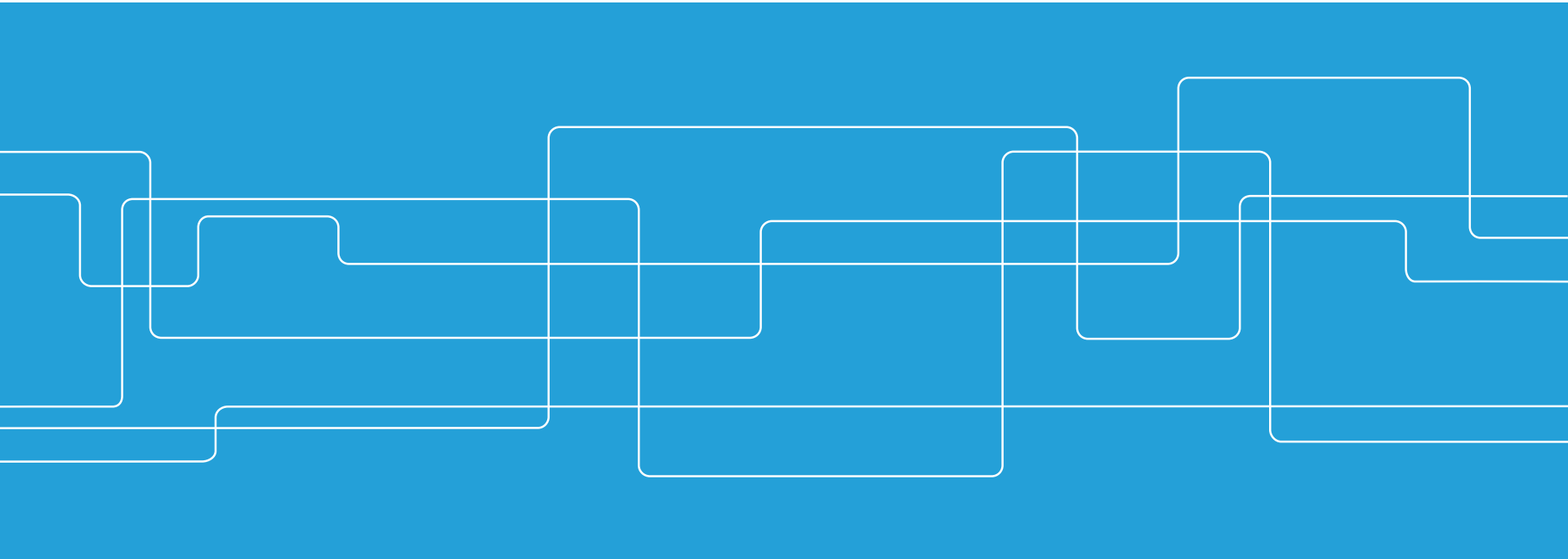




Bore field Sizing with reference to the starting time. Optimum Borehole Spacing.

Optimum BH Spacing





Objective

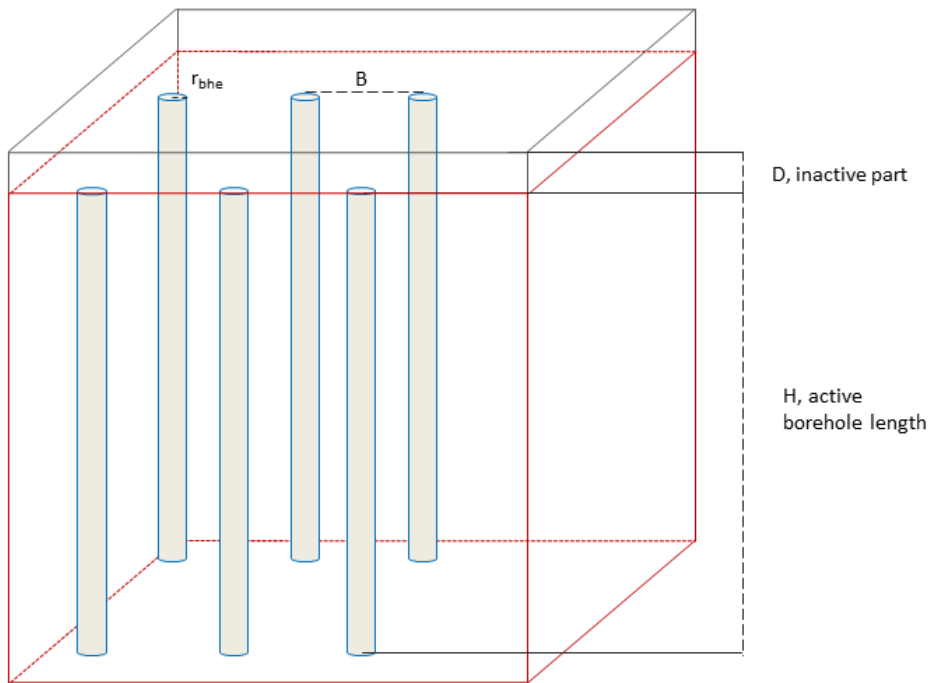
Develop the methodology for L calculation during the 1st year of operation

Application: Study of BH Spacing on L Calculation
in a quasi-balanced thermal system

Borehole (BH) sizing

INVOLVED FACTORS

- Energy Demand
- Temperature Constraint in the HP
- Drilling Area
- Cost



DESIGN PARAMETERS

- ❑ L: Total Bore field Length
- ❑ nb: Number of BHs
- ❑ H: Active BH Length
- ❑ B: Spacing BH-to-BH
- ❑ r_b : BH radius

Methodology

1. ASHRAE's equation

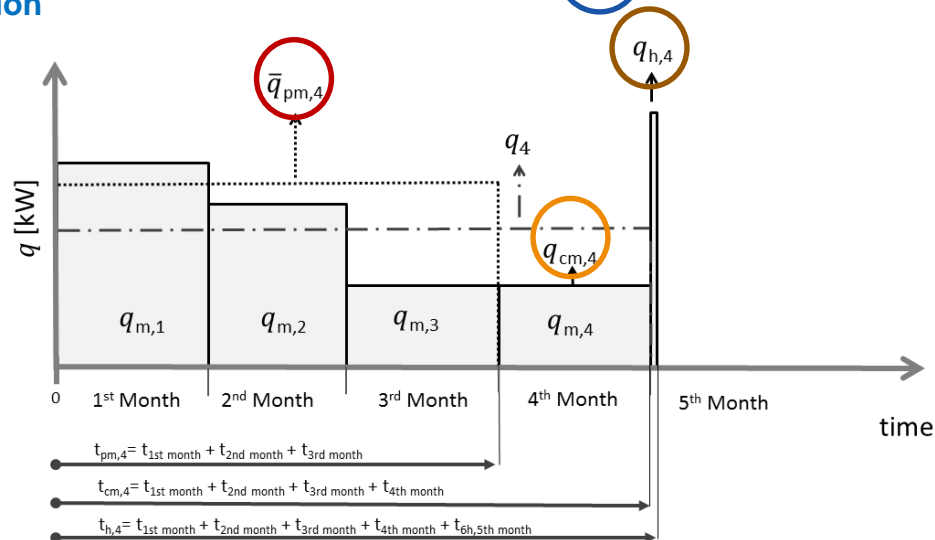
$$L = \frac{q_h \cdot R_b + \cancel{q_y} \cdot R_{10y} + q_m \cdot R_{1m} + q_h \cdot R_{6h}}{T_m - (T_g + T_p)} = 0 \text{ for annual balanced load}$$

Reference: Philippe M and Bernier M. 2010. Sizing Calculation Spreadsheet Vertical Geothermal Borefield

2. Adapt ASHRAE's equation of L calculation for the 1st year of operation

$$L_i = \frac{q_{h,i} \cdot R_b + \bar{q}_{pm,i} \cdot R_{pm,i} + q_{cm,i} \cdot R_{cm} + q_{h,i} \cdot R_h}{T_m - (T_g + T_{p,i})} \quad R_{pm,i}, R_{cm}, R_h$$

Example: 4th month of operation



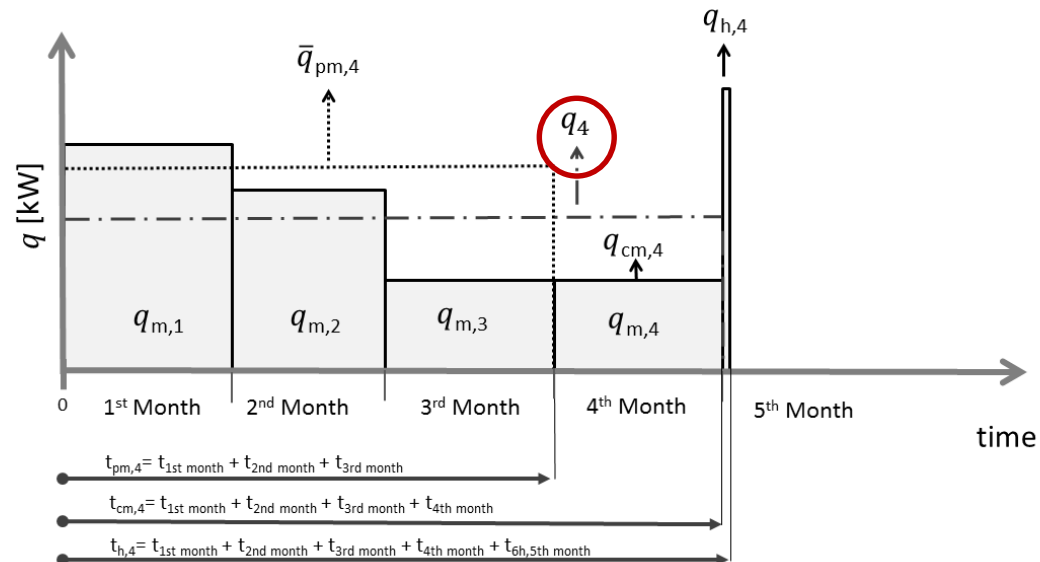
$G (Fo)$

Methodology

4. Adapt T_p equation

$$T_{p,i} = \frac{q_i}{2\pi k_s} \times \left[g_{n,i} \left(t/t_s, B/H, BH \text{ geometry} \right) - g_{1,i} \left(t/t_s \right) \right]$$

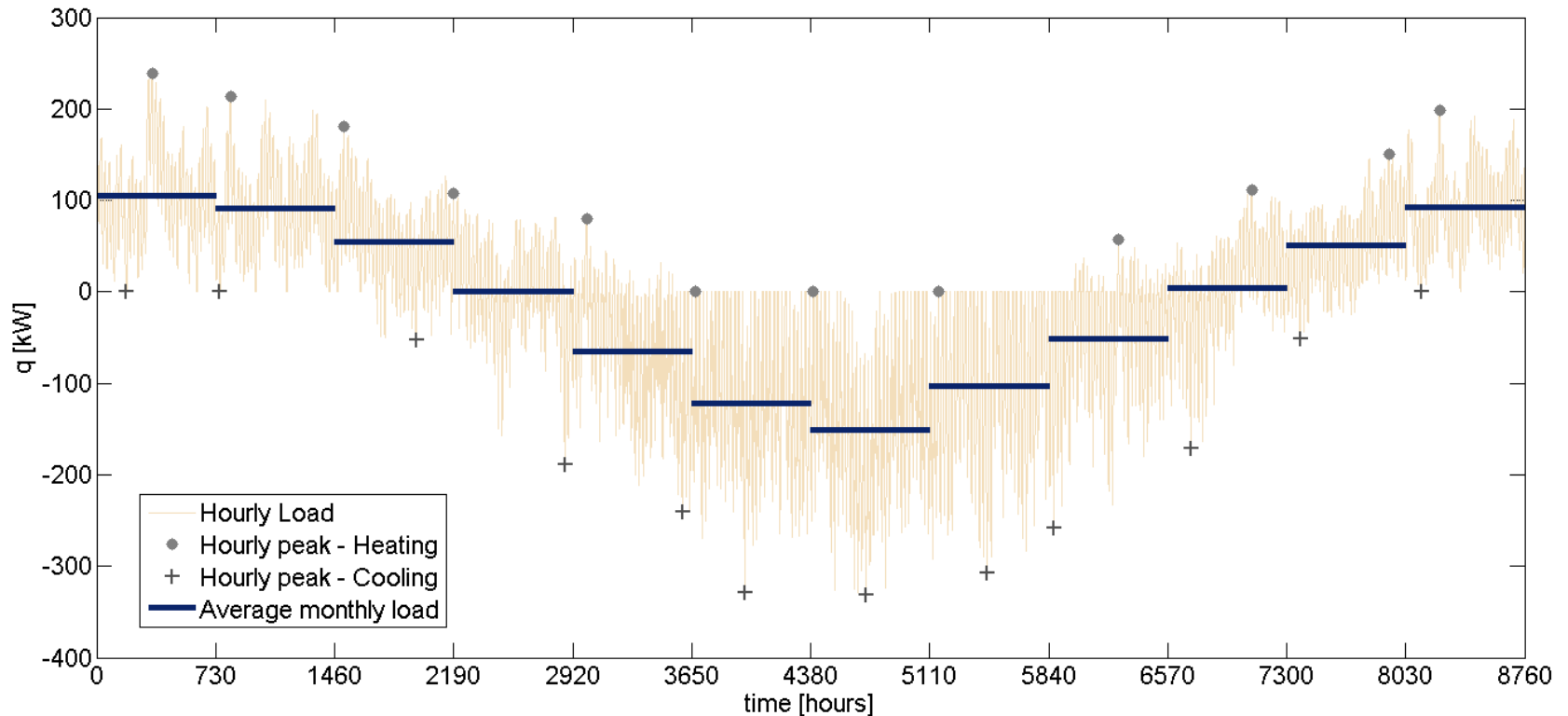
Example: 4th month of operation



Application of the Methodology

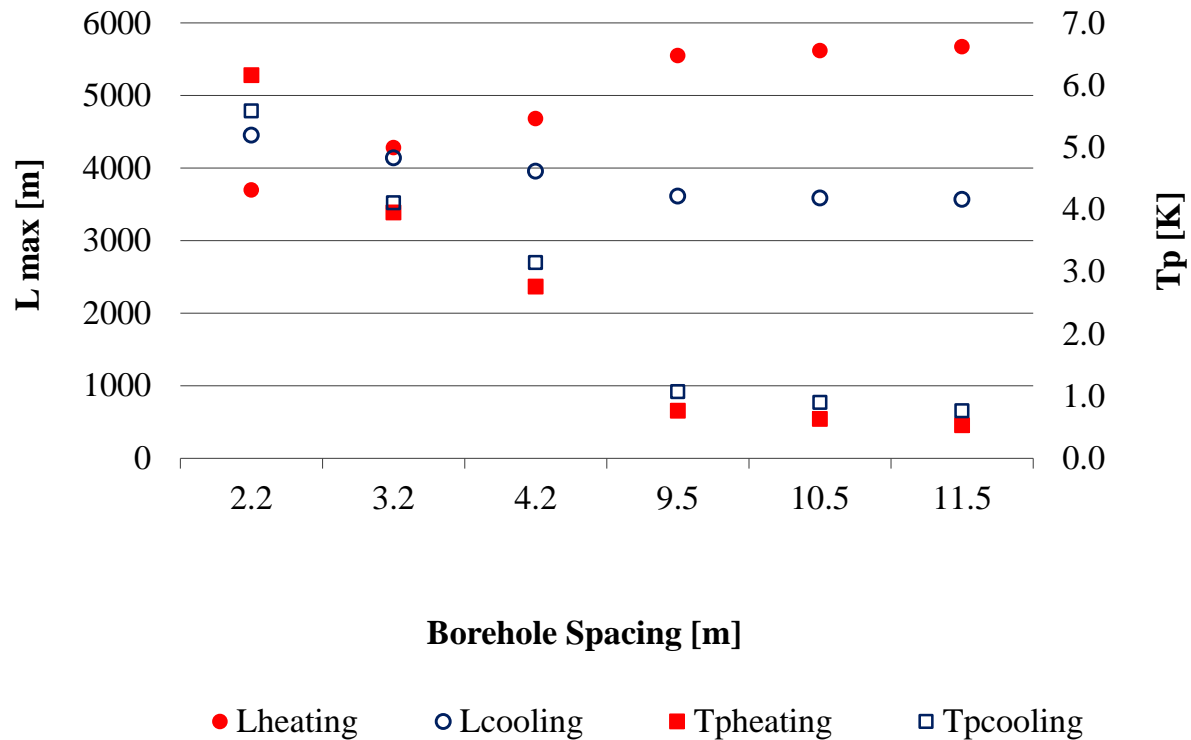
Input Parameters

Ground Load profile



Application of the Methodology BH Spacing

B varies from 6 to 3 m





Conclusion

- Methodology to calculate L at the end of each month throughout the 1st year of operation
- The methodology is applied to a particular cases
- BH Spacing
 - L is calculated for different B .
 - It is possible to optimize B to have a minimum L .