Recycling of subsurface heat loss from thermal energy storage basins through geothermal trenches

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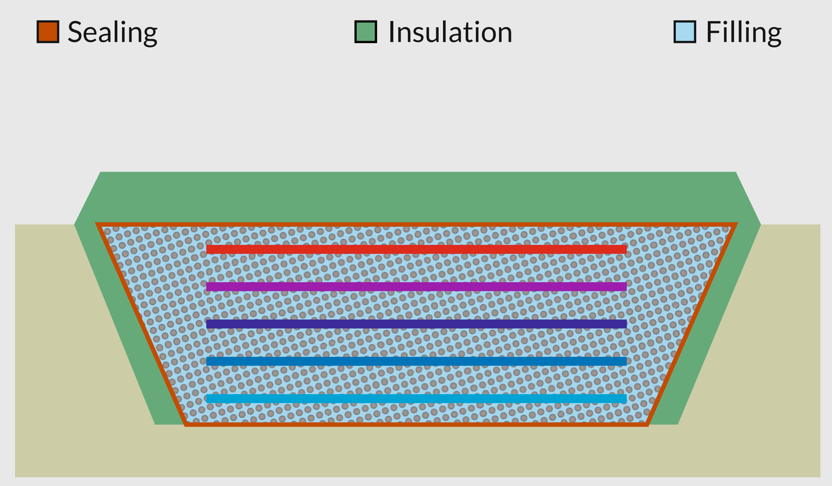
Applied Geology

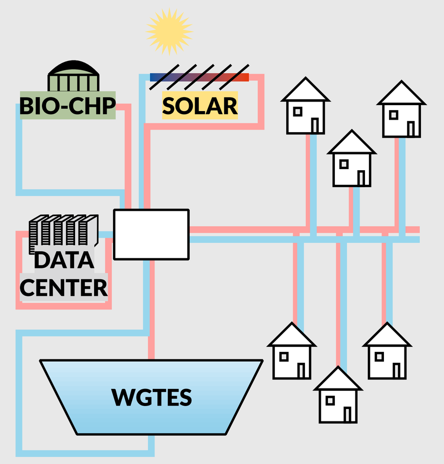
INTER STORES

A Water-Gravel Thermal Energy Storage

Concept



Integration



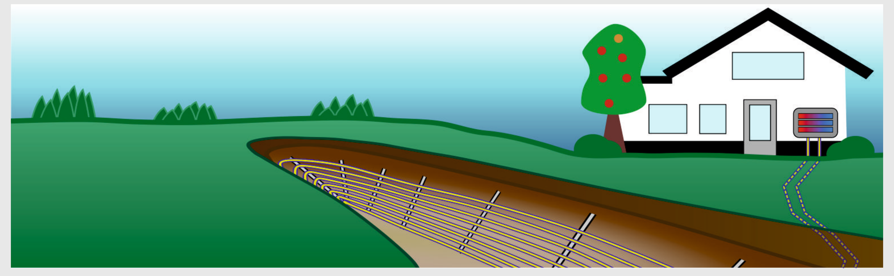
sTES Facts

Application
- District scale
- Integration of renewable sources
- Peak shaving and load shifting

Advantages
- Secured energy supply
- Autarky and flexibilization
- Reduced environmental impacts

Key Barriers
- Planning uncertainty
- High CAPEX and OPEX
- High long-term thermal losses

Geothermal Trenches

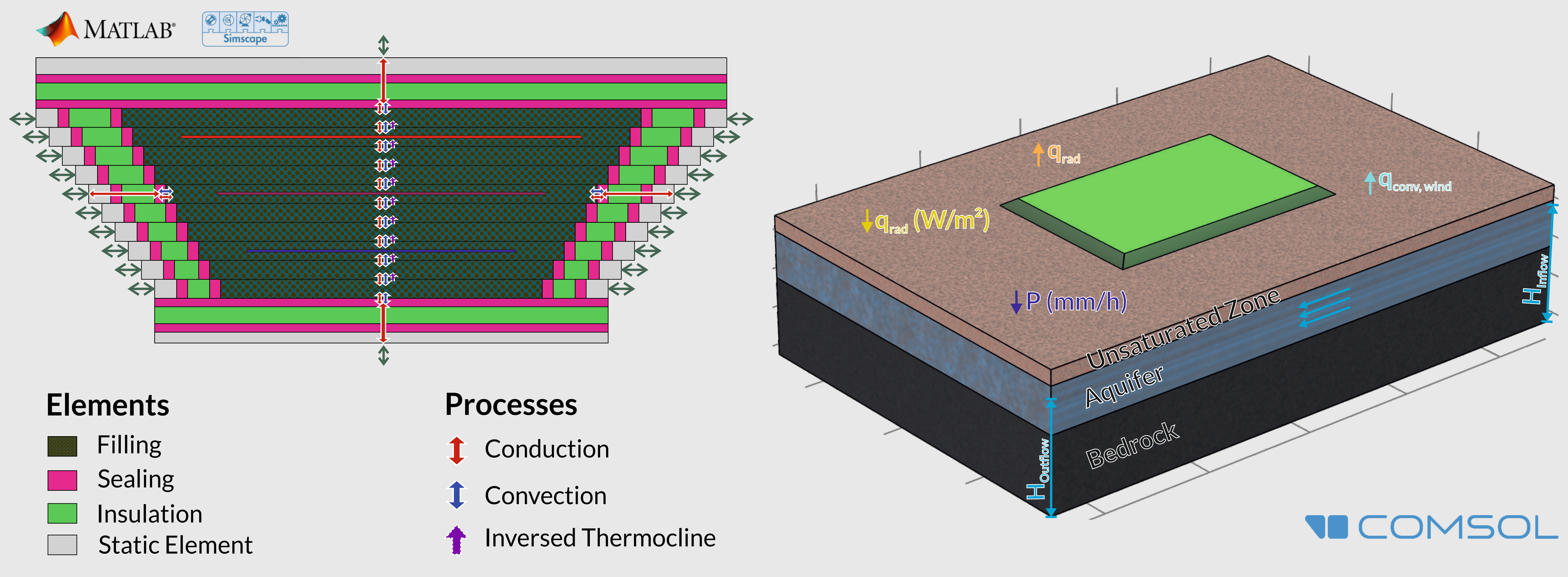


Concept
- Shallow excavation for heating
- Heat pump circulates fluid
- Piping for soil heat exchange

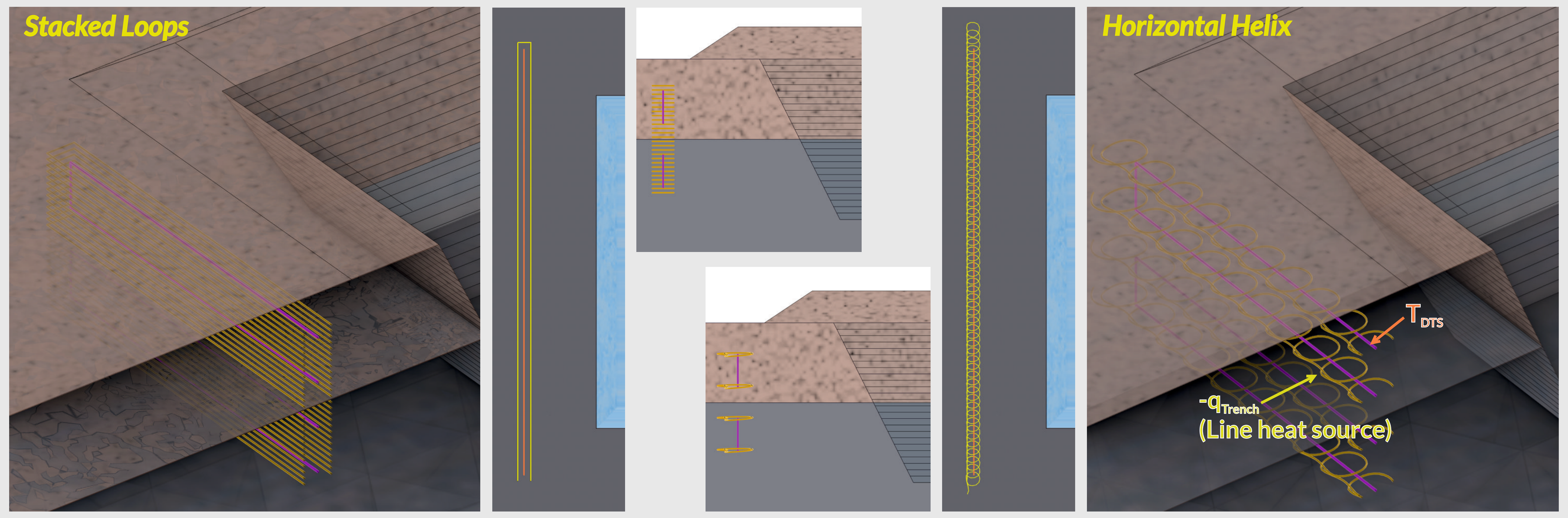
Benefits
- Robust source of energy
- Reduced use of fossil fuels
- Well-proven SGE technology

B Co-Simulation with Geothermal Trench

CoSim-STORE

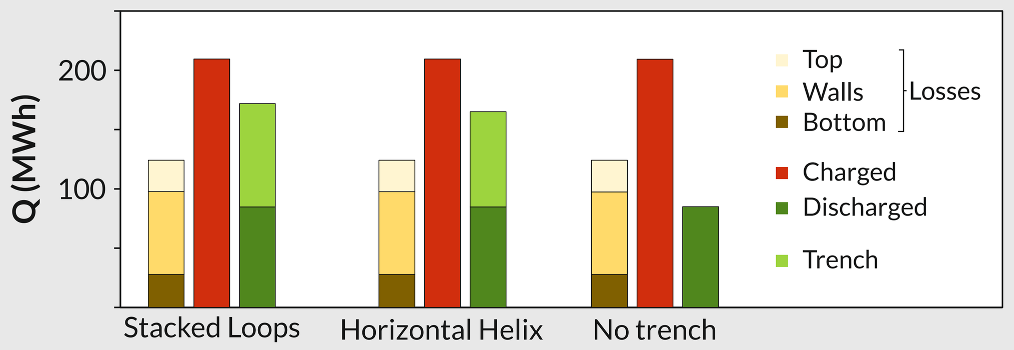


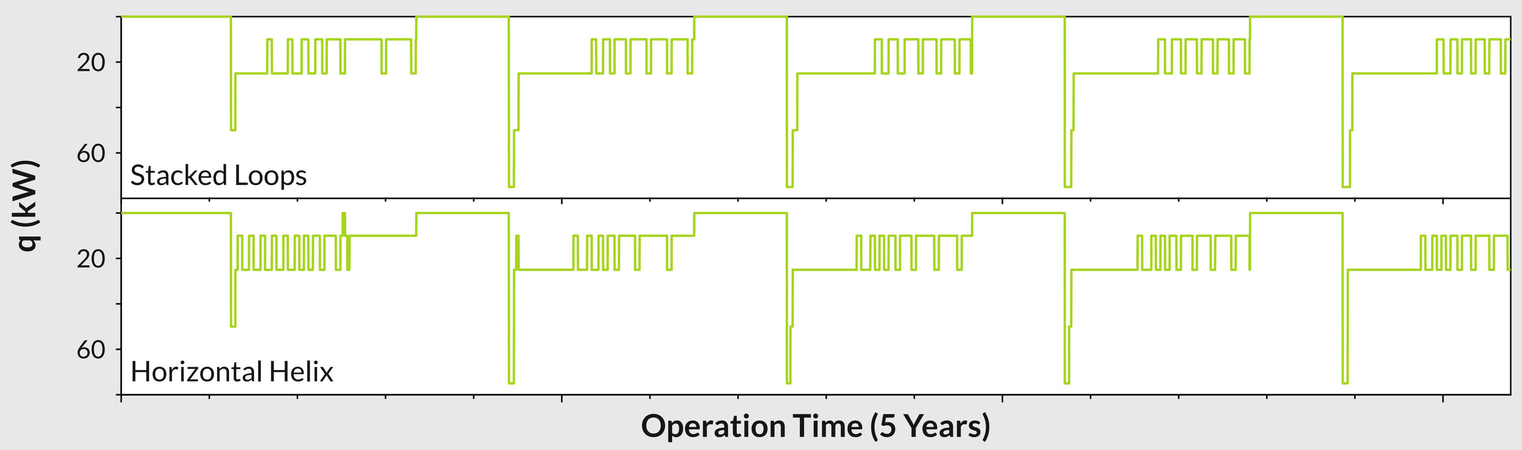
Trench Model



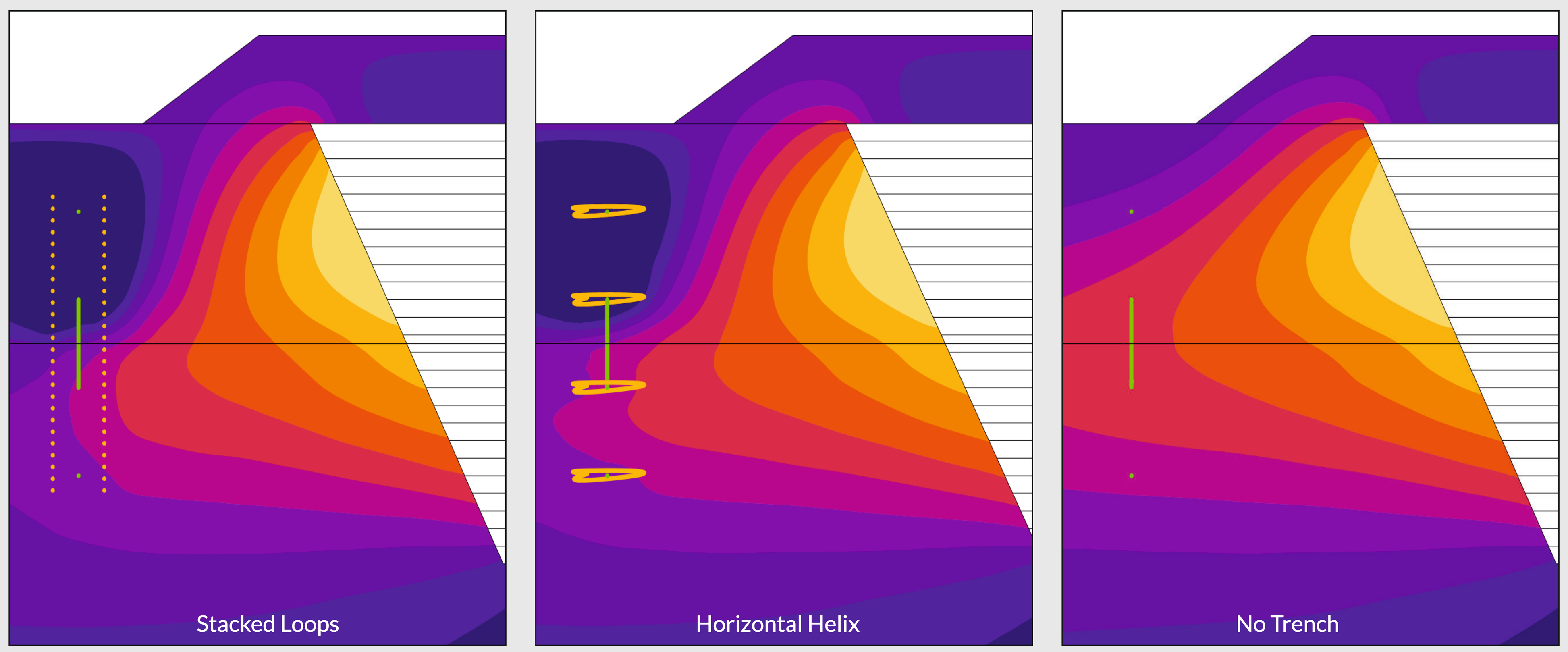
D Results

Storage & Trench Performance





Subsurface Heating



C Case Study

Geology

Stratigraphy
- Unsaturated zone: 3.75 m, sand
- Saturated zone: 15 m, gravel
- Bedrock: 3.75 m, clay stone

Groundwater
- $u = 10^{-5}$ m s^{-1}
- depth = 50 % h_{WGTES}

Storage Design

General
- Location: Synthetic case
- Storage type: WGTES
- Geometry: H = 7.5 m; W, L = 30 m; Slope 1 : 0.5; V_{tot} = 1 400 m³

Components
- Heat exchanger: Ø: 5 cm, PE-X, 3mm; 5 levels, 0.5 m dist.
- Static component: 0.25-0.5 m, concrete
- Sealing: 2.0 mm, PVC
- Insulation: Foam glass gravel; 0.3-0.5 m, ex. trench

Geothermal Trench Designs

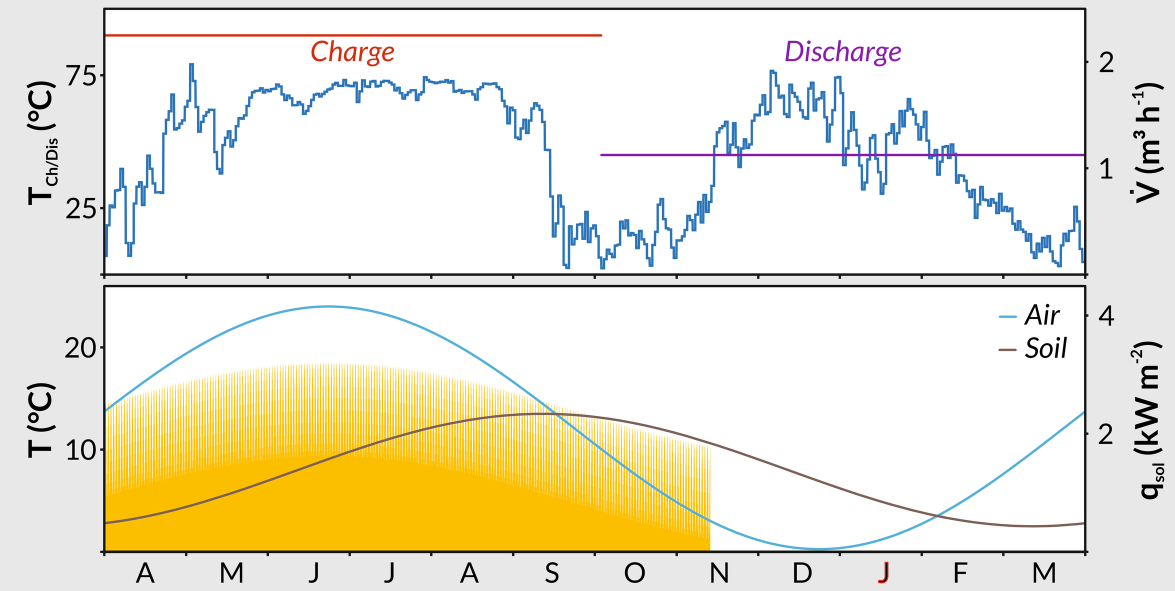
Heat Exchanger Geometry
- Parametric study: No trench (base case); 3 horizontal helix; 20 stacked loops

Pipes
- Material: PE-X; d = 40 mm; asd

Control
- $T_{DTS,avg/max}$ & T_{air} < 18°C
- Thresholds & power:

> 5.0 °C	-10 kW
> 7.5 °C	-25 kW
>12.5 °C	-50 kW
>17.5 °C	-75 kW

Input Data



E Conclusions and Outlook

Summary

Geothermal trenches can provide a complementary **benefit** for ground-based TES. This initial study proves that thermal losses can actively be **harvested**, enhancing system efficiency and **mitigating** adverse subsurface **impacts.**

Future research will focus on **including** simulation of **pipe flow**, and a geothermal **heat pump** in the co-simulation model, Also, parameter studies for evaluating **optimal** control/ operation, geometries, and hydraulics, will be conducted.

Key Figures

Case Study
Trench Operating Hours
max. 5841 h/a
WGTES Efficiencies
Potential increase: +42 %
Recycled Heat Losses
max. 87 MWh/a

Sharing is encouraged

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Further Information

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