Ground source energy

Enhanced ground energy storage

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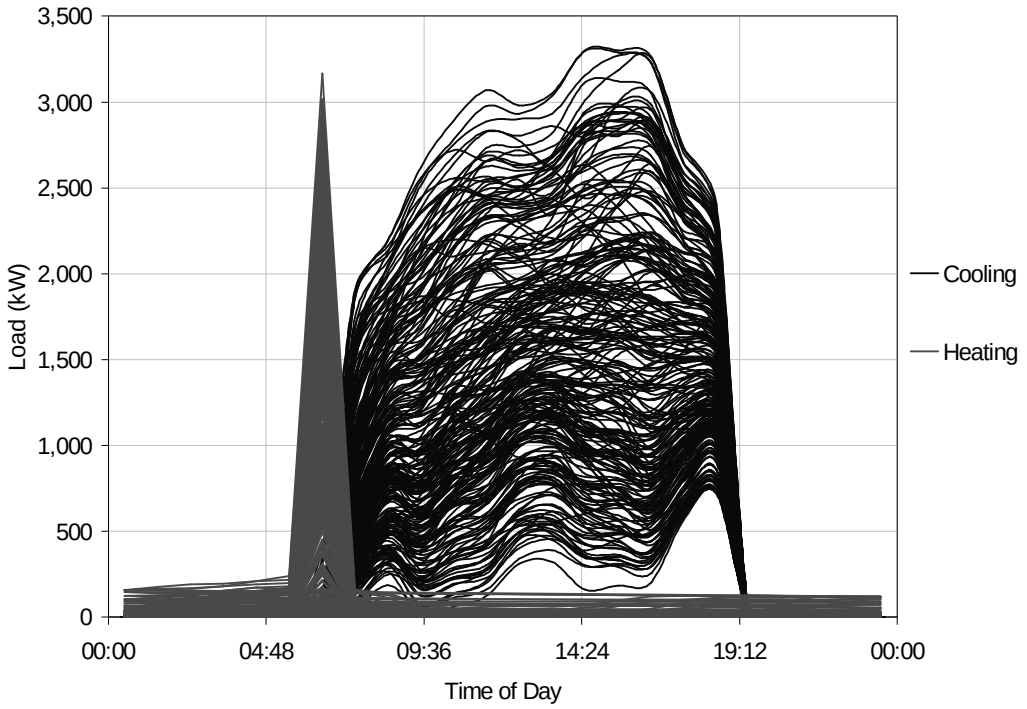
- Urban buildings with small footprints
  - Building demands
  - Thermal breakthrough
  - Ground storage capacity
- Methods of utilising the full storage capacity of the ground
  - Heat storage
  - ‘Coolth’ storage
- Renewable energy on site?

Background

- Arup ground energy projects
  - Large urban developments
  - Planning restrictions have driven the demand in central London

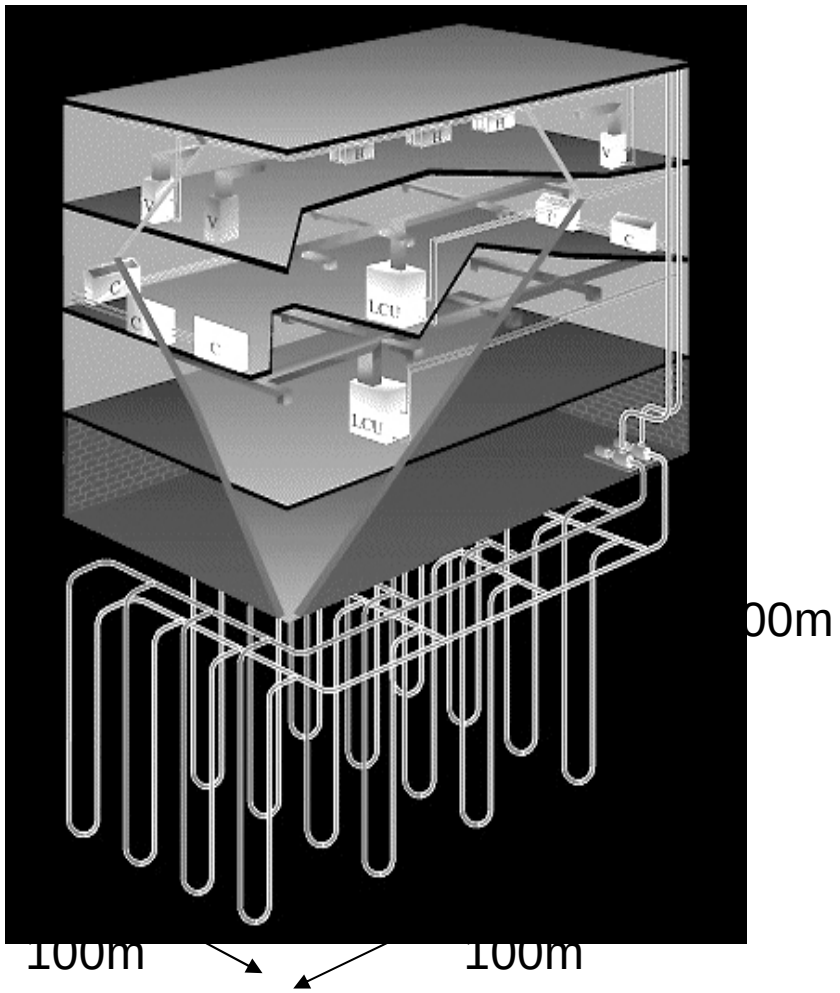
•Tall buildings / small footprint, high total energy demands

•Demands are predominantly for cooling (even in January!)

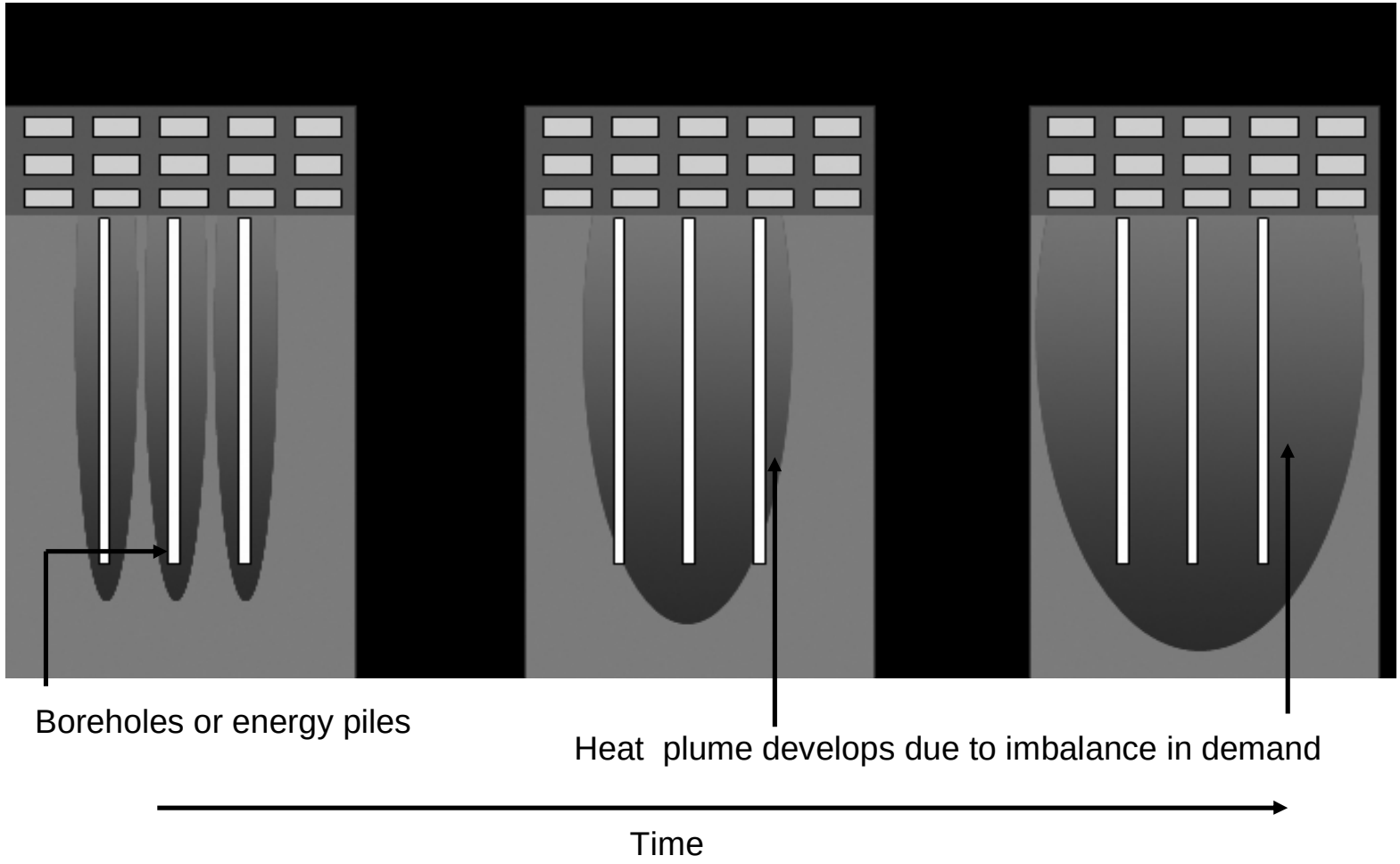


Typical closed loop building in an urban area

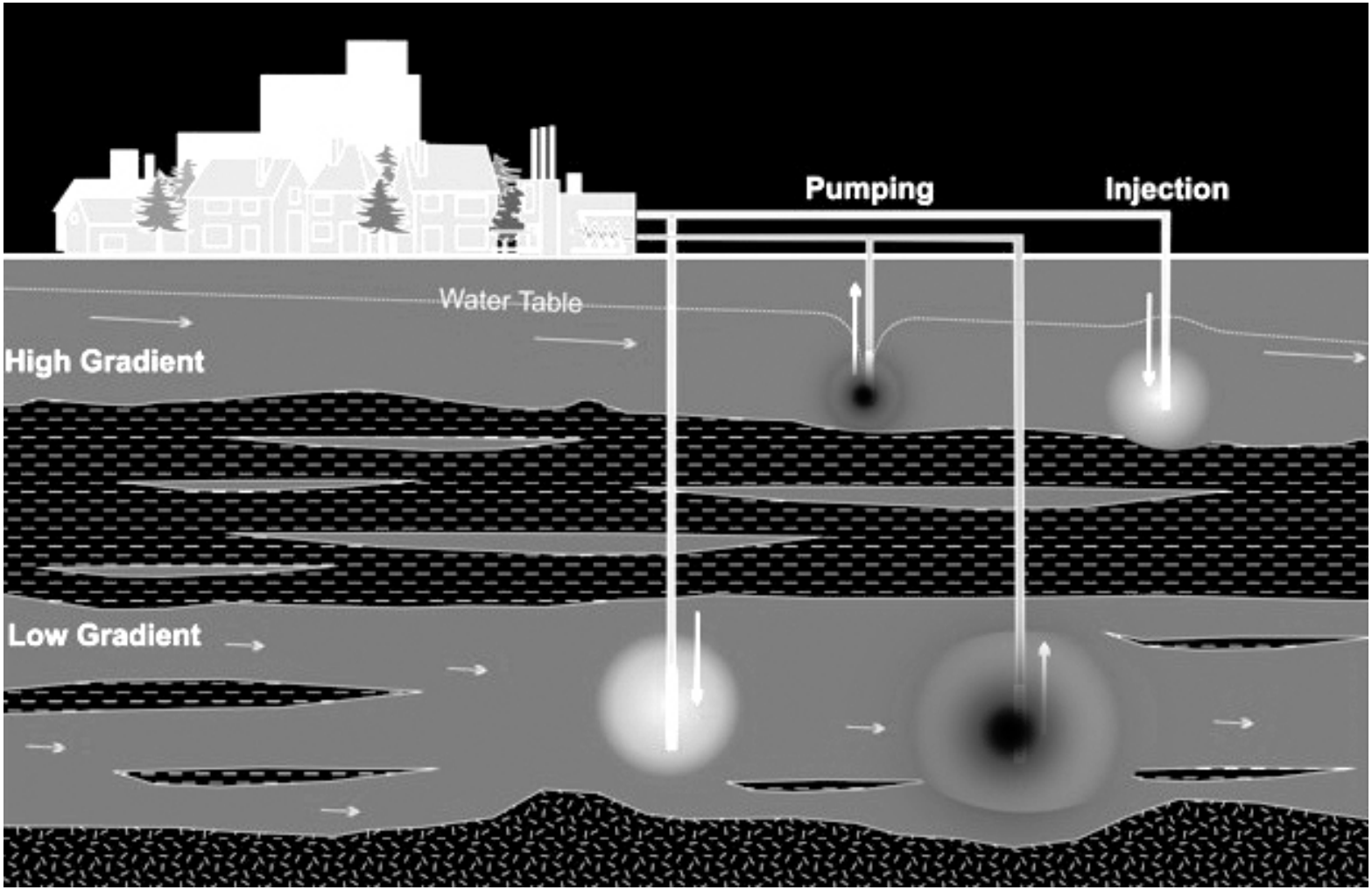
- Example
  - Site, 100m*100m*100m (depth)
  - Ground is effectively thermally isolated from the atmosphere by the building
  - Ground energy system is drawing on storage
  - Approximately 1,000 MWh per year for every 1°C change in the ground
  - Example profile (3,500 MWh annual imbalance!)



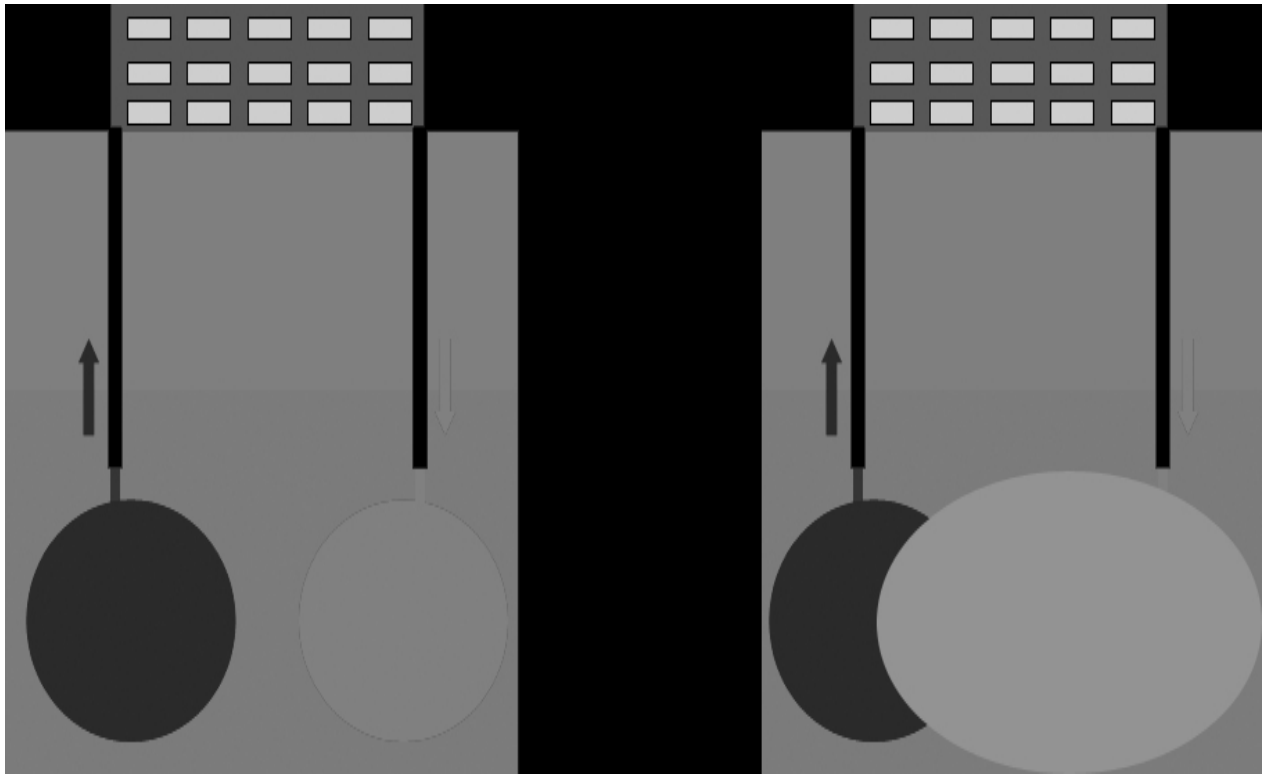
Closed systems – long term imbalance



Ground energy - open systems

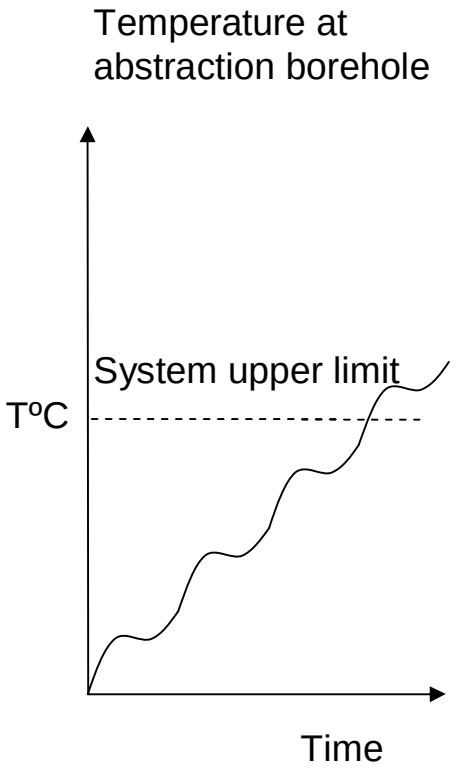


Open system – long term and short term imbalance



Heat plume migrates to abstraction well

Time



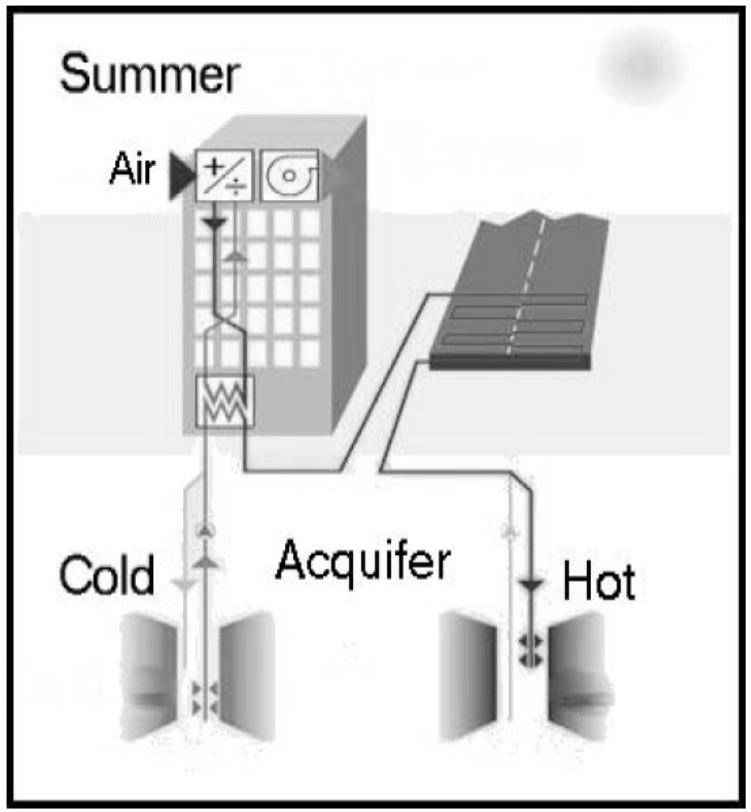
Solutions

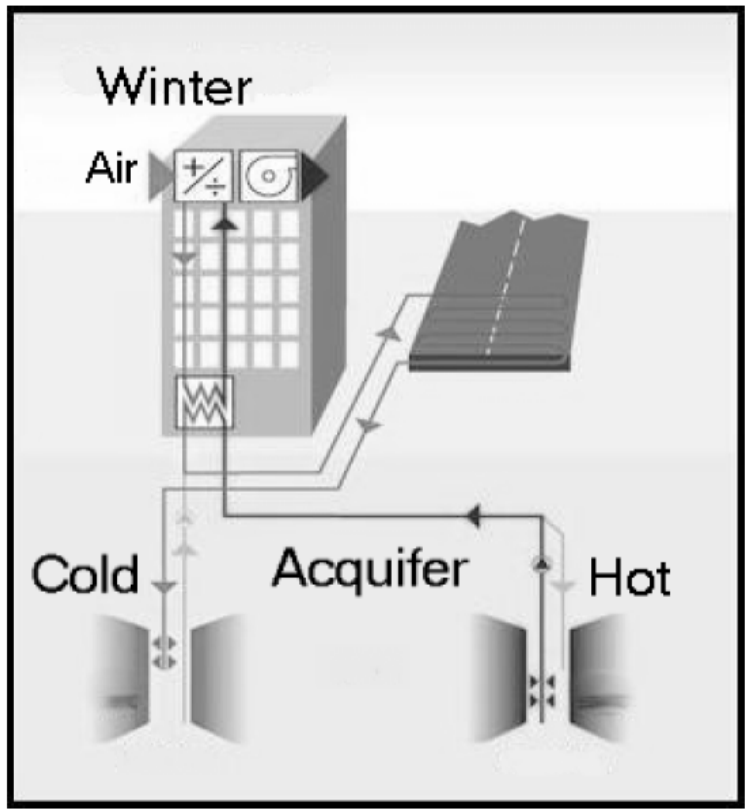
- Rebalance the energy demands of the building – often not possible
- Alter the energy balance of the ground
  - Source nearby buildings with heating or cooling requirements
  - Provide an alternative method of heating or cooling the ground to compensate for energy deficits
- Increase the energy stored in the ground

Replenishment or addition of heat

- Suited to residential buildings (normally a net annual heating demand).
- Principle methods of recharge are solar panels (solar asphalt is similar).
- Solar greenhouses – see later.
- Solar panels can provide more than the required deficit in the summer months.
- Heat boost?
  - Increase in COP of heat pump.
  - Possibility of direct heating?
- Heat recovery approximately 70%

Solar recharge principles

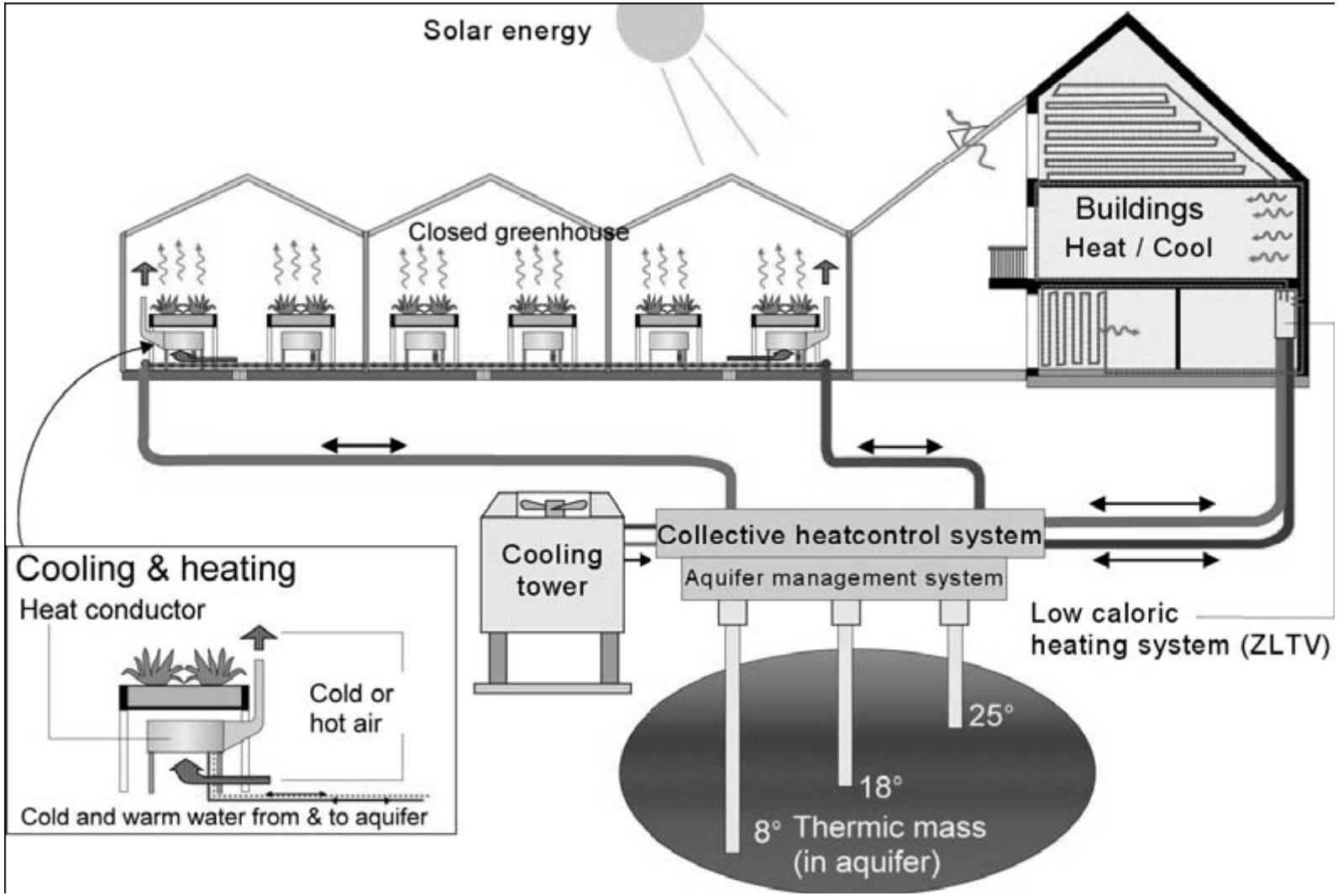




After Ooms technology

Solar recharge examples

Solar greenhouses principles



Solar greenhouses – the future in the UK?

- Existing systems in Holland
- Low transport footprint for vegetables
- Low cost heating for housing developments
- Renewable energy production on site?

Replenishment of cold

- Associated with office developments
- Principle methods of recharge are ‘Air Blasters’ or fountain based heat loss devices
  - Air blaster operate like reverse chillers. Cold air is taken from the atmosphere during the winter, passed through the air blaster and injected into the ground
  - Fountains loose heat to the surrounding atmosphere, linked to a heat exchanger and cold transferred to the ground
- Large quantities of available cold in the UK climate!

Conclusions

- Ground source energy can be seen as a viable method of meeting sustainable energy demands / planning restrictions
- Sustainable? Need to achieve an energy balance with the ground. How? Cold or heat storage methods.
- The future? Meet 20% of demand from renewables? Thermal greenhouses coupled with district heating?