Energy infrastructure planning from 1851 to 2050:

How the institutions developed in the wake of the Great Exhibition

are working together for a low carbon future

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Proposition

By working together at city neighbourhood scale, building owners and occupiers could make a much greater difference in terms of return on investment, both in terms of cost and carbon reduction, than by acting alone.'

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The Carbon Master plan Project

Over the years the several great institutions that occupy the 1851 commission land have become largely independent, although a number of heat sharing networks remain in place, particularly amongst the Museums.

These institutions are now coming together again in the spirit of the Victorians to invest in the development of a Carbon Masterplan. This project is supported by grant funding from the UK Government, from the Treasury via the Department of Culture Media and Sport.

Aquifer Thermal Energy Storage (ATES) Overview

Advanced Ground Source Heat Pump Application

- Maintains a thermal balance in the underground, allowing true sustainability
- Provides a better return on investment
- Leads to significant reductions in carbon dioxide emissions

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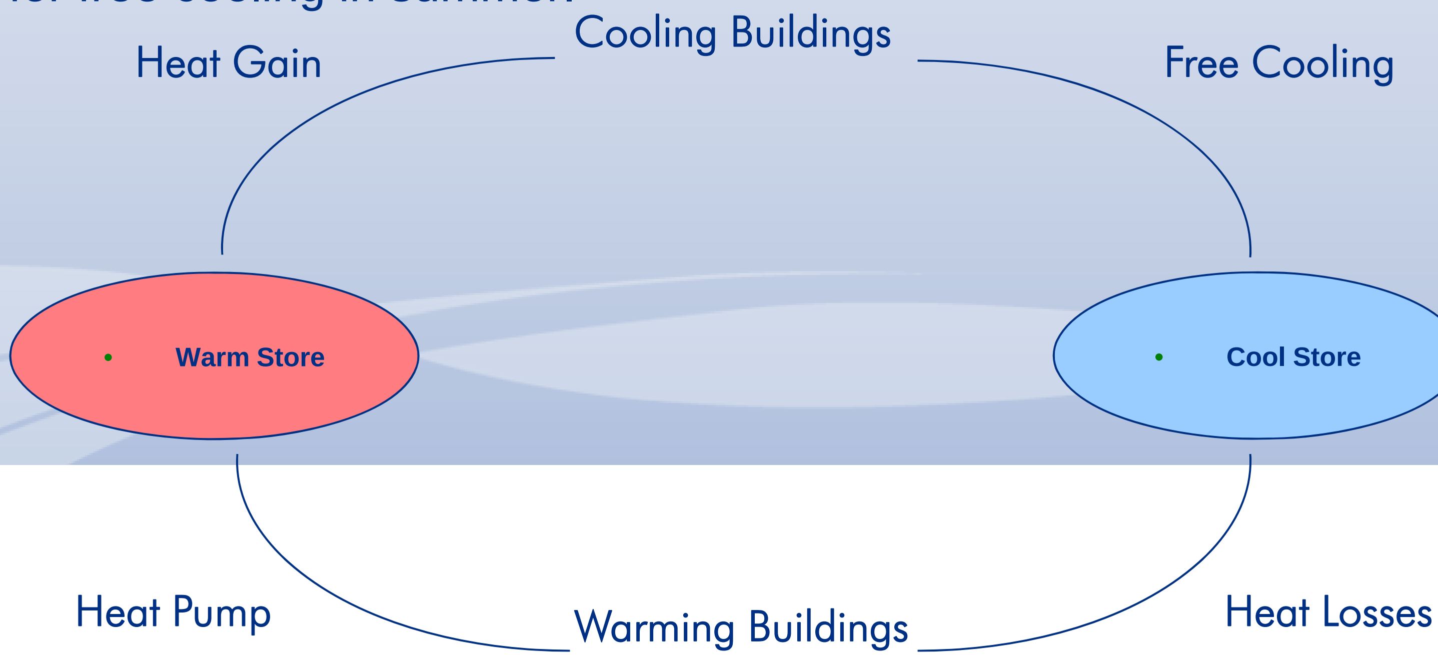
UTES; The Principle

- UTES is a system which utilises Inter-Seasonal Heat Storage. This involves the storage of excess energy
- from summer for use in winter heating applications, and the storage of cooling potential from winter
- for free cooling in summer.



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ATES

ATES SUMMER

1 - Cold bore hole supplying cool water to buildings.

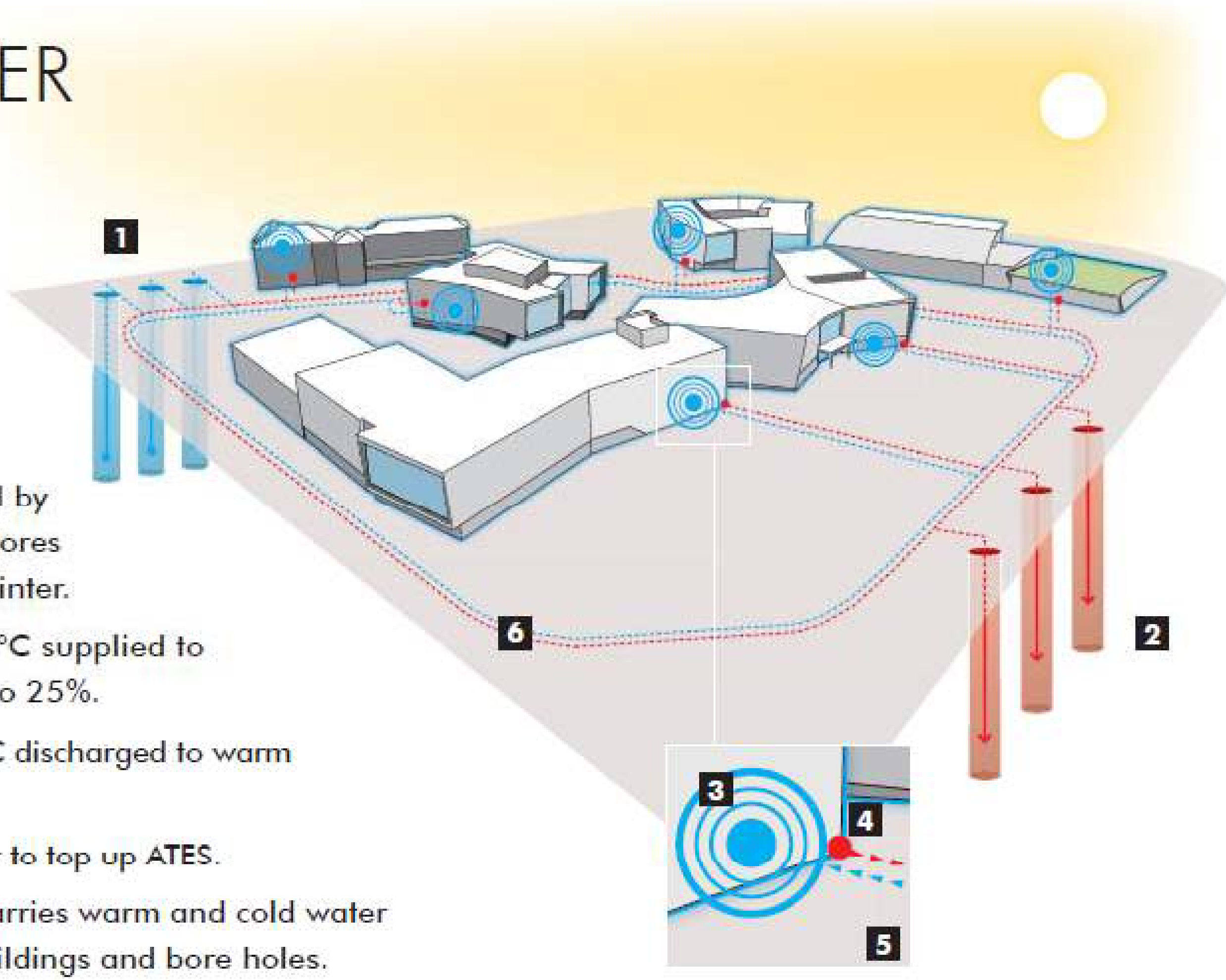
2 - Charging of warm bore hole with water warmed by cooling the building – stores heat for the following winter.

3 - Water at around 10-15°C supplied to building at COP of up to 25%.

4 - Water at around 15-20°C discharged to warm bore hole.

5 - Heat pump acts as chiller to top up ATES.

6 - Distribution pipework carries warm and cold water around site between buildings and bore holes.



ATES

ATES WINTER

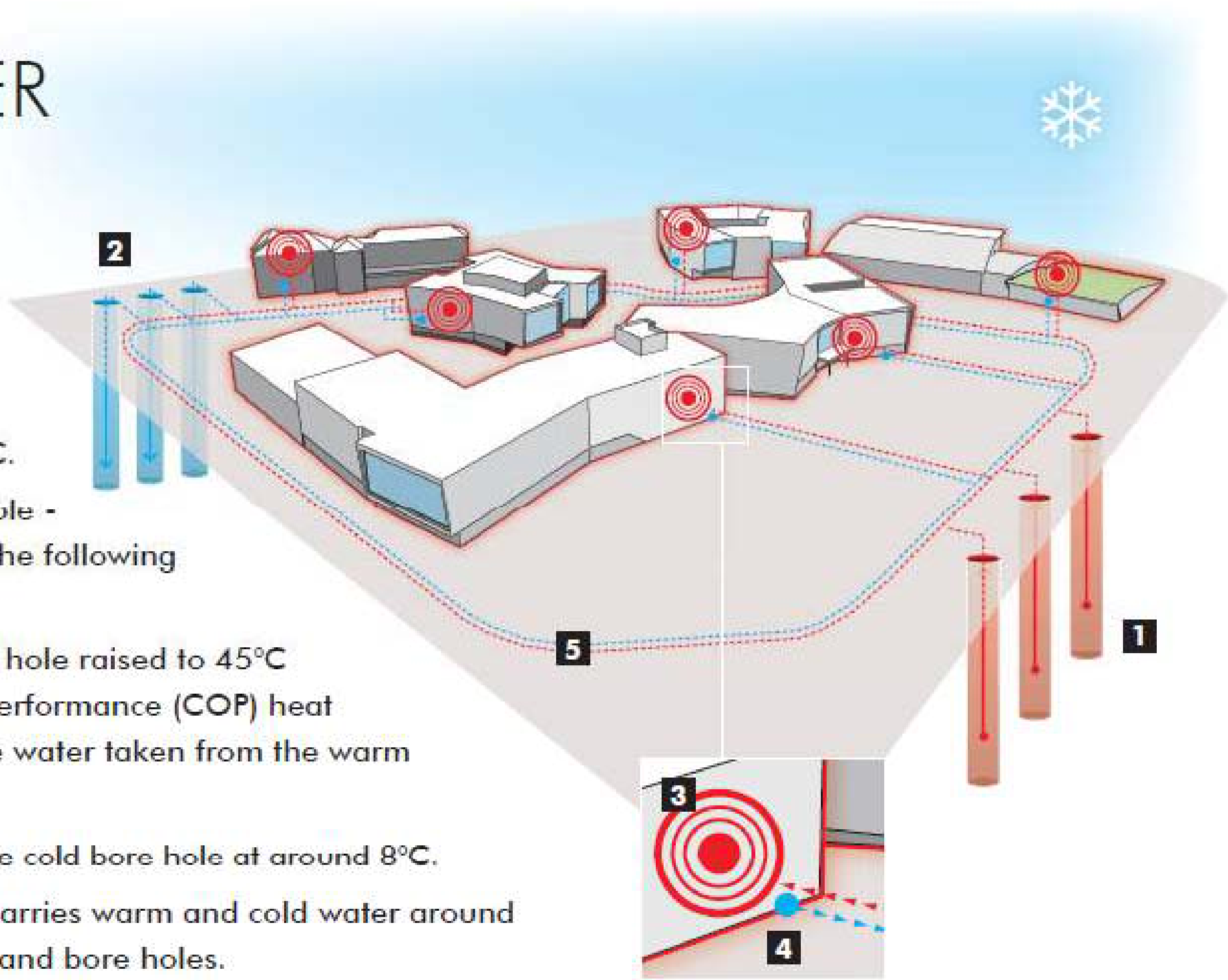
1- Warm bore hole, charged the previous summer, supplies warm water to the building at around 15°C.

2 - Water into cold bore hole - charges cold store for the following summer.

3 - Warm water from bore hole raised to 45°C by high coefficient of performance (COP) heat pump - which cools the water taken from the warm bore hole.

4 - Water returned to charge cold bore hole at around 8°C.

5 - Distribution pipework carries warm and cold water around site between buildings and bore holes.



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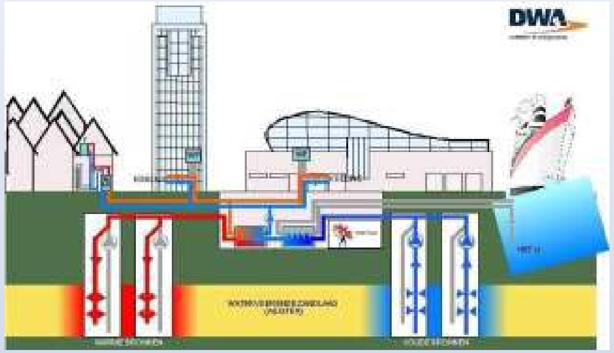
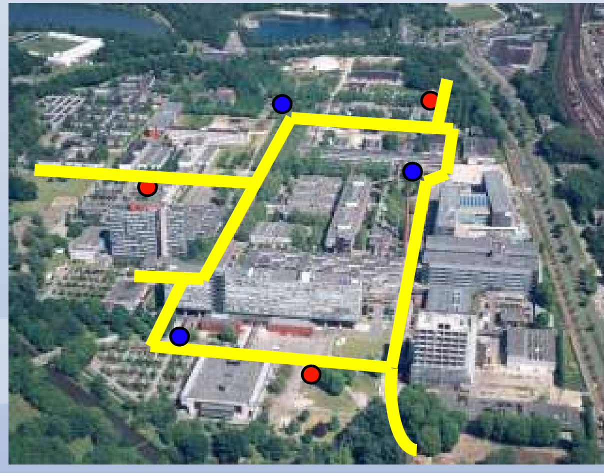
The Dutch Experience

The work of IF Technology in Holland has explored the potential in both new developments and existing campuses.

At passenger terminal “Oostelijke Handelskade” in Amsterdam, the load profiles of the various buildings in a single development are summated over a year.

At Eindhoven University, new buildings with interseasonal net cooling requirement are connected into a site-wide heat network along with older buildings with net heating requirement, with a connected peak load of 20MW.





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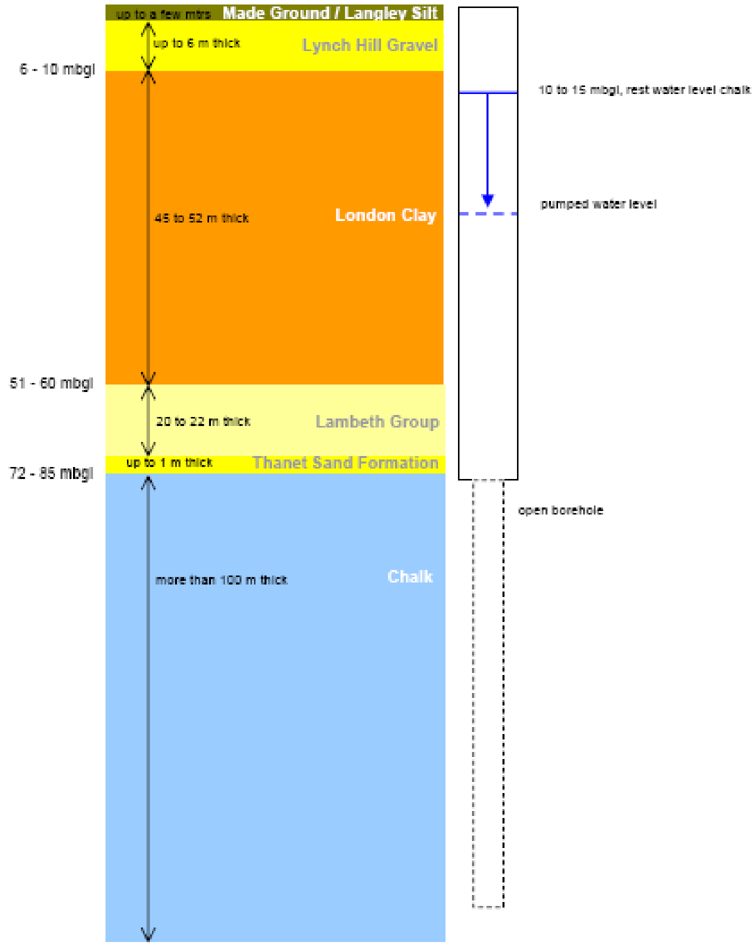
ATES – London Hydrogeology

The chalk aquifer is contained beneath the clay. It is variable due to fissure low but has been found to be suitable for ATES in many London locations.

Many UK cities are on sandstone aquifers, which offer good ATES potential and more even flow patterns.

Where suitable aquifers are not present, close loop borehole systems can be used.



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Borehole Geological Sequence Leamouth

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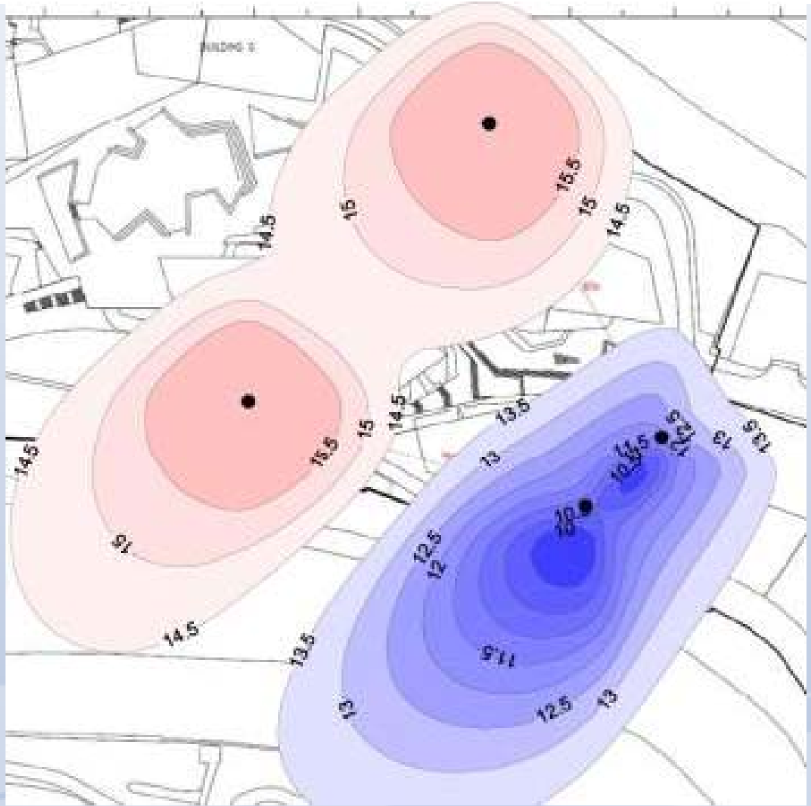
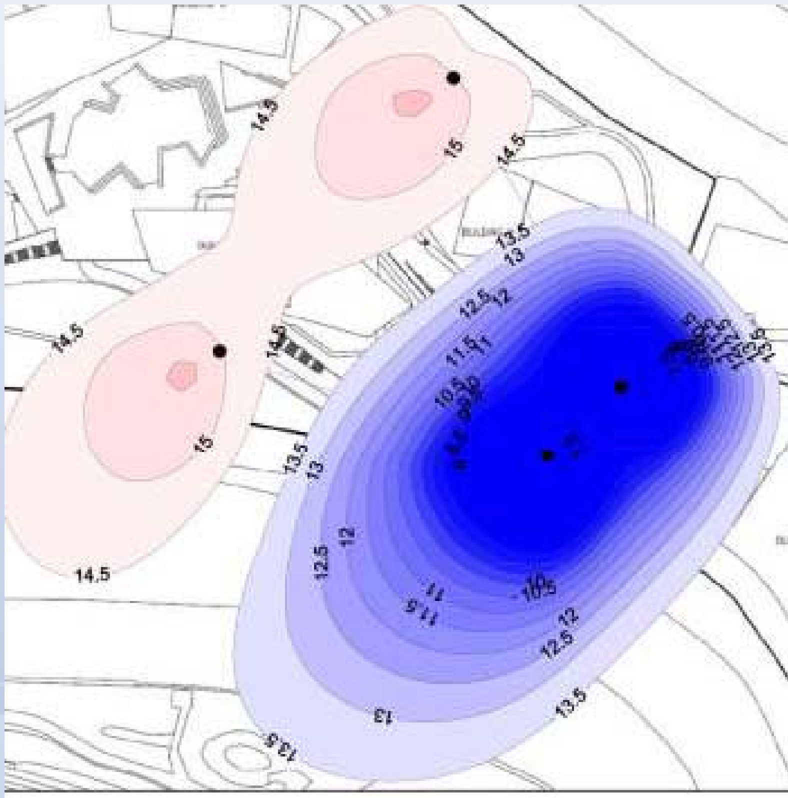
Isotherms



End of summer



End of winter

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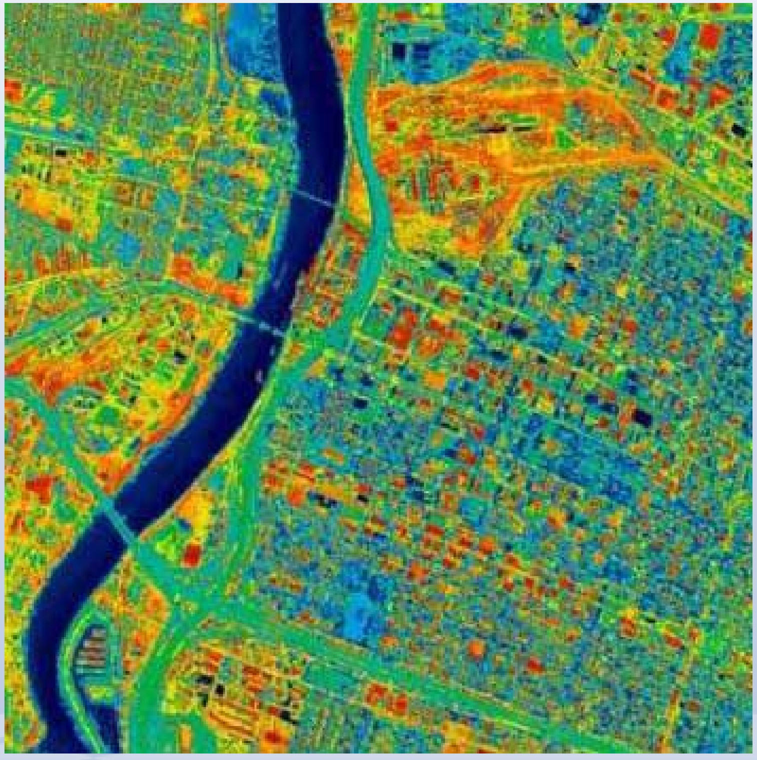
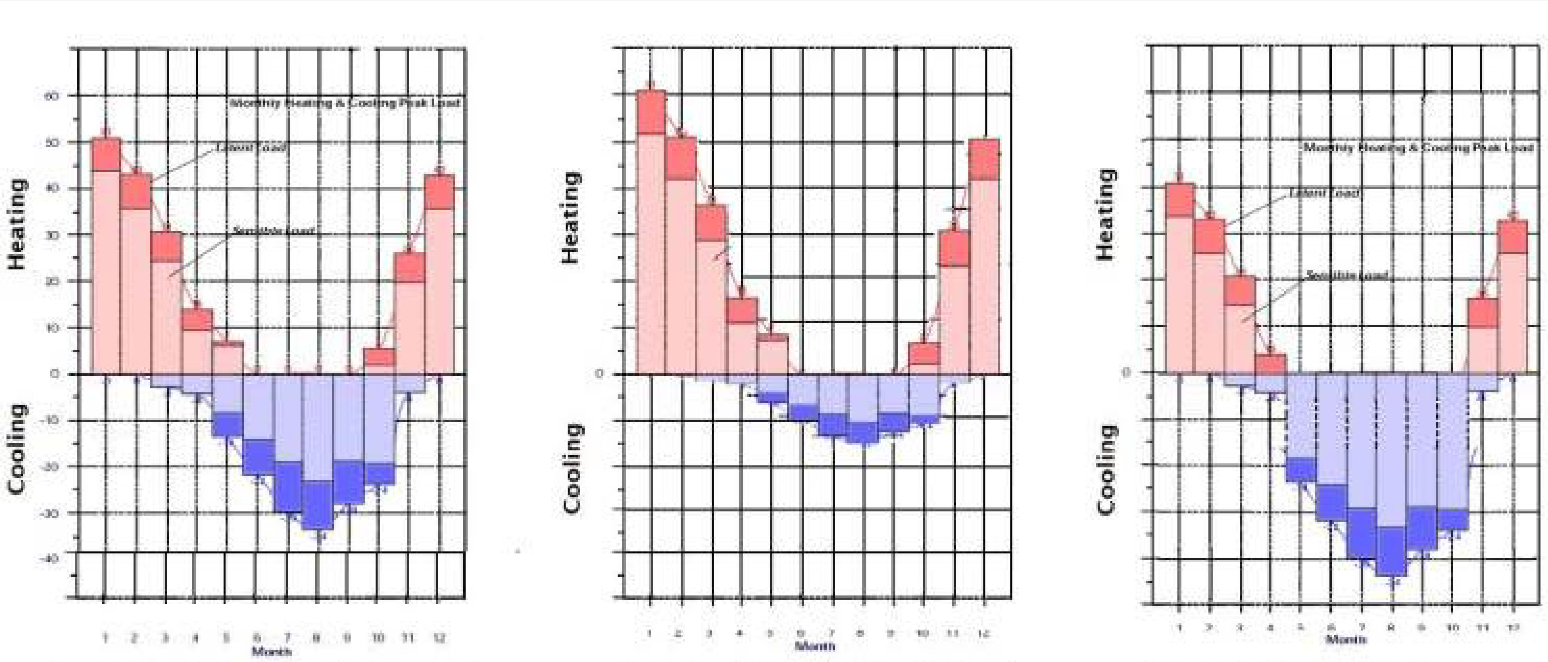
Urban Heat Networks and ATES



Many cities demonstrate simultaneous heat demand from some buildings and heat excess in others

Matching Load Profiles



A typical commercial building load

Some dominated by heating load

Some require more cooling

By introducing ATES, simultaneous heat sharing opportunities can be substantially increased by looking for heat balance over a year

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The Problem of Existing Building Stock

Substantial demand reduction for existing buildings requires fabric performance improvements

The option of over cladding would be suitable for many buildings, but many of our cities are defined by their architecture and over cladding would destroy the heritage

Driving down carbon emissions in historic city centres requires a strategy for low carbon 'renewable' heating and cooling

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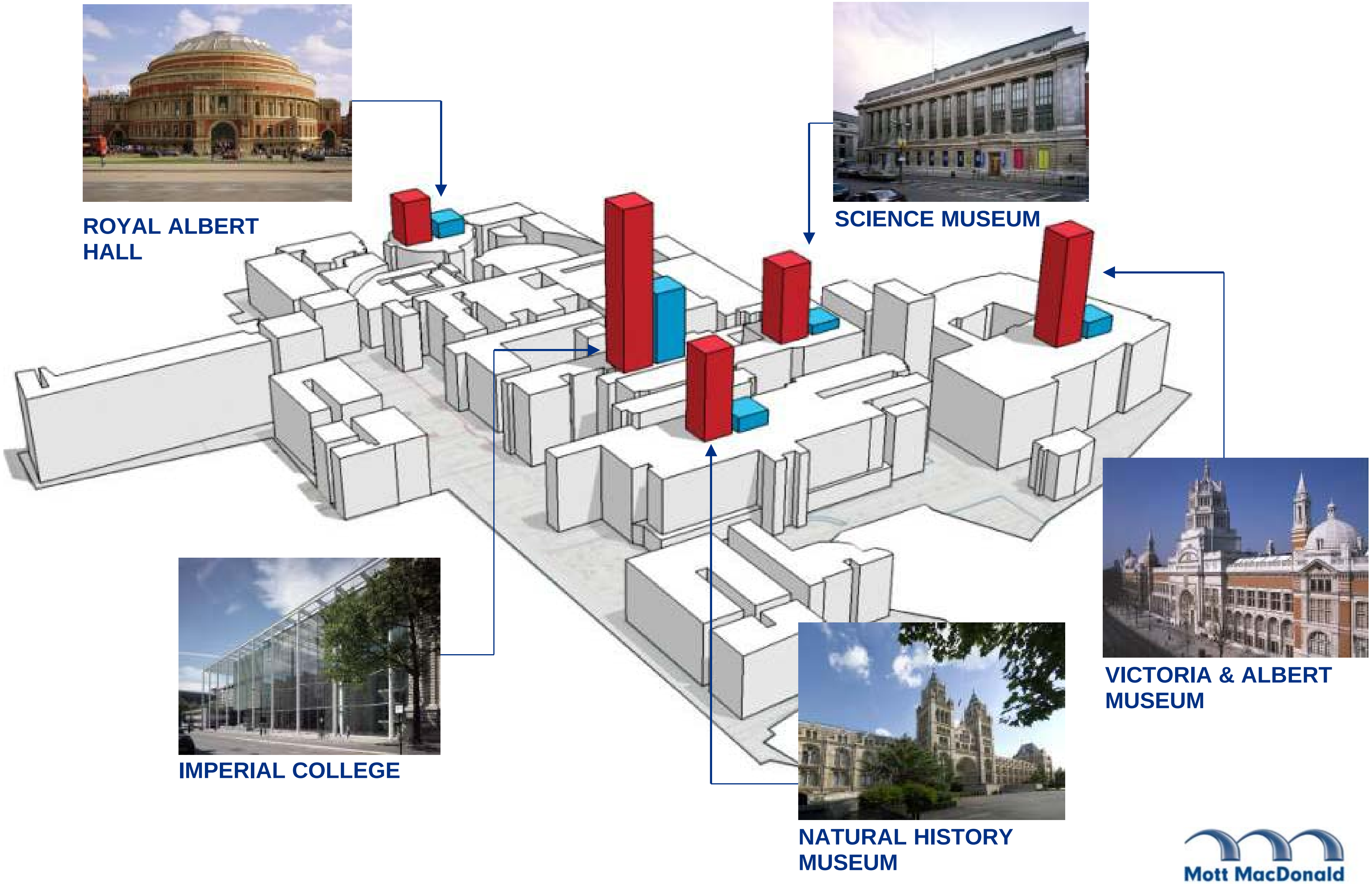
The 1851 Site



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1851 commission project overview

- The research project that forms part of a Carbon Reduction Masterplan for the 1851 Commission Estate.
- The objective of the research is to assess the potential for Aquifer Thermal Energy Storage (ATES) in conjunction with Combined Heat and Power generation (CHP) to be used as part of a heat and cool sharing network.
- The current stage is focused on:
  - Production of a road-map to a possible phased implementation of a site-wide infrastructure
  - Production of a summary of the study that captures the ideas developed and lessons learned from the project

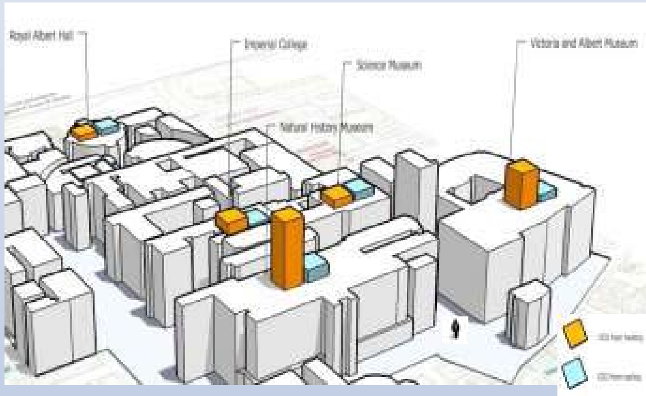
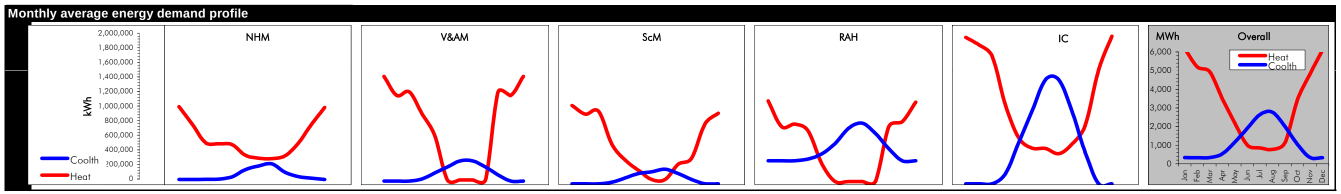


Figure : CO_2 emissions for the five developments due to heating and cooling supply.



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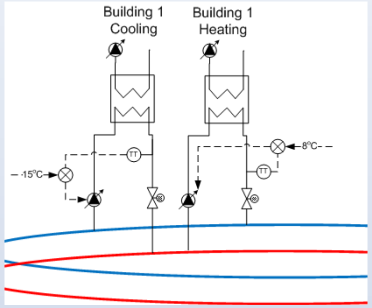
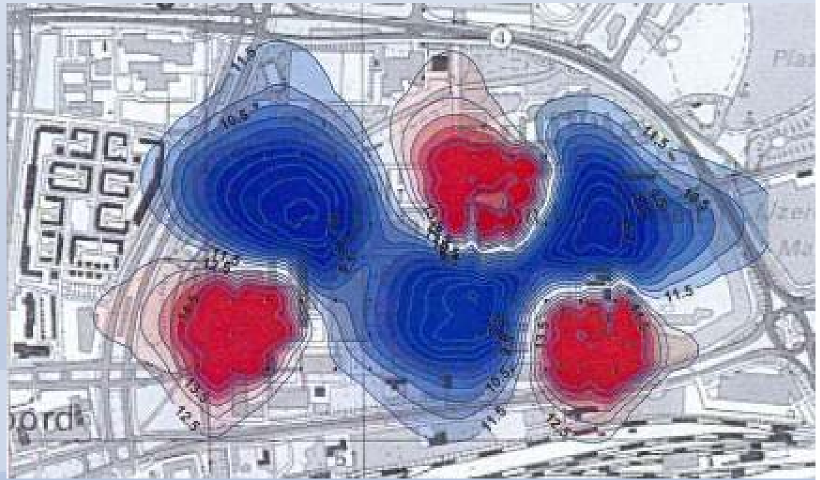
Phasing and underground heat mapping

Key areas to consider when planning a phased ATES scheme are:

- Opportunity cost; fitting in with other drivers
- Supply temperature requirements for existing buildings
- Thermal planning – location of heating and cooling loads and relation to well clusters; simulating Hydrothermal Contours
- Selection distribution process –pipes system and building connections
- Temperature & Pressure control





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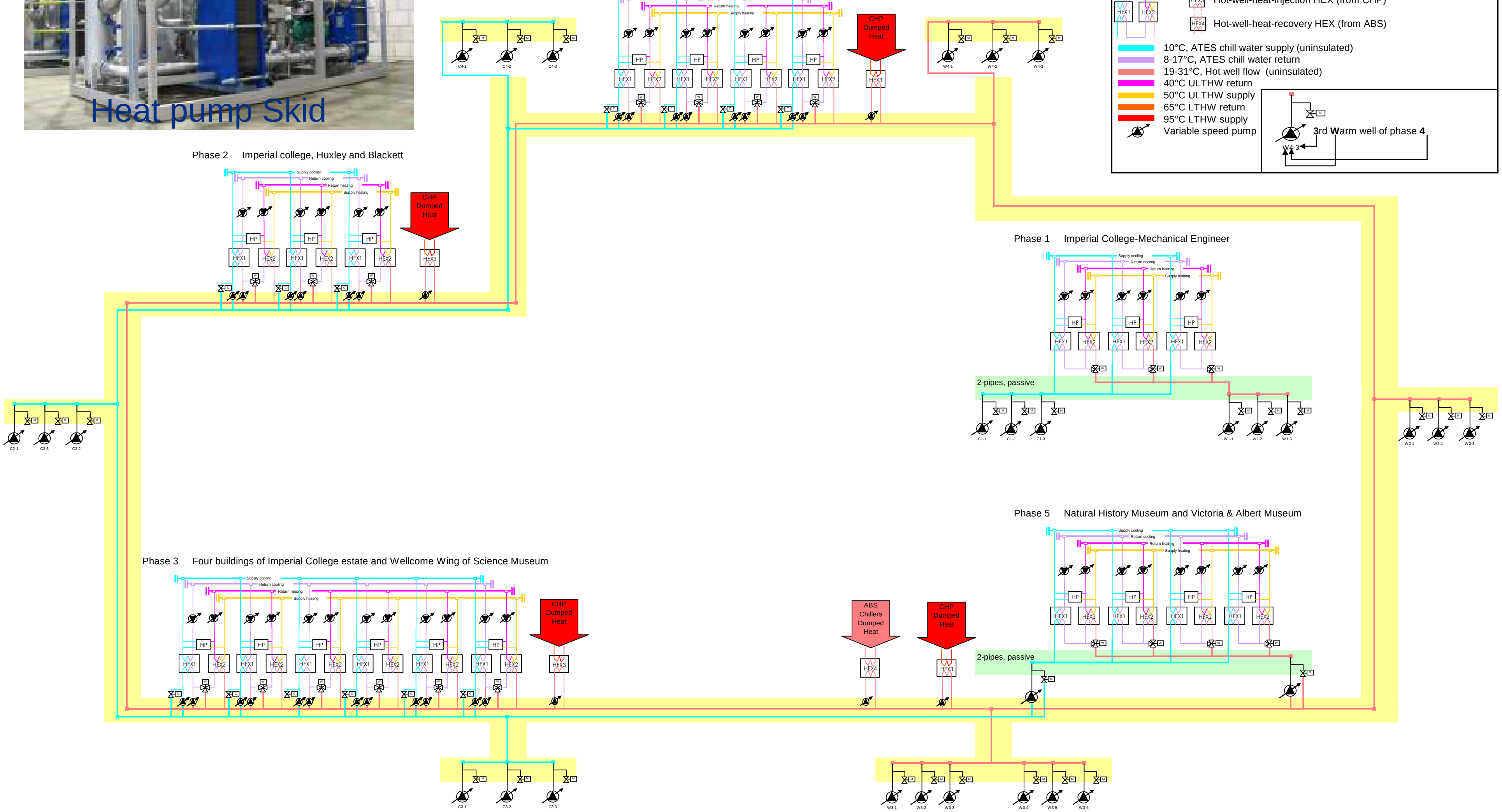
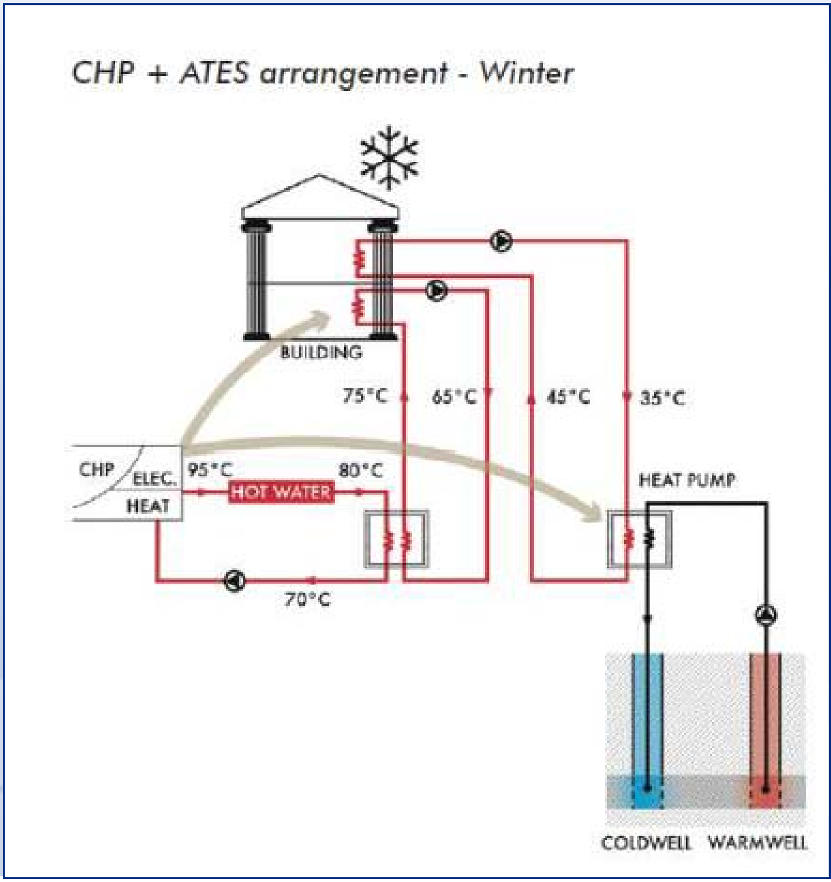
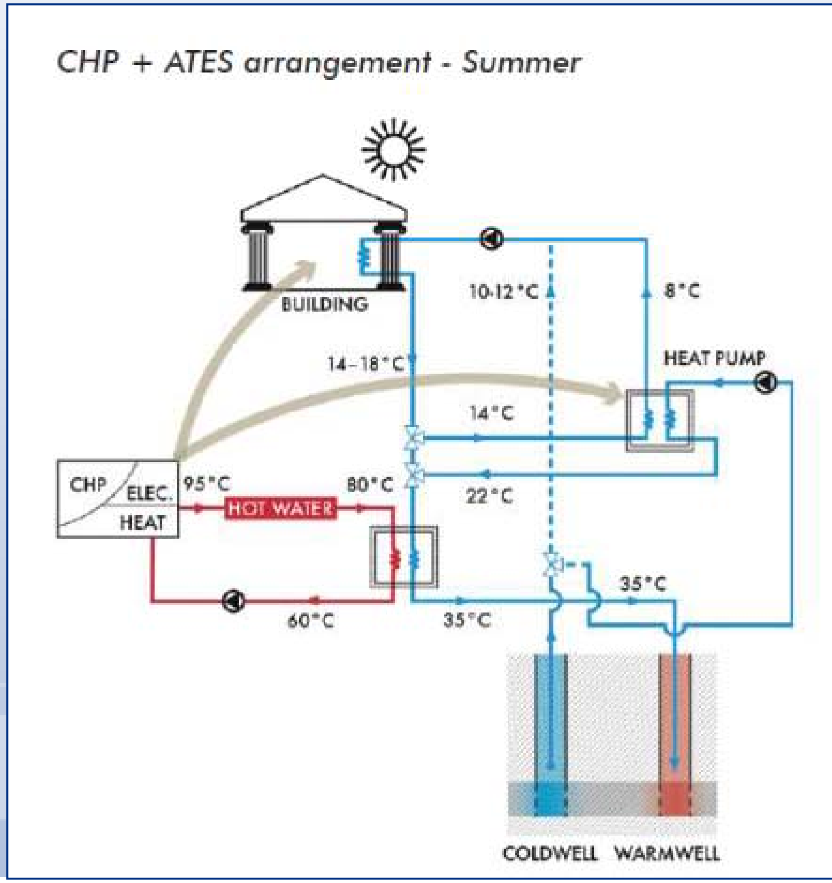
1851 CCRM - DISTRIBUTED HEAT PUMPS



ATES & CHP



CHP + ATES arrangement - Winter
BUILDING
75°C
65°C
45°C
35°C
CHP
ELEC.
HEAT
95°C
HOT WATER
80°C
70°C
HEAT PUMP
COLDWELL
WARMWELL



CHP + ATES arrangement - Summer
BUILDING
10-12°C
8°C
14-18°C
HEAT PUMP
14°C
CHP
ELEC.
HEAT
95°C
HOT WATER
80°C
22°C
35°C
60°C
35°C
COLDWELL
WARMWELL

Urban Heat Planning

Buildings with a net annual cooling demand can act as a heat source for existing buildings with a net annual heat demand

They can collect heat through passive solar gain, human activity or waste heat from essential commercial activity

This heat can be stored using ATES to be used when required

The older buildings reject heat from the ATES system, recharging the cold store for the following summer, but the heat passes through the buildings on the way out.

Moving Forward

Preliminary results of the 1851 commission research project indicate carbon dioxide emissions reductions of over 30%.

The study will be complete at the end of 2010.

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