



RES4LIVE

ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

Geothermal energy concepts for livestock applications

Analysis of energy savings, life cycle cost and animal welfare

#2215738

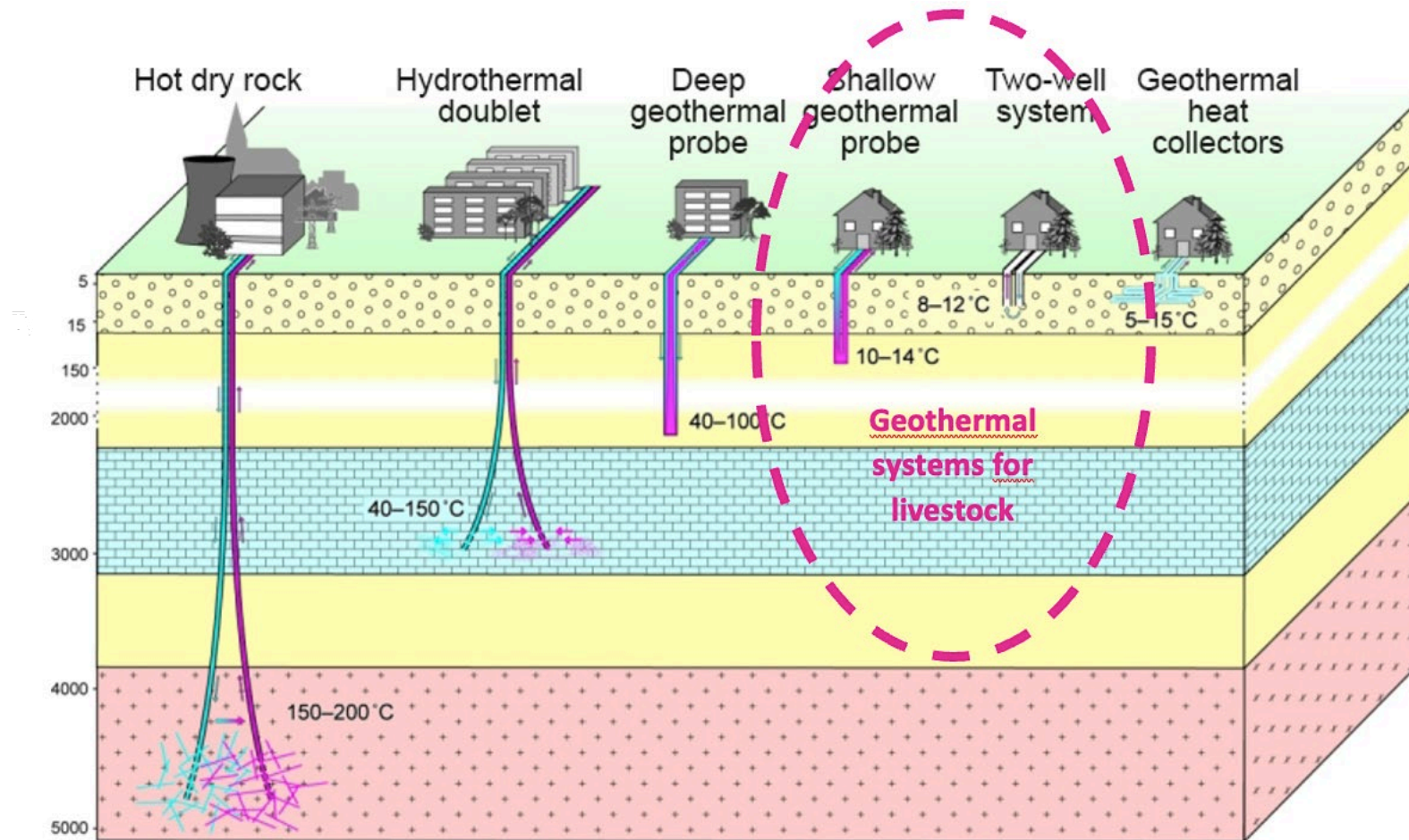
TerraEnergy 
The Alternative Solution

Hans Hoes



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No.101000785

Shallow geothermal energy systems

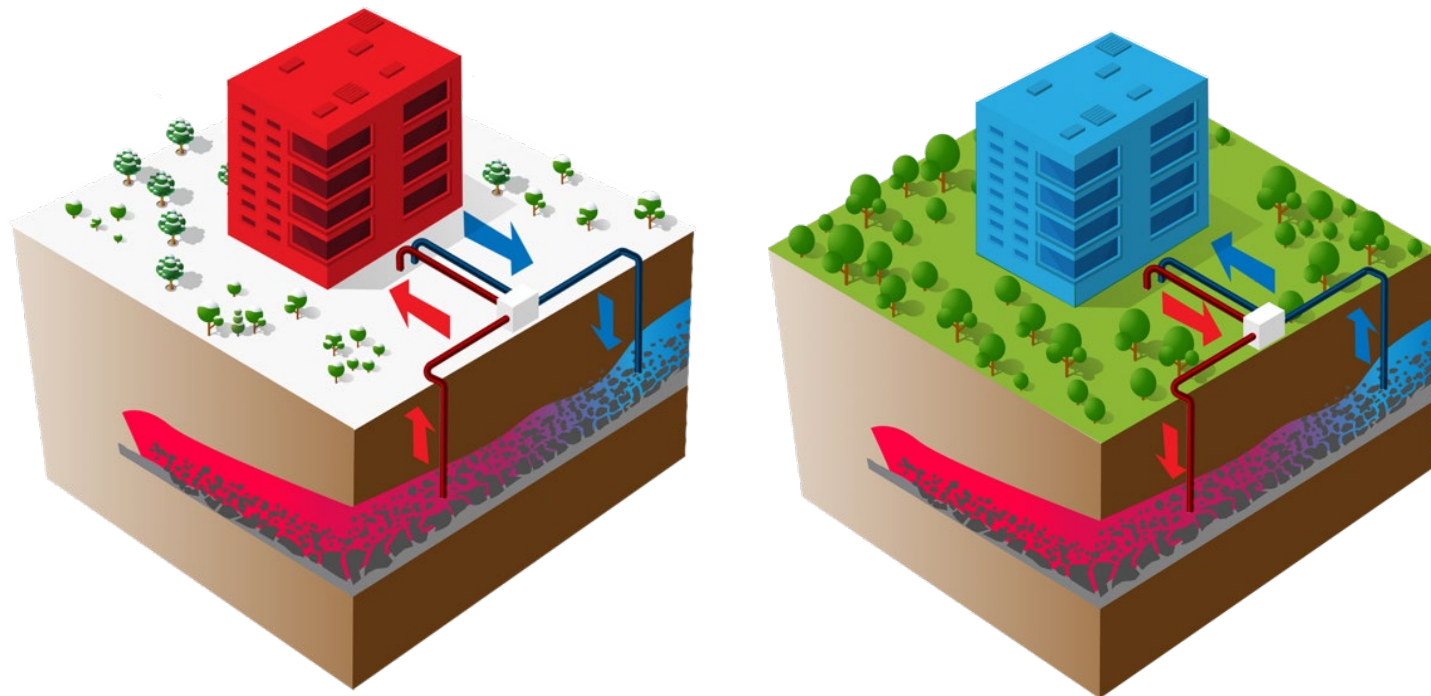


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ATES – Aquifer Thermal Energy Storage



Use of groundwater as energy transport medium to subsurface

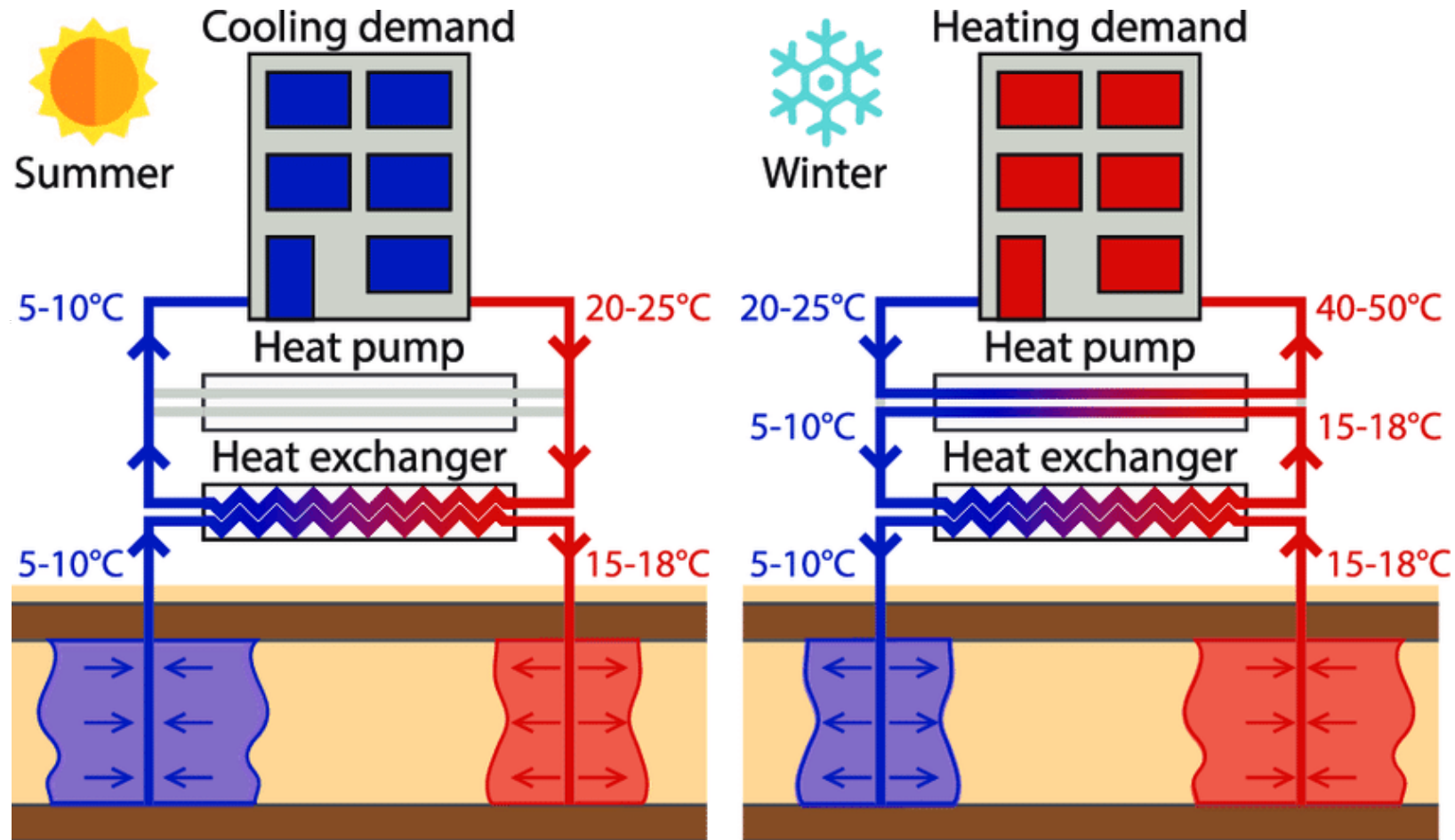
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ATES – Aquifer Thermal Energy Storage



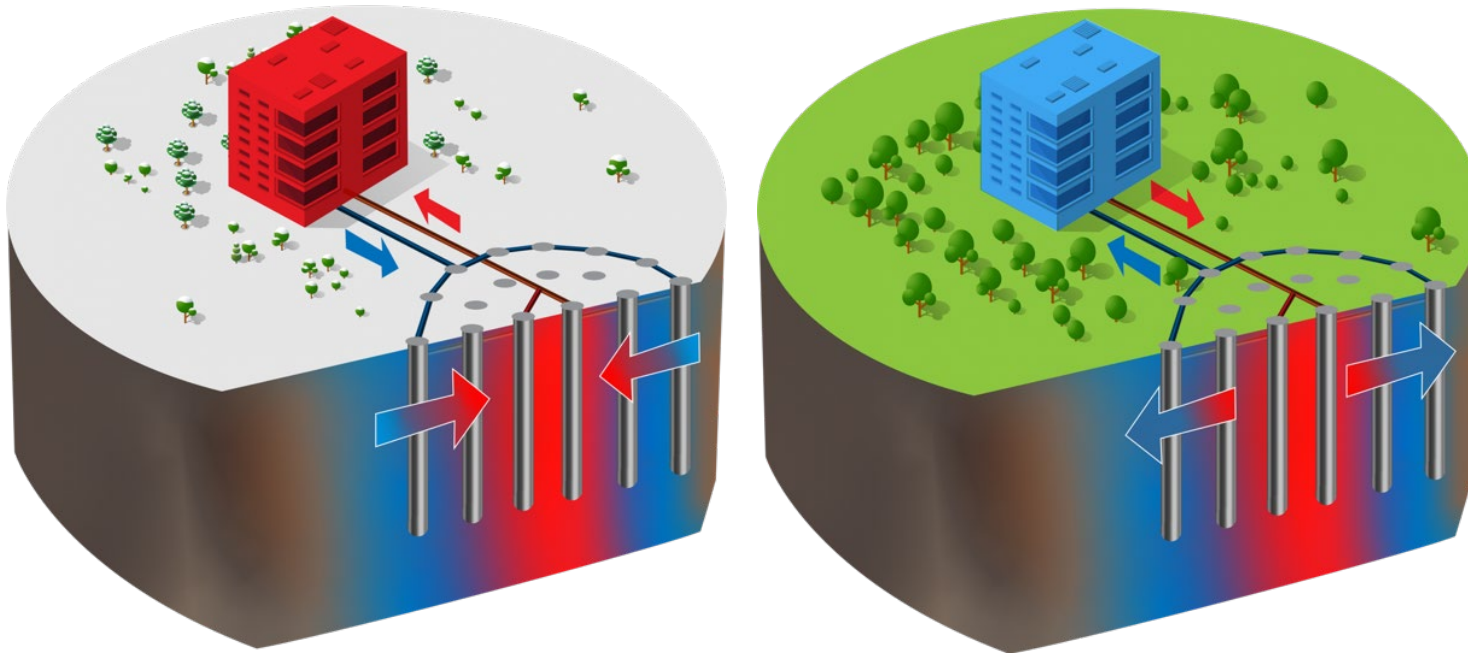
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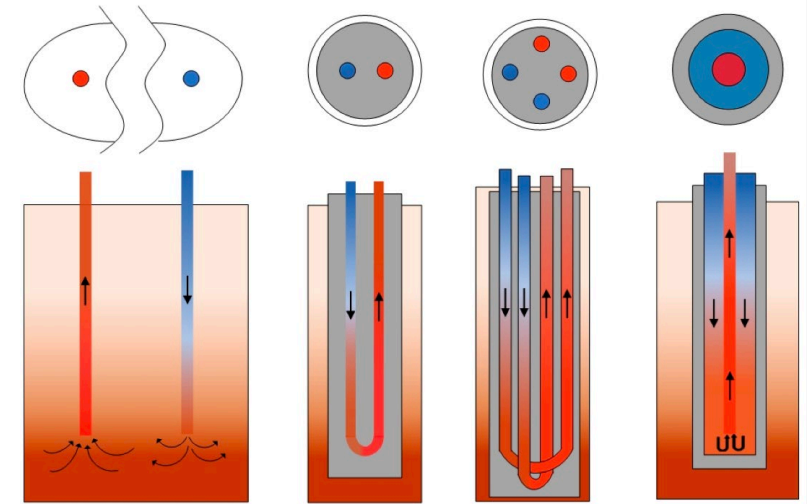
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BTES – Borehole Thermal Energy Storage



Use of vertical loops with circulating medium to exchange heat/cold with subsurface



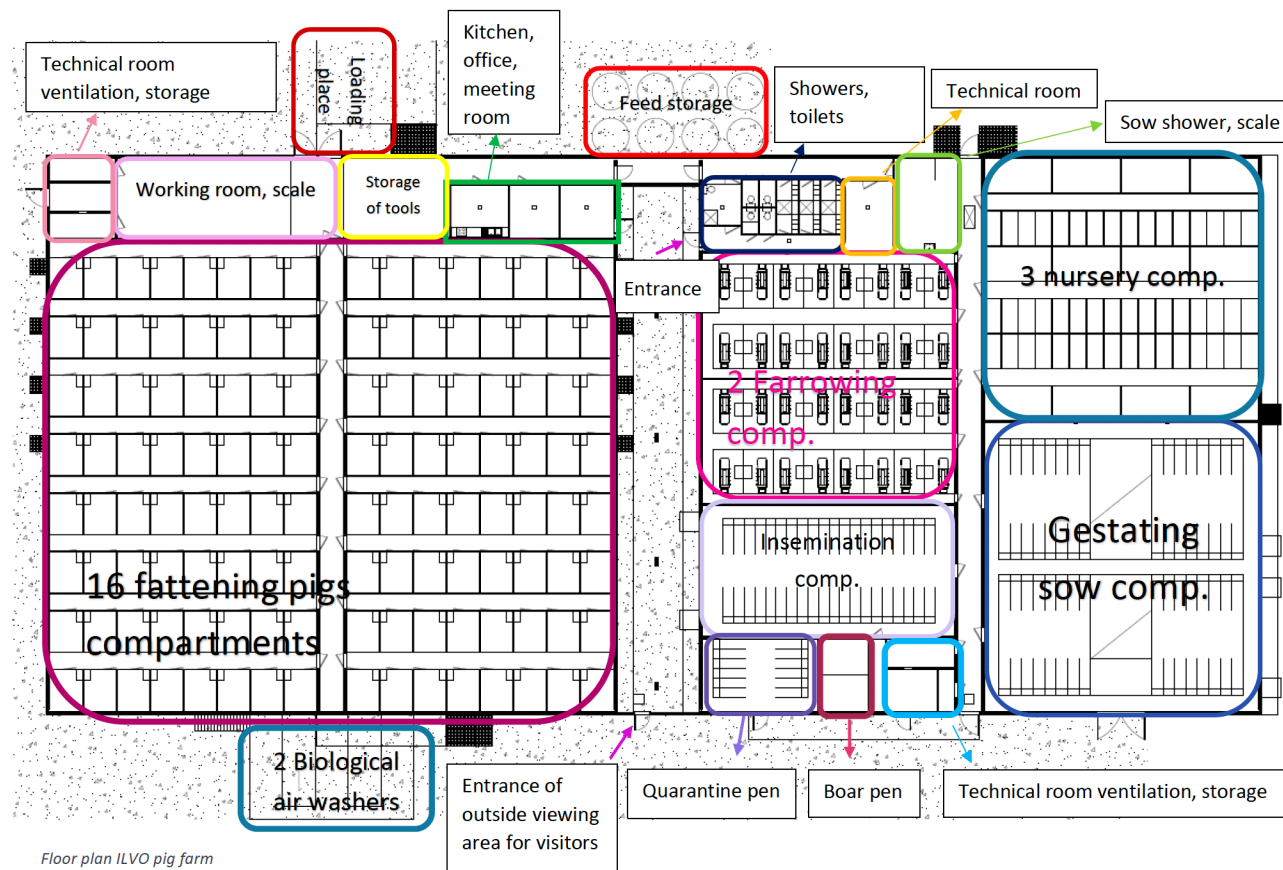
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CASE STUDY – Pig Farm (ILVO – Belgium)



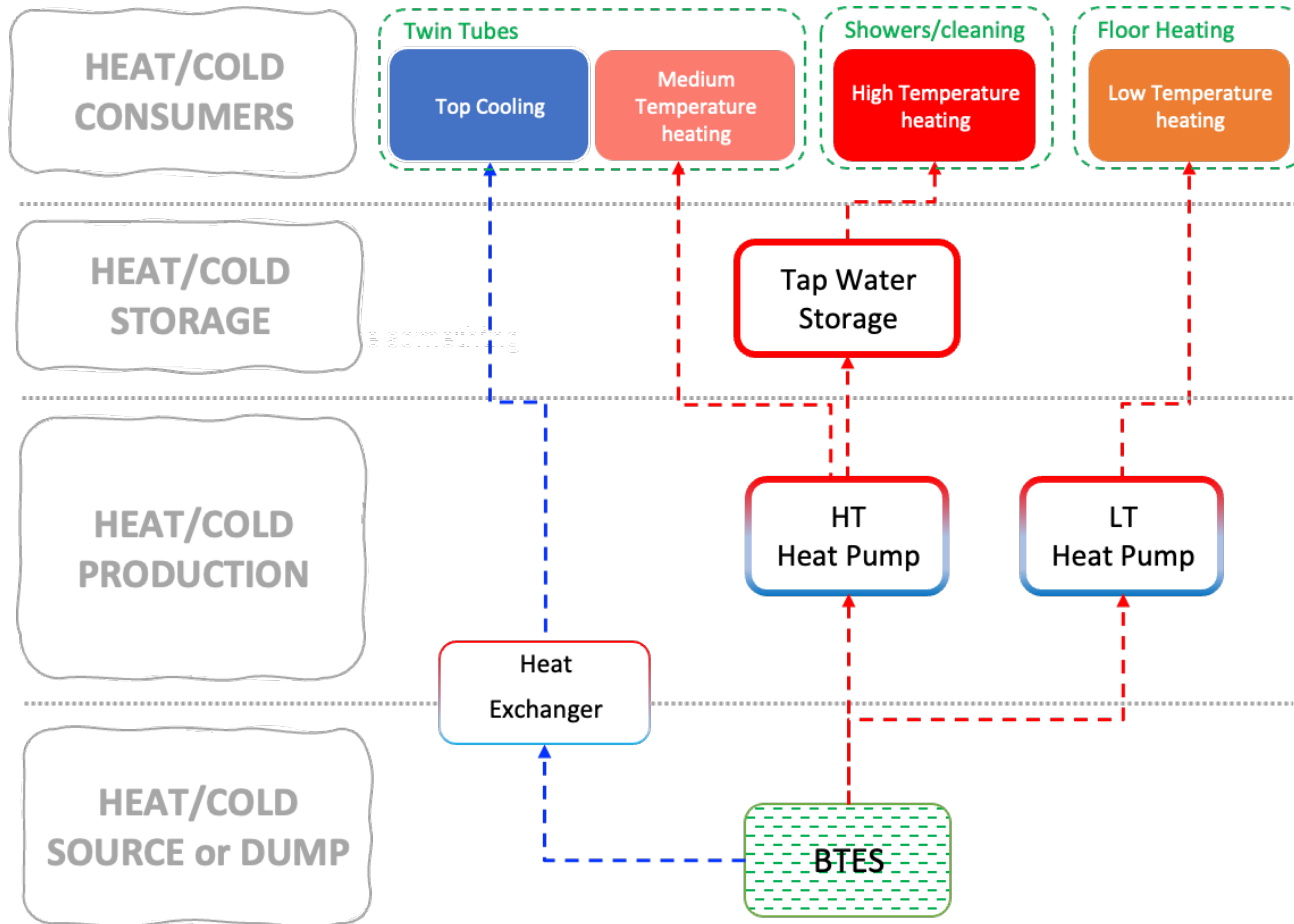
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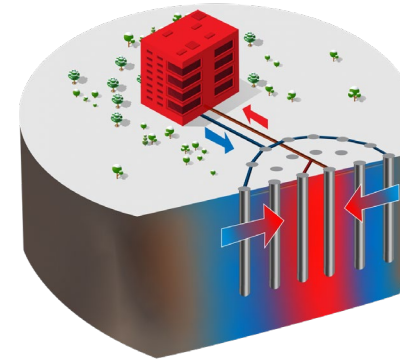
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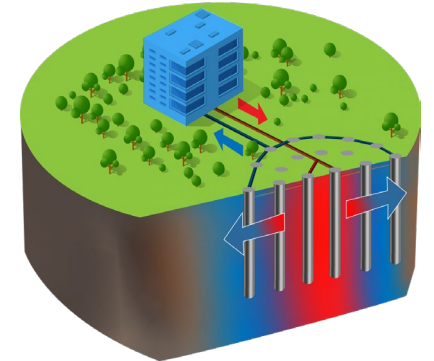
Pig Farm ^(BE) - Geothermal energy concept 1 (→ focus on passive cooling)



BTES winter



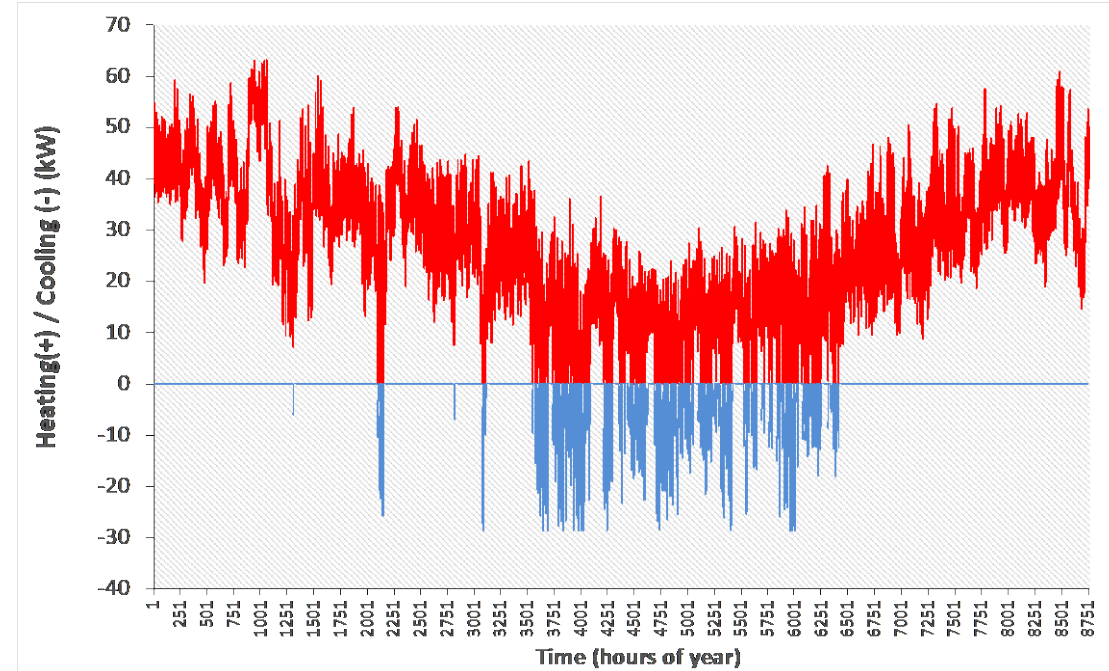
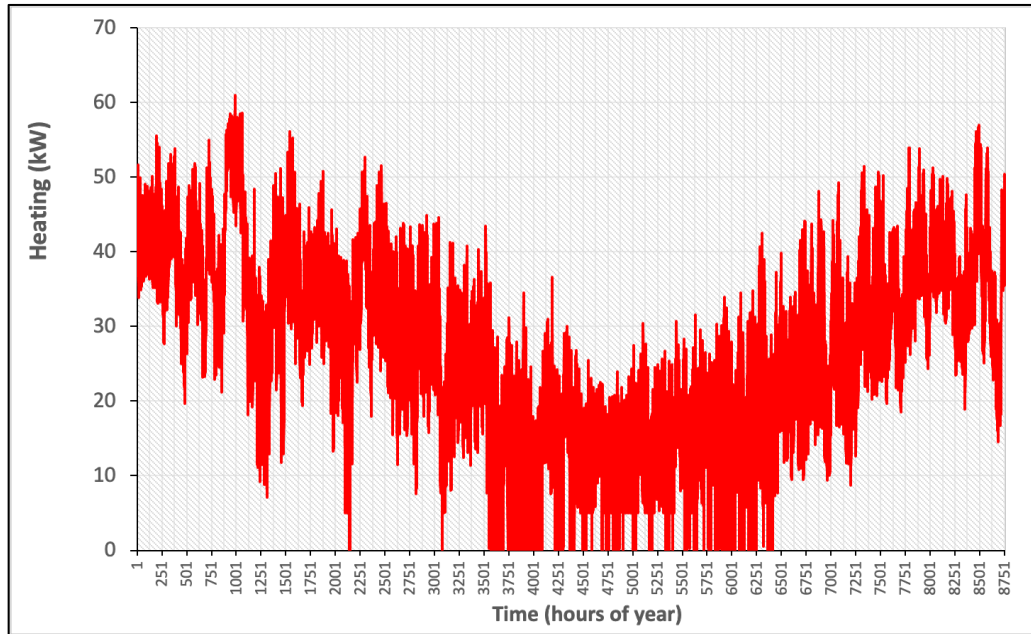
BTES summer



Benefits :

- renewable heating with high efficiency
- passive cooling with very high efficiency
- avoiding overheating in summer
- better animal welfare
- higher production

Pig Farm ^(BE) - Geothermal energy concept 1 (→ focus on passive cooling)



Current heating profile (220 MWh/y) :

- floor heating
- twin tube air heating
- hot water heating

Future heating (220 MWh/y) / cooling (11 MWh/y) profile :

- floor heating
- twin tube air heating & cooling
- hot water heating

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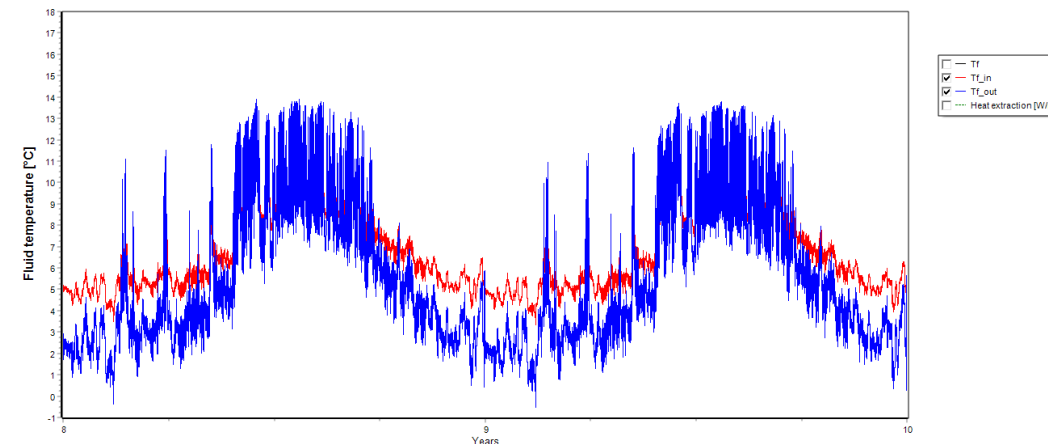
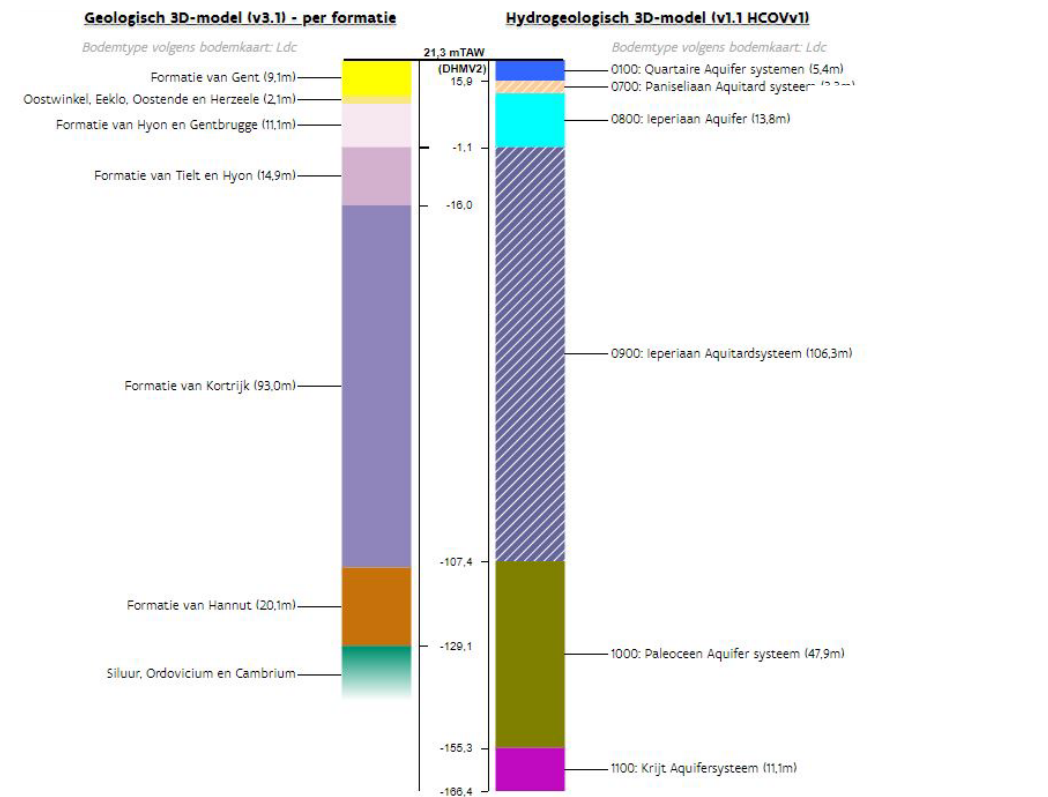
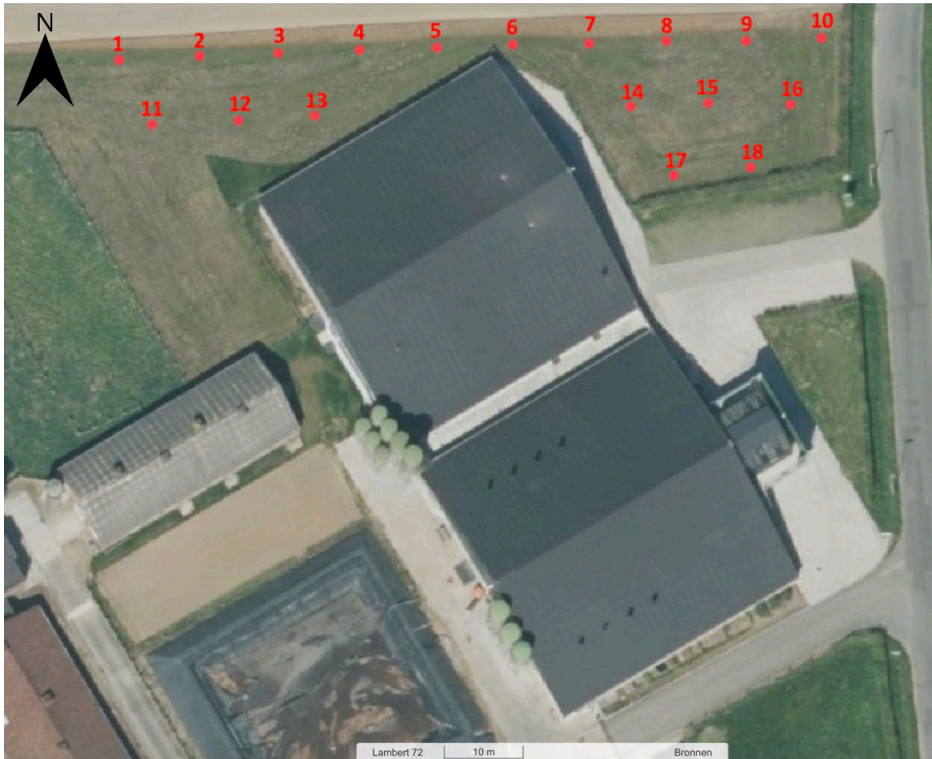
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Pig Farm ^(BE) - Geothermal energy concept 1 (→ focus on passive cooling)

**18 double-U loops at 119m of depth
10 m distance**



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Pig Farm ^(BE) - Geothermal energy concept 1 (→ focus on passive cooling)

**Energetic / financial evaluation
(compared with standard reference installation - Gasboiler)**

Figure 10: Energetic / financial evaluation

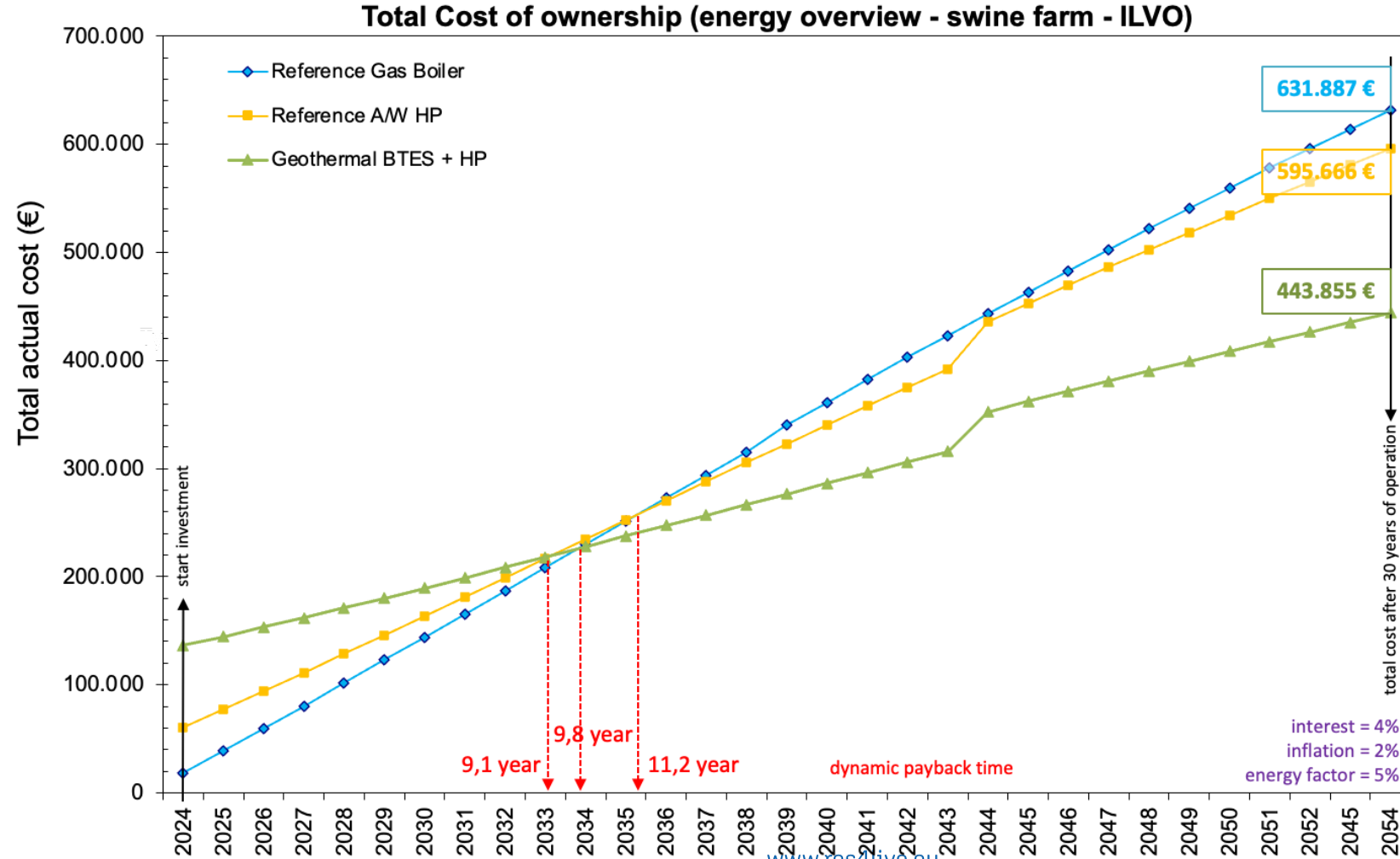
Pig Farm ^(BE) - Geothermal energy concept 1 (→ focus on passive cooling)

**Energetic / financial evaluation
(compared with standard reference installation – air/water HP)**

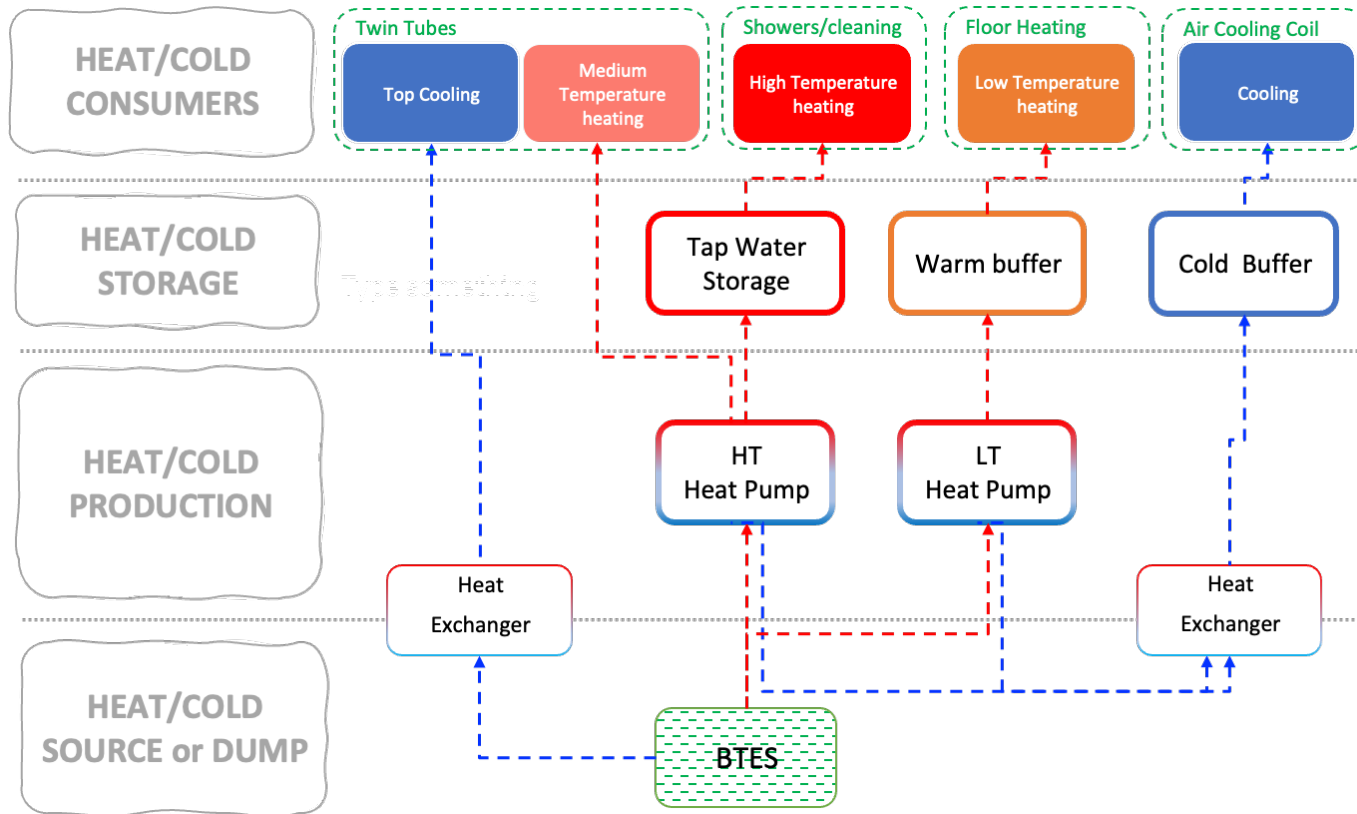
Figure 10: Energetic and financial evaluation

Pig Farm ^(BE) - Geothermal energy concept 1 (→ focus on passive cooling)

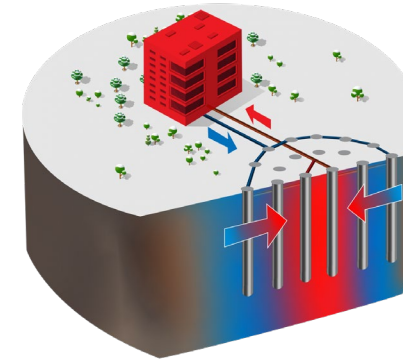
Dynamic Payback Time



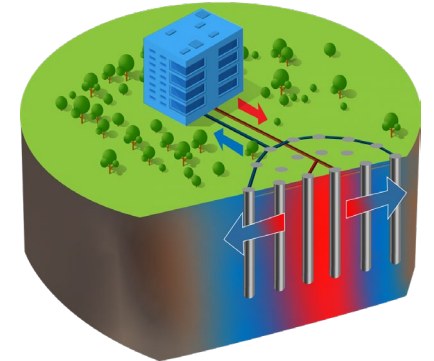
Pig Farm ^(BE) - Geothermal energy concept 2 (→ focus on passive and active cooling)



BTES winter



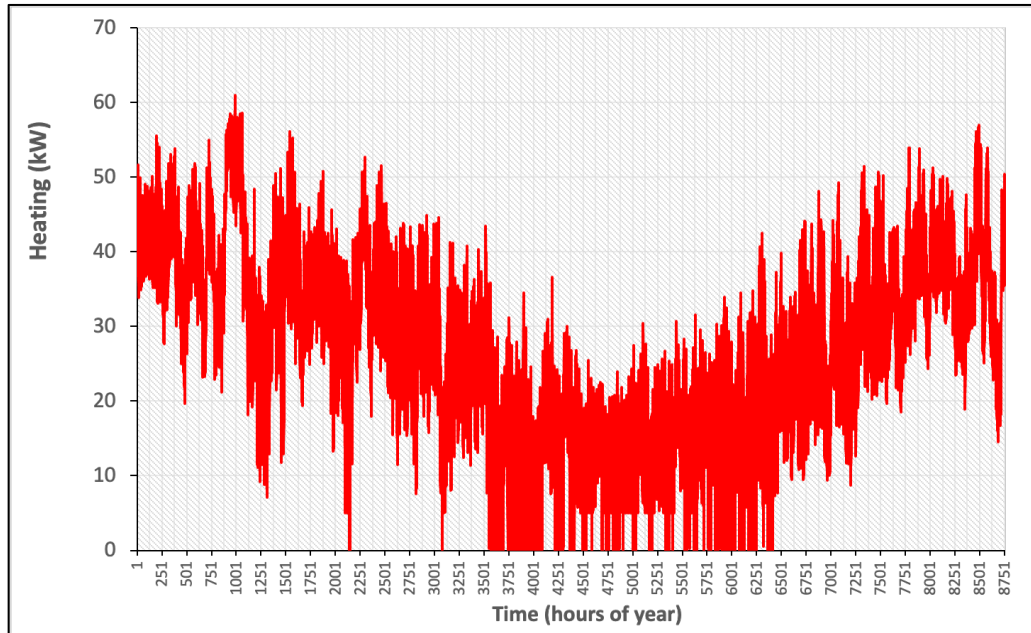
BTES summer



Benefits :

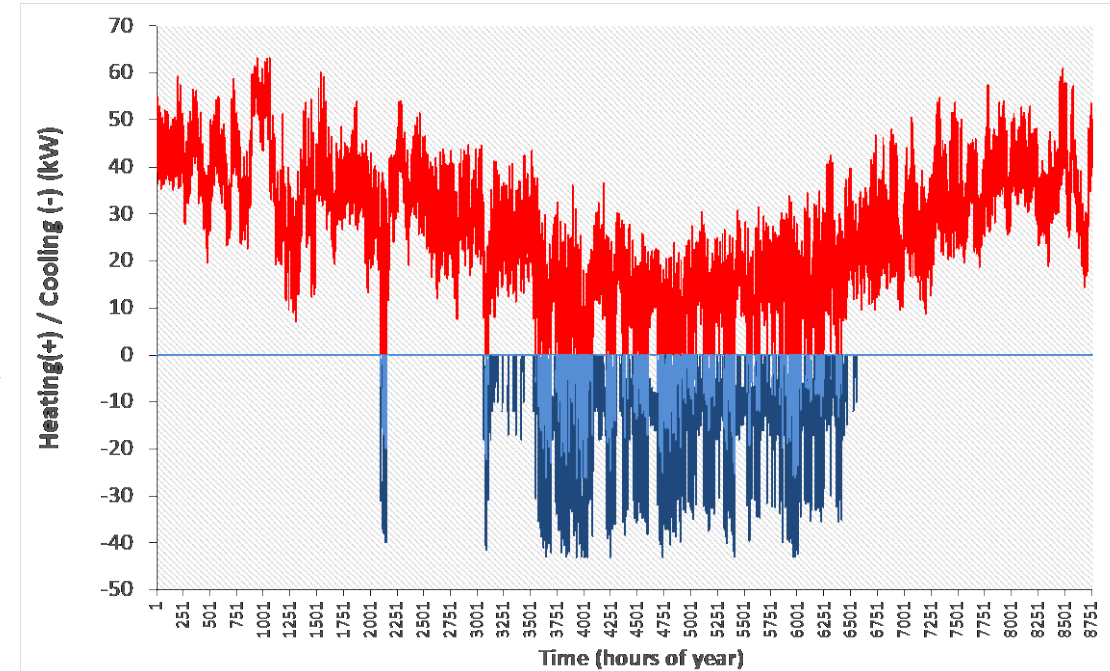
- renewable heating with high efficiency
- passive cooling with very high efficiency
- additional active cooling
- avoiding overheating in summer
- better animal welfare
- higher production

Pig Farm ^(BE) - Geothermal energy concept 2 (→ focus on passive and active cooling)



Current heating profile (220 MWh/y) :

- floor heating
- twin tube air heating
- hot water heating

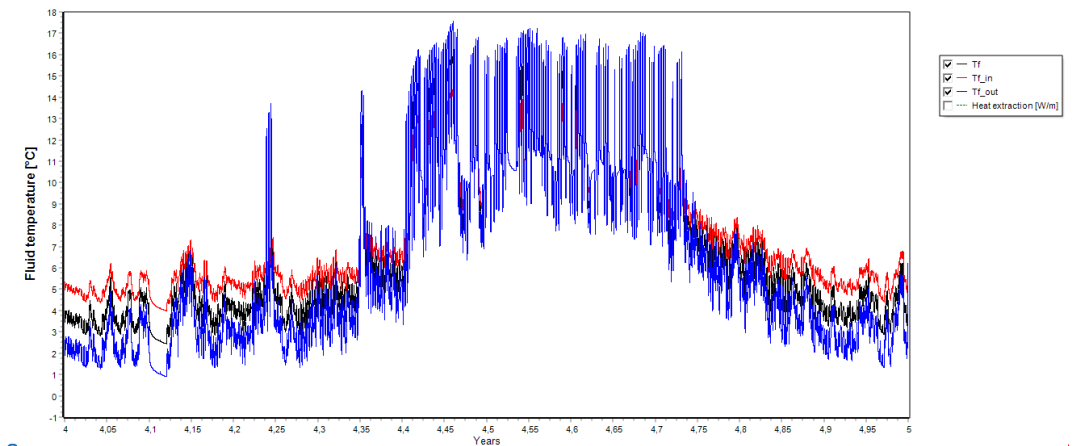
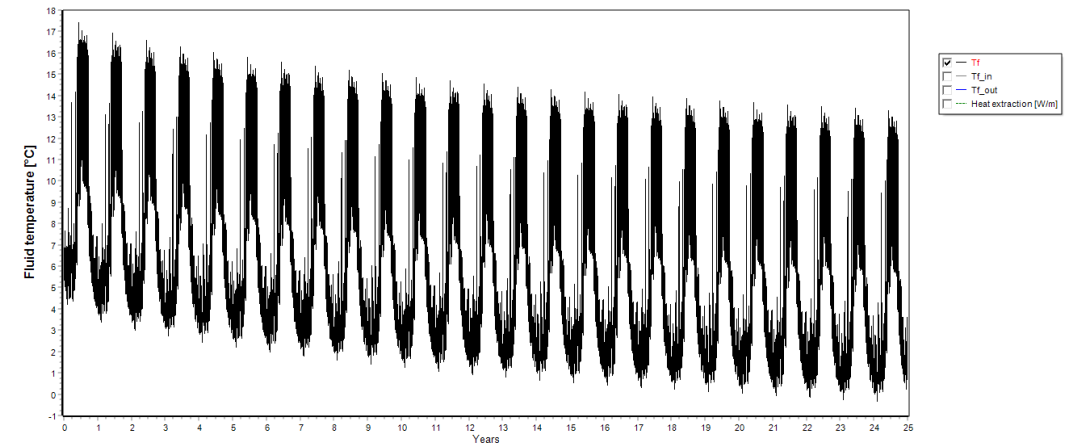


Future heating (220 MWh/y) / cooling (50 MWh/y) profile :

- floor heating
- twin tube air heating & cooling (passive 7 MWh/y)
- air cooling (active 43 MWh/y)
- hot water heating

Pig Farm ^(BE) - Geothermal energy concept 2 (→ focus on passive and active cooling)

16 double-U loops at 119m of depth
10 m distance



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Pig Farm ^(BE) - Geothermal energy concept 2 (→ focus on passive and active cooling)

**Energetic / financial evaluation
(compared with standard reference installation – air/water HP)**

Figure 10: Energetic and financial evaluation

Pig Farm ^(BE) - Geothermal energy concept 2

(→ focus on passive and active cooling)

Dynamic Payback Time

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Geothermal energy, potential and technologies

- Geothermal technologies offer best opportunities when applying heat extraction AND heat injection;
- Geothermal can be used for heating AND cooling, resulting in energy efficient climatization but also bringing summer comfort for the animals (increase of welfare and production)
- BTES has less geological restrictions, it can be applied almost everywhere (ATES requires a suitable aquifer)
- BTES is cheaper for smaller installations, ATES becomes interesting when thermal power exceeds 150 kW
(this is 3x the size of the Pig Farm^{BE})

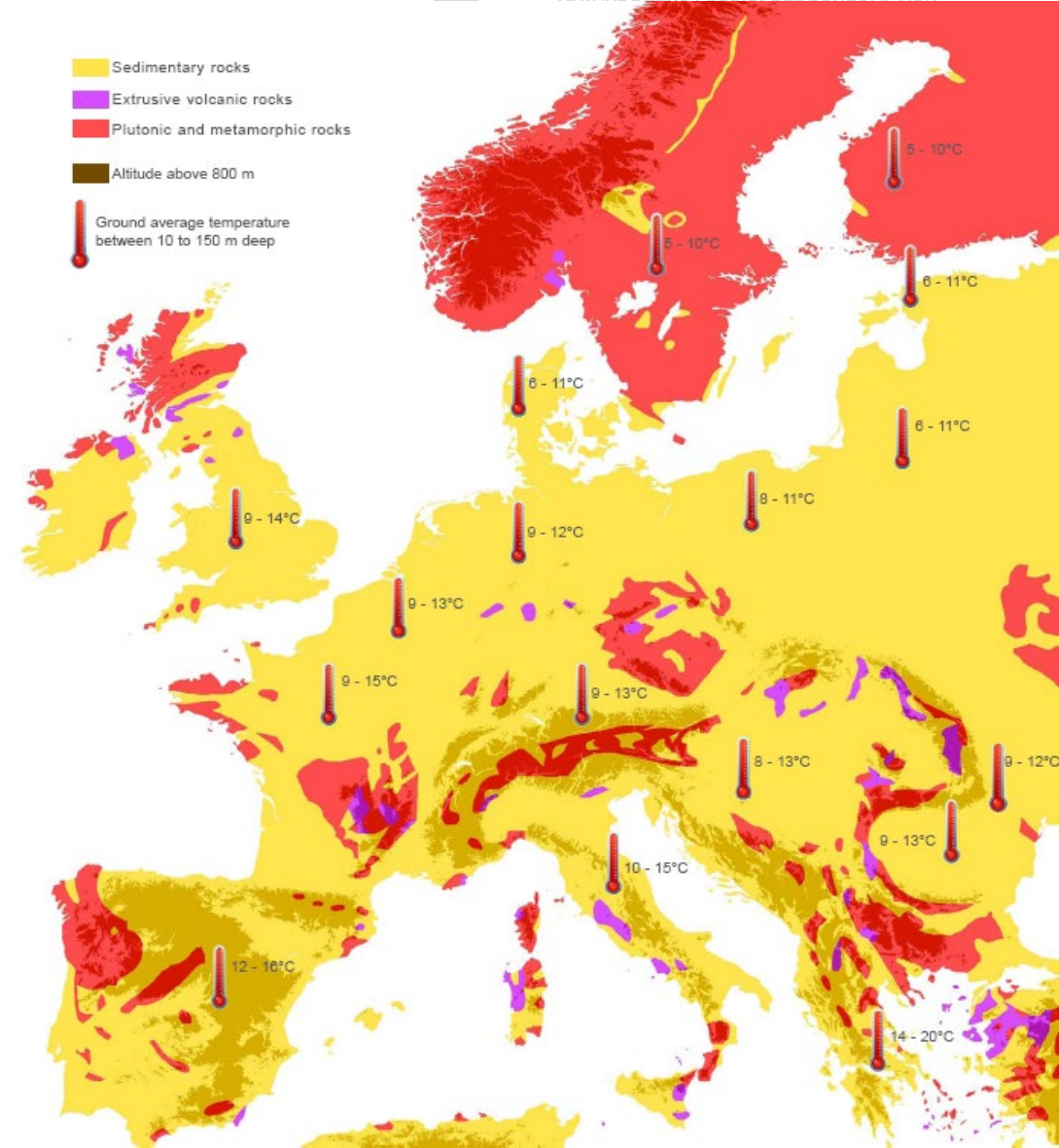
Farm cooling, how to integrate?

- Air cooling
- Floor cooling
- Ceiling cooling



Applicability in Europe

- Two main differences :
 - different undisturbed ground temperature
 - different heating/cooling demand
- Similar opportunities for Central and Northern Europe (typical winter/summer needs)
- Less chances for passive cooling in Southern Europe, but better thermal balancing of underground
- Every livestock application with need for heating and heat stress issues



General conclusions

- Geothermal heating creates efficient heating while cooling down the subsurface;
- Geothermal cold can be very useful for farm cooling, preferably passive cooling;
- At current energy prices, simple or dynamic payback times of 10 to 15 years can be achieved;
- Very important benefit → limiting/avoiding heat stress
- As alternative for gas/oil heating, ratio fossil fuel vs electricity price is important factor for profitability (very different for European countries)



Thank you!



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