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Energy concept Granåsen idrettsby

Snow for the Future - 26.10.2022

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Technology for a better society

Granåsen idrettsby

- Football building
  - Football field
  - Wardrobes
  - Climbing hall
  - Other activities
  - Offices
- Combination building
  - Handball fields and paddle tennis
  - Wardrobes
  - Offices
  - Grocery store

Pir II AS, “Detaljregulering Granåsen idrettsanlegg del 2 – illustrasjonsvedlegg”

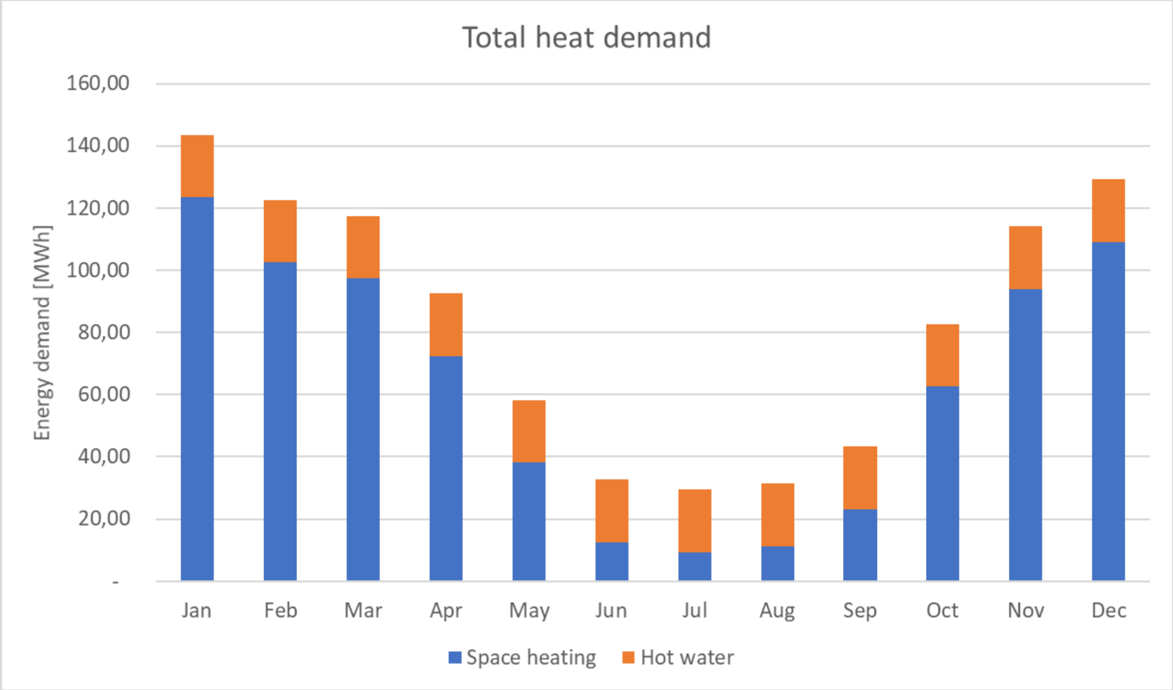
Granåsen idrettsby

- Passive buildings
  - Zero emission building
- Solar panels
- Seasonal energy storage
  - Borehole thermal energy storage (BTES)
  - Charge storage with surplus heat
  - Discharge when heat is needed
- Temperature independent snow machine (TIS)
  - Heat as biproduct

Pir II AS, "Detaljregulering Granåsen idrettsanlegg del 2 – illustrasjonsvedlegg"

Heat demand Granåsen idrettsby

- Based on the building composition
  - Football building: 15 800 m^2
  - Combination building: 17 700 m^2
- Approximately 1 GWh/year heat demand in total
- Space heating is dominating
  - Affects which concepts being favourable
- Want to cover this heat demand with surplus heat from the snow machine



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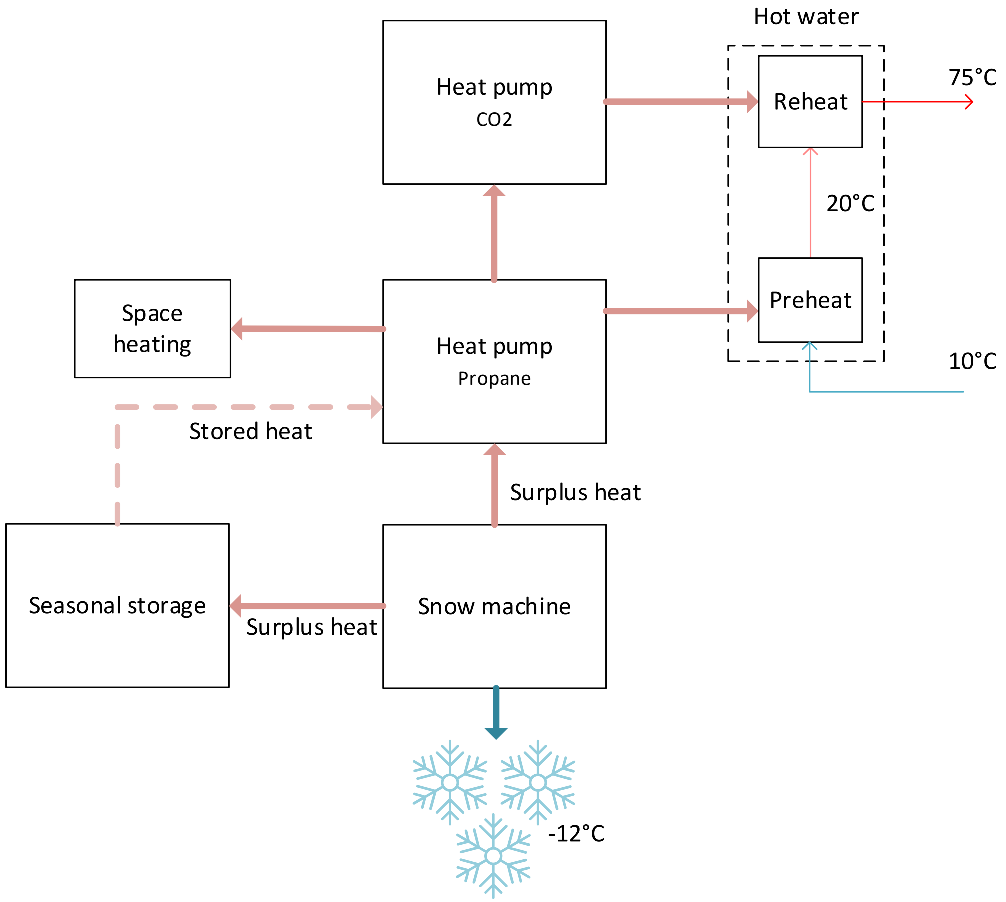
Concept drawing

- Snow production period
  - Heat to buildings
  - Charge storage
- Rest of the year
  - Discharge storage
    → Heat to buildings

Questions:

- When should the snow be produced?
- How much snow should be produced?
- What should be prioritized?
  - Production rate, energy efficiency, costs, time of the year, combination?



Cases

Case 1a)

- Production from August to November
- Produce 20 000 m^3
  - Heat as biproduct

Case 1b)

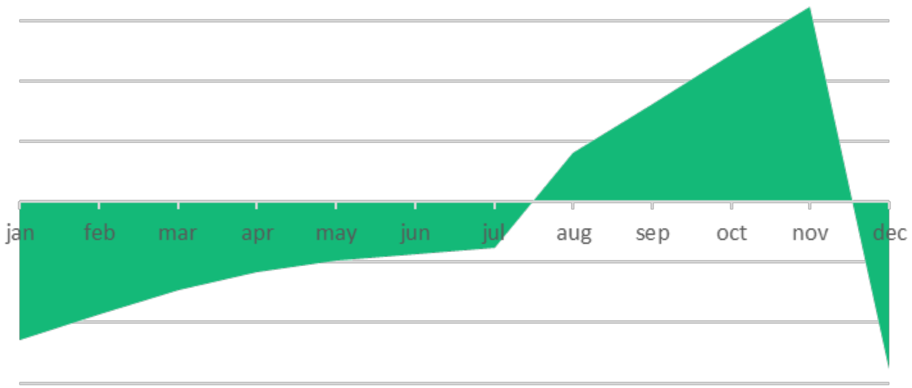
- Production from August to November
- Cover heat demand
  - Results in a snow production rate

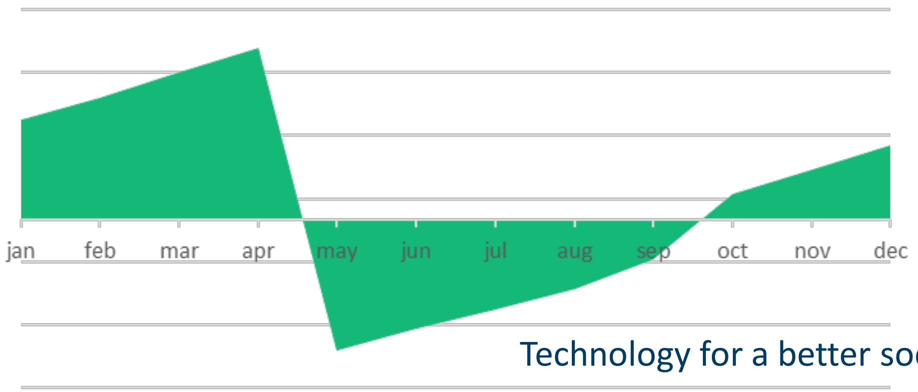
Case 2a)

- Production from October to April
- Produce 20 000 m^3
  - Heat as biproduct

Case 2b)

- Production from October to April
- Cover heat demand
  - Results in a snow production rate





Case study: Results

Case 1a)

- Production Aug-Nov
- Produce 20 000 m^3
- Daily production: 164 m^3
- Heat produced: 1,27 GWh
- Utilization rate: 67%
- Electric energy consumption: 387 MWh

Case 1b)

- Production Aug-Nov
- Produce 16 500 m^3
- Daily production: 120-150 m^3
- Heat produced: 1,05 GWh
- Utilization rate: 82%
- Electric energy consumption: 346 MWh

Case 2a)

- Production Oct-Apr
- Produce 20 000 m^3
- Daily production: 94 m^3
- Heat produced: 1,27 GWh
- Utilization rate: 69%
- Electric energy consumption: 364 MWh

Case 2b)

- Production Oct-Apr
- Produce 14 600 m^3
- Daily production: 50-80 m^3
- Heat produced: 0,93 GWh
- Utilization rate: 95%
- Electric energy consumption: 298 MWh

Case study: BTES

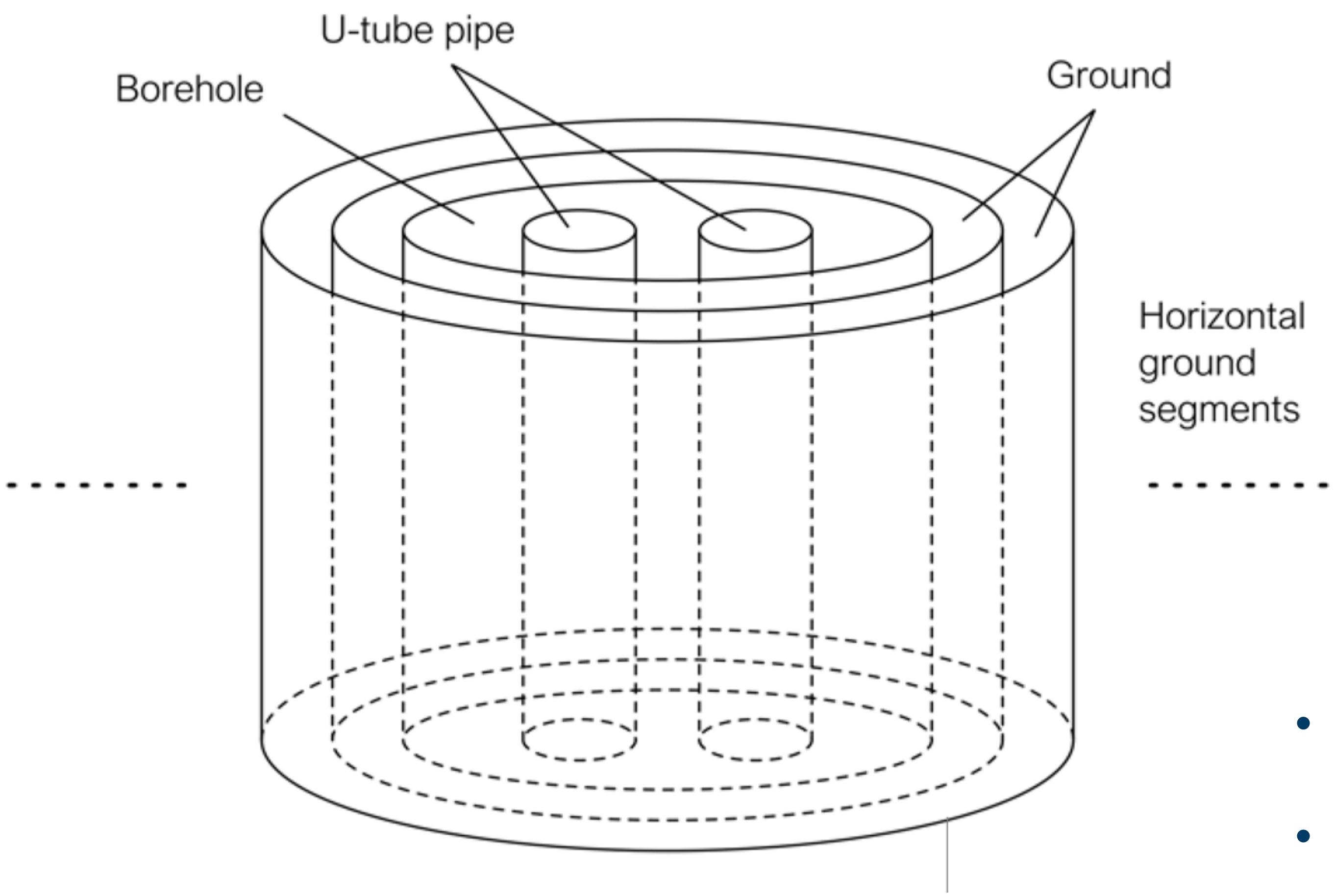
Case 1b)

- Production Aug-Nov
- Produce 16 500 m^3
- BTES charging: 807 MWh
- BTES discharging: 615 MWh
- Heat loss in ground about 24 %

Case 2b)

- Production Oct-Apr
- Produce 14 600 m^3
- BTES charging: 204 MWh
- BTES discharging: 157 MWh
- Heat loss in ground about 23 %

Borehole model and layout

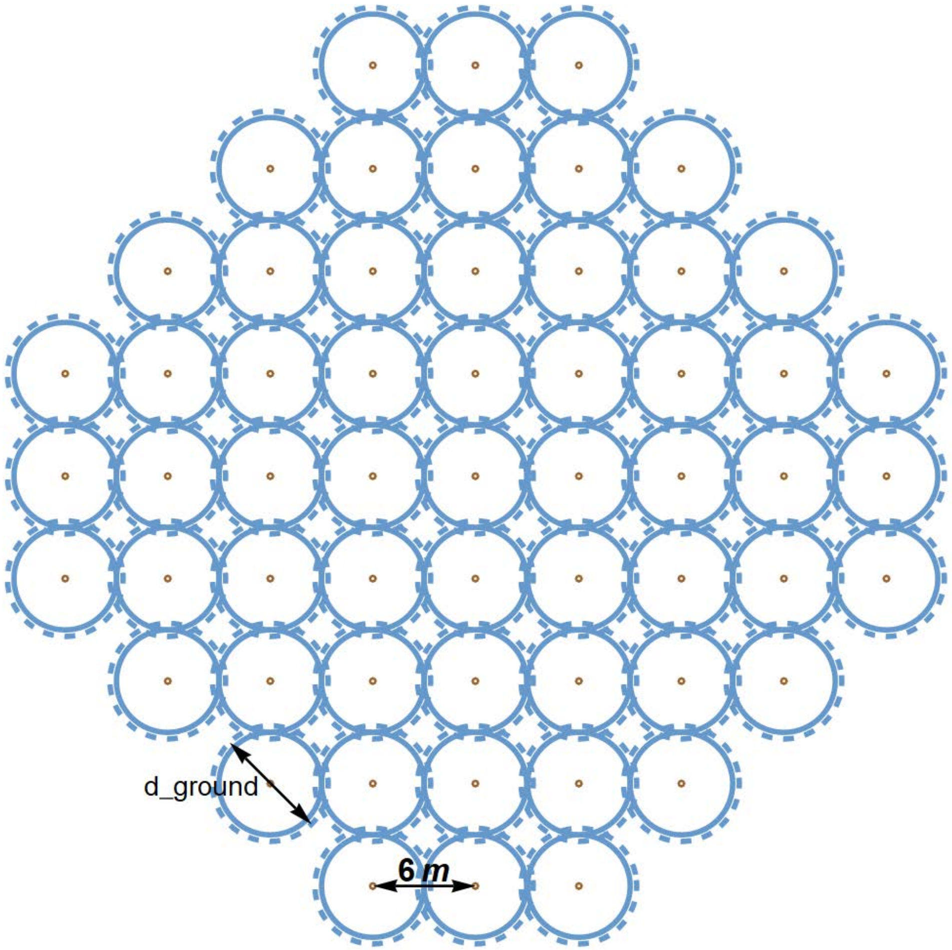


- Schematic of the main parts of a borehole model:
  - Borehole diameter: 10-20 cm
  - U-tube diameters: 25-50 mm
  - Borehole depth: 150-300 m
  - Borehole with filling material
  - Surrounding ground

- Double U-tube

- Single U-tube

Borehole model and layout



Borehole field for 57 boreholes

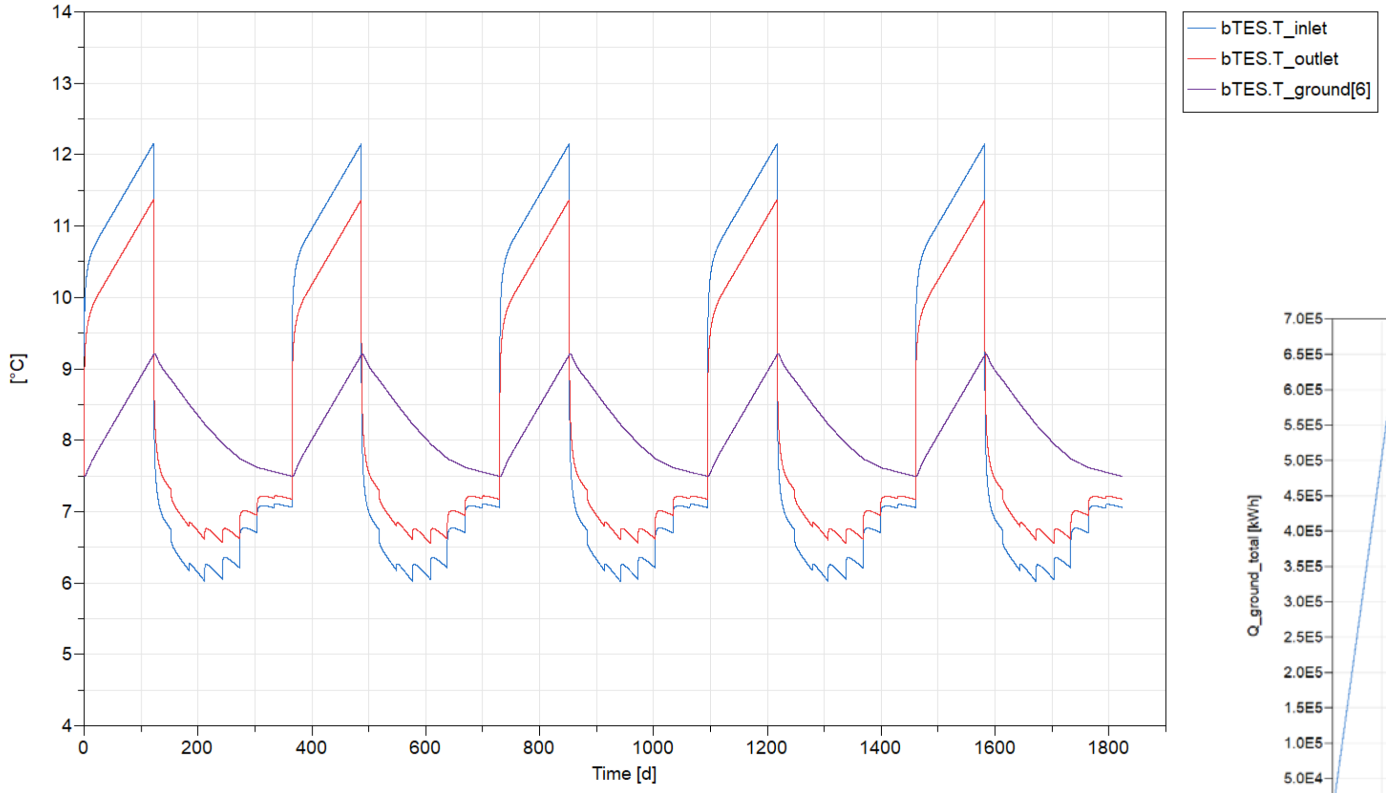
- 6 m distance between holes
- Model parameters:
  - Borehole diameter = 14 cm
  - d_ground = 6.77 m
  - U-pipe diameter: 40 mm
  - Borehole depth: 300 m
- Main sedimentary rock: Greenstone

Borehole parameters and specificatons

Dymola/Modelica modelling tool:

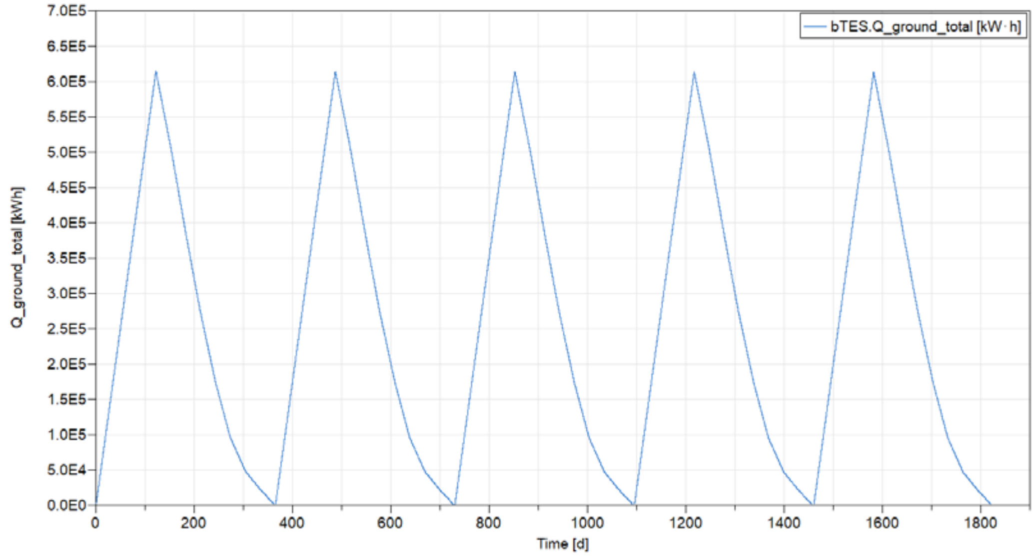
- Single U-tube ground heat exchanger
- U-pipe fluid: 70% water/30% propylene glycol
- Concrete filling

Borehole thermal charging/discharging

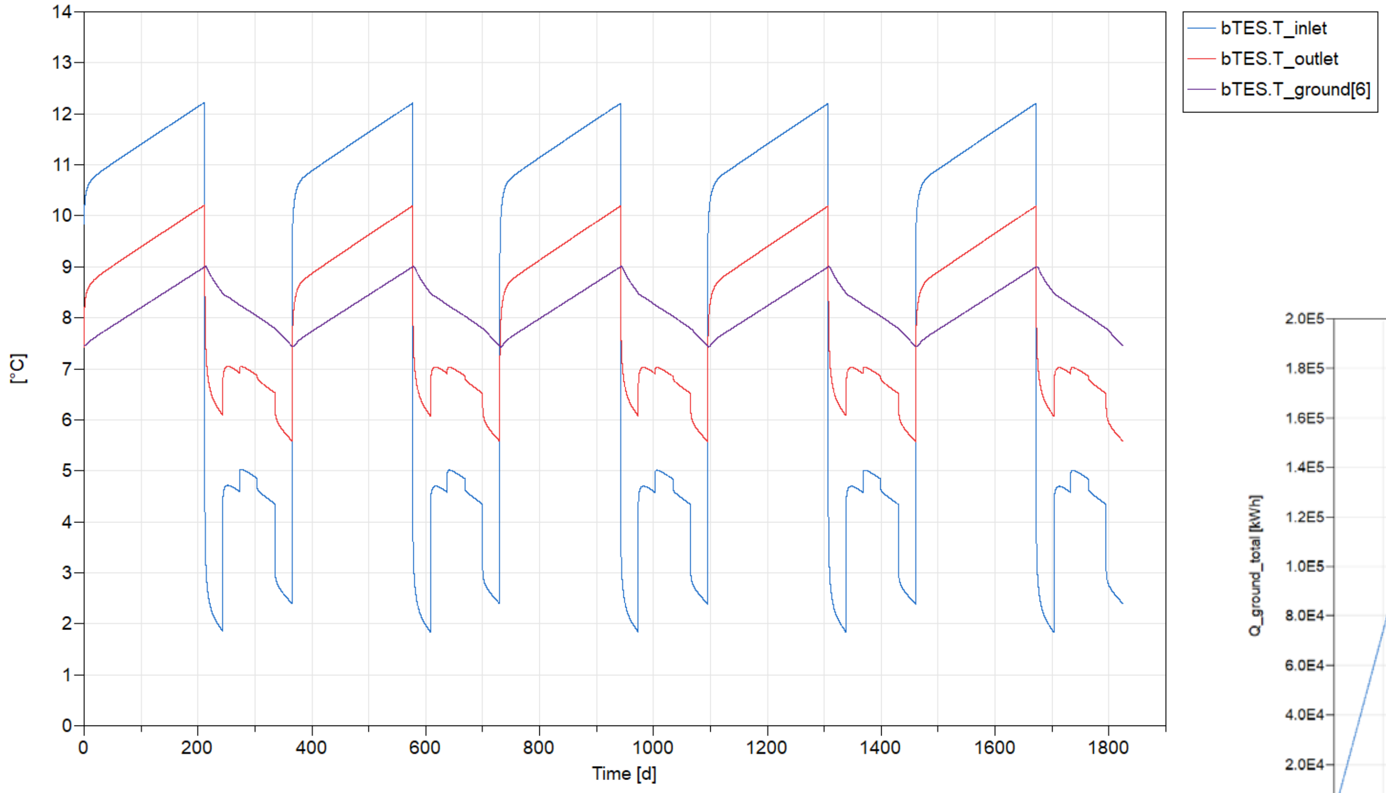


Case 1b – 5 years

- **57 boreholes**
- **4 months of charging**
- **8 months of discharging**

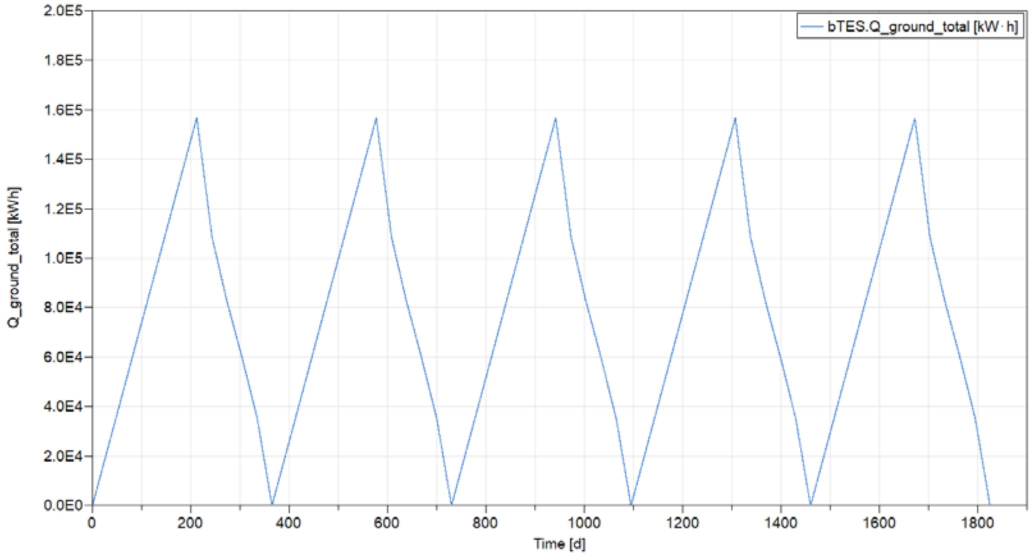


Borehole thermal charging/discharging



Case 2b – 5 years

- 16 boreholes
- 7 months of charging
- 5 months of discharging



Summary

	Case 1a	Case 1b	Case 2a	Case 2b
Snow production	High	Medium	High	Medium
Energy efficiency	Low	Medium	Low	High
Cost (Heat pump + BTES)	High	High	Small	Small

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