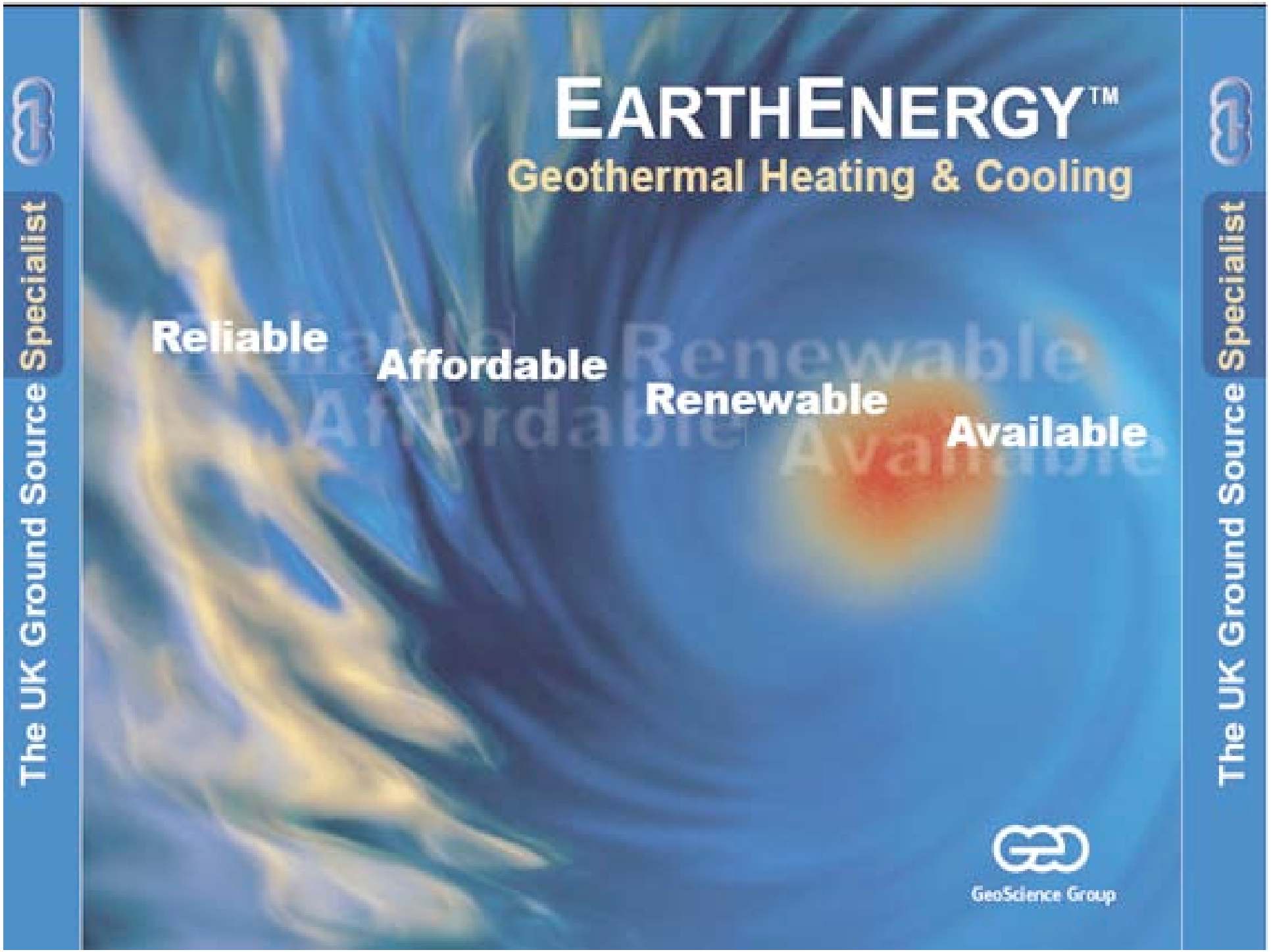
EARTHENERGY™
Geothermal Heating & Cooling
Reliable
Affordable
Renewable
Available
GeoScience Group
The UK Ground Source Specialist
The UK Ground Source Specialist

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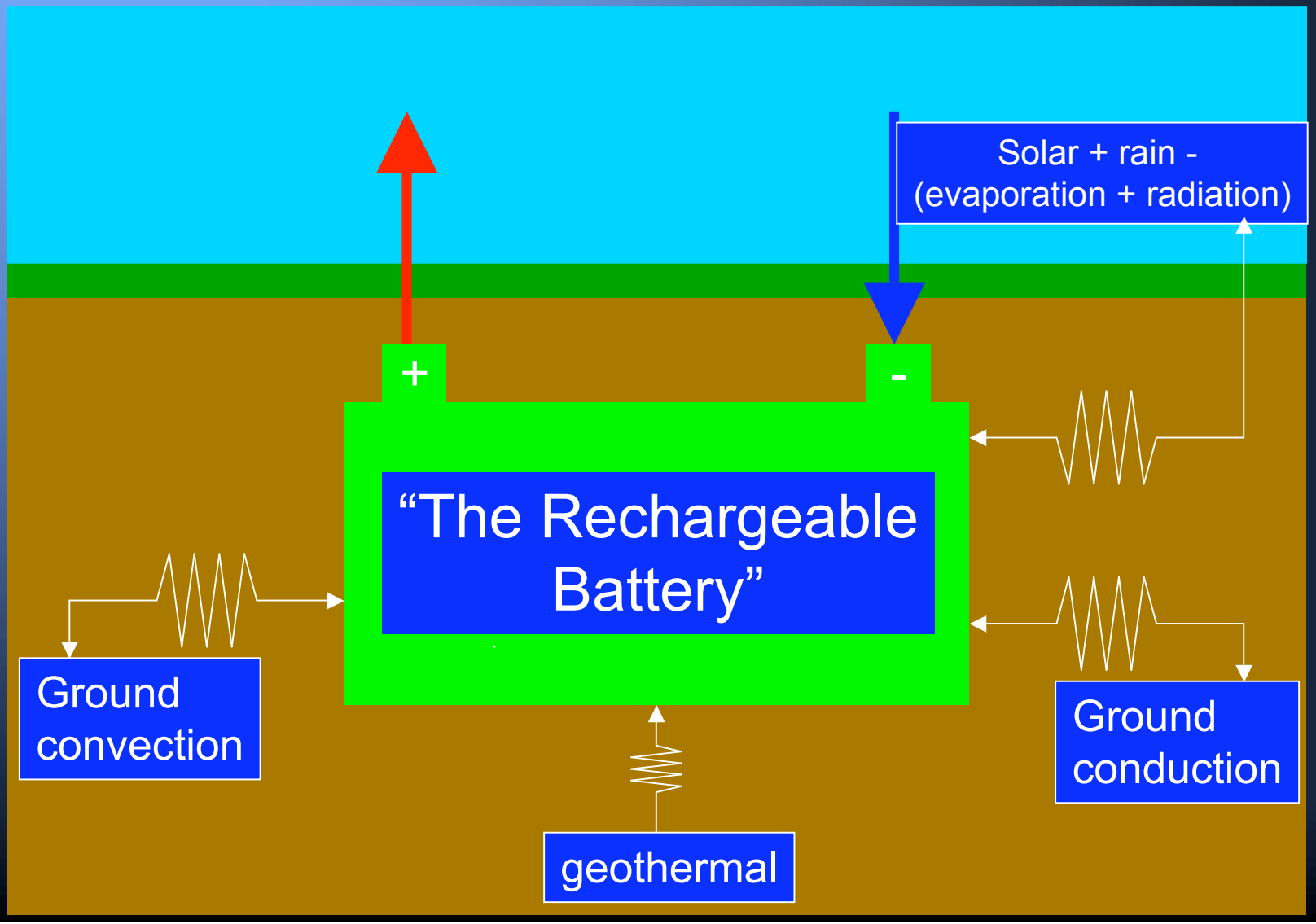
Ground Source Energy



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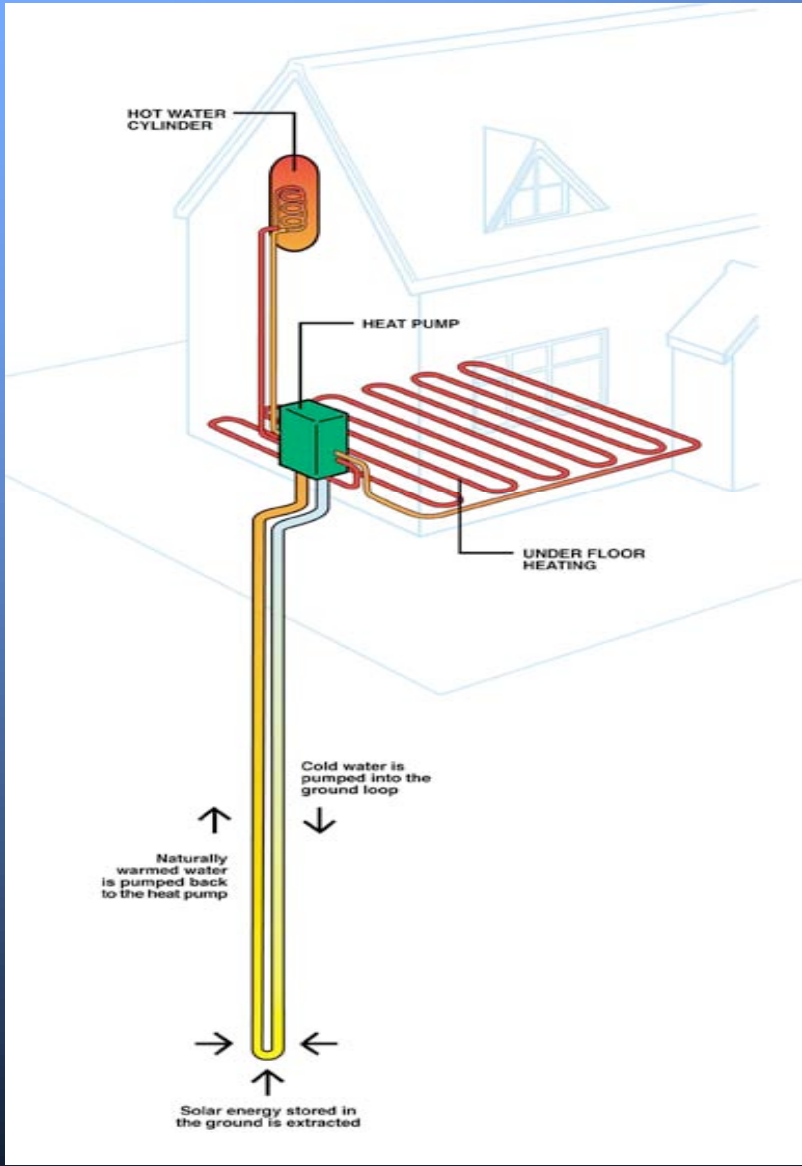

- A pipe is inserted into the ground that is designed to extract the thermal energy naturally stored there. A heat pump concentrates this heat and transfers it through the domestic heating system in the same way as a conventional boiler providing both central heating and hot water.

- It is so efficient, it can provide the heat needed for a well insulated home at around 50% of the cost of a conventional oil fired boiler system

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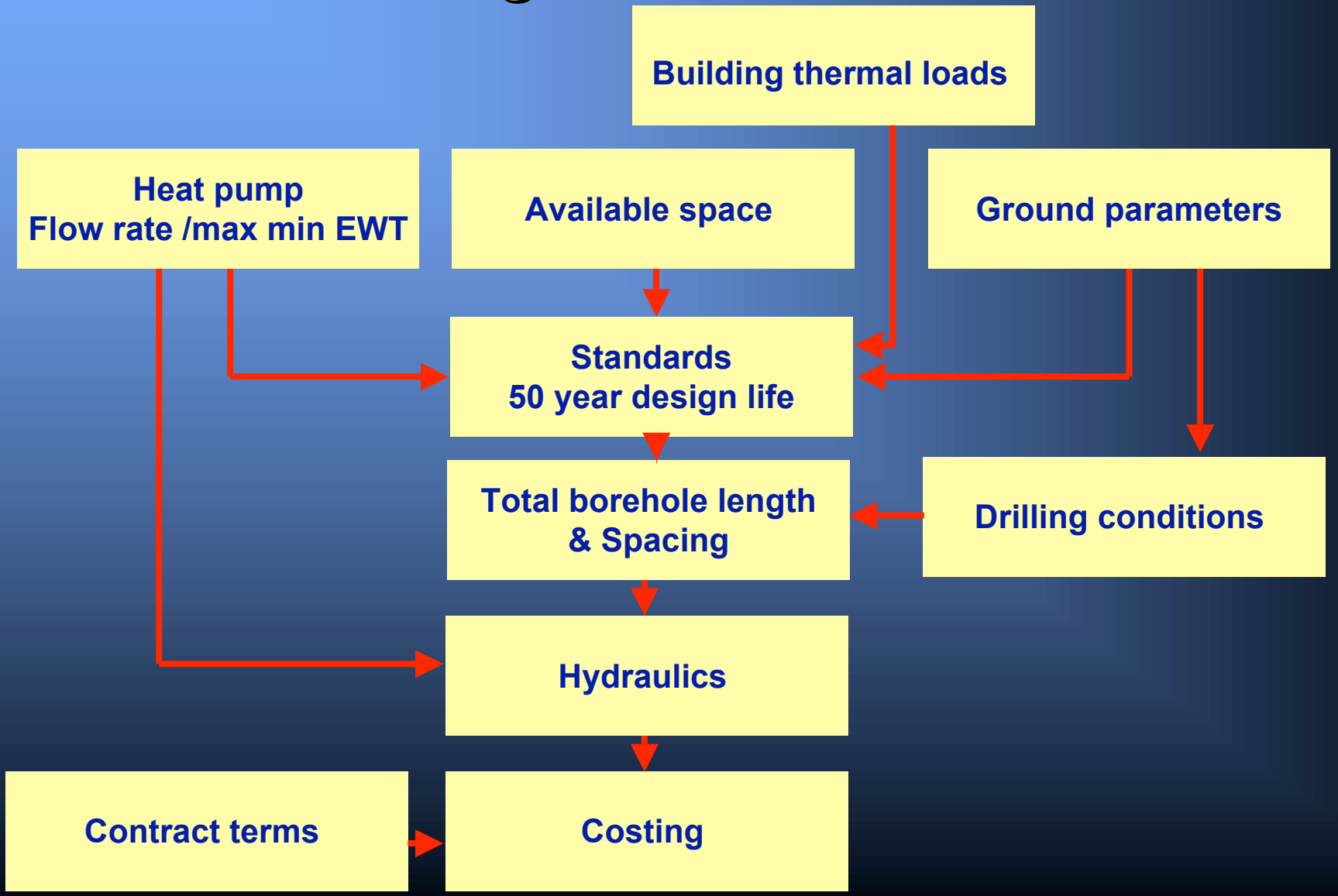
Design Considerations



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Design Standards ?

- Small systems
  - BS EN 15450
  - VDI 4640
- Commercial Scale
  - IGSHPA - Design and installation standards
  - Canadian Design & Installation C447-94
- Installation
  - Swiss Drilling Standard
  - French Drilling standard

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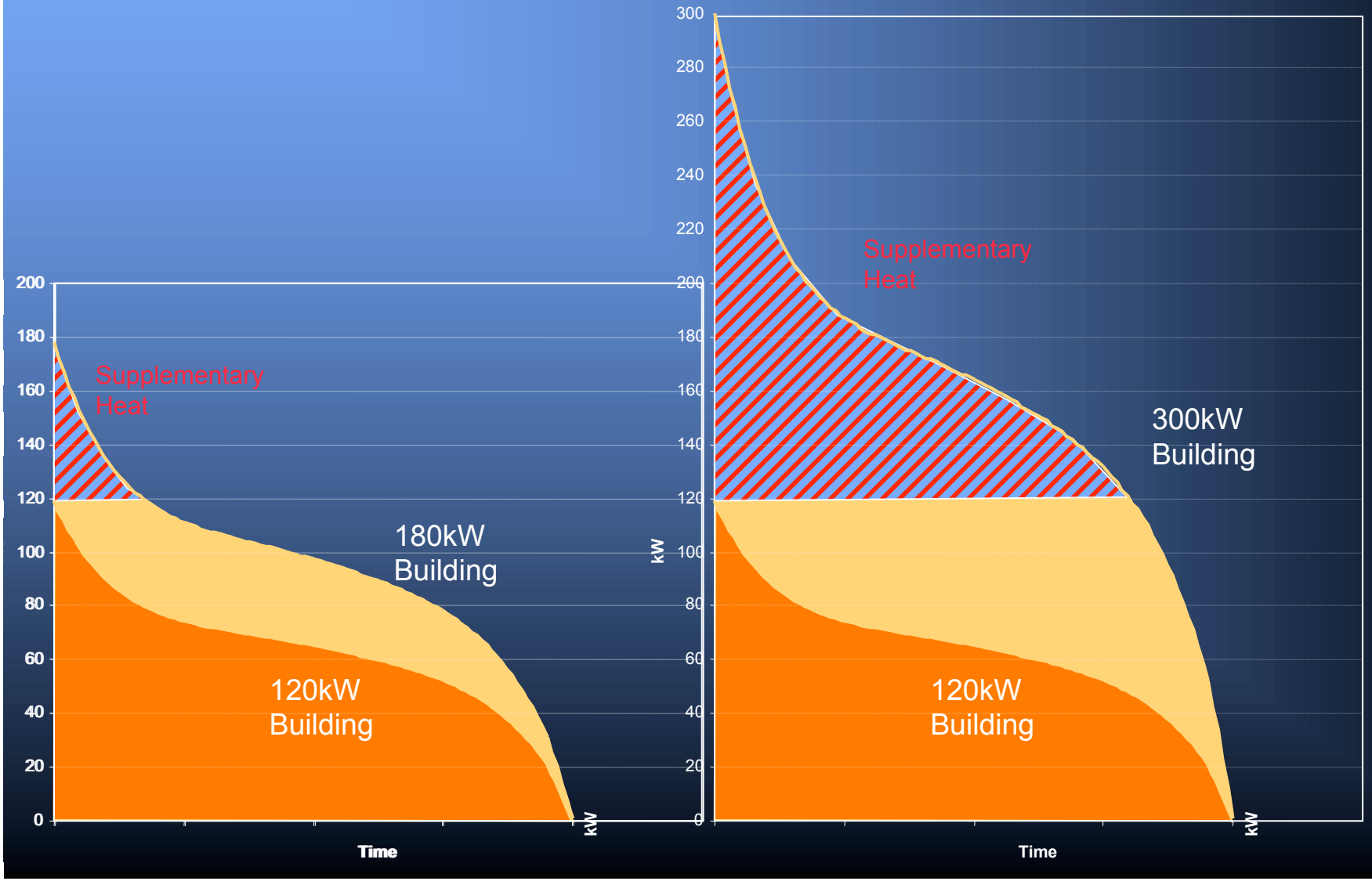
Design Considerations



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Social Housing | Multiple Housing | Bespoke Houses | Public Sector | Commercial | Offices

calorex

Compact

<5kW

Dimplex

Small / Integrated – Mid Range

5kW – 100kW

VIESMANN

Mid Range

12kW – 80kW

COSFI CIAT

Heating and Cooling

Up to 1MW

COLT CLIMATEMASTER

Console / Cassette

1.5kW – 4kW

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Coefficient of Performance

- CoP affected by:
  - Heat source temperature
  - Heating water temperature (flow/return temperatures)
  - Additional supplementary heating
- CoP continually varies
  - A spot measure of performance at optimal conditions
  - Much like car mpg figures

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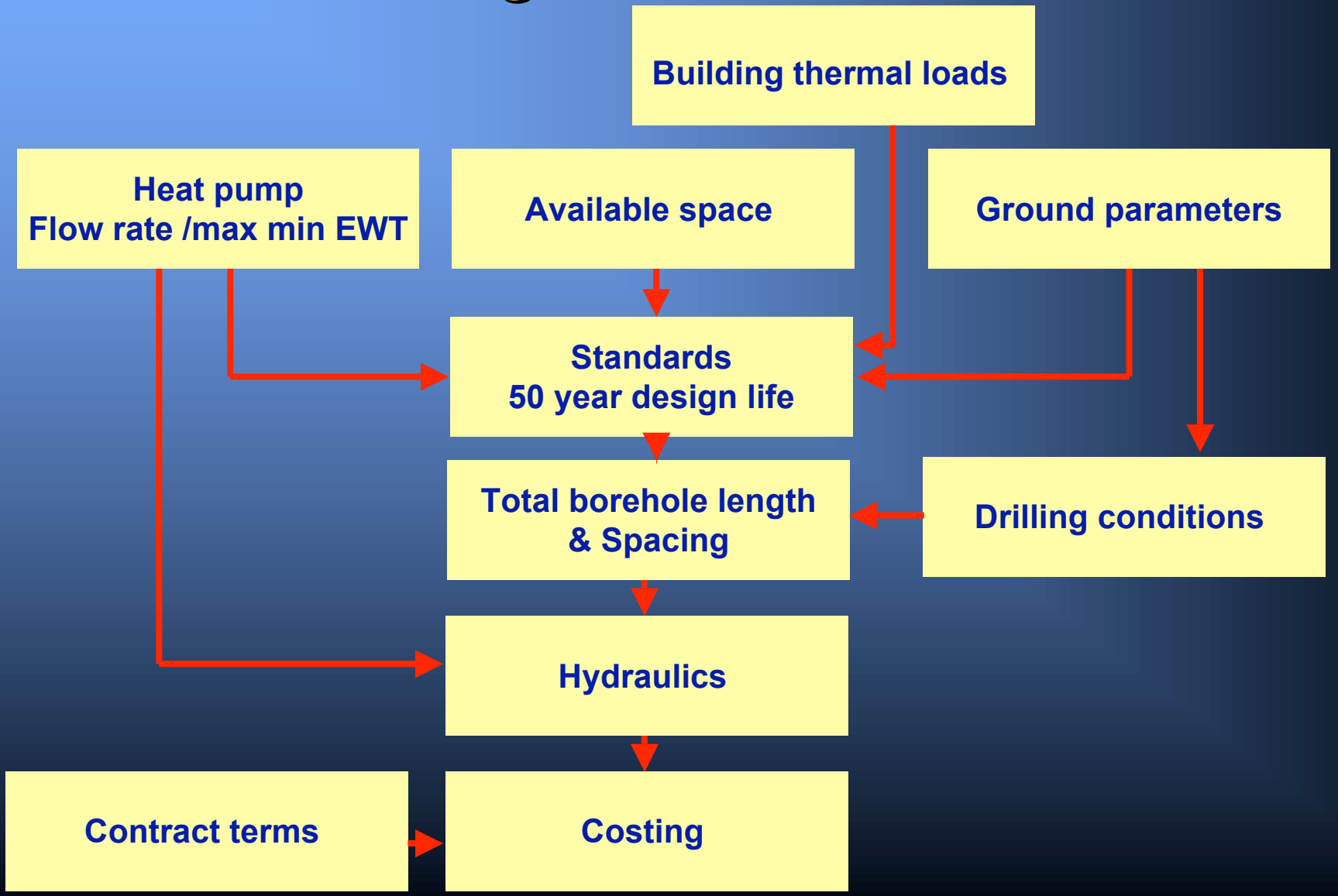
Design Considerations



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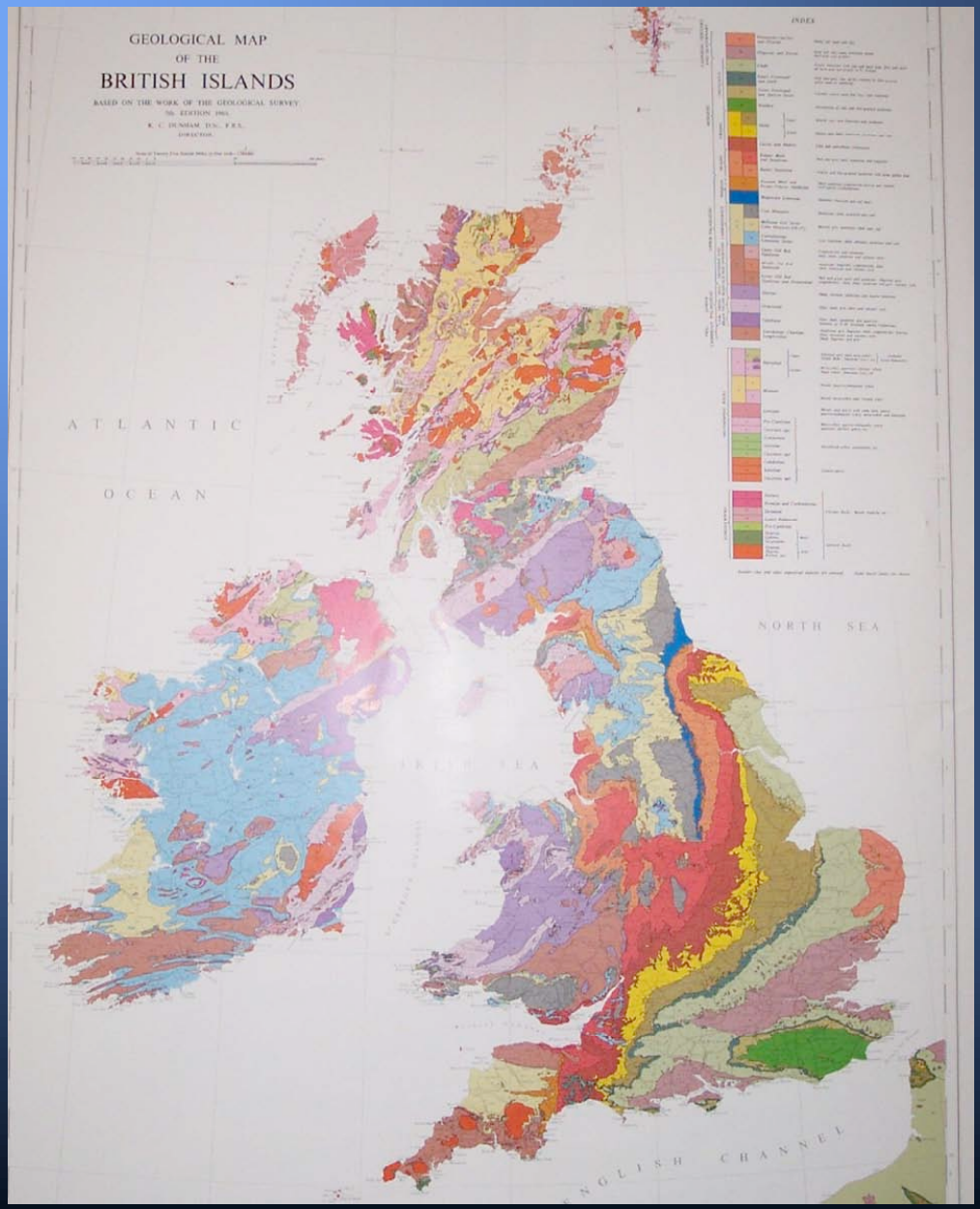

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Ground type	Specific heat extraction rate	
	operation period 1 800 h	operation period 2 400 h
General guidance values:		
poor underground (dry sediment and λ < 1,5 W/(m K)	25 W/m	20 W/m
normal underground and water-saturated sediment 1,5 < λ < 3,0 W/(m K)	60 W/m	50 W/m
consolidated rock with high thermal conductivity λ > 3,0 W/(m K)	84 W/m	70 W/m
Individual ground types:		
dry gravel or sand	< 25 W/m	< 20 W/m
gravel or sand saturated with water	65 to 80 W/m	55 to 65 W/m
gravel or sand and strong ground water flow	80 to 100 W/m	80 to 100 W/m
moist clay	35 to 50 W/m	30 to 40 W/m
massive limestone	55 to 70 W/m	45 to 60 W/m
sandstone	65 to 80 W/m	55 to 65 W/m
siliceous magmatite (e.g.granite)	65 to 85 W/m	55 to 70 W/m
basic magmatite (e.g. basalt)	40 to 65 W/m	35 to 55 W/m
diorite	70 to 85 W/m	60 to 70 W/m
NOTE values valid for heat pump systems with a heating output up to 30 kW		

For larger ground source heat pump systems, specific calculations using analytical solutions or numerical simulation methods are required.

Source: BS EN15450:2007 Heating systems in buildings – design of heat pump heating systems

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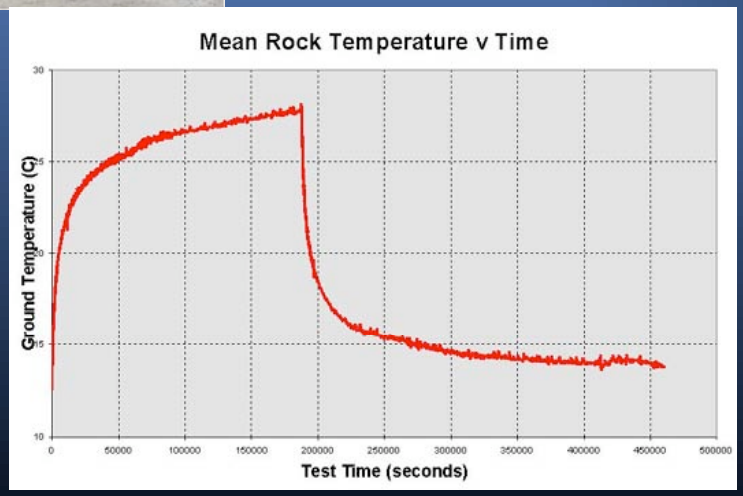
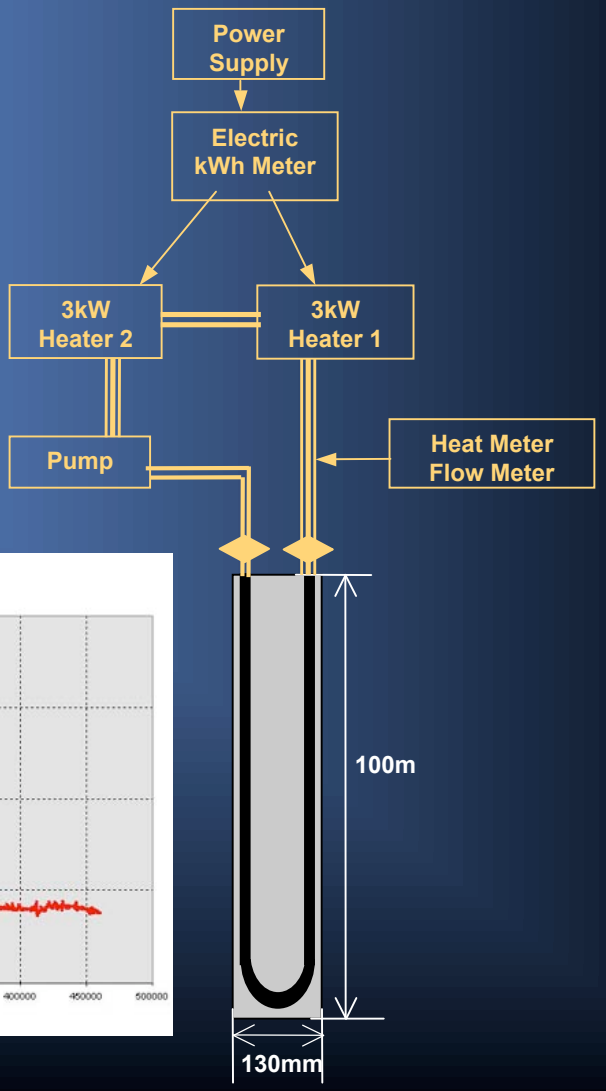
Thermal Conductivity Test





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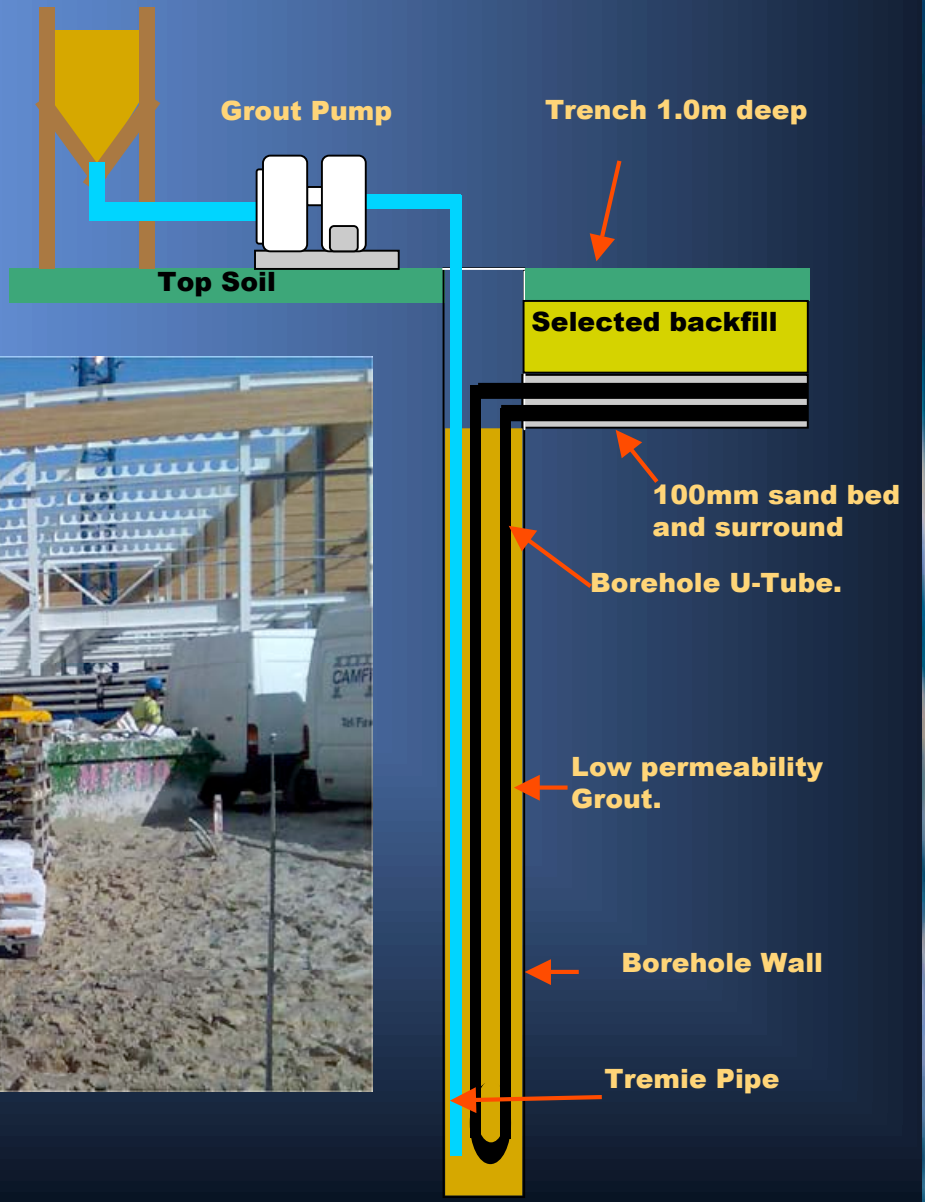

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Design tools

- Software :-
  - EED (v3)
  - GLHEPRO
  - GLD
  - CLGS
- Paper :-
  - IGSHPA - various + courses
  - ASHRAE - GSHPs for Commercial and Institutional Buildings (Kavanaugh + Rafferty)

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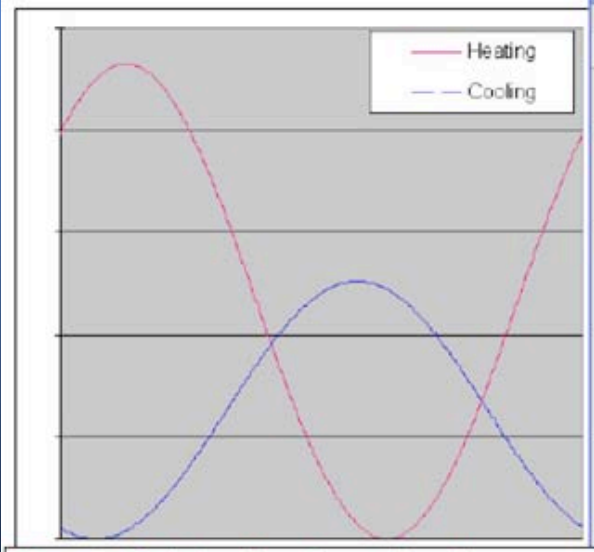
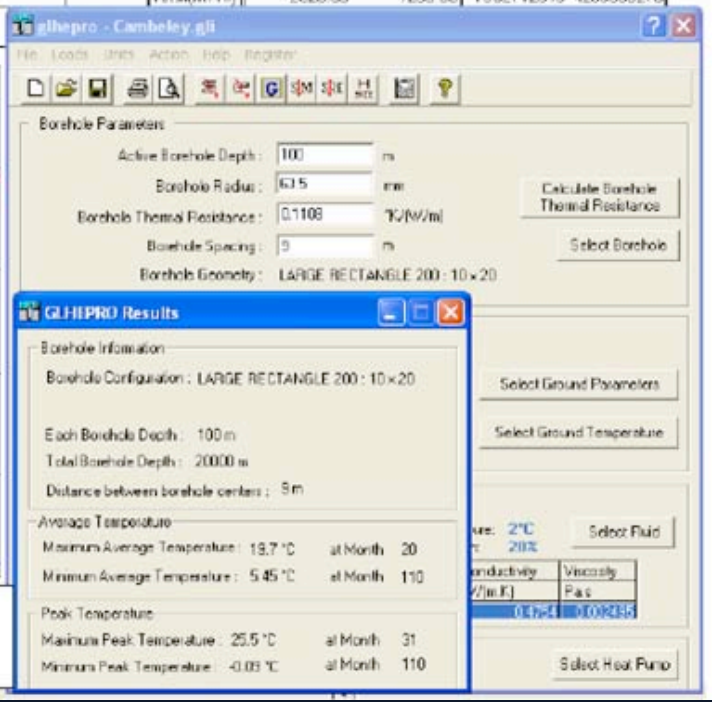
Design Considerations

Synthetic Load Generator			EarthEnergy Ltd 20/12/2007 15:31
Peak heating	2325 kW	Min heating	0 kW
Peak Cooling	1260 kW	Min cooling	0 kW
No of heating hrs per day	8.6 hrs	Heating offset =	0.79
No of cooling hrs per day	8.6 hrs	Cooling offset=	-2.00
Heating days per week	7.00	Carbon Heating	6 %
Cooling days per week	7.00	Carbon Cooling	4 %
Total htg=	2325.00 MWh	Total cooling =	1260.00 MWh
Htg hrs equiv	1000.00	Cool hrs equiv	1000.00

Month	Heating(kWh)	Cooling(kWh)	Heating Btu	Cooling Btu
January	364401	2805	1243306803	9571891
February	366821	6886	1248160339	23493591
March	366465	38158	1250347607	130193088
April	288932	84812	978988012	289371149
May	199472	142357	680582024	485710046
June	98384	181542	335678117	619405067
July	29539	211010	100795603	719946881
August	2322	206155	7922092	703378605
September	27238	168847	92933017	576090386
October	99555	124528	339672411	424879195
November	190611	67625	650349526	230729520
December	284262	25275	1003986992	86236060
Totals(MWh)	2325.00	1260.00	7932712543	4299003270



Case 3; Optimised heating and cooling loads.



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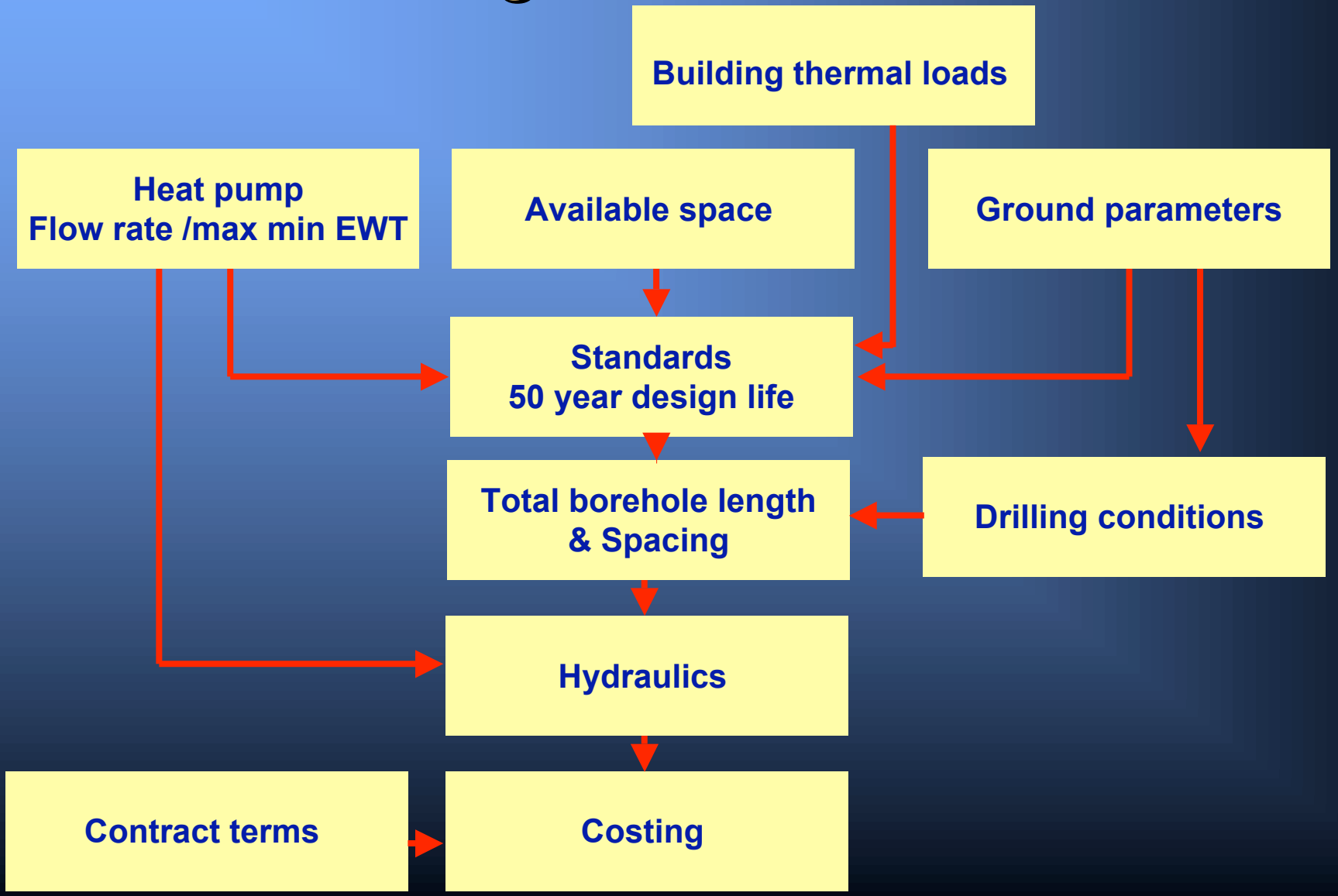
Design Considerations



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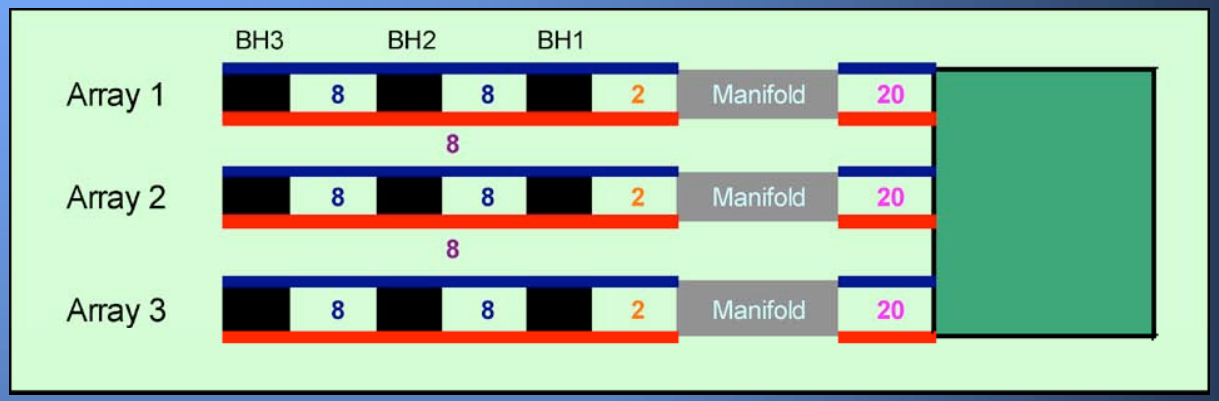

Thermal Performance

Laminar/Turbulent Flow

Hydraulics/Frictional Losses

Boreholes:	Number & Spacing Depth & u-tube dia Number of Arrays
Connecting pipes:	Lengths & Diameters
Header pipes:	Lengths & Diameters
Heat Pump:	Capacity & Run Hours Flow Rate
Circulation Pump	Size

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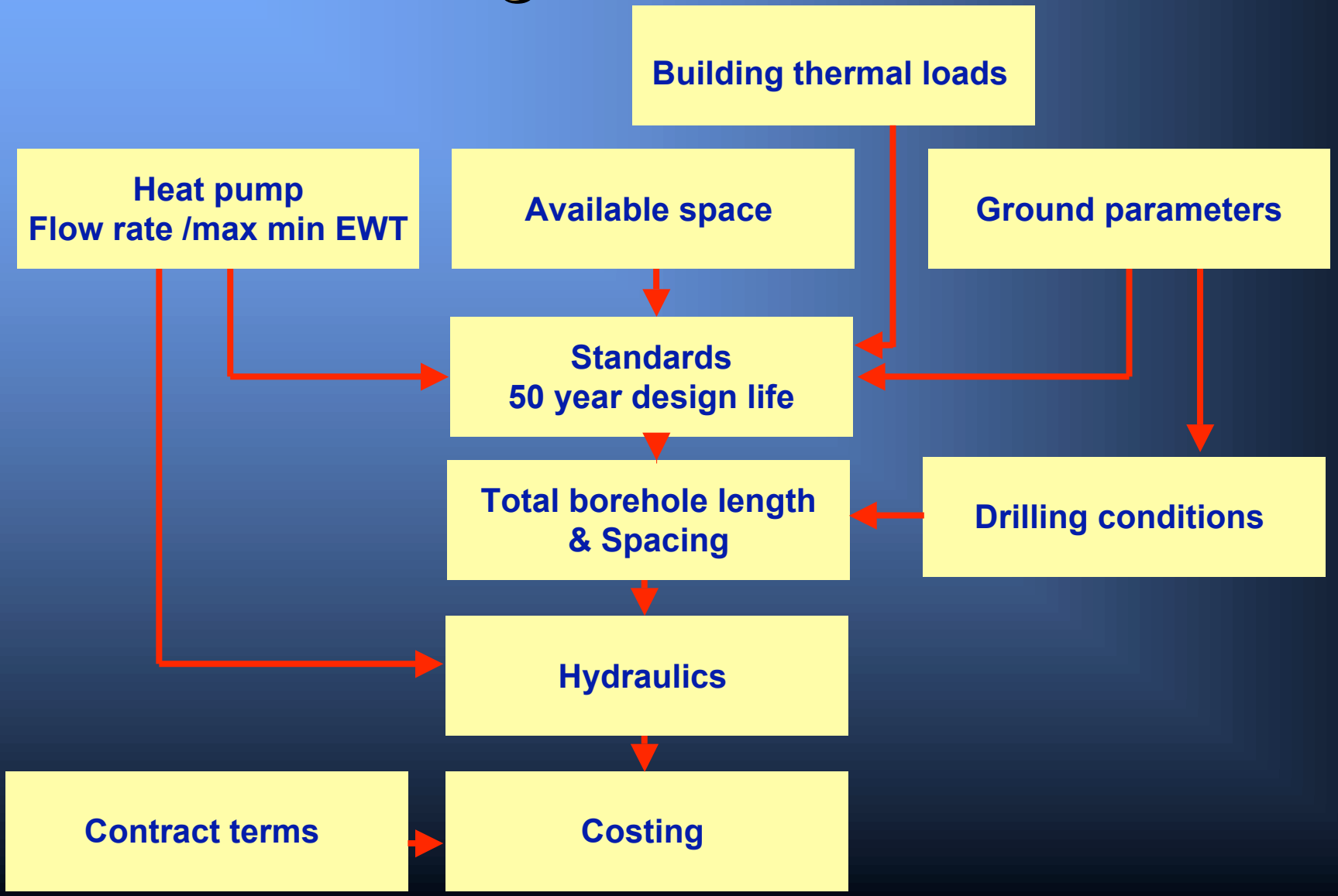

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Contract Procurement

Feasibility	Optioneering	Building Services Consultant
Outline Design	Thermal Response Testing Building requirements Ground Loop Assessment	
Tender	Finalisation of costs Contract Agreement	**Contract Award**
Detail Design	Thermal/Hydraulic Design Plant Room Design	Contractor
Construction	Drilling/Trenching/Pipework Plant Room Installation Controls	
Commissioning	Flushing & Purging Testing Commissioning	

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Case study – Leisure Centre

- 10% On-site Renewable Requirement
- Reverse Cycle Ciat Heat Pump
  - Heating 200kW 422MWh/yr
  - Cooling 165kW 108MWh/yr
- 49 Boreholes 90m deep – 7 x 7 grid