Case Study:
Long term monitoring of energy piles at Keble College, Oxford

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Energy Pile System

- Sloane Robinson Building, Keble College, Oxford
- Commissioned in 2001.
- Design: Enercret (Negelebau)
- Installation: Cementation Skanska Ltd
- 90 piles of varying depths.
- 41 ground loops.
- Design peak heating and cooling demand using a heat pump (45kW).
- Annual heating load 74MWh.
- Annual cooling load 55MWh.
- Operational ground temperature range 1°C to 27°C.
- Direct cooling when ground temperature <19°C.

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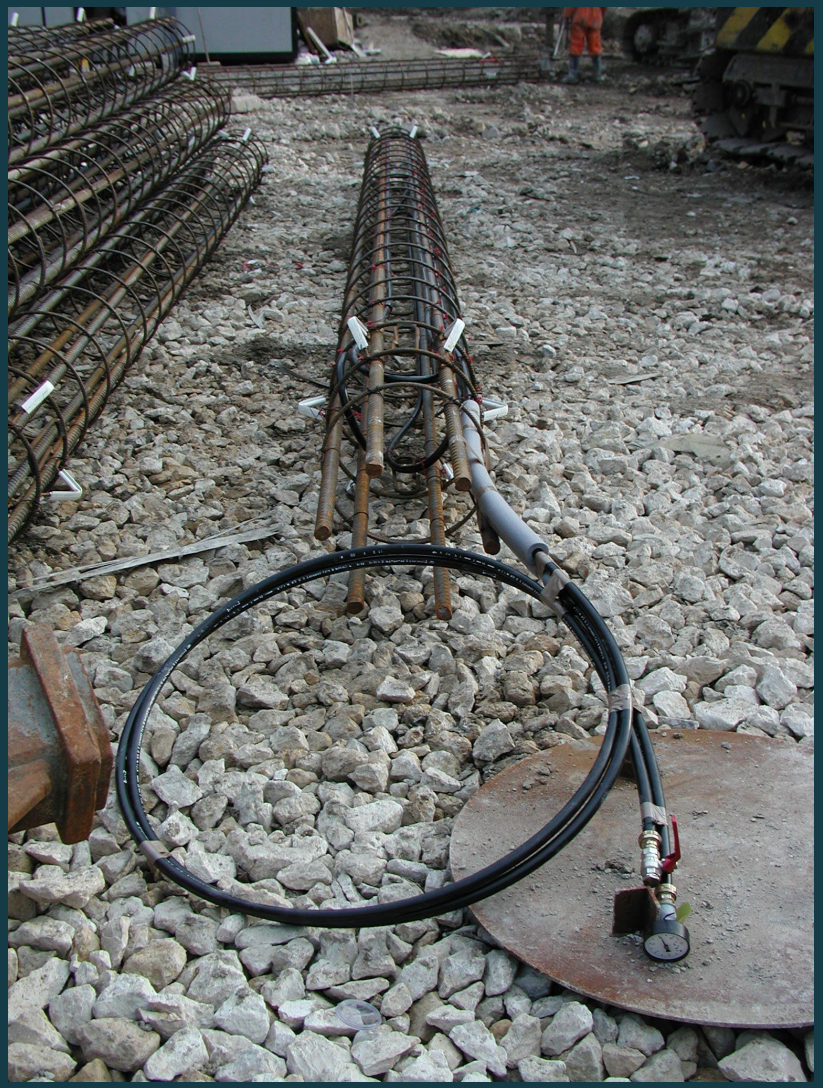
Research Project

- Rationale:
  - DTI Ground Storage of Building Energy (2002-2006)
  - Highlighted lack of case histories on performance and sustainability
  - Check design predictions
- Arup scope (SEEDA):
  - Collect and review data
  - Analyse performance of the system
  - Annual reporting



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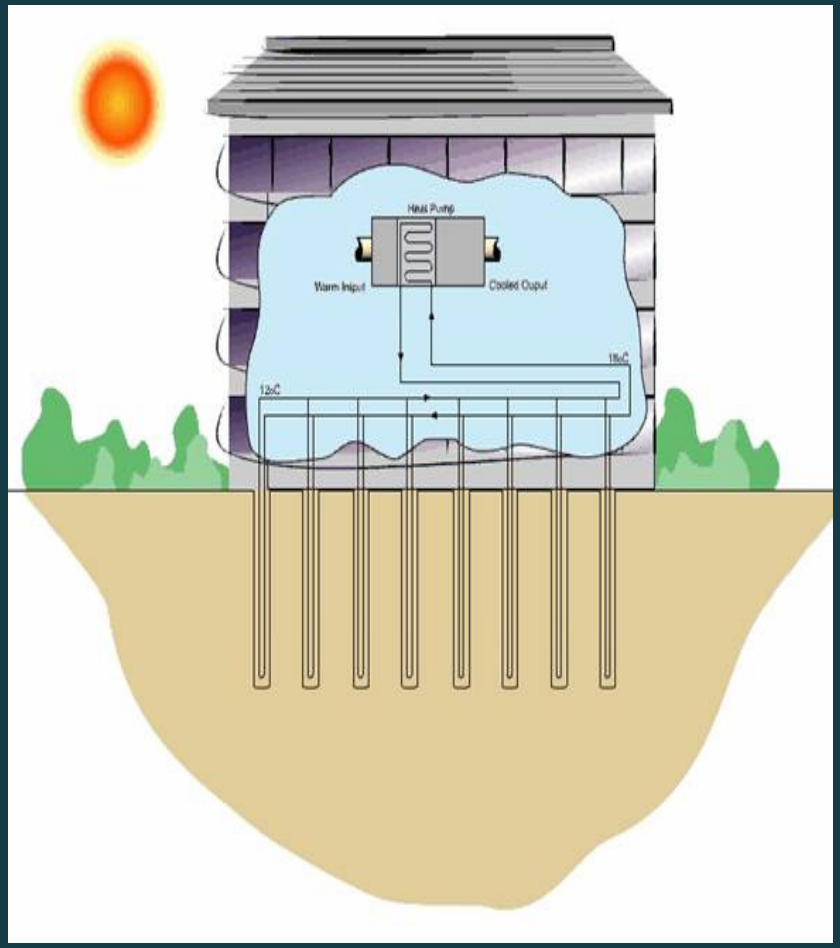
Monitoring Programme

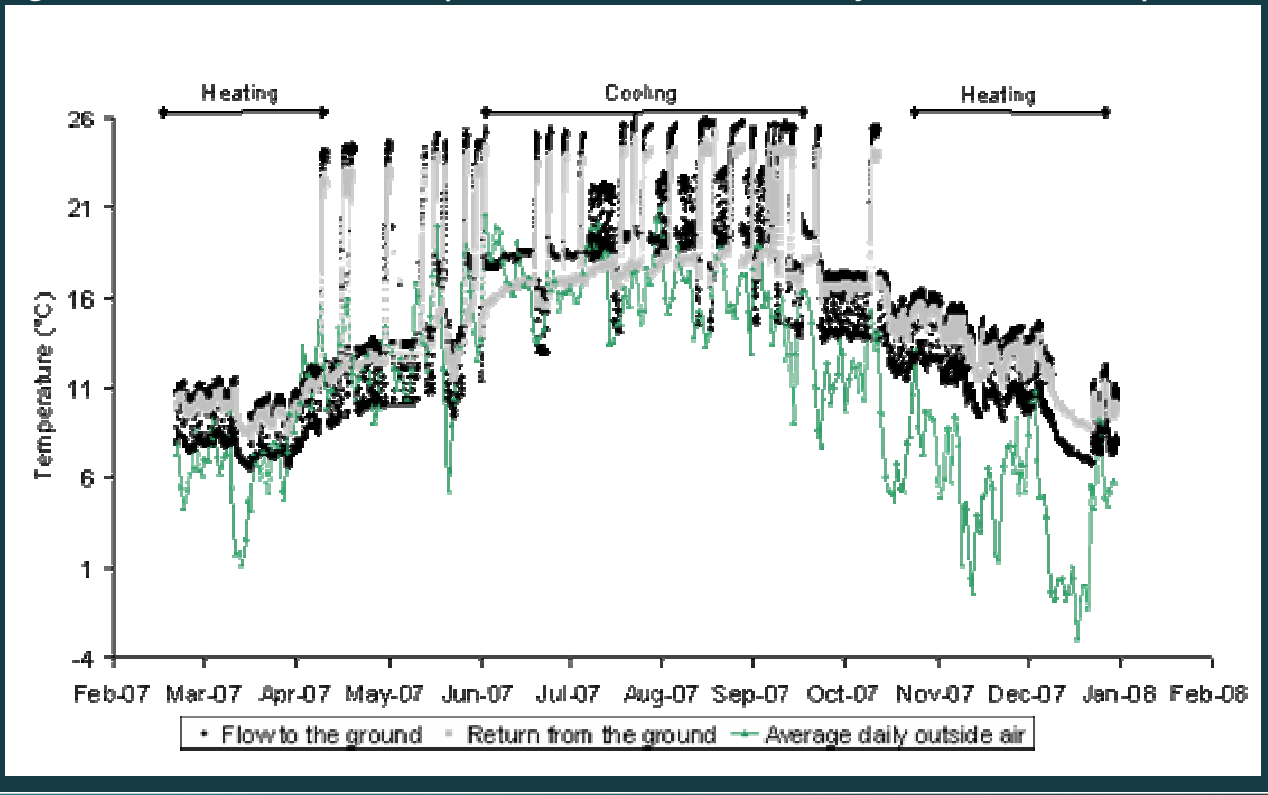
- **Building Management System (BMS)**
  - 15 minute data
  - 52 monitoring points
- **Data**
  - Fluid temperature in the pipes leaving the heat pump
  - Fluid temperature in the pipes returning from the ground
  - Heat pump flow rate (ground loop side)
  - Heat pump flow rate (building side)
  - Outside air temperature.
- **Current data analysis**
  - February 2007 – February 2008



Key Findings

Temperature Trends

1. Periods of heating when temperature of the fluid leaving the ground exceeds that sent to the ground.
2. Periods of cooling when temperature of the fluid leaving the ground is lower than that sent to the ground.
3. Spikes in temperature when energy pile system not in operation.
4. Changes in ambient air temperature mirrored in system fluid temperature.



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Key Findings

Heating Cycle

1. Building has performed as expected.
2. Operated within stipulated temperature limits.

Cooling Cycle

1. Building has **not** performed as expected.
2. Additional cooling systems installed.
3. Met unexpected cooling loads in spring and autumn.
4. Operated within stipulated temperature limits.
5. Direct cooling provides 77% total annual cooling demand from energy piles.

Key Findings

System Efficiency

- The higher than predicted ground temperature indicates that in the **heating** cycle the heat pump is operating very efficiently.
- Periods of intermittent **heating** (spring) – solar gains and/or internal gains to the building.
- Start of the **cooling** cycle temperature differential 2.5℃ and system operating efficiently.
- During the **cooling** cycle the temperature differential decreases to <1℃ – flow rates increase and the efficiency of the system drops.

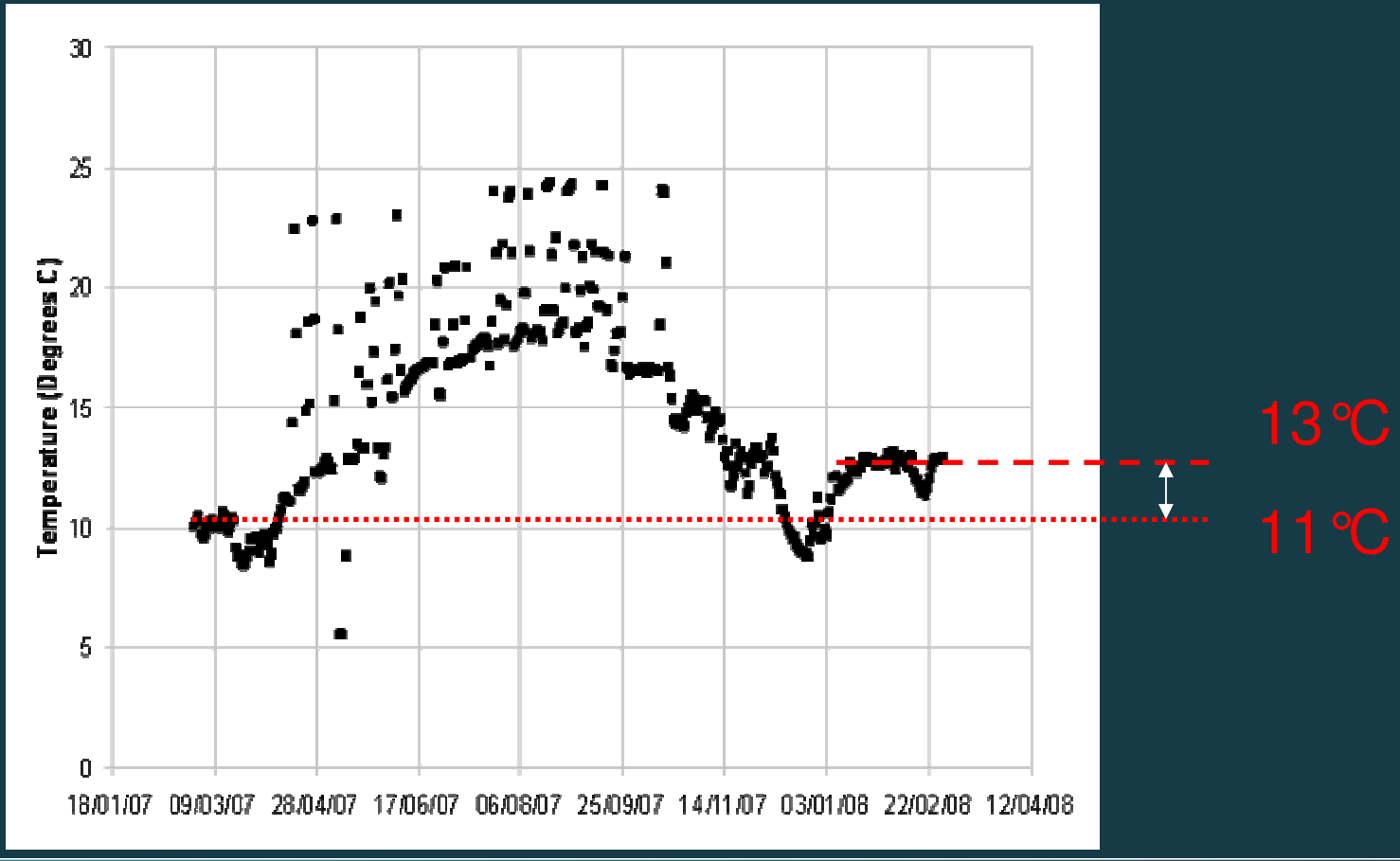
Annual Balance

- 17,000kWh rejected to the ground
- Would therefore expect ground temperature to increase over this period…

Key Findings

Ground Temperature

- Appears to have risen by 2℃ over 1 year.
- If this is a long term trend will effect efficiency of the system.
- However, could be a function of climate over that particular year.



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Way Forward

- Continuation of current monitoring programme – 2 years of data to analyse.
- The ground return temperatures should be monitored to understand whether there is a steady annual increase in temperature.
- Electricity meter installed October 2009 to better understand the performance of the heat pump and running costs of the system.
- The building and supplementary cooling system should be analysed to understand why the cooling loads are different to those that were expected.
- Looking into long term monitoring of other projects – range of systems

Thank you for your attention

- Any Questions?

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