REDAB
UK LTD

Rev 101109

Preliminary
6 Orsman Road London
Energy Centre (Bore Hole Water & Heat Pump)
Low Energy Cooling and Heating System

Computer Generated Image of 6 Orsman Road, London, N1

London, ... 2009.

Tim Edwards / CG Pettersson.

Introduction

Redsat Orsman Ltd commissioned Dsa Engineering to provide a report for an energy efficient cooling strategy. A report was duly prepared and issued on the 17th April 2009.

This report recommended a geotechnical cooling system and is the subject of this study prepared by Redab UK Ltd following discussions with Redsat Orsman Ltd on the 30th April 2009.

Only the office space cooling has been considered in this report the restaurant area will be the subject of a separate analysis.

General Observations

A detailed description of the building planned is contained in the Redsat Orsman Ltd planning documentation.

Redab UK Ltd have approached the review of Dsa's proposals positively with some modifications to reduce performance risk and to take into account the nature of the cooling load and requirements for heating in the winter.

Analysis of the load, based upon our experience of other Redab developments for instance at 77-79 Farringdon Road which is of a similar size to Orsman Road, shows generally an average sustained cooling load of around 165Kw with occasional peaks. The cooling load figures are based upon the data for 77-79 Farringdon Road, however since Orsman Road will be a new build with high construction specification, an overall reduction in the load of around 20% is expected because transmission will be lower. Initial calculations have been carried out and are included in this report.

Recommended System Configuration

Redab UK Ltd are proposing the following configuration of the system, which is illustrated on the line diagram number 20910/M/1B attached to this report and which it is considered provides a very energy efficient solution, but at a significant capital cost but offset by the expected energy cost savings.

The system will use a geotechnical source both for cooling and heating for the normal average load conditions.

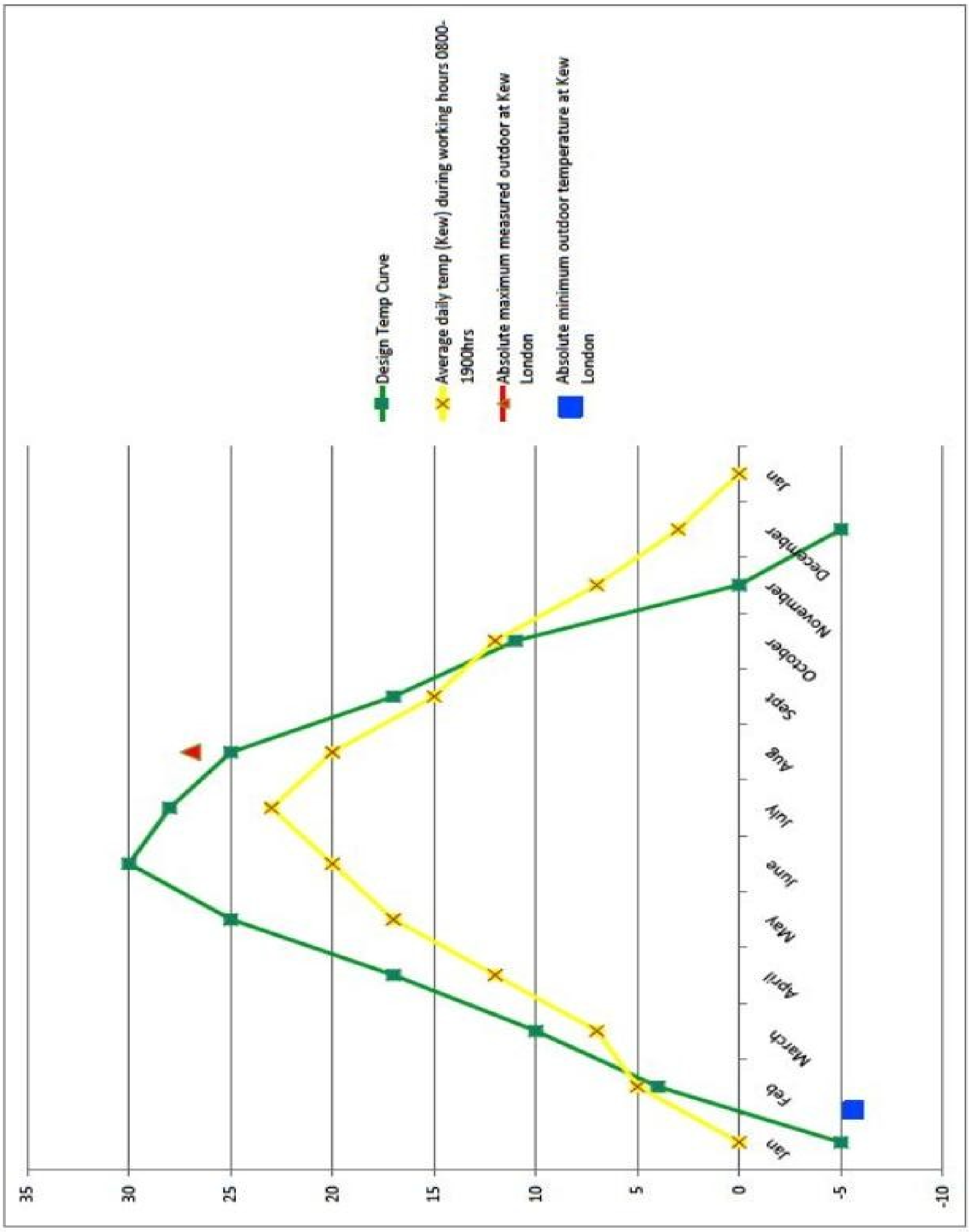
Design Criteria

The figures below are used in the energy analysis.

Internal Summer Room Conditions	22°C ± 1°C dry bulb
External Summer Ambient Condition	30°C dry bulb
	20°C wet bulb
Internal Winter Room Conditions	20°C ± 1°C dry bulb
External Winter Ambient Conditions	-5°C dry bulb
Exposure	Normal
Occupancy	1 person per $8m^2$
Outdoor air	12 L/S per person
Air quality sensor set point in return air	750 ppm
Office Space Lighting Levels	Max at workplace 400 Lux Min 250 Lux
Landlord Area Lighting Levels	100-150 LUX
Domestic hot water	55°C max
Borehole water temperature in ground	12° C min

Outdoor temperatures from weather station at Kew London, presents all real temperatures as an average for the period of 1953-1983 showing maximum and minimum temperature.

Outdoor temperature on Clear Days at Kew London.

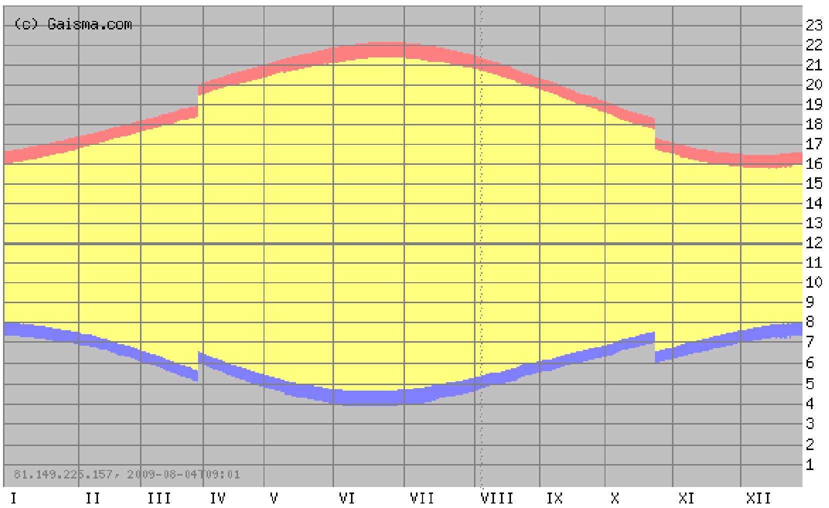


London, United Kingdom - Sunrise, sunset, dawn and dusk times, table

Date	Sunrise	Sunset	Length	Change	Dawn	Dusk	Length	Change
Today	*05:29*	*20:43*	15:14		*04:49*	*21:23*	16:34	
+1 day	*05:30*	*20:42*	15:12	00:02 shorter	*04:50*	*21:21*	16:31	00:03 shorter
+1 week	*05:40*	*20:31*	14:51	00:23 shorter	*05:01*	*21:09*	16:08	00:26 shorter
+2 weeks	*05:51*	*20:17*	14:26	00:48 shorter	*05:14*	*20:54*	15:40	00:54 shorter
+1 month	*06:16*	*19:42*	13:26	01:48 shorter	*05:41*	*20:17*	14:36	01:58 shorter
+2 months	*07:04*	*18:33*	11:29	03:45 shorter	*06:31*	*19:07*	12:36	03:58 shorter
+3 months	06:56	16:31	9:35	05:39 shorter	06:20	17:07	10:47	05:47 shorter
+6 months	07:37	16:51	9:14	06:00 shorter	07:01	17:28	10:27	06:07 shorter

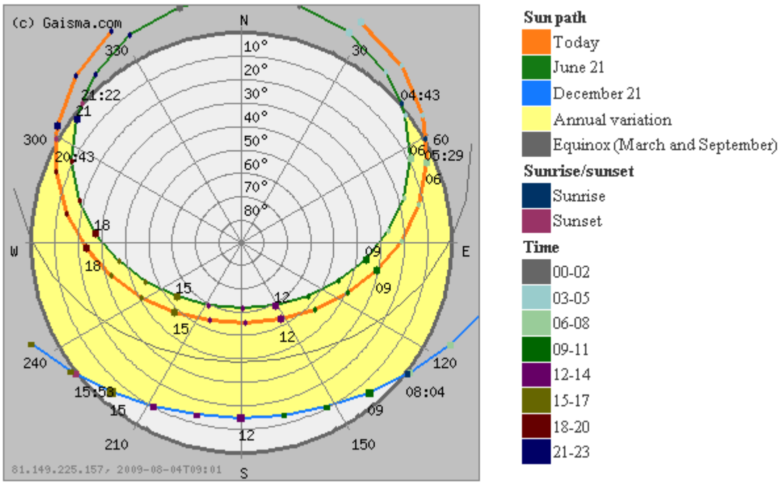
Notes: *Daylight saving time*, * = Next day. Change preferences.

London, United Kingdom - Sunrise, sunset, dawn and dusk times, graph



Darkness Dawn Sunshine Dusk **Notes:** How to read this graph? Change preferences.

London, United Kingdom - Sun path diagram



Notes: • = Daylight saving time, * = Next day. How to read this graph? Change preferences.

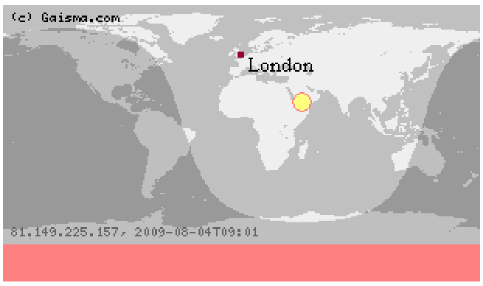
London, United Kingdom - Solar energy and surface meteorology

Variable	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Insolation, kWh/m²/day	0.64	1.25	2.33	3.54	4.59	4.86	4.83	4.13	2.81	1.66	0.82	0.49
Clearness, 0 - 1	0.30	0.34	0.39	0.42	0.44	0.43	0.44	0.44	0.41	0.37	0.32	0.28
Temperature, °C	4.44	4.50	6.39	8.28	11.90	15.22	18.00	18.28	15.51	11.95	7.66	5.37
Wind speed, m/s	8.44	7.85	7.90	6.73	6.18	5.80	5.82	5.90	6.76	7.41	7.85	8.18
Precipitation, mm	55	38	49	47	52	52	49	56	55	58	59	59
Wet days, d	16.0	12.0	14.3	13.5	13.1	10.8	10.4	11.4	11.2	12.5	14.8	14.3

These data were obtained from the NASA Langley Research Center Atmospheric Science Data Center; New et al. 2002
Notes: Help. Change preferences.

London, United Kingdom - Basic information

Latitude: +51.52 (51°31'12"N)
Longitude: -0.1 (0°06'00"W)
Time zone: UTC+0 hours
Local time: 10:08:29
Country: United Kingdom
Continent: Europe
Sub-region: Northern Europe
Distance: ~2.5 km (from your IP)
Altitude: ~40 m
Change preferences.



Winter

Office Floor 1 – 5 (GF Canal Side separate - restaurant)

Estimated transmission loss	17.123 watt
Followed up 77-79 Farringdon Road January – February 2008 ZA heaters used 3790 Kwh divided with 210 running hours becomes 18 Kw/h	
Orsman Road will be much better insulated compared to 77-79 Farringdon Road	
U-value: glass 0.8, walls U = 0.15	
Outdoor air during winter 270 people 10 L/S x 1.2 x 5°C Dt because rotating energy recovery unit approximately 90% efficient.	19.440 watt
Escape doors to residential will be closed and alarmed	
Main reception under floor heating (water) and over door heaters	20.000 watt
Total maximum heating load	(56.563 watt)
Using computer calculated method probably will reduce this figure to below	50.000 watt
Floor area 2,165 m² for Floor 1 – 5. GF separate – restaurant.	23 watt/m²

Summer

Estimated transmission load	24.766 watt
Estimated solar gain	55.817 watt
Estimated transmission and solar gains	80.583 watt

Internal heat

Office lighting 2,165 m² @ 8 watt/m² x 0.9	15.588 watt
People 270 people @ 60 watt/person x 0.66	10,692 watt
Office equipment 270 x 250 watt/station x 0.66	44.550 watt
Total internal heat	70.830 watt
Outdoor air 270 people @ 12 L/S and 5°C Dt (allowing for energy recovery unit)	19.440 watt
Total estimated cooling	170.853watt (79 watt /m²)

Cooling load analysis

Storage needed to minimise P1 run times.

Proposal

Run P1 during 7 hours off peak period only.

Total cooling load is as follows

Transmission and Solar	80 kW	
Internal gain	71 kW	
Outdoor air	19 kW	170 kW

Average load per day will be almost 100 kW. Generate this from boreholes and store.
Rule of thumb is 5 kW of cooling water per m^3 of storage.

100 kW of cooling energy will be stored to give 2/3 hours of capacity to reduce pump run time, and maintenance downtime which equates to 20 m^3 of stored water, say two 3.75 m high tanks.

$$\frac{20\ m^3}{2x3.75} = 2.67\ m^2\ section$$

$$Tank\ Diamitor\ x = \frac{\sqrt{2.67 \text{ x } 4}}{3.142}$$

$$= 1.84\ m\emptyset \text{ (Increased tank coverage)}$$

Say tanks 3.75 mh x 2 mØ x 2N°

Alternative 3.5 mh x 1.6 mØ x 3N°

Will be revised after borehole capacity test.

Summary

Total Cooling load is as follows

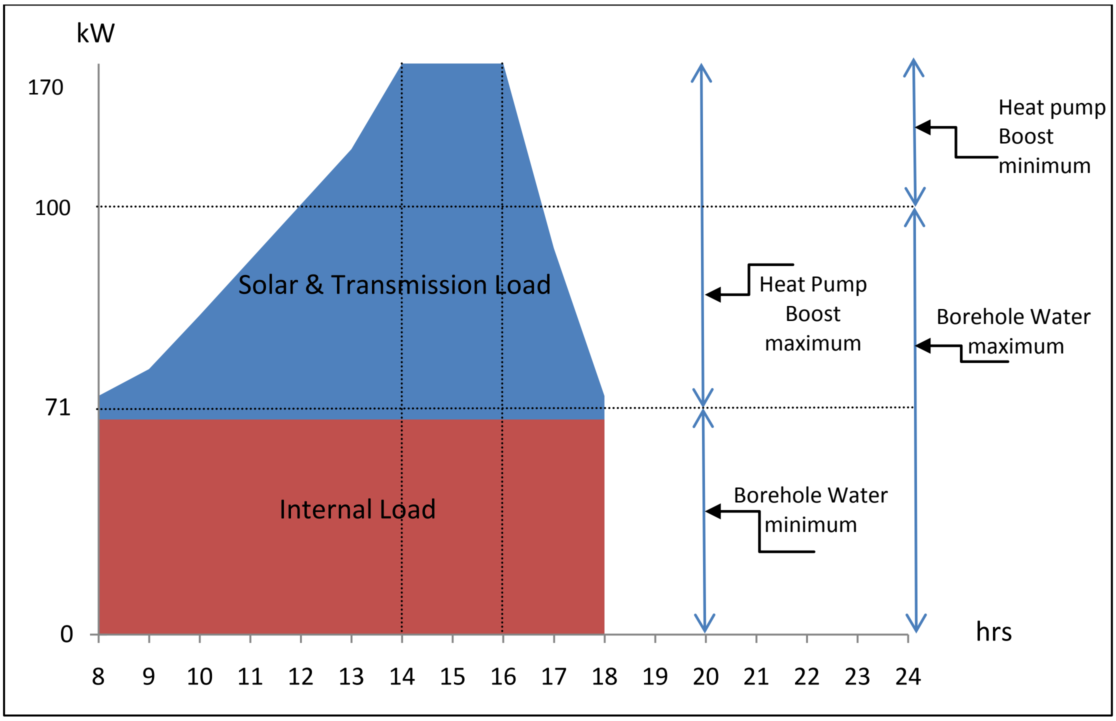
Transmission and solar	80kW	
Internal gain	71kW	
Outdoor air	19kW	170kW

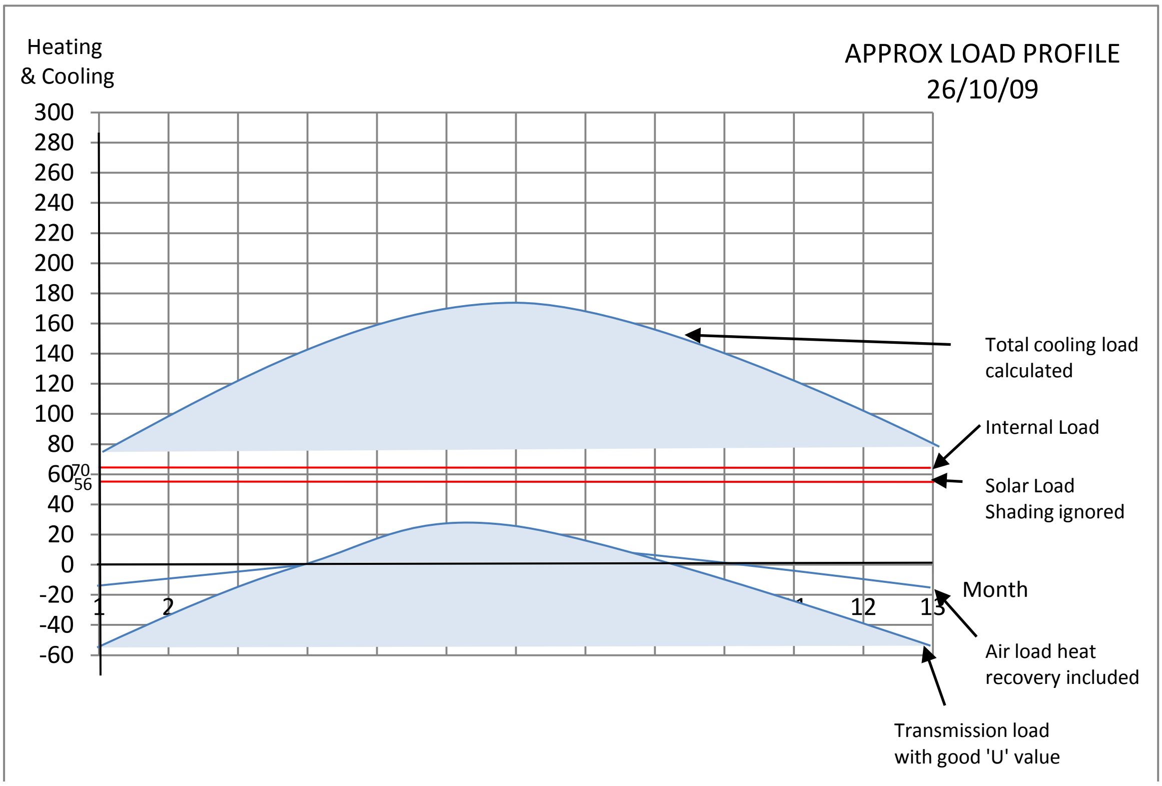
Proposal to minimise Energy Costs

	Type of load	Load	Offset by
Internal load	Constant	71 kW	Borehole Cooling Water no storage Minimum
Outdoor Air Load	Variable	19 kW	Heat Pump
Solar and Transmission Load	Variable	80 kW	Heat Pump

Subject to survey of the ground water energy performance it may be possible to achieve more cooling from this source, reducing the capacity of the heat pump.

Cooling chart





How to produce the above?

Winter heating (November, December, January, February)

A reversible 70 kW heat pump will provide the offices with heating totalling 50 kW and 11 kW for domestic hot water stored in 500 L tank (3.4 L @ 28°C water per person per day)

Winter cooling

Ground water directly exchanged into cooling to supply ZA. OAH uses free cooling by adjusting performance of the rotating energy recovery wheel.

Spring heating (March, April, May)

Offices can use the above winter scenario.
Domestic hot water will use heat pump supported by electrical immersion heaters. When boost cooling on condenser heat can be used.

Spring cooling

Ground water directly exchanges into cooling to support ZA. The water temperature into the ZA coil not above +15°C. By sizing coil correctly that will be enough to create cooling to keep indoor temperature below +23°C.

Summer cooling (June, July, August, September)

Ground water directly exchanged plus with mixing to get lower water temperature to ZA and OAH from heat pump producing cooling that can lead to supply water to ZA and OAH coils 8°C during peak cooling loads generally short duration July and August.

Autumn heating (October and possibly parts of September and November)

The same as for spring.

Autumn cooling

The same as for spring.

Summary

A reversible 70 kW heat pump (30 kW power) will provide office winter heating and hot water 15 kW for the domestic water system.

The average cooling load will be offset by the storage and circulation of cold water cooled in the ground bore holes possible by the steady state ground temperatures at good depths of about 10 to 12 °C enabling the production of cooling water of about 12 to 14°C for the AHU and ZA cooling fan coils.

20 m³ storage of cold borehole water will be included to provide steady supplies of cooling water and minimise pump run times.

Energy Distribution System

The circulation systems and pipe work to carry heating and cooling energy to the Protek System.
The ZA Air handler unit coils will be arranged to be self balancing using reverse return systems .

Two way control valves on the ZA heating and cooling pipe work will control the heating and cooling coil output according to the environmental demand in the office.

Pumps P4 heating and P2 cooling will be fitted with speed control so that pump performance is meeting the cooling and heating demand by measuring the systems differential pressures arising from the two way control valve measurement.

Differential pressure gauges in the ZA cooling coil connections will evolve the monitors of coil pressure drop and hence flow and coil performances.

This will provide date to set the optimum pump speeds.

Water purification and filtration plant to be installed in the incoming water supply to remove any detritus in the utility mains to protect control valves and other devices in the water circuits.

Geothermal Closed Loop Boreholes: almost free cooling (only pump energy)

The review estimates a requirement for 30 N^{o} 150 mm diameter 150 m deep borehole for the cooling system and for the heat pump heat rejection. It is possible to arrange for the cooling boreholes to look after both the cooling and the heating.

Each borehole will comprise a liner with 4 N^{o} 44 mm diameter polyethylene pipes (double loop) joined with return bends lowered into the sleeve to a depth of 150 m. The coupling of the PE100 pipes will be completed at ground level to manifold to collect the cooled water and complete the circulation system. The PE100 pipes will be backfilled with high conductivity grouting to provide a continuous conductive path to the ground.

The number of and depth of the boreholes, will depend on the quantity / conductivity of the ground. Attached is a geological borehole analysis down to 120 m which shows promising results. It is anticipated conductivity is in the order of 2.0 W/mk and will be achieved, on which the estimates are based. This is subject to survey and test data.

The likely costs of the boreholes will be £35 per meter depth based on the anticipated geology. Total costs will be:

Boreholes – cooling and heating   £35 x 150 x 30 = £157,500 lowest estimate

Based on the cost from Geotechnical Engineering Ltd the borehole setting out for the cooling system will be a grid with holes at recommended centres in both directions.
Boreholes can be used both for heating and cooling by using control valves in energy centre.

The layout is subject to the final design.

The power used by the geothermal cold water pumps P1 will depend upon the way the borehole loops are linked. The loops are likely to be a number of series connected loops. Control valves will enable through the environmental control soft ware selection of the number of boreholes to be in circuit according to the load and whether in the cooling or the heating mode.

A detailed computer analysis will confirm the amount of heat transfer occurring and how the loops are arranged.

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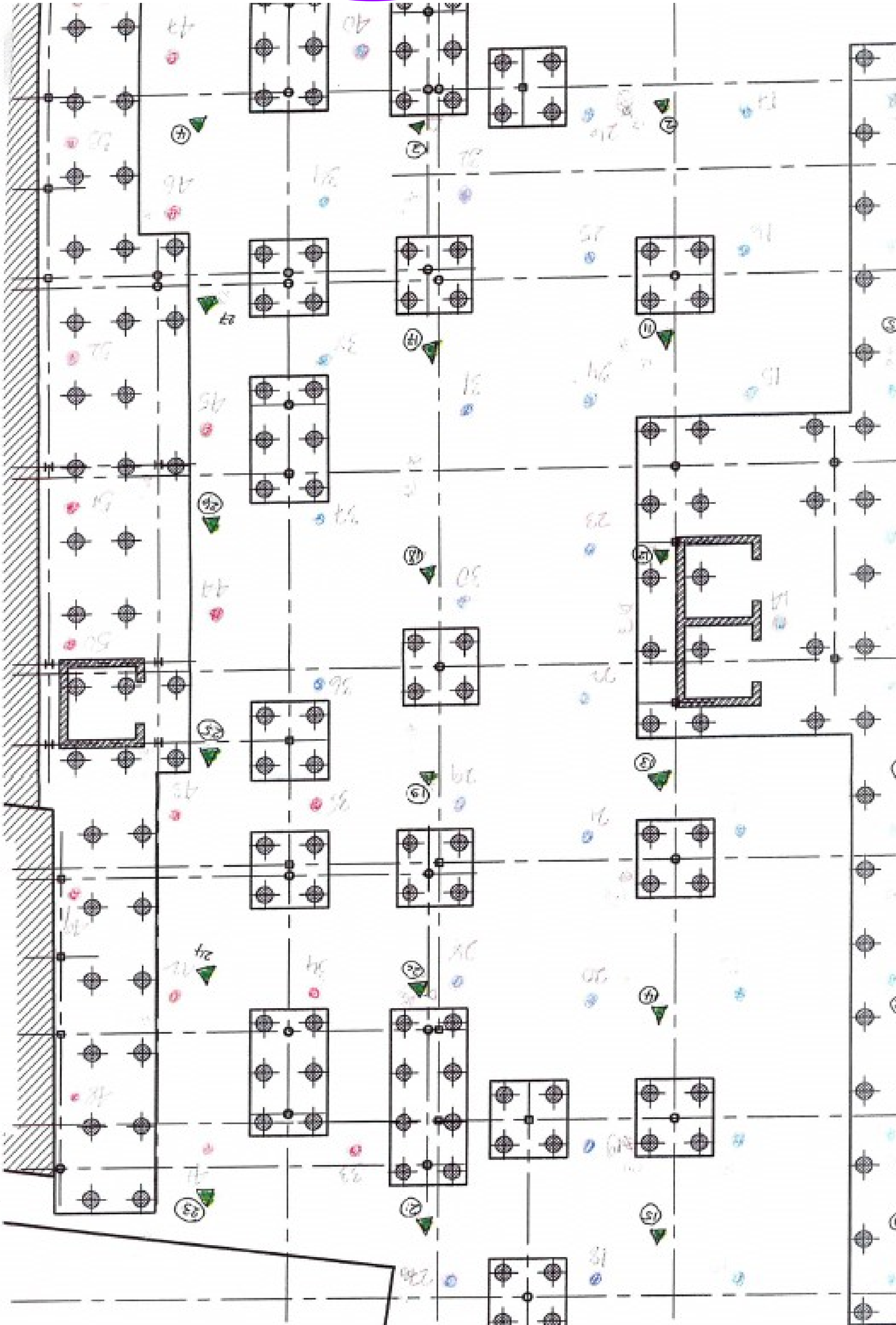


Control Strategy

The most of the cooling is planned to be supplied from a geothermal heat source.

Cooling

Cooling demand from the Protek under floor cooling system will control the operation of the ground water pump P1, P1 will run controlled by a sensor to maintain cold water storage temperature levels so cooling is always available on demand for the ZA. Water will be circulated by P1 through the borehole closed loop system cooled and stored in the buffer tanks from where it will be pumped by P2 to the ZA air handler unit coils and other equipment requiring chilled water. This is normal operation and expected to be so most of the time arising from internal gains.

This cooling water from the geothermal source will be passed through a heat exchanger normally bypassed to be further cooled by the heat pump at peak demand. A control valve will allow the water through the geothermal sub-cooling exchanger when required; otherwise it will go directly to the ZA cooling coils.

During those peak load periods arising from increased solar and transmission gains and additional outdoor air load, the set point deviation will be detected and the heat pump and associated pumps P3 and P4 will be started and chilled water will be pumped through the sub-cooling heat exchanger to cool further the borehole cooling water source.

Heating Cycle

Generally heating is required to preheat the office space before occupancy and before the switch on of internal gains and to heat the outdoor air.

The proposed source for heat is to incorporate a reversible GCHP heat pump with a geothermal heat source. This unit in reverse cycle will also support the cooling system of the geothermal source cannot meet the demand at peak times as described above.

Principles

The target is to achieve maximum cooling and heating from sources which offer the lowest energy consumption of electricity.

The office spaces will be cooled by the Protek Underfloor cooling system with vertical down flow air handling units, floor void air distribution and close control fan assisted floor terminal units RAG. EC motors offering over 95% efficiency are incorporated in the Protek solution.

All outdoor air handling units will incorporate air to air energy recovery units.

Description of Energy Centre

Refer to schematic 20910/M/1B which is a general line diagram layout of the major components comprising.

1) Ground source reversible heat pump for winter. This unit will support the ground source cooling at peak times.

2) Domestic hot water storage totalling 500 L heated by the heat pump supported by electrical immersion heaters..

3) Ground source cooling water system and 20 m^3 of storage providing 100 kW of stored cooling.

Planned Energy Centre Operation

Summer

Pump P1 will pump water through a network of geothermal pipes buried in 30 to 35 boreholes beneath the building to cool the stored water to as close as 12°C as possible. P1 will be controlled by a sensor in the storage tanks to maintain to desired storage temperature

Pump P2 controlled be the Protek system will circulate chilled water from the storage tanks to the Protek ZA air handling units and outdoor air AHU's.

The heat pump designed to provide heating in the winter, can during the summer be put in reverse cycle to provide an additional source of chilled water to sub-cool the geothermal cold water storage.

From energy centre hot water to OAH and ZA will be distributed (P4) and cold water (P2) at temperatures useful to create the indoor climate.

Room sensors in the offices in the ZA and RAG will monitor the office set points for deviation. Sensor in the return water from the ZA pumped by P2 will also monitor the deviation from the set point. An outside sensor will provide data also.

In the cooling season and subject to room sensor deviation exceeding 3°C, the heat pump will go into reverse cycle and will start together with pumps P3 and P4 to deliver chilled water. The heat exchanger bypass valve will close and direct the borehole cooling water through a plate heat exchanger for sub-cooling by the heat pump. In normal cooling the heat exchanger is bypassed.

Winter

The heat pump will use ground source heat source sharing the boreholes provided for cooling system and provide hot water for heating the offices via ZA heating coils.

A heating demand is only expected in the mornings before occupancy and for frost protection. Pump P4, the heat pump and pump P3 start up, will be controlled by the office room sensors. Data from the ZA return air sensors and outdoor air temperature will also be used.

Pump P5 will circulate the hot water to the heating coils.

Pump P3 will circulate a water / antifreeze solution through a geothermal borehole network and the heat pump evaporators. In the reverse cycle the geothermal network will act as a heat sink for the condenser heat.

The heat pump will also provide hot water for heating the domestic hot water storage controlled by a valve and a sensor in the domestic hot water tank.

Spring and Autumn

The whole of the cooling demand is expected to be met by the geothermal sourced chilled water with P1 and P2 only running in accordance with ZA demand.

Room sensors will detect the need for heating in office spaces and switch on the circulation pumps P4 and P3 and the heat pump unit, to generate hot water and circulate to the ZA AHU and other air handling equipment. This heat source will also be used for heating the domestic hot water storage tank.

A benefit of the heat pump is that it can go into cooling mode in the summer and sub-cool the geothermal sourced cold water storage as an additional supplementary cooling source. Domestic hot water can still be heated by the heat pump by diverting some of the heat rejection water to the domestic hot water storage tanks via a heat exchanger and P5.

Energy Centre Equipment Schedule

The following schedule is an estimate pending detailed design.

1 twin	P1 Geothermal cooling water source pump to buffer tanks
2	Off geothermal cooling water buffer / storage tanks 10 m^3 each
1	Off geothermal cooling water boost cooling heat exchanger
1	Off Reversible heat pump. Capacity 65 kW
1	Off domestic hot water storage tank 500 L
1	Off plate heat exchanger for heat rejection / domestic hot water heating
1 twin	P3 Geothermal heat rejection pump
1 twin	P5 Hot water to domestic hot water tanks
1 twin	P4 Hot water circulating pumps to ZA and heat pump
1 twin	P2 Geothermal source cooling water circulation pump to ZA
3	Dosing fill expansion units for systems

Energy Efficient System Operation

Month	System Configuration Operation	Comments
Jan	Heat pump P3, P4	Heating mode
Feb	Heat Pump P3 P4	Heating mode
Mar	P1, P2	Cooling borehole
Apr	P1, P2	Cooling borehole
May	P1, P2	Cooling borehole
Jun	P1, P2	Cooling borehole
Jul	P1, P2, Heat Pump P3, P4, P5 (to heat domestic HW)	Average and boost cooling
Aug	P1, P2, Heat Pump P3, P4, P5 (to heat domestic HW)	Average and boost cooling
Sept	P1, P2	Average cooling borehole
Oct	P1, P2	Average cooling borehole
Nov	Heat Pump, P3, P4	Heating mode
Dec	Heat Pump, P3, P4	Heating mode

Energy Demand Estimated for 1 Year Operation

Heating Energy

Equipment	Run time	Days	Months	kW	kW/hr
Heat pump	3 hrs/day	20/m	J,F,N,D (4)	30	7,200
Pump P3	3 hrs/day	20/m	4	10	2,400
Pump P4	3 hrs/day	20/m	4	2	480
					10,080

Cooling Energy Borehole					
Equipment	**Run time**	**Days**	**Months**	**kW**	**kW/hr**
Pump P1	10 hrs/day x SF 0.7	20/m	M,J,S (3)	20	8,400
Pump P2	9 hrs/day	20/m	M,J,S (3)	2	1,080
					9,480

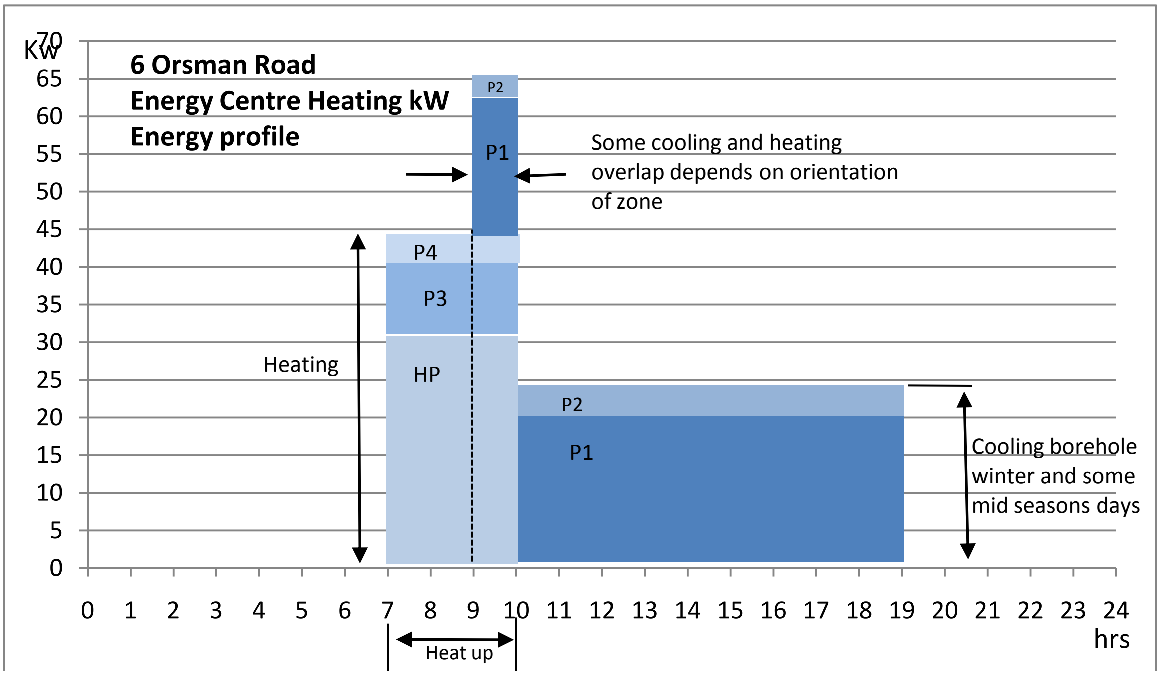
Average Cooling Energy Borehole					
Equipment	**Run time**	**Days**	**Months**	**kW**	**kW/hr**
Pump P1	10 hrs/day x SF 0.7	20/m	M,A,O (3)	20	8,400
Pump P2	9 hrs/day	20/m	M,A,O (3)	2	1,080
					9,480

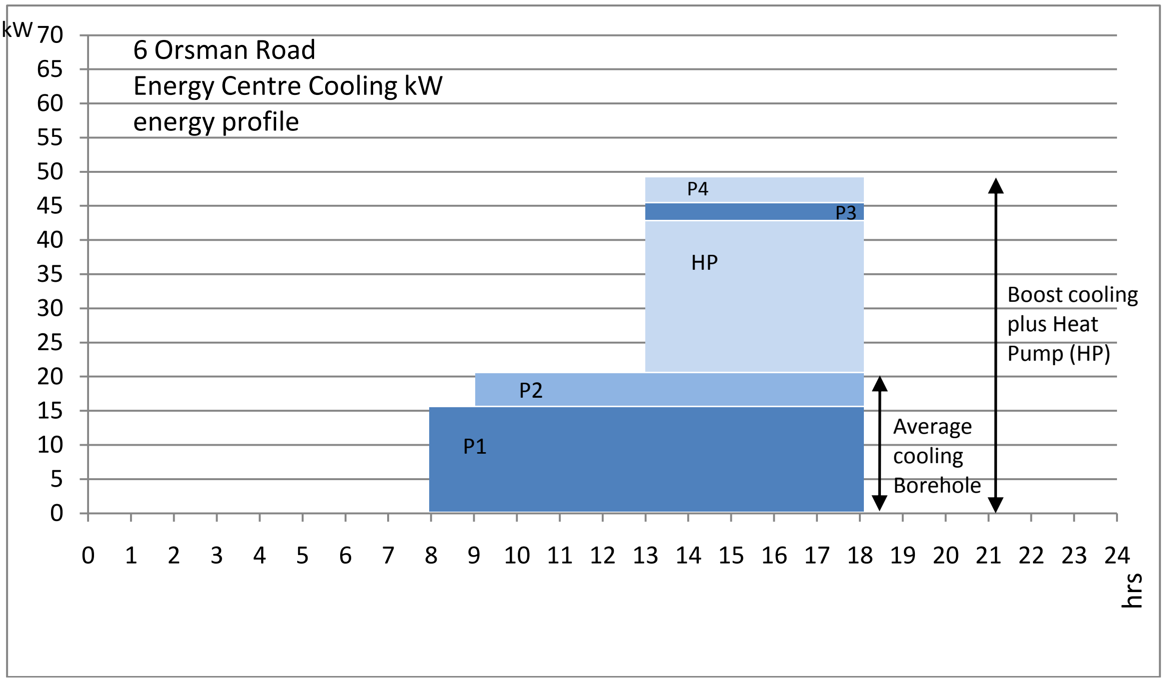
Average Cooling Plus Boost Cooling					
Equipment	**Run time**	**Days**	**Months**	**kW**	**kW/hr**
Pump P1	10 hrs/day x SF 0.7	20/m	J,A,(2)	20	5,600
Pump P2	9 hrs/day	20/m	J,A,(2)	2	720
Heat pump	3 hrs/day	20/m	J,A,(2)	20	2,400
Pump P3	3 hrs/day	20/m	J,A,(2)	10	1,200
Pump P4	3 hrs/day	20/m	J,A,(2)	2	240
Pump P5 (to heat domestic hot water)	SF 0.66 x 9 hrs/day	20/m	J,A,(2)	1	238
					9,438
Total Kwh per annum					**39,438**

Protek System Energy Requirement						
Equipment	**No**	**Run time**	**Days**	**Months**	**kW**	**kW/hr**
ZA320	7	10 x FSF 0.65	20	12	1,1 W	12,012
OA AHU 1600	2	8hrs/day	20	12	2 x 1.6	12,108
RAG	140	10hrs/day	20	12	0.008	2,688
						26,808

Toilet Exhaust Fan Energy						
Equipment	**No**	**Run time**	**Days**	**Months**	**kW**	**kW/hr**
Fan unit	1	8hrs/day	20	12	0.5	960

Total Estimated Energy Consumption for Cooling, Heating & Ventilation System	**67,206**
	31 Kwh/m²


6 Orsman Road
Energy Centre Heating kW
Energy profile
KW
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
P2
P1
Some cooling and heating
overlap depends on orientation
of zone
P4
P3
HP
Heating
P2
P1
Cooling borehole
winter and some
mid seasons days
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
hrs
Heat up


6 Orsman Road
Energy Centre Cooling kW
energy profile
kW
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
P4
P3
HP
P2
P1
Boost cooling
plus Heat
Pump (HP)
Average
cooling
Borehole
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
hrs

Electrical Lighting and Small Power Energy Control

Control of the power and lighting is to be limited to occupancy and usage.

Lighting

Around 8 watt per m² is a good moderate estimate and with application of PIR sensors a diversity of around 75% can be applied giving a realistic consumption under all conditions of 6 watt/m².

The total power requirements therefore would be:

6 x 2,500 m² (including Landlord's common area)	15,000 watt
Over the year this would be:	
15 kW x 8 hours running x 12 months x 20 days	28,800 kWh

Small power including work stations

An allowance of 25 watt/m² and a diversity of around 0.9 can be applied giving 23 watt / m². A computer uses 75% of its power when not being used; therefore a control system that links work station usage to occupancy could be made with computer power being switched by the PIR, i.e. lights on computers' run. However, a programme to provide automatic saving of all the data will be required. Computers are provided with auto save for the eventuality of power going off, but another back facility would be required.

The estimated total computer power could therefore be reduced by 1/3-rd with this arrangement.

The total office power requirements would therefore be 25 watt/m² x 0.66 diversity as lighting x 2,334 m² gives 38,511 watts.

Over the year this would be:
39 kW x 8 hours running x 12 months x 20 days gives 74,880 kWh.

The total energy requirements for lighting and small power are:

Lighting	28,800 kWh
Small power	74,880 kWh
	103,680 kWh

That equates to 45 kWh/m² on the basis that lighting and small power is on 8 hours per day. If the lighting and small power is on longer, 10 hours per day the average would be 57 kWh/m².

The measured kWh/m² for 77-79 Farringdon Road is 80 kWh for the small power and lighting.

The expected energy consumption on 6 Orsman Road is 57 kWh/m² as recommended above, and with modern highly efficient lighting, better management of the usage, so reducing the hours to 8 per day, we can expect to achieve a figure of 45 kWh/m².

Solar Source for Power using Photovoltaic Panels

Daytime power for lighting and small power will be produced by photovoltaic panels on the roof. Surplus energy produced can be sold to tenants and utility companies, and subsidy payments are available to the Landlord. A payment of 36 pence per Kwh installed is availible.

Daytime power requirements will be free and night time power requirements will be off peak supplies the cost of which will be offset against the daytime surplus.

The above estimates are approximate pending resolution of the detailed design and equipment selection.

PV Panels will give around 1 kW of power per 8m² of panel installation on a sunny roof. This gives 850 kWh/8m² installed.

Below is an estimate from Solar UK of the expected energy production possible.

PV electricity generation for: Nominal power = 43.1 kW, System losses = 14.0 %		
	Inclin. = 16 deg., Origent. = 0 deg.	
Month	**Production per month (kWh)**	**Production per day (kWh)**
Jan	1058	34
Feb	1645	59
Mar	2698	87
Apr	4047	135
May	4934	159
Jun	4820	161
Jul	5055	163
Aug	4511	146
Sep	3198	107
Oct	2193	71
Nov	1229	41
Dec	752	24
Yearly average	**3012**	**99**
Total yearly production (kWh)		**36139**

Electricity

The Feed-in Tariff (FiT) is the new financial incentive for people to install renewable electricity generation. It will start in April 2010 (anything installed before then will still qualify) and for PV, the payments are guaranteed for 25 years.

The financial incentives come in three forms:

- Generation Payment: paid for every Kwh generated, regardless of where it is used.
- Export payment: paid for each Kwh exported from the building into the grid
- Avoided import: the money saved when electricity generated is used, and therefore electricity does not need to be purchased from the grid.

Avoided Import: Is just the retail price of electricity, around 10p per Kwh at the moment but will increase over the next 25yrs.

Export payment: A guaranteed minimum price for exported. Currently planned to be 5p per Kwh, but may increase over the 25yrs.

Generation payment: This varies with technology and type of installation. For the size of array that you are looking at (10-100Kw) this is 28p per Kwh (for retrofitted small systems, this is 36.5p).

Payback times 15-17yrs

Our total energy requirement for
- Lighting is 28,800 kWh

Our total yearly production from
- Photovoltaic solar panels is 36,139 kWh

Giving a surplus of 7,339 kWh

Photovoltaic solar panels for electrical power production

Quotation from Solar UK for 196 N° PV panels including installation £173,794

The above area of PV panels is based upon 6 Orsman Road. It may be possible to increase the area of PV panels on 109 – 111 Farringden Road.

Preliminary Investment Cost Estimate for Energy Centre

Heat pump unit – 1N°	£30,000
Storage tanks heavily insulated 2 x 10 m³	£20,000
Plate heat exchanger – 2 N°	£10,000
Twin pump sets P1, P2, P3, P4 and P5 – 5 N°	£15,000
Dosing and fill units – 3 N°	£3,000
Control valves – 5 N°	£5,000
Distribution pipes including insulation Plant Room	£35,000
35 Boreholes double or single loop (Combined heating and cooling)	£157,500
Manifolds for Borehole linking	£60,000
Domestic hot water tank 500 L – 1 N°	£2,000
Controls including software	£50,000

Electrical wiring to all components	£40,000
Estimated Energy Centre Cost installed	**£427,500**

Air conditioning / Acclimatization

OAH 6.000 max m^3/heat – 2 N°	
ZA 52 kW/floor – 7 N°	
RAG (1 per 17m^2) – 140 N°	
BMS for above and all building	
Sub-total	£357,985
Distribution pipe work and insulation	£60,000
Installation	£54,000
Estimated Protek Components Cost installed	**£471,985**

Preliminary estimated energy cost for heating, cooling ventilation and domestic water

A) Daytime consumption 67,206 kWh @11.8p £7,930

Annual power cost for energy production £7,930

Comparison
A standard UK or Swedish building with a cost of 7,.5p/Kwh while daytime in UK 11.8p =+57%
Yearly cost statistic book Sweden 11.8p
In Sweden with open plan and high density of people chiller working 4380h/year
Cost 66SEK/m^2 with 7.5p/Kwh = £8.863/m^2 x 2344 = £20,240
Still lower temperature in Sweden
Heating in Sweden with good energy recovery from ventilation

$$\frac{\frac{42SEK}{m^2x}1.57}{£1=12\ SEK} =$$ <u>£12,880</u>

The above property in climate zone 3 in London £33,120

b) Peter Dewars property 1870m^2 in London
Cooling approx £1/sqft and gas 0.74/sqft £43,920

Say the average cost for cooling and heating **£38,520**

Possible acceptable "future investment" already now for saving energy

Using the difference in a normal buildings running costs compared to 6 Orsman Road design an extra rent payment can take place with £35,000.annum or £1.40.sqft net. That can lead to "further investment" taking place based on the following:

Using presented above with 8% interest and 10 years gives an annuity factor of = 0.15 which leads to a possible over investment of £375,000

$$\frac{£35{,}000\ x\ 10\%\ uplift\ per\ annum}{0.15} =$$

Summary of Performance Efficiency

The annual Cooling and Heating load profile gives a total load requirement represented by the shaded area of approximately 312,500Kwh

The report estimates an electrical energy demand to provide this cooling and heating load of 67,206Kwh

Therefore $\frac{Input}{Output} = \frac{67{,}206}{312{,}500} = 0.22$

A very credible coefficient of performance compared with conventional cooling with water chillers where the COP would be between 0.7 and 0.9.

The electrical power used for small power and lighting is estimated at	130,680Kwh
PV solar panels provide some of this energy	36,139Kwh
Giving a net energy requirement for lighting and small power of	**67,541Kwh**