GEOCAMB

Geocamb, funded by the Belgian Science Policy (Belspo)

Simulating interactions of five adjacent Aquifer Thermal Energy Storage (ATES) systems in the Cenozoic and in the Cambrian aquifers in Brussels (Belgium)

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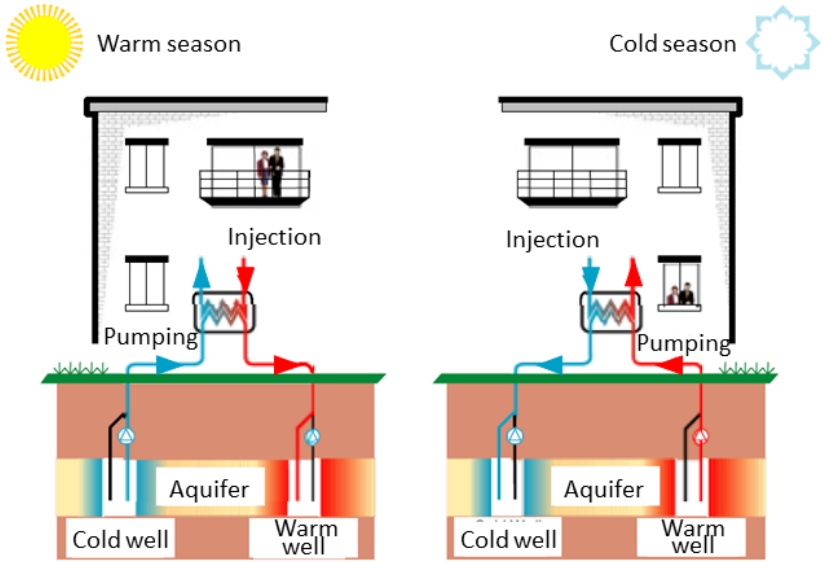
LIÈGE université

Hydrogeology
Environmental Geology

The underground… a source of energy/storage

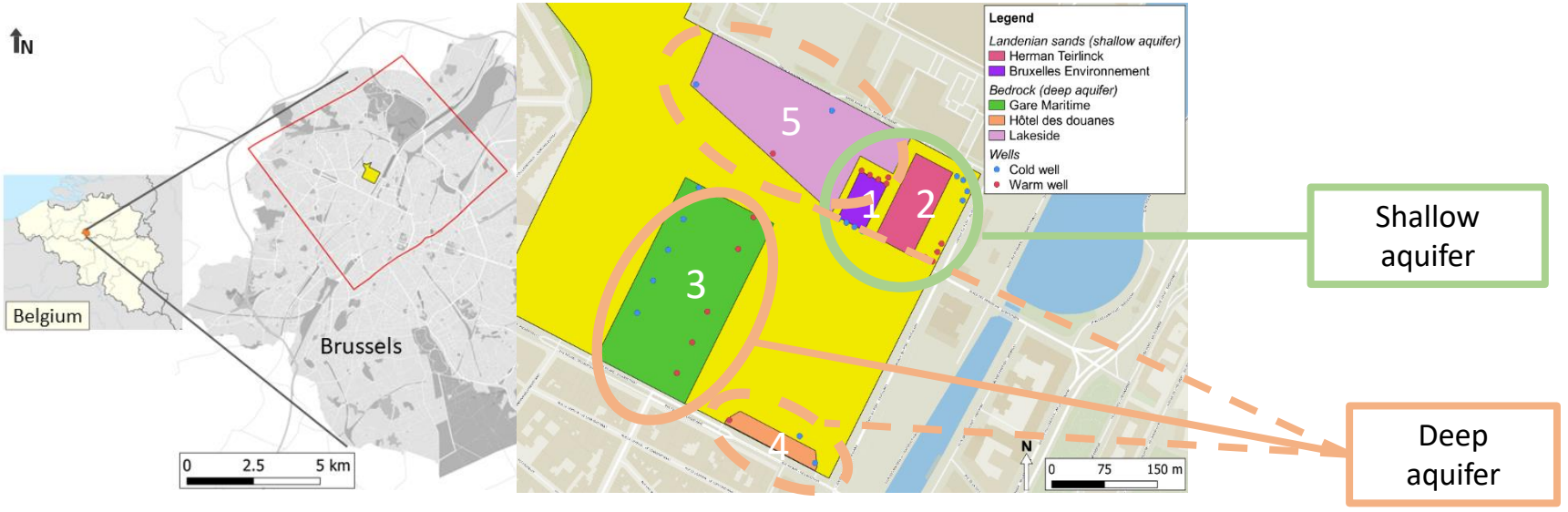


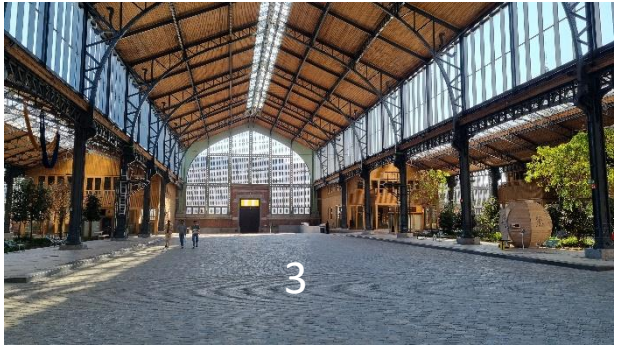
From Hoegaerden & Hagedoorn, 2007

- 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

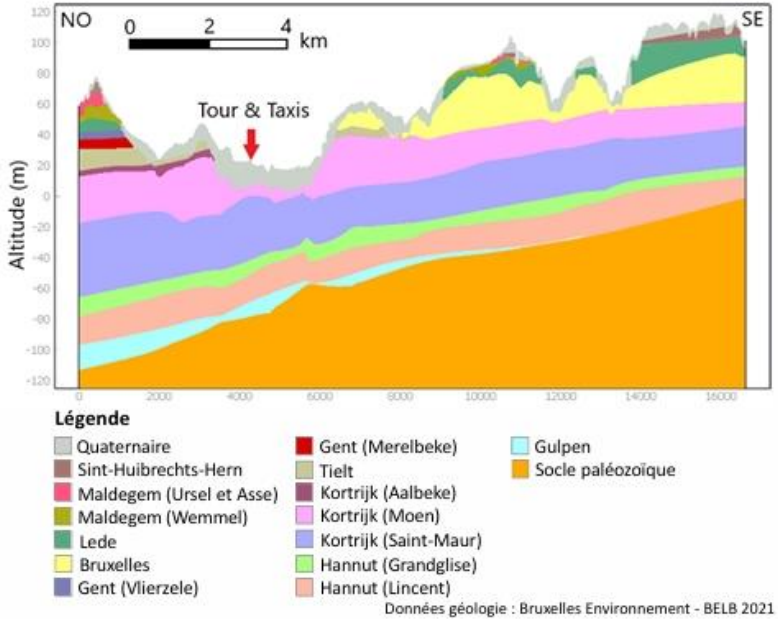
- need of long-term efficiency
- what are the interactions between adjacent systems?

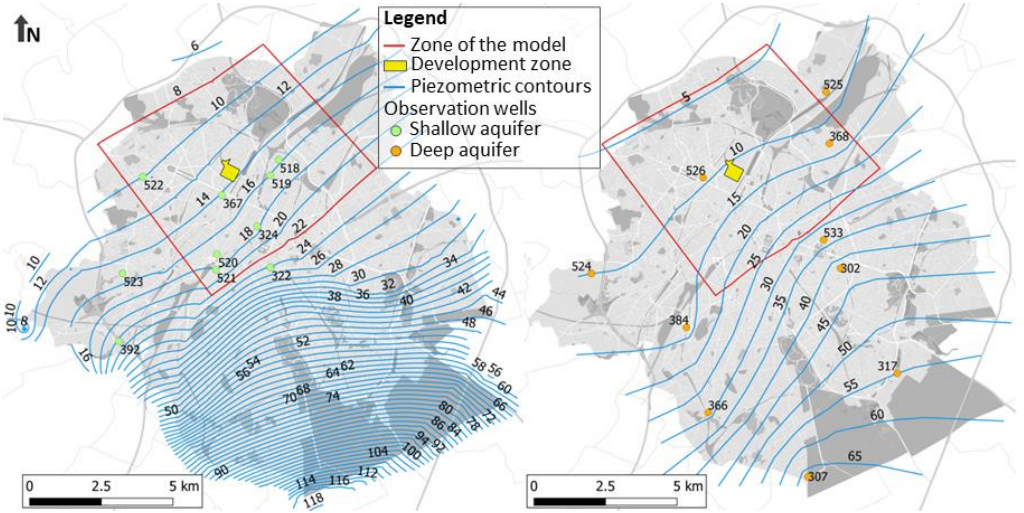
Case study: Tour & Taxi site



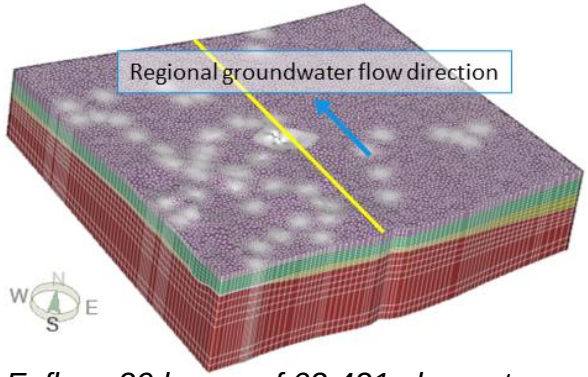


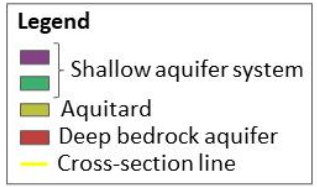
Methodology : Compilation of data



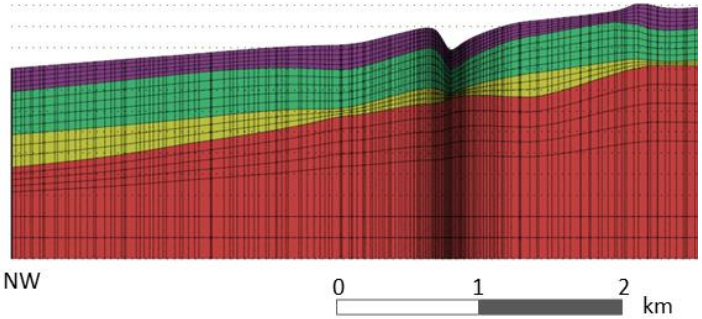


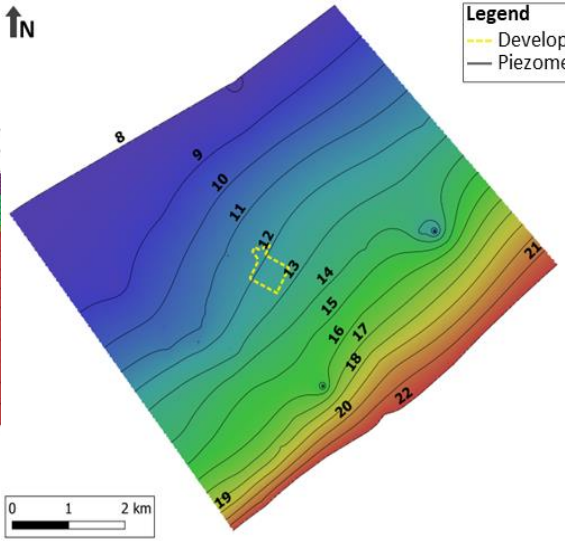
Methodology: Transient state 3D groundwater flow and heat transfer model

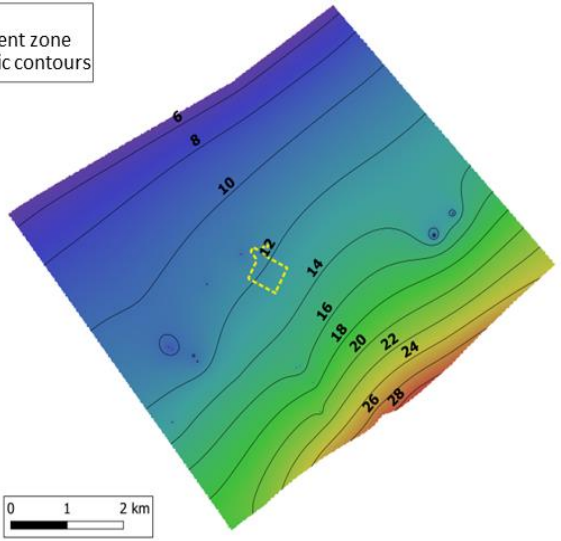




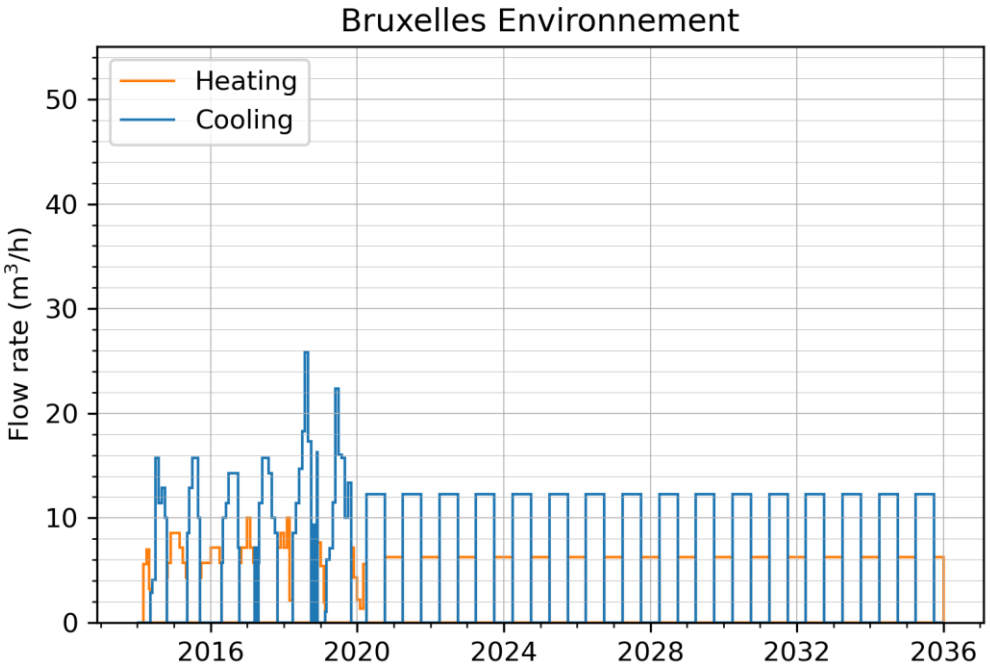
Feflow: 20 layers of 62,421 elements each





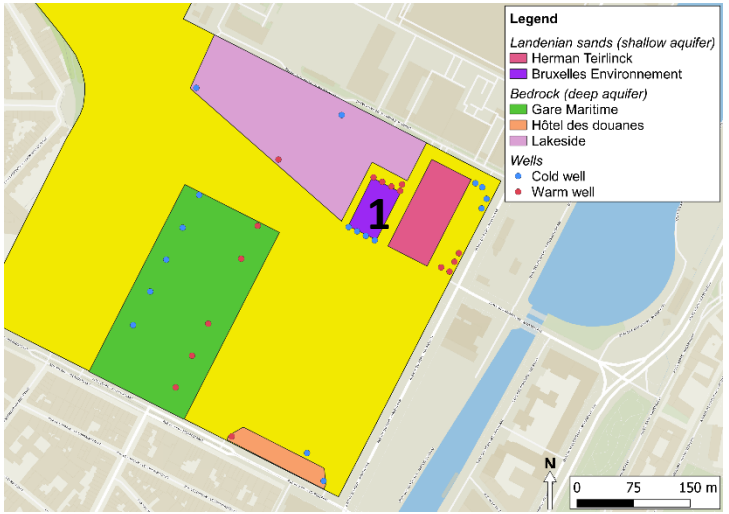


ATES main characteristics: Building 1 – based on historical data



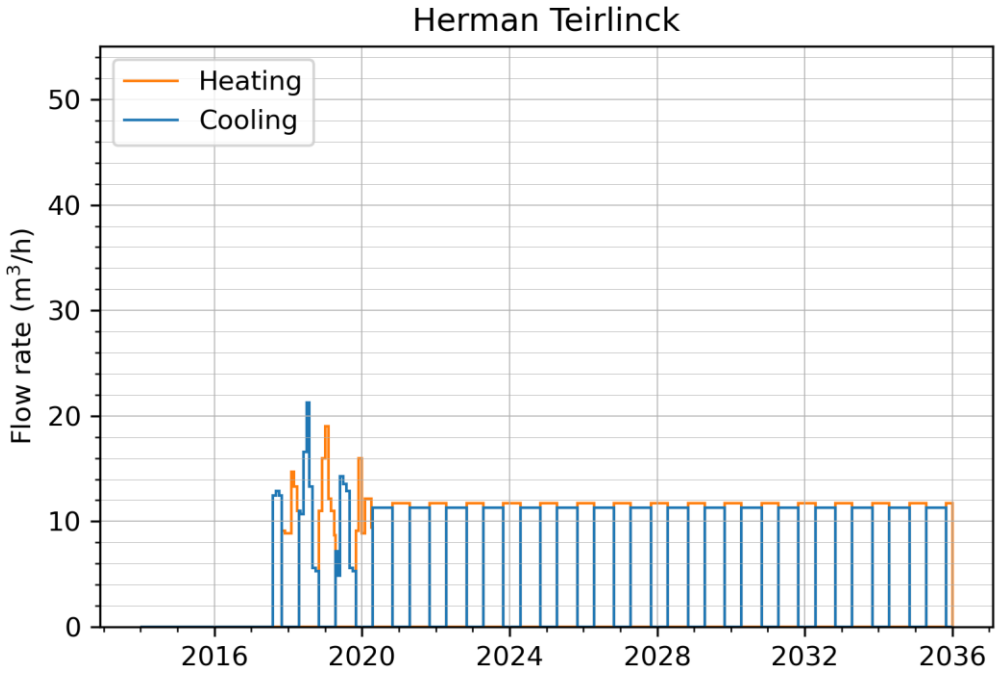
Heating : October 1st – March 31st
Cooling : April 1st – September 30th

Start : 1 March 2014



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

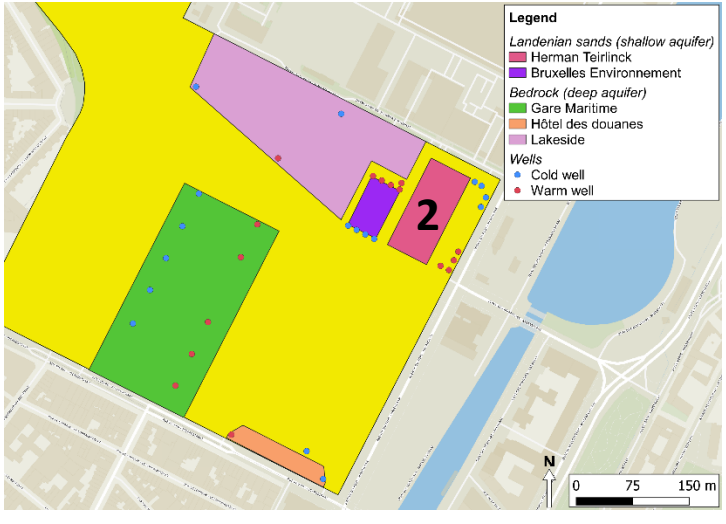
ATES main characteristics: Building 2 – based on historical data



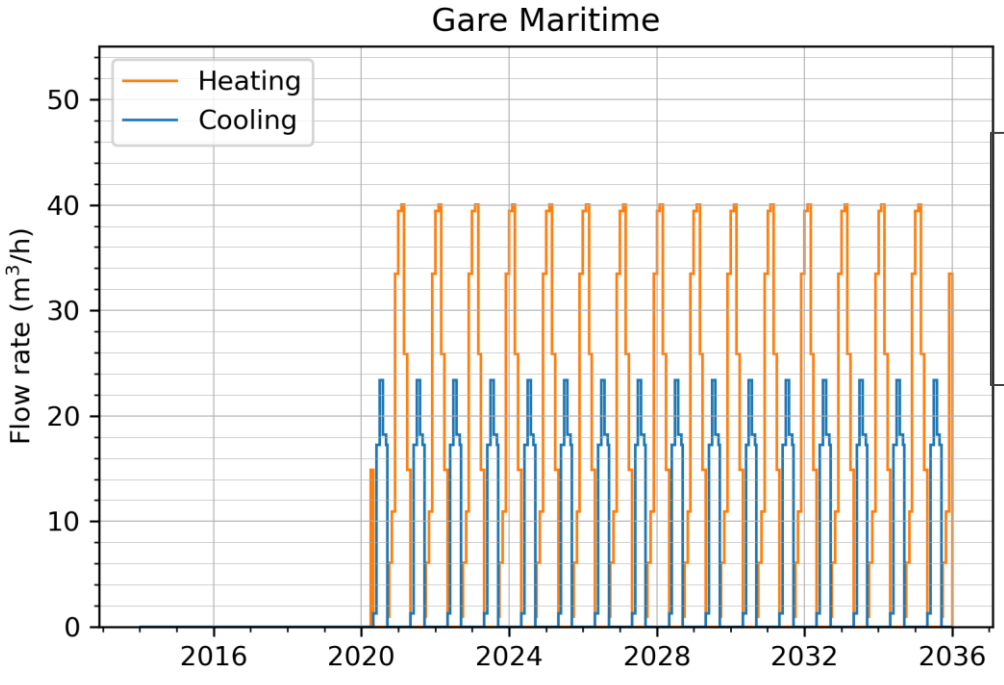
Shallow aquifer, $\Delta T = 6°C$
Cooling demand = Heating demand

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

Start : 1 August 2017



ATES main characteristics: Building 3 – based on historical data



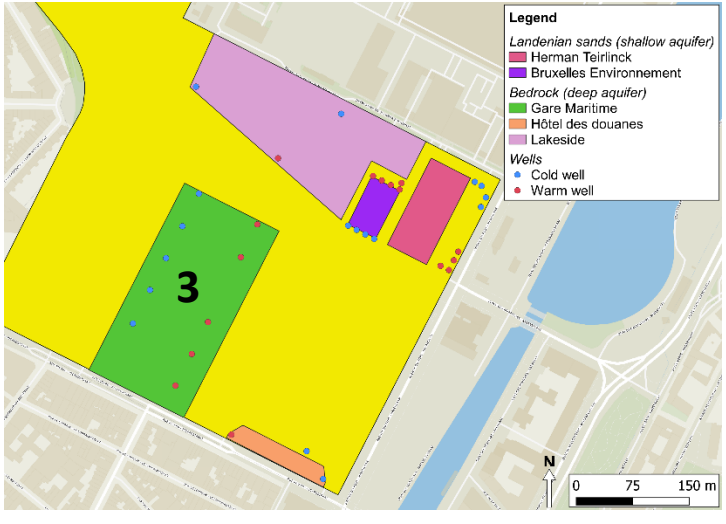
Deep aquifer, $\Delta T = 6°C$

Demand for cooling < Demand for heating

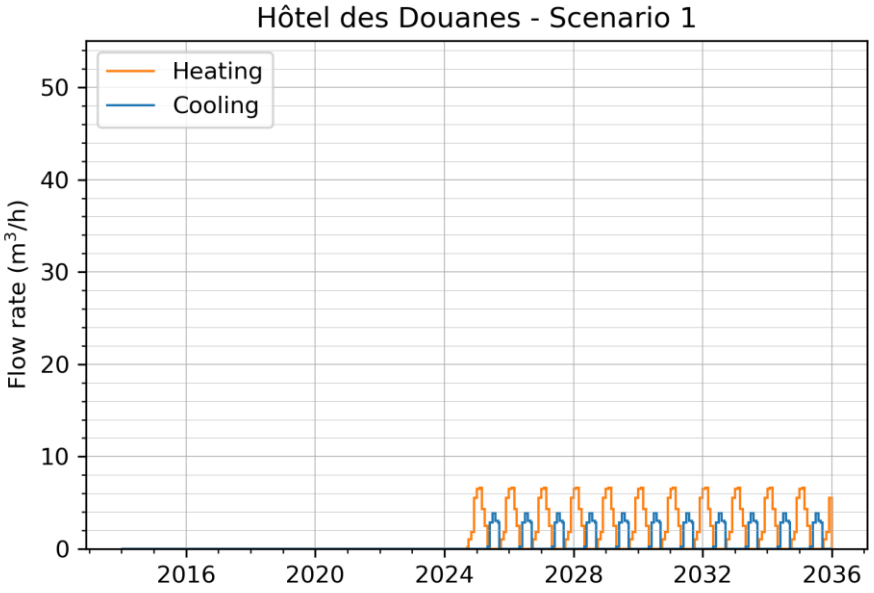
Heating : September 15th – March 31st

Cooling : April 1st – September 14th

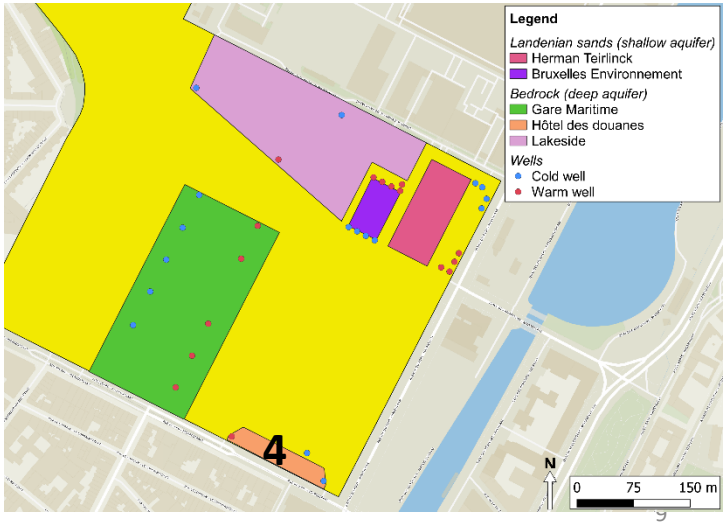
Start : 1 April 2020



ATES main characteristics: Building 4 – Scenario 1

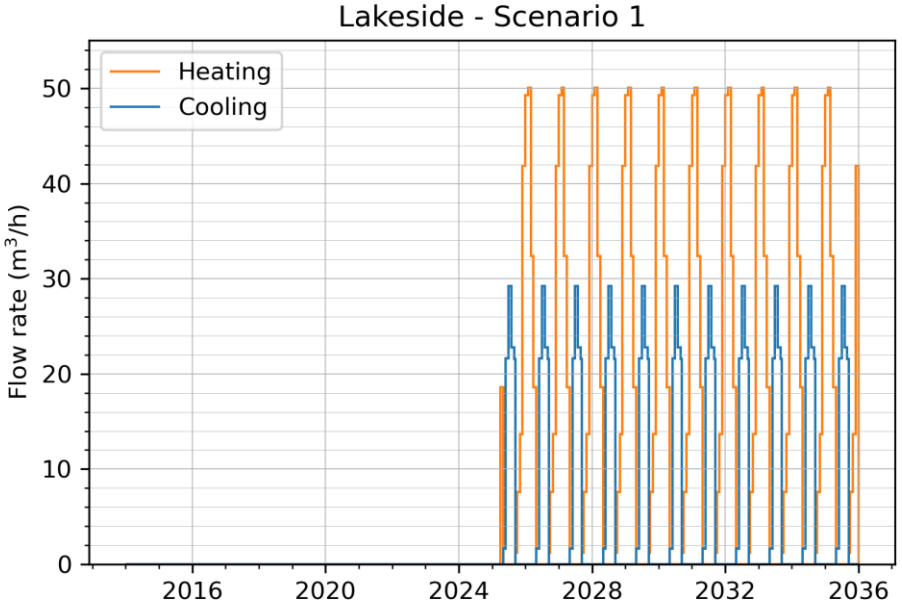


Heating : September 15th – March 31st
Cooling : April 1st – September 14th
Scenario1 : Same demand/surface as building 3
Start : 1st October 2024



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

ATES main characteristics: Building 4 – Scenario 1



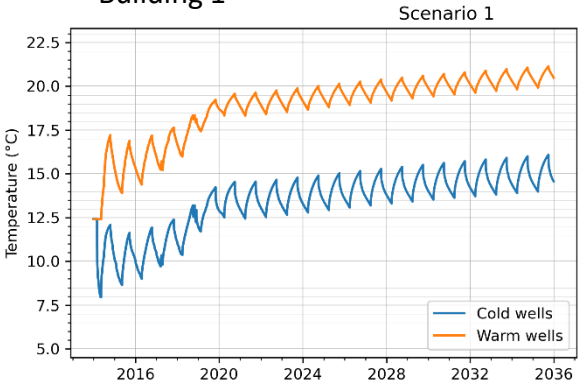
Heating : September 15th – March 31st
Cooling : April 1st – September 14th
Scenario1 : Same demand/surface as building 3
Start : 1st April 2025

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

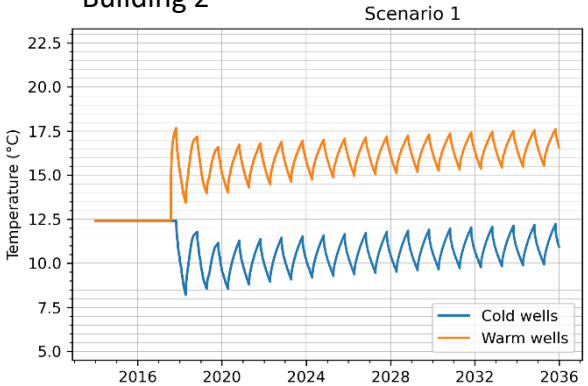
Temperature evolution in the hot and cold wells

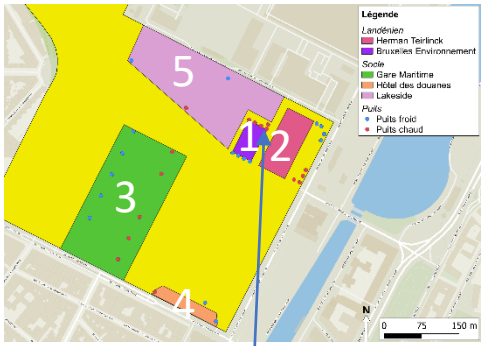
Scenario 1: shallow aquifer

Building 1



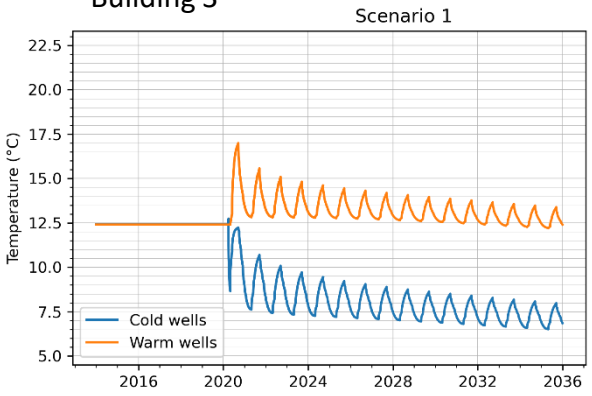
Building 2



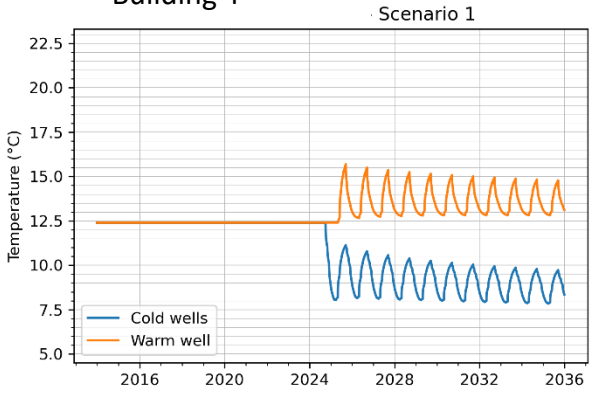


Scenario 1: deep aquifer

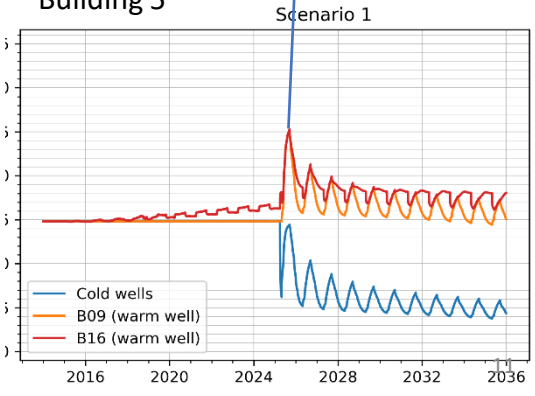
Building 3



Building 4

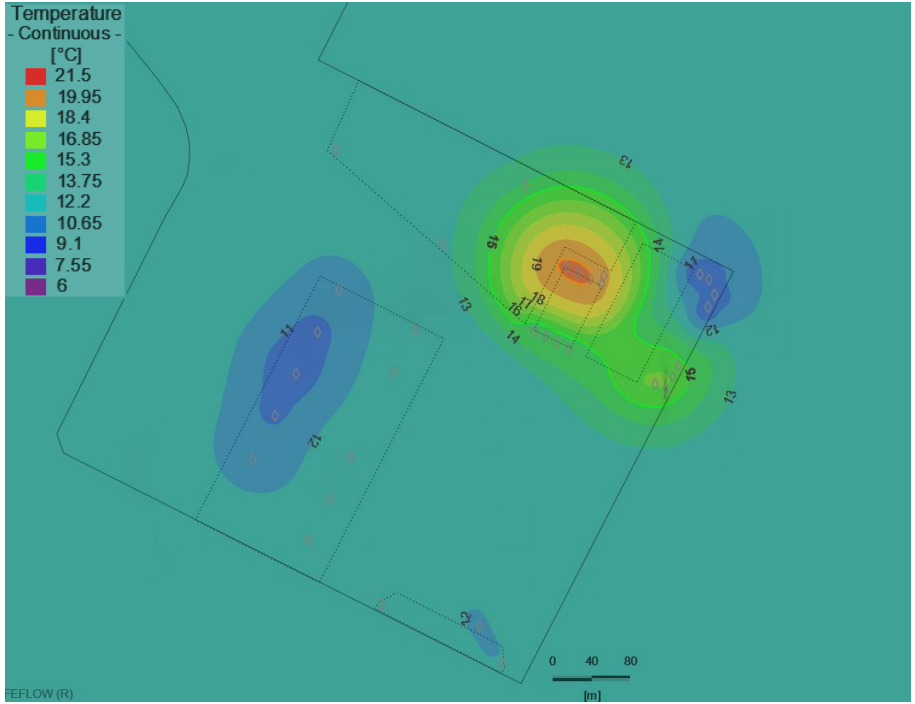


Building 5

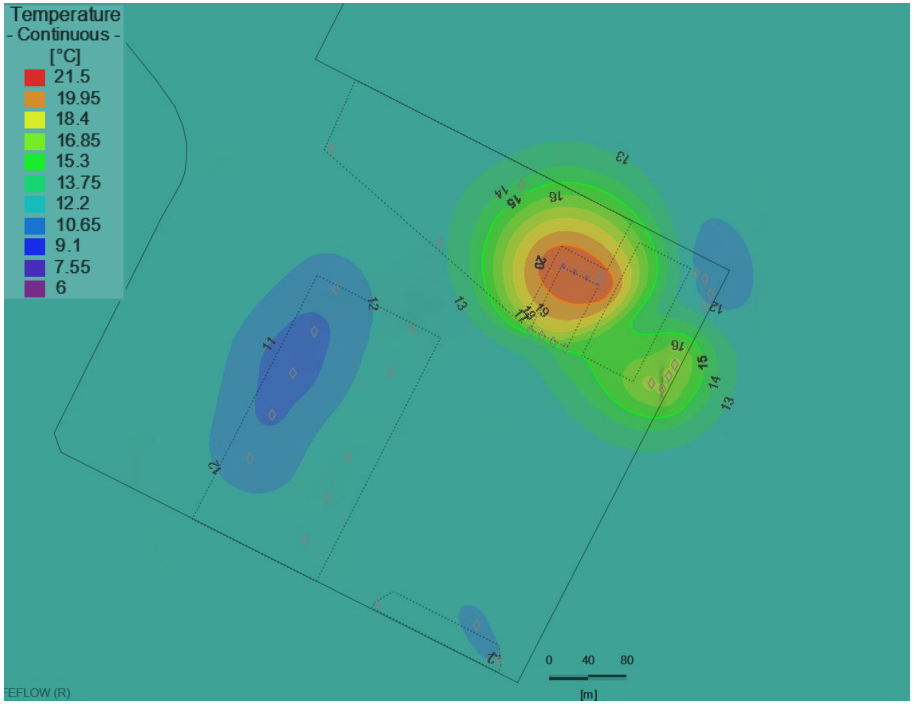


Hot and cold plumes in the shallow aquifer – Scenario 1 after 10 years of operating building 5 (2035)

End of winter

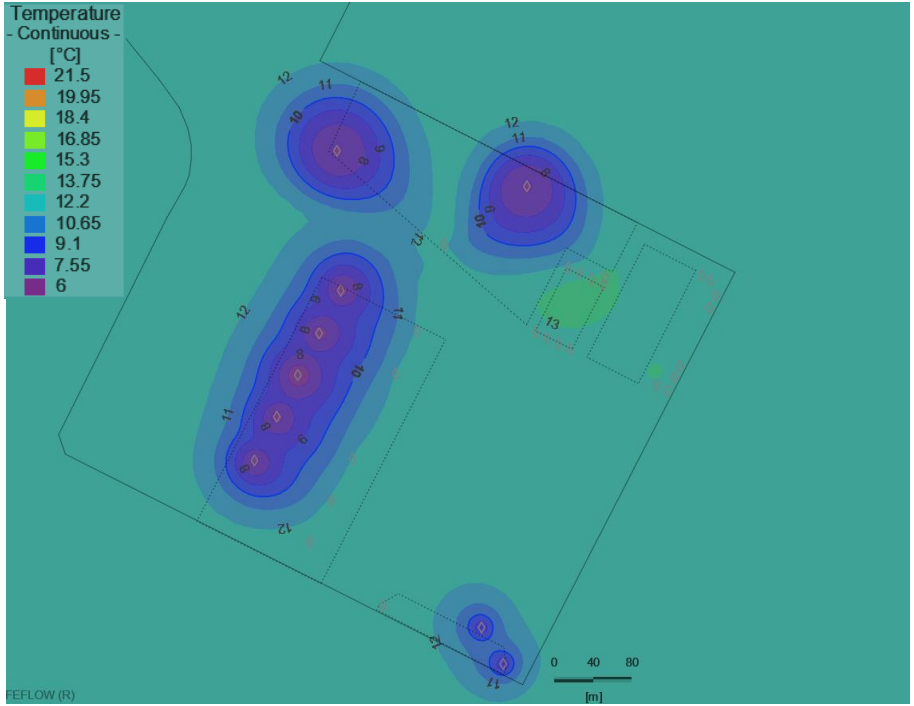


End of summer

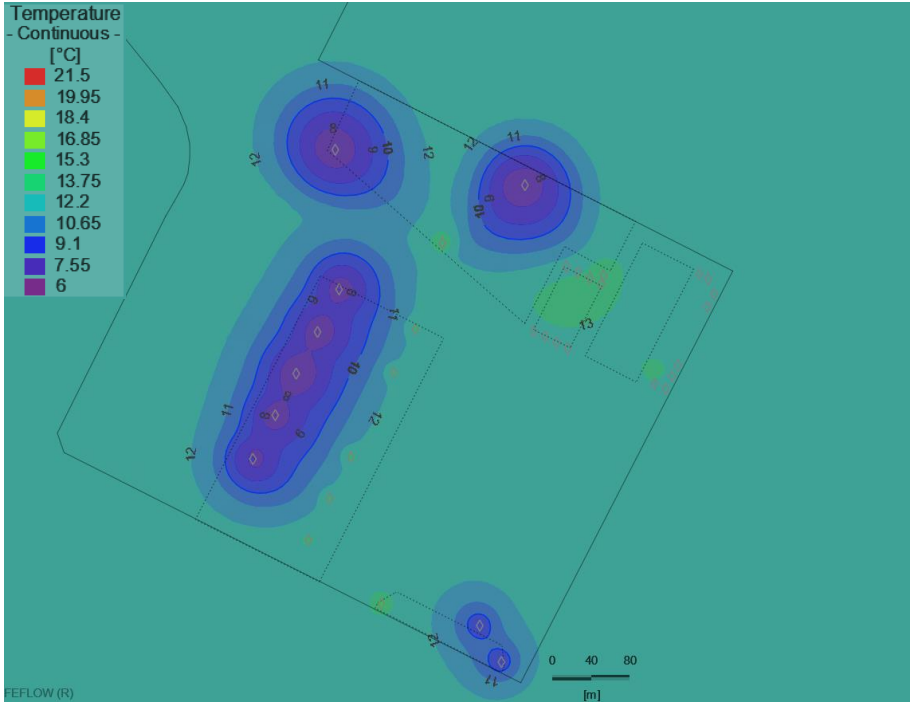


Hot and cold plumes in the deep aquifer – Scenario 1 after 10,5 years of operating building 5 (2035)

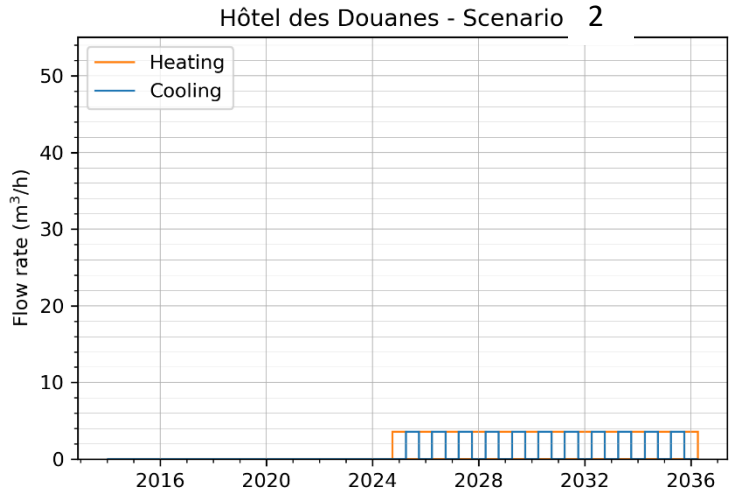
End of winter



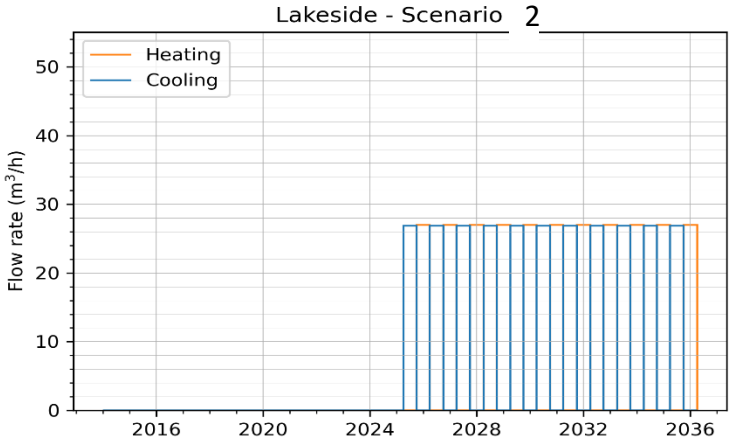
End of summer



ATES main characteristics : Building 4 and 5



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



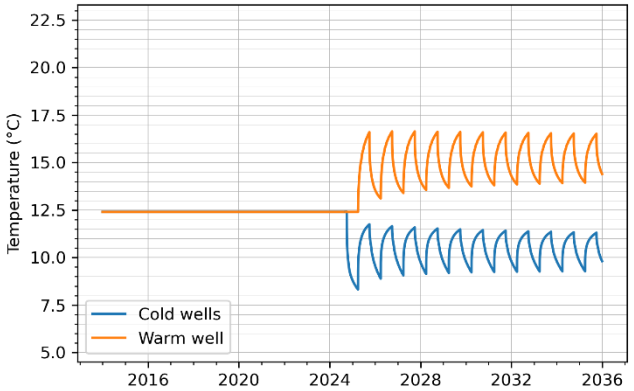
Heating : October 1st – March 31st
Cooling : April 1st – September 30th
Start : 1st April 2025

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

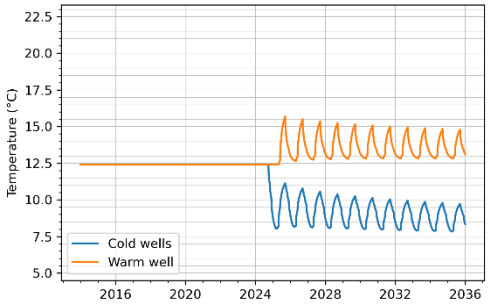
Temperature evolution in the hot and cold wells

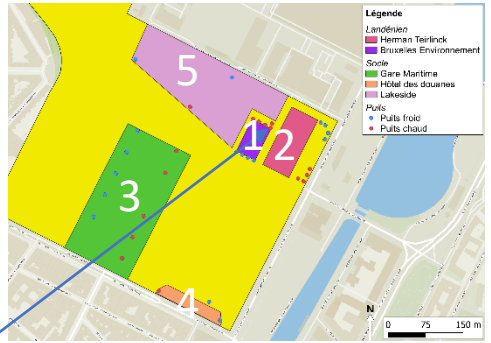
Scenario 2: deep aquifer

Building 4

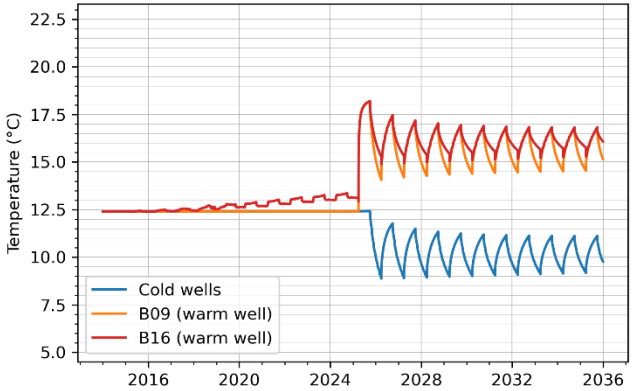


Building 4 Scenario 1

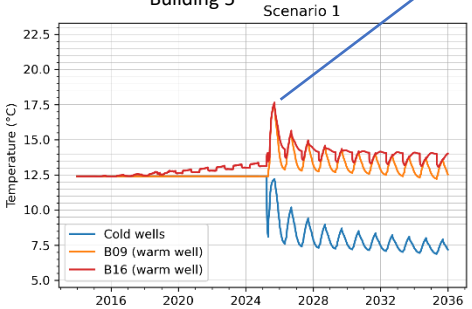




Building 5

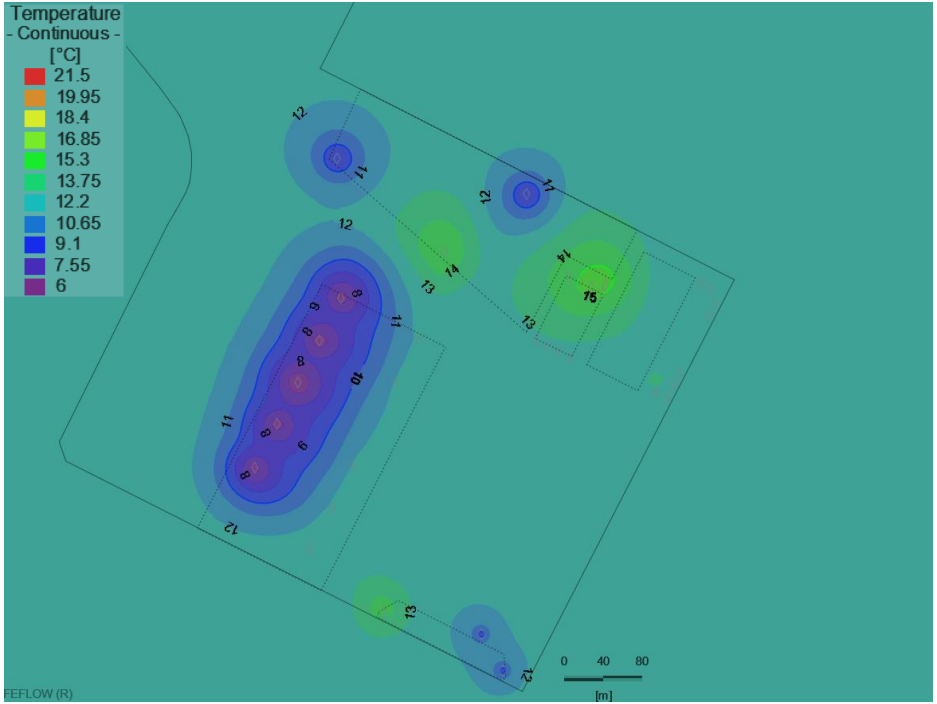


Building 5 Scenario 1

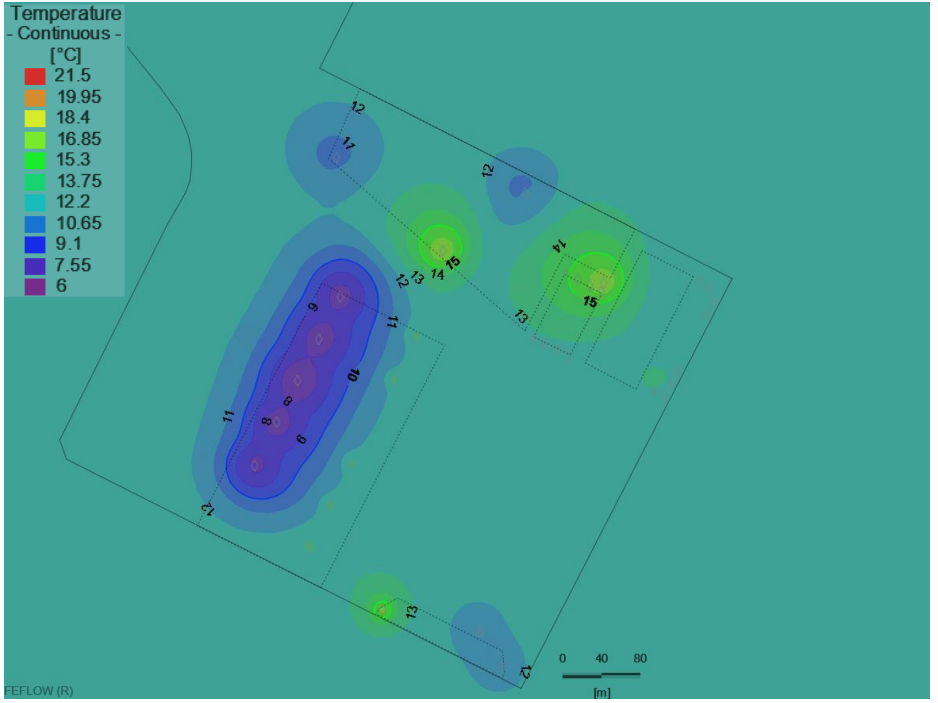


Hot and cold plumes in the deep aquifer – Scenario 2 after 10,5 years of operating building 5 (2035)

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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