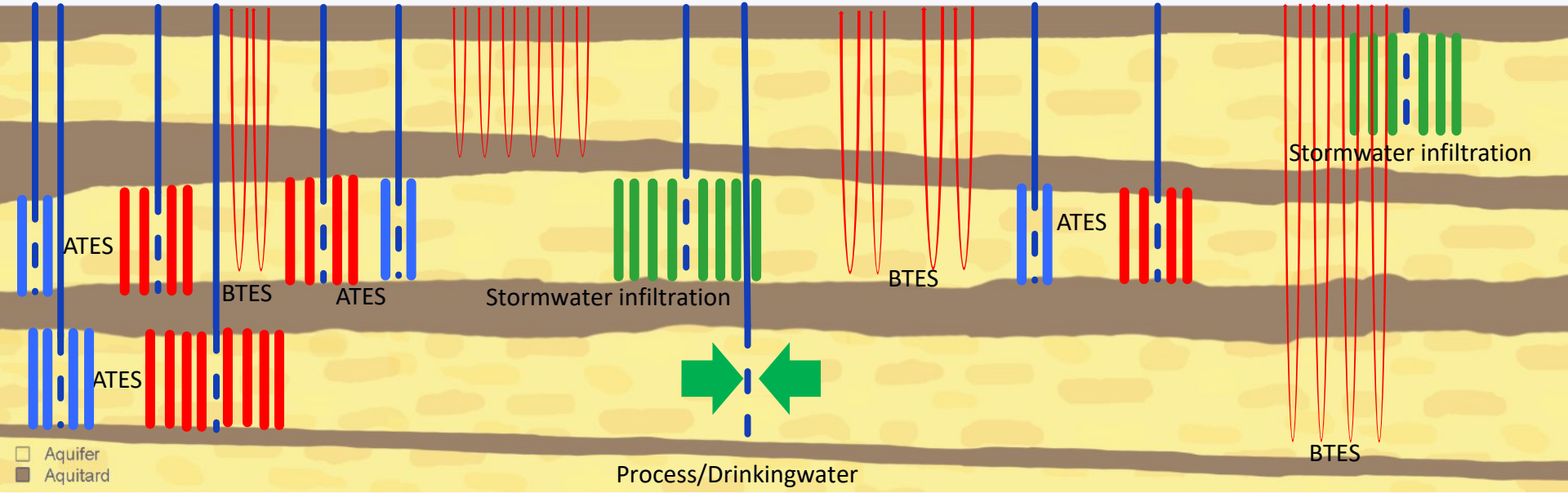
Structured co-existence involves managing interactions to minimize negative impacts and maximize benefits for society.



Need for innovative policy and tools

Growing subsurface demand calls for new governance models and technical solutions to enable coexistence of multiple uses.

i.e. the invisible stakeholder: future users of our common resource



Need for innovative policy and tools

Growing subsurface demand calls for new governance models and technical solutions to enable coexistence of multiple uses.

Dynamic management of actual use and adaptive planning

Assess / manage subsurface interactions

15.30 **4D-modellering ondergrond en energieplanning in Rotterdam - Ruimtewinst door gedetailleerdere modellering**

Gemeente Rotterdam heeft zelf een nieuw bodemenergieplan opgesteld voor het gebied Rotterdam Central District-XL. Uit de inventarisatie van dit gebied bleek dat er voor de toekomst een (te) groot aantal systemen zijn voorzien. Met een 4D model (X-,Y-,Z- en Tijd-) hebben we de filters van bestaande en nieuwe systemen ingepast en doorgerekend. Daaruit bleek de grote meerwaarde van het doorrekenen van de daadwerkelijke filterstelling. Tijdens onze presentatie zullen we met de Rotterdam viewer resultaten laten zien in 4D. We leggen uit hoe deze 4D-modellering past in de verdere energieplanning en welke stappen daarbij worden gezet.

Door Roland van Rooijen en Tobias Mulder, van ingenieursbureau gemeente Rotterdam.

martin.bloemendal@tno.nl

Need for innovative policy and tools

Growing subsurface demand calls for new governance models and technical solutions to enable coexistence of multiple uses.

Dynamic management of actual use and adaptive planning

Assess / manage subsurface interactions

Holistic / cross sectoral assessment of subsurface space allocation

Quantify subsurface space use broader impacts

The good news!

What the law actually allows:

- Omgevingswet: “evenwichtige toedeling van functies” → balanced allocation of subsurface space
- Nota Ruimte: “meervoudig ruimtegebruik” → multipurpose use

en derde lid, in acht genomen.

Artikel 4.2. (toedeling van functies aan locaties)

1 Het omgevingsplan bevat voor het gehele grondgebied van de gemeente in ieder geval de regels die nodig zijn m een evenwichtige toedeling van functies aan locaties.

2 Bij omgevingsverordening kunnen alleen regels worden gesteld over activiteiten die gevolgen hebben of kunn fysieke leefomgeving met het oog op een evenwichtige toedeling van functies aan locaties, als het onderwerp doelmatig en doeltreffend met een regel als bedoeld in artikel 2.22 of een instructie als bedoeld in artikel 2.3 worden behartigd.

Artikel 4.3. (grondslag rijksregels)

Cross-sectoral assessment framework

Societal Cost Benefit Analysis (SCBA) → Broad prosperity perspective:

- Direct effects: (re)investments, maintenance, usage costs, etc.
- Indirect effects: labour market, housing market, etc.
- External effects: climate impact, refrigerant leakage, impact on electricity grid, hea

Not a zero-sum game: gains in one domain can contribute or facilitate to gains and/or los

15.30 **Keuze HT-systemen vs. ZLT-systemen/MKBA rapport CE Delft (mogelijke uitbreiding met beschouwing CO_2-emissie materialenkant).**
Het is bekend dat de warmte- en koudetransitie veel meer is dan een optelling van euro's. Het is een sociale transitie waarin we maatschappelijke voor- en nadelen moeten meenemen in de afwegingen en keuzes voor duurzame oplossingen voor het verwarmen en koelen van de gebouwde omgeving. Namens TKI Urban Energy hebben CE Delft, To Realize Concepts (2RC) en Tri-Es Consultancy een raamwerk ontwikkeld voor de maatschappelijke afweging van de juiste keuzes in de transitie. Een keuze die niet alleen is gebaseerd op de financiële parameters, maar ook op leefbaarheid, gezondheid, comfort, schaalbaarheid, ruimtegebruik en sociale dimensies. Met dit

ruikersplatform Bodemenergie 2026

raamwerk kan men een betere keuze maken voor een langetermijnoplossing die in de breedte het beste is voor de maatschappij. Deze presentatie toont hoe je dit raamwerk als afwegingskader kunt gebruiken en waar de ontwikkelpunten zitten om dit in de komende jaren nog verder uit te werken.
Door Benno Schepers van CE Delft.

Challenge 1. Identifying these effects

Not just a trade off between societal value for drinking water, energy storage, or climate change mitigation/adaptation

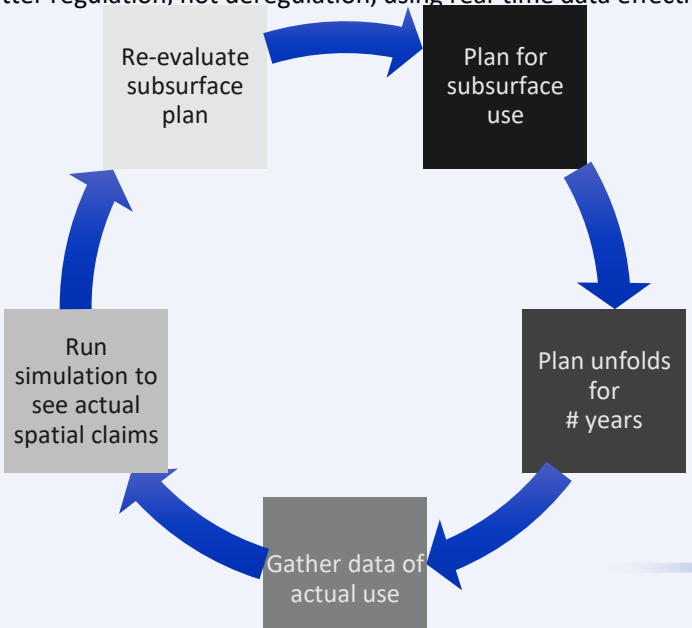
Challenge 2. Quantifying these effects

Value for society by shifting the norm

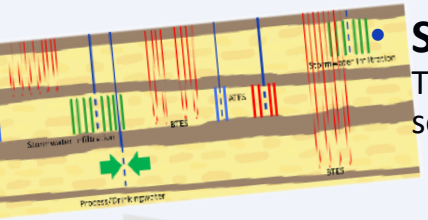
- Shared costs
- Multipliers
- De-risking effects

The core idea: adaptive/dynamic governance

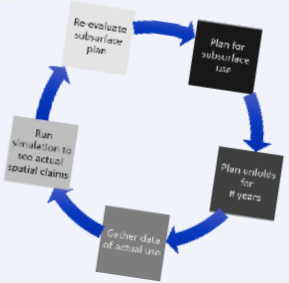
- **Continuous Management**
  Adaptive governance relies on ongoing monitoring and updated dynamic subsurface models for effective management.
- **Dynamic Permit Adjustment**
  Permits and strategies are dynamically adjusted based on actual use and risk profiles.
- **Better Regulation Approach**
  Adaptive management represents better regulation, not deregulation, using real-time data effectively.



Take-home!



- **Subsurface is a common resource in high demand!**
  The subsurface is a collective and strategic resource essential for multiple sectors and various societal challenges.



- **Adaptive / dynamic governance accommodates optimal utilisation**
  Static separation of subsurface use is unsustainable; adaptive, data-driven multipurpose use is necessary and possible.

martin.bloemendal@tno.nl

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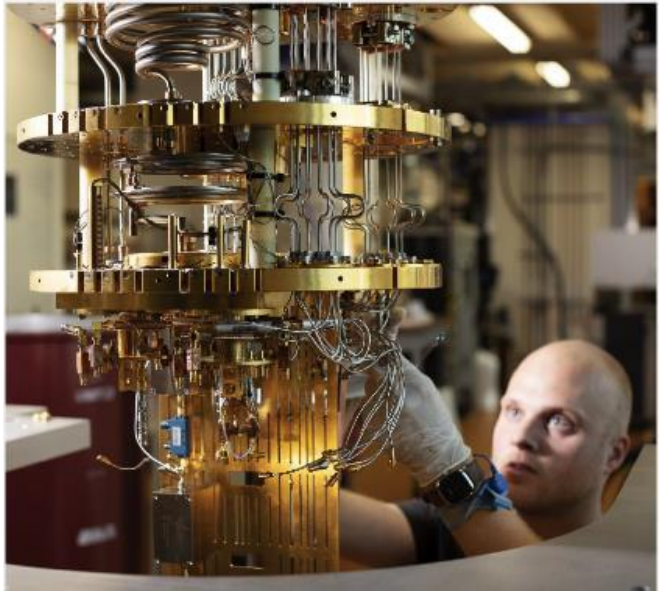
Door Benno Schepers van CE Delft.

Integration in wider energy system

Campus South

Developments



- Education buildings
- Data centres
- New faculty building Physics
- Cleanroom research facilities
- Quantum computing and associated research facilities

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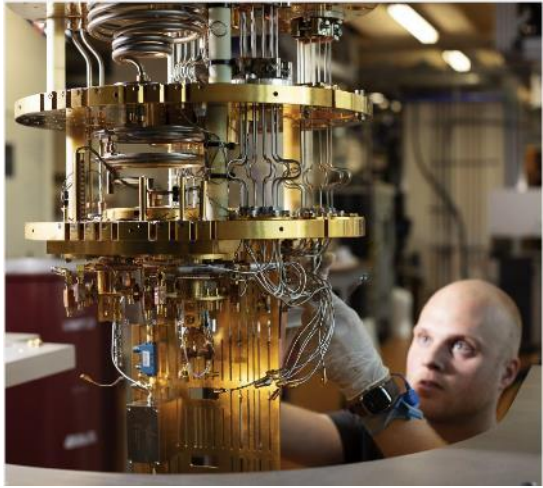
Developments



Heating demand: ~20 TJ

Cooling demand: ~200 TJ

~180 TJ of heat to get rid of.

No sources for cooling available,
only outside air via dry-coolers

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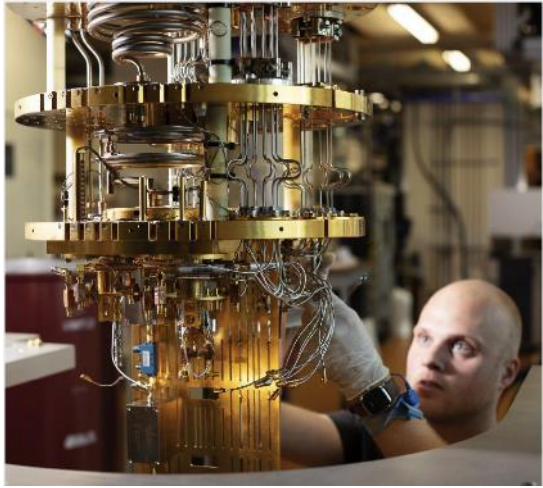
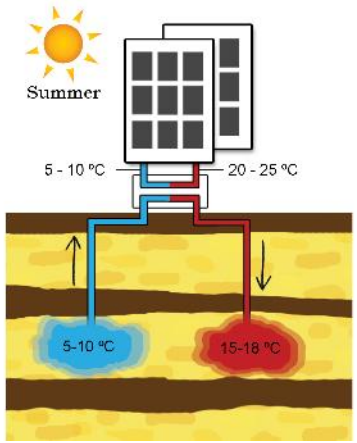
Developments

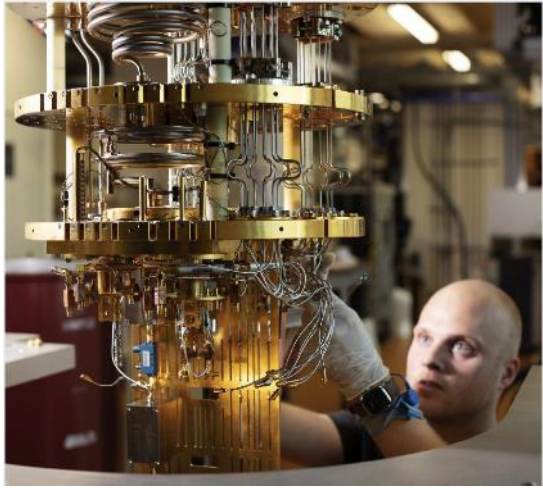


Space cooling requires <5C outside air temperature for charging cold wells

→ Only possible for 800hr/year → >60MW



Developments



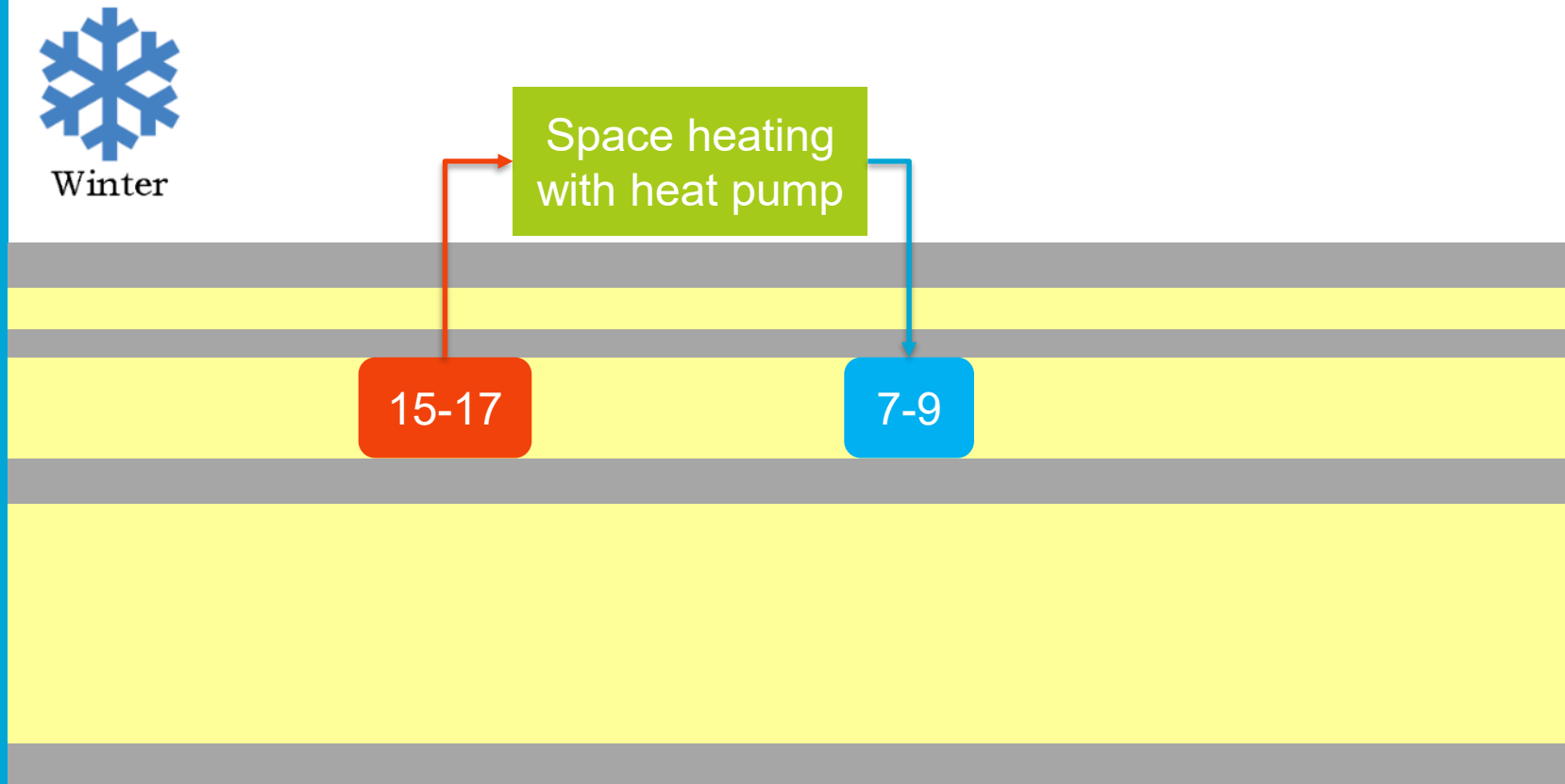
Space cooling requires <5C outside air temperature for charging cold wells

→ Only possible for 800hr/year → >60MW

~ >50% is for process cooling,
also possible with higher temperatures

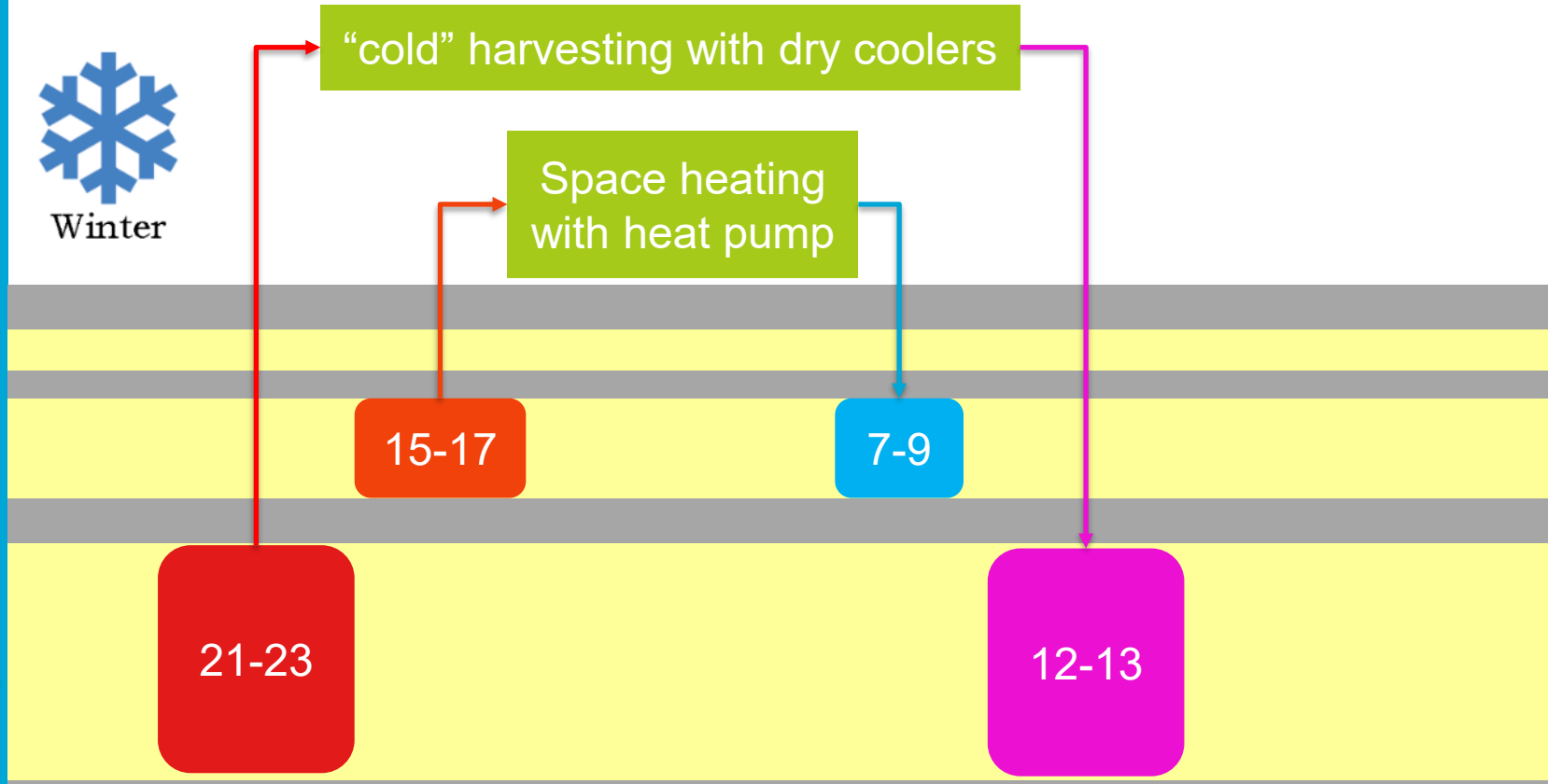
Process cooling can be at higher temperature
→ cold well temperature at ~12C
→ 2500 hr/yr to harvest “cold” → 10 MW

Normal ATES



“normal” ATES

Normal ATES + cold harvesting



“normal” ATES

Process cooling ATES

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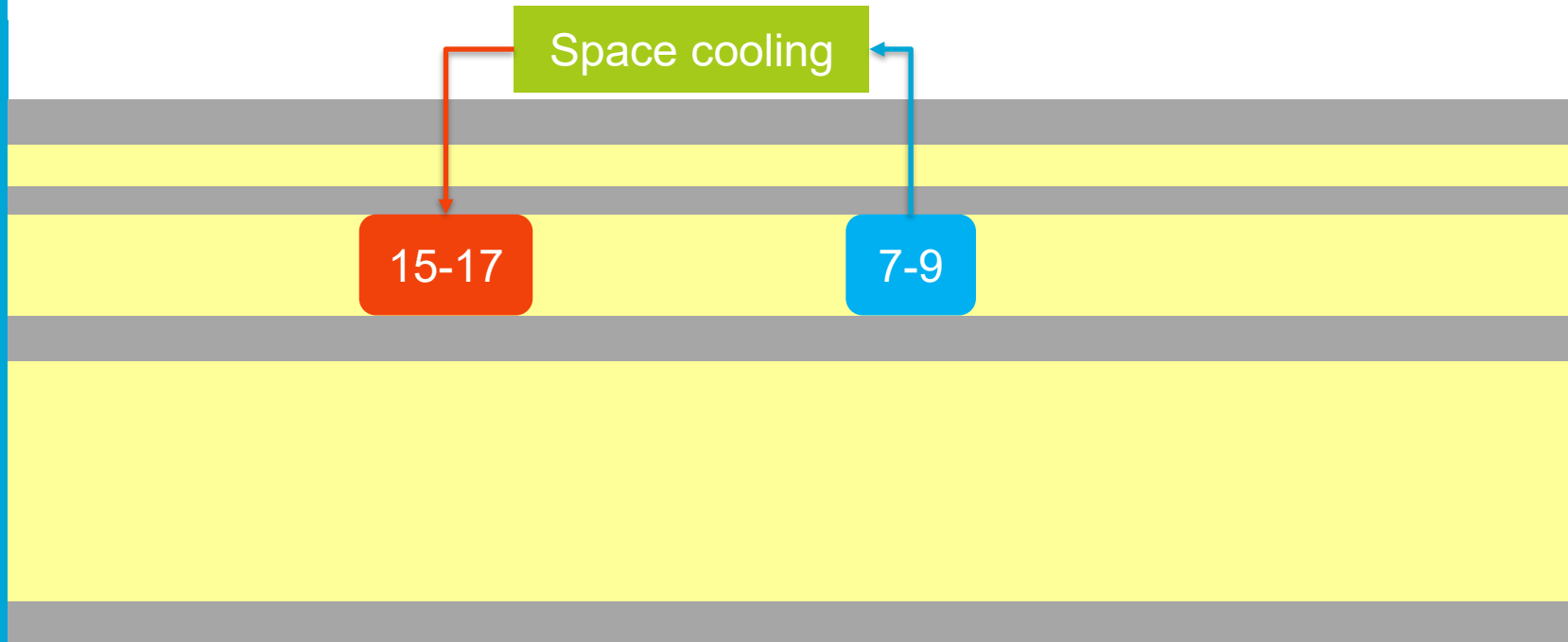
Normal ATES cooling

“normal” ATES



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Space and process co

techniplan adviseurs bv
RAADGEVEND INGENIEURSBUREAU

Process cooling

Space cooling

15-17

7-9

21-23

12-13

"normal" ATES

Process cooling ATES

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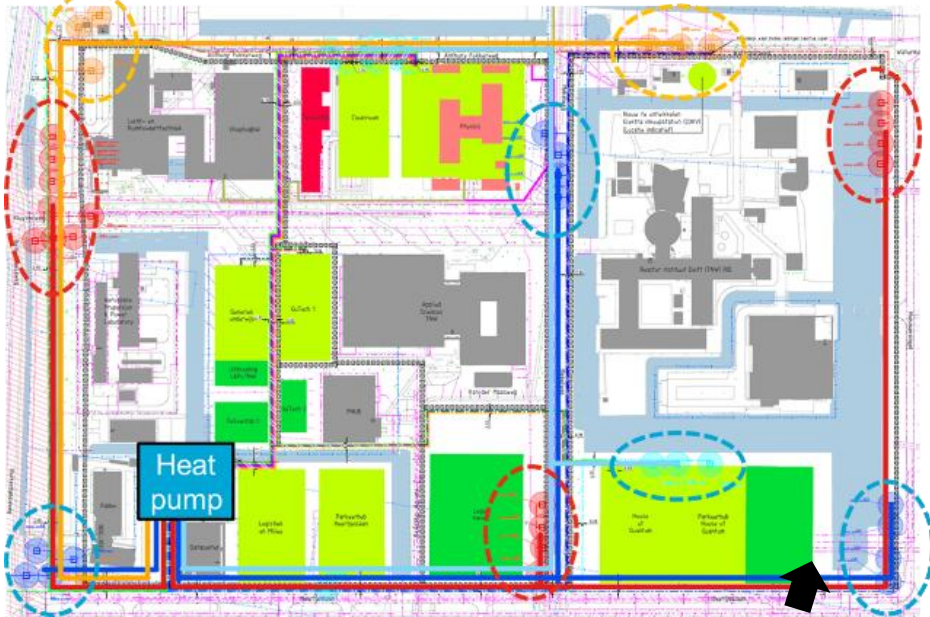
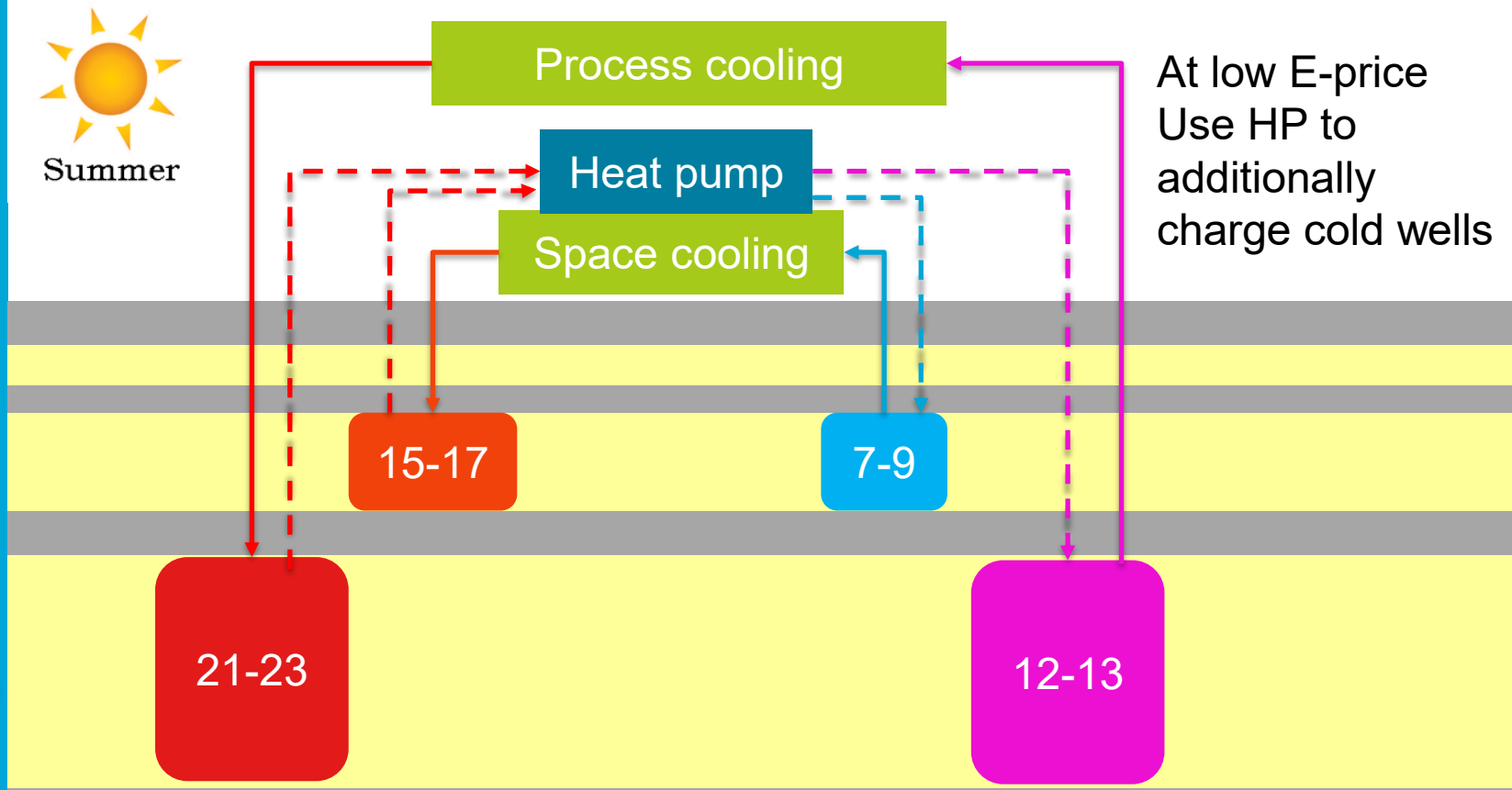
Innovation highlights

- ATES for cooling at different temperatures
- Subsurface interactions, optimal design & operation
- Sector coupling
- Optimal control



Additionally charge cold wells: P2C



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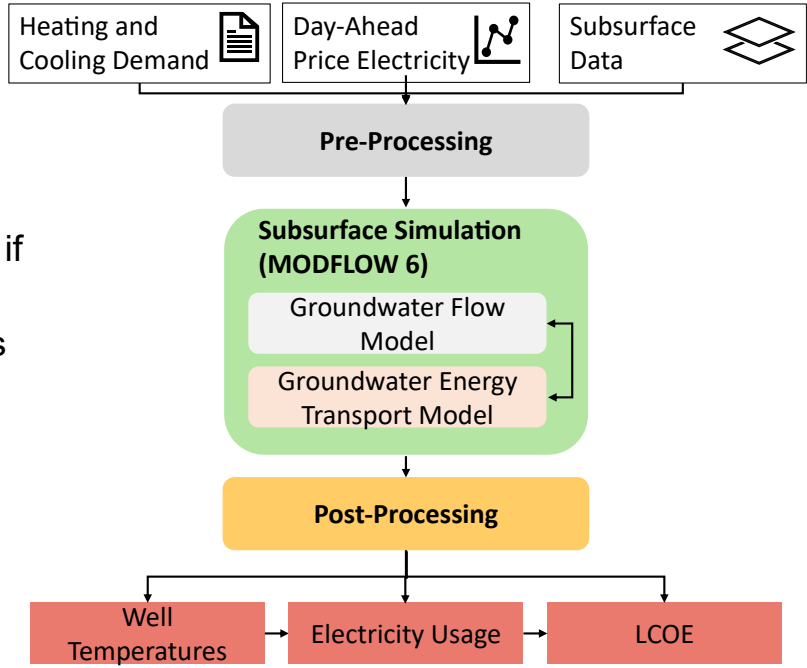
Case Study: Delft Campus Zuid

- Rule-based operation of the ATES:
  - Temperature threshold $T_{threshold}$: decides if heating or cooling mode
  - Price threshold $p_{max,P2C}$: decides if P2C is applied (when in heating mode)



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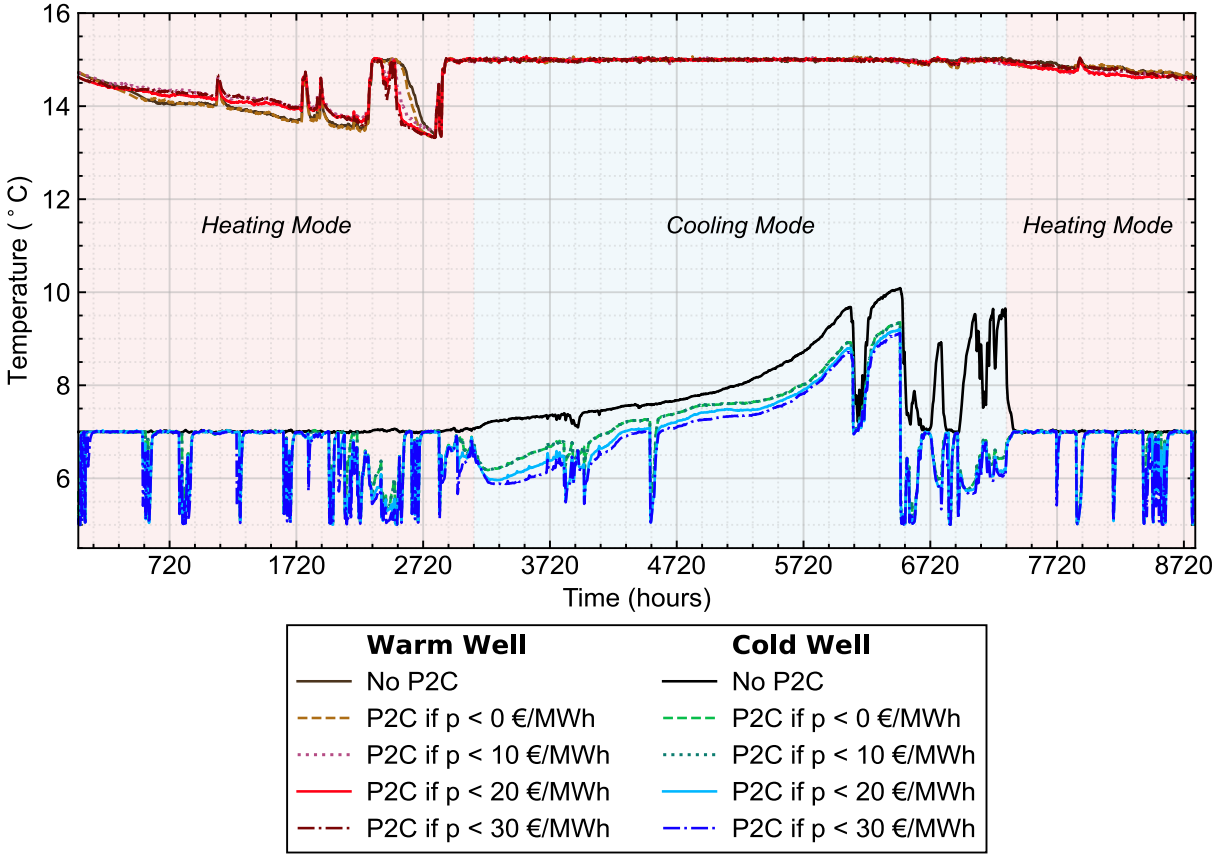
Well Temperature

Temperature at cold and warm well in year 5



Cooling Mode: lower extraction temperatures at the cold well

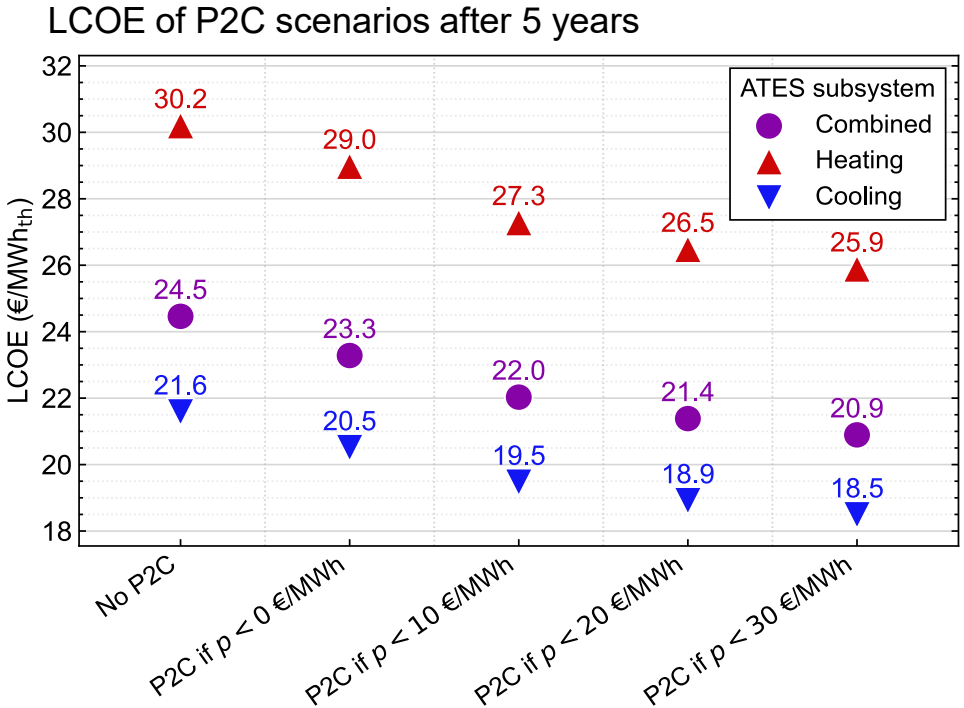
Price threshold:

- Biggest difference from no P2C to P2C if p < 0 €/MWh
- Small additional reduction of cold well temperature by increasing price threshold

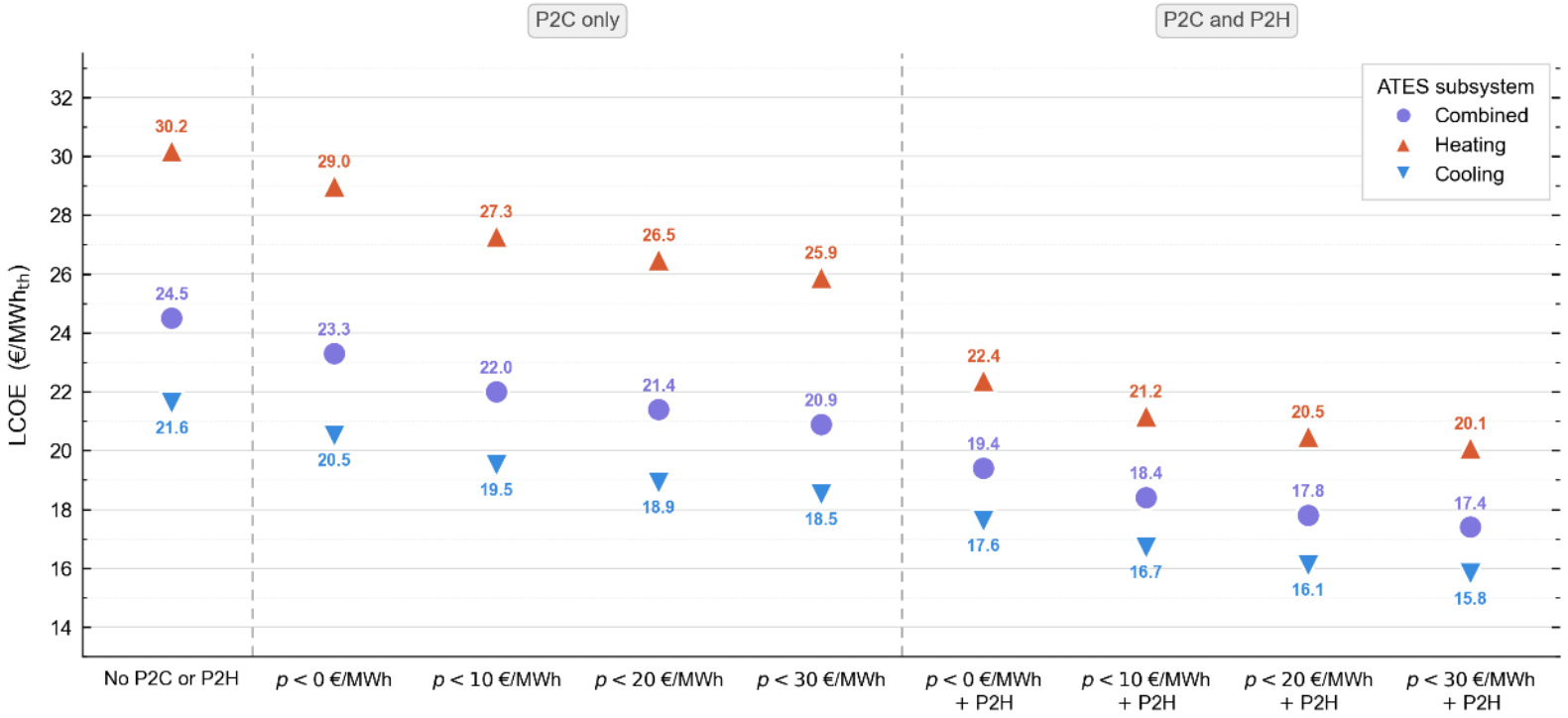
Cost of Heating and Cooling with ATES

P2C reduces costs of cooling with ATES

P2C also affects LCOE of heating



Cost of Heating and Cooling with ATES



LCOE after 5 years of operation in different scenarios

Preliminary takeaways

P2C and P2H operation of ATES in cooling dominated systems is promising to provide **additional flexibility** to the electricity grid while **reducing costs** for heating and cooling.

- P2C reduces cost for cooling with the ATES
- P2H reduces costs for heating, but needs P2C
- Benefits of P2C strongly depend on electricity price and demand uncertainties

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MOOI Max flex

15.00 **Duopresentatie:**

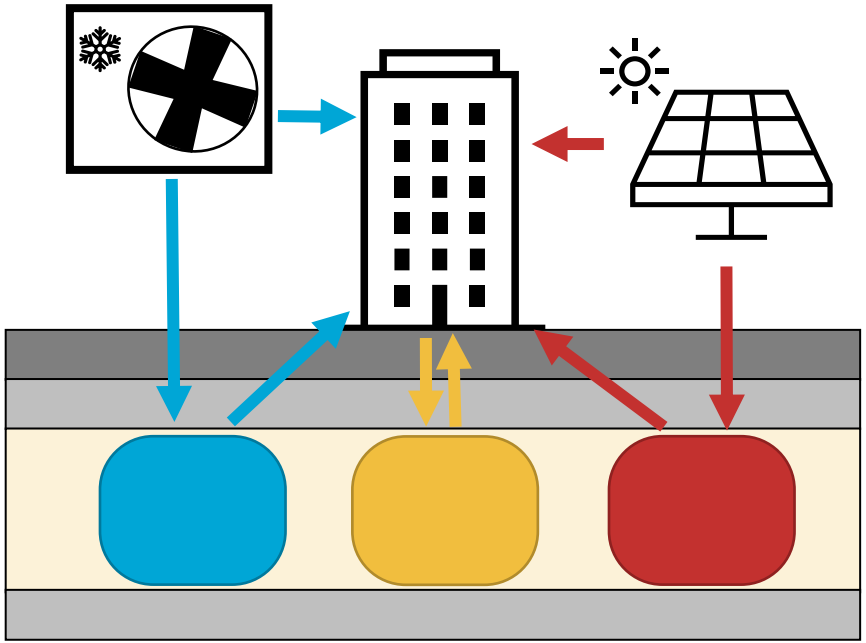
1) Innovatieve monitoringtechnieken voor OBES-bronnen, gericht op optimale realisatie en exploitatie (o.a. MOOI-Diameter).
Door Roeland Nieboer van Deltares.

2) MaxFlex-ZLT, ook een MOOI project.
Dit project gaat over het ontsluiten van flexibiliteit voor het elektriciteitsnet met OBES-bronnen en (utiliteit)gebouwen.
Door Ivo Pothof van Deltares.

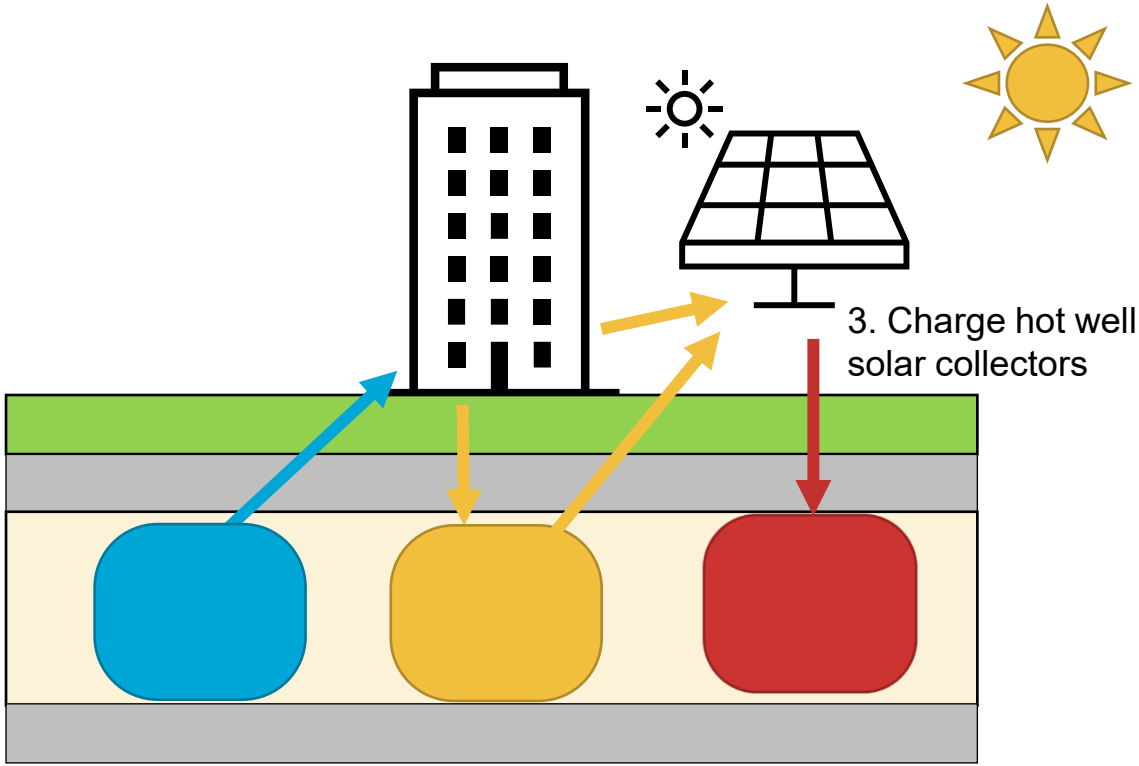
Other MOOI project on system integration aspects:

- CONNECT
- Joule 4 Joule
- CHILL
- Buildinflexergy

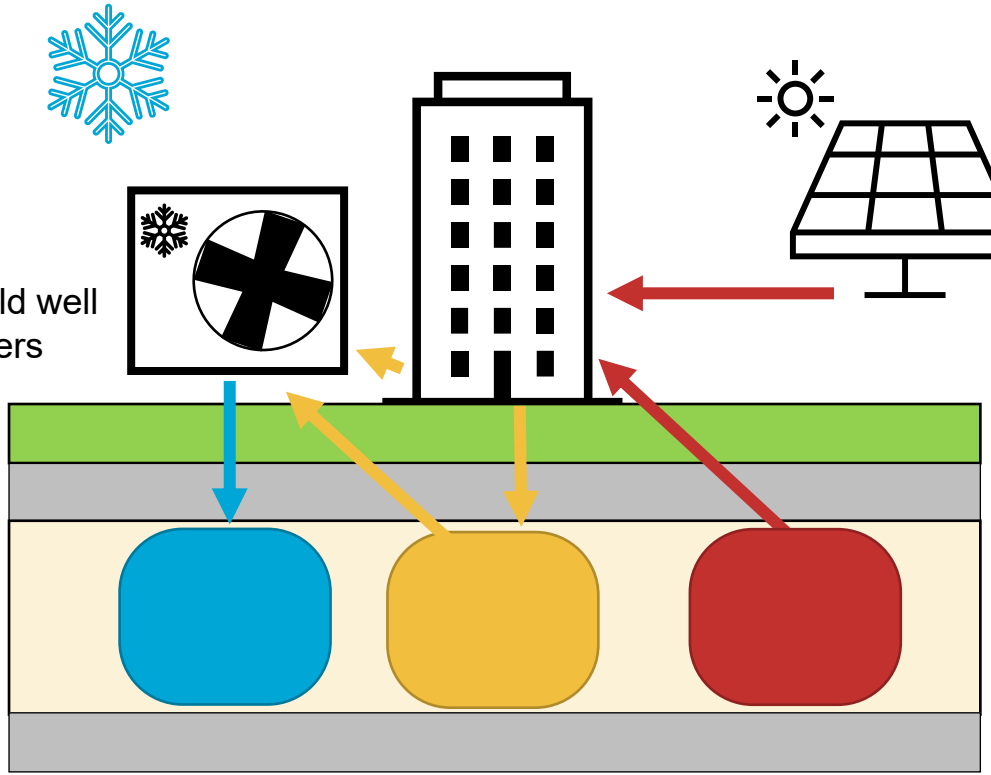
ATES Triplet Robustness for Varying Building Supply Temperatures



Summer operation

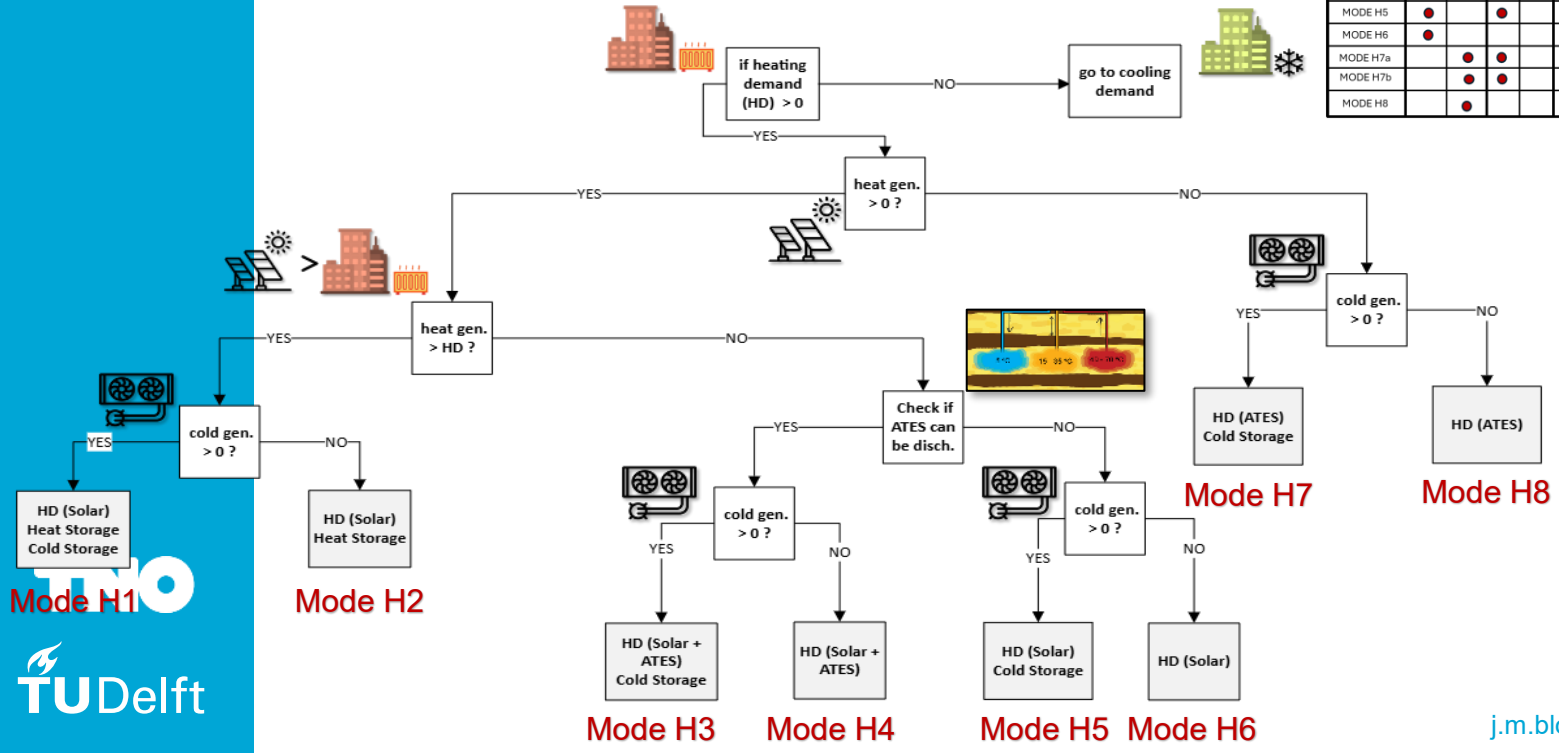


Winter operation

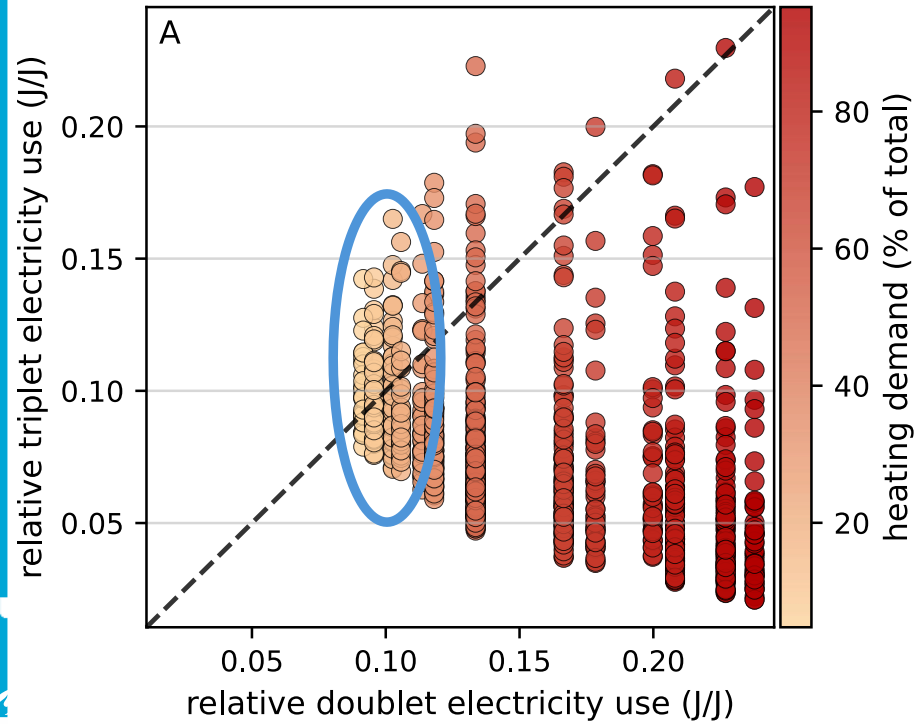


Example Operational Mode Flowchart for Heating

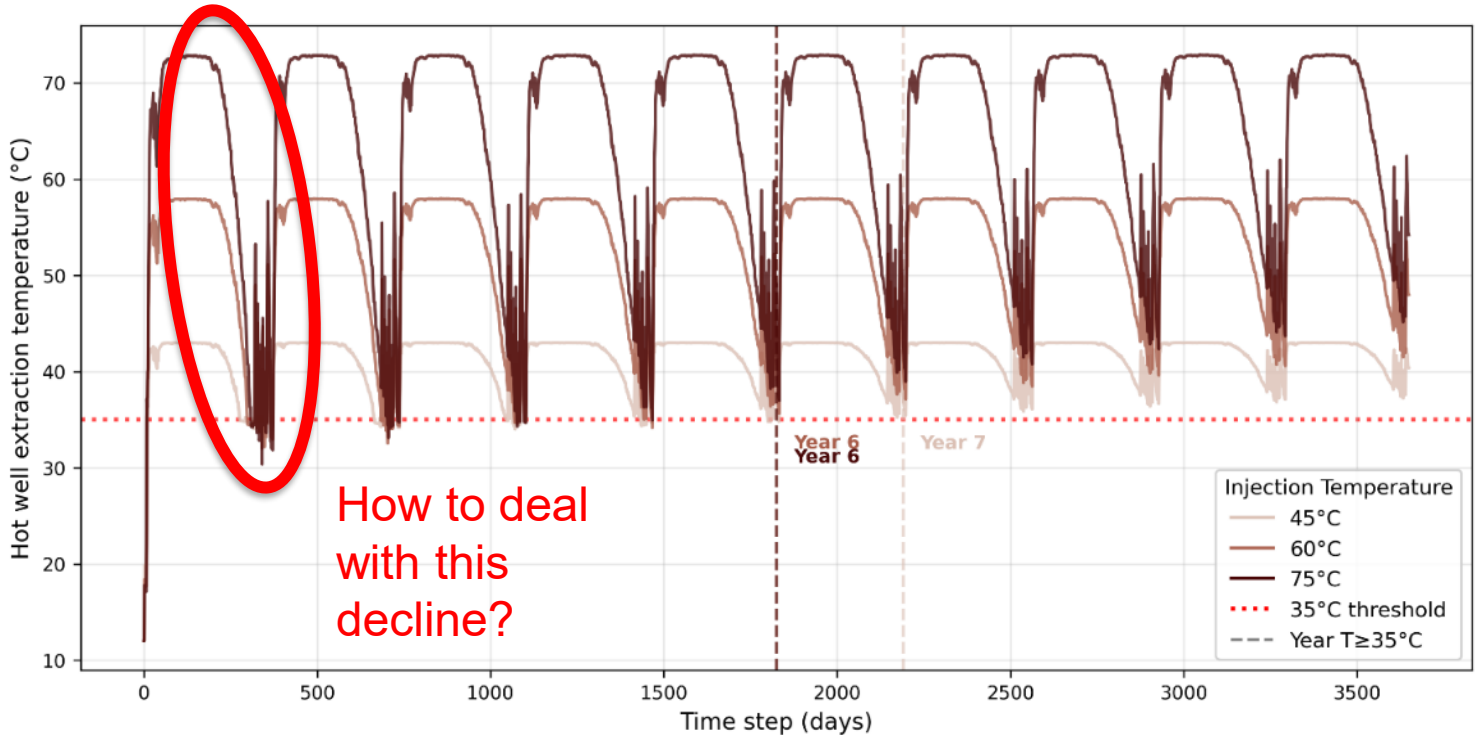
	Heating Sources & Storage				Well Operation					
	Heating		Storage		Cold Well		Med Well		Hot Well	
MODES	Solar	ATES	Cold	Heat	Op. Mode	Conn.	Op. Mode	Conn.	Op. Mode	Conn.
MODE H1	●		●	●	Charge	c12	Discharge	c11	Charge	c1
MODE H2	●			●	n.a.	-	Discharge	c2	Charge	c1
MODE H3a	●	●	●		Charge	c13	Charge	c2	Discharge	c1
MODE H3b	●	●	●		Charge	c13	Discharge	c11	Discharge	c1
MODE H4	●	●			n.a.	-	Charge	c2	Discharge	c1
MODE H5	●		●		Charge	c12	Discharge	c11	n.a.	-
MODE H6	●				n.a.	-	n.a.	-	n.a.	c1
MODE H7a		●	●		Charge	c12	Charge	c2	Discharge	c1
MODE H7b		●	●		Charge	c12	Discharge	c11	Discharge	c1
MODE H8		●			n.a.	-	Charge	c2	Discharge	c1



Triplet vs doublet E-use



Hot well production temperature



Ongoing work

- **Co-simulation** captures the **complexity of building operations**, but is computationally **expensive**
- **Higher injection temperatures** hot well beneficial.
- **Future steps** will entail:
  - Co-Simulation in 3D
  - Extreme years in the dataset
  - Novel approaches for building heat distribution/delivery

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KWR

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Haskoning
Enhancing Society Together

KROPMAN
INSTALLATIETECHNIEK

bodemenergie NEDERLAND

provincie Zuid-Holland

j.m.bloemendal@tudelft.nl

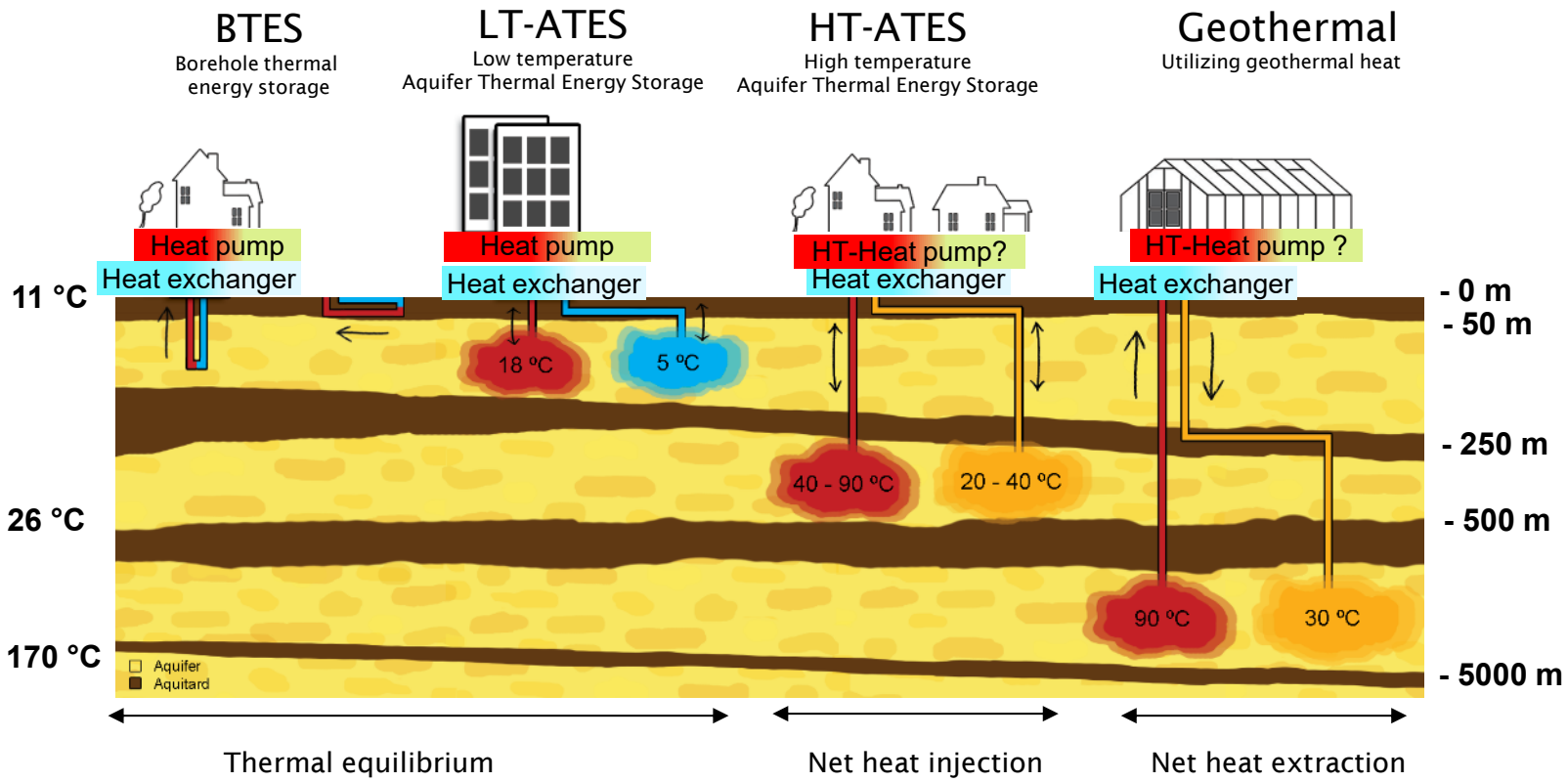
Technology development

Higher temperatures

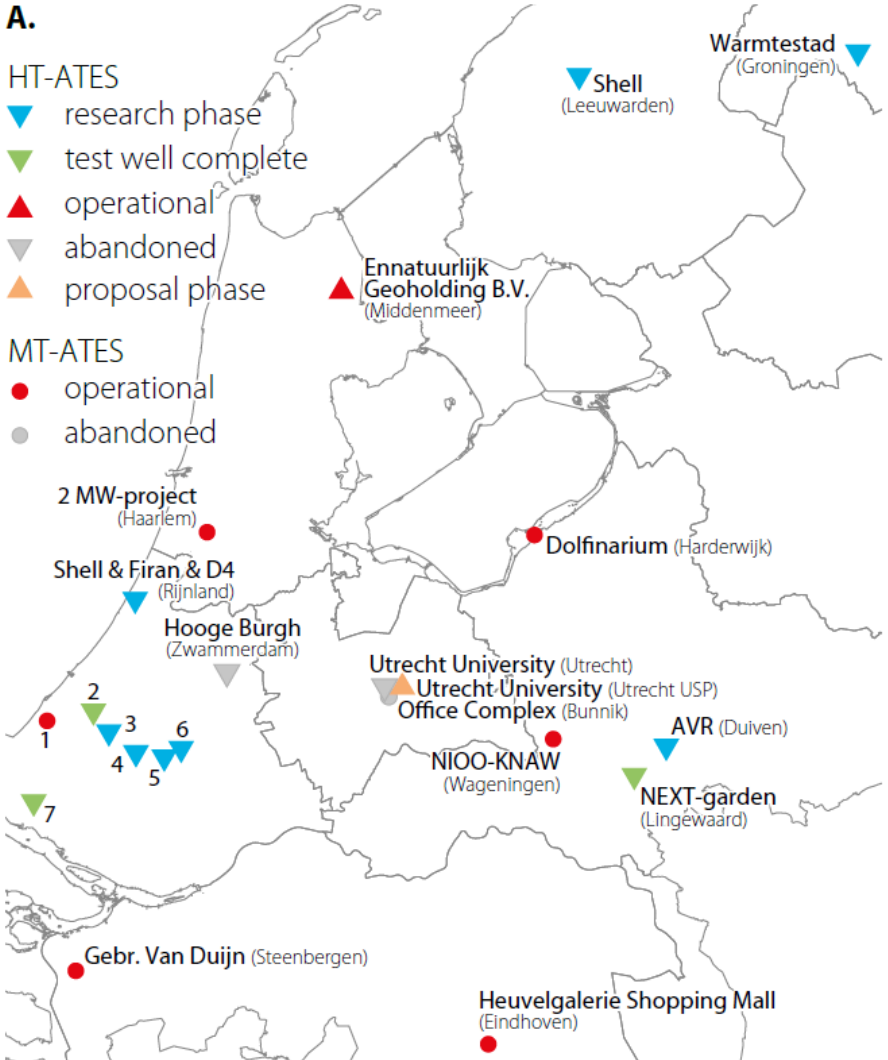
Drilling / completion

The Temperature Gap

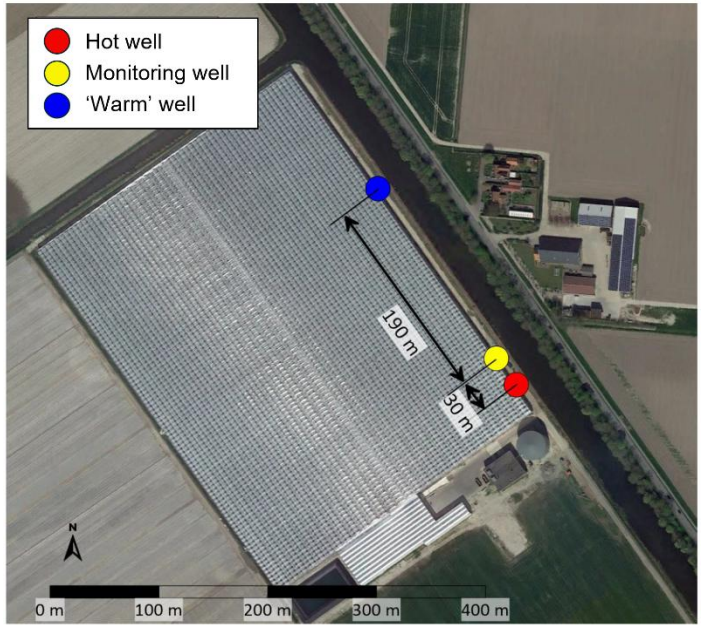
(Existing Buildings)

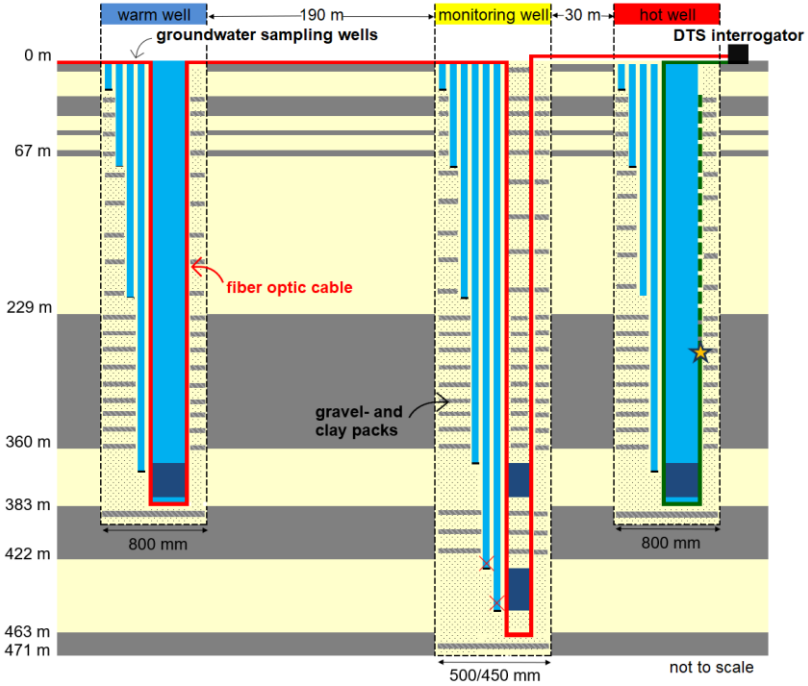


MT/HT-ATES in NL

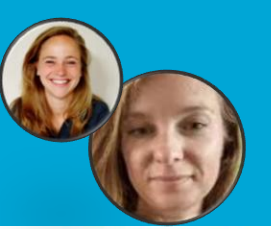


HT-ATES Middenmeer





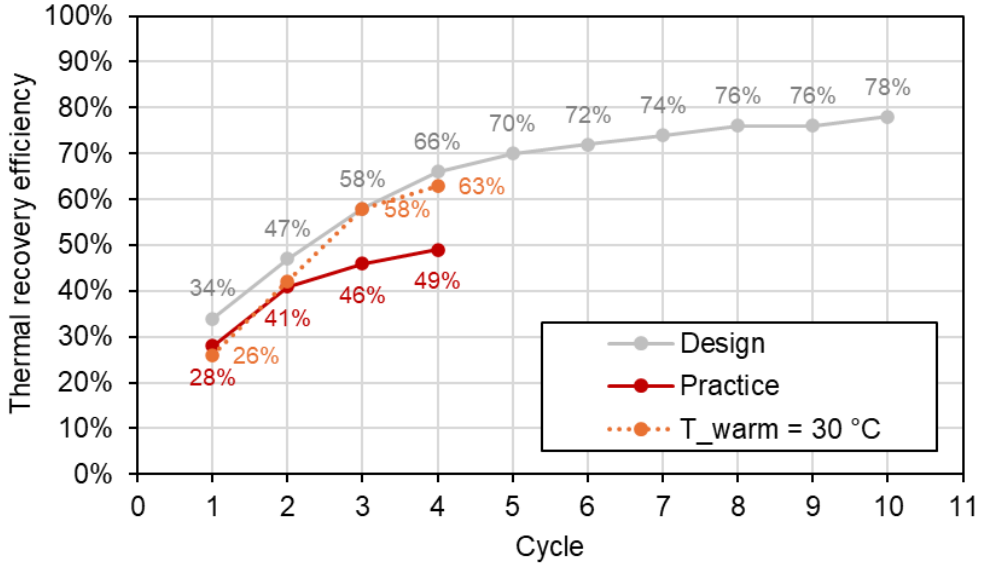
ennatuurlijk aardwarmte



HT-ATES Middenmeer

ennatuurlijk aardwarmte

if Technology Creating energy



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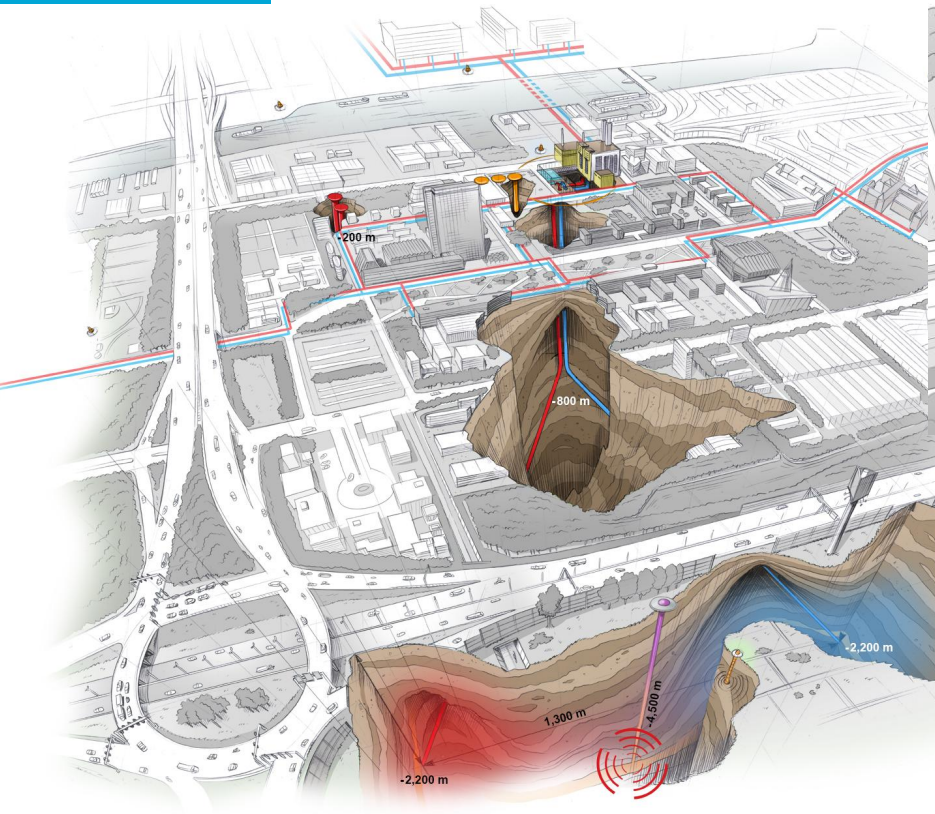
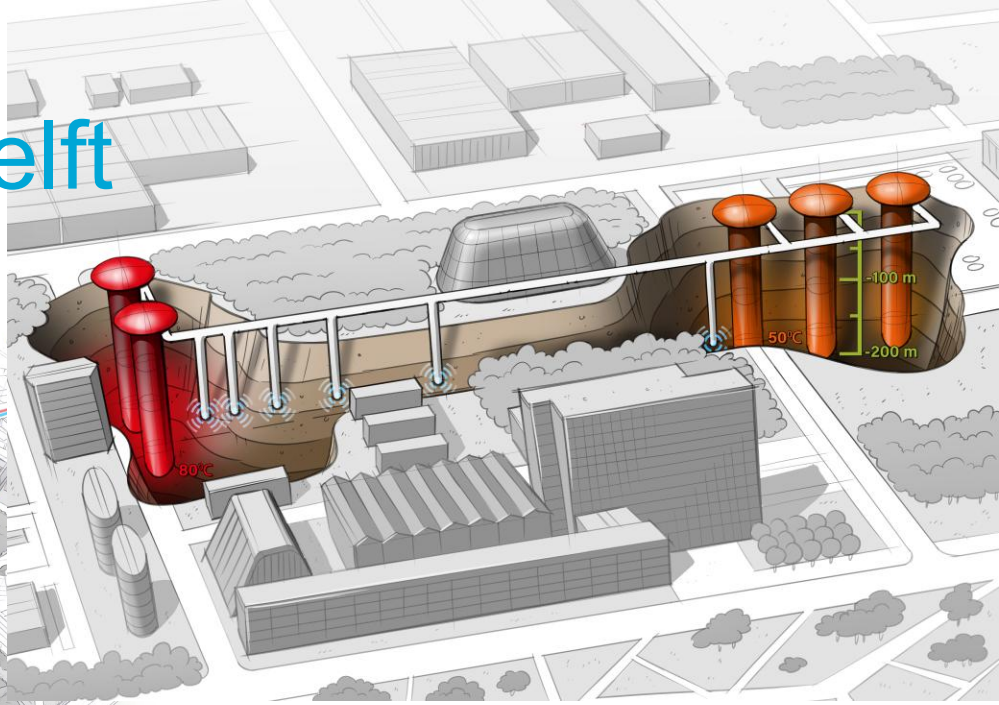
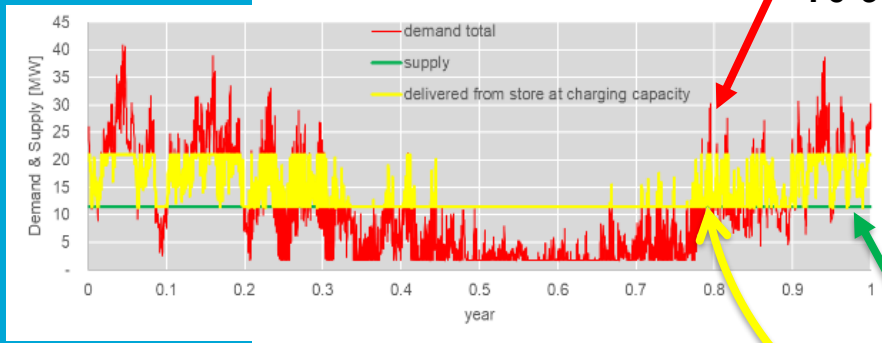


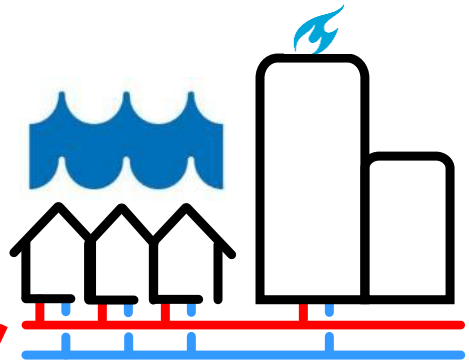


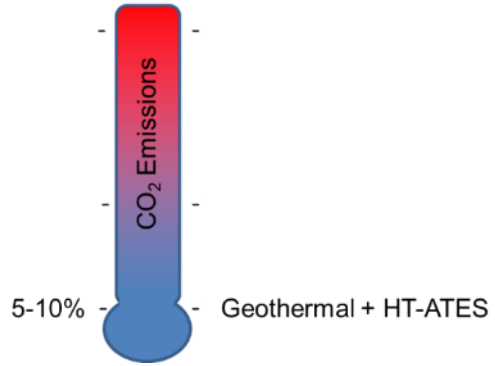
>2026

Novel combination of geothermal & HT-ATES

World-wide unique research & education infrastructure







70-90°C

Winter

Boiler peaks are much fewer

Boiler / CHP

HPC

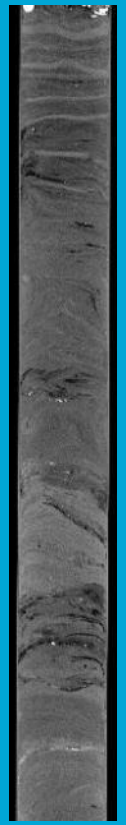
At low E-price, additionally charge HT-ATES

Summer

78°C
2200 m

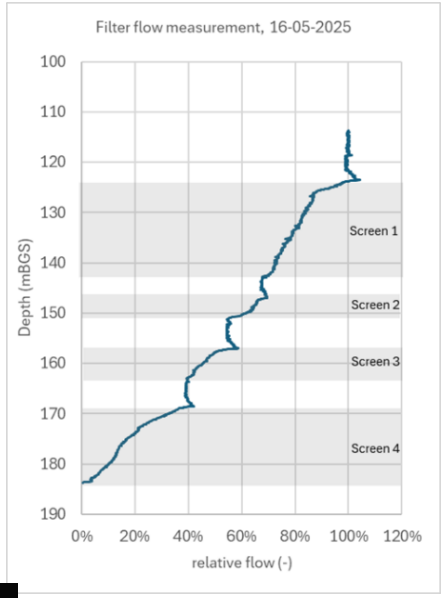
77-88°C
180 m
~400.000 m³
~40TJ

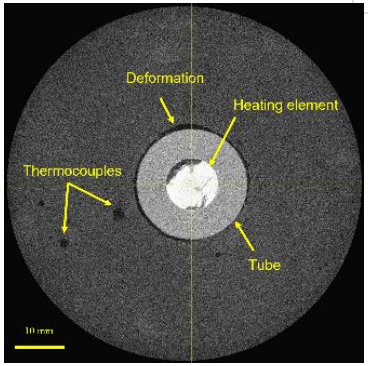
PUSH IT

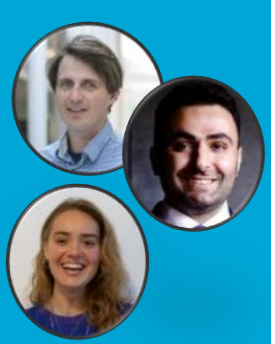


Innovation Highlights

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







Site Layout —monitoring network Hot wells

Borehole legend

F1–F9
Fibre optic boreholes (10 confirmed)

O1, O2
Observation wells

H1–H3
Hot wells (HT-ATES)

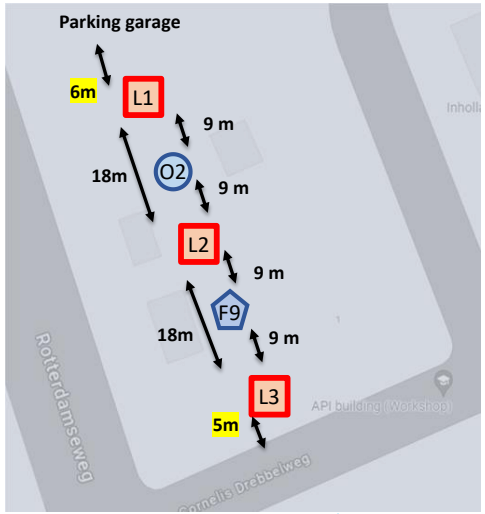
CF1–CF3
CPT + DAS

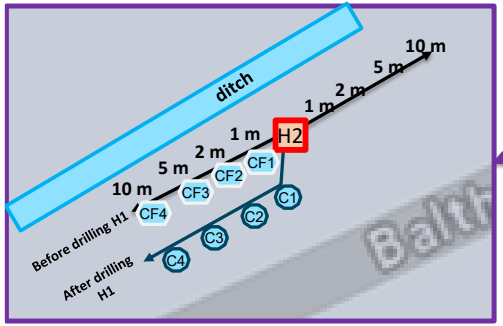
L1–L3
Lukewarm wells

3 cable loops planned

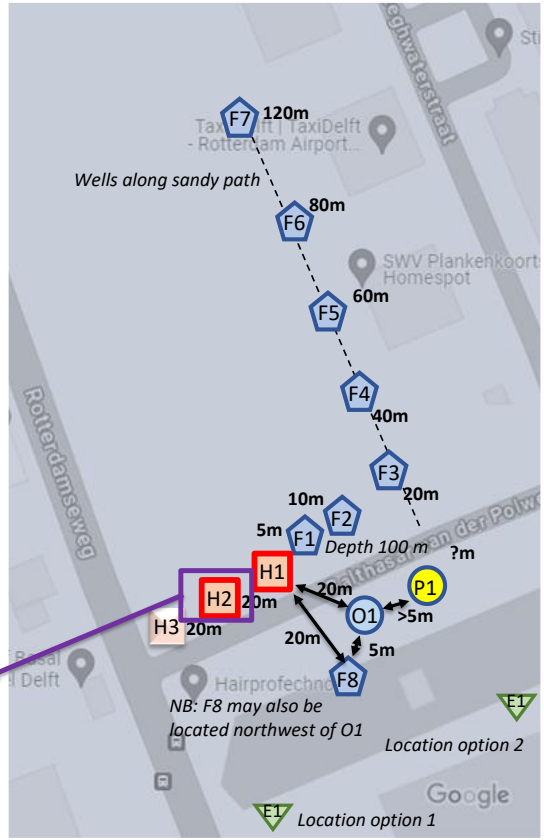
- **AH-DTS hot wells**
  power + burial cable → housing
- **AH-DTS lukewarm wells**
  power + burial cable ⚠ TBD
- **FO: F1–F9 + O2**
  fibre only → housing (1 or 2 cables)

Warm wells

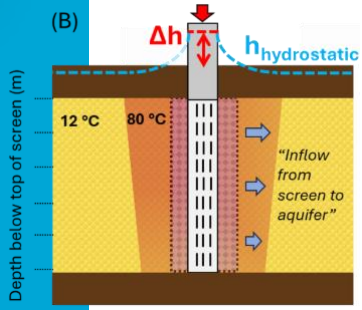


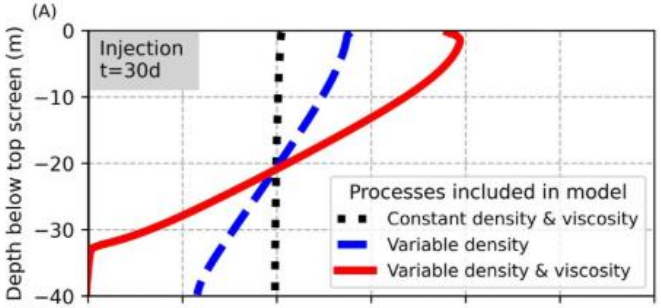


Hot wells



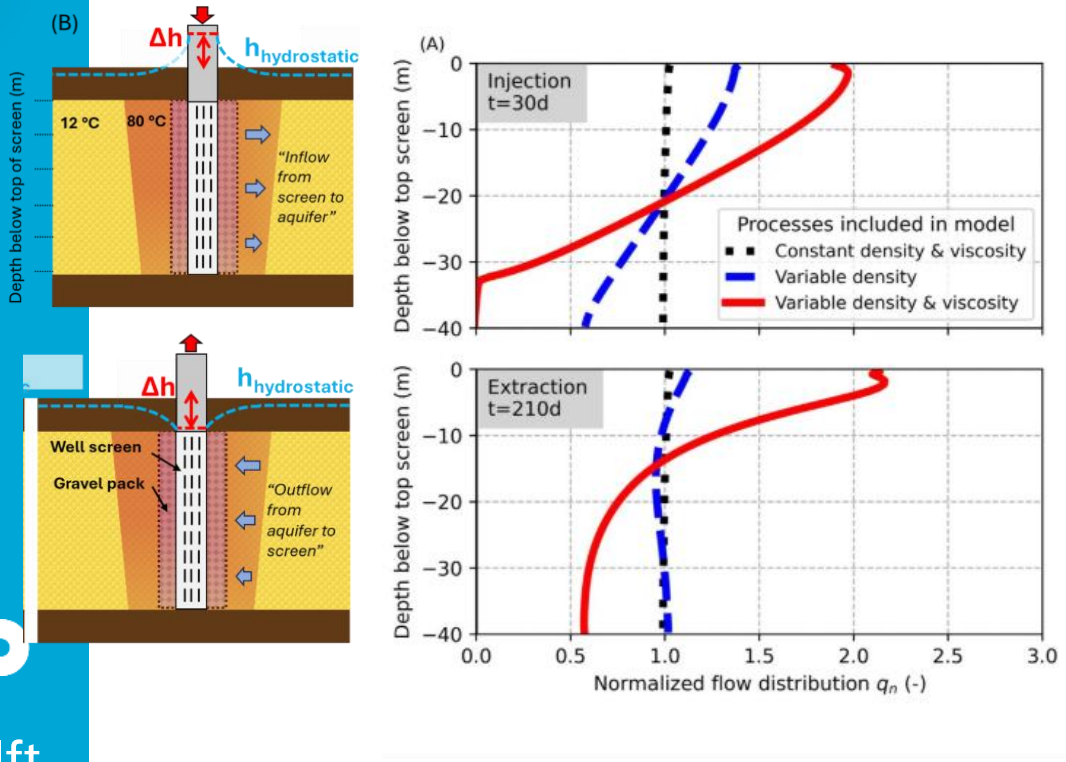
Variable inj./ext. across screen





Beernink et al. 2026 (in press)

Variable inj./ext. across screen



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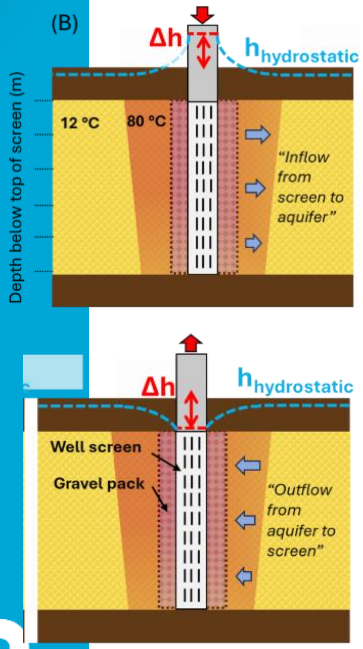
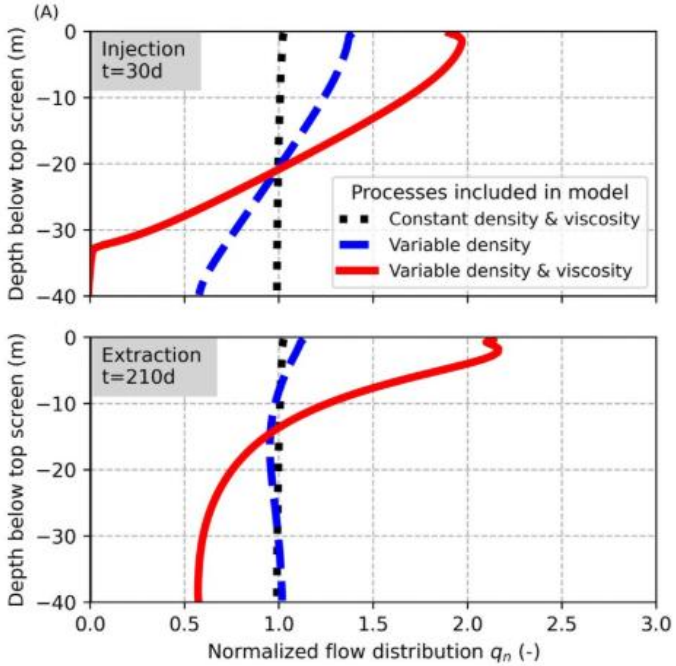
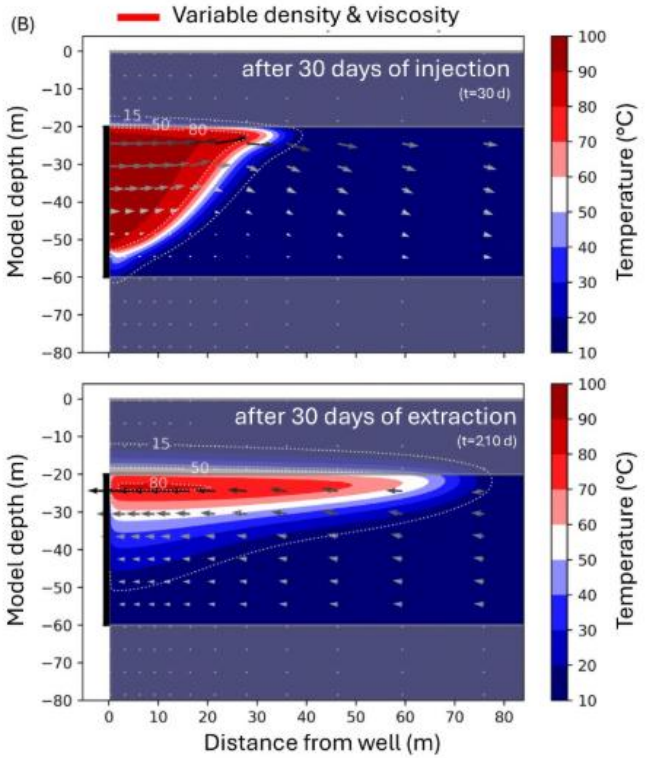
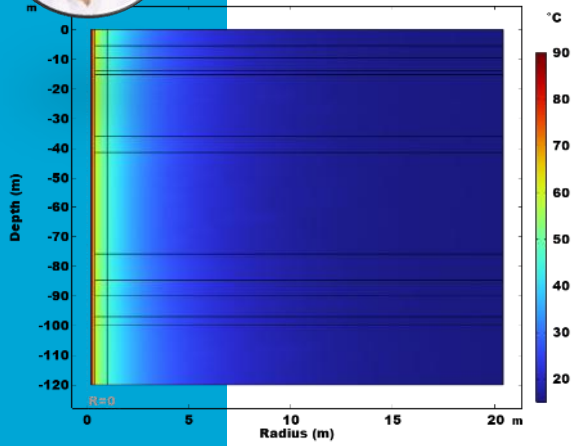


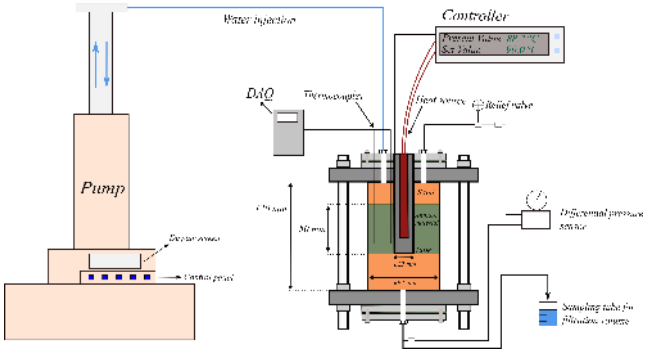


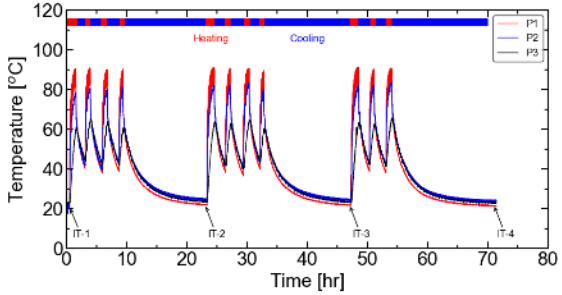


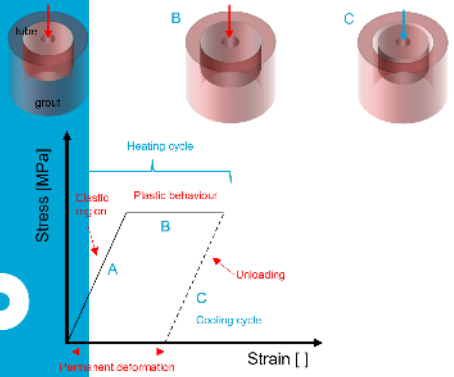
Beernink et al. 2026 (in press)

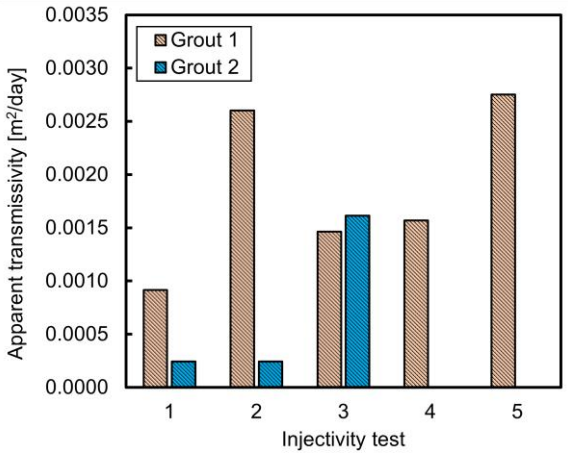
Thermal Cycling Loading – Completion Material(s)

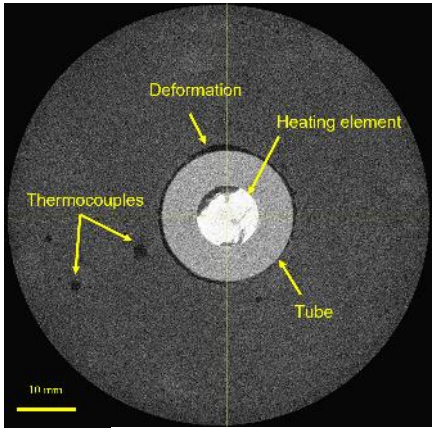










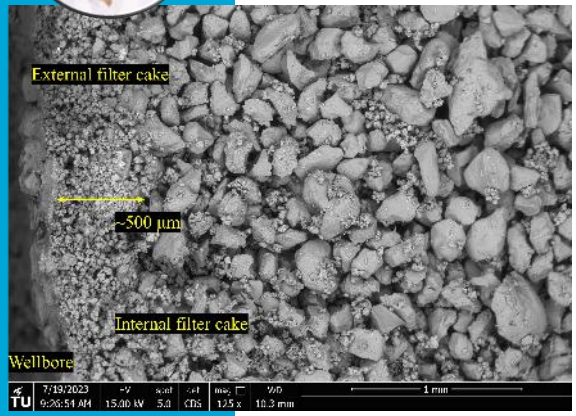


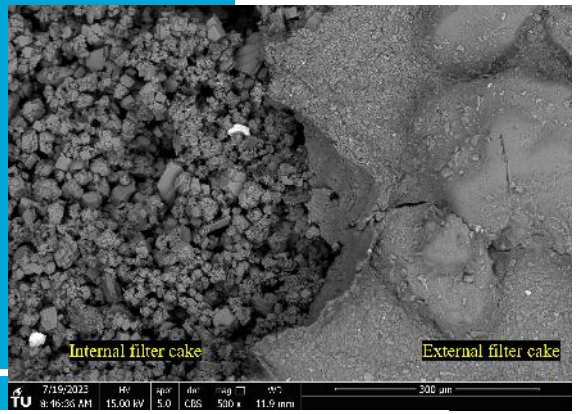
Koulidis et al. *Geothermal Energy* (2026)

Thermal loading → mechanical stress in annular material →formation of a micro-annulus

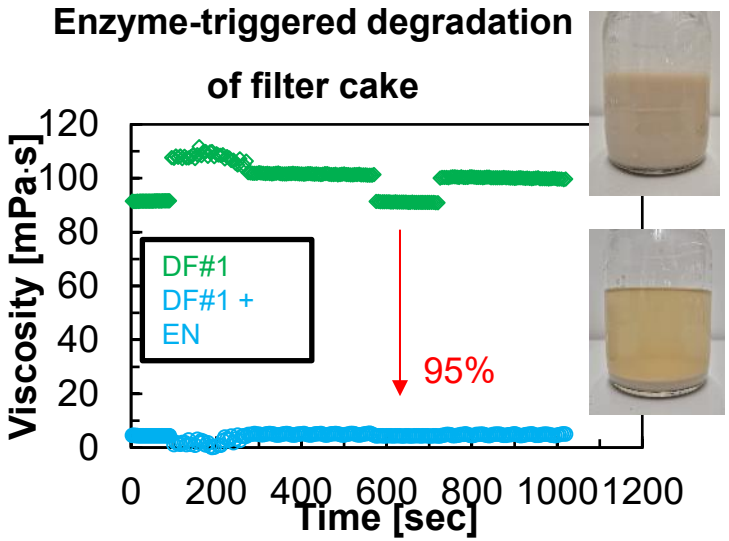
Compromising the well integrity

Wellbore Strengthening and Well Development



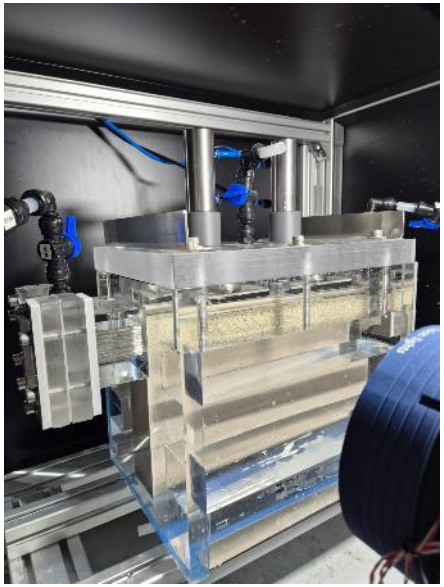


Koulidis et al. *Groundwater* (2025)



Impact:

- 100% biodegradable enzyme additives.
- Replaces harsh chemical breakers/acids.
- Reduces wellbore damage and long-term environmental risk.



- High-pressure/High-temperature custom core flooding system.
- Assess the effectiveness of drilling muds and well development methods.

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Home Smart Energy (HSE)

Geothermal heating for dense urban retrofit

HOME SMART ENERGY
UW EIGEN 40 METER DIEPE WARMTEBRON

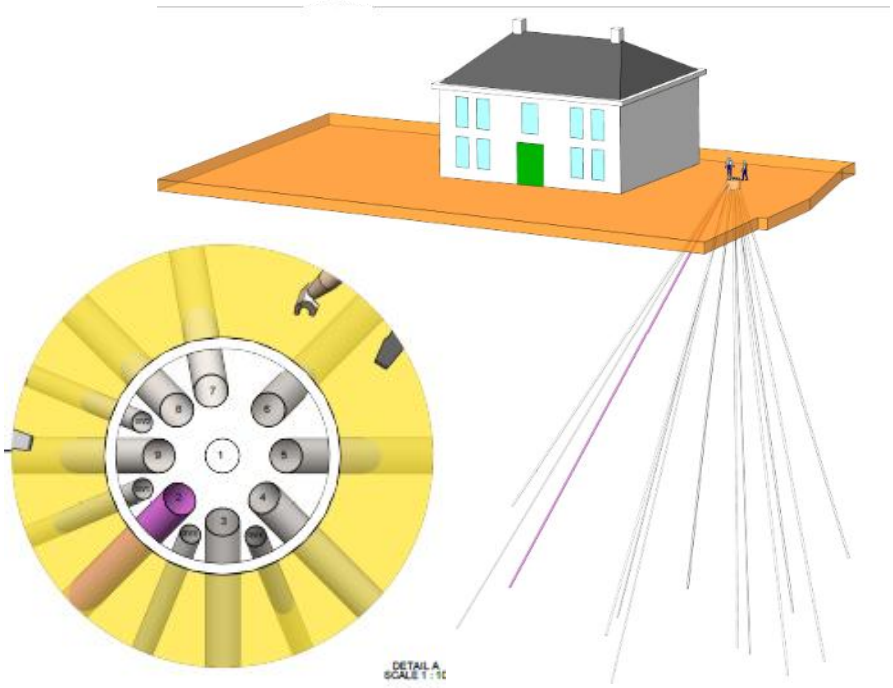
The retrofit problem

- Poorly insulated old housing stock
- Limited access for conventional GSHP drilling
- Drilling depth limited by aquifer protection
- District heating slow and expensive

HSE in one line

A fan of shallow diagonal boreholes drilled from a 1 m² platform in a constrained backyard — coupled to a heat pump with seasonal solar recharge.

Small footprint	High output	Seasonal recharge
1 m² platform	9 boreholes	Solar recharge



Radial diagonal BHE array beneath an existing house.

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DEVREEDEN
TU Delft
kansen voor west
Medegefinancierd door de Europese Unie

j.m.bloemendal@tudelft.nl

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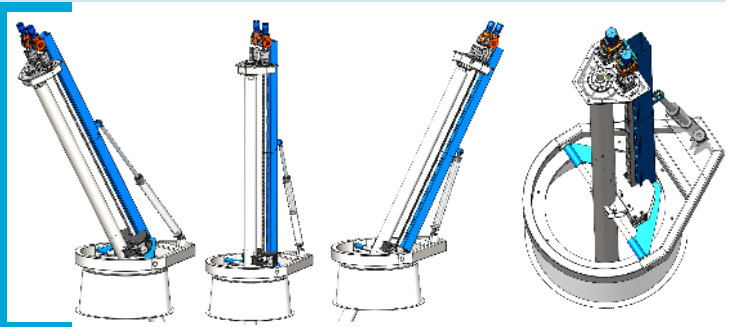

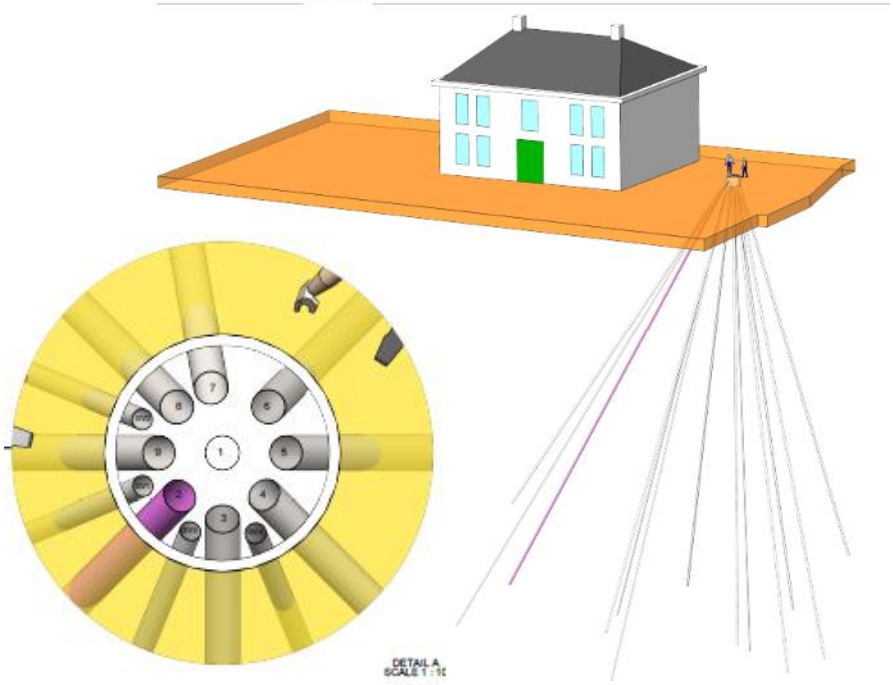

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Various other ongoing MT/HT-ATES projects

- Existing ATES → to Higher T
- ElevATES
- ACCELUTES
- WarmingUPGOO
- ..

Various other drilling/well developments/projects

- Wells in Sulphate Reduction Transition Zone
  - Manage mitigate Clogging risks
- 3V-HTO
  - Well design standards for (HT-) ATES
- Innovative Pilot borehole
- GEO-Loop model
- Collective BTES
- Geheco

Closing and take home messages

Tipping point

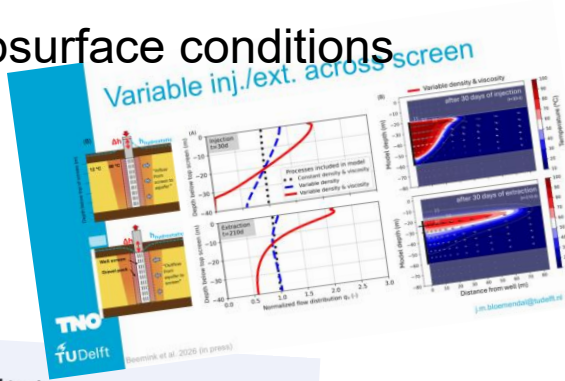
Existing buildings
More complex subsurface conditions

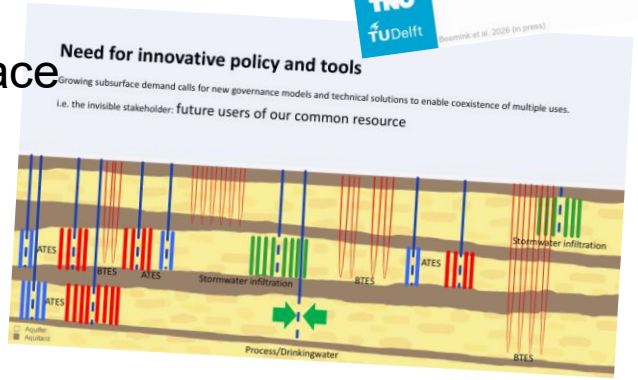
Higher temperatures
Stronger integration

Newly built

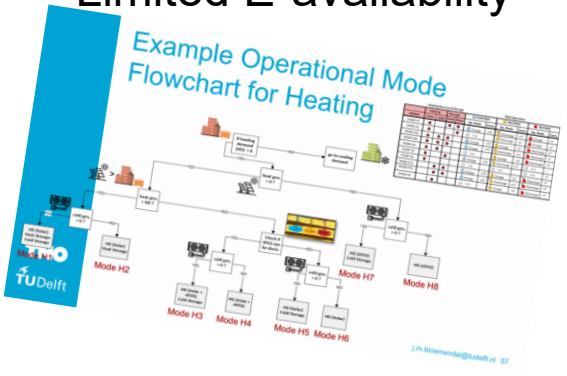
Individual systems

Scarcity in subsurface space

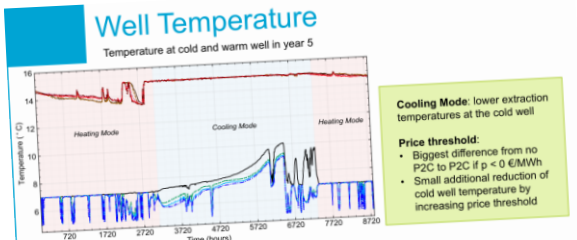




Collective systems
Limited E-availability



Increasing cooling demand



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Take home

- Via research and demos towards cheap and robust novel UTES innovations and sustainable use of the subsurface

- Challenges for improvements/developments
  - Upscaling (temperature, placement density)
  - Integration in in wider energy system / conversion / grid congestion issues
  - Performance (operational control, both HT and LT!)
  - Market conditions

Old	New
Standalone	**Integrated**
Low-temp	**Full spectrum**
Static design	**Adaptive**
First-come	**Coordinated**

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Asjemenou

Promotions

UTES symposium

MSc Sustainable Energy Technology

Electrical Energy track


Wind Energy


Solar Energy


Waste & CHP


Energy Storage


Power Engineering

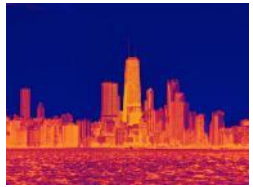

Economics & Society


Electric Mobility

Heating and Cooling track


Heat Sources


LS Heat Systems


Heat in Buildings


Power Engineering


Economics & Society


Waste & CHP


Solar Energy

Developing and demonstrating Underground Thermal Energy Storage

Unlocking UTES for the next phase of the energy transition

Dr.ir. M. Bloemendal

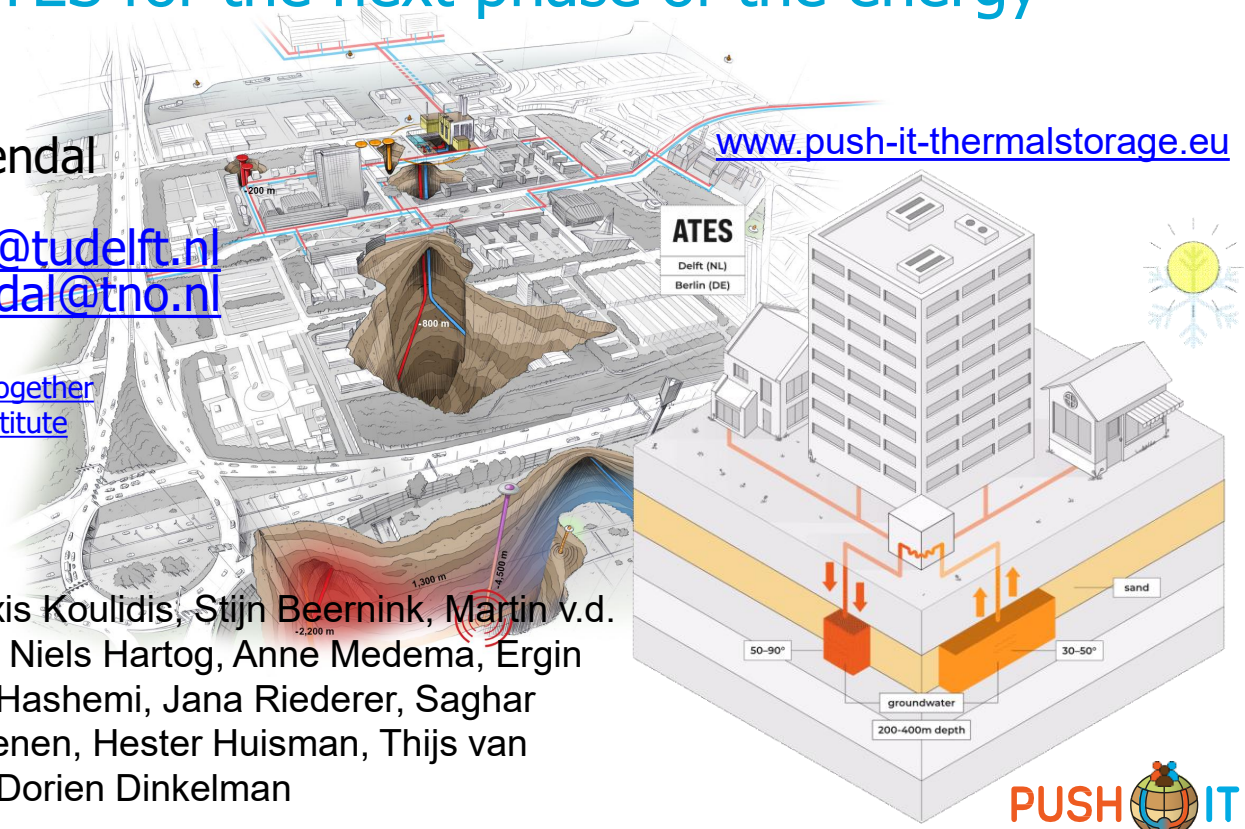
2026-06-28

j.m.bloemendal@tudelft.nl
martin.bloemendal@tno.nl

Stay in touch / connect?

TU Delft geothermal get together
TU Delft Urban energy institute
Delft Aardwarmte project

www.push-it-thermalstorage.eu



Contributions from:
Tessel Grubben, Alexis Koulidis, Stijn Beernink, Martin v.d. Schans, Phil Vardon, Niels Hartog, Anne Medema, Ergin Kukrer, Amirhossein Hashemi, Jana Riederer, Saghar Sarshar, Marielle Koenen, Hester Huisman, Thijs van Esch, Rik Molenaar, Dorien Dinkelman

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Novel combination of geothermal & HT-ATES in complex energy system

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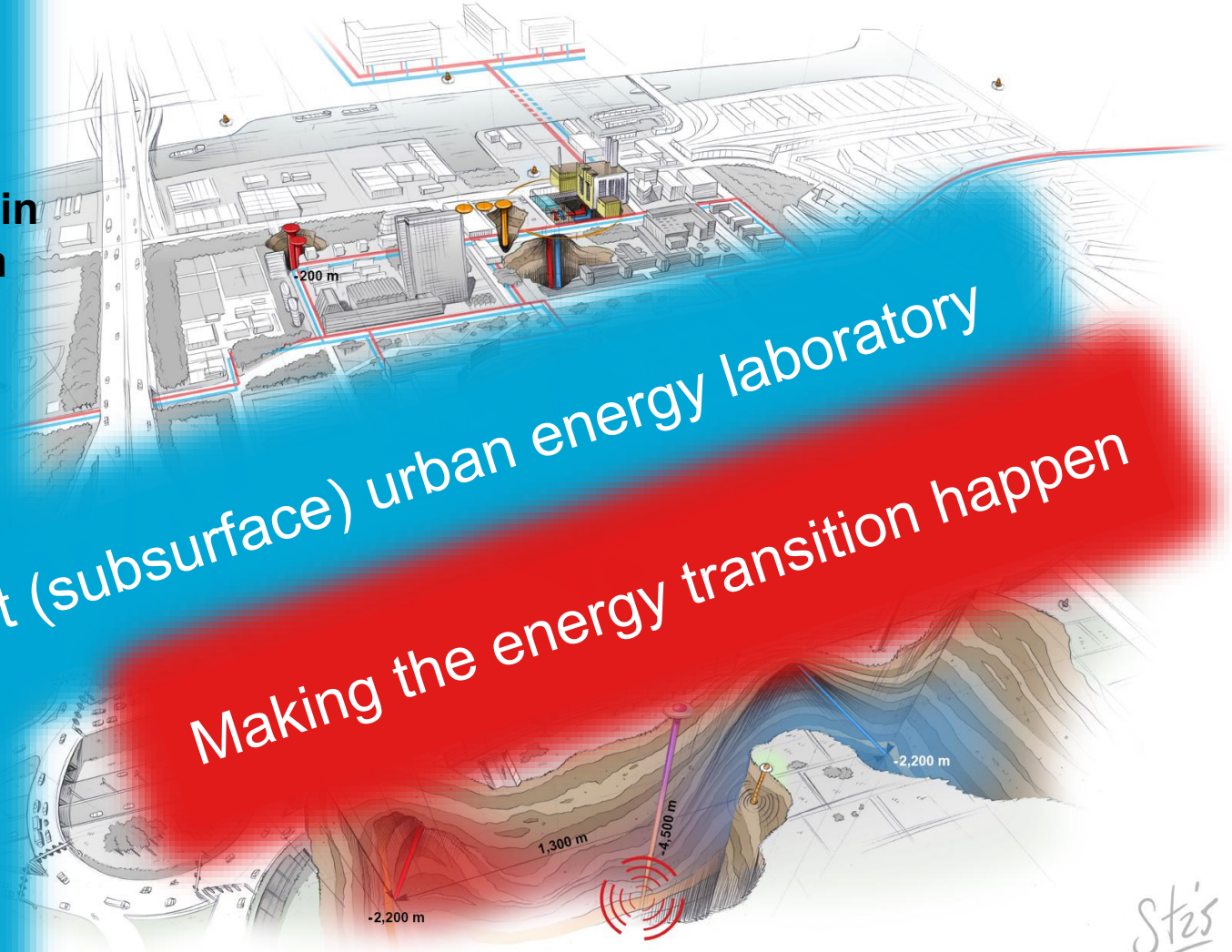

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