Table 5.2: Proposed mechanical services specification	
Indicative summary of building services performance parameters	
Boiler efficiency	92%
Heating controls	Charging system linked to use, programmer, room thermostat
Heating system	Underfloor (concrete)
DHW source	Communal boiler
DHW source Efficiency	92%
DHW Loss factor	1.05
Mechanical ventilation with heat recovery (MVHR)	SFP = 0.6 – 0.8W/l/s, 90% heat recovery
Ductwork	Rigid, insulated.
Internal lighting	All light fittings to be of the energy efficient type

Unregulated Energy

Unregulated energy includes small power electricity use (AV, computers, plug-in devices, lifts) and catering energy consumption. Currently, unregulated energy is not included in the definition of zero carbon and is not included within the Part L assessment.

Such uses will impact the development's actual operational CO_2 emissions and residents' energy bills. They will also translate into internal gains which may increase the risk of overheating.

The provision of white goods is discussed earlier under *'Principle 10'*.

5.3 Carbon Reductions from Energy Efficiency and Passive Design – Residential dwellings

For the purposes of undertaking the energy strategy appraisal for the development, preliminary Part L 2010 calculations have been carried out on a sample of dwellings. Please refer to Appendix A for more details.

Criterion 1

Based on the results of the sample dwellings tested and the assumptions stated in this report, it is expected that dwellings will on average achieve a ~12% CO_2 improvement on Part L 2010 emissions levels, through passive design and energy efficiency alone, before the implementation of LZC sources.

Criterion 3

Preliminary Part L tests on the sample dwellings show expected compliance with criterion 3, which assesses the impact of summer solar gains on overheating risk. The background noise survey and the preliminary Part L analysis of the sample dwellings point to required air change rates which are considered achievable through openable windows. The proposed façade measures include internal light coloured blinds, as well as external shading devices (e.g. roller blinds) to be incorporated where required.

5.4 Carbon Reductions from Energy Efficiency and Passive Design – Commercial areas

Retail areas

There are ground floor retail shell units provided at Phoenix Place. These are proposed as relatively small units and shell and core in nature (with connection to the community heating scheme via a condenser loop), and as such have not been modelled under Part L software. However, tenants will be expected to meet Building Regulations 2010 as a minimum, with an aspiration to achieving a 5% reduction, subject to tenants' fabric and fit out specification.

The shop fronts and lighting to be specified by each individual tenant; however the following table summarises recommended fabric specifications for the retail areas.

Table 5.3: Proposed fabric specification for retail units		
Building Element	**Phoenix Place**	**Limiting Part L1A 2010 Values**
Air permeability, q_{50}	3 $m^3/hr/m^2$	10 $m^3/hr/m^2$
Wall U-value	0.2 W/m^2K	0.35 W/m^2K
Ground floor U-value	0.15 W/m^2K	0.25 W/m^2K
Glazing U-value (includes glass and frame)	1.5 W/m^2K	2.2 W/m^2K
Glazing g-value (solar transmittance)	0.4	-
Glazing visible light transmission	0.65	-
Percentage glazing (includes glass and frame)	90%	-

5.5 Preliminary Energy Demand Assessment

The following tables show estimated breakdowns of annual energy consumption and CO2 emissions for Phoenix Place after passive design and energy efficiency measures, but before the inclusion of low and zero carbon technologies:

- Regulated CO_2 emissions are as estimated by the preliminary Part L calculations carried out on a sample of dwellings, area-weighted across the site
- Un-regulated CO_2 emissions in the dwellings have been estimated from the SAP methodology for un-regulated energy uses, such as cooking and appliances
- An allowance has been made for retail areas, basement spaces, car park and communal lighting.

The table below summarises the benchmarks used in this preliminary energy demand assessment. Subsequent tables show the resulting estimated 'annual energy consumption' and associated CO_2 emissions.

Table 5.4: Annual energy benchmarks					
	Gas for space heating kWh/m²/yr	Gas for domestic hot water kWh/m²/yr	Regulated electricity kWh/m²/yr	Non-regulated electricity kWh/m²/yr	TOTAL kWh/m²/yr
Residential (P1 private)	14.86	32.27	7.79	31.15	86.07
Residential (P1 affordable)	14.50	29.10	6.87	29.00	79.53
Residential (P2 private)	12.6	35.00	7.99	32.90	88.54
Residential (P2 affordable)	14.50	29.80	6.81	29.90	80.95
Retail	0.22	1.65	89.93	20.26	112.16
Basement	0	0	0	20.00	20.00

Table 5.4: Phoenix Place - Estimated annual energy consumption					
	Gas for space heating kWh/yr	Gas for domestic hot water kWh/yr	Regulated electricity kWh/yr	Non-regulated electricity kWh/yr	TOTAL kWh/yr
Residential (Private)	322,700	762,800	180,400	728,900	1,994,800
Residential (Affordable)	84,300	23,600	39,800	170,100	317,800
Retail	200	1,400	74,000	16,700	92,300
Basement	0	0	203,800	0	203,800
Total	**407,200**	**787,800**	**498,000**	**915,700**	**2,608,700**

Table 5.6: Phoenix Place - Estimated annual CO_2 emissions					
	Gas for space heating $kgCO_2/yr$	Gas for domestic hot water $kgCO_2/yr$	Regulated electricity $kgCO_2/yr$	Non-regulated electricity $kgCO_2/yr$	TOTAL $kgCO_2/yr$
Residential (Private)	63,900	151,000	93,200	348,800	656,900
Residential (Affordable)	16,700	33,700	20,500	71,000	141,900
Retail	94	700	38,200	39,000	78,000
Basement	0	0	105,400	105,400	210,800
Total	**80,700**	**185,400**	**257,300**	**564,200**	**1,087,600**

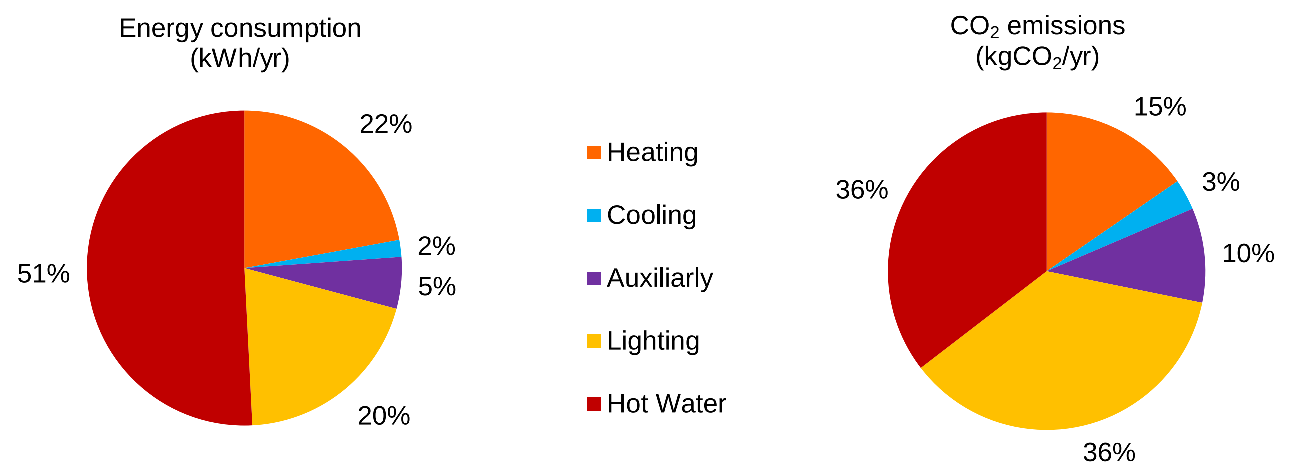


Figure 5.2: Estimated regulated energy consumption and CO_2 emissions by end-use

6.0 BE CLEAN – INFRASTRUCTURE

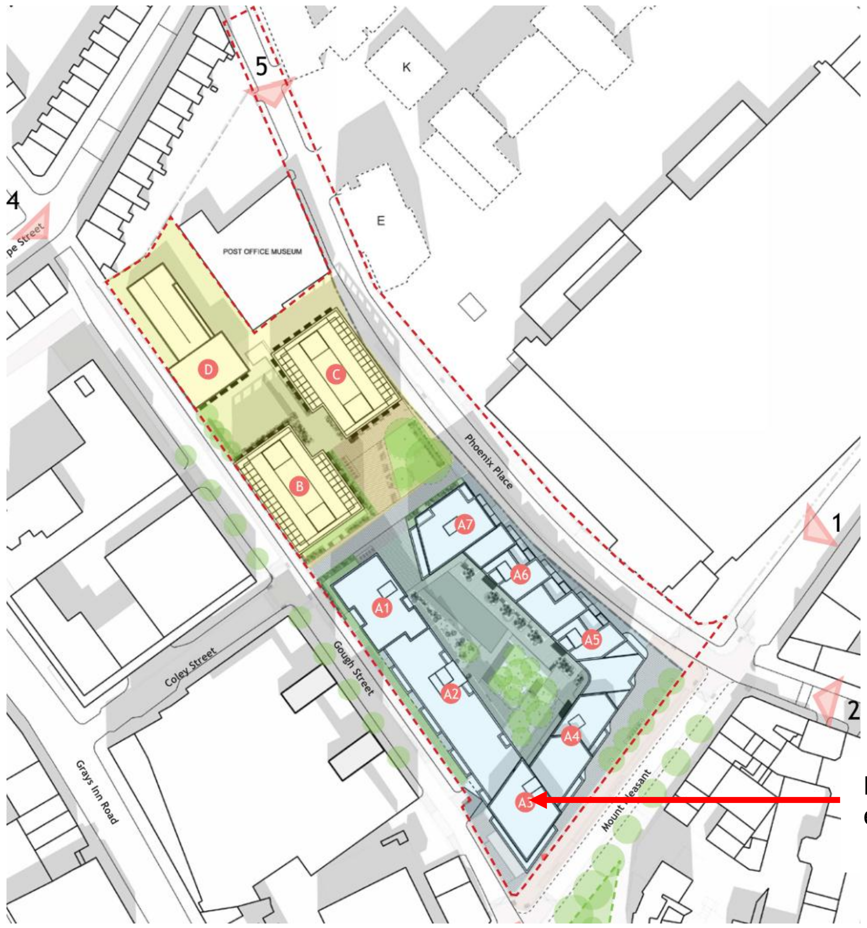
The infrastructure proposals have been developed with consideration to the planning guidance from the London Borough of Camden and Greater London Authority (GLA).Infrastructure Proposals

The Phoenix Place site design proposes the inclusion of an energy centre and district heating network serving all buildings, allowing the large-scale implementation of Combined Heat and Power (CHP).

The **energy centre hosting Combined Heat and Power (CHP) plant** will serve all buildings across the Phoenix Place site.

For flexibility and commercial reasons, the adjacent Calthorpe Street site will include its own energy centre hosting CHP plant, serving all areas on its site via a district heating network. It is important however to note the following:

- Both networks may be connected to each other or to other neighbouring networks that may become available in the future, subject to technical and commercial viability and to an appraisal of CO_2 benefits.
- Each site has a similar residential-led profile and will likely be developed in phases. It is therefore expected that a single energy centre serving both Phoenix Place and Calthorpe Street would not lead to a significant difference in the proposed CHP plant, which would anyway be sized to suit the thermal load and the expected phasing.



Phoenix Place energy centre

Figure 6.1: Location of proposed energy centre at Phoenix Place

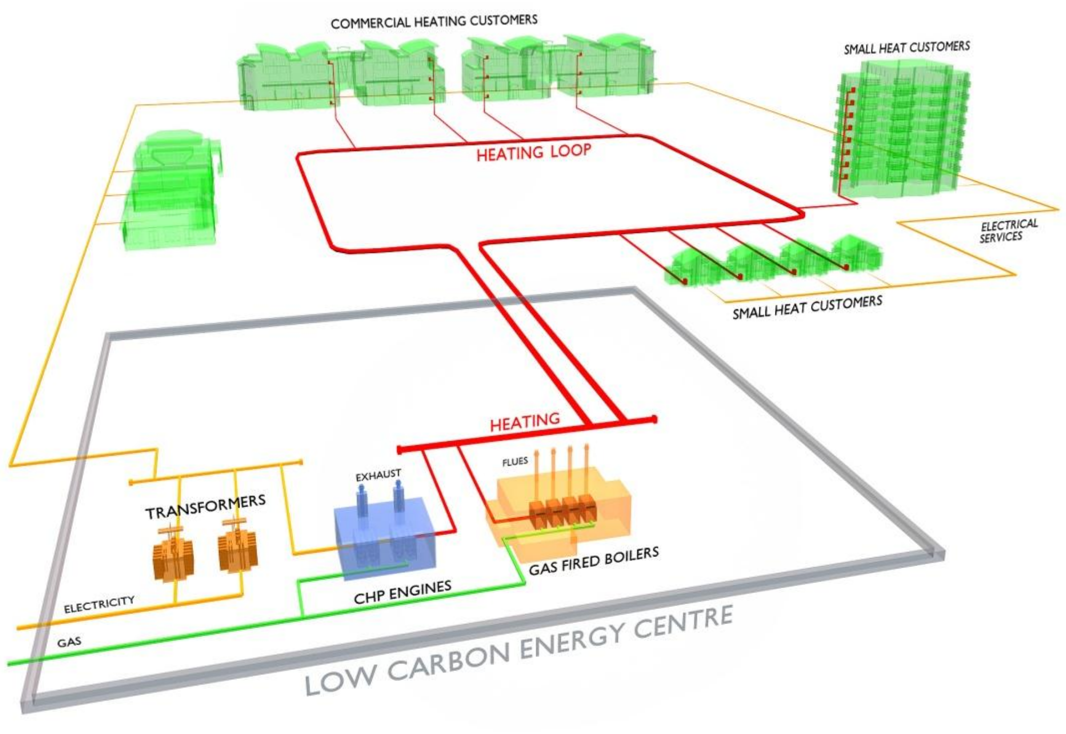


Figure 6.2: Illustrative diagram of low carbon energy centre and district energy network

The approach to sizing and locating the energy centre to serve the Phoenix Place site has taken account of the findings of the energy strategy appraisal and also the energy load analysis of the development.

The following are considered to be the basic elements of the energy centre:

- Gas-fired Boiler Plant
- Gas-fired Combined Heat & Power plant
- Thermal Storage
- Electrical Switchroom
- Ventilation plant
- Ancillary Plant (pumps, pressurisation units, etc.).
- Space for future LZC technology to replace or supplement the CHP plant.

The energy centre has been designed to enable the installation and operation of commercially available and tried and tested plant solutions.

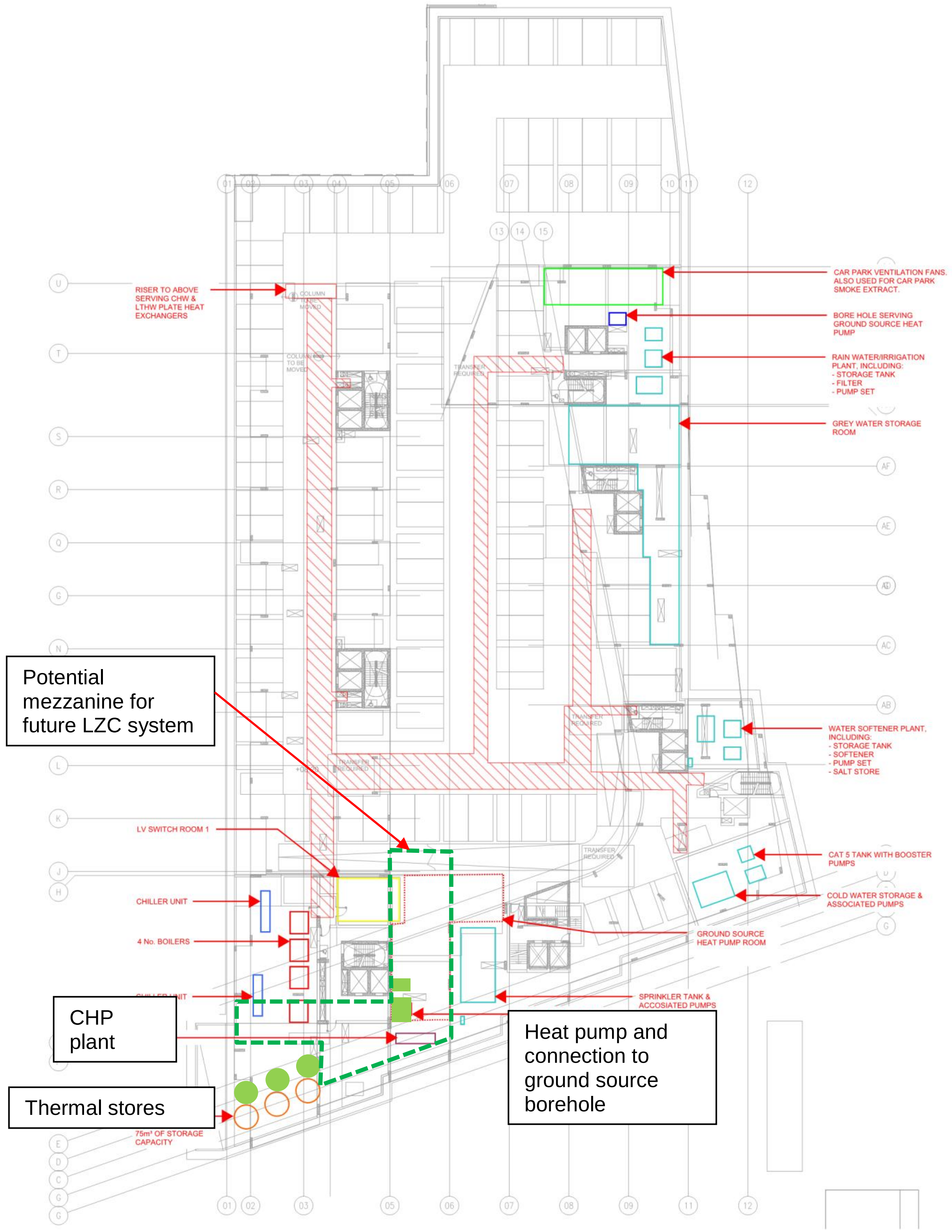


Figure 6.3: Phoenix Place - Preliminary Energy Centre Layout, Upper Basement
Highlighting: CHP, thermal stores, ground source heat pump, and potential space for future LZC systems

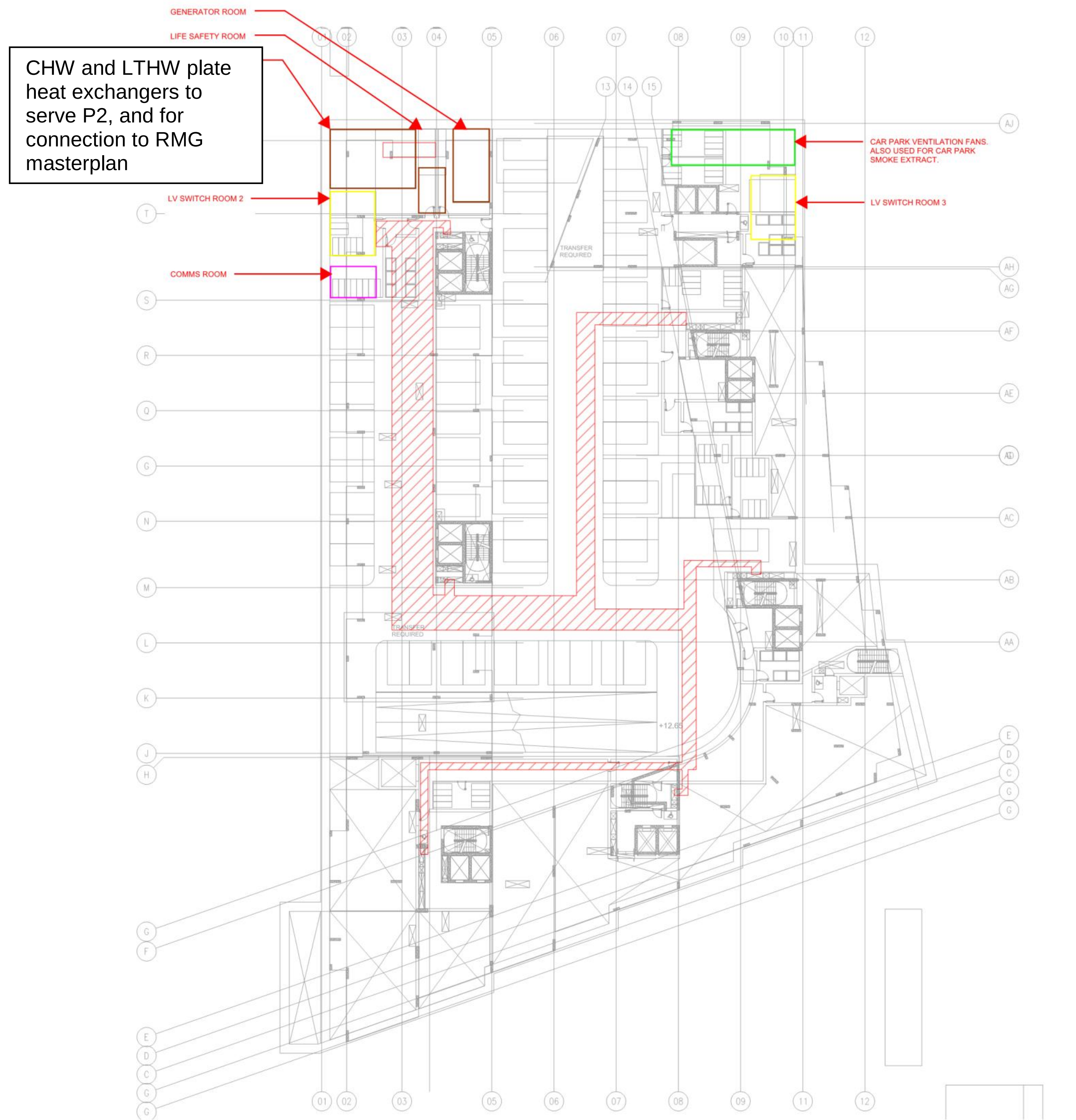


Figure 6.4: Phoenix Place - Preliminary Energy Centre Layout, Lower Basement
Highlighting: space for connection to Calthorpe Street site and to wider external networks, if available in the future.

6.1 Opportunities for Connection to Wider Networks

An early appraisal has been carried out of the viability to link the Phoenix Place site to other networks in the future.

The following image is sourced from the London Heat Map. It describes the heat load density as well as existing and potential district heating networks in proximity to the Phoenix Place site.

The map indicates that while the site is in a medium heat load density area but there is no current or identified potential network in the close surrounding area.

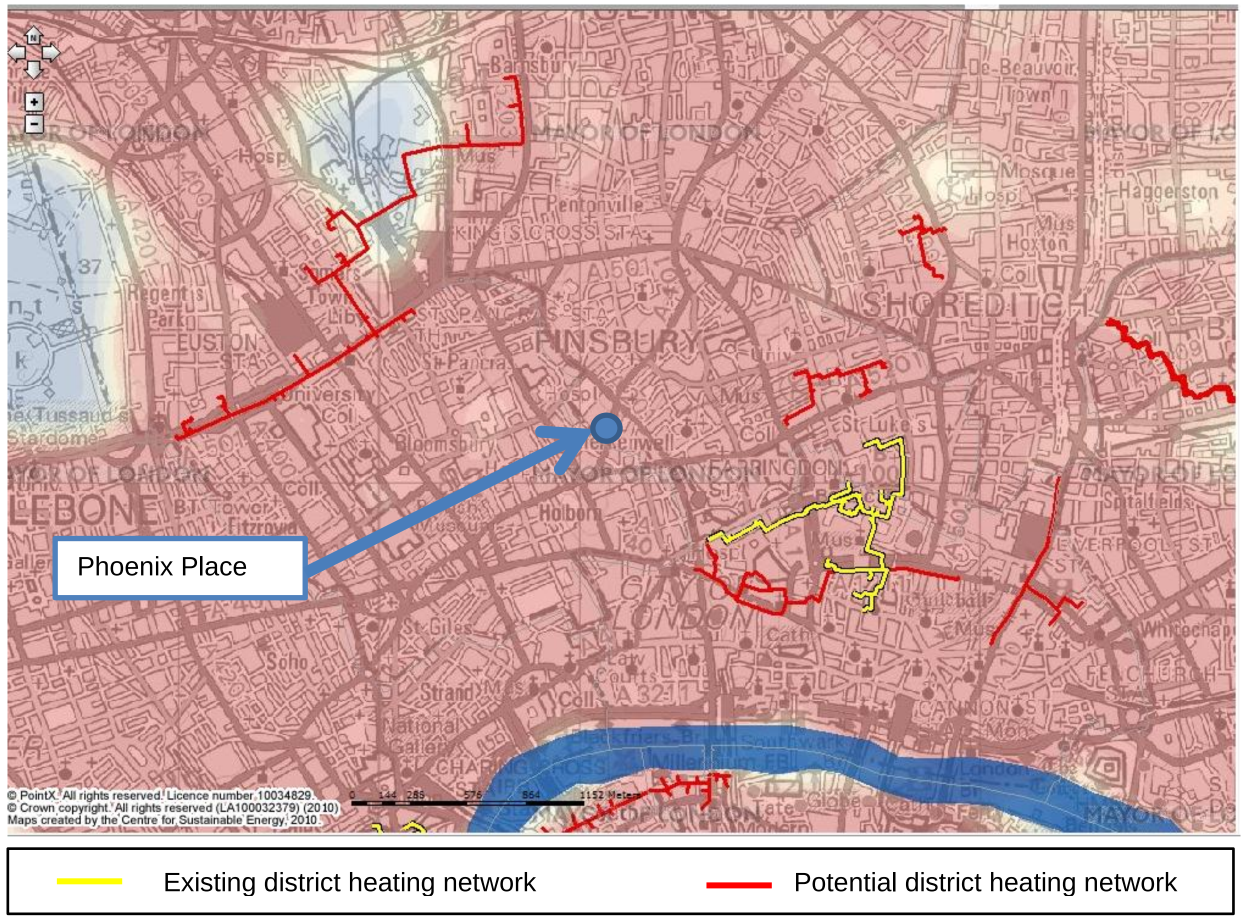


Figure 6.5: London Heat Map, with focus around the Phoenix Place site

Information from the local planning documents was also consulted, which confirms that no existing or proposed network is currently located in the direct vicinity of the site, as shown in Figure 6.6.

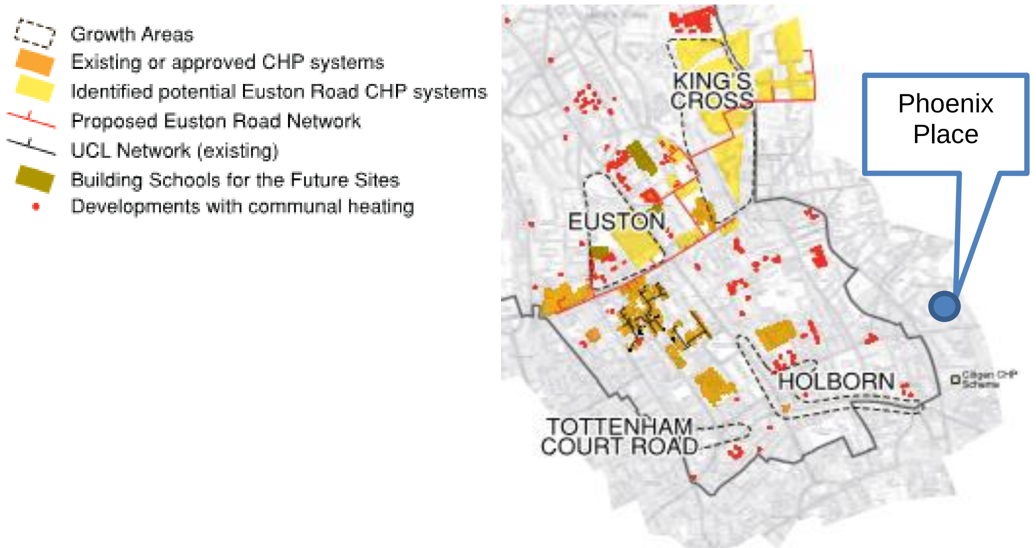


Figure 6.6: Fragment of Decentralised Energy Network Map from Camden's Core Strategy

It is not currently proposed to provide spare capacity for serving neighbouring properties and sites. The **district heating network at Phoenix Place will however allow future connection to other networks, should they be implemented in the future** and subject to an appraisal of commercial and technical viability, as well as CO_2 benefits – see notional allocated space in Figures 6.3 and 6.4 above.

7.0 BE CLEAN – APPRAISAL OF COMBINED HEAT AND POWER AND COMBINED COOLING HEAT AND POWER

It is proposed that gas fired Combined Heat and Power (CHP) plant would be included within the Phoenix Place energy centre.

7.1 Combined Heat and Power (CHP)

CHP generates electricity on-site from natural gas and makes uses the heat which is produced during the generation process. This compares with traditional electrical power generation which results in large heat losses to atmosphere.

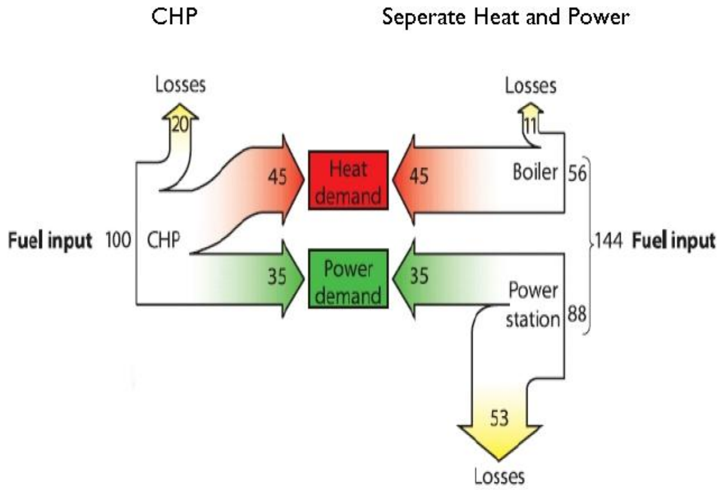


Figure 7.1: Typical comparison of CHP and traditional Heat and Power

In order to appraise the potential benefits of implementing gas-fired CHP, an assessment was undertaken on the basis of the CHP system being sized to provide 100% of the annual domestic hot water (DHW) load and up to 50% of the annual space heating (SH) load. Part L 2010 Carbon Factors for natural gas and displaced electricity have been used.

This result in an estimate that gas-fired CHP could lead to a CO_2 saving of approximately 25 - 30%, based on plant of current expected capacity ~ 135kWe. The resulting anticipated CHP contribution to space heating and domestic hot water at Phoenix Place is represented below.

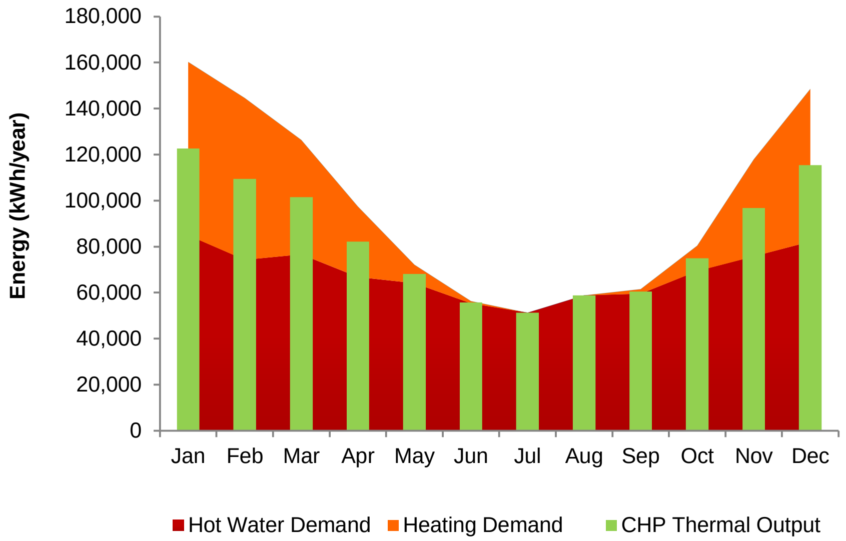


Figure 7.2: Indicative space heating and domestic hot water profiles, with contribution from CHP

The following table summarises the estimated contribution from a 150kW CHP at Phoenix Place.

Table 7.1: Estimated contribution from CHP at Phoenix Place

Capacity	Running hours (full load equivalent, hrs/yr)	Annual thermal output (kWh/yr)	Annual electrical output (kWh/yr)	Net annual CO_2 savings ($kgCO_2$/year)	Net annual regulated CO_2 reduction (%)	CHP unit assumptions
1 no. 135kWe, 215kWth	4,500	997,200	626,200	158,400	**~30%**	• CHP providing 100% of DHW and 50% of Space Heating • CHP running for 10-19 hours per day (season dependant); • 90% CHP availability

Calculations have been based on a commercially available unit in order to ensure that the CO_2 savings are achievable. The size and specification of the CHP plant are indicative only at this stage, and will be detailed as the design progresses.

7.2 Gas-Fired Combined Cooling Heat and Power (CCHP)

CCHP systems (also known as tri-generation) can provide cooling in addition to heat and power by taking excess heat energy from a CHP system to produced chilled water through a heat-driven cooling cycle; in most commercially available systems this is done in an absorption chiller. Using excess heat enables the CCHP system to extend its running hours and in theory to achieve greater CO_2 reductions, contributing to the air conditioning load in the summer and the space heating load in the winter. A critical element in CO_2 savings being realised in cooling mode is the efficient of the absorption chiller, in itself and compared to the mechanical chiller that it displaces.

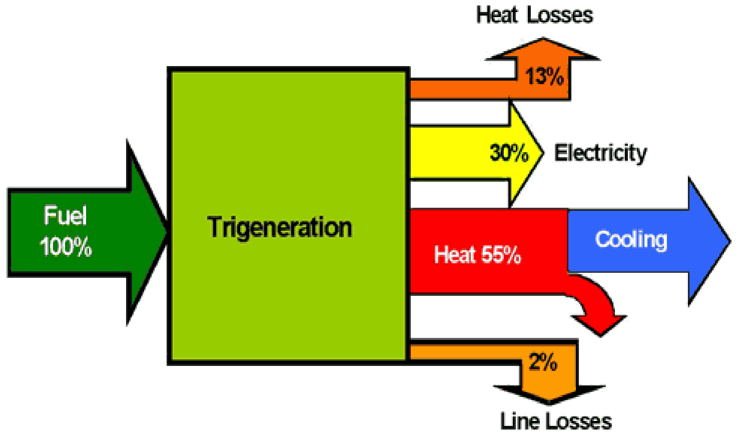


Figure 7.3: Indicative energy generation process of a CCHP (or tri-generation) system

Absorption chiller

The key component of a trigeneration system is the absorption chiller. This is a large piece of equipment that typically has high maintenance requirements compared to mechanical chillers, and rely on a constant cooling load to operate efficiently, typically 100 kW or more.

The inclusion of an absorption chiller can require elevated operating temperatures for the district heating network. This will increase heating distribution losses relative to a system with a lower temperature and the same pipework insulation specification.

Furthermore, absorption chillers typically require the use of wet cooling systems, which necessitate careful commissioning and on-going maintenance to ensure compliance with legionella legislation, with particular care around residential areas as is the case at Phoenix Place.

In terms of carbon emissions, savings can be limited when compared to very efficient vapour compression chillers, especially where there is not a large, constant cooling baseload (which is the case at Phoenix Place). Typical coefficient of performance do not exceed 0.6- 0.7 for the size which would be suitable at Phoenix Place, whereas they can increase in theory to 1.2 for very large two-stage cycles.

Cooling requirements in residential dwellings

The requirement for cooling in residential areas has been minimised through the following design features:

- Openable windows in all residential apartments
- MVHR utilising summer bypass to provide beneficial free cooling to apartments
- External shading e.g. shutters, blinds, or shading through balconies
- Night time cooling purge
- High efficiency chillers.

Please also refer to sections 6.3 and 6.4 for details.

Cooling requirements in retail units

The retail areas will be expected to comply with the current Part L 2A solar gain criterion 3 in their final design.

A key measure will be that centralised cooling will be provided through very efficient plant.

Furthermore, tenants will be encouraged to incorporate features such as the following:

- Efficient façade design including solar control display glazing
- Energy Efficient lighting, especially display lighting to reduce internal gains.

It is anticipated that cooling demand will be limited in the summer season, and thus the base load cooling will not exceed the minimum 100kW typically recommended for absorption chillers.

With a typical chiller coefficient of performance of 0.6 and allowing a CCHP unit to run for a further 200 hours per year compared to a CHP system, it could be expected that an additional CO_2 saving of only 2% could be made against employing a CHP system without cooling.

Therefore, in view of the significant capital costs and space planning implications, as well as maintenance complexities of an absorption system, it is not considered appropriate at Phoenix Place.

7.3 Appraisal of CHP and CCHP - Conclusion

Due to the residential-led profile of the development and insufficient cooling baseload, limited potential CO_2 savings, and the added complexities of maintenance and operation of an absorption chiller, a CCHP system is not considered a viable option for inclusion at Phoenix Place.

Gas fired CHP, however, would provide 100% of the domestic hot water baseload and a significant contribution to space heating, achieving 25 – 30% CO_2 emissions savings. A CHP system is therefore proposed at Phoenix Place.

The figure below summarises the estimated CO_2 savings from passive design and energy efficiency "Be Lean" and the inclusion of gas fired CHP plant "Be Clean".

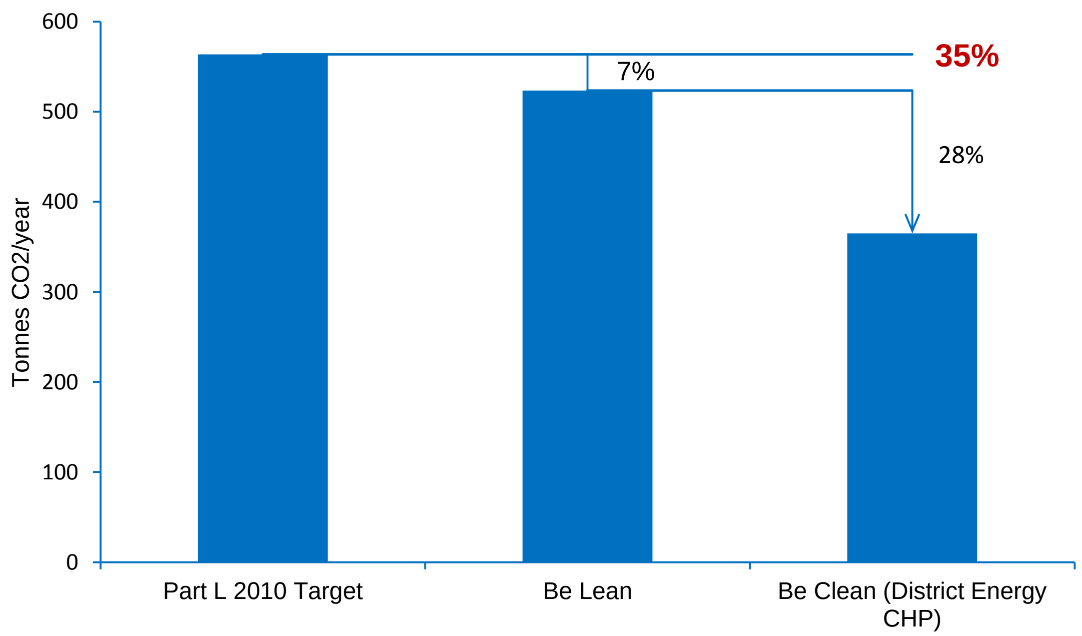


Figure 7.4: Estimated regulated CO_2 savings from the "Be Lean" and "Be Clean" stages

8.0 BE GREEN – RENEWABLE ENERGY

In order to minimise the CO_2 emissions generated through the operation of the development the ability to produce low/ zero carbon energy on-site was considered as part of the energy strategy for the scheme.

The Phoenix Place design has been appraised in terms of integrating low/zero carbon technologies at both a centralised and building level (as defined below). The Part L 2010 carbon factors for electricity from the grid, natural gas, displaced electricity and biomass fuels have been used.

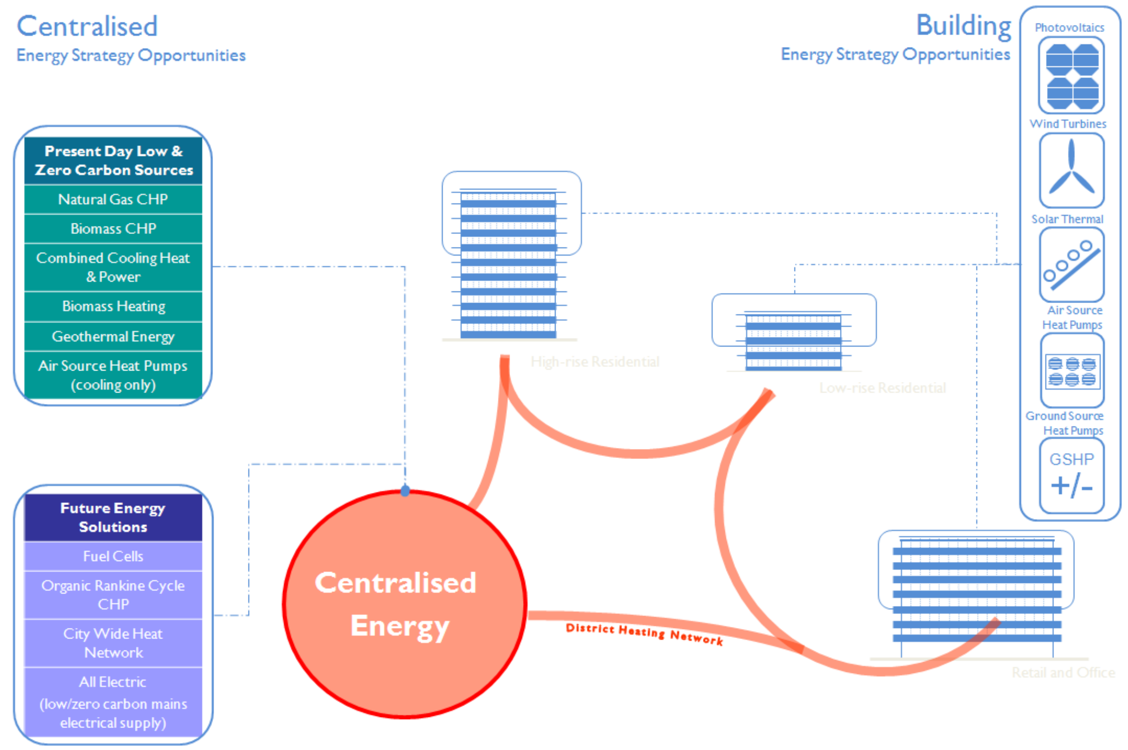


Figure 8.1: Centralised and building energy systems considered at Phoenix Place

- **'Centralised ' systems** – Systems which can be integrated into a centralised energy generation solution and can serve multiple energy users through district energy networks.
- **'Building' systems** – Systems which can be integrated on a building by building basis.

The following low and zero carbon (LZC) technologies have been assessed in order to estimate their potential for delivering carbon savings, after passive design and energy efficiency measures are implemented:

Centralised systems:
- Ground source heat pumps
- Biomass boiler

Building systems:
- Photovoltaics (PV)
- Solar thermal panels
- Wind turbines
- Air source heat pumps.

8.1 Low and Zero Carbon Technologies – 'Centralised systems'

The following LZC options have been preliminary assessed for their suitability for implementation on a centralised basis for the Phoenix Place site.

<u>Ground Source Systems</u>

Ground source systems can be used to extract heat from the ground or adjacent water body by circulating a fluid through a system of pipes to a heat exchanger which transfers the energy to the distribution network. This can provide space heating and/or pre-heat domestic hot water as well as cooling.

An overview of several types of ground system is summarised in Table 9.1 and 9.2. Balanced systems (equal annual heating and cooling energy output) are generally preferred as otherwise an imbalance in ground temperature is likely to occur affecting future performance of the system. The most common two types of ground source systems are:

- open-loop (extracting and rejecting water to an aquifer below the site)
- closed loop (bore-hole or shallow coil).

The potential for use of a ground source system has been independently investigated in a desktop study by a third party geothermal specialist (Loopmaster). The ground conditions at Phoenix Place are particularly complicated due to the proximity of:

- London Underground infrastructure
- Legacy 'Rail Mail' underground system
- Major Thames water sewer system

These items restrict the location of geothermal closed loop arrays or borehole locations.

At this stage, the desktop study indicates that a ground source system could extract and reject water to the underground aquifer and thus provide heating and cooling to Phoenix Place, with associated carbon savings. This will need to be verified at the next stage through detailed design, detailed aquifer modelling, and finally a test borehole.

The preferred **ground source system** for Phoenix Place would:

- Provide an efficient low carbon lead cooling system in residencies and retail areas
- Heat pumps linked to the district heating system, so that beneficial simultaneous heating and cooling may be provided, e.g. pre-heating system water (to partially meet summer Domestic Hot Water demand) when cooling is required

The preferred option would help **limit, and balance annual heating and cooling demands** placed on the ground (or aquifer).

Table 8.1: Overview of ground source systems

Ground Source System		Comments
	Heating **ONLY**	May lead to localised **cooling** of the ground, reducing system efficiency over time. As the site is substantially built over this restricts annual solar energy contribution to warming the ground, reducing annual energy abstraction.
	Cooling **ONLY**	May lead to localised **heating** of the ground, reducing system efficiency over time. As the site is substantially built over this restricts annual heat loss from the ground, reducing the quantity of annual heat rejection from the system.
Preferred option for Phoenix Place.	**BALANCED** annual heating and cooling	Seasonally balancing energy rejected and abstracted from the ground minimises the change in ground temperature. It may also benefit annual operation efficiency as generally warm ground conditions (from summer heat rejection) increase energy abstraction in the winter heating season, and generally cool ground conditions (after winter heat extraction) increase chiller efficiency in the summer cooling season

Table 8.2: Overview of heat interface options in ground source systems

Ground Heat Interface		Comments
	Pond loop – or similar configuration using a local body of water as a heat source or sink	No suitable body of water in the local area. **Not suitable for Phoenix Place.**
	Slinky coil type shallow array	No suitable large area of land where a shallow system may be installed. Requires a large land area to obtain large thermal inputs/outputs. **Not suitable for Phoenix Place.**
	Energy Piles	System rejection/absorption limited to the number of piles installed in foundation, therefore limited by phasing of the development. System output also limited by (relatively) shallow pile depth in comparison to a vertical array. **Not suitable for Phoenix Place.**
Preferred option for Phoenix Place.	Open loop – direct water abstraction	Requires fewer boreholes to inject and abstract water to and from the aquifer below site, though these are more technically complicated to construct than a single closed loop pile. Long term risk that water may not be available or suitable at this location that cannot be closed out until construction of a test borehole. **Preferred option for Phoenix Place.**
	Closed loop	Limited locations this may be installed, limiting total output. Complicated co-ordination required with structural piles, plot phasing and construction works above the array. Difficult to access and maintain all piles once construction takes place above the array. **Possible, though not currently preferred for Phoenix Place.**

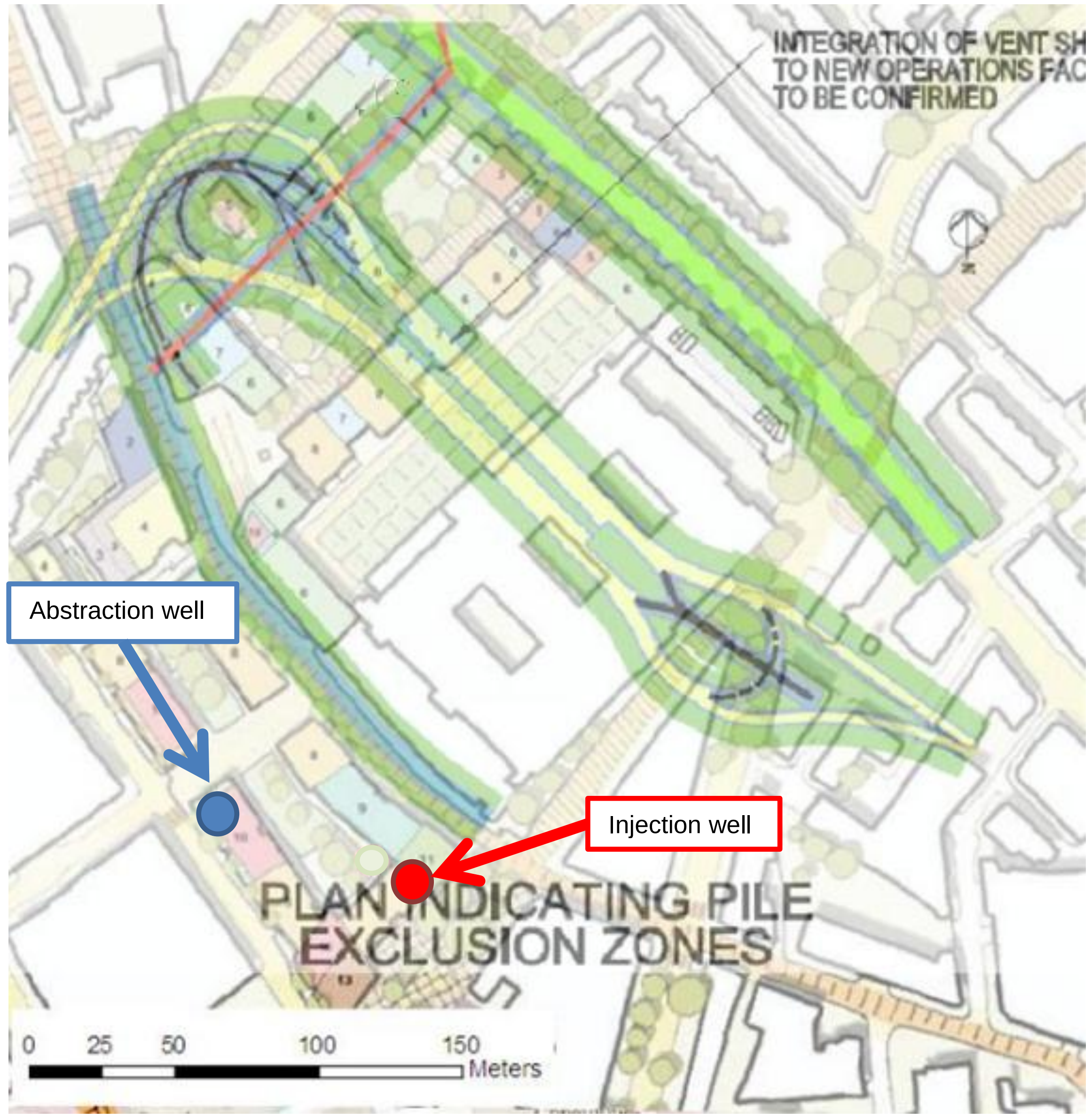


Figure 8.2: Possible locations for the abstraction and injection boreholes for an open loop system (according to Loopmaster study)

Two options are considered viable for the ground interface for inclusion at Phoenix Place.

a) Open loop

An **Open loop** system will typically achieve higher COPs (Coefficient of performance) i.e. more energy extracted from the aquifer per unit of energy required to run the heat pump. Typical COPs have been assumed: COP = 6 in heating mode; COP = 8 in cooling mode. This is subject to confirmation through a test borehole and aquifer modelling at detailed design.

The initial desktop study produced by Loopmaster proposes that a test borehole should be undertaken to inform the location of wells, and a dynamic thermal energy model for the building forms and energy systems proposed, to understand the likely annual operational heating and cooling demands in more detail. An indicative system size of 300kW has been assumed in order to estimate CO_2 savings at this stage, although these aspects would be confirmed after the test borehole and aquifer modelling has been completed.

b) Closed loop

Given that the temperatures of the fluid in a closed loop system are more variable, the efficiency of the system is less reduced and therefore less energy can be extracted per unit of energy used for running the heat pump. Therefore, COPs are less. Recent actual data suggests COP = 4 for both heating and cooling mode.

The addition of a ground source system in conjunction with a CHP would increase complexity as both would provide a proportion of the site's space heating load. Following the energy hierarchy, the CHP contribution would be maximised first. A target of a 50% contribution to the space heating load by the CHP aims to achieve the greatest carbon savings whilst still requiring the engine to run for long hours per day (rather than short periods of peak demand to which it is not suited). Therefore, the remaining 50% could be met by a combination of a ground source system and gas boilers, assumed as 30% and 20% respectively at this stage. The exact contributions would be examined further at detailed design.

The estimated contributions of a CHP and ground source system to thermal loads are illustrated in Figure 8.3.

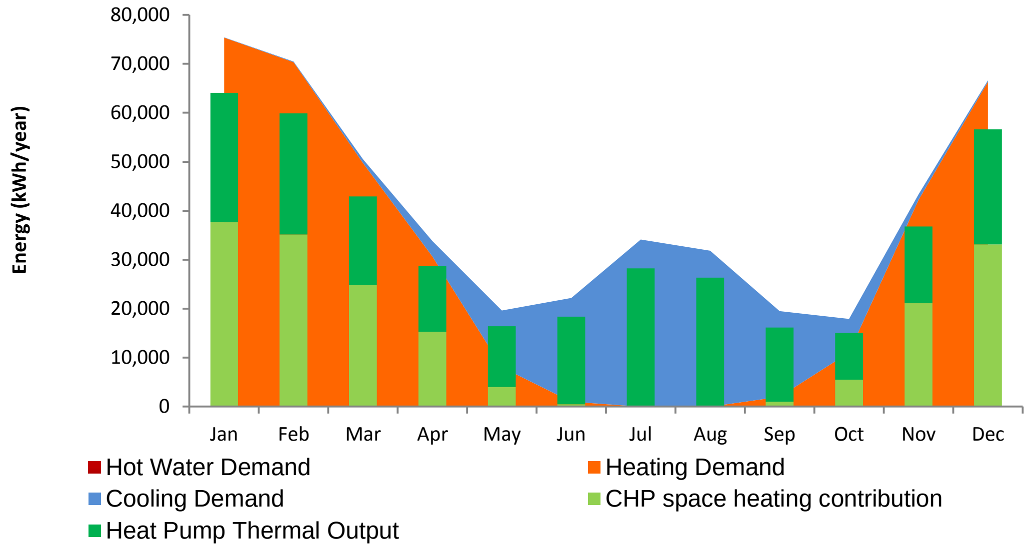


Figure 8.3: Indicative thermal (heating and cooling) output from a Ground Source system (in combination with CHP plant)

Table 8.3: Estimated contribution from Ground Source system at Phoenix Place

	Capacity / COP	Running hours (full load equivalent, hrs/yr)	Annual thermal output for space heating (kWh/yr)	Annual cooling output (kWh/yr)	Net annual CO_2 savings ($kgCO_2$/year)	Net annual regulated CO_2 reduction after CHP (%)
Open loop	368 kW COP heating = 5 - 6 COP cooling = 5 - 8	575 heating 490 cooling	124,000 (~35% of load)	106,000 (~83% of load)	13,600 – 28,200	4 – 7 %
Closed loop	363 kW COP heating = 4 COP cooling = 4	500 heating; 420 cooling	107,000 (~30% of load)	89,900 (~70% of load)	11,500 – 24,200	~ 3 %