World Groundwater Congress
IAH2024 DAVOS
Switzerland
Interacting
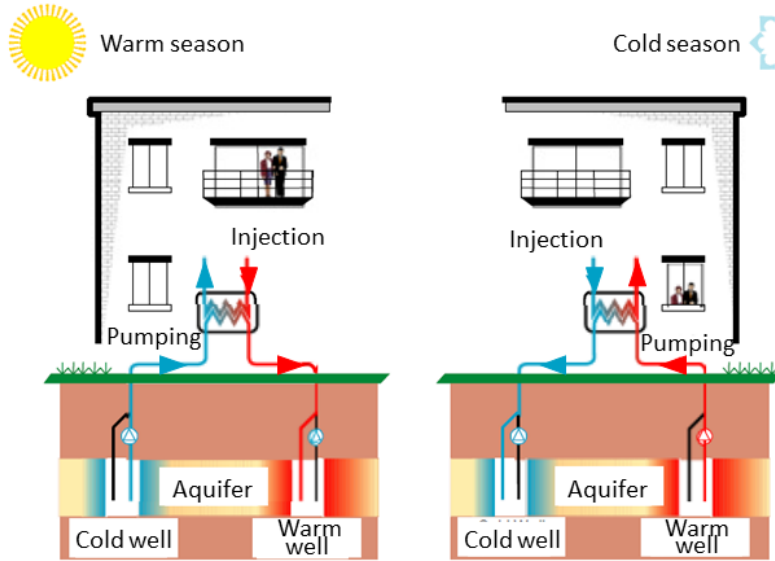Groundwater   8.–13.9.2024

belspo   GEOCAMB

Studying interactions of five adjacent Aquifer Thermal Energy Storage (ATES) systems in Cenozoic and Palaeozoic aquifers in Brussels (Belgium)

C. De Paoli, Ph.Orban, M. Agniel, E. Petitclerc,Th. Duren, J. Peret, A. Dassargues
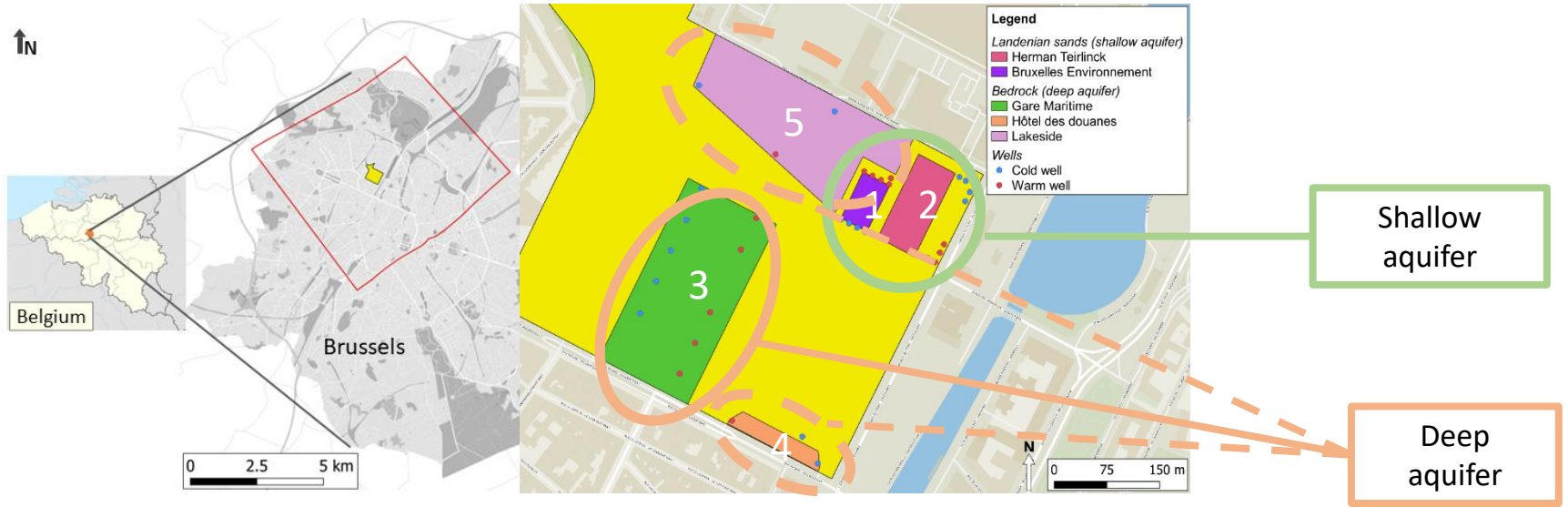
LIÈGE
université
Hydrogeology
Environmental Geology

The underground… a source of energy/storage

Warm season   Cold season

Injection   Injection

Pumping   Pumping

Aquifer   Aquifer

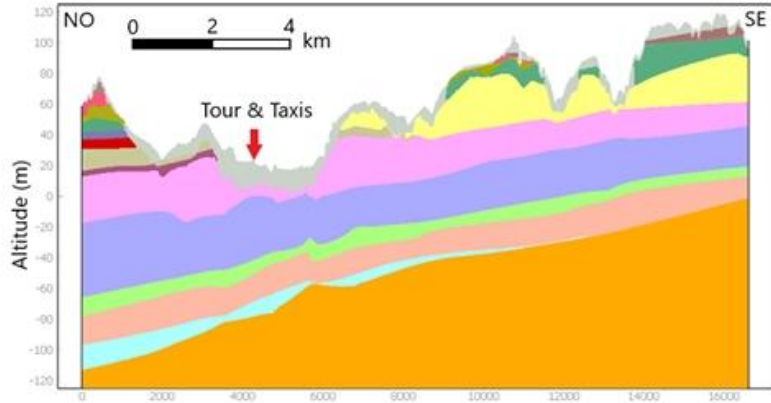Cold well   Warm well   Cold well   Warm well

From Hoegaerden & Hagedoorn, 2007

- geothermal systems are important for decarbonizing the heating/cooling of buildings
- open loop geothermal systems
  - efficient for high power demand
  - P proportional to the water flow rate Q
    → large pumping rate needed

- need of long-term efficiency
- what are the interactions between adjacent systems?
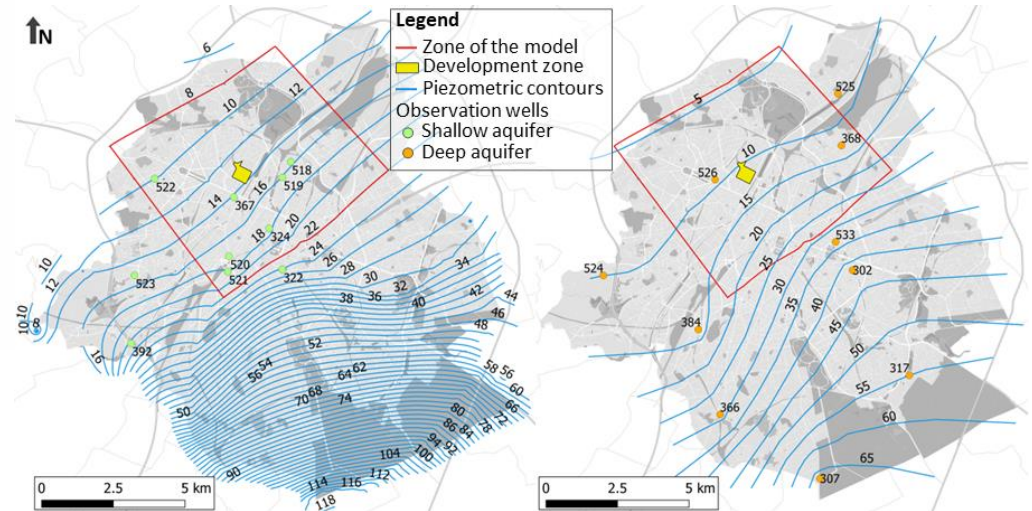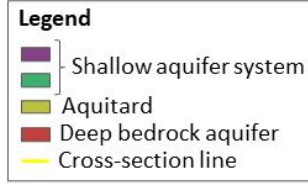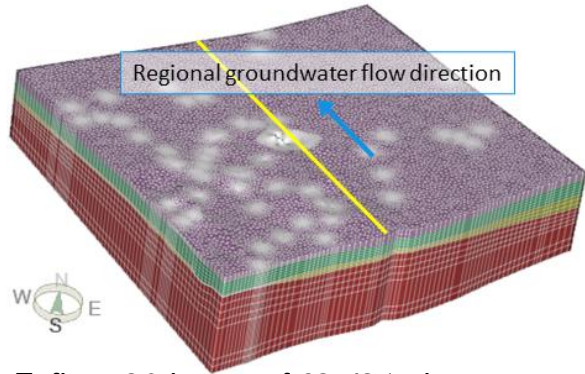
Case study: Tour & Taxi site

Legend

Landenian sands (shallow aquifer)
- Herman Teirlinck
- Bruxelles Environnement

Bedrock (deep aquifer)
- Gare Maritime
- Hôtel des douanes
- Lakeside

Wells
- Cold well
- Warm well

Shallow aquifer

Deep aquifer

Belgium

Brussels

0   2.5   5 km
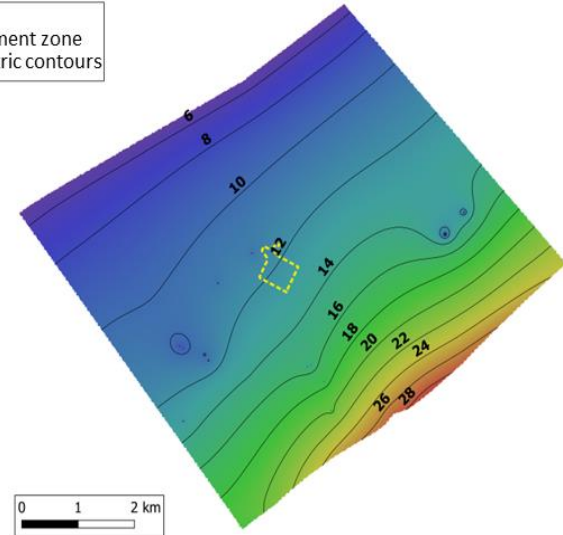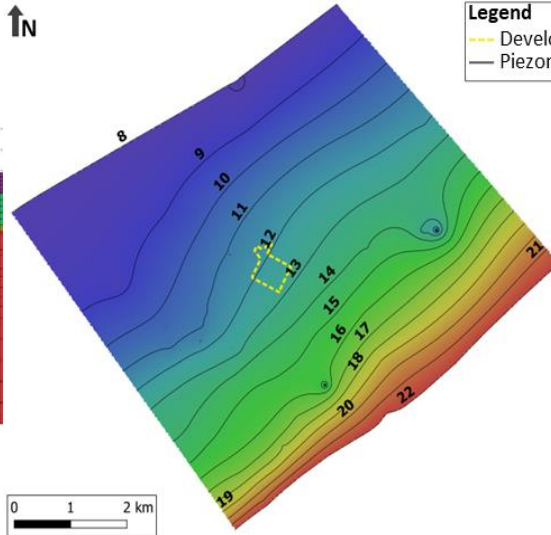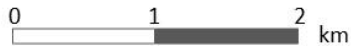
0   75   150 m

Methodology : Compilation of data

Methodology: Transient state 3D groundwater flow and heat transfer model

Feflow: 20 layers of 62,421 elements each
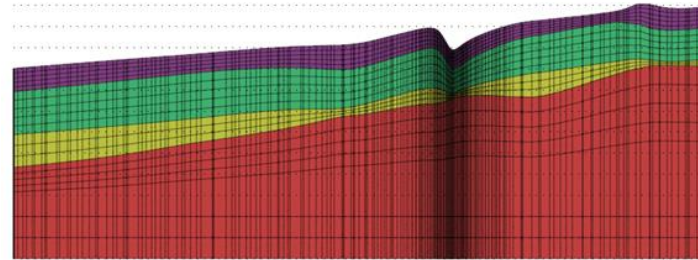
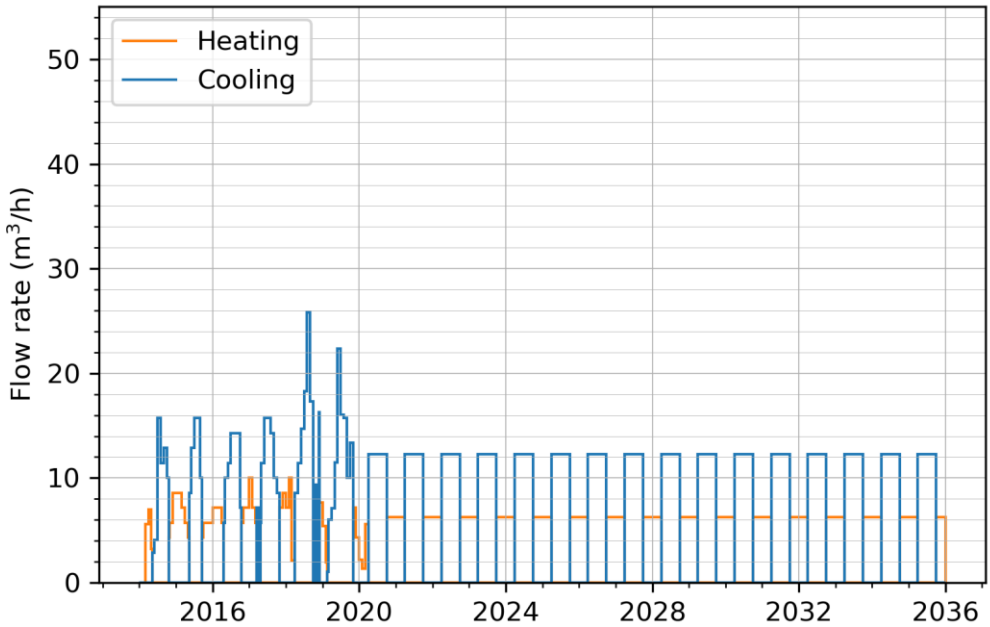# ATES main characteristics: Building 1 – based on historical data

Bruxelles Environnement

Shallow aquifer, $\Delta T = 6°C$
Cooling demand > Heating demand

Heating : October 1st – March 31st
Cooling : April 1st – September 30th

Start :   1 March 2014

ATES main characteristics: Building 2 – based on historical data

Herman Teirlinck

Shallow aquifer, $\Delta T = 6°C$
Cooling demand = Heating demand

Heating : November 1st – April 15th
Cooling : April 16th – October 31st

Start :   1 August 2017

ATES main characteristics: Building 3 – based on historical data

Gare Maritime

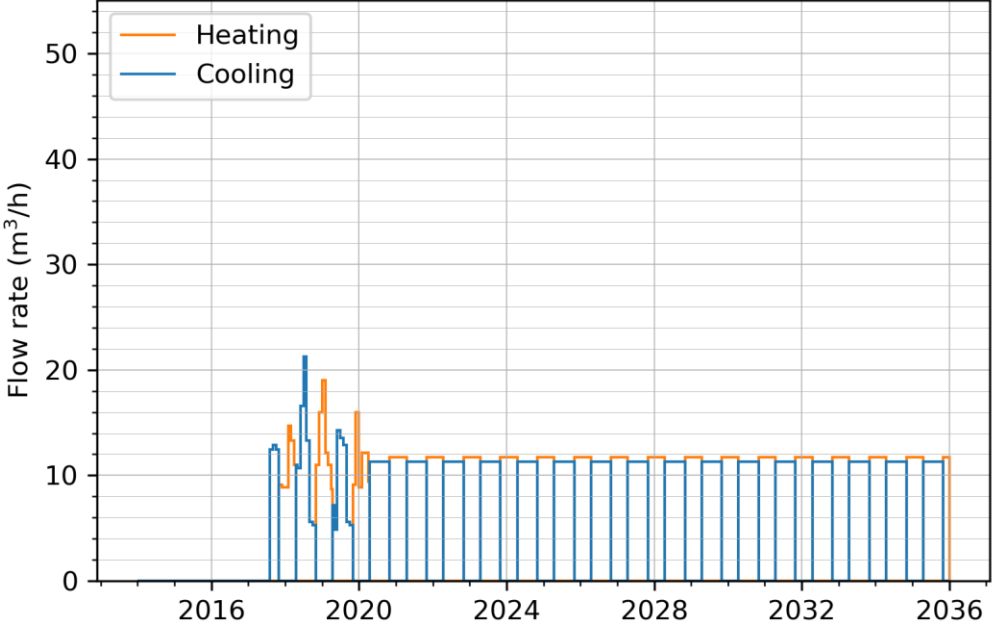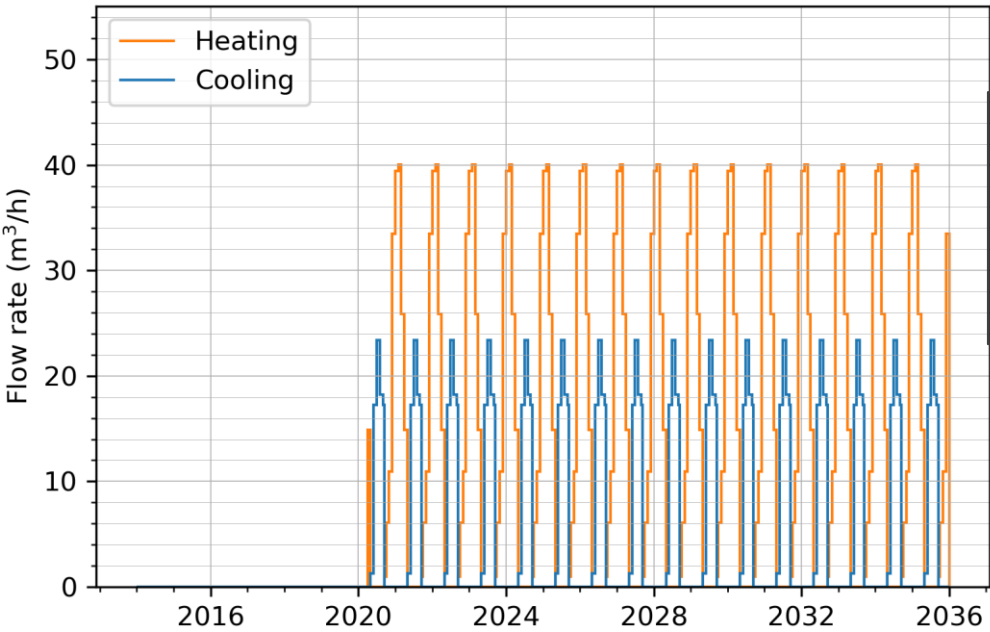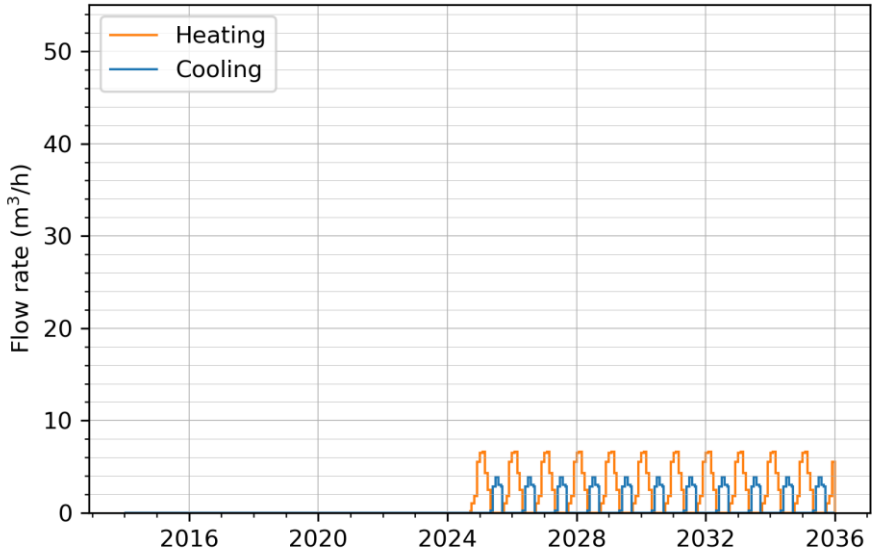Heating : September 15th – March 31st
Cooling : April 1st – September 14th

Start :   1 April 2020

Deep aquifer, $\Delta T = 6°C$
Demand for cooling < Demand for heating

Legend

Landenian sands (shallow aquifer)
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- Bruxelles Environnement

Bedrock (deep aquifer)
- Gare Maritime
- Hôtel des douanes
- Lakeside

Wells
- Cold well
- Warm well

0   75   150 m

ATES main characteristics: Building 4 – Scenario 1

Hôtel des Douanes - Scenario 1

Deep aquifer, $\Delta T = 6°C$
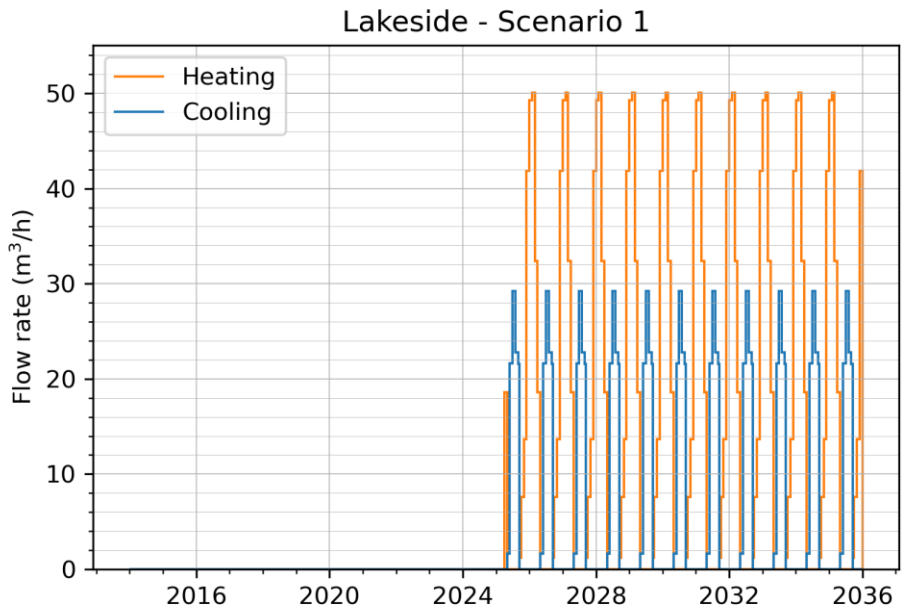
Scenario 1 : Cooling demand < Heating demand

Heating : September 15th – March 31st
Cooling : April 1st – September 14th
Scenario1 : Same demand/surface as building 3
Start :   1st October 2024

ATES main characteristics: Building 4 – Scenario 1

Lakeside - Scenario 1

Heating : September 15th – March 31st
Cooling : April 1st – September 14th
Scenario1 : Same demand/surface as building 3
Start :   1st April 2025

Deep aquifer, $\Delta T = 6°C$
Scenario 1 : Cooling demand < Heating demand

Temperature evolution in the hot and cold wells
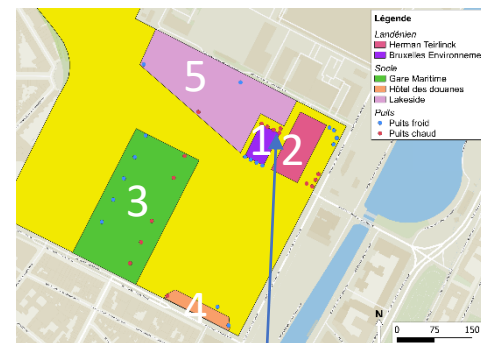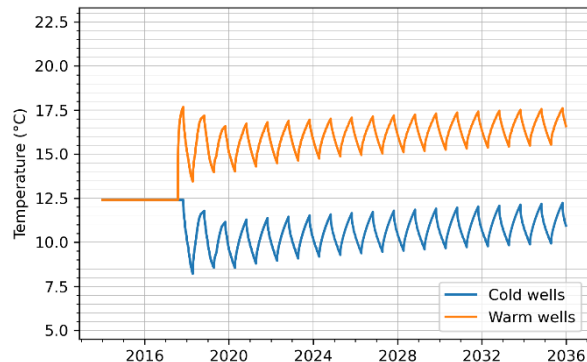
Scenario 1: shallow aquifer
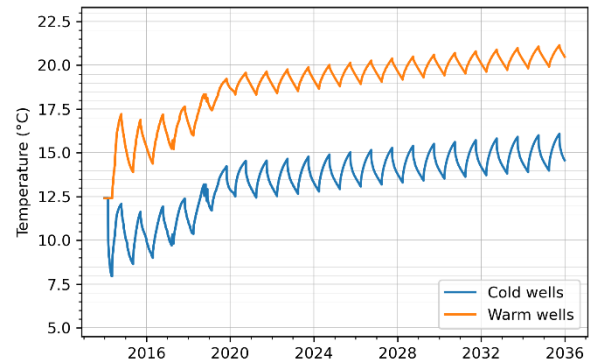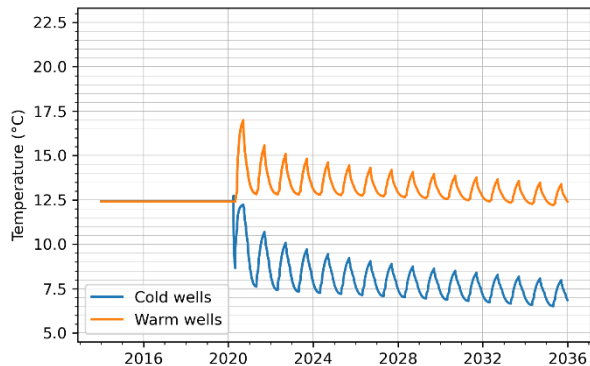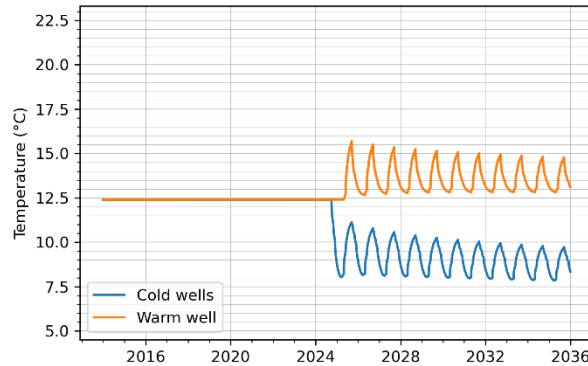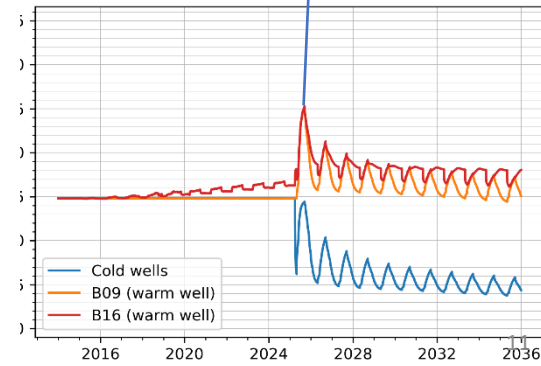

Scenario 1: deep aquifer
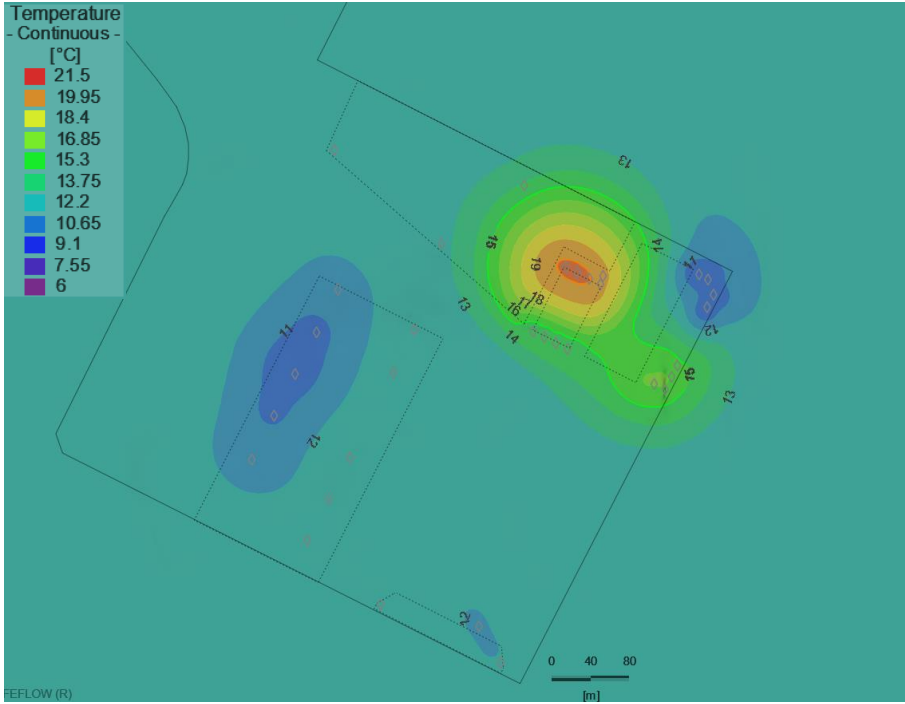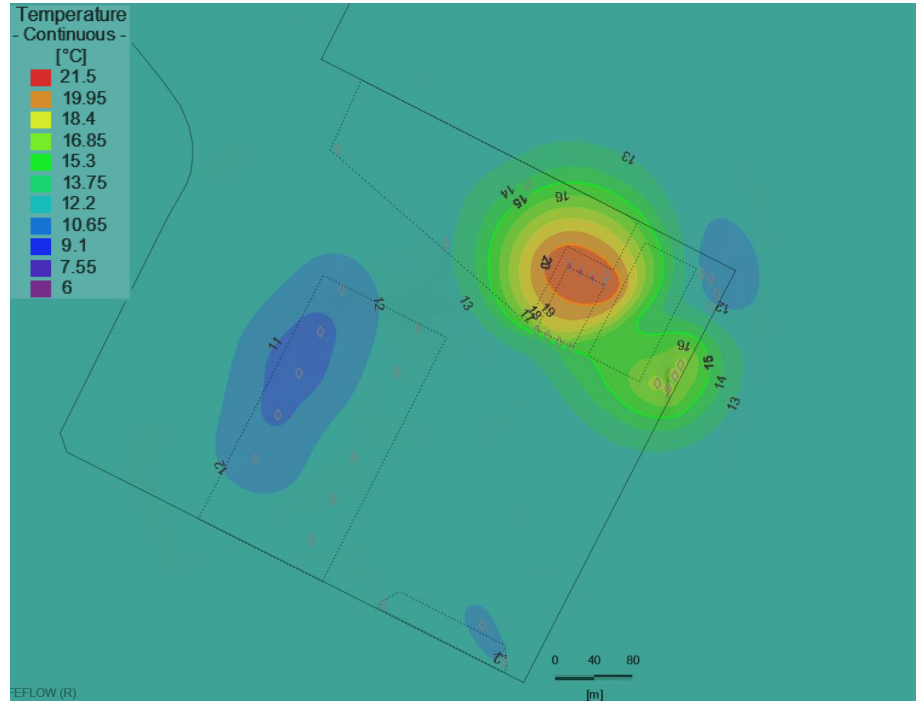
Hot and cold plumes in the shallow aquifer – Scenario 1 after 10 years of operating building 5 (2035)
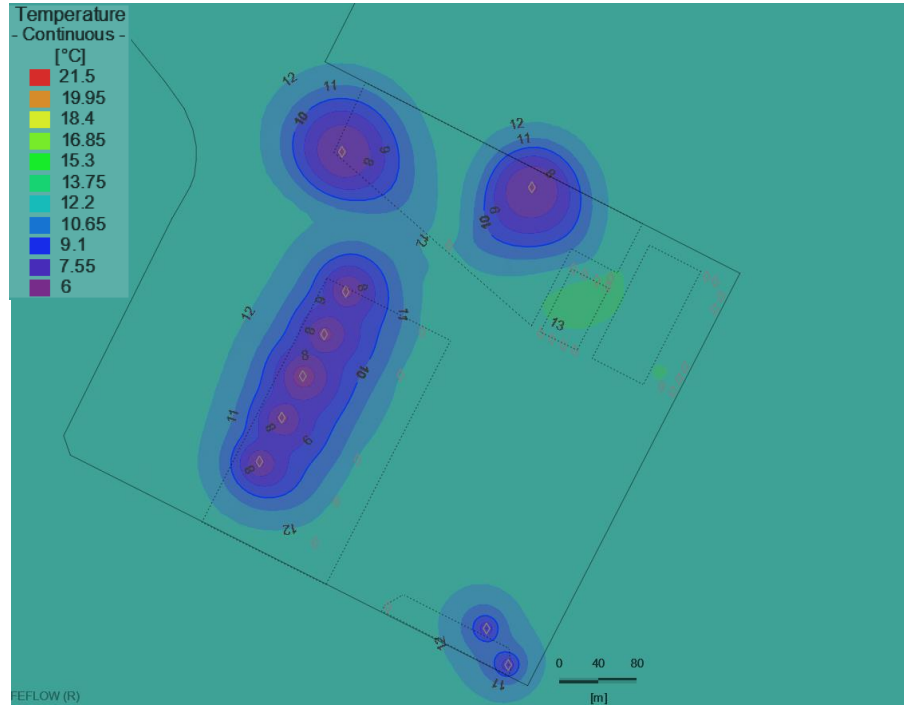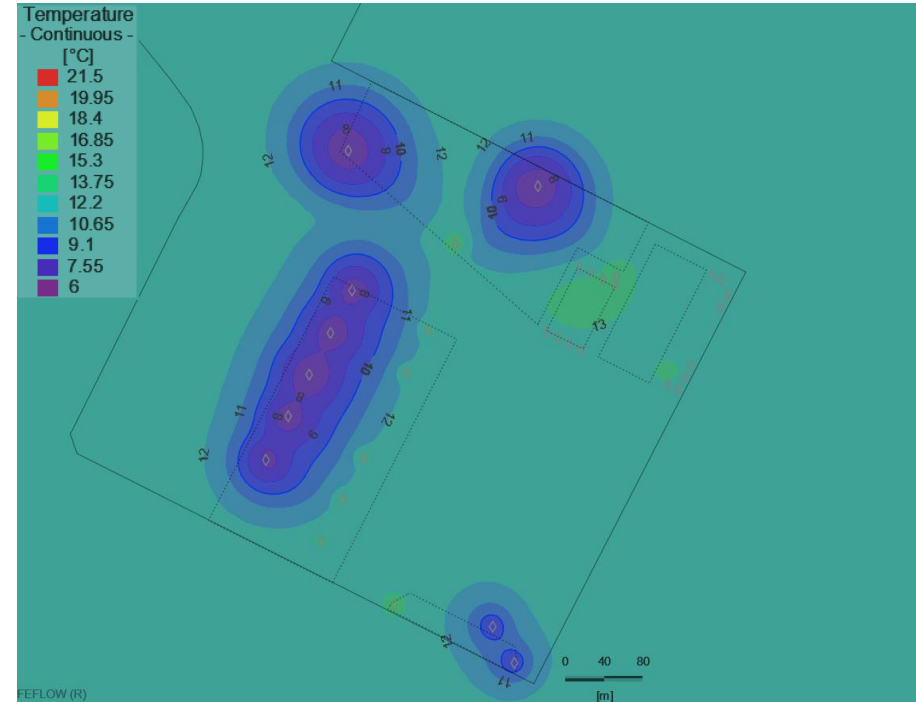
End of winter

End of summer

Hot and cold plumes in the deep aquifer – Scenario 1 after 10,5 years of operating building 5 (2035)
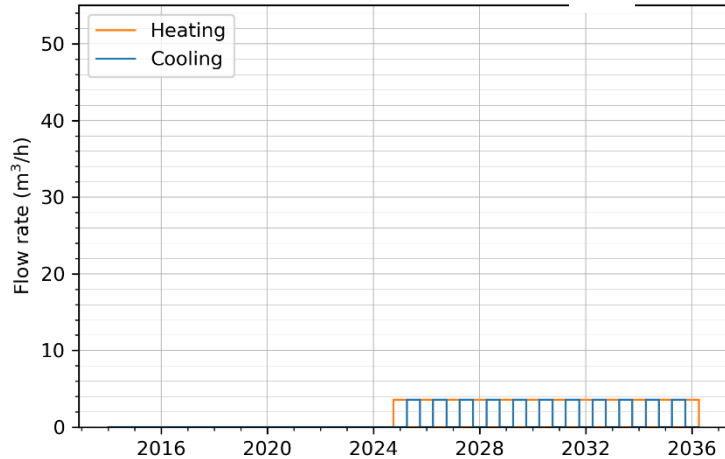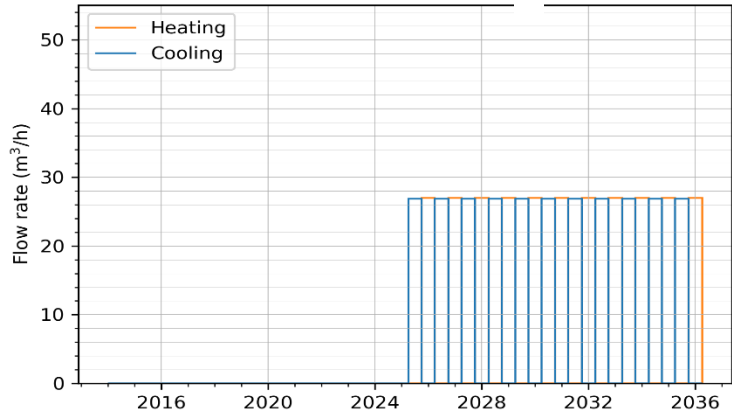
End of winter

End of summer

ATES main characteristics : Building 4 and 5

Hôtel des Douanes - Scenario 2

Heating : October 1st – March 31st
Cooling : April 1st – September 30th
Start :   1st November 2024
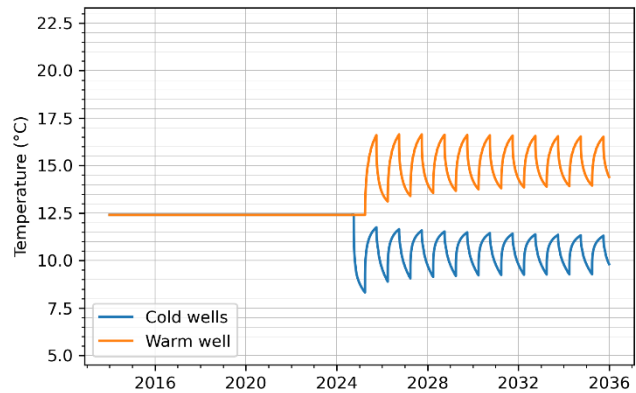

Lakeside - Scenario 2

Heating : October 1st – March 31st
Cooling : April 1st – September 30th
Start :   1st April 2025

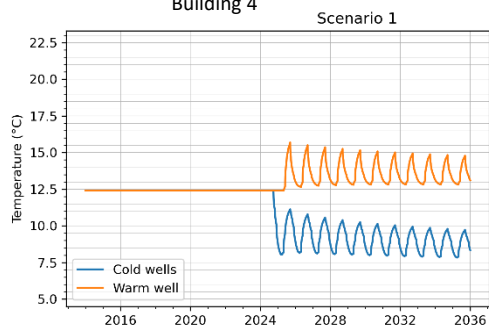Deep aquifer, $\Delta T = 6°C$
Cooling demand = Heating demand

14

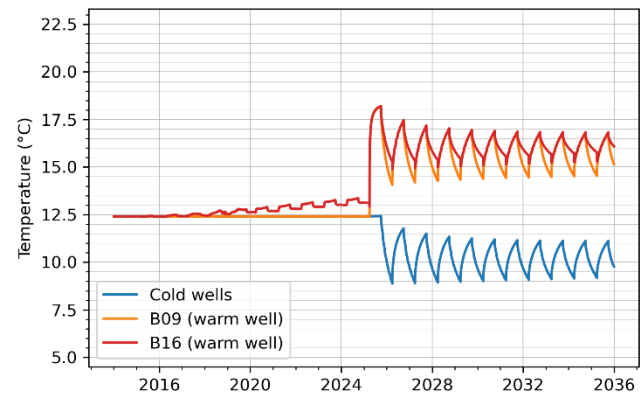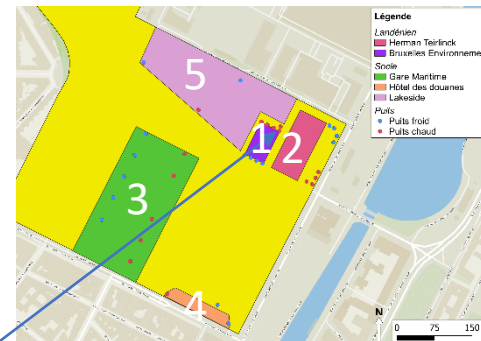# Temperature evolution in the hot and cold wells

Scenario 2: deep aquifer
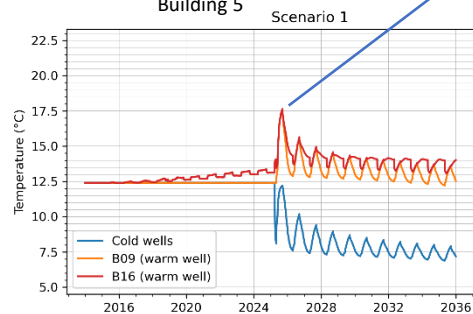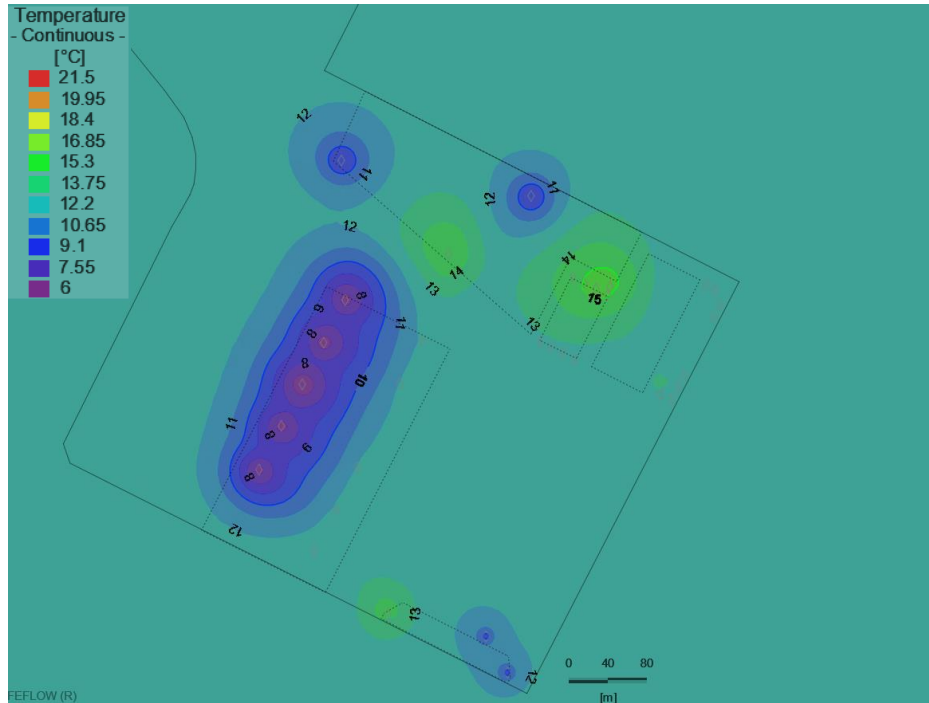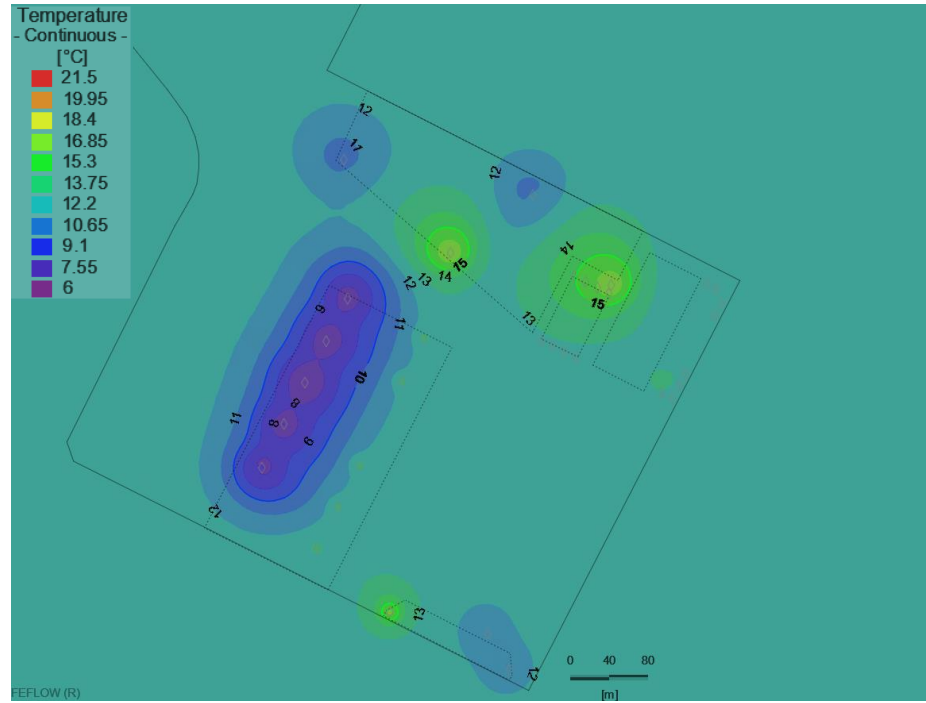
Hot and cold plumes in the deep aquifer – Scenario 2 after 10,5 years of operating building 5 (2035)

End of winter

End of summer

Conclusions, lessons …

- Advection remains limited and the storage is efficient but the cool and heat demands have to be balanced

- Limited heat transfers simulated between the two aquifers through the aquitard and no significant impact on the efficiency of the individual systems

- New data should be collected (pressure and temperature in the wells) but also temperature in the aquifer

- Data on the real heating and cooling demands of the buildings are needed to improve the model

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